

COP29
Baku
Azerbaijan

SPECIAL ISSUE ON

# GLOBAL STRATEGY FOR SUSTAINABLE DEVELOPMENT: INNOVATION, MODELLING AND ALLIANCES

Baku, Azerbaijan – 2025

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AZERBAIJAN TRADE UNIONS CONFEDERATION

AZERBAIJAN ACADEMY OF LABOR AND SOCIAL RELATIONS

# SPECIAL ISSUE ON:
# GLOBAL STRATEGY FOR SUSTAINABLE DEVELOPMENT: INNOVATION, MODELLING, AND ALLIANCES

*This Special Issue of the International Journal of Humanities and Social Development Research (IJHSDR) is dedicated to the 29th Conference of the Parties (COP29) to the UN Framework Convention on Climate Change held in Baku, Azerbaijan, from 11 to 22 November 2024.*

Baku, Azerbaijan -2025

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# NATIONAL SYMBOLS
# OF THE REPUBLIC OF AZERBAIJAN

## The National Flag



The three-colour national flag of Azerbaijan was accepted by the government of the Democratic Republic of Azerbaijan on November 9, 1918. After the collapse of the Democratic Republic on April 28, 1920, and the establishment of the Soviet regime this flag was relinquished in Azerbaijan.

The national flag of the Azerbaijan Republic consists of three equal strips. The upper strip is of blue colour, the middle of red, the lower is green. The blue strip designates the Turkish origin of the Azerbaijan Republic, the red colour- its intention to create a modern state and develop democracy, the green strip-its relation to the Islam civilization. In the middle of the red stripe on both sides of the flag, there is a white-colour crescent and an eight-point star. The relation between the width and the length of the flag is 1 to 2.

# The National Emblem



The government of the Democratic Republic of Azerbaijan declared a competition on the National Emblem of Azerbaijan on January 30, 1920, and made a decision to present the emblem model in May of the same year. However, due to the collapse of the Azerbaijan Democratic Republic on April 28, 1920, the emblem was not approved.

The Supreme Majlis of the Nakhichevan Autonomous Republic discussed the issue connected with the National Emblem and raised petition in the Supreme Council of the Azerbaijan SSR on the declaration of a new competition on the National Emblem of Azerbaijan on November 17, 1990.

The competition was declared by the decision of the Supreme Council of the Azerbaijan Republic on February 5, 1991. Tens of projects of the emblem were presented during the competition of 1991-1992 and it was also proposed to approve one of the projects developed in 1919-1920.

By the Constitutional Law of the Supreme Council of the Azerbaijan Republic, approved on January 19, 1993, one of the projects, developed in 1919-1920 with certain alterations was confirmed the National Emblem of the Azerbaijan Republic.

The National Emblem of the Azerbaijan Republic symbolizes the independence of Azerbaijan. The National Emblem is the image of an oriental shield and a semicircle formed by the branches of an oak-tree and ears resting on it. The shield contains the image of a fire in the centre of an eight-point star against a background of the colours of the National Flag of Azerbaijan.

## The National Anthem of the Republic of Azerbaijan

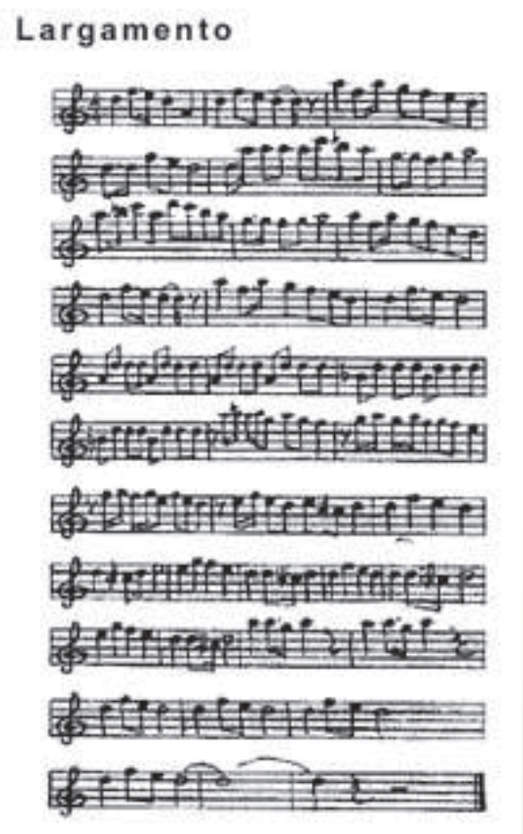
The Council of Ministers of the Azerbaijan Democratic Republic carried out a decision on the development of the National Anthem of the Republic on January 30, 1920, and for this purpose, the Ministry of National Education declared a competition. Yet the collapse of the Azerbaijan Democratic Republic on April 28, 1920, prevented this process.

The Parliament approved a law "On the National Anthem of the Azerbaijan Republic" on May 27, 1992. The law approves the "Anthem of Azerbaijan", created by prominent composer Uzeyir Hajibeyov and poet Ahmed Javad in 1919, the National Anthem of the Azerbaijan Republic. The music (partitur) of the State Anthem of the Republic of Azerbaijan is to be performed in its entirety, by orchestra, choir or orchestra-choir, other vocal means and instruments, and audio devices.

During the performance of the State Anthem of the Republic of Azerbaijan, the citizens of the Republic of Azerbaijan must stand to attention and listen to the anthem to the end or sing along. During the performance of the State Anthem of the Republic of Azerbaijan, foreigners or stateless persons must stand to attention and listen to the anthem to the end. Hailing the peculiarities of the anthem, National Leader Heydar Aliyev said: *"We must love our state anthem and our flag as much as we love ourselves. Because it is a symbol of loyalty, love and affection to our homeland, our nation, and our state."*

**Music by:** Uzeyir Hajibayli
**Lyrics by:** Ahmad Javad

Azerbaijan, Azerbaijan!
You are the country of heroes!
We will die so that you might be alive!
We will shed our blood to defend you!
Long live your three-colored banner!
Thousands of people sacrificed their lives
You're become the field of battles.
Every soldier fighting for you,
Has become a hero.
We pray for your prosperity,
We make sacrifice our lives to you
Our sincere love to you,
Comes from the bottom of our hearts.
To defend your honor,
To hoist your banner,
All the young people are ready.
Glorious motherland,
Azerbaijan, Azerbaijan!



# In Solidarity for a Green World

# COP29 in Baku





*"I want all of you to be nature protectors. Those who cut down trees, those who destroy nature, and those who pollute the environment are the enemies of our society, of all of us. Therefore, build and create."*

**Heydar ALIYEV**
National Leader of Azerbaijan



*"Azerbaijan successfully implements its socio-economic priority of "clean environment, green growth."*

**Ilham ALIYEV**
President of the Republic of Azerbaijan



*"The world faces serious environmental challenges, such as biosphere pollution, freshwater shortages, droughts, and emerging risks to food security. Our country is no exception. We are adjusting our national targets to reduce emissions and transition to clear energy."*

**Mehriban ALIYEVA**
First Vice-president of the Republic of Azerbaijan,
First Lady of Azerbaijan, President of the Heydar Aliyev
Foundation and the Culture Foundation of Azerbaijan,
Goodwill Ambassador of ISESCO



*"There is nothing in the world as valuable as nature. Nature grants us life, so let's learn how to love it."*

**Leyla ALIYEVA**
Vice President of the Heydar Aliyev Foundation
Founder and head of the IDEA Public Union
(International Dialogue for Environmental Action)



# COP29
Baku
Azerbaijan



## Academician Urkhan ALAKBAROV

Editor-in-Chief of the Special Issue titled "Global Strategy for Sustainable Development: Innovation, Modelling, and Alliances" dedicated to the 29th Conference of the Parties (COP29) to the UN Framework Convention on Climate Change held in Baku, Azerbaijan, from 11 to 22 November 2024

Rector of the Academy of Public Administration under the President of the Republic of Azerbaijan, Doctor of Biology, Professor, Full Member of the Azerbaijan National Academy of Sciences, Azerbaijan

In recent years, the extensive reforms implemented in Azerbaijan, which has seen dynamic development across all sectors, have strengthened our country's international reputation and position. As a major oil and gas producer in the region, Azerbaijan is taking significant measures to efficiently utilize alternative energy resources in response to modern global challenges. Reflecting the high regard for our international initiatives in this field, the decision has been made to hold the 29th session of the United Nations Framework Convention on Climate Change Conference of the Parties (COP29) in Azerbaijan.

Azerbaijan has emerged as a leading advocate for global initiatives in "green energy," decarbonization, and hydrogen production. The roadmap for renewable energy in Azerbaijan was established with the "State Program on the Use of Alternative and Renewable Energy Sources in the Republic of Azerbaijan," approved by President Ilham Aliyev on October 21, 2004.

Following its ratification of the Paris Climate Agreement, Azerbaijan committed to a 35% voluntary reduction in greenhouse gas emissions by 2030, compared to 1990 levels, a target that has now increased to 40%. Among Azerbaijan's national priorities for socio-economic development by 2030 is its ambition to become a "clean environment and green growth" country, emphasized by designating liberated territories and the Nakhchivan Autonomous Republic as "green energy" zones, as well as naming 2024 the "Year of Solidarity for a Green World."

The decision to host COP29, one of the world's most prestigious events, highlights Azerbaijan's political and economic influence, as well as its strong potential in alternative energy production. President Ilham Aliyev's May 3, 2021 decree to establish a "green energy" zone in the liberated areas reflects a modern, forward-looking approach to the reconstruction and revitalization of these regions.

Calculations indicate that Azerbaijan's onshore wind and solar energy potential exceeds 27 gigawatts, while offshore wind capacity in the Caspian Sea is estimated at 157 gigawatts. The wind, solar, and hydro energy potential in Karabakh and Eastern Zangezur exceeds 10 gigawatts, which will not only improve the ecological environment and boost tourism appeal but will also significantly enhance Azerbaijan's capacity for electricity exports. A major goal of Azerbaijan's green energy initiatives is to save considerable volumes of natural gas currently used for electricity generation and to increase exports to Europe.

In June of this year, as part of our efforts to prepare for COP29, we launched a project for a special scientific publication titled "Global Strategy for Sustainable Development: Innovation, Modelling, and Alliances," for which I serve as Editor-in-chief. This issue defines COP29's goals and examines key aspects for selecting measurement methodologies. Leading up to its release, a series of events and formal presentations were conducted both domestically and internationally.

To ensure the high-level organization of COP29 and to contribute to enhancing Azerbaijan's international image in this area, we recognized the need for collective mobilization.

I am confident that the international status of our special scientific issue "Global Strategy for Sustainable Development: Innovation, Modelling, and Alliances," will make a meaningful contribution to the global efforts supporting COP29.

I would like to once again express my heartfelt gratitude to everyone who participated in this project, supported us, and contributed to making this publication a reality.



## Sahib MAMMADOV

Project Organizer for developing the Special Issue titled "Global Strategy for Sustainable Development: Innovation, Modelling, and Alliances" dedicated to the 29th Conference of the Parties (COP29) to the UN Framework Convention on Climate Change held in Baku, Azerbaijan, from 11 to 22 November 2024

Chairman of the Azerbaijan Trade Unions Confederation (ATUC), Azerbaijan

Azerbaijan's election as host to the 29th Session of the Conference of Parties to the United Nations Framework Convention on Climate Change (COP29) reflects the trust and confidence of the international community in our country. This is another embodiment of the great success of President Ilham Aliyev's foreign policy, a continuation of the achievements of Azerbaijan such as chairmanship of the Non-Aligned Movement (NAM) and membership in the UN Security Council. The participation of more than 76,000 participants from 196 countries, including 80 presidents, vice presidents, and prime ministers, is an indication of the global importance of COP29. World leaders, officials, experts, and the media highly appreciated Azerbaijan's excellent organization of the conference. The professional organization of the event and the creation of equal opportunities for participants were appreciated by the international community. Hosting COP29 is an important milestone in Azerbaijan's transition to a "green economy." Our country, which plays the role of a bridge between North and South, has created the conditions for taking important steps towards achieving global climate goals.

I would like to note that in September, an international conference on the topic "Climate Change and Just Transition: The Role and Activities of Trade Unions" was held in Baku, jointly organized by the ATUC, the International Labour Organization (ILO), the International Trade Union Confederation (ITUC), and the Pan-European Regional Council (PERC). The event brought together leaders of various international and regional trade unions, as well as relevant representatives from European, Asian, and African countries. The discussions covered climate change, mitigating its impacts, creating "green" jobs and ensuring a just transition, and exchanged experiences and ideas.

Within the framework of COP29, the Azerbaijan Trade Unions Confederation, together with the UNFCCC, also organized the "Strategic Day for Trade Unions" event. The event, attended by trade union representatives from different countries of the world, held thematic sessions discussing the mobilization of financial resources to combat climate change, the Agreement on a New Collective Quantitative Target on Climate Finance, and new trends in labor rights.

I would like to emphasize the initiative of the Azerbaijan Academy of Labor and Social Relations (AALSR), Dokuz Eylul University in Turkiye, Nanjing Communication University in China, and the Global Cooperation and Analytical Research Center Public Union. Together, the scientific publication “Global Strategy for Sustainable Development: Innovations, modeling and alliances" was prepared. The articles in the publication reflect the goals of COP29 and explore methodologies for achieving these objectives.

"The Global Strategy for Sustainable Development: Innovations, modeling, and alliances" international publication is the result of creative labor.

I would like to express my gratitude to everyone involved in its preparation.



## Academician Isa HABIBBAYLI

President of the Azerbaijan National Academy of Sciences, Azerbaijan

### On the path of sustainable development strategy and modernization

The 21st century has introduced new directions for the development of the world. The general concept of scientific and technological progress, which was characteristic of the 20th century, has evolved in the new historical era, reaching the level of shaping a sustainable and resilient development strategy and expanding the modernization movement. The world order, which previously existed as an information society, has transformed into a digital society in the 21st century.

At the current stage, it is impossible to imagine modern development without artificial intelligence and a digital society. Modernization, artificial intelligence, digital development, and green technologies have been brought to the forefront by the Fourth Industrial Revolution, which defines the mark of the 21st century.

In the Republic of Azerbaijan, the transition from scientific and technological progress to innovation and modernization, as well as from the information society to the digital society, has occurred as a real and natural process of the country's sustainable and resilient development strategy.

President of the Republic of Azerbaijan, Ilham Aliyev, evaluates the current realities and potential of the country in close connection with contemporary development trends in the global world and opens new horizons with the decisive steps he takes to move the country forward.

The strategy and national priorities declared at the state level for the near and distant periods successfully contribute to accelerating the development dynamics of our country and direct it towards greater goals.

Due to all this, the level of development in the Republic of Azerbaijan not only coincides with the new development trends of the modern world, but in many respects even surpasses the processes taking place in the world.

COP29, which was successfully held in our country under the leadership of the President of the Republic of Azerbaijan Ilham Aliyev, is considered a magnificent event of the 21st century.

The high-level organization of the 29th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change made Azerbaijan the largest dialogue area of the modern world in the new historical era.

The most pressing issues and challenges of the 21st century related to global climate change and green transformation were addressed to the world from the stage of COP29.

The Republic of Azerbaijan is setting a true example in addressing the challenges posed by global climate change. The alignment between the objectives outlined in the "Year of Solidarity for a Green World," proclaimed by President Ilham Aliyev, and the priorities of COP29 has led to the establishment of a new stage of formalization in the country—one based on climate action and the green digital development.

The Republic of Azerbaijan has become the most modern and exemplary country in the world in terms of alternative energy centers, green energy, smart technologies, and green economy. Azerbaijan presents the world with an example of a green civilization of a new stage of development.

Among the significant outcomes of COP29 is the emphasis on ensuring the collaborative interaction of state institutions, the private sector, civil society, public organizations, and youth in shaping the modern level of development in the new historical era, as well as strengthening the ties between them.

The special scientific publication, titled ""Global Strategy for Sustainable Development: Innovation, Modelling, and Alliances," initiated by the Azerbaijan Trade Unions Confederation, is an "smart" publication that scientifically and practically reflects the ongoing processes in artificial intelligence and the digital society in specific directions during the current historical stage, while forecasting future development.

The presented special scientific publication, is also significant in conveying the experience of the Republic of Azerbaijan to the international community on the basis of contemporary development trends during the era of global climate change.

The Republic of Azerbaijan is an active and leading member of the digital development society.

The Republic of Azerbaijan is a developed green civilization country of the modern era.

The Republic of Azerbaijan is the main dialogue arena for transformations and challenges in society.

This special scientific publication, titled "Global Strategy for Sustainable Development: Innovation, Modelling, and Alliances", holds great importance in creating new opportunities for effective dialogue between the Republic of Azerbaijan and its partners and like-minded entities worldwide.

This is a significant contribution to the development of the digital society and global dialogue by the Azerbaijan Trade Unions Confederation, which has already successfully started the period of renewal and reform.



## Academician Ziyad SAMADZADA

Deputy of the Milli Majlis of the Republic of Azerbaijan

Doctor of Economic Sciences, Professor, Full Member of the Azerbaijan National Academy of Sciences

Chairman of the Azerbaijan Economists' Union

Discussions on organizing accounting systems related to the "transition to green energy" and the "green economy" are both necessary and highly responsible tasks. Hosting the 29th session of the Conference of the Parties to the UN Framework Convention on Climate Change (COP29) in Baku is one of the most significant events confirming Azerbaijan's growing prestige on the international stage.

Undoubtedly, it is a source of pride for our nation that Azerbaijan—a country with extraordinary contributions to the global oil industry—is now hosting a pivotal summit dedicated to the transition to green energy and the development of a green economy, aimed at mitigating the negative effects of climate change.

It must be acknowledged that the terms "green energy" and "green economy" are relatively new in scientific literature and media. Until recent years, the focus on using natural resources while adhering to environmental protection principles was not a primary concern. For decades, issues such as emissions from the production of billions of tons of coal, oil, and construction materials, the growth of chemical and metallurgical industries, deforestation, desertification, and the spread of landfills near urban areas were largely ignored by many countries.

Now, at this new stage, we must consider the meaning and scope of concepts such as green energy, the green economy, the "green budget," and "green finance," in line with modern global challenges. However, forming a unified understanding of these terms is not an easy task. Each term reflects only a specific aspect of real-life, environmental conditions, or economic activity, making it challenging to define their boundaries comprehensively. Despite these difficulties, it is possible to identify the objectives and essence of the transition to green energy and the green economy in specific directions.

The key point is that transitioning to green energy and exploring opportunities in the green economy should be viewed as a vital part of the state's overall economic policy. This approach will support the sustainable and high-quality growth of the national economy.

In the early 20th century, Azerbaijan accounted for 50% of the world's oil production. Under difficult conditions, without advanced technology, we provided oil to the world. During World War II, the victory over Nazi Germany was achieved largely thanks to Baku oil. In 1949, Azerbaijani oil workers discovered the Oil Rocks—the first offshore oil platform in the world—further strengthening the Soviet Union's energy base. Baku's oil has always contributed to humanity's development, our nation's progress, and the economic power of a giant state like the USSR.

As we address the challenges of transitioning to green energy and developing the green economy, we must consider global trends, including the pressures exerted by developed countries on developing nations and their often-bitter consequences. Our calculations show that countries with populations 20-25 times larger than Azerbaijan's account for just 0.1% of global energy production. Interestingly, this figure is the same for Azerbaijan, with a population of 10 million, highlighting the country's significant energy potential. As an independent state, Azerbaijan will continue to develop its energy sector, including its oil and gas complex, using modern technologies.

Today, in the United States and Western countries, per capita electricity production and labor productivity in industry and agriculture are 40-50 times higher than in underdeveloped countries. Therefore, when addressing issues like the transition to green energy and climate finance, the United Nations and developed countries must take this disparity into account.

Azerbaijan's policy is based on peace, security, and mutually beneficial, fair cooperation with other nations. Some Western politicians forget that if resource-rich but economically underdeveloped countries did not provide oil, coal, and other raw materials, their own development would not have been possible.



## Zahid ORUJ

Chairman of the Board of the Social Research Center (SRC), Azerbaijan

Deputy of the Milli Majlis of the Republic of Azerbaijan

In 2024, our country entered a new historical stage of its independent statehood by achieving a diplomatic triumph—being selected to host COP29, one of the world's largest and most significant global climate conferences. Throughout the entire year, not only during the days of the conference, Azerbaijan called on the international community to unite under the motto "Solidarity for a Green World" and to mobilize efforts in the fight against climate change.

The 29th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change — COP29 — concluded with achievements that will be inscribed in the history of climate diplomacy in golden letters. The climate decisions adopted under the name of our capital, Baku, have entered world history and have been dubbed the "Baku Breakthrough." The true significance of these successes will be repeatedly recognized by both us and the entire world as we compare them with the outcomes of future COP conferences.

The outcomes of the global activities conducted at COP29 are currently being discussed worldwide. COP29 brought together United Nations agencies, international organizations, multilateral development banks, climate funds, the private sector, civil society, key coalitions, numerous partners of Azerbaijan, strategic allies, and other stakeholders, as well as COP Presidencies and Parties. More than ten internationally significant decisions were adopted. The importance of these crucial decisions, global initiatives, and calls will be analyzed and studied for decades to come.

There is a pressing need and demand for scientific research, comprehensive studies, and project implementation regarding the historic significance of the COP29 Azerbaijan conference in ensuring local, regional, and global climate security, as well as in realizing the "green transition" strategy. Within this context, the publication of an international special scientific issue titled "Global Strategy for Sustainable Development: Innovation, Modelling, and Alliances," initiated by the Azerbaijan Trade Unions Confederation in cooperation with the Azerbaijan Academy of Labor and Social Relations, Dokuz Eylül University in Turkiye, Nanjing Communication University in China, and the Global Cooperation and Analytical Research Center Public Union holds great importance.

The articles included in this special issue, contributed by scholars and researchers from various universities in Azerbaijan, Turkiye, Pakistan, the People's Republic of China, India, Russia, Estonia, and Nigeria, reflect and define the goals of COP29. These scientific works attract attention due to their scientific quality and relevance. This publication examines issues such as climate change and climate security through the lens of scientific research, provides detailed analyses, and puts forward proposals addressing future challenges.

It should be noted that "climate security," while a relatively new concept, holds strategic significance. Climate security is a concept that ensures the safety of populations and states, as well as the protection of the environment, in the context of climate change. Climate change is recognized by many countries not only as a national security issue but also as a factor that exacerbates various types of conflicts and security risks.

According to the United Nations report on climate change, measures to address climate security must be harmonized with conflict prevention and peacebuilding efforts. Investments in climate action are essential in conflict and post-conflict settings. The Sixth Assessment Report of the United Nations (UN) Intergovernmental Panel on Climate Change (IPCC) emphasizes that climate solutions are critically important in regions prone to conflicts that are vulnerable to climate change.

Overall, climate change and environmental degradation pose an existential threat to every country and to the world at large. To overcome these challenges, a new development strategy, defined as the green transition, has emerged. The Azerbaijani government supports the green transition not merely because the country is a Party to the United Nations Framework Convention on Climate Change, but as part of its strategic political course aimed at designing and implementing reforms that contribute to achieving green energy and economic growth targets over recent decades.

Even prior to COP29, our country had already begun developing the necessary mechanisms and establishing essential processes within central and local governance structures to implement green policies effectively.

Green transitions not only ensure the preservation of socio-economic systems within planetary ecological boundaries but also enable increased prosperity and well-being through a new sustainable economic model. This is not merely about shifting to alternative energy, reducing the demand for oil, gas, coal, and other depleting fuel types, or achieving net-zero carbon emissions. Primarily, it involves moving away from the monopoly on 278 years' worth of oil—extracted industrially in our country—and transitioning to a completely different resource: green energy. This shift holds exceptional significance, considering oil's critical role in the outcomes of two world wars, including the First and Second Karabakh wars.

Despite being rich in energy resources, Azerbaijan has always prioritized the use of renewable energy sources. One of the fundamental goals of the state's energy security policy is to strengthen the utilization of renewable energy within the country.

At COP29, Azerbaijan presented its initiatives to the global community regarding the transition to green energy.

Azerbaijan, actively engaged in combating climate change, is among the countries with high potential in renewable energy sources. The technical potential of renewable energy in the country is estimated at 135 GW on land and 157 GW offshore. The economic potential of renewable energy sources is estimated at 27 GW, including 3,000 MW from wind energy, 23,000 MW from solar energy, 380 MW from bioenergy, and 520 MW from mountain rivers.

The current installed capacities include 1,301.8 MW of hydropower (comprising 35 stations, of which 24 are small hydroelectric power plants), 66.4 MW of wind power (8 stations, including 3 hybrid), 37.7 MW of bioenergy (2 stations, including 1 hybrid), and 281.9 MW of solar power (13 stations, including 3 hybrid).

On May 3, 2021, the President of the Republic of Azerbaijan, Ilham Aliyev, signed an order "On measures to establish a green energy zone in the liberated territories of the Republic of Azerbaijan". These areas are planned to be transformed into a "net-zero emissions" zone by 2050.

To conduct research and prepare proposals related to hydrogen production and utilization in the Republic of Azerbaijan, a Working Group composed of representatives from relevant agencies was established under the co-chairmanship of the Ministry of Energy of the Republic of Azerbaijan.

By liberating lands that were under occupation for more than thirty years and whose nature was devastated, Azerbaijan has made an unparalleled contribution not only to the climate and ecological security of the region but also to that of the world at large. In this regard, investigating and publicizing Armenia's eco-fascist policies that ravaged our lands for three decades, as well as exposing the realities of ecological crimes, represent one of the most crucial tasks ahead within the climate context. Efforts have begun to establish Armenia's image not only as a perpetrator of military and war crimes but also as a country responsible for ecological crimes.

The aforementioned and other related issues necessitate the regular conduct of scientific research to address climate challenges that threaten the future of humanity. We hope that this Special Scientific Issue — initiated and organized by the Azerbaijan Trade Unions Confederation in cooperation with the Azerbaijan Academy of Labor and Social Relations, Dokuz Eylül University in Turkiye, Nanjing Communication University in China, and the Global Cooperation and Analytical Research Centre Public Union—will contribute to enhancing the global efforts made for COP29 held in Azerbaijan, strengthen their sustainability, and provide scientific support for future COP events.

This Special issue, covering key research areas within the framework of climate change under COP, will play a vital role in improving the efficiency of scientific research, increasing the scientific capacity of readers, exploring academic resources, and serving as a primary reference for researchers.




## Misir MARDANOV

Doctor of Sciences in Physics and Mathematics,
Professor, Correspondent member of Azerbaijan National Academy of Sciences, Azerbaijan
Director of the Institute of Mathematics and Mechanics, Ministry of Science and Education of the Republic of Azerbaijan

Editor-in-chief of "Proceedings of the Institute of Mathematics and Mechanics" Journal, Azerbaijan


The holding of the 29th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP29) in our country, and holding of such a prestigious event in Baku, reflects global trust in the country and its significant efforts in addressing the climate change. Hosting such an event is very important in terms of promoting Azerbaijan's interests in the world, implementing our country's mission to support the development of peace and stability in the international community, and establishing and developing new cooperative relations with many countries. Today, at a time when geopolitical conflicts are intensifying in the world, Azerbaijan's hosting of such an important event plays an important role in bringing together valuable members of the world community, playing a central role, creating a common dialogue between countries on key issues such as climate finance and energy transition, and implementing its mission of supporting peace in the world.

The decision to hold COP29 in Baku is also an indicator of global support for Azerbaijan's "green energy" policy. Thus, on December 25, 2023, President Ilham Aliyev signed a decree "On declaring 2024 the "Year of Solidarity for a Green World" in the Republic of Azerbaijan" in order to strengthen international solidarity in the global fight against climate change. The order identifies one of Azerbaijan's five national priorities for socio-economic development by 2030 as "A country with a clean environment and green growth" and, in accordance with that priority, issues such as improving the environment, restoring and increasing greenery, and ensuring the efficient use of water resources and sustainable energy sources are mentioned. It emphasizes environmental restoration, reforestation, and efficient use of water and sustainable energy resources, particularly solar and wind power, where Azerbaijan has significant potential.

COP29 will help attract foreign investment and stimulate the introduction of advanced technologies to our country to realize this potential under better conditions. It also facilitates the expansion and implementation of infrastructure projects, and overall development in this area, can almost be observed.

COP29 supporting Azerbaijan's transition to a green economy is extremely beneficial from an economic perspective for foreign investments.

Our mobilization in organization the COP-29 event at a high level and to make a significant contribution to further enhancing Azerbaijan's international image in this direction was necessary.

Hosting such a prestigious event, Azerbaijan will not only be remembered for its continued contributions to climate change, but will also pave the way for new initiatives in increasing global environmental awareness and responsibility.




## Prof. Dr. Yaprak GULCAN

Dean, Faculty of Business, Dokuz Eylul University, Turkiye


In recent years, we have been feeling the increasing impact of climate change in every aspect of daily live. Climate change, which is increasingly felt all over the world, requires taking responsibility at all levels – individually, socially, nationally, internationally, globally. While advanced technologies offer significant opportunities for humanity, they also pose serious threats in terms of the environment and climate change problems. We all have to take responsibility to build a safer world for ourselves and future generations.

In this period, when we deeply feel the effects of climate change, it is very valuable and meaningful that Azerbaijan, one of the world's leading oil and natural gas producers, is hosting COP29 this year. In today's world, it is almost impossible to imagine a life without using fossil energy sources. On the other hand, it is very crucial to act with the awareness that current situation harms the environment and changes the climate conditions. The fact that the Republic of Azerbaijan is hosting COP29 is an example of high awareness. We also combat climate change with our academic studies. On behalf of Dokuz Eylul University, Faculty of Business Administration, I would like to express my pleasure in collaborating with the International Journal of Humanities and Social Development Research for the publication of the COP29 special issue. As a partner faculty, many of our colleagues have contributed to the special issue of the journal with their valuable work.

I strongly believe that these studies will pave the way for many new research on combating climate change on the eve of and after the COP29 meeting hosted by Republic of Azerbaijan.

At the end of my words, I respectfully and gratefully commemorate the martyrs who sacrificed their lives for the territorial integrity of Azerbaijan. Today, thanks to them, the Azerbaijani flag flies in the skies of Karabakh.

I would also like to thank everyone, who contributed to the realization of this project, especially Dr. Hayala Mammadova, editor of the International Journal of Humanities and Social Development Research, and the valuable academics, who contributed to this special issue. I hope our cooperation will continue on different platforms.



## Chen XI

Vice President of Communication University of China, Nanjing (CUCN), China

Dean of the School of International Education, Communication University of China, Nanjing, China

I am keenly aware of the significance of international cooperation in addressing climate change, particularly in the context of the 29th Conference of the Parties to the UN Framework Convention on Climate Change (COP29), and Azerbaijan's role in these critical discussions. COP29 presents a pivotal opportunity for nations to collaborate on innovative solutions and to advance our commitments toward sustainable development. Azerbaijan, with its strategic position at the crossroads of Europe and Asia, has demonstrated commendable progress in aligning its national policies with global climate goals. The country has not only committed to reducing its greenhouse gas emissions but has also embraced the transition to renewable energy sources, leveraging its rich biodiversity and natural resources responsibly.

As partners in this global dialogue, we must recognize the importance of sharing knowledge and best practices to foster resilient communities and sustainable ecosystems, underscoring a shared vision for a more sustainable future. Chinese universities and research institutions can cooperate with Azerbaijani counterparts to develop courses and research projects related to renewable energy, climate adaptation strategies, and sustainable resource management. This educational collaboration can empower the next generation of climate leaders in both countries, promoting the exchange of knowledge and best practices in addressing climate issues.

We would like to express our gratitude to everyone who contributed to our partnership in this project and wish them continued success.



## Liu SUYUN

Professor, Dean of the School of International Communication, Communication University of China, Nanjing, China

There is an idiom in China: "At the age of thirty, a man should stand on his own feet", which means that when people reach the age of thirty, they should be able to take responsibility and make achievements of their own.

This year, the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP) is expecting the 29th Session. Is it ready to stand up to challenges?

From the year 1992 when the United Nations General Assembly adopted the United Nations Framework Convention on Climate Change, to the year 1995 when the first Conference of Parties was held in Berlin, Germany, and further to the 29th COP hosted in Baku, the Capital of Azerbaijan, people have been stumbling along the path of tackling climate change.

The destination is clear, while the path to reach it is full of twists and difficulties. People are looking forward to a breakthrough at the 29th conference held in Baku, which should pave the way for COP30 next year.

The host country of this year, Azerbaijan, which is also a major energy producer, is an active participant in addressing climate change. Azerbaijan, with its abundant oil and gas resources, is an important energy-producing and exporting country in the world. In recent years, it has proactively adjusted its energy policies and economic structure, embracing a path of green development by vigorously developing renewable energies such as solar power and wind power. Its aim is not only to meet domestic needs but also to export to the European market.

The theme of the Baku World Climate Summit 'In Solidarity for a Green World' showcases the parties' firm determination to achieve their goals in addressing climate change. In Mexico, there is a young girl named Xiye Bastida. She was born in a small town near the capital city, which experiences year-round droughts. One summer the town encountered a flood caused by severe rainstorm, also known as 'extreme weather' in climatology. She was named after her parents' hope for 'gentle rain' to nourish the land. As a result, the girl has become an activist addressing climate change.

She said, “We don’t inherit the land from our ancestors, we borrow it from our children.” Shouldn’t we bear our responsibility for issues on climate change, as reminded by the thought-provoking words of ‘gentle rain’?.

Finally, we would like to express our gratitude to everyone who contributed to our partnership in this project.



## Neil WATSON

International expert and journalist,
United Kingdom

The hosting of COP29 in Azerbaijan is of extreme importance for Baku, Azerbaijan, the South Caucasus and the world. This is the pre-eminent environmental forum where leaders, ministers, business leaders and delegates get down to discuss all facets of pollution, remediation and sustainable practices in a holistic and even-handed manner.

Global warming is an issue that affects us all, and Azerbaijan, as the oldest oil-producing nation on earth, has suffered the effects of pollution more than most. It is apt that COP29 is being hosted in the White City, as this was formerly the Black City, acknowledged as the 'most polluted place on earth' after more than 150 years of unabated mechanised oil extraction.

The oil and gas industry has certainly benefited Azerbaijan, but it has also been a curse. The carcinogens in the atmosphere, earth and watercourses have certainly impacted life quality and life expectancy. It is appropriate that Baku, which has suffered so much, due to international demand for oil and gas, is now spearheading the path towards the adoption of sustainable energy in the South Caucasus by implementing a range of measures, including tax incentives for switching to electric vehicles through to the rebuilding of the desecrated towns and cities in the liberated territories as 'smart cities', powered by solar energy.

Geopolitically, Azerbaijan is perfectly positioned to host such a conference. Located at the crossroads of Europe and Asia, nonaligned and looking to both the East and West for guidance and as its partners, Azerbaijan is well-placed to facilitate change, collaboration and honest dialogue. As it looks beyond the regional conflict that has commandeered vast amounts of its economy for decades and towards a post-war footing, the installation of sustainable concepts and hosting international events is a great development.

Azerbaijan is also located between the Global North and Global South, and is therefore ideally placed to host the dialogue that should assist the Global South in achieving its net zero goals.

The environment affects us all. And COP29 is where guns get set down, animosities are left in the cloakroom and we discuss the concepts that will keep our earth alive.




## Dr.Khayala MAMMADOVA

Project Manager and Founding Editor of the Special Issue titled "Global Strategy for Sustainable Development: Innovation, Modelling, and Alliances" dedicated to the 29th Conference of the Parties (COP29) to the UN Framework Convention on Climate Change held in Baku, Azerbaijan, from 11 to 22 November 2024

Vice-Rector for International Relations, Azerbaijan Academy of Labor and Social Relations (AALSR), Baku, Azerbaijan


The decision to hold the 29th session of the Conference of the Parties (COP29) to the United Nations Framework Convention on Climate Change (UNFCCC) in our country reflects not only the global community's confidence in Azerbaijan but also acknowledges the important work we have done in this field. As President Ilham Aliyev has stated, Azerbaijan's hosting of COP29 is a testament of the country's active role on the international stage.

This event holds immense importance for promoting Azerbaijan's interests globally, fostering peace and stability, and building new avenues for cooperation with various countries. At a time when geopolitical tensions are escalating worldwide, Azerbaijan's role as host to such a prominent event underscores its position as a hub for bringing together key global players. By facilitating dialogue on critical issues such as climate finance and energy transition, Azerbaijan contributes to global peace and solidarity. Addressing global challenges demands a comprehensive approach that aligns with long-term trends, emphasizing the protection and development of human capital—an essential pillar of Azerbaijan's domestic policy.

Azerbaijan's efforts to transition to renewable energy, enhance the circular economy, and promote low-carbon production align perfectly with the nation's broader goal of facilitating a green transition. COP29's selection of Baku as the host city highlights global support for Azerbaijan's "Green Energy" policies. In December 2023, President Ilham Aliyev issued a decree declaring 2024 as the "Year of Solidarity for a Green World" in Azerbaijan, underlining the country's commitment to global climate action. The decree aligns with one of Azerbaijan's five national priorities for socio-economic development by 2030: becoming a country of "clean environment and green growth." Specific actions include environmental restoration, expansion of greenery, and the efficient use of water resources and renewable energy, with Azerbaijan boasting significant potential in solar and wind energy.

By hosting COP29, Azerbaijan has demonstrated its dedication to promoting universal ideals of peace, justice, and sustainable development. Through successful implementation of its strategies, especially in alternative energy, the country has set a positive example on the global stage. In June of this year, under the leadership of the Azerbaijan Trade Union Confederation, and in collaboration with Azerbaijan Academy of Labor and Social Relations (AALSR), Dokuz Eylul University in Turkiye, Nanjing Communication University in China, and the Global Cooperation and Analytical Research Center Public Union we undertook a significant initiative. Together, we prepared a special scientific issue titled Global Strategy for Sustainable Development: Innovation, Modelling, and Alliances. This publication outlined COP29's objectives, explored innovative methodologies, and highlighted crucial aspects of measuring progress. Leading up to its release, we organized numerous events and official presentations locally and internationally.

These initiatives have played a vital role in engaging non-governmental organizations, civil society groups, and international bodies in the COP29 process. By fostering dialogue, strengthening partnerships, and sharing expertise, we have supported the active involvement of stakeholders in delivering tangible outcomes. This collaborative effort strengthens collective commitment, accountability, and solidarity in addressing the climate crisis.

Hosting such a prestigious event has not only reinforced Azerbaijan's legacy of meaningful contributions to global climate change discussions but has also paved the way for new initiatives to enhance ecological responsibility. The execution and presentation of our publication, Global Strategy for Sustainable Development: Innovation, Modelling, and Alliances, stands out as a remarkable achievement.

On behalf of the Organizing Committee, I sincerely thank all local and international organizations and their leaders for their support throughout this journey. I extend my heartfelt gratitude to His Excellency President Ilham Aliyev for his leadership in making COP29 a success, as well as to everyone who played a role in the event's achievements and the publication of this important work. Azerbaijan has showcased its capability to facilitate meaningful, result-oriented dialogue, drive the COP process forward, and implement effective climate actions, culminating in a highly successful outcome for COP29.

# TABLE OF CONTENTS

FOREWORD ..... 36

COP29 in Azerbaijan: Historical Breakthrough in Global Climate Diplomacy ..... 43

Photo Gallery - COP29, Baku-2024 ..... 114

Introduction to the Special Issue ..... 138

Urkhan ALAKBAROV
The Sustainable Development strategy of the Republic of Azerbaijan as a tool for successful Energy transition ..... 140

Yeqianqian LIN, Jiajun BAO, Yi XING, Xinxin ZHANG
The Empowerment of new-quality productive forces in China's green, low-carbon, and circular economic system under Global Climate Change ..... 144

Vusal GASIMLI, Gunay GULIYEVA, Rashad BAGHIROV
Comparative Analysis of National Green Economy Strategies: Successes, Challenges, and Lessons Learned ..... 152

Nesrin DEMIR, Tuğba SINGÖR
The role of Azerbaijan in Green Energy Transition ..... 161

Özge ÖZGEN, Banu DEMİREL, Büşra AYKUT
Understanding the consumer responses to Greenwashing in fast-fashion industry ..... 170

Nathan UDOINYANG
The impact of agriculture, non-renewable energy, international trade and economic growth on Nigeria environmental sustainability ..... 180

Efe Cağlar ÇAĞLI, Nazif MANDACI, Birce TEDİK KOCAKAYA, Pınar Evrim MANDACI
Food security, Climate change concerns and agriculture commodities ..... 187

Damla UMUR, H. Kutay AYTUĞ
Evaluation of Germany's wind energy implementations in the context of EU energy policies ..... 195

Muhammad TARIQ
Assessing the preference and utilization of Green spaces for social harmony in Peshawar ..... 204

Fatma DILMEN, Senem GÜRKAN
A Green Gender Analysis on "Women's empowerment strategy document and Action plan (2024-2028)" of Turkiye ..... 210

Raja Bahar KHAN SOOMRO, Syed Hassan ALI SHAH, Abdul Basit SOOMRO
Do we teach environmental education the way we should? A critical discourse analysis (CDA) of science subject text books-Pakistan ..... 217

Oni Oludolapo OLUMIDE
Internet of things and artificial intelligence: The key to Sustainable development in developing countries ..... 228

Magsud GULIYEV
Clean energy transition dilemma: Future value of Green investment in Azerbaijan ..... 238

Shams ABDULLAYEVA, Ulviyye SANILI AYDIN
Reopening the old chapter in bilateral relations: Russian-Turkish cooperation in Climate change ..... 246

Faig AGHABALAYEV
Azerbaijan as a regional leader in Green energy transition ..... 251

Dilara SÜLÜN
An assessment of the European Green deal, Green economy and Green growth in Europe ..... 255

Elvin I. AZIZBAYOV, Gulnar R. MIRZAYEVA
COP29 and Azerbaijan: Digital technologies and Green energy in Global climate governance ..... 261

Aminul ISLAM
Cooking a chicken Curry by travelling all over the world: An ethnographic observation of consumption and environmental aspect ..... 268

Burçak Müge VURAL, Irem Aşkar-KARAKIR
Mapping out Vulnerability: Climate change and the Syrian Refugees in Lebanon ..... 274

Jabbar AHMED
The role of culture and traditional knowledge in Climate change: Insights from Jammu and Kashmir ..... 281

Afife Duygu AKDENIZ, Seçkin AYDIN
Intellectual capital, Export Performance, Sustainable Production: Analysis on Leading Turkish Exporters ..... 288

Ulker MAMMADOVA
Azerbaijan's Ecotourism perspectives: Dependence on the TTCI Index ..... 294

Tugcan DURMUSLAR, Gozde KAYA
Going beyond the limits of traditional right of Self defence: Preemptive use of military force in international law ..... 300

Sinem ABKA, Zühal ÜNALP ÇEPEL
Revisiting EU migration policy with Postfunctionalism: Shifting focus from sustainability ..... 308

İrem Aşkar- KARAKIR
Climate Justice and the Eastern Mediterranean Arab States: The Cases of Egypt and Jordan ..... 316

Abdul Rasool KHOSO, Shahnaz BHUTTO, Farhan AKHTAR
Strategic approaches promoting Sustainable Development in Solid Waste Management based on Circular Economy: A Literature Review ..... 323

ANNEX ..... 334

ACKNOWLEDGEMENTS ..... 343

# FOREWORD

Environmental and ecological issues are among the most important and pressing challenges of our time. Matters such as global climate change, biodiversity loss, ecosystem disruption, and water and air pollution raise serious concerns not only in developed countries but also in developing nations, including Azerbaijan.

The 20th century is marked as a dark chapter in human history, characterized by humanity's harsh treatment of nature and its resources. The daily increase in the number of rockets in outer space, ongoing research, the First and Second World Wars, conflicts between various countries that persist to this day, emissions from factories, plants, and industrial complexes, radioactive contamination, and the use of chemical agents in agriculture have polluted the atmosphere, hydrosphere, and lithosphere, disrupting the ecological balance of the biosphere and ecosystems. Several leading countries of the world have sought to implement measures to address these issues, establish relevant organizations, and enhance the capacity of existing ones.

Azerbaijan is a country endowed with rich natural resources, diverse climatic zones, and unique biodiversity. However, in recent years, increasing human activity, urbanization, industrialization, and the demands of the agricultural sector have disrupted the balance of ecosystems, threatening the preservation of many species. In the internal policies of the Azerbaijani state, priority issues include ensuring environmental safety and preventing the pollution of the Caspian Sea and the air.

As a result of the successful implementation of the socio-economic development strategy of our Great Leader Heydar Aliyev, our Republic has already become a leading country in the region.

The issue of ensuring our people live in a natural and healthy environment and the sustainable use of natural resources has always been a priority for Ilham Aliyev. From this perspective, the ongoing socio-economic reforms, as well as the steps taken to improve the environmental situation in our country, serve as vivid examples of this commitment.

The Great Leader Heydar Aliyev once said: *"One of the primary tasks before us is to treat the rich resources bestowed upon our country by nature with special care, preserving such unique treasures for the future of humanity."* Throughout his leadership in Azerbaijan, the National Leader consistently ensured that relevant work was carried out to address environmental issues, along with measures aimed at tackling challenges in this field.

Under the leadership of the National Leader Heydar Aliyev, issues such as addressing environmental problems and improving the surrounding environment were integrated into the country's long-term development strategy. Heydar Aliyev was a leader who always stood as a guardian of nature. Reflecting on the early 1990s, he once said: "*...If someone cuts down a healthy tree, they are not only betraying their people, their nation, and their country – they are betraying their family and themselves."*

During Heydar Aliyev's leadership of Azerbaijan from 1969 to 1982, the Republic adopted 8 laws and 32 decrees related to environmental protection and the rational use of natural resources. The decision to green the capital city of Baku was also made in 1971, and the relevant work was done. Additionally, the Shirvan (1969), Aghgol (1978), Ismayilli (1981), and Basitchay (1974) nature reserves and many national parks were established in the regions.

Since gaining independence, Azerbaijan has adopted a serious approach to environmental issues. This approach aims to protect the environment, preserve biodiversity, and promote sustainable development. The country's environmental policy is implemented within the framework of national legislation and international cooperation.

Since the years of independence, environmental policy in Azerbaijan has begun to be implemented at the international level. In 1995, Azerbaijan joined the UN Framework Convention on Climate Change (UNFCCC), on July 18, 2000, it acceded to the Kyoto Protocol, and in 2002, it joined the Convention on Long-range Transboundary Air Pollution (LRTAP). The adoption of the "Environmental Safety" law in 1999 was also one of the important steps in this area. This law aims to protect the environment, restore ecosystems, and safeguard human health. Key issues under the legislation include biodiversity conservation, natural resource management, and environmental protection.

Over the past 20 years, Azerbaijan has made enormous progress in addressing environmental issues and creating a favorable ecological environment. Laws "On Environmental Education and Public Awareness" (2003) and "On Environmental Protection" (1999) were adopted by Milli Majlis and approved by the President of the Republic. Additionally, the "Comprehensive Action Plan for Improving the Environmental Situation in the Republic of Azerbaijan for 2006-2010" was implemented. In accordance with the President's instructions, financial resources were allocated to improve the environmental condition of the Bibi-Eibat area of the Baku Bay, the surroundings of Heydar Aliyev International Airport, lakes on the Absheron Peninsula, oil-contaminated lands, areas flooded by formation waters, and regions contaminated with industrial waste, as well as Baku according to the solid waste management scheme. Additionally, other measures were implemented, and issues were addressed in a timely manner.

The year 2010 was declared the "Year of Ecology" in Azerbaijan. It is noteworthy that environmental education has been included in school and university curricula for the environmental awareness of the future generation.

In recent years, the application of approaches based on the principles of sustainable development has expanded worldwide. The UN Sustainable Development Goals (SDGs) were adopted by 193 countries as of 2015. These goals include areas such as eradicating poverty, ensuring equality, combating climate change, and conserving biodiversity. One of the core principles of sustainable development is conducting economic activities without harming ecosystem health. This promotes the development of renewable energy sources, environmentally friendly production methods, and sustainable agricultural practices. For example, the use of solar and wind

energy helps reduce the carbon footprint while enhancing energy security. Close cooperation between governments, non-governmental organizations, and society is essential for achieving sustainable development. Joint global efforts to combat climate change are one of the main priorities of sustainable development.

According to statistics up to 2020, Azerbaijan has joined more than 30 international environmental conventions. These conventions play an important role in fulfilling the country's international environmental obligations. For example, the UN Framework Convention on Climate Change, the Convention on Biological Diversity, and the Convention to Combat Desertification contribute to the international recognition of Azerbaijan's environmental policy. International cooperation plays a crucial role in Azerbaijan's environmental policy. At the same time, our country implements projects that align with the principles of “green economy”. These projects are aimed at promoting sustainable development.

Unfortunately, Karabakh, which had been under Armenian occupation for 30 years, was subjected to environmental terrorism. As part of the economic development course defined by the President of the Republic of Azerbaijan, Ilham Aliyev, regarding the territories liberated from occupation, one of the main directions is to transform these areas into a “green energy” zone. At the meeting on the economic results of 2020, following the 44-day Patriotic War, on January 6, 2021, the President of the Republic of Azerbaijan, Ilham Aliyev, presented a strategic vision for the creation of a green energy zone in the liberated territories, announcing that there was sufficient renewable energy potential in these areas.

According to the Order No.2620 dated 3 May 2021 by the President of the Republic of Azerbaijan on measures to establish a “green energy” zone in the liberated territories of the Republic of Azerbaijan, an international consulting company was involved. In cooperation with the Japanese company TEPSCO, a relevant Concept document has been prepared.

The purpose of the Concept document is to provide the area with environmentally friendly green energy by using the existing high renewable energy potential in the liberated territories and to formulate proposals by studying the prospects for the application of environmentally friendly and energy efficient green technologies. For this purpose, energy demand models in the liberated areas have been developed by using different scenarios.

As part of the Green Energy Zone, electricity generation from renewable energy sources, energy efficiency measures, use of electric vehicles, installation of renewable energy facilities (especially solar panels) on the roofs of buildings, use of solar energy-based LED lamps in the lighting of streets and roads, use of renewable energy technologies in heating, cooling and hot water supply, application of smart energy management, measures such as waste energy targeted management are designed.

Currently, reconstruction and construction work is underway in the territories liberated from occupation. Karabakh, Eastern Zangezur, and the Nakhchivan Autonomous Republic have been declared “green energy” zones. Azerbaijan is implementing projects aimed at developing renewable energy sources. Solar and wind energy are focused on enhancing the country's energy security and mitigating the effects of climate change. The development of renewable energy projects also provides opportunities for creating new jobs and diversifying the economy.

The environmental policy of the National Leader is successfully continued by President Ilham Aliyev. A number of climate change mitigation strategies are being implemented in Azerbaijan. The state is focused on expanding international cooperation in this area. Ensuring sustainable and balanced development of the country's cities and regions, as well as the restoration of territories liberated from occupation, ensuring further development, creating the necessary infrastructure, and ensuring an environmentally safe environment are key components of the farsighted policy of our President and a vivid example of political continuity.

Recently, a number of initiatives in the field of environmental protection have been put forward in Azerbaijan. The country has joined international environmental conventions, strengthened its environmental legislation, and started implementing conservation programs. However, the approach of each individual in society to environmental issues and their active participation are also essential in these efforts. Thus, the formation of a future “green” Azerbaijan requires the active involvement not only of the state but also of every member of society. Increasing environmental awareness, protecting ecosystems, and promoting sustainable development are crucial for achieving this goal.

The Republic of Azerbaijan, as a reliable partner of the international community, always makes its valuable contribution to the fight against the consequences of climate change. One of the national priorities for Azerbaijan's socio-economic development until 2030 is defined as “a country of clean environment and green growth”. In the “Azerbaijan 2030: National Priorities for Socio-Economic Development”, the President's decree outlines five national priorities for the country's socio-economic development over the next decade. These include “A sustainable, growing competitive economy”, “A dynamic, inclusive, and socially just society”, “Competitive human capital and modern innovation space”, “A great return to the liberated territories”, and “A country with a clean environment and green growth”. By decree of President Ilham Aliyev, 2024 has been declared “The year of solidarity for a green world” in our country.

Climate change, depletion of water resources, increased soil erosion, pollution, and other environmental issues are significant challenges facing Azerbaijani society. In this situation, enhancing environmental responsibility and the role of the human factor are essential for shaping a "green" future. Environmental responsibility encompasses the attitude and behavior of each individual, the state, and non-governmental organizations toward nature. This is not only about preserving ecosystems but also ensuring harmony between social and economic development.

Today, Azerbaijan is a country that cares about solving global environmental problems and protecting the world ecosystem in the South Caucasus region. Azerbaijan has taken a very bold step by declaring 2024 "The year of solidarity for the Green World". At the same time, by hosting the COP29 conference, one of the most important events of the UN, our country confirmed that Azerbaijan has become one of the global actors in the fight against climate change. At the same time, COP29 was a strong impetus to the further increase of Azerbaijan's reputation in the world and the direct and unhindered delivery of the country's realities to the international community. The 29th Session of the Conference of the parties to the UN Framework Convention on Climate Change-COP29 event in Azerbaijan, which was successfully held, was the most important event of 2024 for our country and a logical continuation of the strategy for the transition to a green economy.

The holding of COP29 in Azerbaijan is commendable as another triumph of President Ilham Aliyev. This is the greatest success of our foreign policy after our chairmanship of the Non-Aligned Movement and our membership in the Security Council. At the same time, this was a strong response to certain circles that have recently been conducting a smear campaign against Azerbaijan.

Azerbaijan, known worldwide as an oil and gas country, is also becoming a country of "green energy". The strong political will demonstrated by President Ilham Aliyev, along with the fact that Azerbaijan hosted COP29, clearly proves that our country is an influential, reliable partner, and a powerful state both in the region and internationally. At the present stage, the policy being pursued in our republic in the field of ecology and environmental protection embodies the course set by the National Leader Heydar Aliyev, his wise ideas, and historical-political continuity.

# COP29 IN AZERBAIJAN: HISTORICAL BREAKTHROUGH IN GLOBAL CLIMATE DIPLOMACY

> *"Being elected by unanimous decision as the host country for COP29 is really a big honour for us. We consider it as a sign of respect from the international community to Azerbaijan and what we are doing, in particular, in the area of green energy."*

Ilham ALIYEV
President of the Republic of Azerbaijan

Every year, countries who have joined the United Nations Framework Convention on Climate Change (UNFCCC) meet to measure progress and negotiate multilateral responses to climate change. Today there are 198 Parties to the Convention. The UNFCCC is a multilateral treaty adopted in 1992 – shortly after the first assessment report by the Intergovernmental Panel on Climate Change (IPCC) in 1990 – to stabilize greenhouse gas concentrations "at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system." Since entering into force in 1994, the UNFCCC has provided the basis for international climate negotiations, including landmark agreements such as the Kyoto Protocol (1997) and the Paris Agreement (2015).

UN Climate Change Conferences (or COPs) take place every year, and are the world's only multilateral decision-making forum on climate change that brings together almost every country on Earth. To put it simply, the COP is where the world comes together to agree on the actions to address the climate crisis, such as limiting the global temperature rise to 1.5 degrees Celsius, helping vulnerable communities adapt to the effects of climate change, and achieving net-zero emissions by 2050.

A key task for the COP is to review the national communications and emission inventories submitted by Parties. Based on this information, the COP assesses the effects of the measures taken by Parties and the progress made in achieving the ultimate objective of the Convention.

The first Conference of the Parties (COP) was held in Berlin, Germany, in 1995. The Conference of the Parties, often abbreviated as COP, is a significant international forum dedicated to addressing the global challenge of climate change. COPs have created global milestones for the climate movement, setting standards and advancing action, including on reducing carbon emissions, accelerating a global energy transition, and helping countries adapt and build resilience to compounding climate issues. COPs are crucial in bringing governments together while also mobilizing the private sector, civil society, industry and individuals to tackle the climate crisis.

COP29 is the United Nations Climate Change Conference took place in Baku, Azerbaijan from 11 to 22 November 2024. COP29 brought together world leaders and negotiators from the member states (or Parties) of the UN Framework Convention on Climate Change (UNFCCC) to further global progress, with business leaders, young people, climate scientists, Indigenous Peoples, and civil society sharing insights and best practices to strengthen global, collective and inclusive climate action. Among the key priorities of COP 29 are securing a new goal on climate finance, ensuring every country has the means to take much stronger climate action, slashing greenhouse gas emissions and building resilient communities. Also in focus the next round of national climate plans, or NDCs, currently being developed by countries ahead of next year's deadline and ensuring these bolder, fully implementable and

investable strategies and targets are economy-wide, focus on transitioning away from fossil fuels, and keep the world on track to 1.5 degrees of warming. Note that officially, COP29 stands for the 29th meeting of the Conference of the Parties (COP) to the UN Framework Convention on Climate Change (UNFCCC), a landmark international treaty agreed in 1992, and parent treaty to the 2015 Paris Agreement.

The COP28 Presidency and the COP29 incoming Presidency committed to ensuring a transparent and inclusive process in the lead-up to COP29 to be convened in Baku, Azerbaijan, from 11 to 22 November 2024. Azerbaijan was announced as the host of COP29 towards the end of COP28 in Dubai. The Presidency and the incoming Presidency engaged in Parties throughout the year at ministerial, Heads of Delegation and technical levels, as appropriate, to lay the ground work needed to deliver a successful COP29.

The COP presidency is rotated around the world over a five-year cycle, with Azerbaijan being chosen this time to represent the Eastern European region. The decision came later than normal. Russia had vetoed any EU member in Eastern Europe taking up the presidency, leaving just Azerbaijan and Armenia as viable options. Armenia initially vetoed Azerbaijan based on the long-standing conflict between the two countries. Eventually, Armenia withdrew its candidacy and lifted its veto on Azerbaijan, in exchange for the release of 32 Armenian prisoners. (Armenia has since been chosen to host the COP17 biodiversity summit in 2026.) To ensure coherence, the Presidencies worked closely with the Chairs of the subsidiary bodies, with the support of the secretariat, on a common vision towards COP29.

## Azerbaijan's COP29 Presidency

Azerbaijan places special emphasis on environmental protection and the mitigation of climate change, undertaking significant efforts to deliver on these goals. A clear example of this is the unanimous decision to have our country host the 29th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP29), considered one of the world's largest and most prestigious events. As noted by the President of the Republic of Azerbaijan, Ilham Aliyev, this is testament to the international community's profound respect and trust in our country.

Through his speeches at key events such as the Southern Gas Corridor Advisory Council, the Petersberg Climate Dialogue, the 6th World Forum on Intercultural Dialogue, the "Shanghai Cooperation Organization Plus" Meeting, the Informal Summit of the Organization of Turkic States in Shusha, and the 2nd Shusha Global Media Forum, as well as in various television interviews, President Ilham Aliyev has outlined the architecture of Azerbaijan's COP29 Presidency.

At the core of this vision is the principle that countries rich in oil and gas should not be blamed for their natural resources. President Ilham Aliyev emphasized that, rather than shifting blame, both developed and developing countries must contribute to addressing climate challenges according to their capabilities.

Under the slogan "In Solidarity for a Green World", our country, exemplifying leadership in addressing global issues like climate change under the guidance of the President of the Republic of Azerbaijan, calls on all nations to strengthen solidarity for a greener, fairer, more inclusive, and sustainable world.

As part of preparations for hosting COP29, President Ilham Aliyev chaired a meeting on December 15, 2023, where he issued directives to begin preparatory work immediately. By order of the President of the Republic of

Azerbaijan on January 7, 2024, Mukhtar Babayev, the Minister of Ecology and Natural Resources, was appointed as the COP29 President-Designate.

By order of the President of the Republic of Azerbaijan on January 13, 2024, an Organizing Committee was established for the 29th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP29), the 19th session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP19), and the 6th session of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA6). Additional orders on January 19, 2024, and February 22, 2024, expanded the composition of the Organizing Committee. The Organizing Committee, led by Samir Nuriyev, Head of the Presidential Administration of the Republic of Azerbaijan and Chairman of the Committee, held regular meetings to efficiently manage preparations for COP29 and facilitate discussions on key agenda issues.

The COP29 Action Plan has been adopted and implemented by the relevant government agencies. The Host Country Agreement and other important documents have already been signed between the Government of Azerbaijan and the Secretariat of the United Nations Framework Convention on Climate Change. The World Leaders Climate Action Summit, the highest-level event of COP29, took place on November 12-13, 2024. The COP29 Presidency has put forward 14 initiatives covering topics such as the link between climate action and sustainable development goals, green energy zones and corridors, energy storage, harmony for climate resilience, agriculture, clean hydrogen, methane reduction from organic waste, green digital action, and more. Additionally, one of the initiatives included the establishment of the Climate Finance Action Fund. As the President of the Republic of Azerbaijan emphasized, COP29 is a result of a peace process, and in this regard, one of Azerbaijan's COP29 Action Agenda initiatives was the “COP Truce Appeal."

Following Azerbaijan's decision to host COP29, various countries, international organizations, and other foreign counterparts have expressed their desire to collaborate closely with Azerbaijan in this area. Accordingly, strong cooperation was continued with relevant international partners.

To support the successful organization of COP29, an International Advisory Committee has been established, also to promote scientific collaboration in addressing climate change, the COP29 Scientific Council has been formed, bringing together renowned scientists and experts from leading universities and think tanks worldwide.

**For more information about COP29, please visit the website: www.cop29.az**

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## COP29 Presidency Team

**Mukhtar Babayev**
COP29 President

**Yalchin Rafiyev**
COP29 Lead Negotiator

**Elnur Soltanov**
Chief Executive Officer of COP29

**Narmin Jarchalova**
Chair of COP29 Azerbaijan Operating Company and
Chief Operating Officer for COP29

**Nigar Arpadarai**
Climate Change High-Level Champion for COP29

**Leyla Hasanova**
Youth Climate Champion for COP29

## COP29 Organising Committee

On January 13, 2024, the President of the Republic of Azerbaijan, H.E. Mr. Ilham Aliyev, signed an order "On the establishment of the Organising Committee regarding the holding of the 29th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP29), the 19th session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol and the 6th session of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement" in Azerbaijan.

The Head of the Presidential Administration of the Republic of Azerbaijan, Mr. Samir Nuriyev, was appointed as the Chairman of the Organising Committee.

In order to ensure inclusiveness in the composition of the Organising Committee, the President of the Republic of Azerbaijan, H.E. Mr. Ilham Aliyev, signed new orders to expand the Organising Committee on January 19 and February 22, 2024.

**The members of the Organizing Committee include:**

- **Mukhtar Babayev**
Minister of Ecology and Natural Resources, President-Designate of COP29

- **Jeyhun Bayramov**
Minister of Foreign Affairs

- **Mikayil Jabbarov**
Minister of Economy

- **Vilayat Eyvazov**
Minister of Internal Affairs

- **Farah Aliyeva**
Head of the Department of Humanitarian Policy, Diaspora, Multiculturalism and Religious Issues of the Presidential Administration

- **Hikmet Hajiyev**
Assistant to the President of the Republic of Azerbaijan, Head of the Department of Foreign Policy Affairs of the Presidential Administration

- **Anar Alakbarov**
Assistant to the President of the Republic of Azerbaijan

- **Emin Amrullayev**
Minister of Science and Education

- **Kamaladdin Heydarov**
Minister of Emergency Situations

- **Teymur Musayev**
Minister of Health

- **Arif Samadov**
Chief of the Protocol Service of the President of the Republic of Azerbaijan

- **Rashad Nabiyev**
Minister of Digital Development and Transport

- **Parviz Shahbazov**
Minister of Energy

- **Samir Sharifov**
Minister of Finance

- **Khanlar Aghalarov**
Chairman of the Board of the Seaside Boulevard Department

- **Nigar Arpadarai**
Member of the Milli Majlis

- **Gulshan Akhundova**
Chairperson of the "Women, Development, Future" Public Union

- **Shahin Baghirov**
Chairman of the State Customs Committee

- **Aygun Aliyeva**
Executive Director of the Agency for State Support to Non-Governmental Organisations

- **Vugar Ahmadov**
Chairman of the "Azerishig" Open Joint Stock Company

- **Sabina Aliyeva**
Commissioner for Human Rights (Ombudsperson)

- **Eldar Azizov**
Head of the Baku City Executive Power

- **Sabina Hajiyeva**
Head of the State Service of Cultural Heritage Conservation, Development and Rehabilitation under the Ministry of Culture

- **Mehriban Imanova**
Executive Director of the Azerbaijan Science Foundation

- **Sevinj Fataliyeva**
Member of the Milli Majlis

- **Vusal Huseynov**
Chief of the State Migration Service

- **Ilhama Gadimova**
Deputy Minister of Agriculture

- **Elchin Guliyev**
Chief of the State Border Service

- **Vugar Gurbanov**
Executive Director of the Administration of the Regional Medical Divisions (TABIB)

- **Anar Guliyev**
Chairman of the State Committee on Urban Planning and Architecture

- **Ulvi Mehdiyev**
Chairman of the State Agency for Public Service and Social Innovations under the President of the Republic of Azerbaijan

- **Maryam Majidova**
Head of the "Gender Hub" Public Union of the Youth Gender Equality Center

- **Natavan Mammadova**
Secretary General of the National Confederation of Entrepreneurs (Employers) Organisations

- **Saleh Mammadov**
Chairman of the Board of the State Agency of Azerbaijan Automobile Roads

- **Nigar Mammadova**
Director of "DOST Center for Inclusive Development and Creativity" Limited Liability Company

- **Shabnam Mammadova**
Founder of the "SmartNation" platform

- **Bahar Muradova**
Chairperson of the State Committee for Family, Women and Children Affairs

- **Zaur Mikayilov**
Chairman of the Azerbaijan State Water Reserves Agency

- **Ilgar Musayev**
Chief of the State Service of Special Communication and Information Security

- **Samira Musayeva**
Deputy Chief of the State Tax Service under the Ministry of Economy

- **Zakiyya Mustafayeva**
Deputy Chairman of the Food Safety Agency

- **Ali Naghiyev**
Head of the State Security Service

- **Fuad Naghiyev**
Chairman of the State Tourism Agency

- **Rovshan Najaf**
President of the State Oil Company

- **Balababa Rzayev**
President of the “Azerenerji” Open Joint Stock Company

- **Konul Nurullayeva**
Member of the Milli Majlis

- **Samir Rzayev**
President of the Azerbaijan Airlines Closed Joint Stock Company

- **Ruslan Sadigov**
Executive Director of the Baku White City project

- **Firuza Sultanzade**
Chairperson of the Board of “EkoSfera" Socio-Ecological Center

- **Umayra Taghiyeva**
Deputy Minister of Ecology and Natural Resources

- **Inara Valiyeva**
Chairperson of the Innovation and Digital Development Agency under the Ministry of Digital Development and Transport

- **Parvana Valiyeva**
Executive Director of the "Health Service" Public Union, co-founder of the "Environmental Protection First" Coalition

- **Mariana Vasileva**
Deputy Minister of Youth and Sports

- **Fatma Yildirim**
Member of the Milli Majlis

- **Saadat Yusifova**
Deputy Minister of Culture

## COP29 International Advisory Committe

The COP29 Presidency is engaging with a broad range of international stakeholders to ensure everyone's voices are heard and perspectives are considered so that we deliver inclusive outcomes based on shared solutions.

As one important mechanism to drive this vision forward, the COP29 Presidency established the COP29 International Advisory Committee (COP29 IAC). The Committee consisted of eminent personalities who would bring valuable perspectives on issues related to various pillars of climate action.

### Objectives of the COP29 IAC:

- To represent diverse voices of climate advocates from different communities such as finance, government, academia, entrepreneurship, civil society etc. in order to provide multi stakeholder guidance and expert advice to the COP29 Presidency on key issues in the sphere of climate change;
- To facilitate international collaboration and partnerships that enhance and promote COP29 initiatives;
- To ensure that COP29 preparations and its decisions are informed by the latest scientific research, best practices, and innovative solutions;

- To assist in the identification and mobilization of resources for COP programs and projects;
- To promote transparency, accountability, and stakeholder engagement in COP-related processes.




Members of the COP29 International Advisory Committee

## The Scientific Council of COP29 Presidency

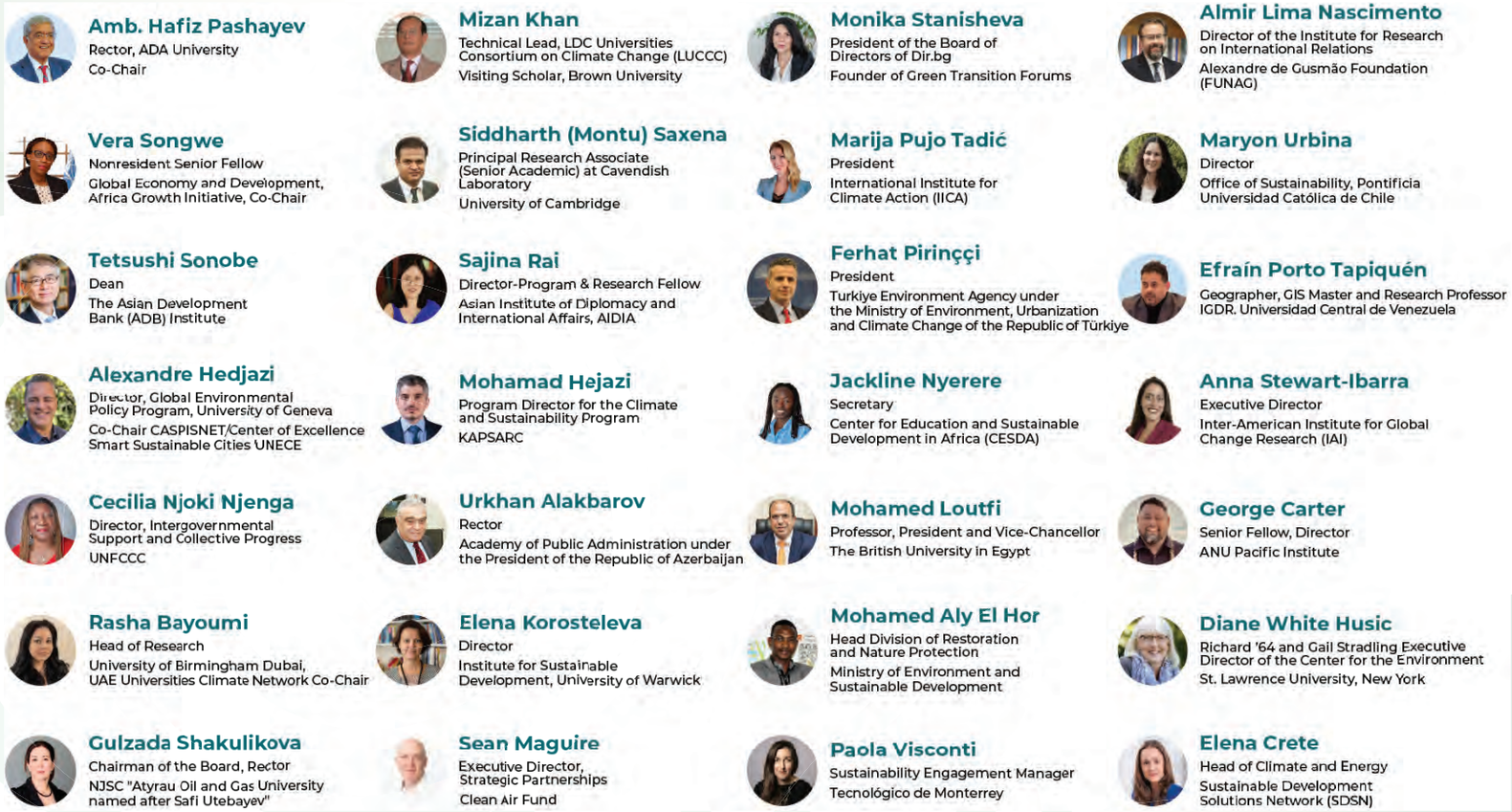
The Scientific Council of COP29 Presidency is a distinguished scientific advisory body that brings together leading scientists, universities, and think tanks from around the world. Its mission was to to provide scientific guidance, support international collaboration, and contribute to the implementation of the Paris Agreement. The Council played a vital role in supporting the COP29 process by increasing access to scientific research and promoting meaningful academic and policy discussions on key climate issues.

### Objectives of the Scientific Council of COP29 Presidency

- To unite leading academic institutions, research organizations, and think-tanks worldwide to raise awareness and improve access to cutting-edge climate science;
- To facilitate access to scientific research to support the COP29 process and ensure that science remains at the core of climate discussions;
- To strengthen cross-border research projects by fostering regional cooperation, diversifying geostrategic approach, and sharing best practices and technological advancements;
- To organize capacity-building programs for various stakeholders and actors, and enhancing cross-border cooperation;
- To engage students and young individuals in the action against climate change through education, outreach, and inclusivity.

### Structure of the Scientific Council of COP29 Presidency

- 2 Co-Chairs – Leading the Council's efforts;
- Executive Secretary – Overseeing the Council's agenda and research output;
- 28 Board Members – Representing various geographic regions and leading institutions.




Board Members of Scientific Council of COP29 Presidency

# COP29 Daily Programme Summary

## COP29 Venue

*Baku Stadium is more than just a venue for sports and entertainment; it is a symbol of Azerbaijan's ambition and its ability to host international events. It plays a crucial role in promoting sports, inclusivity, culture, and tourism in the region. Officially opened on March 18, 2015, it stands as one of the largest and most modern stadiums in the region, showcasing Azerbaijan's growing prominence in international mega events.*

### The COP29 Blue Zone

The Blue Zone is the formal conference and negotiation space managed by the UNFCCC. All the official sessions, meetings, side events and press conferences held during COP29 took place in the Blue Zone. Only UNFCCC-accredited participants, including Party delegations, Heads of State, admitted observers and the accredited press could enter the Blue Zone.

### The COP29 Green Zone

The COP29 Green Zone, organised and managed by the COP29 Presidency, has seen strong demand. The COP29 Green Zone offered a dynamic platform for innovative initiatives and discussions on sustainability and climate action. The program emphasized greater participation from youth, women, and local communities in promoting climate solutions. A dedicated area, Extreme Hangout, provided creative programming for young eco-champions aged 6-18, featuring cultural events, performances, and interactive sessions engaging both children and their parents.

The concept behind the Green Zone under the guidance of the COP29 Presidency emphasized the essential collaboration between government bodies and all stakeholders in tackling climate issues.

### 11 November, 2024

Parties assembled for the first day of the UN Climate Change Conference achieved a critical early success by reaching consensus on standards for the creation of carbon credits under Article 6.4 of the Paris Agreement. This will enable climate action by increasing demand for carbon credits and ensure that the international carbon market operates with integrity under the supervision of the United Nations.

The COP29 Presidency identified the full operationalization of Article 6 as a key negotiating priority this year. Finalising Article 6 negotiations could reduce the cost of implementing national climate plans by $250 billion per year by enabling cooperation across borders.

The COP29 President opened the summit by setting clear expectations for how global leaders must enhance ambition and enable action during the conference. COP29 was a critical moment for global leaders to come together and demonstrate their collective commitment to climate action. The summit ran from 11-22 November in Baku, Azerbaijan, and approximately 70,000 delegates were registered to attend, including heads of state and government who participated in the leaders' segment on 12-13 November.

To enhance ambition, the COP29 President called for countries to submit 1.5-aligned Nationally Determined Contributions to reduce emissions ahead of next year's deadline, submit National Adaptation Plans by 2025 to prepare for a warming world, and deliver their first Biennial Transparency Reports (BTR) this year.

*The COP29 Green Zone,* organized by the COP29 Presidency and featuring community engagement, green transition, technological solutions, and global collaboration, opened its doors on the first day of the international climate conference, marking the launch of a series of events were held throughout the conference. The opening day programme included an event hosted by the COP29 Azerbaijan Operating Company focusing on climate action and carbon neutrality. The event, titled "Towards Net-Zero Carbon Emissions: COP29 Partnerships for a Sustainable Future", brought together stakeholders to discuss COP29's climate action initiatives. Attendees learned about collaborative efforts in developing and implementing sustainability initiatives and discussed how to support COP29's positioning as a sustainable event benchmark, efficiently utilizing greener and more sustainable resources.

Throughout the first opening day, various companies held discussions and seminars covering topics such as biodiversity conservation, innovations in renewable energy, intergenerational cooperation in the pursuit of climate justice and sustainability, the crucial role of higher education in addressing climate change, and various other pertinent issues. It was accompanied by performances and interactive sessions organized in the dynamic "Extreme Hangout" area, as well as by the overall activities in the Green Zone's pavilion areas. Until November 22, a series of panel discussions were held in collaboration with COP29's official partners on various topics. These sessions were feature prominent experts and distinguished figures in the fields of climate action and sustainability.

Today, the Presidency, in partnership with the International Energy Agency (IEA), shared five key opportunities for COP29 to demonstrate positive progress on energy goals identified at COP28.

*The five opportunities identified are*:

- Scale up energy storage and electricity grids as a key enabler to achieving the global goal of tripling renewable energy capacity this decade and ensuring that the full benefits are realized;

- Ensure countries accelerate policy implementation to achieve the goal of doubling energy efficiency progress by 2030;
- Maintain a focus on cutting emissions from methane and fossil fuels.
- Implement solutions to boost clean energy investment in developing economies to support their transitions;
- The next round of Nationally Determined Contributions should be informed by the Global Stocktake (GST) outcomes.

12 November, 2024

A ceremony at COP29 in Baku celebrated the signing of the Trustee Agreement and the Secretariat Hosting Agreement between the Board of the

Fund for responding to Loss and Damage and the World Bank, as well as the Host Country Agreement between the Fund Board and the Fund Board's host country, the Republic of the Philippines. The Presidency was working with all countries that have pledged money to complete their contribution agreements as soon as possible.

At today's event, Sweden pledged 200M kr (approximately $19M) to the Fund, subject to government approval. This significant contribution brings the total pledged funding to more than $720M. The COP29 Presidency thanked Sweden for answering the call to action and continues to urge further pledges to the Fund to better meet the needs of communities on the frontlines of climate change. Loss and damage have been a key priority in the COP29 Presidency's plan to enhance ambition and enable action. The Presidency has pushed for progress across all parts of the loss and damage landscape throughout the year.

Alongside the official negotiations in the Blue Zone, the COP29 Green Zone, overseen by the COP29 Presidency, continued its programme of public events on the second day. A joint panel discussion on corporate sustainability, hosted by the COP29 Azerbaijan Operating Company and Azerbaijan International Bank, COP29's Principal Banking Partner, took place on November 12.

The event, titled "Corporate Sustainability and Climate Action", focused on the crucial role of businesses in mitigating the impacts of climate change and their efforts towards achieving global net-zero carbon targets. Panel discussions highlighted the sharing and integration of best practices in sustainability, strengthening efforts to combat climate change, particularly given the private sector's adoption of sustainability principles as core business strategies. Topics included the low-carbon transition, sustainable supply chains, and green technology innovation. The event showcased successful strategies and partnerships, encouraging companies to integrate sustainability into their operations and demonstrating the power of the private sector in building a sustainable future. Local and international experts participated in these events, organized by a variety of stakeholders.

A group of leading multilateral development banks (MDBs) today shared an estimate of their annual collective financing for low- and middle-income countries to conclude the first day of the World Leaders Climate Action Summit at COP29 in Baku, Azerbaijan. For low- and middle-income countries, the annual collective climate financing contributions from the group of MDBs is set to cumulatively reach USD $120 billion by 2030, including USD $42 billion for adaptation. The MDBs also aim to mobilise USD $65 billion annually from the private sector. For high-income countries, this annual collective climate financing is projected to reach USD $50 billion, including USD $7 billion for adaption, and the MDBs aim to mobilise USD $65 billion from the private sector.

The estimates encompass lenders including the Asian Development Bank (ADB), the World Bank Group, the African Development Bank (AfDB), the Asian Infrastructure Investment Bank (AIIB), the Council of Europe Development Bank (CEB), the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB), the Inter-American Development Bank Group (IDB), the Islamic Development Bank (IsDB) and New Development Bank.MDBs have exceeded their 2025 climate finance projections set in 2019, with a 25% increase in direct climate finance and mobilisation for climate efforts doubling over the past year.

Throughout the year, the COP29 Presidency has been supporting the full operationalisation of the Fund for responding to Loss and Damage so that it can begin disbursing much needed and long-awaited funds as soon as possible.

The Fund is now ready to accept contributions after the signing of key documents. A ceremony on the second day of COP29 in Baku celebrated the signing of the Trustee Agreement and the Secretariat Hosting Agreement between the Board of the Fund for responding to Loss and Damage and the World Bank, as well as the Host Country Agreement between the Fund Board and the Fund Board's host country, the Republic of the Philippines. With this important milestone reached, the Fund is now expected to start financing projects in 2025.

At today's event, Sweden also pledged approximately $19 million to the Fund, subject to government approval. This brings the total pledged funding to more than $720 million. The COP29 Presidency thanked Sweden for answering the call to action and continues to urge further pledges to the Fund to better meet the needs of communities on the frontlines of climate change.

The COP29 Presidency also launched today a new high-level annual dialogue on coordination and complementarity for funding arrangements responding to loss and damage that will bring together stakeholders from within and outside of the UNFCCC process.

## World Leaders and Heads of Government address delegates at COP29

The first day of the World Leaders Climate Action Summit began with an address from Ilham Aliyev (President of the Republic of Azerbaijan). During his speech, President Aliyev said: *"As the President of COP29, Azerbaijan will do its best to find common understanding between developed and developing countries, between Global South and Global North."*

Additionally, 80 Heads of States, Governments and Vice-Presidents participated in the World Leaders Climate Action Summit. The Summit, starting on the second day of the two-week COP29 conference in Baku, aimed to build consensus and momentum around Azerbaijan's plan to enhance ambition and enable action and demonstrate to all stakeholders a clear political to deliver. Leaders addressed the need to raise ambition for mitigation and adaptation through Nationally Determined Contributions (NDCs), National Adaptation Plans (NAPs), and long-term low-emission development strategies (LT-LEDS), enabling action with the New Collective Quantified Goal on Climate (NCQG), and other means of implementation and support. In other significant developments during the day, The United States, People's Republic of China, and Azerbaijan convened a Summit to accelerate action to cut emissions of methane and other non-CO2 greenhouse gases. The Summit focused on key actions to reduce near-term warming and keep a goal of limiting global average temperature increase to 1.5 degrees Celsius within reach. During the session, a Letter of Intent was signed between the Government of Azerbaijan and the FAO to formalise partnership, capacity building and knowledge sharing efforts. The agreement builds on the COP29 Presidency's Action Agenda initiative Baku Harmoniya Climate Initiative for Farmers to address the impacts of climate change on agriculture and food and water security. The Presidency also hosted the COP-IEA leader segment.




# SPEECH AT THE OPENING CEREMONY OF THE WORLD LEADERS SUMMIT

by

President of the Republic of Azerbaijan H.E.Ilham Aliyev

https://doi.org/10.30546/BAKUCOP29.2024.01

*Distinguished Secretary-General of the United Nations,*
*Distinguished heads of state and government,*
*Ladies and gentlemen,*
*I welcome you all to Azerbaijan.*

Many of our guests are visiting Azerbaijan for the first time. I hope they will have a chance to get acquainted with our country, its history, traditions, and culture.

I would like to thank the Secretary-General of the United Nations, Mr. António Guterres, and the Secretariat of the UNFCCC for their support of Azerbaijan on the path to COP29. I congratulate my dear brother, President of the UAE, His Highness Sheikh Mohamed bin Zayed Al Nahyan, and all his team on the landmark UAE consensus achieved at COP28 in Dubai, and their support in the preparation for COP29 in Baku.

Last December, by a unanimous decision of almost 200 countries, Azerbaijan was honored to host COP29. We consider this decision as a sign of respect for our country, as well as an appreciation of our active role on the international arena.

Azerbaijan is a country where East and West, North and South meet, and this is not only about geography. We can build political, cultural, energy, trade, and transportation bridges between different international actors. The mega projects initiated by Azerbaijan have already changed the energy and transportation maps of Eurasia and have led to the establishment of fruitful multinational cooperation formats.

Despite the 30-year-long occupation by Armenia of almost 20% of the internationally recognized territories of Azerbaijan, despite ethnic cleansing and the deportation of 1 million Azerbaijanis from their ancestral lands, we managed to build a strong country with a self-sufficient economy and independent policy. Four years ago, we celebrated the historical Victory in the Second Karabakh War.

A year ago, we fully restored our sovereignty in accordance with the UN Charter, international law, and UN Security Council resolutions, which had remained on paper for 30 years. We implemented these resolutions ourselves and restored international law, justice, and put an end to the Armenian occupation. As the President of COP29, Azerbaijan will do its best to find a common understanding between developed and developing countries, between the Global South and the Global North. For four years, by unanimous

decision of 120 countries, Azerbaijan successfully chaired the Non-Aligned Movement, the second international institution after the United Nations.

Azerbaijan is also an active member of the Organization of Islamic Cooperation, which unites almost 60 countries. Azerbaijan has signed agreements and adopted declarations on strategic partnership with 10 members of the European Union. All this allows us to think that we may be very helpful and useful in building bridges between different important actors on the issue of climate change. Azerbaijan is an active supporter of multilateralism. At the same time, we play an active role in intercultural dialogue.

Together with the United Nations Alliance of Civilizations, every two years, we organize the Intercultural Dialogue Forum in Baku. Multiculturalism is our state policy and, at the same time, it is our lifestyle. The people of Azerbaijan, regardless of their ethnic or religious identity, live in peace and harmony as one family.

Now, I'd like to say a couple of words about Azerbaijan's green agenda. Our technical potential for renewable energy is estimated at 135 gigawatts onshore and 157 gigawatts offshore. Last year, Masdar from the UAE inaugurated the solar power plant of 230 megawatts, the biggest in our region. ACWA Power from Saudi Arabia is currently constructing a wind power station with a potential capacity of 240 megawatts.

During COP29, an agreement will be signed with bp from the UK to build a 240-megawatt solar power station in the district of Jabrayil, which was liberated from Armenian occupation four years ago. This project will provide decarbonization of one of the biggest oil and gas terminals in the world, the Sangachal terminal.

By 2030, we plan to build solar, wind, and hydro power stations of approximately six gigawatts. But this is not all of our plans. Contracts and MoUs for 10 gigawatts of renewable energy projects have been signed.

We are also looking at export markets and working actively with our partners in order to implement another important energy security project—the Black Sea Caspian energy cable.

This will allow us to export green energy to Europe, and the technical potential of this cable - by the way, feasibility studies will be ready very soon—is close to four gigawatts. But again, this is only the beginning. Our green agenda also covers different regions of Azerbaijan, so Nakhchivan, Karabakh, and East Zangazur regions of Azerbaijan have been declared green energy zones, and this is about the quarter of our territory.

Now, a couple of words I'd like to say about another segment of energy security, which is oil and gas. I understand that this topic is not very popular at a climate change conference, but without that, my comments would not be complete. Just to begin with information, the world's first industrial oil well was drilled in Azerbaijan, in Baku, in 1846. It is situated not far from this place. Maybe it may take a 10-15 minute drive. The first offshore oil well was also drilled by Azerbaijani oilmen in the Caspian Sea in the middle of 20th century. In the 19th century, Azerbaijan produced more than half of the world's oil.

If, then, some Western politicians and media called us a petrostate, that would probably have been acceptable. But when they call us a petrostate now, today, this is not fair, and it only demonstrates a lack of political culture and knowledge. Today, Azerbaijan's share of global oil production is 0.7%, and its share of global gas production is 0.9%. But the fake news media of the country, which is the number one oil and gas producer in the world and produces 30 times more oil than Azerbaijan, calls us a petrostate.

They had better look at themselves, or at least at their neighbor, which produces 10 times more oil than Azerbaijan. Azerbaijan's share in global gas emissions is only 0.1%. I have to bring these figures to the attention of our audience because right after Azerbaijan was elected as the host country of COP29, we became the target of a coordinated, well-orchestrated campaign of slander and blackmail.

Western fake news media, so-called independent NGOs, and some politicians seemed to be competing in spreading disinformation and false information about our country. To accuse us of having oil is the same as accusing us of having more than 250 sunny days a year in Baku.

Countries should be judged by other criteria. For instance, the level of unemployment in Azerbaijan, it is 5.4%, the level of poverty, it is 5.2%, our green agenda—I have already described our plans – how countries manage their foreign debt - in Azerbaijan, it's only 7.5% of GDP.

These, along with many other important criteria, should serve as the basis for evaluating the country's performance, rather than its natural resources, which are a gift from God. I said this several months ago, and now those who want to attack me, particularly the international media, simply quote me saying that this is a gift from God.

And I want to repeat it here today: it is a gift from God. Every natural resource, whether it's oil, gas, wind, sun, gold, silver, copper, they are all natural resources. Countries should not be blamed for having them, and should not be blamed for bringing these resources to the market because the market needs them. The people need them. So, this is my message. As the President of COP29, of course, we will be strong advocates for the green transition, and we're doing it, but at the same time, we must be realistic.

Another point of accusation is that two years ago, Azerbaijan and the European Commission signed a Declaration on strategic partnership in the field of energy. But it was not our idea. It was a proposal from the European Commission. The President of the European Commission came to Baku two years ago to sign this document with us. Because they needed our gas due to the change of geopolitical situation, and they asked us to help. And we said, "okay." We are always ready to help if our help is needed. We said, "Okay, we will help Europe with the energy security." When we signed this declaration two years ago, the number of countries, which were receiving our gas, I mean, European countries, was equal to two. So now, it's eight countries.

Eight out of ten countries, which have access to Azerbaijani gas are in Europe. The European Commission also asked us to double the gas supply to Europe by 2027, and this is reflected in the Declaration, which was signed by the President of European Commission and myself two years ago in Baku. Unfortunately, double standards, the habit of lecturing other countries, and political hypocrisy have become a kind of modus operandi for some politicians, state-controlled NGOs, and fake news media in some Western countries.

My last message is for those who, for almost one year, have been advocating for a boycott. They used all the tools in their possession to launch a campaign to boycott COP29 in Baku. I have bad news for them. We have 72,000 registered participants from 196 countries. Among them are 80 presidents, vice-presidents, and prime ministers. So, the world has gathered in Baku, and we say to the world: Welcome to Azerbaijan.

Thank you.




# SPEECH AT THE OPENING CEREMONY OF THE WORLD LEADERS SUMMIT

by

United Nations Secretary-General António Guterres

https://doi.org/10.30546/BAKUCOP29.2024.013

President Ilham Aliyev, I thank you, the COP President, Mukhtar Babayev, and the government of Azerbaijan for your welcome and hospitality. The presidents can count on a full cooperation in your efforts to achieve the successful COP we all need.

The sound you hear is the ticking clock. We are in the final countdown to limit global temperature rise to 1.5 degrees Celsius. And time is not on our side.

Exhibit a: 2024. With the hottest day on record …and the hottest months on record …this is almost certain to be the hottest year on record. And a masterclass in climate destruction: Families running for their lives before the next hurricane strikes; Biodiversity destroyed in sweltering seas; Workers and pilgrims collapsing in insufferable heat; Floods tearing through communities, and tearing down infrastructure; Children going to bed hungry as droughts ravage crops.

All these disasters, and more, are being supercharged by human-made climate change. And no country is spared. In our global economy, supply chain shocks raise costs – everywhere. Decimated harvests push up food prices – everywhere. Destroyed homes increase insurance premiums – everywhere. This is a story of avoidable injustice.

The rich cause the problem, the poor pay the highest price. Oxfam finds the richest billionaires emit more carbon in an hour and a half than the average person does in a lifetime. Unless emissions plummet and adaptation soars, every economy will face far greater fury. But there is every reason to hope. At COP28, all of you agreed to move away from fossil fuels; To accelerate net zero energy systems, setting milestones to get there; To boost climate adaptation; And to align the next round of economy-wide national climate plans – or NDCs – with the 1.5 degree limit. It's time to deliver. Humanity is behind you: a poll by the University of Oxford and the United Nations Development Programme finds that eighty percent of people around the world want more climate action. Scientists, activists, and young people are demanding change – they must be heard, not silenced. And the economic imperative is clearer and more compelling – with every renewables roll out, every innovation, and every price drop.

Last year – for the first time – the amount invested in grids and renewables overtook the amount spent on fossil fuels. Almost everywhere, solar and wind are the cheapest source of new electricity. Doubling down on fossil fuels is absurd. The clean energy revolution is here. No group, no business, and no government can stop it. But you can and must ensure it is fair, and fast enough to limit global temperature rise to 1.5 degrees Celsius. I urge you to focus on three priorities. First, emergency emissions reductions. To limit global temperature rise to 1.5 degrees Celsius, we must cut global emissions nine percent every year. By 2030, they must fall 43 percent on 2019 levels. Unfortunately, they are still growing at the present moment.

Now At this COP, you must agree to rules for fair, effective carbon markets that support that fight. Yesterday you made an important first step. You must build on it by agreeing rules for markets that respect the rights of local communities, and leave no space for land-grabbing. By next COP, you must deliver new economy-wide national climate action plans. You've agreed that your new plans will align with 1.5 degrees. That means they must cover all emissions and the whole economy; Advance global goals to triple renewables capacity, double energy efficiency, and halt deforestation by 2030; Slash global fossil fuel production and consumption thirty percent by the same date; And align national energy transition strategies and sustainable development priorities with climate action – to attract needed investment. All this must be achieved in line with the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances. All countries must do their part. And the G20 must lead. They are the largest emitters, with the greatest capacities and responsibilities. They must bring their technological know-how together – with developed countries supporting emerging economies. Every nation must have the tools and resources for climate action. And the United Nations will support that effort every step of the way. We're supporting developing countries with new NDCs through the climate promise initiative; And striving for justice in the renewables revolution through our panel on critical energy transition minerals. But ultimately, only you can deliver, on national ambition and action. Only you can beat the clock on 1.5 degrees.

Second, you must do more to protect your people from the ravages of the climate crisis. The most vulnerable are being abandoned to climate extremes. The gap between adaptation needs and finance could reach up to $359 billion a year by 2030. These missing dollars are not abstractions on a balance sheet: they are lives taken, harvests lost, and development denied. Now more than ever finance promises must be kept. Developed countries must race the clock to double adaptation finance to at least $40 billion a year by 2025. Adaptation investments can transform economies, driving progress across the sustainable development goals. We need countries' new climate action plans to set out adaptation financing needs. We need every person on earth to be protected by an alert system by 2027, in line with our early warnings for all initiative. And we need climate justice. Particularly, a surge in pledges to the new loss and damage funds. And commitments turning into cash – with finance pouring into the fund's coffers. But we also need a fundamental step-change across the board.

And so, excellences, the third priority is finance. Developing countries eager to act are facing many obstacles: scant public finance; raging cost of capital; crushing climate disasters; and debt servicing that soaks up funds. The result: adaptation denied. And a tale of two transitions. Last year, developing and emerging markets outside China received just fifteen cents for every dollar invested in clean energy globally. COP29 must tear down the walls to climate finance. Developing countries must not leave Baku empty-handed. A deal is a must. And I am confident it will be reached.

We need a new finance goal that meets the moment. Five elements are critical to success. First, a significant increase in concessional public finance. Second, a clear indication of how public finance will mobilize the trillions of dollars developing countries need. Third, tapping innovative sources, particularly levies on shipping, aviation, and fossil fuel extraction, based on the principle that polluters must pay. Fourth, a framework for greater accessibility, transparency, and accountability – giving developing countries confidence that the money will materialize. Fifth, boosting lending capacity for bigger and bolder multilateral development banks. And I hope that some good news will come. This requires a major recapitalisation. And it requires reforms of their

business models, including so that they can leverage far more private finance. The resources available may seem insufficient. But they can be multiplied with a meaningful change in how the multilateral system works. Big sums require big change. The COP29 outcome must build on the pact for the future – agreed by consensus in New York in September – and drive progress.

I urge the major MDB shareholders to use your position to push for change. There is no time to lose. On climate finance, the world must pay up, or humanity will pay the price. In this crucial period, you and your governments must be guided by a clear truth: Climate finance is not charity, it's an investment. Climate action is not optional, it's imperative. Both are indispensable: to a livable world for all humanity. And a prosperous future for every nation on earth. The clock is ticking. I count on you.

Thank you.




# WELCOMING REMARKS

by

United Nations Framework Convention on Climate Change (UNFCCC) Executive Secretary Simon Stiell

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*Excellencies, Delegates, Colleagues, Friends,*

It is an honor to welcome you to COP29. I thank Dr. Sultan Al Jaber and the Emirati Presidency for their tireless work, as they pass the baton to COP President Mukhtar Babayev and Azerbaijan.

In tough times, up against difficult tasks, I don't go in for hopes and dreams. What inspires me is human ingenuity and determination. Our ability to get knocked down and to get up again over and over again, until we accomplish our goals.

The lady I'm standing with, in this picture, is my neighbour, Florence, in Carriacou. In July this year, this was us, standing in all that remained of her home after the devastation of Hurricane Beryl.

At 85, Florence has become one of the millions of victims of runaway climate change this year alone.

She was focused on one thing: Being strong for her family and strong for her community.

And there are people like Florence in every country on Earth. Knocked down, and getting back up again.

This UNFCCC process is the only place we have to address the rampant climate crisis, and to credibly hold each other to account to act on it.

And we know this process is working. Because without it, humanity would be headed towards five degrees of global warming.

In these halls, we negotiate on specific pieces of the puzzle each year. It can feel far away from what's happening in Florence's living room. We cannot afford to continue up-ending lives and livelihoods in every nation - so let's make this real:

*Do you want your grocery and energy bills to go up even more?*
*Do you want your country to become economically uncompetitive?*
*Do you really want even further global instability, costing precious life?*

This crisis is affecting every single individual in the world one way or another. And I'm as frustrated as anyone that one single COP can't deliver the full transformation that every nation needs. But if any of your answers to those questions was no, then it is here that Parties need to agree a way out of this mess.

That's why we're here in Baku. We must agree a new global climate finance goal.

If at least two thirds of the world's nations cannot afford to cut emissions quickly, then every nation pays a brutal price.

If nations can't build resilience into supply chains, the entire global economy will be brought to its knees. No country is immune.

So, let's dispense with the idea that climate finance is charity. An ambitious new climate finance goal is entirely in the self-interest of every single nation, including the largest and wealthiest.

But it's not enough to just agree on a goal. We must work harder to reform the global financial system. Giving countries the fiscal space they so desperately need.

And here in Baku, we must get international carbon markets up and running, by finalising Article 6.

We need to move forward on mitigation, so targets from Dubai are realized. We mustn't let 1.5 slip out of reach. And even as temperatures rise, the implementation of our agreements must claw them back.

Clean energy and infrastructure investment will reach two trillion dollars in 2024. Almost twice that of fossil fuels.

The shift to clean-energy and climate-resilience will not be stopped. Our job is to accelerate this and make sure its huge benefits are shared by all countries and all people.

We must agree adaptation targets. You can't manage what you don't measure. And we need to know if we're on a pathway to increasing resilience. And we must continue to improve the new mechanisms for financial and technical support on loss and damage.

We can't make decisions in the dark. Biennial Transparency Reports, due this year, will give us a clearer picture of the progress we're making, and the gaps that we need to fill.

[Next] year, all countries will deliver their third generation of national climate plans – NDCs.

To support countries in creating and communicating them, the UNFCCC will launch a Climate Plan Campaign.

It will mobilise action from all stakeholders, and align with the efforts of the UN Secretary-General and the incoming Brazilian COP Presidency.

In parallel, we'll re-start Climate Weeks from 2025. Aligning them more closely with our process and the outcomes it must deliver.At the Secretariat, we will continue to work tirelessly with what we have got, while being clear on what funding we need, so we can deliver on what's increasingly being asked of us. And we will keep focus on the safe, inclusive, and meaningful participation of all observers at this COP.

In the past few years, we've taken some historic steps forward. We cannot leave Baku without a substantial outcome. Appreciating the importance of this moment, Parties must act accordingly.

Show determination and ingenuity here at COP29 – We need all parties to push for agreement right from the start - To stand and deliver.

Now it is the time to show that global cooperation is not down for the count. So I urge you all, let us rise together.

I thank you.

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Maimunah Mohd Sharif, Mayor of Kuala Lumpur, Malaysia, and Former Executive Director of the United Nations Human Settlements Programme (UN-Habitat), also addressed the summit.

A special video message from NASA astronauts Sunita Williams and Nick Hague aboard the International Space Station was presented at the Summit.

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Then as part of the 29th session of the Conference of the Parties (COP29) to the UN Framework Convention on Climate Change, a conference titled "Youth at the Forefront of Climate Action" took place in Baku.

Attendees included Mehriban Aliyeva, First Lady of Azerbaijan; Aigul Zhaparova, First Lady of Kyrgyzstan; Ziroatkhon Mirziyoyeva, First Lady of Uzbekistan; Emine Erdogan, First Lady of Türkiye; along with Salim bin Mohammed AlMalik, Director-General of ICESCO; Tatiana Molcean, Executive Secretary of the United Nations Economic Commission for Europe (UNECE); and Regina De Dominicis, UNICEF Regional Director for Europe and Central Asia.

The event aimed to draw international attention to the commitment of Central Asian and Turkic-speaking countries in the fight against climate change, spotlighting the role of youth involvement in these nations' climate agendas in alignment with international obligations.

First Ladies Ziroatkhon Mirziyoyeva, Aigul Zhaparova and Emine Erdogan delivered speeches at the conference.

Mehriban Aliyeva, First Lady of Azerbaijan, then addressed the event.




# WELCOMING REMARKS

by

First Lady of the Republic of Azerbaijan Mehriban Aliyeva

President of Heydar Aliyev Foundation, Azerbaijan

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*Distinguished First Ladies,*
*Dear guests,*
*Dear young participants,*
*Ladies and gentlemen,*

First of all, I would like to greet you in Azerbaijan and wish you good health, and wish peace, and prosperity for the countries you represented at COP29. The title of our panel, "Youth at the Forefront of Climate Action," speaks for itself.

According to recent studies, over 60% of the world's youth consider climate change as an urgent issue. I hope that within the framework of COP29, we will have the opportunity to initiate the creation of platforms for cooperation, the exchange of experiences, and the generation of common projects by the younger generation.

I welcome all representatives of youth organizations, eco-activists, and all young people who care and are participating in COP29.

I express my gratitude to the First Lady of the Republic of Türkiye for her initiative in founding the Zero Waste Foundation and for her personal contribution to projects that protect environmental and cultural heritage.

I highly appreciate the efforts of Uzbekistan, whose initiative led to the adoption of the Central Asian Strategy last year to promote sustainable development and involve children and youth in the climate agenda for 2024-2030. I would like to thank the First Lady of Uzbekistan, Ziroat Mirziyoyeva, for her personal patronage of this important mission.

I am grateful to the First Lady of Kyrgyzstan for her participation and her active role in raising awareness and involving young people in the environmental agenda.

Dear friends, it is great honor for us to be chosen as the country for COP29, and we are proud that the first conference in the South Caucasus, Central Asia, and the broader region is being held in Azerbaijan.The world faces serious environmental challenges, such as biosphere pollution, freshwater shortages, droughts, and emerging risks to food security. Our country is no exception. We observe a decrease in river water levels, the shrinking of the Caspian Sea, and face the threat of water shortages.

I would like to note that Azerbaijan accounts for only 0.1% of global greenhouse gas emissions. We are adjusting our national targets to reduce emissions and transition to clear energy. With the current pace of achievements in renewable energy, we expect to reach 32% of our installed capacity by 2027, three years earlier than our original target of 30% by 2030.

We are also focused on creating a net-zero emission zone in Karabakh and East Zangazur regions, liberated from occupation of Armenia, and the Nakhchivan Autonomous Republic by 2050. Active work is already underway on major solar and wind energy projects. The production and export of green energy are priorities in Azerbaijan's energy strategy.

Climate action has long been one of the most critical and prioritized issues on the international arena. Despite the steps taken, the challenges and threats facing humanity grow more serious day by day. Given this, perhaps it is the time to rethink approaches and methods in addressing global issues. Today, I want to address an important topic that needs to be spoken about openly and honestly. The hypocrisy and double standards are evident in the international environmental agenda.

Azerbaijan, as the host of COP29, has faced an unjust wave of attacks, false narratives, and double standards, driven by consideration far removed from environmental issues.

In undertaking the responsibility to host COP29, Azerbaijan seeks to build bridges between the Global South and the Global North, between the developed and developing world. We aim to ensure that our contribution to solving this issue becomes a contribution to a common future. However, instead of support and constructive dialog, in some cases, we became the subject of slander and blackmail campaigns through numerous Western media. It is evident that these media have become tools for discrediting countries that do not follow imposed scenarios or play by imposed rules—countries that pursue independent policies and defend their national interests.

Some large media platforms, influenced by certain states, start spreading negative narratives about Azerbaijan upon command.

What truly lies behind this? What goals are the sponsors of this dirty campaign pursuing? Actually, we know the answer.

Our citizens have the right to fair and honest representation of their country on the international stage. They have the right not to be subjected to pressure and manipulation by those who might see Azerbaijan's independent position as a threat.

Our achievements and work deserve respect, not distortion for the geopolitical purposes of some states.

Hypocrisy also manifests in how various countries set their climate commitments.

Developed countries, which for centuries were the main sources of pollution and irresponsible resource consumption, now take the role of strict judges. They advocate for strong restrictions for all while simultaneously pursuing ambitious goals in their own policies and continuing to act in their own interests. They demand transformation from other countries, yet they are slow to assist financially or technologically.

Azerbaijan is a country that wants to see effective action, real solutions, and fair interaction—not manipulation and pressure.

We wish to use our platform to create a global coalition where every country, big or small, developed or developing, has a voice and the right to fair treatment.

False narratives and hypocrisy not only distort reality but undermine fundamental concepts like justice, honesty, virtue, and responsibility.

The use of media to spread and distort information, to conduct smear campaigns against countries, does not harm those countries as much as it devalues the essence of moral values, erodes trust, and creates division.
I urge all participants, all partners to remember that COP29 is not an arena for political attacks but a place where we must unite in the face of the climate crisis.

Only fair cooperation and readiness for real action will lead us to success.

Dear friends, in conclusion, I would like to present a proposal regarding the organization of future conferences. I suggest considering the possibility of holding future conferences online. This approach would not only save significant resources but also reduce environmental impact by cutting emissions from flights and large events.

Working groups could meet in person for detailed discussions and coordination, while leadership summits could be held via video conferences. This would allow us to focus resources, efforts, and time on targeted tasks while making the process more environmentally responsible.

Thank you for your attention.

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Then, young eco-activists from Azerbaijan, Hungary, Kazakhstan, Kyrgyzstan, Türkiye, and Uzbekistan gave presentations highlighting the environmental concerns and initiatives of their respective countries.

The conference also featured a signing ceremony for the "International Strategy for the Promotion of Cultural Development and Involvement of Children and Youth in the Climate Agenda" for 2024-2030.

A group photo was taken afterward.

Following the conference, the dignitaries toured the Solidarity Center at COP29 in the Green Zone, a joint pavilion of the Heydar Aliyev Foundation and

Türkiye's Zero Waste Foundation. The pavilion showcased the Heydar Aliyev Foundation's environmental protection initiatives and included an interactive zone highlighting projects in education, healthcare, and social spheres. On this platform, the Zero Waste Foundation presented its projects on resource efficiency, waste management, and recycling, along with environmental education programs and innovative solutions.

During the visit to the pavilion, the First Ladies watched via video a tree-planting initiative in the Shamakhi district, involving youth and volunteers. In this campaign, more than 10,000 pine trees were planted as a contribution to environmental protection.

**13 November, 2024**

A joint panel session was held and organized by the COP29 Azerbaijan Operating Company and Rhenus, the Official Logistics Partner for COP29. The session, entitled "Climate Justice and Equity", addressed the critical role of businesses in mitigating the impacts of climate change and their contributions to achieving the global net-zero carbon target. The panel underscored the urgent need for just and inclusive climate policies, citing the disproportionate impact of climate change on vulnerable populations, including low-income communities, indigenous groups, women, and youth. Successful examples of gender-responsive approaches, equitable policies and youth-led initiatives were also highlighted.

Meanwhile, the Green Zone's Extreme Hangout offered a vibrant mix of yoga, film screenings, and live music.

Also today, the co-chairs of the NCQG contact group published a first iteration of a draft decision text for the COP29 Presidency's top negotiating priority – a new climate finance goal. The COP29 Presidency had encouraged the co-chairs to produce this draft as early as possible to guide conversations around potential landing zones and help to identify concerns. Parties welcomed the decision to transition to a draft text and, for the first time in the three-year technical process, described it as a workable basis for discussion.

The day also placed a strong emphasis on health, with a high-level meeting featuring the COP29 Presidency, the WHO, Spain's Secretary of State for Health, Mr. Javier Padilla Bernáldez, and representatives of the Presidencies of COP26 Glasgow, COP27 Sharm el-Sheikh, COP28 Dubai and COP30 Belem. The meeting included a discussion on how to formalise the role of health in the climate agenda, leverage the collective experiences of former COP Presidencies, and ensure alignment and continuity across all health-focused initiatives. It also sought to establish health as a core feature of future COP conferences. This followed the agreement announced on the previous day between the WHO and the Islamic Development Bank (IsDB) regarding the operationalisation of the Health Impact Investment Platform (HIIP).

Of the 70,000 registered delegates for COP29, 80 Heads of States, Governments and Vice Presidents attended the two-day World Leaders Climate Action Summit, which concluded today. Those in attendance made statements on how they are advancing the Paris Agreement on climate change, including remarks made today by Mr. John Podesta, Senior Advisor to the President for International Climate Policy for the United States and Her Excellency Ms. Giorgia Meloni, Prime Minister of Italy.

### 14 November, 2024

On the fourth day of COP29, a joint panel session organized by the COP29 Azerbaijan Operating Company and PASHA Holding, COP29 Impact Partner, the session took place on November 14.

A panel session, "Climate Finance Landscape in the South Caucasus and Central Asia", analysed the current state, challenges, and future of climate finance in the region, emphasizing sustainable investments, public-private partnerships, and existing financial mechanisms for resilience and adaptation.The discussion focused on increasing and optimizing financial support and exploring strategic partnerships.The COP29 Green Zone also hosted several panel discussions throughout the day covering diverse topics such as innovative approaches to sustainable development, carbon emission

reduction strategies, industrial sustainability, green technologies, sustainable energy, successful models for resource-based economies, and future prospects.

In the opening days of COP, there has been significant progress on Article 6 and the NCQG. Outside the negotiations, the COP29 Presidency is providing the platform for other actors to step up and contribute. Finance, Investment and Trade Day saw representatives from the private sector, multilateral development banks and philanthropic organisations, climate funds, international organisations, and civil society come together in a collective effort to finance tangible climate action.

The COP29 Business, Investment, and Philanthropy Climate Platform (BIPCP) took place today, convening over 1,000 business, finance and philanthropic leaders to discuss the active role the private sector needs to play in addressing climate change. Highlighting the event was the announcement from investor groups—with over $10 trillion in assets—that they will unite to develop a shared vision and action plan to accelerate the deployment of private capital into climate markets.

**15 November, 2024**

"Children's Eyes on Earth", an international photo contest for children and teenagers, initiated by internationally renowned photographer Reza Deghati, founder of "Reza Visual Academy," and under the patronage of Leyla Aliyeva, Head of the IDEA Public Union, officially concluded.

The international photo contest titled "Children's Eyes on Earth",' held from October 11 to November 2 for children up to the age of 18, was organized in the run-up to the 29th session of the Conference of the Parties (COP29) to the United Nations Framework Convention on Climate Change (UNFCCC). The contest aimed to raise awareness about climate challenges and invited young people to share their perspectives on the beauty of nature, as well as the challenges posed by pollution and climate change. Under the banner "I Love Nature, I Fear Pollution", the contest, which featured nearly 3000

photographs, 11 candidates were awarded. In the 10-17 age category, three candidates from the Philippines, Sri Lanka, and Malta in the 10-17 age category were awarded first, second, and third place respectively, and got prizes. In the same category, three photographers from Bangladesh, Iran, Ireland, and the UK received honorable mentions and got mentoring by Reza Deghati for their creative and thought-provoking photographs in the under-10 category, the top five finalists from Turkey, Switzerland, France, and Iran received special mentions from the jury and organizations such as the 'Reza Visual Academy,' 'Degati Agency,' and 'Webistan' for their outstanding submissions.

Today, the COP29 Presidency launched the Baku Call on Climate Action for Peace, Relief, and Recovery (BCCAP), a milestone initiative aimed at addressing the urgent nexus of climate change, conflict, and humanitarian needs. This initiative responds to the growing recognition that the adverse effects of climate change—such as water scarcity, food insecurity, land degradation and human displacement—can act as catalysts for conflict and instability, especially in the most climate-vulnerable regions.

Through multiple rounds of consultations over the last six months, the COP29 Presidency has developed, in collaboration with Partner Co-lead countries of Egypt, Italy, Germany, Uganda, the United Arab Emirates, and the United Kingdom, who has already endorsed The Call, the concrete, solution-oriented responses that build upon climate and peace initiatives championed by previous COP Presidencies. It has established the Baku Climate and Peace Action Hub as a coordination platform to deliver on pledges to mitigate challenges on peace and climate nexus.

The development of the Baku Call has been a highly inclusive process, informed by consultations with a diverse range of international partners, think tanks, governments, UN agencies, development banks, civil society, and the private sector and represents an opportunity to collectively amplify commitments to peace-sensitive climate action, while scaling up support for the most vulnerable communities worldwide.

Today at COP29, delegates and representatives from the private and public sectors and civil society came together to support initiatives and

actions centered on energy and peace, relief and recovery. Aligned with COP29's vision to enhance ambition and enable action, these commitments build a strong foundation for us to measure progress, send strong market signals to direct financial flows, and foster a sense of shared responsibility and urgency across all sectors of society. While hosting a High-Level Roundtable on Green Energy, Hydrogen and Global Energy Storage and Grids, the COP29 Presidency officially launched three energy initiatives and called on Party and non-Party stakeholders for endorsement of each. These initiatives reflect the Presidency's efforts to take forward the outcomes of the first Global Stocktake on renewable energy and hydrogen.

The Baku Call was launched at the High-level panel titled "Climate and Peace: Enabling Joint Action to Leave No One Behind" to inaugurate the COP29 Peace, Relief, and Recovery Day, which brought together ministers and governmental envoys from both the Global North and South to develop a strategy for increased prevention of climate-induced conflicts and support for climate and conflict vulnerable nations with high humanitarian needs.

### The COP Truce Appeal

The COP Truce Appeal was unveiled today, symbolizing the role of cooperation and peace as indispensable components of global climate action. 132 countries have joined the Appeal, which is supported by over a thousand international institutions, private sector representatives, civil society organizations and influential public figures.

UNIDO and the Climate Club also today officially launched the Global Matchmaking Platform (GMP) for Industrial Decarbonisation, which is a platform dedicated to accelerating decarbonisation in heavy-emitting industries in the presence of key donor and partner organisations. As the only platform of its kind focused specifically on decarbonising industrial sectors, GMP is open to all emerging and developing economies and connects country-specific needs with global technical and financial assistance to reduce emissions in energy and emissions-intensive industrial sectors. UNIDO

and the Climate Club accepted formal project and programme application requests from countries as well as expressions of interest in becoming network partners from institutions and donors.

Today, at Peace, Relief, and Recovery Day at COP29, the COP29 Presidency announced that a total of 132 countries have joined the COP Truce Appeal, an initiative which is also supported by more than a thousand international institutions, private sector representatives, civil society organisations, and influential public figures. The "COP Truce" urged nations to halt military operations during the month of the conference.

This appeal, inspired by the Olympic Truce, represents a powerful initiative from the COP29 Presidency, designed to foster peace, environmental preservation, and the global fight against climate change. The COP Truce draws its inspiration from the Olympic Truce, which has been revived by the international community since the early 1990s. Rooted in a United Nations resolution passed in 1993, the Olympic Truce calls on nations to suspend hostilities during the Olympic Games as a symbol of peace and unity. This tradition has been honoured biannually, with the latest resolution reaffirming the Olympic Truce in November 2023. Recognising the similar need for unity in the climate crisis, the COP29 Presidency has adapted this concept to create the COP Truce initiative, calling for a halt to military operations during the month of the conference.

### 16 November, 2024

The COP29 Presidency today launched the global conference's inaugural Digitalisation Day with more than 90 governments and over 1,000 members of the digital tech community, including companies, civil society organisations, and international and regional organisations endorsing the COP29 Declaration on Green Digital Action.As part of the COP29 Action Agenda in September 2024, the COP29 Presidency has focused on building support amongst multisector partners for the Declaration, which urges to use of digital

tools to reduce greenhouse gas (GHG) emissions, strengthen climate resilience, and advance sustainable development.

The introduction of the Digitalisation Day to the thematic programming for the conference reflected the critical role of technology in addressing climate change. It also reflected the COP29 Presidency's commitment to integrating digital solutions into global climate action, in collaboration with the International Telecommunication Union (ITU), the UNFCCC Technology Executive Committee (TEC), and other partners. It builds on efforts launched at COP28 by ITU and over 40 partners to underscore the challenges and opportunities in harnessing technology for climate action. Through this initiative, COP29 aimed to place digitalisation at the heart of climate action, empowering nations and communities to adapt to and mitigate the effects of climate change.

The other joint panel session was held by the COP29 Azerbaijan Operating Company and CISCO.The panel session, titled "Empowering Youth for a Digital Climate Revolution", focused on digital solutions for climate action, highlighting the crucial role of young people as drivers of innovation and change. The discussion highlighted how digital technologies are revolutionizing climate action, with young people emerging as key players in leveraging digital tools to advocate for sustainability, monitor environmental impacts, and scale climate initiatives. The event showcased cutting-edge digital platforms, applications, and AI-powered solutions enabling real-time youth engagement in climate action. Throughout the day, the Green Zone also featured a variety of activities. These covered a range of topics including progress on decarbonization commitments, the role of corporations in ensuring sustainability, leveraging green fintech and climate technology to close the climate finance gap, and achieving financial inclusion through digital technologies.

17 November, 2024

Sustainable carpets made with the theme of global climate challenges using sustainable materials and dyes, a collaboration between COP29 Azerbaijan Operating Company and Azerkhalcha OJSC, were showcased to delegates at the COP29 climate event in Baku, starting November 11. Displayed in both the Blue and Green Zones of the Baku Stadium, venue for COP29, these carpets represented a fusion of Azerbaijan's rich cultural heritage and its commitment to addressing contemporary environmental challenges. Made entirely from sustainable materials, reflecting the conference's green ethos, each carpet was hand-woven by Azerbaijani women artisans at Azerkhalcha OJSC's Shabran workshop. The project not only provided economic support to women craftspeople from remote regions but also offered a platform to share their stories about climate change through their artistry. The artworks combined art and environmental advocacy to promote environmental awareness by highlighting the importance of cultural heritage.

A key event was a joint panel session hosted by the COP29 Azerbaijan Operating Company and Azercell Telecom, COP29's Telecommunications Partner, on November 17. The panel discussion titled "Women Leading the Charge: Climate Champions for a Sustainable Future", brought together leading female experts and climate leaders driving transformative change in combating climate change. The panel discussion focused on the role of gender equality in combating climate change, exploring how to expand women's contributions to climate resilience and environmental protection, and proposing solutions to gender-based challenges in this area. Participants emphasized the importance of amplifying women's voices and initiatives for more effective global climate action, highlighting the need to promote women's participation at all levels of climate action, particularly in decision-making processes.

### An event on "Strategic Day for Trade Unions" was held within the framework of COP29

A "Strategic Day for Trade Unions" event was held within the framework of COP29 on November 17. The event was attended by ITUC Secretary General Luc Triangle, as well as representatives of trade unions from various countries participating in COP29. Secretary General Luc Triangle expressed his satisfaction with the exemplary organization of COP29 and noted that the discussions and outcomes would be beneficial in the fight against the impacts of climate change.

The Chairman of the Azerbaijan Trade Unions Confederation, Sahib Mammadov, emphasized that our country has always taken a sensitive approach to global issues and that President Ilham Aliyev has put forward important initiatives concerning the future of humanity. The Chairman of Confederation also highlighted the tasks of trade unions in the fight against climate change and stressed the importance of solidarity and cooperation in this regard.

Bert De Vel, ITUC's Global Climate Policy Coordinator, shared his thoughts on the negotiations, discussed issues, and priorities addressed during the event. Within the framework of the event, thematic sessions were held, where emerging trends in labor rights related to climate change were discussed and proposals were made.

### ITUC Deputy Secretary General: "I am impressed by the Beauty of Baku "

Erik Manzi, Deputy Secretary General of the International Trade Union Confederation (ITUC), who participated in COP29, visited the UNESCO World Heritage site of the Old City (Icherisheher) in Baku. Sahib Mammadov, Chairman of the Azerbaijan Trade Unions Confederation (ATUC), provided the guest with information about the historical and architectural landmarks.

The ITUC Deputy Secretary General also had the opportunity to observe the natural phenomenon of the flaming hill at the "Yanar Dag" State Historical, Cultural, and Natural Reserve.

Deputy Secretary General Eric Manzi visited the Buzovna Physiotherapy Center of the Confederation of Trade Unions of Azerbaijan and got acquainted with the conditions created there. He also met with ATUC volunteers and was briefed on the "ATUC Volunteers" program, highlighting the active involvement of the volunteers in organizing COP29.

Erik Manzi expressed his pleasure in being in our country, shared his positive impressions of Azerbaijan, and emphasized that COP29 was organized at a high level, particularly noting the hospitality of the Azerbaijani people.

18 November, 2024

The COP29 Presidency has hosted the meeting of COP29 International Advisory Committee (IAC), attended by distinguished guests and members of the Committee. Members of the International Advisory Committee (IAC), including eminent leaders such as Vaira Vike-Freiberga, Rosen Plevneliev, Joyce Banda, Maria Fernanda Espinosa, Maimunah Mohd Sharif, Abid Qaiyum Suleri, Hindou Oumaru Ibrahim, Patricia Espinosa, Izabella Teixeira, Ismahane Elouafi, Todd Stern and the guest of honour Tarja Halonen discussed the importance of strategic guidance on engaging with Parties and non-Party stakeholders for promoting effective solutions that would support further developments on NCQG, loss and damage, mitigation and adaptation and other related topics at COP29. Makhtar Diop, Managing Director of the International Finance Corporation (IFC) addressed the Committee members via a special video message.

Today, the COP29 Presidency formally recognised 11 countries for their leadership in submitting their Biennial Transparency Reports (BTRs) ahead of the December 31st deadline. The Presidency also recognised the efforts of all other Parties who have committed to the timely submission of their BTRs.

The COP29 Presidency highlighted early submitters during the ministerial roundtable on global climate transparency, where countries joined the COP29 Presidency in endorsing the Baku Declaration on Climate Transparency in a

show of global commitment to the full operationalisation of the Enhanced Transparency Framework (ETF). The ETF is a crucial enabling mechanism designed to build mutual trust and promote effective implementation of the Paris Agreement. Transparency is essential for building trust between Parties and enhancing international cooperation. Endorsed by state and non-state actors, the Declaration will complement the Baku Transparency Platform (BTP) and support Parties in delivering on their transparency requirements.

Alongside the COP29 Blue Zone, a series of events continued in the Green Zone, a dynamic platform for diverse stakeholders to share their perspectives, organized and managed by the COP29 Presidency. A joint panel session was held in the Green Zone by the COP29 Azerbaijan Operating Company and NEQSOL Holding, Synergy Partner of COP29.The panel discussion, focused on Raising Human Capital for Green Future, explored the role of human capital, particularly children and youth, in building a sustainable, low-carbon future. Panellists emphasized the need for innovative solutions and support for sustainable economies, given the unprecedented challenges posed by climate change. They stressed the importance of equipping future generations with the necessary knowledge, skills, and environmental awareness to address these issues. By focusing on education and capacity building, young people can be empowered to contribute to a sustainable future and lead the green transition.

Today, representatives of international organisations, multilateral development banks, and international climate and environmental funds endorsed the Baku Initiative on Human Development for Climate Resilience.

This year, the COP29 Presidency hosted the first holistic Human Development Day to bring together these inter-related issues and support them with commensurate financing and multi-faceted policy approaches. The statement was issued during the High-Level Meeting on the Baku Initiative on Human Development for Climate Resilience, hosted by the COP29 Presidency. It seeks to enhance cooperation between these organisations and bridge global efforts to address climate change impacts on human development. Galvanising actors from across different sectors, it also

contributed to enhancing climate finance and embedding human development into climate resilience strategies.

19 November, 2024

Azerbaijan made history at COP29, becoming the first country to receive ISO 20121 Certification for Sustainable Management and Delivery of the Event. An award ceremony celebrating the COP29 Azerbaijan Operating Company's achievement was held on November 18 at the Azerbaijan Pavilion.The ceremony was attended by UNFCCC officials, COP29 Azerbaijan Operating Company leadership and representatives of strategic contractors. The event highlighted the COP29 Azerbaijan Operating Company's commitment to effective implementation and lasting impact of sustainable event management principles. Furthermore, a panel discussion on "ISO 20121 – Sustainable Event Management and Delivery" was held during the event. The discussion covered the implementation of sustainability principles, operational transparency, and showcase of successful international best practices.

A joint panel discussion on sustainable tourism was held by the COP29 Azerbaijan Operating Company and AZERSUN Holding, COP29's Sustainable Growth Partner. Experts, sustainability researchers, business leaders, and tourism professionals gathered at an event titled "Slow Food, Low Impact: Advancing Sustainable Tourism with Local Agriproducts" to discuss how the Slow Food movement and sustainable agriculture principles can foster low-impact tourism. Panellists discussed the role of local agricultural products and sustainable farming practices in reducing the food industry's carbon footprint and promoting eco-friendly tourism experiences. The discussion highlighted how prioritizing local produce and supporting sustainable agriculture can reduce tourism's carbon footprint, enhance the travel experience, and foster a greener, more sustainable future.

Today, the COP29 Presidency also launched the Reducing Methane from Organic Waste Declaration, with over 30 states amongst the initial signatories

(who combined represent 47% of global methane emissions from organic waste) declaring their commitment to set sectoral targets to reducing methane from organic waste within future NDCs. This includes 7 of the world's 10 largest organic waste methane emitters. Signatories commit to launching concrete policies and roadmaps to meet these sectoral methane targets. This declaration, developed with the UNEP-convened Climate and Clean Air Coalition (CCAC), builds on the work of previous COPs by supporting the implementation of the 2021 Global Methane Pledge (GMP), launched at COP26. The GMP sets a global target of reducing methane emissions by at least 30% below 2020 levels by 2030. Organic waste is the third largest source of anthropogenic methane emissions, behind agriculture and fossil fuels, meaning that action on this sector is crucial to meet the goals of the GMP.

Also today, the COP29 Presidency, in partnership with the Food and Agriculture Organization of the United Nations (FAO), officially launched the Baku Harmoniya Climate Initiative for Farmers, to acknowledge the fundamental role of farmers as agents of climate action. This leading effort will bring together on one platform the dispersed landscape of existing climate initiatives in the field of food and agriculture. In doing so, the platform will help to identify gaps and opportunities for future policymaking and support that recognise and empower farmers, villages and rural communities. Building on strong collaborations with financial institutions, Harmoniya will develop an online portal and produce accessible guidelines for farmers and agricultural organisations, making support easier to find and access.

Alongside this, the Ministry of Agriculture of Azerbaijan, in partnership with the UNEP-convened Climate and Clean Air Coalition, has announced today a new cooperation on the development of a methane reduction roadmap for the country's agricultural sector. This collaboration supports Azerbaijan's commitment to the Global Methane Pledge and aims to implement innovative, sustainable practices in livestock management and manure systems.

20 November, 2024

A panel discussion titled "Enhanced Climate Action in Tourism: Innovative Solutions and Way Forward" explored the future of sustainable tourism and how to minimize the industry's environmental impact while boosting local economies and preserving cultural heritage. Tourism experts on the panel shared best practices for reducing carbon emissions, protecting biodiversity, and ensuring both economic and ecological sustainability in the tourism sector. The discussion highlighted how innovative approaches like ecotourism, green infrastructure, and responsible travel can contribute to the development of global tourism. In addition to the panel discussion, the COP29 Green Zone featured other events throughout the day focusing on sustainable urban infrastructure development, creating more resilient, inclusive, and human-centred environments, tourism's contribution to climate resilience and ecosystem restoration, and decarbonizing the construction sector. Local and international experts participated in these discussions.

On the tenth day of COP29, thematic sessions centered on urbanization, transport and tourism. The day was marked by the launch of two key initiatives: the COP29 MAP Declaration for Resilient and Healthy Cities and the COP29 Declaration on Enhanced Climate Action in Tourism.These initiatives are set to play a vital role in tackling climate change and promoting urban resilience. With its tourism declaration, the COP29 Presidency is focused on supporting the tourism sector, a key economic driver, in adopting sustainable practices to reduce its environmental impact. This is the first time that the COP Presidency has organised a tourism focused thematic day whilst the MAP Declaration calls for cross-sector collaboration to create cities that are resilient and inclusive.

Together, these initiatives set the stage for global action towards a sustainable future. The commitments they represent are vital for shaping the path to COP30 and will play a crucial role in advancing urban climate strategies and solutions.

### COP29 Declaration on Enhanced Climate Action in Tourism

Launched in partnership with UN Tourism, the COP29 tourism initiative aims to drive climate action within the global tourism sector. A number of ministers and other high-level representatives participated in the First Ministerial Meeting on Enhanced Climate Action in Tourism, where the COP29 Presidency unveiled ambitious plans to align the sector with climate action goals.

**21 November, 2024**

In the final day of its thematic agenda, the COP29 Presidency launched Water for Climate Action, part of its Action Agenda. This programme includes a declaration, so far endorsed by nearly 50 countries, which commits to taking integrated approaches to combat the causes and impacts of climate change on water basins, paving the way for greater regional and international cooperation. It also calls for the integration of water-related mitigation and adaptation measures in national climate policies, including NDCs and NAPs. To support these efforts, signatories will work together to strengthen the generation of scientific evidence on the causes and impacts of climate change on water resources and water basins, including through data sharing and the creation of new basin-wide climate scenarios. The declaration has been endorsed by prominent non-state actors, including WWF, Water.org & Water Equity, Stockholm International Water Institute and the Islamic Development Bank.

The Baku Dialogue on Water for Climate Action was also launched today in an event featuring high-level representatives from the European Union, Finland, Gambia, Germany, Moldova, the Netherlands, Slovenia, the United Arab Emirates, the United Kingdom, and the United States. The platform builds collaboration between COPs on water and its interplay with climate change, biodiversity loss, pollution and desertification—ensuring this important topic stays on the climate agenda.

The COP29 Azerbaijan Operating Company hosted another session in the Green Zone.A panel session titled "SIDS' Ecosystems and Communities Amid Climate Change" discussed the challenges faced by developing SIDS in combating the escalating impacts of climate change. The panel highlighted how issues ranging from sea-level rise and extreme weather events to the loss of vital ecosystems make small island developing states (SIDS) particularly vulnerable. The session discussed the socio-economic consequences of climate change for these nations, including displacement, livelihood losses, and the weakening of economies reliant on marine and coastal resources. The degradation of natural ecosystems and the resulting threats to biodiversity and the livelihoods of indigenous communities were also key discussion points.

22 November, 2024

Throughout the year, the COP29 Presidency has been pushing for a fair and ambitious new climate finance goal, taking into account the needs and priorities of developing country Parties. These texts form a balanced and streamlined package for COP29. The COP29 Presidency urges Parties to study this text intently, to pave the way towards consensus, on the few options remaining. As a first reflection of Parties indications the New Collective Quantified Goal decision contains a call on all Parties to work together to scale up financing to developing countries for climate action from all public and private sources to at least USD 1.3 trillion per year by 2035.Further, reflecting the submission of developed country parties, it includes a decision to set a goal in extension of the goal of jointly mobilizing USD 100 billion per year, with developed country Parties taking the lead, to USD 250 billion by 2035 for developing country Parties for climate action.

A panel discussion titled "Building Tomorrow: The Legacy of COP29 in Azerbaijan" took place in the Green Zone on November 22, the final day of COP29. The event was jointly organised by the COP29 Azerbaijan Operating Company and GILTEX, the Green Zone's Textile Partner. The panel focused on the long-term impact and shaping of the COP29 legacy.

This closing discussion, held after eleven days of the conference, highlighted COP29's legacy in driving sustainable development and combating climate change both locally and globally. Participants shared their perspectives on opportunities for Azerbaijan to create a lasting legacy of climate leadership. The discussion also touched upon advancements in corporate ESG (Environmental, Social, and Governance), investment in renewable energy and innovation, and policy changes geared towards building a sustainable, low-carbon future.

### 23 November, 2024

The COP29 Presidency announced the end of the decade-long wait for the conclusion of negotiations on high integrity carbon markets under Article 6 of the Paris Agreement. This was one of the Presidency's top priorities for the year and it drove Parties towards this milestone achievement through intensive dual-track technical and political negotiations. This strategy broke through years of stalemate and finalises the last outstanding item in the Paris Agreement. Article 6 provides trusted and transparent carbon markets for countries as they collaborate to reach their climate goals. This cross-border cooperation is expected to reduce the cost of implementing countries' national climate plans (NDCs) by up to $250 billion per year.

The COP29 Presidency encourages Parties to reinvest these savings in even greater climate ambition. The next generation of NDCs, due in February, are make-or-break for the world's hopes of keeping 1.5 degrees within reach. Today's milestone has been reached just in time to aid countries in committing to more ambition in their climate plans. The COP29 Presidency employed a dedicated approach that unlocked previous multilateral stalemates. Throughout the year, the Presidency fostered productive engagement between Parties and drove progress by bridging the technical and political discussions to create consensus. This set the ground for early adoption of Article 6.4 standards on day one of COP29, which in turn-built momentum towards today's breakthrough. The COP29 Presidency

acknowledges with gratitude the many individuals and organisations that have been working tirelessly for nearly a decade to reach this achievement.

Today's consensus would not have been possible without the progress they achieved through their years of efforts. The decisions unanimously adopted today on Article 6 will play a pivotal role in ensuring environmental integrity, transparency and robustness of carbon markets through real, additional, verified and measurable emission reductions and removals, while also unleashing their enormous potential to drive global climate investment.

The guidelines and rules adopted are designed to ensure that carbon projects maintain practicality and inclusivity, respect human rights and provide support to sustainable development, enabling countries and project developers to cooperate under the Paris Agreement with confidence. The adoption of these decisions does not mark the end of their evolution. The Parties can continually adjust the Article 6 rulebook as they learn by doing.

### Historic Decision in Baku: The Loss and Damage Fund fully operationalized

At COP29, a decision was made to ensure the full operationalization of the Loss and Damage Fund, long awaited by developing countries, including small island states, least developed countries, and African nations. This aligns with the priority set by the President of the Republic of Azerbaijan, Mr. Ilham Aliyev, to address the challenges posed by climate change impacts on small island states under the COP29 Presidency.The establishment of the Loss and Damage Fund was agreed upon during COP27 held in Egypt. The fund aims to provide financial assistance to countries most vulnerable to the impacts of climate change. During COP28 in the United Arab Emirates, a decision was made to launch the Fund's operations.

The COP29 Presidency has taken significant steps to ensure the Fund's operationalization, working closely with its Board and the World Bank. In September of this year, during the Fund's third Board meeting held in Baku, critical measures were taken to commence its operations, including the appointment of Ibrahima Cheikh Diong as the Fund's Executive Director. Within

the framework of COP29, several important agreements related to the Loss and Damage Fund were signed. These include the "Trustee Agreement" and "Secretariat Hosting Agreement" between the Fund's Board and the World Bank, as well as the "Host Country Agreement" between the Fund's Board and the host country, the Republic of the Philippines.To date, the total pledged financial support for the Fund exceeds $730 million. With these achievements, the Loss and Damage Fund will be able to start financing projects beginning in 2025. This marks yet another success of Azerbaijan's COP29 Presidency.

**24 November, 2024**

The COP29 Presidency of Azerbaijan today announced the agreement of the Baku Finance Goal (BFG), a new commitment to channel $1.3tn of climate finance to the developing world each year. Success on the COP29 Presidency's top priority for the UN Climate Summit represents a significant uplift from the previous climate finance goal of $100 billion and will unlock a new wave of global investment.

The Baku Finance Goal contains a core target for developed countries to take the lead on mobilizing at least $300 billion per year for developing countries by 2035. This represents a $50bn increase on the previous draft text, and is the product of 48 hours of intensive diplomacy by the COP29 Presidency. It pays special consideration to support the least developed countries and small island developing states, with provisions on accessibility and transparency. The Baku Finance Goal is the centrepiece of a package of agreements that deliver progress across all climate pillars. These breakthroughs are the result of months of intensive diplomacy by the Azerbaijani Presidency to deliver some of the most complex and controversial tasks in multilateral climate action. They mark a critical step in putting in place the means to deliver a pathway to 1.5C. COP29 ended the decade-long wait for the conclusion of Article 6 negotiations on high integrity carbon markets under the UN. Financial flows from compliant carbon markets could reach $1 trillion per year by 2050. They also have the potential to reduce the cost of implementing national climate plans by $250 billion per year. When combined, the Baku Finance Goal and Article 6 will forever change the

global climate finance architecture by redirecting investment to the developing world. In the plenary session, Parties in Baku unanimously agreed to an expression of gratitude to the government of the Republic of Azerbaijan and to the people of Azerbaijan for the generosity and hospitality they demonstrated in hosting the 29th Conference of the Parties.

The successful agreement of the Baku Finance Goal comes as part of a series of achievements that the COP29 Presidency delivered and secured, as in Annex 1.

## Annex 1: COP29 Achievements

Parallel to delivering a balanced package of negotiated priorities, the COP29 Presidency's Action Agenda called on a wider group of stakeholders to contribute to global climate action. The Action Agenda Initiatives confront some of the most pressing problems, shine a light on forgotten priorities, offer unique solutions based on the experiences and perspective of the host, and reinforce coherence and COP-to-COP continuity. These Initiatives were designed in an inclusive and transparent process in consultation with all stakeholders. They serve to complement existing initiatives and bring new, creative approaches to climate challenges.

Together, these Initiatives will support the implementation of ambitious climate action.

**Baku Initiative for Climate Finance, Investment and Trade (BICFIT) Dialogue:** The COP29 Presidency brought UN agencies, international organisations, multilateral development banks, multilateral climate funds, the private sector, civil society, key coalition, and other stakeholders, alongside COP Presidencies and Parties together to ensure that finance, investment and trade remain at the centre of the climate agenda. Announced the new Baku Climate Coalition for SMEs Green Transition.

**Energy pledges and declarations:** The COP29 Presidency launched its pledges and declarations on energy storage, grids, zones, corridors and hydrogen, which were endorsed by more than 150 parties.

**COP29 Declaration on Green Digital Action**: More than 83 governments and around 2000 stakeholders endorsed the declaration to use digital tools to reduce emissions and strengthen climate resilience.

**Baku Initiative on Human Development for Climate Resilience:** A joint statement among 8 UN agencies, 3 MDBs and 3 climate funds, saw the adoption of the Baku Guiding Principles on Human Development for Climate Resilience and established the Baku COP Presidencies Continuity Coalition for Climate and Health.

**Climate and Health Continuity Coalition:** Five COP Presidencies (COP26 to COP30), alongside the WHO Director-General, embedded health into the climate agenda—and advocated for health to be a core feature of future COP conferences—by introducing the Baku COP Presidencies Continuity Coalition for Climate and Health.

**Reducing Methane from Organic Waste Declaration:** Over 65 countries—including 8 of the world's 10 largest organic waste methane emitters and representing 51% of global methane emissions from organic waste—endorsed the declaration committing to sectoral targets to reduce methane from organic waste within future NDC, which will contribute to the implementation of the Global Methane Pledge.

**Baku Harmoniya Climate Initiative for Farmers**: A platform that brings together the dispersed landscape of existing climate initiatives in the field of food and agriculture, in order to make support for farmers easier to find and to facilitate access to finance.

**COP29 MAP Declaration for Resilient and Healthy Cities:** Brings together UN agencies and IGOs, MDBs, MCFs, philanthropic organisations, bilateral donors and implementing agencies for partnership and collaboration on urban climate finance, with over 160 endorsers, including more than 40 Parties, intending to work on multisectoral approaches to climate action and

planning in urban areas. Launched Baku Continuity Coalition for Urban Climate Action, which takes a multisectoral and multilevel approach to continuity and coherence between COP, UNFCCC and UN Habitat urban processes.

**COP29 Declaration on Enhanced Action in Tourism:** Commits more than 70 government endorsers to promote sustainable tourism practices by reducing emissions and increasing resilience in the sector—ultimately positioning tourism as a key component of climate solutions.

**COP29 Declaration on Water for Climate Action:** With endorsers from over 69 countries, this declaration will take an integrated approach to combating the causes and impacts of climate change on water basins and water-related ecosystems. It advocates for the integrations of water-related mitigation and adaptation measures in national climate policies, including NDCs and NAPs.

### Significant progress made throughout the course of the two weeks

In addition to its Action Agenda initiatives, the COP29 Presidency made progress in several priority areas for ambitious climate action. This included advancing transparency and securing funding for Loss and Damage. In addition to Presidency-led initiatives, Parties and other stakeholders stepped up and showed leadership with their own commitments.

- The COP29 Presidency placed a significant emphasis on the importance of transparency and Biennial Transparency Reports (BTRs) by launching the Baku Transparency Platform and calling for early submissions from Parties, resulting in 11 Parties plus the European Union submitting before the 31 December deadline. Leading by example, the Presidency also submitted its own BTR.
- Parties continued progress towards the goal of operationalizing Article 6, which would direct resources to the developing world and reduce the cost of implementing national climate plans. They reached consensus on Article 6.4 standards for trusted and transparent carbon markets and

concluded negotiations on Article 6.8 which facilitates international cooperation through non-market approaches to implementing national climate plans and promoting sustainable development.

- During the World Leaders Climate Action Summit, 80 Heads of States, Governments and Vice-Presidents delivered official statements on how they are advancing the Paris Agreement and committing to climate action, addressing the need to raise ambition for mitigation and adaptation.
- Multilateral Development Banks (MDBs) announced projections for their contributions to climate action as $170 billion per year by 2030, with $120 for low- and middle-income countries.
- Positioned the Fund for responding to Loss and Damage to be ready to distribute funds in 2025 by securing contributor agreements and pledges as well as signing the host country agreement with the Philippines and hosting and trustee agreements with the World Bank. The largest contributions made during COP29 came from Australia and Sweden. Total pledges to the Fund to date have surpassed $730 million.
- Countries—including the US, China, EU, UAE, UK, Brazil, Canada, and Nigeria—came together and announced policies focused on reducing methane from organic waste.
- Ensured the participation of Small Island Developing States (SIDS) throughout the conference, creating opportunities for them to raise key priorities and concerns, such as accessibility of climate finance.
- Brought together over 1,000 private and philanthropic leaders from more than 70 countries at the Business Investment and Philanthropy Climate Platform (BIPCP) where investor groups with over $10 trillion in assets united to deploy private capital into climate markets.
- Pledges to climate finance projects and initiatives totaled $7.3 billion on Finance, Investment and Trade Day, with the largest support coming from the Asian Development Bank ($3.5 billion), the Azerbaijani banking sector ($1.2 billion), Sweden ($760 million) and Canada ($1.5 billion from the Canadian Government and $290 million from philanthropies) on

investments in combating impacts of melting glaciers, green taxonomies, and climate action.

- Development finance institutions pledged to support the 10GW Lighthouse Initiative for renewable hydrogen projects in emerging markets and developing countries.
- Over 50 shipping industry actors agreed to accelerate zero and near-zero emission fuels by 2030, translating to at least 5 million tonnes of green hydrogen.
- As part of a $193 million package for various clean energy initiatives, the UK supported clean cooking for 10 million people across Sub-Saharan Africa, South Asia, and the Indo-Pacific to leave coal and wood cooking behind.
- Signified the role of cooperation and peace as indispensable to global climate action—with the COP Truce Appeal garnering support from 132 countries and 1,200+ organizations, as well as the Baku Call on Climate Action for Peace, Relief and Recovery being adopted, an initiative which will launch the Baku Climate and Peace Action Hub to address the urgent nexus of climate change, conflict, and humanitarian needs.
- With Germany's pledge of $65.1 million and Ireland's pledge of $13 million, contributions to the Adaptation Fund reached $133 million.
- Climate Investment Funds increased, collecting additional contributions from the US ($325 million), Germany ($220 million), and the UK ($211 million).
- 25 countries and the European Union indicated their intentions to put forward national climate plans that reflect no new unabated coal in their energy systems and issued a call to action for others to do the same.
- Mexico announced their commitment to net-zero emissions by 2050, meaning all G20 members have committed to a net-zero target.
- *Local Communities and Indigenous Peoples*: Established the Baku Workplan of the Local Communities and Indigenous Peoples Platform.
- *UK government pledges £239 million ($299 million USD)*: The UK government has pledged over $299 million to tackle deforestation, including money to support the development of high-integrity forest carbon markets, for blended finance for sustainable forest enterprises, and for the UNFCCC to help countries protect forests.

### Adaptation

COP29 was an important moment for adaptation, with the delivery of several key outcomes. The COP decision on matters relating to the least developed countries (LDCs) contains a provision for the establishment of a support programme for the implementation of National Adaptation Plans (NAPs) for the LDCs. Parties extensively discussed the second five-year assessment of progress to formulate and implement NAPs, and will continue that in June 2025. A High-Level Dialogue on National Adaptation Plans convened ministers from least developed countries and small island developing States, financial experts and international donors to address the growing urgency of climate adaptation. Their discussions focused on innovative financing, technical support, and accelerated action to meet the 2025 submission deadline for NAPs. The event concluded with a strong call to action to expedite NAPs and translate plans into tangible outcomes. The outcome on the global goal on adaptation sets a clear path forward on the road to COP30 for the indicators work programme, providing a process for experts to continue their technical work before passing the baton to Parties. COP29 also launched the Baku Adaptation Road Map and Baku high-level dialogue on adaptation to enhance the implementation of the UAE Framework. Finally, the outcome raises ambition by agreeing to continue unpacking transformational adaptation moving forward.

COP29 took a decisive step forward to elevate the voices of Indigenous Peoples and local communities in climate action, adopting the Baku Workplan and renewing the mandate of the Facilitative Working Group (FWG) of the Local Communities and Indigenous Peoples Platform (LCIPP). The adopted decision acknowledges the progress made by the FWG in fostering collaboration among Parties, Indigenous Peoples and local communities, andunderscores the leadership of Indigenous Peoples and local communities in addressing the climate crisis.

### Gender and climate change

Countries agreed a decision on gender and climate change, extending the enhanced Lima Work Programme on Gender and Climate Change for another 10 years, reaffirming the importance of gender equality and advancing gender mainstreaming throughout the convention. They also agreed to develop a new gender action plan for adoption at COP30, which will set the direction for concrete implementation.

### Civil society participation, children and youth

World leaders at COP29 were joined by civil society, subnationals, business, Indigenous Peoples, youth, philanthropy, and international organizations. More than 55,000 people attended COP29 to share ideas, solutions, and build partnerships and coalitions. The decisions taken at COP29 also reemphasize the critical importance of empowering all stakeholders to engage in climate action; in particular under Action for Climate Empowerment (ACE). Parties recalled the importance of integrating ACE elements into national climate change policies, plans, strategies and action, and noted the secretariat's compendium of good practices for integrating ACE elements into NDCs. COP29 marked a significant milestone as dedicated spaces were created to ensure the meaningful participation of children within the Youth-led Climate Forum for the first time. Four children, including the youngest at just 10 years old, took on roles as moderators and speakers, engaging directly with Parties and observer organizations. Their participation highlighted the importance of inclusivity and intergenerational collaboration in driving climate action. In parallel with the formal negotiations, the Global Climate Action space at COP29 provided a platform for governments, businesses and civil society to collaborate and showcase their real-world climate solutions.

We were very pleased that Azerbaijan was chosen as the host country of COP29. Azerbaijan was very successful in hosting and organizing the Conference of the Parties (COP29), the world's biggest event in the field of climate and the fight against environmental change. Azerbaijan has proved

its great organizational power, distinguished human capital and advanced technical skills.

We would like to conclude by reiterating our sincere gratitude to **His Excellency Ilham Aliyev, President of the Republic of Azerbaijan**, and to **First Lady Mehriban Aliyeva, First Vice-President of the Republic, ICESCO Goodwill Ambassador,** for the success of the COP29 and for making Baku one of the safest, most organized and developed world capitals, having brought together the most important international policy makers and players in climate action.

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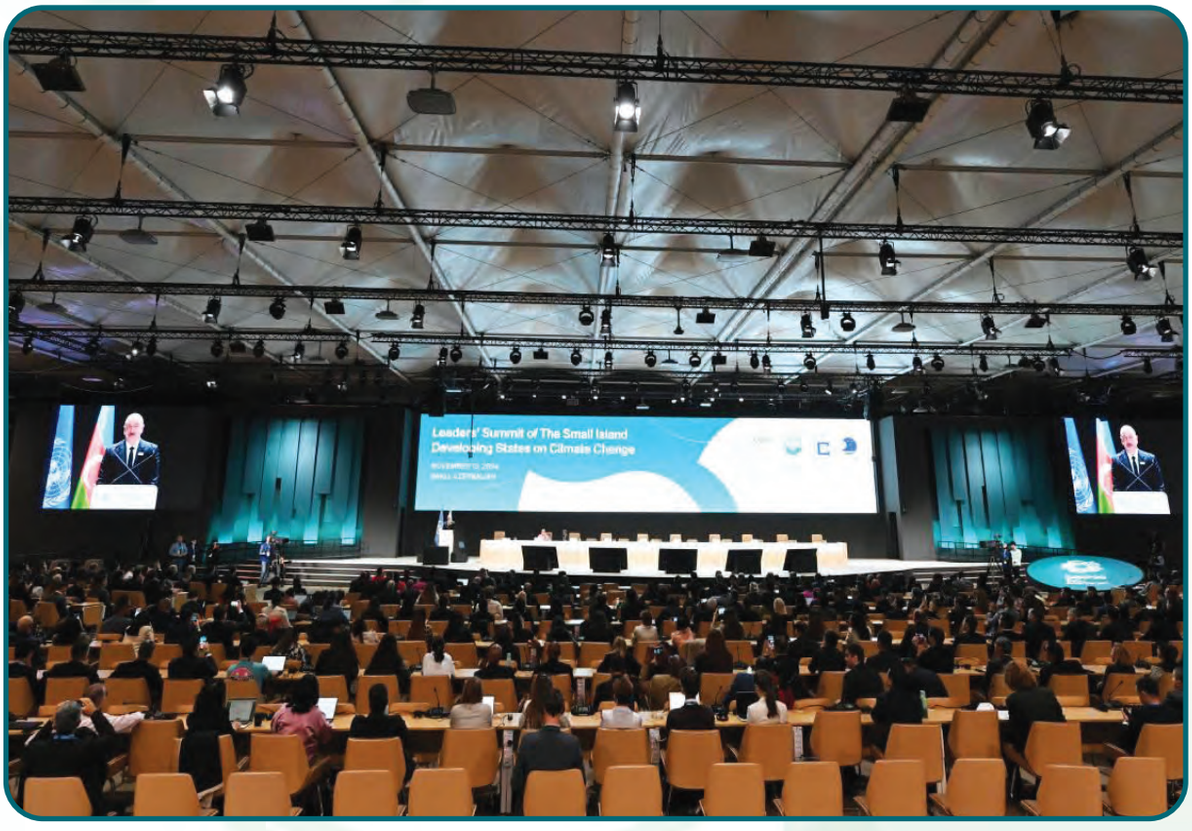
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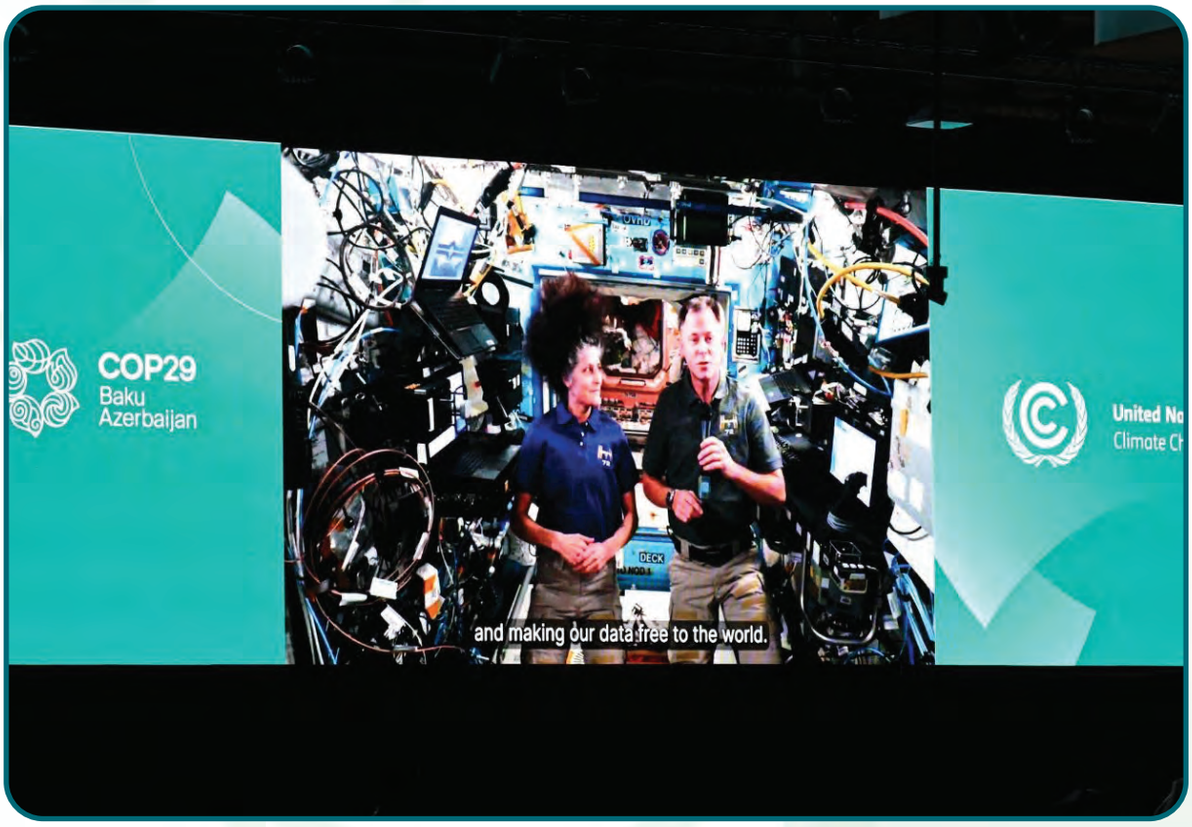
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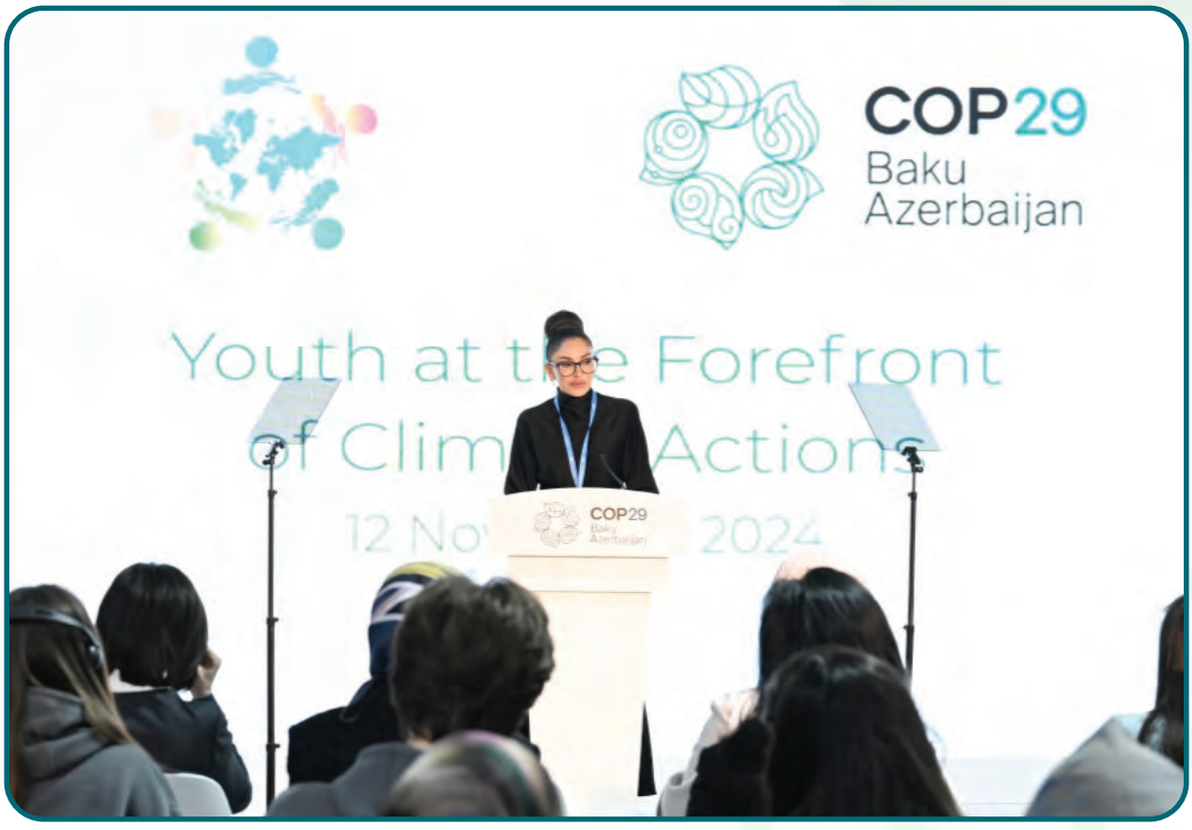
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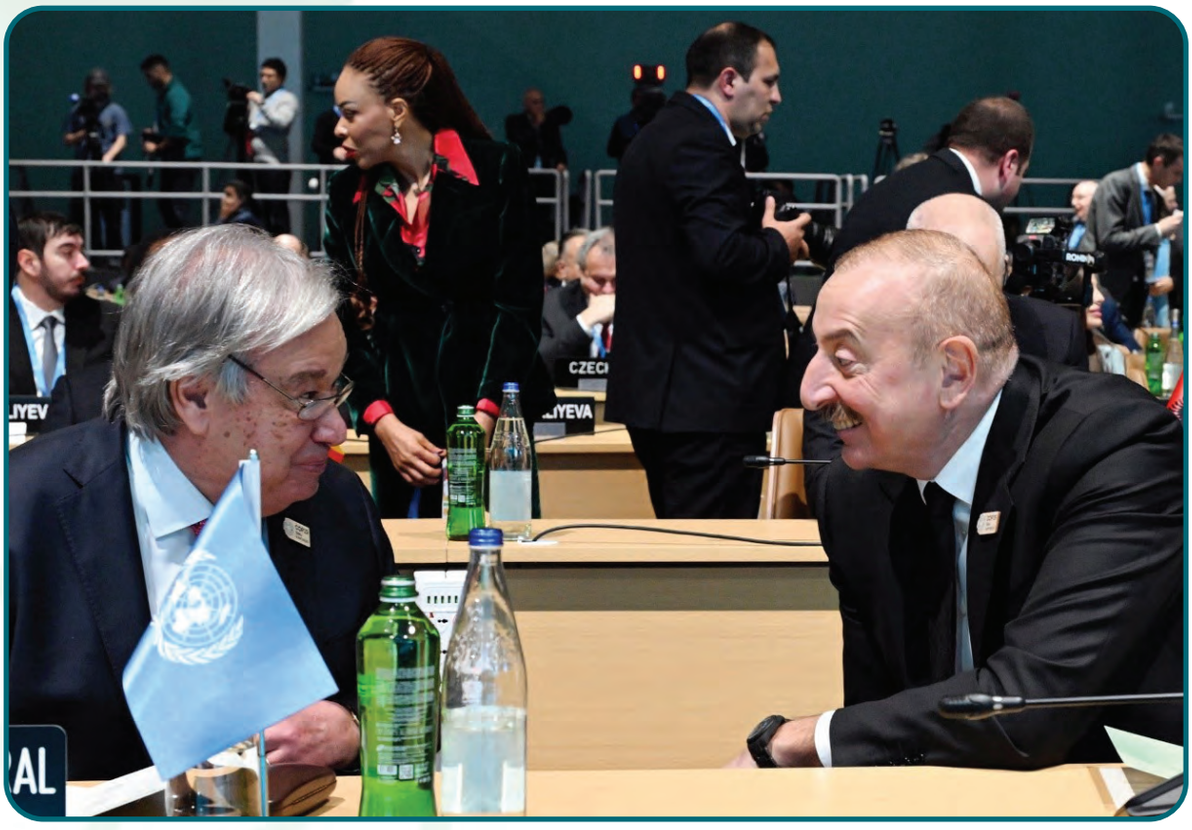


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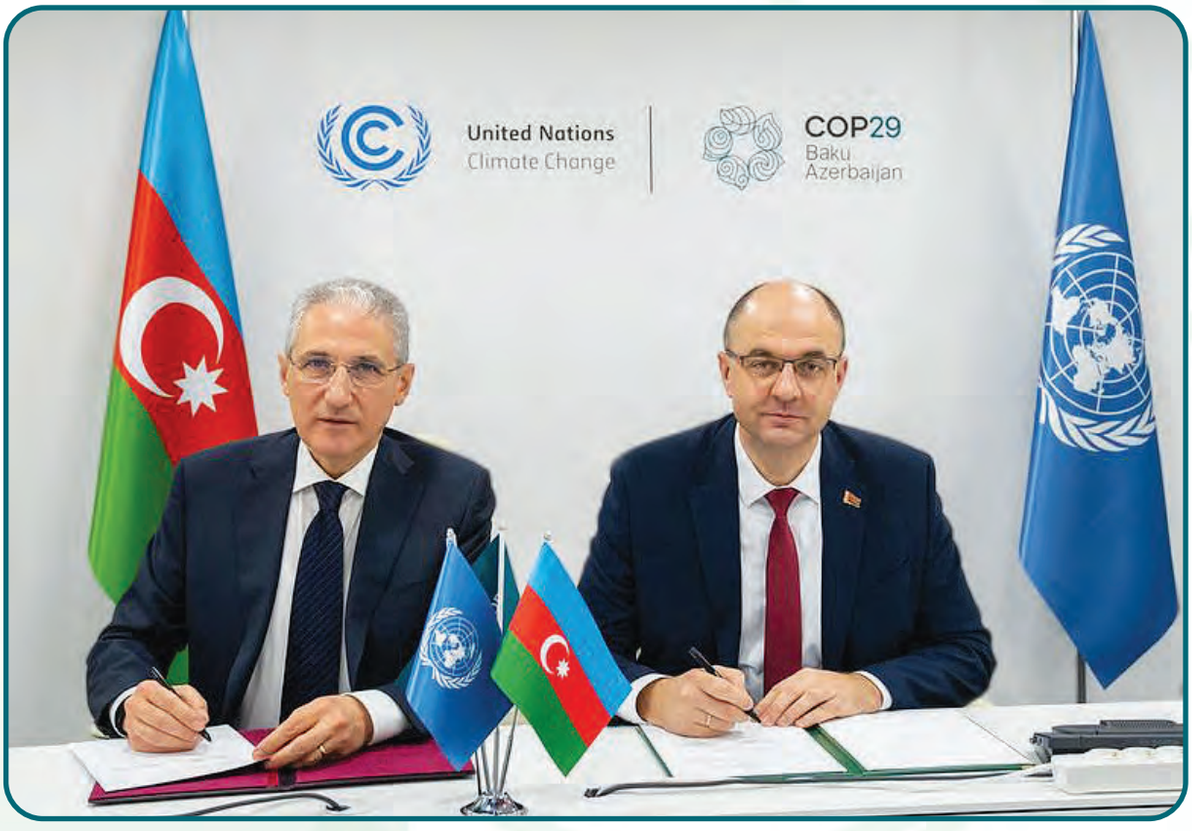
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AZERBAIJAN TRADE UNIONS CONFEDERATION

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# SPECIAL ISSUE ON:
# GLOBAL STRATEGY FOR SUSTAINABLE DEVELOPMENT: INNOVATION, MODELLING, AND ALLIANCES

In connection with the declaration of 2024 as the "Year of Solidarity for a Green World" in Azerbaijan by the Decree of the President of the Republic of Azerbaijan Ilham Aliyev dated December 25, 2023, and the holding of a discussion event such as the 29th session of the Conference of the Parties to the UN Framework Convention on Climate Change (COP29) in Azerbaijan, the announcement of our international Special Issue- scientific publication called "Global Strategy for Sustainable Development: Innovation, Modelling, and Alliances" in May 2024 was a continuation of this work. The announcement for article submissions on topics related to environmental and ecological development opened on May 25, 2024, and continued until November 20, 2024. In the initial process, scientific articles those determined the goals of COP29 and formed the selection of measurement methodologies were selected. Articles submitted by both local and international researchers underwent plagiarism checks and were then subjected to a double-blind peer-review process. Articles receiving positive feedbacks from both reviewers were selected and forwarded to the Editorial Committee designated for the Special Issue publication. In the next process, these articles were reviewed by the Editorial Committee to ensure their fully compliance with the journal's standards and requirements before accepting them for publication.

As a successful foreign policy of the President of the Republic of Azerbaijan, COP29 became a turning point in climate diplomacy, and the Baku COP event went down in history as one of the most remarkable COP sessions. Based on the interest generated in the local and international community from the date of the project announcement to this day, we confidently say that this publication, which we have produced with great enthusiasm and painstaking effort, will arouse great interest both in our country and in the international community. Our Special Issue publication will set new demands and tasks for us, as well as open up new opportunities, both as a print and online publication, in increasing the efficiency of scientific research work covering important areas of climate change within the framework of the COP, in increasing the scientific potential of readers, in exploring scientific sources, and in being one of the main sources of reference for scientific researchers.

Therefore, we consider it a great pleasure to participate in this project, which we have implemented with the aim of increasing our contribution to the global efforts for the COP29 event held in Azerbaijan, and to provide scientific support, and as a result, to take part in such a publication.

RESEARCH ARTICLE https://doi.org/10.30546/BAKUCOP29.2024.1.0108

# THE SUSTAINABLE DEVELOPMENT STRATEGY OF THE REPUBLIC OF AZERBAIJAN AS A TOOL FOR SUCCESSFUL ENERGY TRANSITION

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**Abstract**

This paper provides information on the state of the energy transition in the Republic of Azerbaijan and compares these indicators with countries around the world. It is shown that, according to international organizations, Azerbaijan's Energy Transition Index is higher than that of several countries with greater economic capabilities. The application of new public administration technologies, developed and implemented for the first time in the world in Azerbaijan, has ensured that the country generates the highest number of Energy Transition Index units per financial resource in the world.

**Keywords:** COP29, sustainable development administration, climate change, energy transition

## Introduction

In recent decades, humanity has faced numerous environmental, social, humanitarian and political challenges. All these challenges are interconnected and have serious consequences, leading to economic, social, environmental and humanitarian losses. Global climate change is one of the most significant challenges facing humanity and may threaten its existence (Aliyev, 2023 and Climate Reports, 2024). As a result, combating global change is an important international task, the implementation of which is carried out using various instruments, including international agreements and conventions. The primary international legal document for combating global climate change is the "United Nations Framework Convention on Climate Change" (UNFCCC). This convention was adopted in 1992 and supplemented by the Kyoto Protocol in 1997 and the Paris Agreement in 2015 (United Nations Framework Convention on Climate Change, 1992). The progress of countries – parties to the convention in implementing the tasks in the field of global climate change is the subject of discussion at special UN Conferences (COP), which are held annually in various countries around the world. In 2024, this twenty-ninth UN Conference (COP 29) will be held in Baku. The choice of the capital of Azerbaijan as a platform for discussing such a global problem as the fight against climate change is based on the country's high reputation as an important international platform for discussing global problems. Baku has repeatedly acted as an international center for discussing global economic, social and humanitarian problems of sustainable inclusive development (Baku Humanitarian Forum, 2022).

The holding of the UN Conference on the Climate Changes (COP 29) in Baku in 2024 is also associated with the successes achieved by the Republic of Azerbaijan in the field of energy efficiency (Alakbarov & Lawrence, 2017). This article examines some of the processes

of formation and development of the national strategy for energy transition of the country, which is the basis for combating global climate change. The indicators of energy transition in Azerbaijan compared with the energy transition indexes of the world countries.

## The energy transition planning as a long-term policy

The year 2004 can be considered the basis of the modern concept of energy transition of the country, when in accordance with the Order of the President of the Republic of Azerbaijan Ilham Aliyev, a special national program for the use of alternative and renewable energy sources was approved in the country. It should be noted that this program was adopted in conditions when the country had to solve such important problems as the placement and provision of vital needs of about a million refugees and internally displaced persons, who at that time constituted 13% of the country's total population, the formation of a new modern security system capable of restoring territorial integrity and sovereignty throughout the country, the creation of an effectively functioning innovative economy based on the principles of sustainable development, capable of ensuring the solution of existing problems, the development of human potential for these purposes through the development of science, education, sports, culture, etc.

It is important to note that all of this occurred in a country that was energy self-sufficient and, moreover, a recognized global exporter of hydrocarbon resources. This means that the initiation of energy transformation in the Azerbaijan Republic was not a necessity arising from energy shortages, but rather a response to the goals of sustainable development aimed at preventing processes that lead to global climate change.

Energy transformation, which gained significant momentum in the Azerbaijan Republic following the adoption of a targeted national program in 2004, transitioned to institutional reforms in 2009. In accordance with Decree No. 123, dated July 16, 2009, by President Ilham Aliyev, the State Agency for Alternative and Renewable Energy Sources was established in the country. For successful energy transformation aimed at reducing impacts on global climate change, the State Strategy for the Development of Alternative and Renewable Energy, covering the period from 2012 to 2020, was of great importance. This strategy, approved by President Ilham Aliyev on December 29, 2011, by Decree No. 1958, facilitated significant progress in the energy transition. Overall, it should be noted that in the Azerbaijan Republic, over the past two decades, more than ten various decisions have been made at the state level, aimed at fostering sustainable development processes and fulfilling the country's international obligations under the UN Framework Convention, the Kyoto Protocol, and the Paris Agreement (United Nations Framework Convention on Climate Change, 1992).

The implementation of energy transition tasks required training of personnel capable of solving various problems related to global climate change based on knowledge in the field of sustainable development management. For this purpose, on June 4, 2015, the Cabinet of Ministers of the Republic of Azerbaijan adopted two Resolutions No. 213 and No. 214, which for the first time in world practice introduced a new specialty "sustainable development administration" into the nomenclature of higher education at the level of bachelors, masters and doctors of sciences. Several textbooks have been published on this specialty, which are the first in the world and have no analogues. Among them are "Fundamentals of Sustainable Development and Ecological Civilization Administration", "Fundamentals of Inclusive Development Administration", "Fundamentals of Human Development", "Fundamentals of Human Development and Ecological Civilization". All of these resources build knowledge and skills in the most modern technology of public administration, with a priority on the natural and social environment and corporate responsible decision-making.

The systematic efforts undertaken in the Azerbaijan Republic to reduce impacts on global climate change have led to progress in energy transition in the country.

## Comparative assessment of energy transition efficiency

The country's achievements in the field of energy transition are reflected in the World Economic Forum Reports published in Geneva in 2023 and 2024 (Energy transition, 2023 and Fostering Effective Energy Transition, 2024). These reports contain information on the state of work in the field of energy transformation in countries around the world. A quantitative assessment of this indicator is given in the form of the Energy Transition Index. This index is calculated based on indicators that consider such parameters as the share of renewable energy sources, energy efficiency, greenhouse gas emissions, energy security, the state of the energy infrastructure, the level and conditions of investment in the energy sector, the state of the regulatory framework for energy transition, etc.

The report published in Geneva presented the energy transformation indices for 120 countries. The Republic of Azerbaijan with an index of 62 ranks 32$^{nd}$ in the world, which is a significant achievement. Azerbaijan's energy transformation index is higher than a number of countries that are members of the European Union and the Organization for Economic Cooperation and Development. Among the countries whose data are presented in the Figure is Italy, which is also a member of the group G 7 (Figure 1).

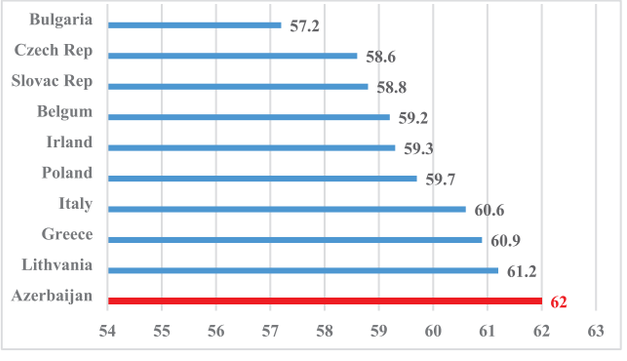


**Figure 1**. Energy transiation indices of the Republic of Azerbaijan and countries with high indicators in the field of economic development (Energy transition, 2023).

The countries whose data are presented in Figure 1 belong to the group of states with high economic potential. The GDP indicators in US per capita dollars taking into account the Purchasing Power Parity of these countries significantly exceed the economic

potential of Azerbaijan (GDP per capita, PPP, 2024). Despite this, the Energy Transition Index in Azerbaijan is higher than in the compared countries.

There is a simple rule in the management of sustainable development administration processes: in conditions of limited material and financial resources, high results can be achieved only through innovative public administration and on ground management technologies. Azerbaijan's successes in effectively managing the processes of energy transition are the result of applying innovative technologies in public administration for sustainable development. These methods of public administration, based on the application of a complex of synergetic, complementary, compensatory, resonant technologies, developed for the first time in the Republic of Azerbaijan, ensured the successful development of the country (Alakbarov, 2019 and Alakbarov, 2023). According to the World Economic Forum, the World Bank, the Republic of Azerbaijan is a world leader in the field of sustainable inclusive development, which is the most modern indicator of state development (GDP per capita, PPP, 2024 and The Inclusive Development Index, 2018).

The success of the Azerbaijan Republic in managing energy transformation processes is evident when analysing the effectiveness of energy transformation management in oil and gas producing and exporting countries (see Figure 2).

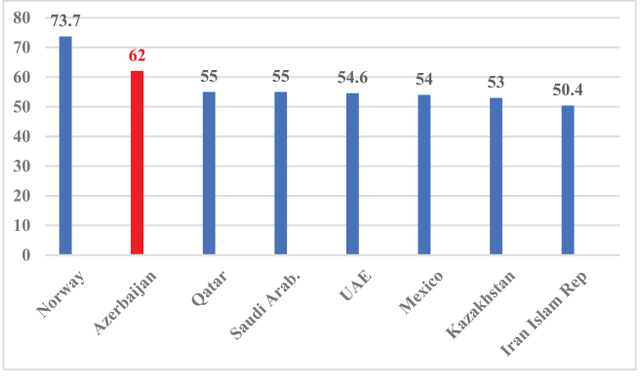


**Figure 2.** Energy transformation indices of the Republic of Azerbaijan and countries with high indicators in the field of economic development (Energy transition, 2023).

The data presented in Figure 2 shows that among hydrocarbon-producing and exporting countries, the Azerbaijan Republic ranks second in the world regarding the current state of energy transformation. Only Norway has a higher energy transformation index than Azerbaijan. However, the effectiveness of management processes aimed at preventing global climate change and mitigating unavoidable consequences is significantly higher in Azerbaijan than in Norway. According to data from the World Economic Forum and the World Bank published in 2023 and 2024, Norway generates 0.61 units of the Energy Transformation Index for every unit of GDP (1,000 US dollars, adjusted for Purchasing Power Parity). In Azerbaijan, the use of the same amount of material resources (1,000 US dollars, adjusted for Purchasing Power Parity) contributes to the formation of 2.62 units of the Energy Transformation Index. As seen, the effectiveness of resource management aimed at reducing impacts on global climate change in Azerbaijan is significantly higher than in Norway (Energy transition, 2023 and GDP per capita, PPP, 2024). It should be noted that the Republic of Azerbaijan is also characterized by a high energy efficiency (Alakbarov, 2019).

It should be noted that the Republic of Azerbaijan is a global leader in the effective management of material resources in order to ensure the energy transformation process. A comparative analysis of the data presented in Figures 3 and 4 illustrates this process.

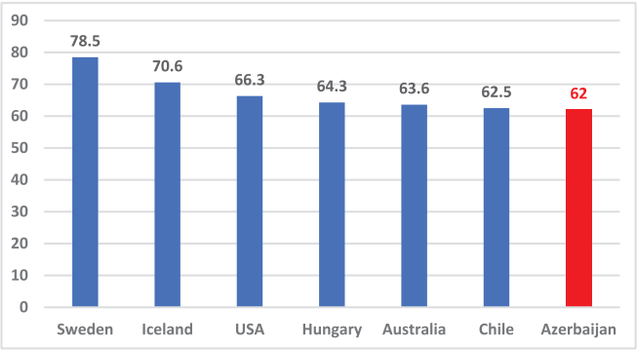


**Figure 3.** Energy transformation indices of countries with the highest indicators and the Republic of Azerbaijan (Energy transition, 2023).

The data presented in Figure 3 show that Azerbaijan has the lowest energy transformation index among the compared countries. According to this indicator, the country lags behind Chile by 21%.

However, the analysis of the data presented in Figure 4 shows that the greatest efficiency in organizing the management of material resources in order to reduce the impact of global climate change is demonstrated in the Republic of Azerbaijan.

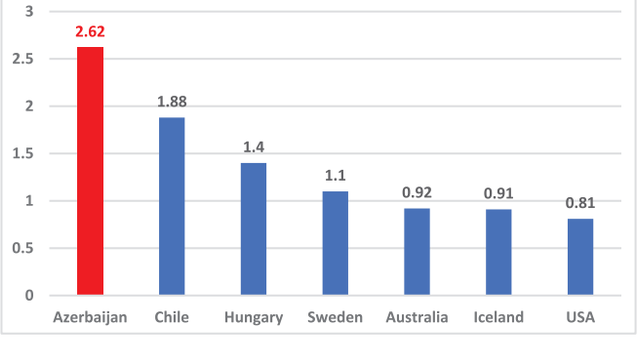


**Figure 4.** Energy Transformation Indices (ETI) formed by using one unit of GDP (1000 US dollars taking into account purchasing power parity) in countries with the highest ETI indicators and the Republic of Azerbaijan (Energy transition, 2023 and GDP per capita, PPP, 2024).

It is known that the Energy Transformation Index depends not only on the share of renewable energy sources in the total energy consumption of the country. When calculating the ETI, such indicators as energy efficiency, energy security, energy stability, greenhouse gas emissions, investments, legal support, etc. are taken into account. The innovations in public administration applied in the country, based on a set of synergistic, complementary and resonant technologies, ensure high efficiency not only in the implementation of tasks in the field of sustainable development, but also in ensuring the inclusiveness of this process. According to

international development institutions, the Republic of Azerbaijan, which ranks 75th in the world in terms of economic opportunities, ranks 25th in the world in terms of inclusive development indicators (The Inclusive Development Index, 2018).

Innovative technologies in the field of sustainable development management, first developed and applied in the Republic of Azerbaijan, are an important contribution to the fight against global climate change.

## Conclusion

Research has shown that forward-looking planning of activities in the field of energy transition, initiated in the Republic of Azerbaijan in 2004, has significantly contributed to progress in this area. Azerbaijan's Energy Transition Index is higher than that of several countries with the more valuable economic capabilities. The new public administration technologies, which were first developed and implemented in Azerbaijan, have significantly improved the efficiency of material resource utilization to achieve the goals of the energy transition. Undertaken comparisons have shown that Azerbaijan generates more Energy Transition Index units per unit of GDP than the compared countries.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

## Peer-review

Externally peer-reviewed.

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## Conflict of interest

No potential conflict of interest was reported by the author(s).

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# THE EMPOWERMENT OF NEW-QUALITY PRODUCTIVE FORCES IN CHINA'S GREEN, LOW-CARBON, AND CIRCULAR ECONOMIC SYSTEM UNDER GLOBAL CLIMATE CHANGE

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**Abstract**

In the process of globalization, sustainable development is related to the future of human society. Building an effective model to promote the development of green economy is an urgent issue to be solved. Developing countries are undoubtedly an important part of global ecological governance. As the backbone of developing countries, China has always taken the global governance principal of "extensive consultation, joint contribution, and shared benefits" as the basic concept, implemented the "Community with a Shared Future for Mankind" initiative, and promoted the construction of the "Belt and Road Initiative" ecological community. In recent years, China is unswervingly following the Sustainable development path. In terms of energy, it continues to increase investment and development in clean energy such as solar and wind energy, and reduce dependence on non-renewable energy such as coal. In urban construction, emphasis is placed on the development of green transportation and the creation of an ecological and livable environment. This paper focuses on the excellent cases of China's ecological governance construction, analyzes the experience and inspiration contained in them, and uses the strategic deployment of "green development is the base color of high-quality development, and new quality productivity itself is green productivity" put forward by Chinese President Xi Jinping to explore in the new era, the new type of harmonious coexistence between man and nature relations of production, firmly establish the concept that green waters and green mountains are golden mountains and silver mountains, and contribute China's experience to the rapid development of the world's green economy.

**Keywords:** China's new-quality productive forces, Sustainable development path, Ecological construction, Green economy

## Introduction

### 1. Research Background

The impact of climate change on humans is increasingly affecting socio-economic development and human settlements. According to one of the most recent studies published by the World Weather Attribution Consortium, an international scientific research organization, the 10 worst meteorological disasters in the world since 2004 are all linked to global warming.

On the 30th local time, *the **2024 Report of The Lancet Countdown on Health and Climate Change*** (van Daalen, K.R. et al, 2024) was released, Threats to human health from climate change have reached "record levels", the report said. In addition, the report estimates that extreme weather events will cost the global economy an average of $227 billion per year between 2019 and 2023. The report calls for an accelerated global energy transition, noting that fossil fuel investment will account for more than one-third of global energy-related spending in 2023, while clean energy investment is severely underfunded. In order to address climate change and adapt to the international demand and purpose of the new energy transition, governments around the world have made sustainable development and green and low-carbon development goals.

### 2. Research Objectives

In the context of the global response to climate change, many countries have taken the development of green economy and sustainable development as their main strategic goals, and are actively seeking effective methods. As a key force in developing countries, China has fully realized the importance of green economy for the long-term development of the country and the sustainable development of the world. In recent years, it has promulgated a series of laws and regulations to promote energy transformation. At the same time, it has promoted the low-carbonization of the energy system, the modernization of urban construction, and the intelligent living environment through independent innovation practices. Under the multiple benefits of policy support and win-win cooperation, it has firmly adhered to the United Nations Framework Convention on Climate Change, the goals, principles, and institutional arrangements of the Paris Agreement, China will always contribute Chinese wisdom to the development of the world's green economy as a responsible major country.

This paper starts with a case study of China's high-level modernization construction, attempts to analyze, and summarize the experience and wisdom contained in it, focuses on the important discussions of Chinese President Xi Jinping's "New-quality Productive Forces", explores the context of China's construction of the "Belt and Road Initiative" ecological community, and uses data visualization to show the achievements of China's ecological governance in recent years. The purpose of this paper is to provide a new paradigm for global ecological governance, strive to remove the factors that have led to the "failure" of current climate action, respond to the spirit of COP 29, and from the perspective of ambitious developing countries, provide the world with an effective methodology that can be learned, and emulated.

## China's sustainable development path and the new quality productive forces

### 1. Global Sustainable Development Theory and China's Path to Sustainable Development

#### 1.1 Global Sustainable Development Theory

The ongoing process of climate change has shown that sustainable development of humankind is a necessity. Existing resources need to be used in a form of a circular economy, and no more in a linear economy as has been the case until now. Resources need to be better managed to meet the needs of future generations. Therefore, energy, water and environment systems need to be integrated in order to slow down their overexploitation. (Mikulčić, et al, 2022)

In 1987, the WCED released a report entitled "Our Common Future." (Visser, et al, 2017) For the first time, the concept of "sustainable development" was proposed: human beings should enjoy the right to live healthy and productive lives in harmony with nature, meeting the needs of the present without compromising or diminishing the ability of future generations to meet their own needs Sustainable development (SD) means, "Development that meets the needs of current generations without compromising the ability of future generations to meet their needs and aspirations", and can be implemented in many different ways (Yu, et al, 1483). Therefore, sustainable development requires the coordination of economy, society, resources and environment, so as to achieve the purpose of economic development while protecting natural resources and their environment, and to maintain the population within the carrying limits of the geographical environment, so that human beings and their future generations can survive and develop sustainably. In September 2015, the United Nations adopted *the 2030 Agenda for Sustainable Development* (Cf, et al, 2015), with 17 Sustainable Development Goals at its core, committing to eradicating poverty, promoting equality, and addressing climate change by 2030.

#### 1.2 The path of China's sustainable development path and its achievements

In the process of promoting economic and social development, we are facing a triple contradiction between man and nature: the contradiction between the limited carrying capacity of natural resources and the ecological environment and the people's growing material and cultural needs; the contradiction between respecting the value of nature and respecting human rights to development; the contradiction between technological development and nature protection. Based on the above three points, it is inevitable for China, as a developing country, to take the path of sustainable development. In September 2021, Chinese President Xi Jinping first proposed the Global Development Initiative (GDI) in his speech at the General Debate of the 76th Session of the United Nations General Assembly, the initiative advocates that all countries adhere to development priorities, people-centered, inclusive, innovation-driven, harmonious coexistence between man and nature, and action-oriented, so as to promote stronger, greener, and healthier global development.

The global development initiative is aligned with the United Nations 2030 Agenda for Sustainable Development, and cooperation in the eight areas of poverty reduction, food security, climate change, and green development that countries are most concerned about in the Sustainable Development Goals has injected new impetus into the implementation of the United Nations 2030 Agenda for Sustainable Development, reflecting China's wisdom and strength in addressing global challenges.

According to the *2024 Sustainable Development Goals Report* released by the United Nations in June 2024, The world faces

serious challenges in achieving the Sustainable Development Goals on schedule. Only 17% of the 169 Sustainable Development Goals are on track, nearly half are "making little or no progress," and more than a third are "stagnant or regressing." On current trends, nearly 600 million people will continue to live in extreme poverty by 2030. Faced with the huge obstacles to the implementation of the global sustainable development goals, China's "Global Development Initiative" is forward-looking and positive, and aims to bring sustainable development back to the center of the international cooperation agenda.

As a major developing country, China has steadily carried out cooperation in new fields such as health, green, and digital in the process of sustainable development, continued to provide assistance to jointly build countries, supported green and low-carbon energy development in developing countries, promoted information sharing and capacity building for green and low-carbon development, and deepened cooperation on ecological environment and climate governance, which has yielded outstanding results in recent years.

*The Report on Big Earth Data in Support of the Sustainable Development Goals (2024)* written by the International Research Center for Big Data for Sustainable Development was officially released on the United Nations website recently. The report shows that China has achieved remarkable results in promoting sustainable development, with more than half of the targets meeting the goals of the United Nations 2030 Agenda for Sustainable Development ahead of schedule.

The Earth Big Data Supporting Sustainable Development Goals Report (2024) uses multi-source satellite remote sensing data and artificial intelligence algorithms to quantitatively evaluate seven global sustainable development goals and 227 sustainable development indicators in China. The report points out that, despite the slow progress in some global indicators, China has made significant contributions to industrial energy conservation, emission reduction, and renewable energy development. From 2017 to 2021, China contributed 33.61% of the global decline in industrial heat sources; by the end of 2023, China's offshore wind power cumulative installed capacity accounted for about 50% of the global total.




**Figure 1:** Changes in China's green energy transition in recent years (the data in the figure is from the Earth Big Data Supporting Sustainable Development Goals Report (2024))

In addition, China has also made positive progress in agricultural water resources management and drinking water safety, public transportation convenience, energy conservation and emission reduction, and marine pollution reduction.

## 2. The new-quality productive forces and the green productive forces

### 2.1 The new-quality productive forces and the green productive forces

New quality productivity is an advanced productive force that plays a leading role in innovation and conforms to the new development concept. It has the characteristics of high technology, high efficiency, and high quality. New quality productivity, as a specific manifestation of advanced productive forces, is the innovation and practice of Marxist productivity theory in China.

The term "new-quality productive forces" was first coined by Chinese President Xi Jinping during his inspection tour in Heilongjiang in September 2023. On January 31, 2024, Xi Jinping emphasized at the 11th collective study of the Political Bureau of the CPC Central Committee that we should accelerate the development of new quality productivity and solidly promote high-quality development. Adhere to green development, get rid of the traditional production and consumption mode of "mass production, mass consumption, and large amount of emissions", realize the coordination and unity of economic and social development and ecological environmental protection, and realize the harmonious coexistence of man and nature. Present Xi Jinping pointed out: "Green development is the base color of high-quality development, and new quality productivity itself is green productivity." This important assertion points out the intrinsic connection between new quality productivity and green development, and provides theoretical guidance for promoting the comprehensive green transformation of China's economic and social development.

In short, the new quality productivity is the new driving force for China's high-quality development and the new driving force for the world's sustainable development. Sustainable development is an inevitable product of the development of social productive forces and scientific and technological progress, and is the golden key to solving current global problems.

### 2.2 Specific cases and analysis of China's green productive forces

#### 2.2.1 The cases of China's energy transformation

From the perspective of green and low-carbon field, green and low-carbon technology is one of the important driving forces for new quality productivity. Technological breakthroughs in power batteries, photovoltaic cells, wind turbines and other fields are a significant symbol of China's green productivity development. The green and low-carbon transformation and upgrading of the energy industry is one of the important carriers for the formation of China's green productivity. The following is an excellent practical case of China's energy transformation and development.

#### 2.2.1.1 The "super power bank" of the power industry – Hebei Fengning Pumped Storage Power Station, China

Fengning Pumped Storage Power Station is located in Fengning County, Hebei Province, China, and supplies power to the Beijing-Tianjin-Tang power grid. The power station is planned to have an installed capacity of 3600MW and will be built in two phases, each with an installed capacity of 1800MW, with weekly adjustment performance.Its completion, with other existing pumped storage power stations and peaking power supply to solve the Beijing-Tianjin-Tang power grid peaking capacity shortage and other problems. At the same time, the power station can also undertake system frequency regulation, load standby and other tasks to maintain power grid security. (Wang Jianhua, 2020.)

Fengning Pumped Storage Power Station is a highlight project of China's rational utilization of ecological resources and green key technology breakthroughs. The geographical location of the power station has natural advantages, with good topographic conditions of upper and lower reservoirs and large adjustable storage capacity. Pumped storage power stations are an efficient way to store energy, providing reliable power supply during peak power demand periods and storing energy during low power demand periods. This will not only improve the reliability of the power grid, but also reduce emissions from coal-fired power plants and protect the environment. After the project is completed, it will exert huge economic, social and environmental benefits. It will strongly support the implementation of the "foreign power into Hebei" strategy, alleviate the dilemma of abandoning wind and light in the "Three North" (Northeast, North and Northwest China) region, and better absorb cross-regional clean energy. (Yan Xudong and Wang Jianhua, 2012) Taking 1.80 million kilowatt-scale pumped storage as an example, it can be converted from full-load pumping to full-load power generation within 5 minutes, providing 3.60 million kilowatts of accident support capacity. At the same time, the pumped storage power station has good regulation performance, which can effectively improve the peak shaving capacity of the system, meet the part of the peak shaving demand increased by the rapid growth of wind power in Hebei, ensure the efficient consumption of local new energy, and provide favorable conditions for the large-scale development of new energy in the local area. It can greatly promote energy conservation and emission reduction and air pollution prevention. It can save 480,000 tons of raw coal consumption and 1.14 million tons of carbon dioxide emission reduction every year.



**Figure 2:** Multiple working faces in the underground plant of Fengning Power Station operate simultaneously (Image source: State Grid Xinyuan Group Co., Ltd.)



**Figure 3:** Upper Reservoir of Fengning Power Station (Image source: State Grid Xinyuan Group Co., Ltd.)

After the completion of the power station, it will effectively support the "foreign power into Hebei" strategy, alleviate the dilemma of abandoning wind and light in the "Three North" region, better absorb cross-regional clean energy, and undertake peak regulation, frequency regulation, phase modulation, energy storage, system backup and black start tasks in the Beijing-Tianjin-Hebei power grid, generating important economic, social and environmental benefits.

After all 12 units are put into operation, the excess electricity can be consumed 8.80 billion kWh per year, and the annual power generation 6.612 billion kWh, which can meet the electricity consumption of 2.60 million households for one year, save 480,800 tons of standard coal per year, and reduce carbon emissions 1.20 million tons, equivalent to more than 240,000 acres of afforestation.

Fengning Pumped Storage Power Station absorbs electricity like a super "power bank", allowing the stable utilization of "scenery" resources. The construction of Fengning Pumped Storage Power Station is of great significance to the development of China's power industry.

### 2.2.2 Green productivity in urban construction

#### 2.2.2.1 "Garden City" - to create a high-quality development demonstration area to promote green urban development in Beijing

A few days ago, the *Beijing Garden City special project plan (2023-2035)* was officially released, and Beijing will create a green barrier of great green and beauty. By 2035, the city's forest coverage rate will reach more than 45%. This also marks the "Garden City" as an important part of the capital's planning system. Beijing is striving to realize the expectation that "ordinary people can walk into gardens when they go out of their homes".

At present, Beijing has deepened the spatial construction pattern, and constructed an urban spatial pattern of "one screen, five belts, two axes, three rings, and nine wedges and fifteen pieces". Optimize the management and control strategy of natural elements, take the forest as the base, and create a green barrier. By 2035, the forest coverage rate in the city will be

increased to more than 45%, effectively ensuring the protection space of 1.66 million mu of cultivated land. Build a water-green interconnection ecological network, and the landscape waterline in the central urban area will reach 500 kilometers by 2035. Improve the leisure tour routes, and by 2035, the coverage rate of the 500-meter service radius of the park green space will be increased to more than 95%, and the per capita park green space area in the built-up area will reach more than 17 square meters. Strengthen the management of ecological protection red lines, and by 2035, the ecological control area will reach more than 75% of the municipal area.

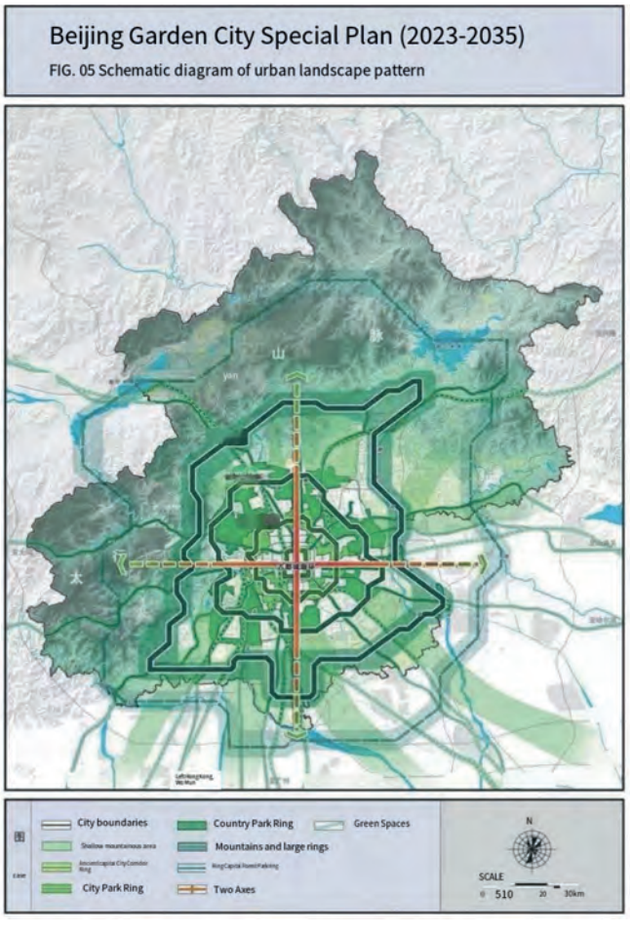


**Figure 4:** Beijing Garden City special project planning map (2023-2035) (picture source: "Beijing Garden City special project planning (2023-2035) "

At present, China has achieved remarkable results in green consumption and domestic energy consumption, and all provinces and cities have achieved excellent results in energy transformation and urban environmental construction. All localities actively promote energy-saving and low-carbon products such as new energy vehicles and energy-efficient household appliances. The government encourages citizens to trade in household appliances and consumer electronics. The scale of government procurement of green products has reached more than 85%.The green transformation of the energy system is developing rapidly. The installed scale of renewable energy exceeds that of non-renewable energy such as coal and power, and the newly installed capacity accounts for more than 50% of the world's new renewable energy capacity. At the same time, the national urban sewage treatment rate exceeds 98%, the harmless treatment rate of urban solid waste reaches 99.9%, and the proportion of rural solid waste collection and treatment administrative villages exceeds 98%. At present, the Chinese government is actively building green highways, green railways, green waterways, green ports and green airports. Vigorously develop green buildings in various cities, accelerate the energy-saving renovation of existing buildings, more than 27,000 projects have obtained green building labels, and the proportion of new green building area has reached 94%.

## The process of China's green, low-carbon and circular development economic system

### 1. Green low-carbon circular development economic system

On February 22, 2021, the Chinese government issued the Guiding Opinions of the State Council on Accelerating the Establishment and Improvement of a Green, Low-carbon and Circular Development Economic System. It is proposed to establish and improve a green, low-carbon and circular development economic system to promote a comprehensive green transformation of economic and social development. The core of "China's green, low-carbon and circular development economic system" is to implement green planning, green design, green investment, green construction, green production, green circulation, green life, and green consumption in an all-round and whole process, so that development is based on the efficient use of resources, strict protection of the ecological environment, and effective control of greenhouse gas emissions. On the basis of promoting high-quality development and high-level protection, establish and improve the economic system of green, low-carbon and circular development, ensure the realization of peak carbon dioxide emissions and carbon neutrality goals, and promote green development to a new level.

### 2. The green, low-carbon and circular development economic system has achieved positive results in many aspects

#### 2.1 Industrial and agricultural production

By the end of 2023, China's industrial green manufacturing system has been continuously improved, and nearly 5,100 green factories, more than 370 green industrial parks and more than 600 green supply chain management enterprises have been cultivated. Actively develop a circular economy in agriculture, and use agricultural waste resources. A total of 300 national modern agricultural industrial parks, 180 advantageous and characteristic industrial clusters and 1,509 agricultural towns have been built. The number of green food and organic agricultural products in the country has reached more than 60,000.

### 2.2 Utilization of circular transportation resources

The use of green and low-carbon transportation tools is vigorously promoted nationwide. In 2023, the total freight volume of railways and waterways will account for 26.3%. As a major e-commerce freight country, China actively promotes the standardization of express packaging, reduces secondary packaging, and no longer has a secondary packaging rate of more than 95%. Recycling and utilization of renewable resources is nearly 40,000 tons.

### 2.3 Green technology innovation

Encourage enterprises to innovate independently, stimulate the innovation vitality of universities and scientific research institutes, and provide corresponding fund policy support for various green technology innovation and projects. At present, China's technologies in clean and efficient coal processing and utilization, remanufacturing, energy equipment, pollution control and other fields have reached the international leading level. China's National Green Technology Trading Center has completed more than 1,500 green technologies, with a transaction amount exceeding 3.60 billion yuan.

### 2.4. Promulgation of policies and regulations related to green, low-carbon and circular development

China has written "ecological civilization" into the national constitution, and basically established a legal system covering all key regions, various types of resources, and various environmental factors. Build a "1 + N" policy system for peak carbon dioxide emissions and carbon neutrality, increase national financial support for green and low-carbon development, and improve the green tax system. By the end of the first quarter of 2024, the balance of green loans reached 33.77 trillion yuan, an increase of 35.1% year-on-year.

## 3. The "Belt and Road Initiative" ecological community

China is now the world leader with green capital actually creating renewable energy technologies. (Schwartzman, et al, 2024). In the process of developing a green, low-carbon and circular development economic system, China is gradually becoming a global pioneer of climate security. As part of the "Belt and Road Initiative" initiative, China is implementing the "Community of Shared Future for Mankind" initiative based on the concept of global governance of "extensive consultation, joint contribution and shared benefits", and building a "Belt and Road Initiative" ecological community with countries along the route.

### 3.1 "Belt and Road Initiative" and "Azerbaijan Energy Corridor"

Promoting the green development of the "Belt and Road Initiative" is an extension of China's concept of ecological civilization, and it is also the value pursuit of high-quality development by the countries that jointly build the "Belt and Road Initiative". Most of the countries that jointly build the "Belt and Road Initiative" are developing countries and emerging economies. With the rapid advancement of industrialization and urbanization, complex and diverse sustainable development issues related to biodiversity, resources and environment, ecosystems, green energy, climate change and other fields have followed.

Azerbaijan is at the heart of the Belt and Road Initiative, an important energy node linking Eurasia. It hopes to bring renewable energy to European markets by establishing a green energy corridor from the Caspian Sea to the Black Sea and then to Europe. Chinese companies see huge opportunities in Azerbaijan's renewable energy sector. Many companies, including China Datang Group, TBEA and Guangdong Electric Power Design Institute, have actively participated in negotiations and cooperation with the Azerbaijani government. China's extensive experience in global clean energy projects, particularly its leadership in solar, wind, and energy storage technologies, makes it an ideal partner for Azerbaijan to develop renewable energy. China's cooperation with Azerbaijan in renewable energy covers several technical fields. In terms of wind energy development, Azerbaijan has abundant offshore wind energy resources, especially in the Caspian Sea region. The Azerbaijani government expects to build large-scale wind farms with the help of offshore wind energy development technology from Chinese companies. In terms of solar power generation, Chinese companies are expected to vigorously promote the construction of solar power plants in Azerbaijan. It also includes the upgrade of the power grid that China is best at. In order to cooperate with the promotion of green energy, Azerbaijan needs to upgrade the existing power grid. Chinese companies are able to participate in Azerbaijan's power grid transformation by leveraging their power grid technology and HVDC power supply experience to improve power transmission efficiency and reduce energy consumption.

Sino-Arab cooperation in renewable energy projects is not limited to the commercial level, but also has important political and strategic implications. Through cooperation with Azerbaijan, China can further consolidate its energy influence in Central Asia and the South Caucasus, while strengthening its strategic position in the global energy market. Azerbaijan can make full use of China's superior technologies to empower the country's green development.

The global ecosystem is an organic whole, and energy flows and material cycles continue among ecosystems around the world, forming a community of mutual ecological destiny. That is to say, in the face of increasingly complex and severe global ecological and environmental problems, no one or any country can be immune, and the joint construction of the "Belt and Road Initiative" has found the greatest common divisor to solve the challenges and contradictions of global ecological and environmental problems, breaking the artificial barriers and barriers created by some countries, and building a high-quality "Belt and Road Initiative" with ecological base colors and green chapters.

To build a more open green, low-carbon and circular development economic system, we must adhere to mutual benefit and win-win results, and cannot do it behind closed doors. The construction of the "Belt and Road Initiative" ecological community can widely carry out green international cooperation, jointly build countries to deeply integrate with each other, and continuously expand green international cooperation "Friend zone".

## Conclusion

In the process of sustainable development, green development is a key link. Accelerating the green and low-carbon transformation of the development mode and leapfrogging the traditional development path are major issues facing many countries around the world in carrying out high-quality development. In the past 40 years of rapid economic growth, China has accumulated more lessons and experiences in the urgency and difficulty of protecting and managing the environment brought about by extensive development. Green and low-carbon are being integrated into all aspects of China's economic and social development, continuously stimulating new momentum for high-quality development. The 10-year joint construction of the "Belt and Road Initiative" has formed an international circulation pattern of interconnection, which has greatly improved the connectivity and nesting of the global green economy. It provides a specific and feasible practical reference path for promoting the "Belt and Road Initiative" to jointly build a country to form a green, low-carbon, circular and sustainable development mode and lifestyle.

In general, facing the challenge of global ecological governance, countries need to build a more open green, low-carbon and circular development economic system to empower green productivity. Incorporating peak carbon dioxide emissions and carbon neutrality into the overall layout of ecological civilization construction, and comprehensively promoting the development of green, low-carbon circular economy. We can emulate the fruitful part of the Chinese model explained in this article, actively participate in the formulation of international rules in the fields of climate change, marine pollution control, biodiversity protection, plastic pollution control, etc., and promote the construction of a fair, reasonable, and win-win global environmental and climate governance system. Participate in leading global green development.

## Discussion

The "green, low-carbon and circular development economic system" has a long way to go for domestic and international development, and countries around the world can strengthen policy exchanges around green and sustainable development. At the same time, governments and organizations of all countries should also respond to the spirit of the 29th Conference of the Parties to the United Nations Framework Convention on Climate Change, reduce greenhouse gas emissions, respond to global climate change, and jointly promote sustainable human development. Increase ambition and catalyze action, especially for developing countries, by agreeing on a fair and ambitious new climate finance target, completing Article 6 of the Paris Agreement, strengthening the Global Financial Institutions Group and securing private sector commitment to climate action. We will jointly enhance the international communication efficiency of ecological civilization, so that developing countries can fully respond to the goals and needs of ecological governance, and jointly build a cleaner and more beautiful world, with beauty and harmony.

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## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The authors confirm being the sole contributor of this work and have approved it for publication.

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# COMPARATIVE ANALYSIS OF NATIONAL GREEN ECONOMY STRATEGIES: SUCCESSES, CHALLENGES, AND LESSONS LEARNED

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**Abstract**

This review article provides a comparative analysis of national green economy strategies, focusing on the successes, challenges, and lessons learned from Germany, Sweden, Azerbaijan, China, and the United States. By examining the integration of environmental sustainability with economic growth, the study illuminates diverse approaches to sustainable development. Methodologically, a systematic review of academic articles, policy documents, and reports from reputable sources was conducted. Key metrics for comparison include policy coherence, institutional frameworks, and technological innovations, investment patterns in renewable energy and green technologies, and socio-economic impacts. The findings underscore the importance of aligning national strategies with global sustainability targets, such as those set by the Paris Agreement and the United Nations Sustainable Development Goals (SDGs). This analysis highlights the varying degrees of success and the unique challenges faced by each country, offering insights into effective policy frameworks and international cooperation necessary for achieving global environmental and socio-economic objectives. The comparative approach provides a nuanced understanding of how national contexts, resources, and socio-economic factors influence green economy strategies and their outcomes, contributing to the evolving discourse on sustainable development.

**Keywords:** Green Economy, Sustainable Development, Green Energy, National Sustainability, Strategies, SDGs, the comparative.

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## Introduction: Purpose, scope and methodology of the comparative analysis

The purpose of the comparative analysis is to address the complex challenges associated with sustainable development by examining and contrasting national green economy strategies. Understanding these strategies is essential for integrating environmental sustainability with economic growth.

The scope of this literature review includes a comprehensive analysis of green economy strategies implemented by various nations. This involves identifying common themes, success factors, challenges, and lessons derived from existing literature and data. Key metrics used for comparison include policy coherence, institutional frameworks, technological innovations, investment trends in renewable energy, and socio-economic impacts.

Methodologically, the review follows a systematic approach to gather and analyze relevant academic articles, policy documents, and reports from reliable sources such as international

organizations, government agencies, and peer-reviewed journals. Countries are selected based on their prominence in green economy initiatives, availability of substantial literature, and diversity in geographical and socio-economic contexts. Qualitative methods are employed to synthesize findings and provide a detailed understanding of how theoretical models influence the development and implementation of green economy strategies. This comparative approach enables a structured evaluation of the effectiveness of national policies in countries such as Germany, Sweden, Azerbaijan, China, and the United States, offering insights into how varying contexts shape green economy outcomes.

## Definition, principles and importance of the Green Economy

In the context of economic activities, the utilization of finite natural resources to meet infinite human demands forms a dialectical relationship with nature. This interaction intensifies as economic impacts on natural systems proliferate, necessitating a harmonization with ecological imperatives. Acknowledging the futility of combating nature, economies are increasingly adopting environmentally conscious practices, symbolized by the integration of "green" principles amidst the advent of the 4th industrial revolution and in anticipation of the 5th. The concept of "green economy," initially coined by economists in a 1989 report commissioned by the UK government, now embodies a pivotal trajectory in global human development (Gasimli et al., 2022).

At its core, the green economy promotes a shift towards low-carbon, resource-efficient, and socially inclusive economic systems. This entails restructuring production processes, promoting sustainable consumption patterns, and investing in renewable energy sources and green infrastructure (United Nations Environment Programme, 2011).

The growing scarcity of energy resources highlights the need for biofuels as an alternative energy source. Biofuels, derived from plant or animal materials, come in various forms: liquid (biodiesel, ethanol), solid (straw, wood), and gaseous (biogas, hydrogen). Countries transitioning to renewable energy can benefit economically and, more importantly, environmentally. This shift can help mitigate climate change and improve the health of ecosystems, such as the hydrosphere and atmosphere. Early adoption of renewable energy can also prevent future economic and environmental crises, positively impacting public health (Guliyeva et al., 2022).

One of the Sustainable Development Goals focuses on achieving socioeconomic growth while prioritizing environmental conservation and ecosystem protection, which are closely tied to transportation. Since transportation contributes to 60-65% of environmental damage and 15 kg of oxygen is required to fully ignite 1 liter of fuel, the growing number of vehicles presents challenges for sustainable development. It is crucial to conduct research and develop scientifically backed proposals for a new transportation system. Addressing urban planning issues and learning from global experiences highlights the need for a "green transportation" system (Asadov, 2022).

Sustainable development can only be achieved through the "reconciliation" of economic growth and environmental goals. The term "green growth", which is a logical continuation of the green economy concept, originated in Asia and the Pacific Ocean. At the Fifth Ministerial Conference on Environment and Development (MCED) held in Seoul in March 2005, 52 Governments and other stakeholders from Asia and the Pacific agreed to move beyond the rhetoric of sustainable development and embrace the concept of 'green growth' (Gasimli et al., 2022).

The fourth industrial revolution's impact on economic growth is widely debated. Technopessimists believe its peak has passed, limiting future productivity gains, while techno-optimists foresee substantial growth from technological advancements. A pragmatic stance emphasizes technology's nuanced effects, such as deflationary trends and sustainable consumption benefits. However, global economic challenges like capital misallocation, debt, and ageing populations complicate predictions. An ageing workforce and higher dependency ratios may hinder growth, though retirees' savings could offset some challenges. Measuring productivity remains difficult due to evolving goods and services. Despite this, optimism about integrating billions into the global economy, addressing environmental issues, and enhancing renewable energy supports GDP growth and climate change mitigation (Schwab, 2016). In addition to Schwab's approach, Gasimli et al. (2022) assert that economic growth should not be an end in itself but a means to achieve human well-being and sustainability. They stress that efficiency in the green economy requires resource use that ensures inclusivity and avoids environmental degradation. The authors advocate for policies promoting equitable growth, balancing economic development with environmental stewardship, and highlighting the need for a holistic approach to lasting societal welfare and sustainability.

The Fifth Industrial Revolution (5IR) differs from the Fourth (4IR) by emphasizing human-technology collaboration over competition. While the 4IR focused on maximizing technology, often causing tension between human and robotic roles, the 5IR promotes optimizing the complementary strengths of both. This shift prioritizes societal well-being through integrated human-machine cooperation, particularly in retail and services (Noble et al., 2022).

The Rio+20 summit demonstrated a clear link between green economy development and job creation, highlighting the green economy's role as a catalyst for growth across several sectors. This includes agriculture, fisheries, mining, processing industries (such as light and food industries), renewable energy, and tourism, each of which presents opportunities for generating new employment. Advancements in these sectors also facilitate a more diversified economic strategy, promoting broader economic stability and resilience (Gasimli et al., 2014).

In summary, the green economy embodies a transformative approach to sustainable development, combining environmental care, economic growth, and social equity. Early adopters' experiences will guide future global strategies and policies.

## Overview of SDGs and theoretical frameworks guiding national Green Economy strategies

The Sustainable Development Goals (SDGs) provide a global framework for integrating economic, social, and environmental aspects of development, with a focus on sustainability by 2030.

Key SDGs linked to the green economy include Goal 7, which emphasizes renewable energy and energy efficiency; Goal 8, promoting green jobs and sustainable industries; and Goal 9, encouraging cleaner industrial innovation. Goals 11 and 12 focus on sustainable cities and responsible production, while Goal 13 addresses climate action. Together, these goals support greener, resilient, and inclusive economies.

National green economy strategies are shaped by various theoretical models and frameworks that integrate economic growth with environmental sustainability. The "Green Growth" framework is central, advocating for economic development through investments in renewable energy, sustainable agriculture, and green technologies, thereby achieving both economic prosperity and ecological sustainability (OECD, 2011). The "Circular Economy" model complements this by emphasizing resource efficiency, waste reduction, and the promotion of recycling and reuse, suggesting that closing material loops can reduce environmental impact (Ellen MacArthur Foundation, 2013). Additionally, "Natural Capital Accounting" (NCA) incorporates the value of natural resources into economic decision-making, promoting policies that protect and restore ecosystems, which are vital for sustainable development (Bass et al., 2021).

In summary, national green economy strategies are shaped by theoretical models and frameworks that emphasize sustainable development, economic growth, and environmental protection. These models guide countries in adopting policies and practices that promote green technologies, resource efficiency, and natural capital preservation. By aligning economic activities with ecological sustainability, countries can achieve resilient and inclusive growth while safeguarding natural resources for future generations.

## National Green Economy Strategies: Case Studies

### *Case Study of Germany*

Germany's long-term climate strategy is articulated in the Climate Action Plan 2050, which outlines a pathway to achieve significant reductions in GHG emissions. The plan sets ambitious targets: a 40% reduction by 2020, 55% by 2030, 70% by 2040, and 80-95% by 2050, relative to 1990 levels. Despite substantial progress, Germany faced challenges in meeting its 2020 target, achieving only a 31% reduction by 2018 (International Energy Agency, 2020). In response to the shortfall in meeting the 2020 targets, Germany adopted the 2020 Climate Action Programme, focusing on energy efficiency, building modernization, transport sector reforms, and increased renewable energy generation. More recently, the Climate Action Programme 2030 introduced a phased carbon pricing system for sectors not covered by the EU Emissions Trading System (ETS), increased subsidies for electric vehicles (EVs), and incentives for energy-efficient building renovations (World Economic Forum, 2023).

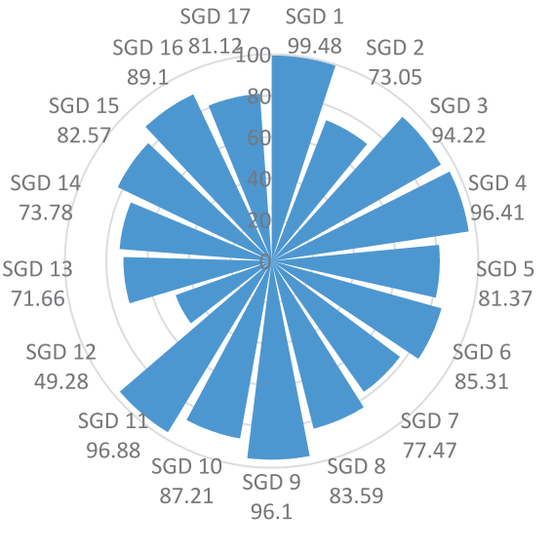
The Sustainable Development Report 2024 for Germany reveals the country's strong performance in achieving the Sustainable Development Goals (SDGs). Germany ranks 4th out of 167 countries with an overall score of 83.4, surpassing the OECD average (77.2) (refer to Table 1). Figure 1 illustrates the average performance by SDG.

**Table 1. Indicators of Germany (Sustainable Development Report 2024)**

| | |
|---|---|
| 2024 SDG Index Score | 83.45 |
| 2024 SDG Index Rank | 4.00 |
| Percentage missing values | 1.02 |
| International Spillovers Score (0-100) | 63.18 |
| Regional Score (0-100) | 77.25 |
| International Spillovers Rank | 146.00 |
| Regions used for the SDR | OECD |

**Source:** Sachs, J.D., Lafortune, G., Fuller, G. (2024). The SDGs and the UN Summit of the Future. Sustainable Development Report 2024. Paris: SDSN, Dublin: Dublin University Press. doi:10.25546/108572

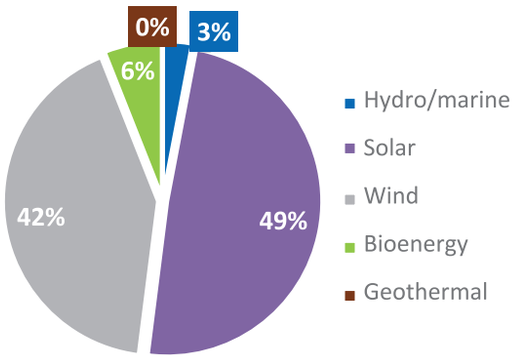
**Figure 1: Average performance of Germany by SDG**




**Source**: Sachs, J. D., Lafortune, G., & Fuller, G. (2024). The SDGs and the UN Summit of the Future. Sustainable Development Report 2024. Dublin: Dublin University Press. https://doi.org/10.25546/108572

The energy policy priorities in Germany focus on enhancing renewable energy capabilities, increasing renewable power auctions, and accelerating grid planning and offshore wind connections to facilitate the energy transition. (World Economic Forum, 2023). The renewable capacity proportion indicated below in the Figure 2.

**Figure 2: Renewable capacity in 2023**




**Source: (IRENA statistics, 2024 c)**

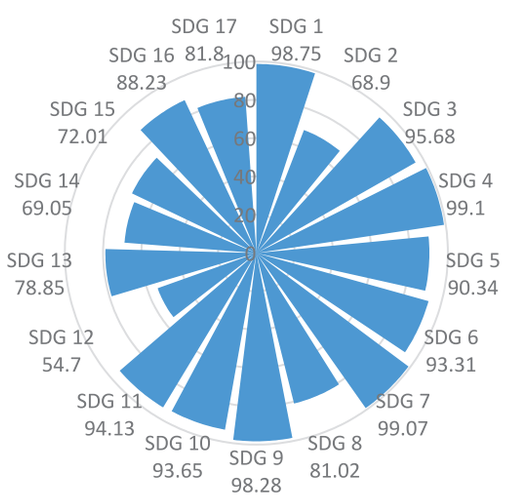
Overall, while Germany is a leader in sustainable development, the report underscores the importance of addressing remaining challenges and enhancing efforts to achieve the 2030 Agenda comprehensively.

## Case Study of Sweden

Sweden has been at the forefront of green economy strategies, with a comprehensive legislative framework and ambitious targets to transition towards sustainability. The country's commitment to environmental protection and climate action is evident in its national policies and international engagements.

Sweden's green economy strategies are guided by a robust legislative superstructure created iteratively since 1991. The Climate Act, introduced in 2017, is a key addition to this framework. It sets a target of net-zero emissions by 2045, including offsets, and establishes a Climate Council to monitor progress. The Act also includes a generational target that defines sustainability in terms of physical living conditions, such as health and noise environment, rather than financial metrics like GDP (Green Economy Tracker, 2022). The Sustainable Development Report 2024 for Sweden highlights the country's exemplary performance in achieving the Sustainable Development Goals (SDGs) (Figure 3).

**Figure 3: Average performance of Sweden by SDG**




**Source**: Sachs, J. D., Lafortune, G., & Fuller, G. (2024). The SDGs and the UN Summit of the Future. Sustainable Development Report 2024. Dublin: Dublin University Press. https://doi.org/10.25546/108572

Sweden ranks 2nd out of 167 countries, with a remarkable overall score of 85.7, which the regional average is 77.2.

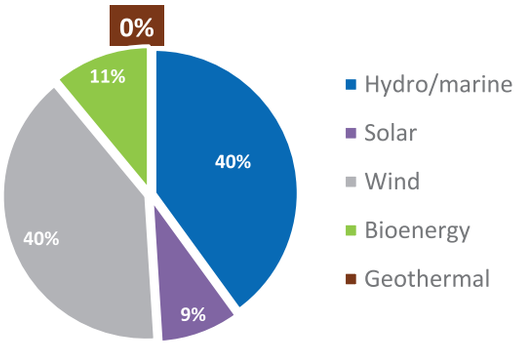
**Table 2. Indicators of Sweden (Sustainable Development Report 2024)**

| | |
|---|---|
| 2024 SDG Index Score | 85.70 |
| 2024 SDG Index Rank | 2.00 |
| Percentage missing values | 3.06 |
| International Spillovers Score (0-100) | 63.41 |
| Regional Score (0-100) | 77.25 |
| International Spillovers Rank | 144.00 |
| Regions used for the SDR | OECD |

**Source:** Sachs, J.D., Lafortune, G., Fuller, G. (2024). *The SDGs and the UN Summit of the Future.* Sustainable Development Report 2024. Paris: SDSN, Dublin: Dublin University Press. doi:10.25546/108572

The Swedish green model emphasizes the integration of business and sustainability. Together with its Nordic neighbors, Sweden has promoted the idea that green growth and competitiveness are not mutually exclusive (Swedish Institute, 2023). The country's green competitiveness has benefited from earlier investments in renewable energy, particularly hydropower (Green Economy Tracker, 2022). Figure 4 shows the renewable capacity of the country.

**Figure 4: Renewable capacity in 2023**




**Source: (IRENA statistics, 2024d)**

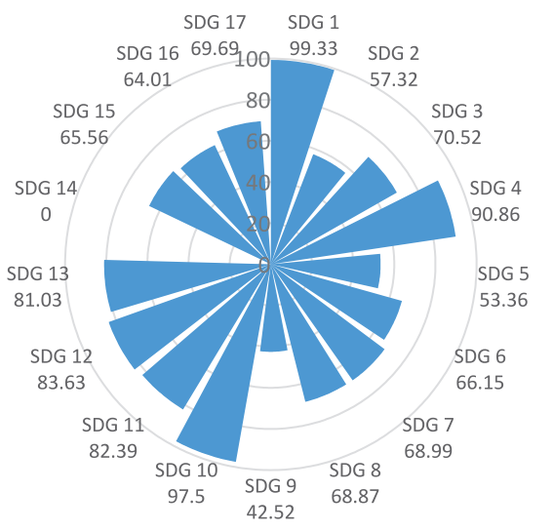
While Sweden has made significant progress in its green economy strategies, it also faces challenges in investing in electricity supply and people to fuel the green transition. The country needs to address issues related to the process for regional and transmission network development, which is currently facing challenges in terms of mapping the current status and identifying bottlenecks. Despite these challenges, Sweden remains committed to its green economy strategies and is poised to continue its leadership in the global transition towards sustainability. By maintaining its ambitious targets, inclusive governance, and innovative measures, Sweden can serve as a model for other countries seeking to achieve a sustainable and prosperous future (Pareliussen & Purwin, 2023).

## Case Study of Azerbaijan

Azerbaijan's green economy strategies are closely aligned with its international commitments. The country ratified the Paris Agreement in 2016, pledging to reduce its greenhouse gas emissions by 35% by 2030 compared to 1990 levels. In line with this commitment, Azerbaijan has developed its Nationally Determined Contribution (NDCs), which was updated in 2022 to reflect more ambitious targets (Green Growth Index, 2023).

The Sustainable Development Report 2024 for Azerbaijan provides a comprehensive overview of the country's progress towards achieving the Sustainable Development Goals (SDGs) (Figure 5).

**Figure 5: Average performance of Azerbaijan by SDG**




**Source:** Sachs, J. D., Lafortune, G., & Fuller, G. (2024). The SDGs and the UN Summit of the Future. Sustainable Development Report 2024. Dublin: Dublin University Press. https://doi.org/10.25546/108572

Azerbaijan's overall SDG performance is positioned above the regional average (70.6), with a score of 72.2, placing it 63rd out of 167 countries (Sachs et al., 2024).

**Table 3. Indicators of Azerbaijan (Sustainable Development Report 2024)**

| | |
|---|---|
| 2024 SDG Index Score | 72.20 |
| 2024 SDG Index Rank | 63.00 |
| Percentage missing values | 7.53 |
| International Spillovers Score (0-100) | 91.80 |
| Regional Score (0-100) | 70.56 |
| International Spillovers Rank | 73.00 |
| Regions used for the SDR | E. Europe & C. Asia |

**Source:** Sachs, J.D., Lafortune, G., Fuller, G. (2024). The SDGs and the UN Summit of the Future. Sustainable Development Report 2024. Paris: SDSN, Dublin: Dublin University Press. doi:10.25546/108572

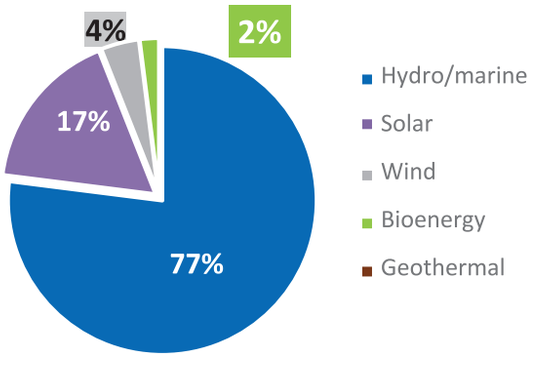
Azerbaijan is set to host the 29th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP29) in Baku in 2024, marking a significant milestone in the country's commitment to addressing climate change and transitioning to green energy. The country has signed several important green energy agreements with global companies to implement renewable energy projects and transform Azerbaijan into a "green energy hub" in the region (UNCCC COP29).

The potential for solar and wind energy in Azerbaijan is substantial. On the Absheron Peninsula, on the coast of the Caspian Sea, and on the islands in the northwestern part of the water area, there is a great prospect for the application of wind energy facilities. In the west of Azerbaijan, in the Ganja-Dashkasan zone and in the Sharur-Julfa area of the Nakhchivan Autonomous Republic, the average annual wind speed is 3-5 m/second, so it is possible to use medium-power wind power plants in these regions (Gasimli et al., 2022).

Based on operational data for the first seven months of 2024, Azerbaijan's total electricity production reached 16,269.0 million kWh between January and July. During this period, thermal power plants (TPPs) generated 13,863.7 million kWh, while hydropower plants (HPPs) contributed 1,867.3 million kWh, and other sources produced 538.0 million kWh. Specifically, wind power plants (WPPs) generated 33.3 million kWh, solar power plants (SPPs) produced 352.0 million kWh, and the solid household waste incineration plant accounted for 152.7 million kWh. Consequently, electricity generation from renewable energy sources, compared to the same period last year (1,327.7 million kWh), increased by 1,077.6 million kWh, reaching a total of 2,405.3 million kWh (Ministry of Energy of Azerbaijan, 2024).

According to the IRENA Statistical Profiles, renewable capacity of Azerbaijan illustrated below in the Figure 5.

**Figure 5: Renewable capacity in 2023**




**Source:** (IRENA statistics, 2024a)

Moreover, alternative energy initiatives are one of the "Araz Valley Economic Zone" Industrial Park`s primary operations. The regions of Karabakh and East Zangazur hold substantial potential to evolve into economic powerhouses. With a focus on sustainable and inclusive growth, these areas are poised to make significant contributions to both local economies and national development (Guliyeva & Alakbarov, 2024). Besides, another key pillar of the Green Economy is the adoption of green transportation. Asadov (2023) has prepared a schematic form of the development plan of the green transport system in the conditions of sustainable development, emphasizing that the shortest way to the formation

and sustainable development of the green transport system is through the comprehensive consideration of transport, environment and health issues (Asadov, 2023).

Since 2022, Azerbaijan has intensified its focus on implementing megaprojects in the green energy sector. The involvement of major global companies and cooperation with the European Union on green energy exports enhance the prospects of achieving its ambitious goals. Agreements with leading companies from countries like Saudi Arabia, China, the UAE, and the UK aim to increase the production capacity to 28 GW, aiding in portfolio diversification and sustainable development. This green energy transition promises ecological, political, economic, and social benefits for Azerbaijan and its neighboring regions (Gasimli et al., 2024).

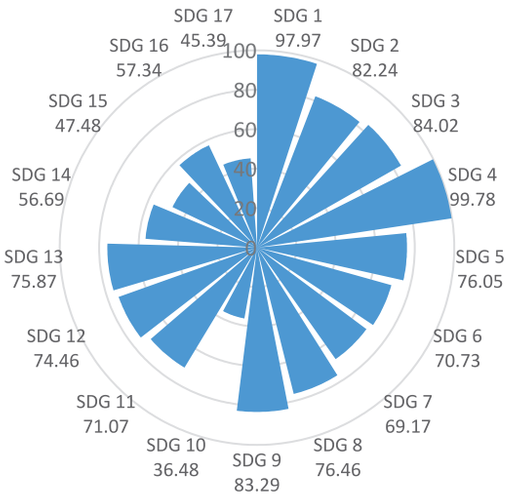
While challenges remain, the opportunities for growth and collaboration are substantial. Continued investment in green technologies, international partnerships, and robust regulatory frameworks will be essential for Azerbaijan to achieve its green economy objectives.

## Case Studies of China

China's 14th Five-Year Plan (2021-2025) for National Economic and Social Development, approved in March 2021, highlights the country's commitment to high-quality, green development. Building on the achievements of the previous plan, the 14th Five-Year Plan aims to reduce carbon emissions, promote innovation, and pursue a dual circulation growth strategy that relies more on domestic consumption and technological self-reliance. By implementing these measures, China aims to transition to a more sustainable, inclusive, and technologically advanced economy while addressing pressing social and environmental challenges. The 14th Five-Year Plan represents a significant step forward in China's pursuit of high-quality development and its commitment to global climate action (Asian Development Bank, 2021).

According to the Sustainable Development Report 2024, China has made significant strides in its pursuit of the Sustainable Development Goals (SDGs), though challenges remain in several areas.

**Figure 7: Average performance of Sweden by SDG**




**Source:** Sachs, J. D., Lafortune, G., & Fuller, G. (2024). The SDGs and the UN Summit of the Future. Sustainable Development Report 2024. Dublin: Dublin University Press. https://doi.org/10.25546/108572

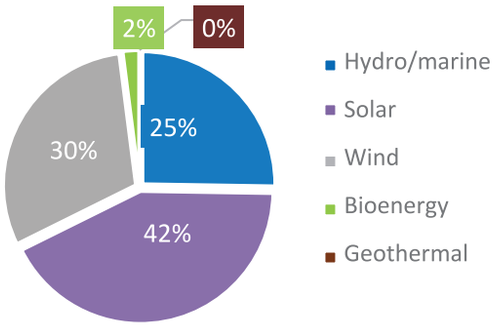
China's overall SDG performance score is 70.9 (Sachs et al., 2024) (Table 4) and the proportion of the renewable capacity indicated in the Figure 12.

**Table 4. Indicators of China (Sustainable Development Report 2024)**

| | |
|---|---|
| 2024 SDG Index Score | 70.85 |
| 2024 SDG Index Rank | 68.00 |
| Percentage missing values | 8.16 |
| International Spillovers Score (0-100) | 90.32 |
| Regional Score (0-100) | 66.53 |
| International Spillovers Rank | 81.00 |
| Regions used for the SDR | East & South Asia |

**Reference:** Sachs, J.D., Lafortune, G., Fuller, G. (2024). The SDGs and the UN Summit of the Future. Sustainable Development Report 2024. Paris: SDSN, Dublin: Dublin University Press. doi:10.25546/108572

**Figure 12: Renewable capacity in 2023**




**Source:** (IRENA statistics, 2024b)

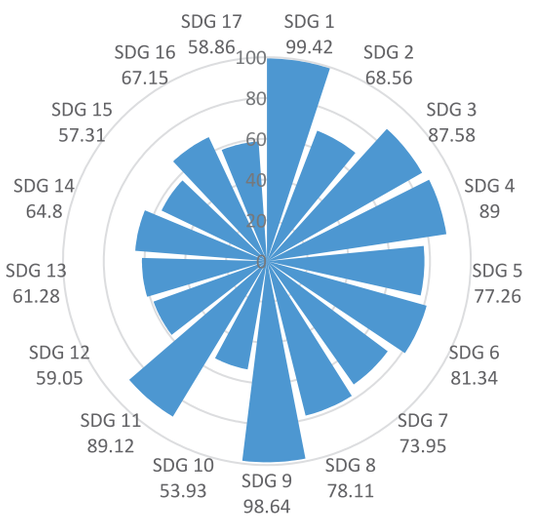
Overall, China's progress towards the SDGs is mixed, with notable achievements in some areas but persistent challenges in others. Continued efforts, policy reforms, and international cooperation will be essential for the country to fully realize its sustainable development aspirations (Sachs et al., 2024).

## Case Studies of the United States

The United States has implemented a range of federal and state-level green economy initiatives aimed at fostering sustainable development, reducing greenhouse gas emissions, and promoting renewable energy adoption.

According to the Sustainable Development Report 2024, the United States ranks 46th out of 167 countries with an overall score of 74.4, the OECD average is 77.2 (refer to Table 5). Besides, the average performance by SDG is illustrated in the Figure 7.

**Figure 7: Average performance of the USA by SDG**




**Source:** Sachs, J. D., Lafortune, G., & Fuller, G. (2024). The SDGs and the UN Summit of the Future. Sustainable Development Report 2024. Dublin: Dublin University Press. https://doi.org/10.25546/108572

**Table 5. Indicators of the USA (Sustainable Development Report 2024)**

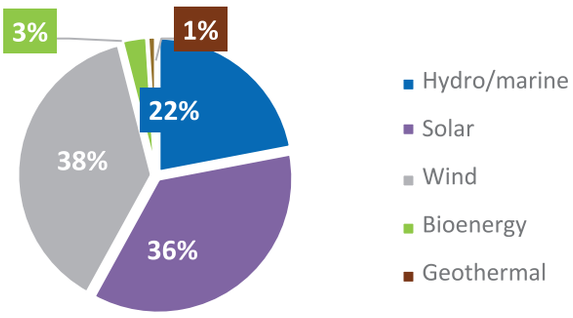
| | |
|---|---|
| 2024 SDG Index Score | 74.43 |
| 2024 SDG Index Rank | 46.00 |
| Percentage missing values | 2.04 |
| International Spillovers Score (0-100) | 61.85 |
| Regional Score (0-100) | 77.25 |
| International Spillovers Rank | 148.00 |
| Regions used for the SDR | OECD |

**Source:** Sachs, J.D., Lafortune, G., Fuller, G. (2024). The SDGs and the UN Summit of the Future. Sustainable Development Report 2024. Paris: SDSN, Dublin: Dublin University Press. doi:10.25546/108572

State governments in the U.S. have played a critical role in advancing green economy initiatives tailored to regional needs and priorities. California, for instance, has implemented the California Global Warming Solutions Act (AB 32), establishing a comprehensive cap-and-trade program to limit greenhouse gas emissions across sectors. This initiative has not only driven emission reductions but also generated revenue reinvested in renewable energy projects and energy efficiency programs (CARB). Similarly, states like New York and Massachusetts have adopted ambitious renewable portfolio standards (RPS) requiring utilities to source a significant portion of their electricity from renewable sources by specific target years, thereby stimulating growth in the renewable energy sector (Mass.gov; NYSERDA).

According to the Green Growth Index 2023, the United States, leading the Americas region, demonstrates robust green growth performance with a score of 63.72, placing it 28th globally (Lilibeth A. Acosta et al., 2023). Moreover the major renewable capacity accounted for wind and solar, 38% and 36% respectively (IRENA statistics, 2024e) (Figure 4).

**Figure 4: Renewable capacity in 2023**




**Source:** (IRENA statistics, 2024e)

## Benefits of the Analyzed Countries' Green Economy Strategies and Practices for Other Countries

The green economy strategies of Germany, Sweden, Azerbaijan, China, and the United States present valuable insights and practical approaches for nations pursuing sustainable development. Each country's strategy is tailored to its specific socio-economic conditions, resource availability, and environmental challenges, offering diverse models for integrating economic growth with environmental sustainability. By examining these cases, other nations can extract key practices, adapt them to their local contexts, and promote international collaboration to address global environmental issues.

A comparative analysis of these countries highlights several important lessons. Firstly, investment in innovation and green technology is essential. The progress seen in these nations shows that technological advancements and innovation drive the green economy forward. Promoting research and development, supporting startups, and facilitating the transfer of technology are effective ways to speed up the green transition. Secondly, public-private partnerships play a critical role. The private sector's involvement in funding and implementing sustainable solutions is a consistent feature in these countries. By creating policies that encourage private sector engagement through incentives and regulatory support, governments can leverage business resources to advance green economy objectives. Lastly, international cooperation and knowledge exchange are crucial for enhancing green strategies globally. Through sharing best practices, engaging in climate agreements, and participating in global initiatives, countries can strengthen their green economy efforts and address climate change collectively.

## Conclusion

This review article has examined the green economy strategies of Germany, Sweden, Azerbaijan, China, and the United States, highlighting their successes, challenges, and best practices. Germany's Energiewende emphasizes long-term political commitment and substantial investments in renewable energy. Sweden's comprehensive sustainability policies showcase the effectiveness of integrated frameworks and societal support.

Azerbaijan's transition efforts underscore the importance of international cooperation and energy diversification. China's extensive renewable energy investments and technological advancements demonstrate the impact of strong governmental directives. The diverse approaches within the United States reveal the potential of decentralized policy frameworks and market-based mechanisms.

Despite these achievements, several research gaps persist. There is a critical need for longitudinal studies to evaluate the long-term impacts of green economy policies, as short-term results often leave uncertainties about sustainability and scalability. Cross-sectoral assessments are essential to understand the interconnected impacts of green economy initiatives, ensuring a holistic approach to sustainable development. Enhancing international cooperation and knowledge transfer, as well as understanding the role of financial systems and green finance, are also vital areas for future research.

Addressing these research gaps will provide a more comprehensive understanding of green economy strategies and their effectiveness, aiding policymakers in developing more inclusive and sustainable approaches. This comparative analysis underscores the necessity of adapting green economy strategies to national contexts, ensuring a balanced approach to sustainability and economic development.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The authors confirm being the sole contributor of this work and have approved it for publication.

## Peer-review

Externally peer-reviewed.

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## Conflict of interest

No potential conflict of interest was reported by the author(s).

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# THE ROLE OF AZERBAIJAN IN GREEN ENERGY TRANSITION

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**Abstract**

The importance of energy for the continuity of global order and progress is irrefutable. Energy, which is an important factor in life, undoubtedly has a critical role in the development of countries. However, recent events have shown the urgent need to change how we source energy. Climate change and its negative consequences are forcing nations to take precautions against its devastating effects. In response, countries, both individually and collaboratively, have begun to frame their energy strategies in line with the green energy concept. As one of the countries taking responsibility, Azerbaijan has assumed a leading regional role. The Azerbaijani government has outlined actions to mitigate $CO_2$ emissions through both a national climate change strategy and a low-carbon development plan. This study explains the reasons behind and the expected outcomes of countries transitioning to low-carbon economies by using green energy sources instead of fossil fuels. It also highlights Azerbaijan's role in this transition toward sustainable energy efficiency.

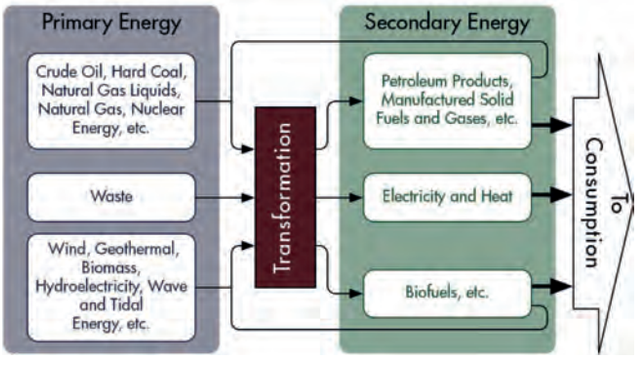
**Keywords:** Climate change, energy efficiency, sustainable development, carbon economies

## 1. Introduction

Energy is an important factor in meeting people's daily needs and contributing to the welfare of countries. Energy sources are divided into two main categories. It is possible to categorize them as Primary (Traditional) and Secondary (Alternative) Energy Sources. Traditional energy can be expressed as natural gas, coal or crude oil and its products."[1]

Energy produced from primary or secondary intermediate sources is referred to as alternative energy.

**Table 1.** Traditional and Alternative Energy Sources




**Source:** Stem. Guide (2024). "Primary Resources and Secondary Energy" (https://stem.guide/topic/primary-resources-and-secondary-energy/)

Modern energy development worldwide aims to ensure accessibility. Due to various reasons, traditional energy sources often fall short of achieving this objective. Consequently, the significance of alternative energy is on the rise. It encompasses promising approaches for producing energy from renewable sources, which, while not as prevalent as traditional sources, are appealing due to their low environmental impact[2].

Traditional or Alternative, these resources are not distributed equally on the country basis. Some countries are categorized as "rich" in hydro-carbon energy sources while some others are "rich" in renewable energy resources. Today, primary energy still has the highest rates recorded to produce the energy that we need in our daily lives and in industrial productions. Recently, more than %60 of global electricity is produced via fossil fuels. Additionally, the need for energy has been increasing each year. According to International Energy Administration (IEA), the energy need will grow by %50 until 2050. The agency stated that robust economic expansion, particularly in developing Asian economies, will lead to worldwide growth in energy usage, even in the face of pandemic-related decreases and ongoing enhancements in energy efficiency.[3]

Nevertheless, the world is currently headed for a dangerous 3°C warming. While the planet grapples with the negative effects of the climate change (species loss, ocean changes, rising sea levels, droughts and floods, heat waves...) the shift away from the fossil fuels to renewable energy has never been more urgent. Therefore, to meet the rising demand, fossil energy must be replaced by equal amount of green energy which is obviously difficult to manage but obligatory.

The adoption of green energy is vital for several reasons:[4]

1. The use of wind, solar and hydroelectric energy minimizes the release of greenhouse gases, which aids combat climate change by reducing water pollution as well as air pollution.

2. Renewable energy sources are plentiful and naturally replenished, unlike finite fossil fuels that can lead to environmental degradation during extraction and use.

3. Investment in local renewable energy sources decreases dependence on imported fuels, which can be influenced by geopolitical tensions and price fluctuations, thus enhancing energy security.

4. The rapidly expanding green energy sector generates employment opportunities in manufacturing, installation, and maintenance, promoting economic growth and innovation.

5. Reduced air pollution from the combustion of fossil fuels leads to improved public health outcomes, resulting in lower healthcare costs and a better quality of life.

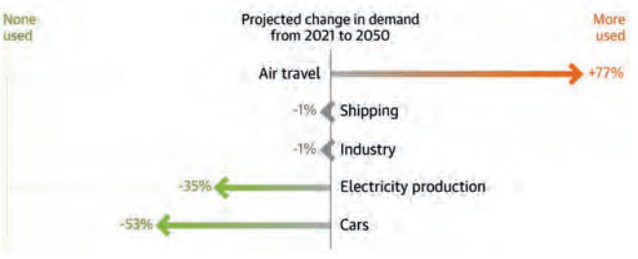
6. The transition to green energy has driven technological innovation, leading to more effective energy solutions and creating opportunities for advancement across various fields.

7. Adopting green energy use can facilitate communities' adaptation to climate change outcomes by promoting sustainable methods and building resilient infrastructures.

Overall, the significance of transitioning to green energy lies in its potential to create a more sustainable, economically viable, and healthier future for future generations.

However, although some important steps have been taken to limit fossil fuel consumption, such as the growth of the electric vehicle market and the reduction of coal-based production, reaching the target of zero CO2 emissions by 2050 is still a long way off.

**Graphic 1.** Global Fossil Fuel Demand




**Source:** Rhodium Group "Analysis of Global Fossil Fuel Demand". (https://www.theguardian.com/environment/2024/feb/09/biggest-fossil-fuel-emissions-shipping-plane-manufacturing)

The reason of the continuing carbon pollution derives from three main areas: aviation, shipping and industry. Apparently, there is not an alternative to jet fuel or ship diesel yet. Additionally, it would seem some industries such as cement-making and plastic will prevent a meaningful cut in carbon-intensive fuels till 2050. Still, the world needs to face to the fact that green energy is no longer a choice it is an obligation. More greenhouse emissions will cause more extreme reflections in line with climate change and its widespread terrifying effects will be experienced across the world. The severity of impacts from climate change will depend on the direction of future human activities. Executive Director of International Energy Agency Fatih Birol underlined the importance of getting prepared for this transition, stating, "We are observing the initiation of the fossil fuel era's conclusion and must ready ourselves for the forthcoming epoch." He also mentioned that substantial investments in new fossil fuel projects carry serious climate and financial risks.[5]

When we consider the developments regarding the transition to green energy, we see that some important voluntary steps have been taken to reduce greenhouse gas emissions after the 2015 Paris Agreement. For example, the European Union's target of reducing emissions by at least 55% compared to 1990s levels and the US's commitment to a 50-52% reduction by 2030 compared to 2005 levels are examples of global methane gas emission reduction efforts[6]. In addition, Azerbaijan, one of the world's leading energy producers and exporters, plays a critical role in the green energy transition by cooperating with European markets. Azerbaijan aims to reduce greenhouse gas emissions by 2030 and increase energy security by expanding the use of renewable energy sources. To this end, the country has developed an Offshore Wind Energy Roadmap in cooperation with the World Bank and the International Finance Corporation (IFC). Azerbaijan, despite being a top producer of gas and oil globally, is seeking to transform into a hub for renewable energy in the region, with the assistance of its international allies. By 2030, Baku is aiming for 30% of Azerbaijan's domestic electricity to be generated from renewable sources. The main goals of this initiative include diversifying government revenue streams, improving clean and sustainable electricity production, and decreasing greenhouse gas emissions. To accomplish these goals, Baku has entered into agreements with foreign partners,

including BP, Masdar in the UAE, ACWA Power in Saudi Arabia, and Fortescue in Australia. Consequently, significant contributions from abroad have been made to the development of renewable energy infrastructure in Azerbaijan.[7]

## 2. Importance of the Green Energy

Green energy can be described as the energy obtained from sun light, wind, rain, plants, algae and geothermal heat sources. These energy sources are naturally renewable, and with a well-planned production, the system could renew itself. Renewable energy is also called as "sustainable" energy.[8] On the contrary, fossil fuels need millions of years to exist, and they are described as "limited" sources which will end up in time because of excessive use.

The phrases green energy and renewable energy are commonly used interchangeably, but there is a crucial and sometimes perplexing distinction between them[9]. While most green energy sources are renewable, not all renewable energy sources are considered entirely green. Clean energy refers to energy that does not pollute the atmosphere and these energy sources will not release any greenhouse gases into the atmosphere. Once again, there are clear overlaps between clean energy, green energy, and renewable energy. Here is a simple method to distinguish between them:[8]

- Clean energy = unpolluted air
- Green energy = derived from natural sources
- Renewable energy = sources that can be recycled

Compared to fossil fuels, green energy sources have much less negative effects on the environment. To be able to reach fossil fuels, it is needed to apply mining and drilling methods on ecologically sensitive areas. Burning fossil fuels has been the primary source of energy for over a hundred years, supplying the power needed for transportation, businesses, and household lighting. Currently, approximately 80 percent of the energy demands are met by oil, coal, and gas, as reported by the U.S. Energy Information Administration. The use of fossil fuels for energy has resulted in significant consequences for humanity and the environment, including air and water pollution as well as global warming. Additionally, there are numerous adverse effects associated with petroleum-based products such as plastics and chemicals.[10] However, green energy is easy to find and available even in faraway places that don't have access to electricity.

Even though (because it is in its infancy) green energy seems more expensive than traditional resources, by the help of technology, the costs of solar panels, wind tribunes and other green sources would decrease. The future potential of green energy to replace fossil fuels may necessitate diverse production methods. For instance, geothermal energy is highly effective in areas where it is readily accessible, while wind and solar power may be more suitable in different geographic locations. By combining various green energy sources and leveraging advancements in their production and development, there is a strong possibility of phasing out fossil fuels.[11] It also gives a chance to everyone, not only to big companies that produce oil, gas or coal, to produce their electricity by themselves.

But although it is easier to access to renewable energy sources there is a very important problem that forces countries and companies to move on with fossil fuels: Fossil fuels are easy to store but we cannot say the same for the Renewables. Recently, some projects have been introduced to improve storage technologies, but they are not efficient enough especially in large scale areas. Still, the main answer to the question "why green energy" is obvious, because it never pollutes the environment. If we want the humanity to survive, then there is no other way than transition to Green Energy. Although fossil fuels are cheaper, easier to store or ship but they pollute our planet and cause global warming which will have devastating effects on environment.

Today, transition from fossil fuels to green energy resources is in the center of many countries especially the developed countries which demand energy more than others. In addition to environmental problems, fossil fuels are also used as a political weapon when there occurs a crisis between countries as we have witnessed in the war between Russia and Ukraine started in 2022. The war increased tensions between Russia and the West. This political crisis brought about many sanctions against Russia, which caused an energy crisis, especially in the European Union, which was heavily dependent on Russian gas.

The ongoing war between Russia and Ukraine has prompted the EU to take new measures to break Moscow's monopoly on energy imports. Russia, which does not hesitate to use its energy card for political purposes, has prompted the search for new measures and resources to counter it. Germany has reduced its dependency on Russian gas from 55% to 35% (BBC, 2022). In addition to the individual measures taken by countries, the EU has also made collective decisions. On March 8, 2022, the EU published the "REPowerEU: Joint European Action for Affordable, Secure and Sustainable Energy" plan, which aims to free the EU from its dependency on Russian gas by 2030 (European Commission, 2022). The plan includes topics such as renewable energy, diversification of fossil fuel use, and energy savings. As a result, the EU began to develop projects aimed at reducing energy dependency on Russia and securing and diversifying energy resources. In this process, Azerbaijan in the Caucasus and the Central Asian countries played an important role as diversification and transit points in providing energy to Europe.[12]

More than fifteen years EU has been evaluating the measures to green energy. In 2019, EU members launched the European Green Deal, in line with the commitments of the Paris Agreement, to combat global warming and accelerate the clean energy transition. The European Commission approved a set of proposals to align the EU's climate, energy, transport and tax policies to reduce net greenhouse gas emissions by at least 55% by 2030, compared with 1990 levels.The economy's key sectors are subject to legally binding climate targets within the EU. The comprehensive plan encompasses reduction targets for emissions in various sectors, an objective to enhance natural carbon absorption, a revised emissions trading system to limit emissions, impose a pollution charge, and stimulate investments in the transition to green practices, as well as assistance for citizens and small enterprises. Member States are now required to dedicate 100% of their emissions trading revenues to climate and energy-related initiatives and the social aspect of the transition.13 The newly established Social Climate Fund will allocate €65 billion from the EU budget, and a total of over €86 billion, to provide support for the most vulnerable citizens and small

businesses during the green transition. This commitment aims to create opportunities for all individuals by addressing inequality and energy poverty, and by enhancing the competitiveness of European companies, ensuring that no one is left behind.[14]

Important developments have been observed in terms of Renewable Energy transition in EU. In the initial six months of 2024, renewable sources accounted for 50% of the EU's electricity production. Surpassing gas, wind power became the EU's second leading electricity source after nuclear energy. From 1990 to 2022, the EU's greenhouse gas emissions decreased by 32.5%, while the EU economy expanded by approximately 67% during the same time frame.[13]

Even though the need for fossil fuels to generate the energy hasn't replaced completely by the Green Energy Resources yet, it is still the most important item in countries' agenda. Countries' ability to switch to green energy is related to their capacity of technology. Because even though it is significant to take precautions to protect the environment it is equally needed to find finance to support any project for green energy transition. Renewable energy means higher costs compared to traditional energy resources which triggers the concerns about how to motivate people and countries to prefer it. At that point, motivation and encouragement relates to three main positive motives of green energy. These are ecological benefits, the rise in countries' economical levels and social pressure.

## 3. Azerbaijan's role in Green Energy

Having a huge renewable energy potential, Azerbaijan has been a good example of successfully transition to alternative energy. Although the country's development and progress in economy is still strongly linked to oil and gas production, Azerbaijan intends to become an effective regional actor in applying the innovative approaches for green energy transition.

The Republic of Azerbaijan has implemented a State Program to promote the use of alternative and renewable energy sources on 21 October 2004, by Presidential Decree No. 462. This important program is considered a strategic addition to the country's energy policy. The main purpose of the program is to support energy production from environmentally friendly renewable energy sources and to ensure more efficient use of hydrocarbon-based resources. The State Program sets goals such as revealing the potential of renewable energy sources, increasing the country's energy efficiency by developing these sources, creating new energy production areas and providing job opportunities, and strengthening national energy security by supporting existing energy capacity with renewable resources.[15]

The Memorandum of Understanding signed between the EU and Azerbaijan in 2006 set important goals in the energy sector. These goals include modernizing the electricity grid, making the energy infrastructure safer and more reliable, creating new programs and regulations for renewable energy sources, and increasing energy efficiency. These goals are in line with the State Program implemented by the Ministry of Industry and Energy of Azerbaijan. SAARES was established within the framework of this program in 2009. In December 2011, a new government strategy aimed at achieving the 20/20/20 climate and energy targets set by the EU in 2006 was approved for the period 2012-2020. This strategy focuses on the development of alternative and renewable energy sources.[16]

The country aims to reduce greenhouse gas emissions by approximately 40% by 2050. It aims to increase its use of renewable energy to 30% by 2030. It also aims to expand and diversify its existing energy infrastructure to become a pioneer in the field of green energy. To follow through its ambitions in renewables Azerbaijan aims at developing projects with important companies such as ACWA Power (Saudi Arabia) and Masdar (United Arab Emirates). Within the frame of alternative energy transition, the government plans to implement a project to instruct a power plant in Yashma and make Nachchivan to become a green energy zone together with Karabakh and Zanzegur.

Azerbaijan is implementing the country's largest renewable energy project to date. In this context, three new facilities are being built, two solar and one wind power plant, to meet Baku's goal of providing 30% of its energy production from renewable sources by 2030. The projects are managed by a consortium formed by UAE-based Masdar renewable energy company and Azerbaijan's state oil company Socar. The capacities of the facilities are planned to be 445 Megawatts of solar energy in Bilasuvar. Also, 315 Megawatts of solar energy in Neftchala and 240 Megawatts of wind energy in the Absheron-Garadagh region, respectively.[15]

Considered one of the countries in the sunny countries category, Azerbaijan has significant potential for solar energy production. It receives up to 3,200 sun hours per year. Solar intensity can reach up to 2,000 kWh/m2.17 In October 2023, the 230 MW Garadagh Solar PV Plant was inaugurated. Additionally, several other projects are underway with the agreements planned to be signed with stakeholders. While expanding its solar infrastructure the country collaborates with private and public partners in the sector.

Although it has a great potential in solar energy generation, much attention has been paid to wind power electricity production. Azerbaijan has a great potential to generate wind power. According to the Ministry of Energy, the country has a technical potential of about 3,000 MW and an economic potential of 800 MW of wind energy. This economic potential can generate about 2.4 TWh of energy, which means saving about 1 million tons of conventional fuel, which indicates a significant reduction in CO2 emissions (International Energy Agency). Hydropower has been the primary renewable energy source in Azerbaijan for over a century. The first hydroelectric power plant, established in 1883 in the Galakend village of the Gedebey district, aimed to provide electricity to both the local population and the surrounding industrial facilities. With the arrival of the 1950s, the Varvara and Mingachevir hydroelectric power plants increased their production capacities and made significant contributions to the development of the sector. Hydroelectric energy accounts for approximately ten percent of the country's total annual electricity production. While approximately twenty-five percent of freshwater resources are located in the Karabakh and Zangezur regions, the Mingachevir Hydroelectric Power Plant constitutes the largest hydroelectric infrastructure in the region with a capacity of 424 MW.

With the support of the European Bank for Reconstruction and Development (EBRD), Azerbaijan began exploring low carbon hydrogen production in February 2023. Azerbaijan is committed to realizing its ambitious goal of establishing a thriving green hydrogen industry. By entering into partnership agreements with

international private sector entities, Azerbaijan aims to facilitate the creation of approximately 10 GW of renewable energy soon, which will play a significant role in hydrogen production.[18]

Azerbaijan's rise to a leading position internationally, thanks to the government's transition to green energy and climate protection efforts, led to the 29th meeting of the Conference of the Parties to the UN Framework Convention on Climate Change (COP 29) being held at Baku. COP29 Presidency's plan is based on enhancing ambition to ensure all parties commit to ambitious national plans and enhance transparency. The plan's second key point is to "enable action" which reflects the critical role of finance, a key to put ambition into action because to reduce the emissions and loss and damage caused by the climate change finance has a big part[19].

## 3.1. Azerbaijan's Major Solar Projects

By 2050, Azerbaijan plans to significantly expand its hydropower capacity as part of its renewable energy strategy. Key projects and goals include:

a. Masdar Solar Plant: In October 2023, the plant began its commercial operation. Annually, the project produces 500 million kilowatt-hours of electricity, sufficient to fulfill the requirements of over 110,000 households, and it will decrease emissions by 200,000 tonnes per year. Furthermore, the solar power plant has generated employment opportunities for the local community.[20]

b. Nakhchivan Solar Power Plant: Nobel Energy, a subsidiary of NEQSOL Holding, has signed an agreement with the Ministry of Energy of Azerbaijan to build a 400 megawatt (MW) solar power plant in the Nakhchivan region of Azerbaijan.[21]

c. The Gobustan Hybrid Power Plant (HPP): integrates wind, solar, and biogas power generation, transmitting electricity to the grid in a hybrid form. The Gobustan HPP aims to explore options for self-sustained energy supply to villages and districts using power generated at the station. Initially, the focus is on meeting the energy demands of Gobustan city, with plans to extend to the Gobustan region. Spanning 38 hectares, the station is situated in Gobustan city of Gobustan region. The station's project capacity is 6.4 MW, with the first stage of construction completing in 2013, adding 3.6 MW of power. Since commissioning, the station has generated 36.3 million kWh of electricity up to January 1, 2022.[22]

e. Garadagh Solar Plants: The Garadagh Solar PV Power Plant, with a capacity of 230 MW, was opened on October 26, 2023, with significant participation from Azerbaijan and the UAE. Azerbaijani President Ilham Aliyev and UAE Minister Sultan Ahmed Al Jaber also attended the opening ceremony. This facility is the largest solar power plant in the Caspian region and the CIS countries and was established with foreign capital worth 262 million US dollars. It is also the first large-scale solar power plant to be implemented in the country with foreign investments. The plant is expected to produce 500 million kilowatt-hours of electricity annually, save 110 million cubic meters of natural gas and reduce 200 thousand tons of carbon emissions. The plant, which is located on a large area of 550 hectares, houses 570 thousand solar panels. It is integrated into the grid with a 330-kilovolt transformer substation.[23]

## 3.2. Azerbaijan's Major Wind Power Projects

a. Khizi-Absheron Wind Energy Project: It is an onshore wind power project with a capacity of 240.5MW, scheduled to be in Absheron, Azerbaijan. According to GlobalData, a company that monitors and profiles more than 170,000 power plants globally, the project is currently in the construction phase and will be executed in several stages. Construction of the project is anticipated to start in 2022, with commercial operation expected to commence in 2025.[24]

b. Azerbaijan's Offshore Wind Energy (Caspian Sea): Azerbaijan, in partnership with the World Bank and the International Finance Corporation (IFC), has announced its Offshore Wind Roadmap for 2022. The roadmap highlights the country's potential to reach 7 GW of offshore wind capacity by 2040, given appropriate strategies, infrastructure development, investments and policies. The roadmap details steps to maximize the potential of offshore wind energy. Recommendations include setting targets for 2030 and 2036, implementing a 200 MW pilot project and launching a competitive bidding process ahead of large-scale projects, further examining potential offshore wind regions, modernizing infrastructure, adopting global best practices for funding, and providing all government departments and the future workforce with the necessary expertise and skills.[25]

## 3.3. Azerbaijan's Major Hydropower Projects

Azerbaijan's hydropower contributes approximately 10% to the country's annual electricity production. The Karabakh and East Zangazur regions hold around 25% of the nation's freshwater reserves, emphasizing the importance of hydropower in meeting the 2050 Net Zero goal within these specified Green Energy Zones. With an installed capacity of 424 MW, Mingachevir Hydroelectric Power Plant stands out as one of the leading examples of Azerbaijan's hydroelectric infrastructure.[26]

Azerenergy OJSC has committed to investing more than 40.5 million manats (equivalent to over $23.8 million) in the refurbishment of three small hydropower plants and the incorporation of six additional plants into the energy grid in Azerbaijan's Karabakh and Eastern Zangezur regions. The Public Procurement web portal reported that AzerEnerji has entered a contract with Azconstruction CJSC, the successful bidder of the relevant tender, to undertake the reconstruction and integration projects.[27]

# 4. Azerbaijan's Partnership with Georgia, Romania and Hungary for Green Energy

Transelectrica, the transmission system operator in Romania, along with Georgian State Electrosystem, the transmission system operator in Georgia, AzerEnerji, the power utility in Azerbaijan, and MVM, the power utility in Hungary, have come together to form a collaborative company with the purpose of laying a submarine cable beneath the Black Sea.[28]

The plan is to extend a cable connecting Romania and Georgia to include Hungary and Azerbaijan. This extension aims to create a link between the transmission networks of the four countries and make it easier for renewable electricity to be transmitted. The first results of the feasibility study are set to be presented at

COP29 in Baku. It is aimed to contribute to the decarbonization of energy sector by transporting renewable energy via this project. At a meeting held in Brussels on April 5, 2024, representatives of the EU, the US and Armenia came together. At this meeting, EU Commission President Ursula von der Leyen announced that they will invest in new infrastructure projects. In particular, she said, "We will invest in a new electricity transmission line that will pass through the Black Sea. This line has the potential to provide clean and renewable energy to Europe and we are ready to support this project."[29]

## 5. Azerbaijan's Partnership with Kazakhstan and Uzbekistan for Green Energy

A joint venture is set to be formed by Azerbaijan, Kazakhstan, and Uzbekistan for the purpose of exporting green energy to Europe. "The Energy and Economy Ministers of Azerbaijan, Uzbekistan and Kazakhstan came together at a meeting held in Baku. At this meeting, the possibilities of Central Asian countries exporting electricity to Europe via Azerbaijan were discussed and it was stated that a mutual agreement was reached on this issue.[29]

After the meeting, a collective statement was issued by the ministry leaders acknowledging the renewable energy capabilities of regional countries and their willingness to participate in the initiative for supplying electricity to Europe from sustainable sources.

As per the statement, the participants will establish a collaborative task force to brainstorm on energy exchange cooperation, emphasizing renewable energy sources, the generation and shipment of eco-friendly ammonia and hydrogen, and the development of relevant infrastructure.

Uzbekistan aims to generate 20 gigawatts (GW) of additional capacity from renewable energy sources by 2030. Once this goal is achieved, the country's total renewable energy capacity will reach 27 GW. In April, the government approved agreements for wind and solar power projects that will generate a total of 12 GW. As part of Uzbekistan's energy reforms, it is planned to include private investors in electricity distribution networks and double energy efficiency. Uzbekistan also aims to expand its renewable energy exports, particularly to European countries such as Hungary and Romania. It aims to increase green energy production to 13 billion kWh by 2024 and achieve a 15% share in the country's energy balance.[30]

Kazakhstan plans to invest 50 billion tenge (about $110.7 million) in renewable energy projects in 2024. The funds will be distributed as follows: 9 billion tenge (about $19.9 million) for wind energy projects, 13 billion tenge (about $28.7 million) for solar energy projects and 28 billion tenge (about $62 million) for hydropower projects. Renewable energy capacity in Kazakhstan has increased 16-fold, from 178 MW in 2014 to 2,868 MW in 2023, and this is a significant growth in this area.[31]

## 6. Azerbaijan and European Union Partnership for Green Energy

The EU has been continuously reviewing its green energy policies over the last fifteen years.

Russia's military operations against Ukraine urged EU countries to get on with the energy shift even faster. The REPowerEU plan which was launched after the Russia's operations and Covid 19 pandemic aims at accelerating the clean energy transition by diversifying supplies.

Main goals of EU for energy transition are (European Council):

a) to become more independent in energy trade, especially from Russia.

b) to decrease the use of fossil fuels and support the effective use of renewable energy sources

c) increase and improve energy efficiency and infrastructure in line with its integration across EU countries.

As it mentioned, EU's main goal is to diversify energy supplies and create a more competitive energy market. In this context, Azerbaijan becomes an important partner. Being a strategic and reliable partner for EU with its geological position and energy sources, Azerbaijan is an ideal country for the transportation of energy sources.

On 18 of July 2022, European Commission President Ursula von der Leyen and Energy Commissioner Kadri Simson held talks with Azerbaijan's President Ilham Aliyev and Energy Minister Parviz Shahbazov to bolster the ongoing cooperation between the EU and Azerbaijan. During the meeting, both presidents signed a new Memorandum of Understanding focused on a Strategic Partnership in the Energy sector.32 This key agreement outlines a commitment to increase the capacity of the Southern Gas Corridor pipeline to over 20 billion cubic meters (bcm) annually by 2027. This expansion aims to enhance energy security and diversify supply sources for the EU. By allowing the transport of greater volumes of natural gas from Azerbaijan to multiple European countries, the increased pipeline capacity will help reduce Europe's reliance on Russian energy and improve its resilience to potential supply disruptions.

The Memorandum of Understanding (MoU) also includes vital EU support to help Azerbaijan reduce methane flaring and venting in its gas production processes. This initiative aligns with global environmental standards and aims to assist Azerbaijan in joining the Global Methane Pledge. By implementing best practices and advanced technologies to reduce methane emissions, Azerbaijan can strengthen its environmental responsibility and contribute to global climate change mitigation efforts. The EU's backing in this area highlights a commitment to securing energy supplies while ensuring environmentally responsible production, reinforcing the shared sustainable development goals of both parties.[33]

President Von der Leyen said: *"Today, with this new Memorandum of Understanding, we are opening a new chapter in our energy cooperation with Azerbaijan, a key partner in our efforts to move away from Russian fossil fuels. Not only are we looking to strengthen our existing partnership which guarantees stable and reliable gas supplies to the EU via the Southern Gas Corridor. We are also laying the foundations of a long-term partnership on energy efficiency and clean energy, as we both pursue the objectives of the Paris Agreement. But energy is only one of the areas where we can enhance our cooperation with Azerbaijan and I look forward to tap the full potential of our relationship".*

In 2011, the Nabucco project failed due to obstacles created by Russia and difficulties in providing uninterrupted gas to the European Union. Following these developments, Azerbaijan and

the European Union signed a memorandum of understanding on the Southern Gas Corridor (SGC), which is considered a more effective and promising alternative to the Nabucco project. The SGC includes projects that will transport gas from Azerbaijan's Shah Deniz natural gas field to Southern Europe, especially Italy and Greece, primarily the Trans Adriatic Pipeline (TAP) and the Trans Anatolian Pipeline (TANAP).

## Conclusion

The importance of transitioning to green energy lies in its potential to create a more sustainable, economically viable, and healthier future for future generations. To achieve this goal all countries should take responsibility and put ambitious effort to manage a healthy transition for green energy.




**Map 1: Southern Gas Corridor**

**Source:** SOCAR, 2024. (https://socar.de/en/socar-2/southern-gas-corridor/)

Azerbaijan is currently supplying 5% of Europe's energy needs by transporting Caspian gas to EU market through the Southern Gas Corridor. European Commissioner for Neighbourhood and Enlargement Policy Oliver Varhelyi visited Azerbaijan in February 2024. During this visit, he highlighted the critical importance of the Southern Gas Corridor for energy security in Europe. He also shared information that the European Union will provide financial support of €2 billion for energy projects in Azerbaijan. European Union also takes steps to strengthen the partnership with Azerbaijan in the field of green energy (European Commission, 2022).

European Union and Azerbaijan have reached an agreement to back the future growth of renewable hydrogen. TAP's capacity expansion could facilitate the transportation of additional quantities of hydrogen and other renewable gases to promote long-term sustainability and facilitate the energy transition in the region. The Green Energy Advisory Council 1st Ministerial Meeting has reinforced the foundation for future cooperation, highlighting Azerbaijan's significant potential to support European Green Deal initiatives. Azerbaijan aims to export both natural gas and green energy to Europe, as it seeks to enhance its strategic partnership with the EU. Both electricity and renewable hydrogen are set to become crucial sources of energy from Azerbaijan to Europe.[34]

Azerbaijan, aiming to diversify its economy and become independent of fossil fuels, is taking an active role in the field of green energy in cooperation with other countries and institutions.

The country has the potential to benefit from various renewable energy sources such as wind, solar and hydroelectric, and thanks to its geographical location and climate, it could use solar and wind energy effectively.

The Azerbaijani government has been concentrating on enacting policies that promote the development of renewable energy. This includes specific targets for renewable energy generation, incentives for green energy projects, and the establishment of laws and regulations to encourage investment in the sector.

Azerbaijan aims to increase the share of renewable energy sources in its portfolio. According to Azerbaijan's 2020-2025 strategic plan, it aims to provide 30% of its total energy production from renewable sources by 2030.

Azerbaijan has been seeking partnerships with other countries and international organizations to enhance its capabilities in renewable energy. Collaborating with countries experienced in green technologies can help Azerbaijan accelerate its energy transition.

Interest in renewable energy projects in Azerbaijan is constantly growing among both local and international investors. Various solar and wind energy projects developed in the country are adopting advanced technologies and best practices from around the world.

Increasing awareness and education regarding the benefits of renewable energy and sustainability practices is essential for gaining public support and encouraging participation in green energy transition.

Azerbaijan's journey toward a green energy future presents both challenges and opportunities. By leveraging its renewable energy potential and fostering a supportive policy environment, the country can play a significant role in global efforts to combat climate change while ensuring sustainable economic growth.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The authors confirm being the sole contributor of this work and have approved it for publication.

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# UNDERSTANDING THE CONSUMER RESPONSES TO GREENWASHING IN FAST-FASHION INDUSTRY

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**Abstract**

The main purpose of this study is to explore how consumers perceive and respond to greenwashing, specifically focusing on its impact on their purchasing behaviors and emotional reactions. Additionally, the study aims to examine how the ecological image of a product's country of origin influences consumer evaluations of greenwashing practices. In this context, the research analyzed Youtube comments of consumers based on 2 cases and integrated the outcomes of this analysis with the insights gathered from focus group study to understand the deeper connections between greenwashing, consumer responses, and country-of-origin effects. Finally, the findings of this study highlights that consumers' perceptions of greenwashing lead to negative purchase intention, green consumer confusion, loss of trust, and altered purchase behavior such as shifting to second-hand stores or competitors. It is also evident that negative emotions are generated, although not intensely expressed. On the other hand, COO ecological image is not directly associated with greenwashing, but rather focuses on regional differences.

**Keywords:** Greenwashing, Sustainability, Fast-Fashion, Consumer Responses

## Introduction

Companies are aware of the growing interest of consumers in sustainable products, packaging, and practices, and the increasing demand for product safety, toxicity, and recyclability has led companies to make significant investments in sustainable practices and green marketing (Iannuzzi, 2024). Green marketing activities are carried out to satisfy the needs and wants of environmentally aware customers and meet new consumer expectations by producing environmentally friendly products and services. (Nekmahmud & Fekete-Farkas, 2020; Gelderman et al., 2021). Green marketing is a tool for companies in order to position themselves better in the market and to add to the trust of the client surrounding the brand (Szabo & Webster, 2021). Thus, most businesses use green marketing terms in their promotional activities (Malinauskaite et al., 2020; Sumrin et al., 2021; Zorpas, 2020). A firm's marketing communications to consumers represent an important factor in shaping consumer attitudes toward the legitimacy of a company's environmental claims (Wang et al., 2021). However, it is essential to make a distinction between authentically sustainable practices and misleading green initiatives within the realm of green marketing, the latter of

which often seek to exploit perceived environmental benefits for competitive advantage. Greenwashing is defined as the deliberately disingenuous manipulation of environmental benefit and impact concern to lend a company or its offering an environmentally superior profile, attempting to create consumer goodwill for the brand or its products and services (Cao et al., 2022). Greenwashing involves emphasizing a single positive practice or a minor aspect of a company's activities while concealing the broader negative environmental impacts, thereby creating a misleading impression of being more sustainable than it actually is (Generation Climate Europe, 2021). Since greenwashing diminishes the effectiveness of genuinely responsible corporate behavior and compromises its extent, the question of what consumers think of the organization's legitimacy has considerable significance (Kudłak, 2024). The emotional reactions elicited by greenwashing practices warrant significant attention. Research indicates that the detection of greenwashing can provoke emotional responses such as distrust, disappointment, and frustration among consumers (Chen & Chang, 2013). These emotions not only impact individual consumer relationships but can also lead to broader reputational damage for companies, affecting their long-term viability in the market.

The customers' trust, along with the use of brands, vision, knowledge, thinking, and sensations, can have repercussions for their beliefs and will become much more negative (Bigné et al., 2023). The existing literature states that customer perceptions of greenwashing predict decreased degrees of trust and consequently influence brand capital in a detrimental manner (Ha et al., 2022; Uitslag, 2024). Hence, understanding the influence of greenwashing on purchasing behavior is vital. Consumers who perceive a brand as engaging in greenwashing may change their purchasing choices, opting for competitors perceived as more genuine in their sustainability efforts (Testa et al., 2011). On the other hand, assessing the origin of a product provides insights into the social, geographical, cultural, and economic factors influencing consumer behavior (Trentinaglia et al., 2020). In today's era of globalization, awareness of a product's origin offers consumers more comprehensive information than ever before. Consumers increasingly consider global ethical issues, such as labor conditions and environmental practices, to discern the country of origin (COO) of a product (Bhattacharya et al., 2023). These communicated social representations enable consumers to draw inferences about the products. Consequently, the characterization of a product's COO – whether positive or negative – can significantly impact consumers' assessments, especially in the context of greenwashing marketing strategies (Xiao & Myers, 2022).

In summary, it should be highlighted that the investigation into how consumers perceive and respond to greenwashing is critical for understanding its effects on purchasing behavior. Furthermore, examining the influence of a product's country of origin provides essential insights into consumer evaluations of environmental claims, emphasizing the strategic importance of aligning marketing practices with genuine sustainability efforts. Research on consumer behavior, particularly in relation to greenwashing and the COO, remains sparse and requires further development (Martínez et al., 2020). Drawing on this, the primary aim of this study is to investigate consumers' perceptions of and reactions to greenwashing. Pertaining to this objective the current study seeks (1) to elucidate how consumers conceptualize the notion of greenwashing (2) to determine consumers' perceptions and responses regarding greenwashing (3) to comprehend how the ecological image of a product's COO impacts consumer assessments of greenwashing practices.

The subsequent sections provide a review of recent studies on greenwashing, the country-of-origin ecological image, consumer responses, and the fast fashion industry. Following this, the research methods employed in two studies are detailed, and the findings are systematically presented using content analysis. The article concludes with a discussion on consumer reactions to greenwashing within the fast fashion sector.

## Background

### *Definition of Greenwashing*

Environmental issues have started to receive significantly more attention in recent years, and this has caused society to scrutinize the actions of many profit and non-profit organizations with relation to the environment. Stakeholders such as governments, investors, consumers are increasingly conscious of environmental consideration because of the growing number of environmental crises, and they are creating pressure on companies specifically over the last ten years to provide real, manipulation-free information about their environmental performance (Kim and Lyon, 2015). Additionally, as greenwashing litigation evolves, companies confront heightened scrutiny and legal concerns across multiple platforms, including product claims and carbon neutrality assertions (Runyon, 2024). So, the term "greenwashing" which is described as "the act or practice of making a product, policy, activity, etc. appear to be more environmentally friendly or less environmentally damaging than it really is'' (Merriam-Webster, 2024) has been the subject of interest among academics (Santos, et al. 2024).

The origin of greenwashing dates back to 1986, when environmental activist Jay Westerveld published an essay on a hotel's promotional campaign that claimed towel reuse was part of its environmental corporate plan (Becker-Olsen and Potucek, 2013) and recognition and dissemination of the term increased during the late 1990s (Greer & Bruno, 1997). Walker and Wan (2012) define greenwashing as the difference between "symbolic" and "substantive" corporate social actions. Additionally, Delmas and Burbano (2011, 66) define greenwashing as "the act of misleading consumers regarding the environmental practices of organizations (firm-level greenwashing) or the environmental benefits of a product or service (productlevel greenwashing)". The debate on what constitutes greenwashing is ongoing. The scope of potential greenwashing activities is much broader than suggested by lists such as TerraChoice's (2010) "seven sins of greenwashing (The sin of (1) the hidden trade-off; (2) no proof; (3) vagueness; (4) irrelevance; (5) the lesser of two evils; (6) fibbing; (7) worshiping false labels)". For example, two main types of greenwashing, namely decoupling and attention deflection, highlighted in the study of Siano et al. (2017). According to their study, decoupling occurs when firms try to meet stakeholders' environmental expectations without essentially changing their structure and behaviors. It usually happens when a corporation promotes ambitious sustainable projects without forming an effective sustainability department (structures/activities disconnection) or without enough resources to meet the desired corporate goals (means/ends disconnection). On the other hand, attention deflection consists of symbolic

actions meant to draw stakeholders' focus away from immoral business activities. Moreover, Demas and Burbano (2011) define the firms that communicate positively about their poor environmental performance as greenwashing organizations, while organizations that have poor environmental performance and do not communicate at all about their environmental performance as silent brown organizations .

## Greenwashing and Country-of-Origin Ecological Image

Since 1962, when Dichter wrote in the Harvard Business Review that a product's COO can have "an enormous impact on the acceptance and success of products," numerous studies have analyzed the impact of COO and proved that COO has a significant impact on customers' decision-making process and product evaluation (Diamantopoulos et al., 2020). If customers have a positive attitude towards the COO of the product, they are likely to transfer this attitude to the product. Recent empirical studies suggest that about half of consumers are likely to respond to country-of-origin (COO) cues when making purchasing decisions (Herz and Diamantopoulos, 2017). When used in the field of green marketing, this term refers to the concept of the ecological image of the COO. Although the COO construct is one of the most researched constructs in international marketing, only a few studies have elaborated a country's ecological image and its influence on consumer perception of a product (Xiao and Myers, 2022). There is evidence that when a country has a strong ecological image, products from these countries are assumed to be more environmentally friendly (Dekhili and Achabou, 2015). Although the country of origin (COO) is linked to ecological image and environmentally friendly purchasing behavior (e.g., Thøgersen & Pedersen, 2021), no studies, to the best of the authors' knowledge, have examined its role in shaping perceptions of greenwashing. Consequently, to address this gap, the COO ecological image construct has been incorporated into this research.

## Consumer Responses to Greenwashing

Multiple factors shape consumers' behavioral and emotional responses to greenwashing, a phenomenon that can be analyzed through the lens of psychological contract theory. This framework elucidates how greenwashing can lead to detrimental attitudes among consumers towards responsible corporations (Hung & Chang, 2024; Ibrahim Nnindini & Dankwah, 2024). Individual predispositions, beliefs, values, norms, and prior knowledge regarding environmental issues significantly influence the extent to which consumers are affected by greenwashing (Bladt et al., 2024). Greenwashing, which involves companies creating a misleading impression of their environmental practices, often triggers negative emotional responses among consumers (Leonidou & Skarmeas, 2017). Such emotions can include feelings of outrage, anger, irritation, frustration, disappointment, and anxiety (Pabon, 2023). These negative emotions are significant because they can influence consumer behavior in several ways. Firstly, they can lead to reduced trust in not only the specific brands involved in greenwashing but also in the broader marketplace, as consumers may become skeptical of other environmental claims (Chen & Chang, 2013). Secondly, negative affective responses can decrease consumer loyalty and deter future purchases from the offending brands, as trust is a critical component in the consumer-brand relationship (Laufer, 2003). Thus, the affective dimension is pivotal in understanding consumer reactions to greenwashing, as it underscores the psychological and behavioral impacts of such deceptive practices.

Liao (2024) investigates the relationship between greenwashing and purchase intention, revealing that consumers' perceptions of greenwashing in a specific electric vehicle brand negatively influence their purchase intentions toward other brands. This detrimental effect is mediated by a general skepticism towards environmental claims in the industry. Furthermore, findings from Bladt et al. (2024) suggest that perceptions of greenwashing can substantially harm both current and potential customers' brand attitudes, thereby leading to adverse consequences for brand image and sales. In the green industry, consumer resistance to greenwashing perceptions varies based on their brand attitudes. Consumers with strong brand attitudes are better equipped to withstand the negative effects of greenwashing perceptions on their purchasing behavior compared to those with weaker brand attitudes (Wang et al., 2020). Notably, ambiguous claims do not enhance consumers' perceptions of greenwashing. In contrast, false claims can severely damage consumers' attitudes towards the associated advertisements and brands (Schmuck et al., 2018). From a behavioral perspective, the impact of deceptive marketing claims on consumers directly leads to a range of tangible reactions.

Additionally, green trust, defined as the willingness to depend on a product or service based on beliefs or expectations rooted in its credibility, benevolence, and competence regarding environmental performance (Chen, 2010), is positively linked to green repurchase intention (Lam et al., 2016). Chen and Chang (2013) demonstrate that greenwashing negatively impacts green trust, with their study revealing that green consumer confusion and perceived risk mediate the adverse relationship between greenwashing and green trust. Additionally, Aji and Sutikno (2015) found that switching intention is a consequence of green trust.

## Greenwashing and Fast Fashion

The apparel and textile industry contributes millions of employment and US$1.5 trillion in revenue to both local and global economies. The fashion apparel industry continues to be transformed significantly, driven by global changes and technological advancements, allowing suppliers to expand into new markets and reduce production costs. This shift has led to the rise of fast fashion, with companies doubling production compared to the 1990s and adopting rapid design cycles to meet consumer demand. However, this accelerated production has brought substantial environmental costs. The UN Environmental Programme (2023) has dramatic statistics. Every year, the textile industry contributes 2-8% of the world's greenhouse emissions, consumes the equivalent of 86 million Olympic-sized swimming pools of natural water resources, and accounts for 9% of microplastic contamination in our oceans. Furthermore, the value chain has significant social consequences, putting textile workers at risk of exploitation, underpayment. In the textile industry, fast fashion accounts for around half of the fashion industry's emissions and this sub-sector is particularly detrimental due to fragmented supply networks, the use of synthetic materials, and chronic overproduction (Wren, 2022).

Today, there is a growing demand for environmentally friendly products and a corresponding increase in companies' communication efforts around environmental awareness. Consumers want businesses to follow ethical business practices and demand greater transparency from companies and thus, this has led to the growth of "greenwashing," as businesses try to appeal to customers while maintaining their competitiveness (Torelli et al., 2019). It's common for the fashion and textile industries to engage in greenwashing due to the same reason. For example, Fast fashion retailers like H&M and others often refer to their eco-friendly lines by broad terms, such as JoinLife by Zara, Committed by Mango, and Conscious by H&M. Additionally, H&M's *Conscious Collection* has been criticized for lacking transparency regarding its sustainability claims. In 2019, the Norwegian Consumer Authority noted that H&M did not provide enough information about the actual sustainability level of the collection (Kaner, 2021) H&M has also faced criticism for promoting a cycle of consumption, rather than encouraging consumers to maintain and care for the clothes they already own. As well, Chinese online fast fashion giant Shein is also under investigation by the Italian Competition Authority for potentially making misleading claims about its sustainability practices (Hadero, 2024). While the number of news articles about greenwashing in traditional media and social media has been increasing, there are also studies in the literature that also address the issue of greenwashing from the consumer perspective related to the fashion industry. For example, according to Diaz-Bustamante-Ventisca et al. (2024), consumers who are more concerned and aware of sustainability are more sensitive to perceiving the sustainable communication of fast-fashion brands as greenwashing. Additionally, study of Costa Policarpo et al. (2023) reveals that cynical individuals are more likely to perceive companies' sustainability engagement as greenwashing, which in turn decreases their trust toward clothing brands. Another study by Apaolaza et al. (2023) supports the idea that when consumers perceive green product claims as vague or seemingly unlikely, it leads to doubts about the marketing information. This suspicion that the company is greenwashing negatively impacts their purchasing behavior in the sustainable fashion industry. Although there are some studies as indicated in the literature review, previous research on greenwashing in the case of the fast fashion industry is very limited.

## Research methodology

A recent systematic review of consumer behavior in sustainable fashion (Busalim et al., 2022) identified limited use of qualitative methodologies despite a strong emphasis on quantitative approaches. Since this study aims to grasp the meanings behind consumers' behavior and to explore and understand their perceptions and evaluations, qualitative research seems to be the most appropriate approach (Silverman, 1998). Thus two studies were applied as part of an exploratory approach to understand how consumers evaluate the companies' greenwashing cases. While the first study examined Youtube comments on greenwashing through 2 company case studies, a focus group was conducted in the second study in the same context to delve deeper into consumer perceptions and validate the findings from YouTube comments.

## Study 1. Analysis of YouTube Comments

In the context of the first study, this study analyzed comments scraped from YouTube related to true greenwashing cases to investigate the perceptions and sentiments of the YouTube audiences. Since this study aims to see consumer responses to greenwashing as well as the impact of COO ecological image, the research focused on Hennes & Mauritz AB (H&M) and Shein brands, inspired by two recent real cases in the fast fashion industry. These brands were specifically chosen because they represent both high and low levels of country-of-origin (COO) ecological image and have recently been the subject of greenwashing investigations in various countries. H&M has Swedish origin and its headquarters being in Stockholm, Sweden and it is a significant representative for one of the nations with a strong ecological image. However, SHEIN was established in the People's Republic of China (PRC) and its headquarters are in Singapore and it is associated with the negative COO ecological image Comprehensive study of Greenmatch (2024) analyzing the most and least green countries globally support this brand-country selection.

First of all, videos linking these brands with greenwashing were searched on Youtube with the following keywords: search 1: "greenwashing" and "H&M" and search 2: "greenwashing" and "Shein". The filter tool was used to select and rank videos in decreasing order based on relevancy. The relevancy of YouTube video content about greenwashing and selected brands, the number of views on each video, and the number of comments created by commentators were used to choose videos for this study. The comments are listed using Microsoft Excel program, and any comments made in response to the initial comment and repeated comments are omitted to enhance the credibility of the research. Excluding unrelated 289 comments, there are a total of 500 comments listed for content analysis (323 for H&M Case and 177 for Shein Case) (Table 1).

**Table 1: The Most Watched YouTube Videos Based on Specific Terms Chosen**

| URL | The Author | Title | Number of Views | The Number of Comments | The Date of Extraction |
|---|---|---|---|---|---|
| https://www.youtube.com/watch?v=00NIQgQE_d4&t=618s | DW Planet A (653K Followers) | H&M and Zara: Can fast fashion be eco-friendly? | 644.609 | 517 | 30.06.2024 - 20.06 |
| https://www.youtube.com/watch?v=3nDiGQ51gLE | Shelbizleee (344K Followers) | SHEIN's repulsive greenwashing using influencers to promote fast fashion & lies | 56.572 | 272 | 30.06.2024 - 00:35 |

In the coding process of YouTube comments, the framing processes outlined by Benford and Snow (2000) can be effectively applied to the discourse around greenwashing in social movements. Diagnostic framing in the context of greenwashing identifies the misleading environmental claims made by companies and attributes responsibility to these corporations for deceiving consumers and neglecting genuine environmental commitments. Prognostic framing suggests actionable solutions, such as implementing stricter regulations on advertising, encouraging companies to adopt transparent

reporting practices, and promoting consumer advocacy aimed at holding companies accountable. Motivational framing mobilizes collective action by urging consumers, environmental activists, and policymakers to challenge greenwashing practices through awareness campaigns, boycotts, and policy reforms, highlighting the critical necessity to maintain environmental integrity. These framing processes help consolidate public understanding, build consensus on the need for honest corporate practices, and stimulate action against greenwashing. Additionally, consumer responses toward greenwashing are classified as negative brand attitude, negative purchase intention (Wang et al. 2020), green distrust, green perceived risk, green consumer confusion, switching intention (Aji and Sutikno, 2015). Affective responses were also analyzed in content analysis and coded under the following headings (De Kwaadsteniet et al., 2013): angry, frustrated, irritated, indignant, agitated, and hostile.

## Study 2. Focus Group Study

For the focus group study, participants were selected using a judgmental sampling technique, aiming to enhance diversity in terms of country of origin. A total of 14 participants were chosen. The discussions were conducted in English using open-ended questions and spanned approximately 90 minutes. With verbal consent from the participants, and assurances that all responses would remain confidential and anonymous, the focus group sessions were recorded and subsequently transcribed verbatim for data analysis. Participants were queried about their understanding and perception of greenwashing, the impact of greenwashing on their purchasing behavior, their emotional reactions to it, and how the ecological reputation of a product's country of origin influences their assessment of greenwashing practices.

As shown in Table 2, the focus group consisted of eight male and six female participants, with the majority being within the 18-35 age range. The largest segment of respondents hailed from Turkey (n=6), followed by Iran with four participants. The remaining members of the focus group, each representing one participant, were from the UK, Poland, Kazakhstan, and Iraq.

**Table 2. Demographics of the Focus Group**

| Gender | N | Nationality | N |
|---|---|---|---|
| Male | 8 | UK | 1 |
| Female | 6 | Türkiye | 6 |
| Age | N | Iran | 4 |
| 18-35 | 10 | Poland | 1 |
| 36-55 | 4 | Kazakhstan | 1 |
| | | Iraq | 1 |

## Findings

### *Findings of Study 1*

First of all, consumer responses to the greenwashing practices of these firms are not predominantly shaped by the environmental image linked to their country of origin. A significant number of the commentators had unclear comments about COO ecological image, mostly they focused on their personal experiences with the products acquired from these firms. Consumers predominantly engage in discussions about the brand itself rather than its COO. Users do not explicitly associate Sweden with H&M. They generally characterize H&M as a Western brand, attributing its identity to the COO. The remarks are polarized, predominantly evaluating the COO of Western companies in relation to Chinese brands like SHEIN and TEMU. For example:

> "It's always the West who creates this problems! in Romania I used to get clothes from my brothers if in good condition. In the west there are a lot of shallow people, with no education regarding the environment desperate to look cool and wasting a lot of money."

> "Clothes, plastic bottles or our waste sent to another country is called recycling by governments. It doesn't matter where it goes... it seems. As long as it goes outside our western developed countries!!!"

The analyzed data suggests that diagnostic framing is the most prevalent (231 comments), indicating a strong focus on identifying problems, challenges, or issues related to greenwashing in fast-fashion industry. Prognostic framing is used less frequently (78 comments), showing some attention to solutions or strategies for addressing the diagnosed issues. However, there is a relatively low level of emphasis on encouraging action or mobilizing individuals against green washing, namely motivational framing is minimal (36 comments). This situation shows that consumers generally comment on the current situation rather than taking action and remain hesitant to produce solutions. An example of a comment about diagnostic and prognostic framing can be seen below:

> "…And I'm surprised about the fashion habits of some of my friends, who send me pics of what they just bought like every second week... So it is really important to spread awareness to this problem of overconsumption. Thank you for your work!" *(Diagnostic framing example)*

> I'm really trying not to buy too much clothes and try to buy second hand clothing. It's hard but it need to be done for the environment and also my pocket." *(Prognostic framing example)*

**Table 2.** Category for Collective Action Frames

| Collective Action Frames | Title of the video | | | |
|---|---|---|---|---|
| | H&M and Zara: Can fast fashion be eco-friendly? | | SHEIN's repulsive greenwashing using influencers to promote fast fashion & lies | |
| | Number of comments | % | Number of comments | % |
| Diagnostic framing | 83 | 25.7 | 43 | 24.3 |
| Prognostic framing | 30 | 9.3 | 6 | 3.4 |
| Motivational framing | 2 | 0.6 | 0 | 0 |
| Diagnostic framing & Prognostic framing | 14 | 4.4 | 6 | 3.4 |
| Prognostic framing & Motivational framing | 29 | 9 | 2 | 1.1 |
| Diagnostic framing, Prognostic framing & Motivational framing | 5 | 1.5 | 2 | 1.1 |
| Diagnostic framing & Motivational framing | 0 | 0 | 1 | 0.6 |
| N/A | 160 | 49.5 | 117 | 66.10 |
| Total | 323 | 100.00 | 177 | 100.00 |

Analysis of the comments on both videos shows that a significant proportion do not express negative emotional reactions. However, there are also comments with negative sentiments that cannot be ignored. The dominant emotions are frustration (H&M Video: 23 comments - Shein Video: 17 comments) and agitation (H&M Video: 21 comments - Shein Video: 7 comments), suggesting that many viewers feel discontent and disturbed by the video. Irritation (H&M Video: 17 comments - Shein Video: 4 comments) also appears frequently, indicating annoyance. While fewer comments express stronger emotions like anger (H&M Video: 6 comments - Shein Video: 0 comments), indignation (H&M Video: 4 comments - Shein Video: 2 comments), or hostility (H&M Video: 3 comments - Shein Video: 11 comments).

> "Feel more guilty for the people who get no clothes, and only get clothes through what we throw out.. its only the brands fault, also this brands aren't sustainable they just want your money and to market to you a wealthy snob whose willing to pay 80 dollars for a white t-shirt."

> "UK here, and we like our high-street charity shops. I've started seeing Shein stuff in the charity shops I frequent and it makes me very sad. And is if the problem wasn't bad enough, now Temu has popped up. Another waste factory profiting off of slavery and aggressively advertising all over the internet, bragging about their cheap prices... we never learn, do we?."

The data reveals various negative consumer reactions toward the brand. Negative purchase intention is the most prominent for both brands and indicating a significant reluctance among consumers to engage in future purchases. Consumer feedback indicates that greenwashing adversely affects brand perception, resulting in diminished purchasing behavior towards these companies. Consumers predominantly evaluate the pricing and quality of products acquired from these brands. Green consumer confusion is important consumer response mentioned in the comments, suggesting that many consumers are uncertain or unclear about the brand's green claims or sustainability efforts. Negative brand attitude, green distrust, green perceived risk are relatively less observed consumer responses. Finally, switching intention is noted in some comments, indicating some consumers are considering switching to other brands. Furthermore, they also explore the possibilities of producing their own apparel and acquiring pieces from thrift shops as alternatives to purchasing from these firms.

> "The most eco friendly product is the one you already have. Keep it for as long as possible, repair it, resell it from person to person, stop buying new products, go thrifting, rent one-time-use clothes like suits and wedding dresses."

## Findings of Study 2

First, focus group participants were asked whether they had heard of greenwashing terminology and if so, what greenwashing means. 9 out of 14 participants stated that they had heard the word "Greenwashing" before and knew the meaning of the word, while the remaining participants stated that they had not heard this concept before. While most participants defined the concept as a mismatch between words and deeds, some participants defined it as a firm's behavior that is negatively adverse to what they promised beforehand.

> "Not exactly sure, but if I remember correct, it was something about companies trying to show them as environmentally friendly as possible, but while not being so." ( Male, Turkey)

> "Perhaps it is mentioned when companies try to pass themselves as environmentally friendly, but beneath the surface they perhaps actually harm the environment. Through marketing or various means, they can generate publicity that makes them perceived as environmentally friendly" (Male, Turkey)

The concept of greenwashing was explained to all participants in order to eliminate the lack of information about the concept and to prevent misidentifications. It was then realized that the concept was actually known by all participants, but some of the participants were not familiar with the terminology. As the second question in the focus group is addressed, a deeper exploration into consumer experiences with greenwashing is aimed for. Participants were asked whether they were aware of any greenwashing instances and to share their experiences. While some comments focused on well-known cases, others emphasized why and how companies engage in greenwashing.

> "I think a lot of companies nowadays use greenwashing. A big example is brands like H&M and Zara." (Female, UK)

"For example, one of the companies that I can name is Nestle. I think they are one of the companies that are harming the nature more than any other company. Even though they are producing maybe coffee, even water." (Female, Iran)

"The fact that they also have the power to affect our decisions makes it harder. For example, Starbucks. They use paper but at the end of the day, they also harm us. Harmful for our health because they color the paper and it's also chemical." (Male, Turkey)

"They just wrap popcorn in a plastic bag. After that, they put this plastic bag in a paper bag. And to say we are eco-friendly recycling, you can recycle this paper bags, but inside they have a plastic bag again." (Female, Turkey)

"Actually, I watched a documentary about this. There was a tuna company that fished there. And they have ocean friendly belt. But the charity was funded by that company also. That was also the sub-charity of that company." (Male, Turkey)

In particular, participants stated that it is not economical for companies to fully and accurately implement sustainability, and that companies engage in greenwashing practices to protect their own interests. As two participants stated:

"They try to deceive people for their own benefits...That's why we are not that much, I mean, trustful for businesses. Maybe they are right, but as we have deceived a lot of times, we don't trust them." (Female, Kazakhistan)

"I think it's not economically friendly to follow whatever it's written on sustainable development goals. That's why most of the companies or factories are trying to show that in the advertisement they are having. That they are following the lead, but unfortunately it is not what they want to do." (Female, Iran)

When asked how do you feel when you recognized companies making greenwashing, participants were a little more reserved than in the previous study, where Youtube users were more open about their feelings. Indignance and anger were the most commonly expressed emotions. Some participants expressed these emotions as follows:

"They probably assume that we are stupid." (Male, Turkey)

"Because they generally do it without lying, but by misinterpretation of the data. Feel manipulated" (Male, Iran)

I feel infuriated that they assume me as stupid. (Mae, Turkey)

One participant said that she approached the issue from another dimension. She said that she could no longer feel anything because she had been manipulated by so many parties in so many different ways. Emotionally feeling indifferent against greenwashing was an interesting finding of this study.

"And as consumers, we have very little resources to take action against it. Okay, we're going to make a discussion about those actions. But as for feelings, I don't feel anything. … We are manipulated all the time. It's like a kind of our daily life. Manipulated by influencers, manipulated by customers, from projects, from companies. We're manipulated from everything. And it doesn't make any sense anymore" (Female, Turkey)

In exploring whether consumers feel empowered to influence corporate behavior, we seek to understand the extent to which individuals believe their purchasing choices and actions can impact how businesses operate. This question is central to discussions about consumer pressure on companies and the potential for collective action to drive change in business practices. In general, the responses were more in diagnostic framing which refers to the identification and attribution of problems, rather than prognostic or motivational framing.

"I mean, we end up resigning to what the companies are trying to do. What they do is very obvious, but since they didn't get away with it, they continue doing the same." (Female, Turkey)

One participant responded in a more prognostic framework by suggesting a solution. The participant expresses that the ability to boycott an unsustainable company is a privileged decision, particularly in underdeveloped countries where purchasing sustainable or ethical products may be too expensive. The participant suggested that the cost of opting for more ethical options can be a significant barrier for many people, so alternatives such as buying second-hand should be considered. One participant, however, stated that greenwashing should influence purchasing decisions but acknowledged that the problem is too large to be solved by an individual's actions alone. She also noted that very few people are concerned about this issue and, as a result, they prefer to do whatever they want without thinking about whether a company or brand is environmentally friendly.

In this focus group discussion, participants explored how COO and its ecological image impact perceptions of greenwashing, particularly in the cases of H&M and Shein. They noted that H&M, associated with stricter regulations in Europe, is seen as more sustainable, while Shein, produced in China, is criticized for exploiting weaker regulations and promoting overconsumption through cheap, low-quality products. The discussion highlighted how COO influences consumer trust and ethical considerations, emphasizing the role of regulatory environments in shaping corporate sustainability.

"And because of the cheap prices, they promote overconsumption. And I think our main issue with H&M and Shine and other fashion companies is the overconsumption due to microtrends." (Female, UK)

"Different countries have different regulations. Companies with stricter governmental rules will be more sustainable, whereas companies like Shein, produced in China, have fewer regulations, allowing for less ethical practices." (Male, Turkey)

## Conclusion

The current study illuminates several key dynamics in consumer perceptions of greenwashing, contrasting and complementing existing literature while answering the research questions posed. It reveals that consumer conceptualization of greenwashing centers around perceived discrepancies between company claims and actual practices, a notion consistent with accounts from focus group participants and prior research (Delmas & Burbano, 2011). This study further delineates specific ways consumers perceive greenwashing, showcasing an erosion of trust and an inducement of skepticism, especially when consumers engage more deeply with brand narratives.

Regarding consumer perception and response, the research finds that greenwashing significantly impacts purchasing behaviors. Consumers often resort to alternative strategies, such as buying from thrift stores or competitors, reflecting a disillusionment with greenwashing tactics. This aligns with Lyon and Maxwell's (2011) findings, which show that consumer actions can pressure firms to change unsustainable practices.

Additionaly, both analyzing Youtube comments and conducting a focus group study, namely using the two data collection techniques complementary to each other, contributed to deeper insights. For example, there were limited responses to the question asked in the focus group to learn about the emotions associated with greenwashing, but negative emotional responses were expressed more frequently and intensely in Youtube comments. Affective responses are also complex and varied. While many consumers feel irritation and agitation, understanding of the broader greenwashing phenomenon generates emotional fatigue among others. This implies that frequent exposure to greenwashing might desensitize some, underscoring the need for companies to engage in authentic interactions rather than superficial sustainability rhetoric.

The study confirms that the ecological image of the COO impacts consumer evaluations but is not a sole determinant. While there is an association between perceived COO ecological image and brand practices, consumers often judge brands like H&M and Shein on direct experience rather than COO alone. This finding necessitates a reframing of environmental branding strategies, taking into account regional consumer perceptions and the importance of aligning COO ecological image with genuine corporate practices.

The research contributes theoretically by expanding the understanding of greenwashing perception beyond the simple dichotomy of true versus false environmental claims. It underscores complex consumer attitudes shaped by a blend of cognitive evaluations and emotional responses. For instance, while some consumers express irritation, others experience emotional indifference, a finding that challenges the traditional narrative of uniform consumer backlash against greenwashing (Laufer, 2003). This suggests a nuanced spectrum of consumer responses, advocating for theoretical models to account for diverse emotional and cognitive factors.

Practically, the study highlights the critical need for brands to prioritize transparency and authenticity in environmental messaging to mitigate skepticism. Particularly for brands like H&M and Shein, which operate globally and under varying regulatory contexts, understanding local consumer perceptions can guide strategic decisions regarding communication and sustainability practices. Enhancing beyond surface-level commitments to demonstrate real environmental action could restore brand credibility and potentially stimulate consumer trust and loyalty.

This study faces several limitations. The use of YouTube comments may introduce self-selection bias, capturing only opinions from those motivated to comment, potentially skewing the results. Additionally, the limited focus group size restricts the generalizability of the findings, and relying solely on YouTube limits insights from other social media platforms and offline contexts. Future studies could delve into analysis of comments on other platforms and longitudinal analyses to observe changes in consumer perceptions over platforms and over time, particularly in response to evolving environmental market trends. In-depth examinations of geographical and cultural variations in consumer responses to greenwashing might reveal important insights into regional differences and provide more comprehensive guidance for global brands.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The authors confirm being the sole contributor of this work and have approved it for publication.

## Peer-review

Externally peer-reviewed.

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## Conflict of interest

No potential conflict of interest was reported by the author(s).

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# THE IMPACT OF AGRICULTURE, NON-RENEWABLE ENERGY, INTERNATIONAL TRADE AND ECONOMIC GROWTH ON NIGERIA ENVIRONMENTAL SUSTAINABILITY

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## Abstract

Agriculture is a key player in the economic growth of developing nations, with energy policies for climate change crucial for development. This study in Nigeria from 1965 to 2022 explores the impact of agriculture, non-renewable energy, trade openness, and economic growth on CO2 emissions. The data was found to be stationary, and a long-term relationship was confirmed through ARDL analysis. Results showed that a 1% boost in agriculture productivity and trade openness increased CO2 emissions by 0.42% and 0.20% respectively. Increased use of renewable energy helped reduce emissions, while economic growth also played a role. Implementing renewable energy, fostering a low-carbon economy, and implementing trade reforms and strong environmental policies will benefit the agriculture sector and green economy in Nigeria.

**Keywords:** Agriculture, Environmental sustainability, International trade, Nigeria, Non-Renewable energy.

## Introduction

Concern about environmental degradation has become an important topic of study for researchers in the last century due to the increase in emissions of greenhouse gases (GHG), especially $CO_2$. By 2022, total global greenhouse gas emissions increased by 1.7 percent, reaching a new peak of 53.8 billion tons of greenhouse gas equivalent. Global emissions of greenhouse gases have increased more than sixty percent since 1990 (Chen et. al). Global warming is a major concern that has attracted the attention of countries around the world (Kumar et al.). Since the UN introduced the SDGs, international initiatives to address global warming have increased by implementing emission reduction strategies that specialize in factories and energy industries (Yang et al 2023). The 13th Sustainable Development Goal (SDG) focuses on addressing the effects of global warming. Air pollution is usually caused by the use of oil and gas and other non-renewable resources. These factors have negative consequences for people's health and the surrounding environment (Bukhari et.al 2023). Polluted air has the potential to enter ecosystems and natural water bodies, harming marine life and contaminating clean water. Economic expansion in developed and developing countries is closely related to air pollution, because different economic activities in different sectors contribute to this problem (Balsalobre-Lorente et.al 2023). Electricity is vital for steering business growth by helping to generate income, growth, employment and productivity. In addition, many studies show that climate is mostly related to economic expansion and resource use and trade openness is a fundamental and effective product of economic growth. Previous studies have investigated the effect of resource exchange between countries and discussed the effects of trade access

on the environment (Wang et.al 2023). A theoretical perspective on the impact of trade openness on environmental impacts shows that the consequences of maintaining pollution can be better understood through the perspective of environmental management laws (Ozturk et.al 2023). Investigating the impact of environmental laws on making strategic decisions in relation to business models can strongly influence the degree of transparency (Song & Feng 2023). The implementation of environmental laws in developed countries promotes clean production methods. As a result, many large companies are interested in investing in contaminated goods in new countries with measures to prevent pollution and this strategy allows them to generate high profits in their countries. However, there is no persuasive argument because environmental regulations have little impact on trade and investment flows. A number of academic studies have been conducted in different countries, but the findings are not conclusive. Dauda et al (2023) found evidence supporting the contamination phase hypothesis. This hypothesis is supported by evidence that $CO_2$ emissions increase with greater openness to trade. On the other hand, different literature suggests that the opening of trade significantly reduces $CO_2$ emissions, supporting the truth of the paradise-halo hypothesis (Bhattacharyya et.al 2023). Also emissions from agriculture-related activities, including burning hedgerows, commercial use, use of deforestation materials, insufficient hunting, and modification of the forest to the garden during growth, which contributes to the increase of greenhouse gases globally. Around 20%-24% of a significant portion of global greenhouse gas emissions come from AFOLU, which refers to farming, forestry, and additional activities involving land (Anyanwu et.al 2023). Throughout the final decade of the last century, there came to be a notable rise in global agricultural production, paralleling the increase in population. The rapid growth of the global population delivers a substantial danger to the sustainability of agriculture and the health of the planet is of utmost importance, as it results in a significant increase in the world's need for nutrition. The agriculture sector was officially recognized just like a major source of the release of greenhouse gases since it is inefficient farming methods used to boost productivity and ensure food security (Balasundram et.al 2023). Utilizing fossil fuel-powered farm machinery, implementing irrigation systems, practicing confined animal rearing, and applying nitrogen-rich nutrients contribute to emissions in the agriculture sector (Kabange et.al 2023). By adopting measures such as preventing deforestation, promoting afforestation, improving plant and animal protection and investing in green energy production, the agricultural sector may be able to reduce the 25% in total greenhouse gas emissions by 2050. The economic growth of Nigeria has been largely driven by agriculture sector which account for 70% of the workforce and has also contributed to Nigeria GDP. Large percentage of the lands in Nigeria is devoted to agriculture. However, the agriculture sector in Nigeria is the one of the largest contributor to greenhouse gas emissions in Africa. The agricultural sector plays an important role in a country's economic development and progress. Many studies have been done to analyse $CO_2$ emissions, but few agricultural variables have been considered. However, the findings are mixed and few studies examine the relationship between agriculture, international trade, non-renewable energy and carbon emissions in Nigeria. Although Nigeria has shown strong commitment to reducing its greenhouse gas emissions. Many academic studies on greenhouse gas emissions have focused on environmental factors, often ignoring the country's trade openness and its impact on emissions. Nigeria as a growing economy is expected to produce more greenhouse gas emissions due to its strong economic performance and commitment to international trade and non-renewable energy dependency. Analysing the country's greenhouse gas emissions from growth using a method that increases transparency in the business world is important. This study aims to analyse the relationship between agriculture, non-renewable energy, exports, and economic growth in carbon dioxide emissions in Nigeria. This study adds to the existing literature on environmental sustainability by examining the relationship between parameters using a systematic approach. The study will also examine the relationship between agriculture and environmental quality in terms of economics, trade and non-renewable energy. In addition, several data sets from 1970 to 2023 are used for analysis. The ARDL approach has the advantage of capturing both short-term and long-term trends simultaneously. In addition, some unit root tests and statistical tests are used to verify the accuracy of the results. In addition, this paper provides new theoretical and practical insights that are very useful for policy makers. This research would assist to the execution of procedures focused on achieving zero hunger, ensuring access to affordable and clean energy, promoting sustainable economic growth, encouraging responsible consumption and production and taking action on climate change (SDG 2, 7, 8, 12 & 13). This study is notable for employing a pollution-based examine that evolved in accordance with the ecological oasis hypothesis. The findings of this research have important consequences for Nigeria, Africa and other developing countries of the world.

## Literature Review

Extensive research has been conducted in the literature that examines the effects regarding transparency in trade, farming, energy efficiency, as well as $CO_2$ emissions. The following work explores different countries, with varying strategies alongside observations that are influenced by the financial framework of each country being studied. A study that examines the impact of agriculture on environmental quality is a concept known as the Agricultural Kuznets Curve (EKC). There is little literature available on the growth of EKC derived from agriculture.

Asif et al. (2024) examined the impact of agriculture, renewable energy, international trade, and economic growth on India's environmental sustainability from 1965 to 2022. The findings supported the Environmental Kuznets Curve (EKC) and Pollution Haven Hypothesis in the Indian context. They proposed that promoting renewable energy, fostering a low-carbon economy, facilitating trade reforms, and enforcing robust environmental regulations to curb $CO_2$ emissions could drive growth in the agriculture sector and green economy.

Ali et al. (2021) conducted a comprehensive study to explore the relationship between agro-ecosystems and $CO_2$ emissions in Pakistan from 1972 to 2014. Utilizing the Granger causality test and the Autoregressive Distributed Lag (ARDL) model, the researchers identified several factors influencing $CO_2$ emissions, including proficiency in manufacturing agricultural machinery for converting farm waste into crops, crop cultivation, livestock management, and diversified food production.

Balsalobre-Lorente et al (2023) used FMOLS and DOLS methods to assess the impact of agriculture on $CO_2$ emissions in BRICS countries. This study showed a clear link between agricultural production and CO2 emissions in the atmosphere.

Atasal et al (2022) use the AMG method and find that agriculture plays an important role in reducing $CO_2$ emissions in the top 10 agricultural countries. Currently, many parts of the financial system contribute to CO2 emissions. Therefore, the relationship between growth and energy is assessed in terms of environmental pollution and emissions. It successfully explored the relationship between environmental degradation and economic well-being. Increased energy use and economic growth have increased $CO_2$ emissions in many countries around the world. Different energy sources are known for their ability to reduce $CO_2$ emissions and promote a sustainable environment. Countries should improve environmental quality and develop environmental policies to encourage widespread use of clean energy sources. Many studies have investigated the impact of green energy on carbon dioxide emissions in different countries. However, the results differ in terms of the percentage of green energy in the total energy consumption of these countries. There is debate about the relationship between trade openness and $CO_2$ emissions. Many articles discuss the effects of scale, structure and method. Increased income growth is directly linked to subsequent increases in $CO_2$ emissions. The result is openness to trade and economies of scale. As trade increases, GDP also increases, and greenhouse gas emissions from the industrial sector increase. By carefully examining the effect of the composition, it can be seen that the effect of trade is small but it is harmful to the society. Finally, when looking at the effectiveness of the method; It is clear that the manufacturing sector has a significant impact on the environment due to the increasing demand for environmentally friendly production methods. The effects of openness on business fall into three main areas: scale, structure, and method. The pollution harbour hypothesis and the pollution halo hypothesis describe two different ways in which trade openness affects the environment.

According to the pollster's opinion, companies seeking refuge in areas with relaxed environmental regulations are likely to contribute to higher levels of $CO_2$ emissions.

For example, Dawda et al. (2023) highlight the presence of the sacred concept of waste in African countries in the period 1990-2016.

Mahmoud et al. (2019) reported on the estimation of sewage sludge in Tunisia through the ARDL method. But the host country will benefit from business innovation that promotes environmental sustainability and will encourage a positive impact on our planet. This phenomenon is known as the pollution halo effect.

Asandeh et al (2020) confirmed the validity of the halo pollution effect in 52 developed and developing countries from 1991 to 2014. It was found that trade openness has a negative effect on $CO_2$ emissions in developed countries. Trade-related knowledge sharing was found to be effective in reducing $CO_2$ emissions across countries. By leveraging human capital and different resources, international locations can maximize the advantages of financial spill over. Nevertheless, a chunk of a dearth of studies investigating pollutants haven speculation on the subject of Nigeria, mainly that specialize in agriculture and renewable power. This observe seeks to cope with the modern-day void in scholarly studies; this observe investigates the impact concerning agriculture, smooth power, alternate, in addition to financial boom on Nigerian $CO_2$ emissions.

## Methodology

This study analysed the outcomes of inexperienced power, agriculture, and alternate openness on $CO_2$ emissions in Nigeria. The studies applied the ARDL technique and blanketed the time span from 1965 to 2022. Variables have been selected primarily based totally on previous studies. Data on $CO_2$ emissions and renewable power have been accumulated from the Our World in Data (OWD) database, even as facts on agricultural cost added, alternate, and GDP have been retrieved from the World Development Indicators (WDI) database.

**Figure 1** illustrates the visible illustration of every year styles of the variables. Variables have been converted into natural logarithms to make certain facts normality.

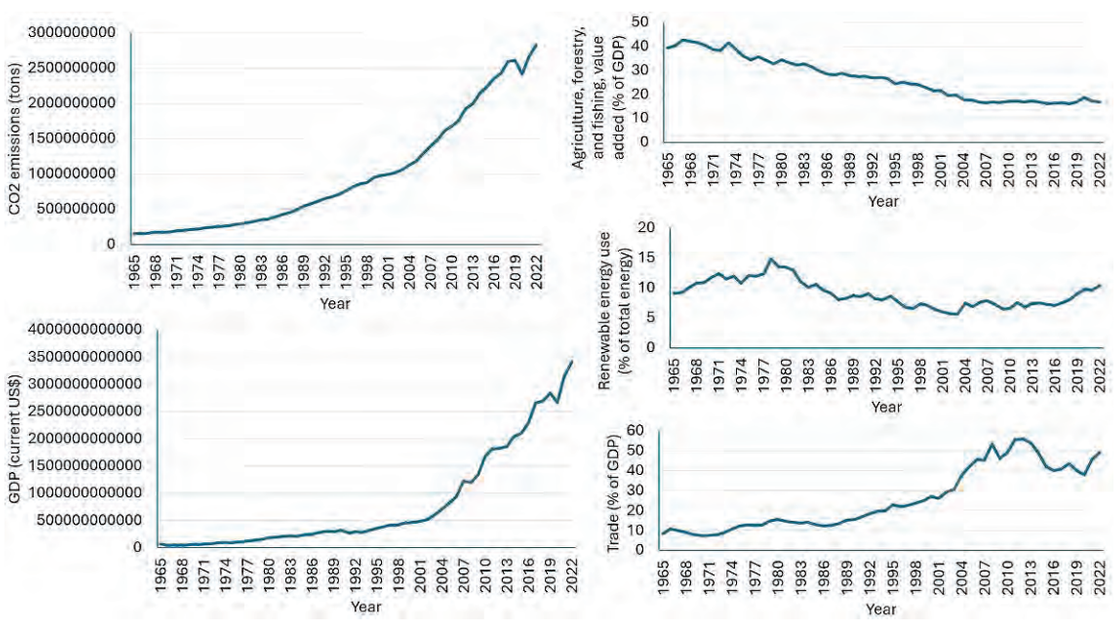


**Figure 1.** Annual trends of the variables.

## Empirical Literature

This framework analyses the impacts of agriculture, non-renewable energy and international trade on $CO_2$ emissions in Nigeria. We derive the following formulae:

$At = f(Bt; Ct; Dt; Et)$ (1)

Where:

At, Bt, Ct, Dt, and Et are $CO_2$ emissions, agricultural value-added, renewable energy, economic growth, and trade at time t.
Once the variables are assumed to have a relationship and a logarithmic form. The empirical model suggests the following:

$$LA_t = \tau_0 + \tau_1 LB_t + \tau_2 LC_t + \tau_3 LD_t + \tau_4 LE_t + \varepsilon_t \quad (2)$$

However, using non-stationary variables in the regression can produce incorrect results. Therefore, check later that everything is stable before you make any repairs. To evaluate the stability of the data sets in this study, a three-way t test was used. These tests include Augmented Dickey-Fuller (ADF) test (1979), Dickey-Fuller Generalized Least Squares (DF-GLS) test and Phillips-Peron (P-P) test (1988). This study used the ARDL model to analyse the relationship between each of the variables. The ARDL model was chosen because of several advantages. One of the most important advantages is the ability to evaluate both short-term and long-term aspects at the same time. Furthermore, this framework can be used regardless of whether these time-series variables have frictional input, I (0) or I (1). It is important to use the appropriate variables to ensure accurate regression or ARDL method results. To assess whether there is a longitudinal relationship between the variables, the bounds test was used. Pesaran et al. (2001) table of critical values, if the F-test result is greater than the required maximum limit, the null hypothesis of association between the research variables is rejected. If the value of the F-test falls within critical limits, it indicates a biased result. The analysis shows that the null hypothesis is supported and shows that there is no interaction between the variables. Fortunately, the approximate result of the F-test falls below the critical limit. Additionally, long-run coefficients are created when there is a long-run relationship between the investigated variables. An example of a long-term estimation model is as follows:

$$\Delta LA_t = \tau_0 + \tau_1 LA_{t-1} + \tau_2 LB_t + \tau_3 LC_t + \tau_4 LD_t + \tau_5 LE_t + \sum_{i=1}^{q} \alpha_1 \Delta LA_{t-i} + \sum_{i=1}^{q} \alpha_2 \Delta LB_{t-i} + \sum_{i=1}^{q} \alpha_3 \Delta LC_{t-i} + \sum_{i=1}^{q} \alpha_4 \Delta LD_{t-i} + \sum_{i=1}^{q} \alpha_5 \Delta LE_{t-i} + \varepsilon_t \quad (3)$$

When a long-term relationship between a parameter is found, a short-term model prediction can be made. Equation (4) represents the transient/short-term model, known as the error correction model (ECM).

$$\Delta LA_t = \tau_0 + \tau_1 LA_{t-1} + \tau_2 LB_t + \tau_3 LC_t + \tau_4 LD_t + \tau_5 LE_t + \sum_{i=1}^{q} \alpha_1 \Delta LA_{t-i} + \sum_{i=1}^{q} \alpha_2 \Delta LB_{t-i} + \sum_{i=1}^{q} \alpha_3 \Delta LC_{t-i} + \sum_{i=1}^{q} \alpha_4 \Delta LD_{t-i} + \sum_{i=1}^{q} \alpha_5 \Delta LE_{t-i} + \theta ECM_{t-1} + \varepsilon_t \quad (4)$$

The error correction coefficient θ is an important function of the estimation model. The given value represents the adjustment speed parameter, which indicates how quickly the series converges to long-term equilibrium.

## Results and Discussion

Table 1 shows the descriptive and correlational statistical results of our study variables. The results show that $CO_2$ production shows a negative trend, while the balance shows a positive trend. Bright values, close to zero, indicate that most of them follow a normal distribution. All series show platykurtic characteristics with kurtosis values less than 3. According to the Jarque-Bera probability, it can be ensured that each of the variables adheres to a normal distribution. The correlation matrix shows that trade openness and GDP are positively and significantly related to $CO_2$ emissions. On the other hand, agriculture and green energy have a negative relationship with $CO_2$ emissions.

**Table 1.** Descriptive and correlation statistics

| Variables | LA | LB | LC | LD | LE |
|---|---|---|---|---|---|
| Mean | 20.321 | 3.2290 | 2.1760 | 26.697 | 3.0520 |
| Median | 20.371 | 3.2861 | 2.1532 | 26.515 | 2.9890 |
| Maximum | 21.774 | 3.7565 | 2.6960 | 28.871 | 4.0288 |
| Minimum | 18.862 | 2.7570 | 1.7282 | 24.550 | 2.0373 |
| Skewness | -0.0170 | 0.0323 | 0.2167 | 0.1052 | 0.0550 |
| Kurtosis | 1.6924 | 1.5447 | 2.1286 | 1.9283 | 1.6530 |
| Jarque-Bera | 2.1420 | 3.1363 | 2.2827 | 2.8875 | 2.4154 |
| Probability | 0.2172 | 0.1778 | 0.3187 | 0.2373 | 0.1123 |
| Observations | 59 | 59 | 59 | 59 | 59 |
| Correlation between the variables | | | | | |
| | LA | LB | LC | LD | LE |
| LA | 1.0000 | | | | |
| LB | -0.9789 | 1.0000 | | | |
| LC | -0.6734 | 0.7159 | 1.0000 | | |
| LD | 0.9876 | -0.9679 | -0.5892 | 1.0000 | |
| LE | 0.9560 | -0.9757 | -0.6621 | 0.9507 | 1.0000 |

The results of unit root testing using ADF, DF-GLS, and P-P tests are displayed in Table 2. The results indicate that the variables were not stationary in their original form but became stationary when their first differences were considered in all three-unit root tests. The results of the unit root tests proceed us to conduct the analysis within the ARDL framework.

**Table 2.** Results of unit root testing

| | ADF | | DF-GLS | | P-P | |
|---|---|---|---|---|---|---|
| Variables | Log levels | Log first difference | Log levels | Log first difference | Log levels | Log first difference |
| LA | -0.1611 | -7.6776*** | -0.7176 | -7.3295*** | -0.1624 | -7.6752*** |
| LB | -0.6015 | -8.1213*** | -0.7708 | -4.2033*** | -0.6015 | -8.1213*** |
| LC | -1.2927 | -7.7088*** | -1.3187 | -7.6031*** | -1.3395 | -7.7076*** |
| LD | -0.5072 | -8.5875*** | -0.8952 | -7.1057*** | -0.5063 | -8.5106*** |
| LE | -0.6676 | -6.1753*** | -0.6964 | -5.2563*** | -0.7140 | -6.2548*** |
| | | | | | | |

***P<0.01

The study utilized the ARDL-bound testing procedure for a comprehensive and concise long-run cointegration within the variables (Table 3). The result shows the coexistence of accumulation, which indicates the long-term relationship between the variables. This

is supported by the F-statistic (26.14) for this sample, which exceeds the critical values.

**Table 3.** The outcome of the ARDL bounds test

| Test statistic | Value | Significance | I(0) | I(1) |
|---|---|---|---|---|
| F-statistic | 26.141 | At 10% | 1.99 | 2.94 |
| K | 4 | At 5% | 2.27 | 3.28 |
| | | At 2.0% | 2.55 | 3.61 |
| | | At 1% | 2.88 | 3.99 |

Table 4 displays the estimated findings of the long- and short-run results obtained through the ARDL approach. The outcome suggests that over time, there is a notable increase in $CO_2$ emissions due to agriculture and trade openness, whereas energy efficiency and GDP have the opposite effect, leading to a decrease in $CO_2$ emissions. Utilizing renewable energy sources in the immediate future has been shown to lower emissions, while factors such as GDP, agriculture, Trade openness and professional expertise play a crucial role in the rise of $CO_2$ emissions. The estimated coefficients for agriculture show a clear positive relationship with $CO_2$ emissions. This implies that a 1% increase in agriculture productivity culminates in a 0.42% rise in $CO_2$ emissions in the long run, and a 0.15% increase in the short run. One possible reason for this could be the continued dependence on fossil fuel energy in Nigeria's agricultural sector. The agricultural sector heavily relies on fossil fuels for various processes such includes thawing, watering, warmth, wrapping, water delivery, along with conveyance of crop-related merchandise. Unfortunately, the transportation of petroleum and gas leads to the increased emissions of $CO_2$. It appears that the promotion of the agricultural sector in India does not lead to improvements in the field of energy optimization or the implementation of sources of clean energy. Considering the significant magnitude of the farming industry and the widespread use of fossil fuels in Nigeria, it can reasonably conclude that the expansion of farming processes brings about a rapid increase in $CO_2$ emissions. Preceding empirical results support the foregoing conclusion Emir et al (2023). It has been stated that farming leads to an upsurge in $CO_2$ emissions. On the other hand, these findings challenge other scientific evidence that argue farming diminishes $CO_2$ emissions Raza et al (2021).

**Table 4.** ARDL long and short-run results

| | Long-run | | | Short-run | | |
|---|---|---|---|---|---|---|
| Variables | Coefficient | t-Statistic | p-value | Coefficient | t-Statistic | p-value |
| LB | 0.4192** | 3.3519 | 0.0243 | 0.1519** | 3.6397 | 0.0342 |
| LC | -1.7624*** | -5.1815 | 0.0001 | -1.037*** | -5.8351 | 0.0000 |
| LD | -0.0236* | -1.8467 | 0.0693 | 1.9819*** | 3.6085 | 0.0002 |
| LE | 0.1983** | 2.5014 | 0.0188 | 0.6061*** | 4.9516 | 0.0009 |
| A | 15.720 | 1.8319 | 0.1047 | - | - | - |
| ECM (-1) | - | - | - | -0.5417*** | -3.3119 | 0.0000 |
| $R^2$ | 0.9883 | | | | | |
| Adjusted $R^2$ | 0.9821 | | | | | |
| | | | | | | |

***P<0.01, **p<0.05, *p<0.1

The findings indicate that a 1% increase in non-renewable power consumption increases $CO_2$ emission by 1.76% in the long run whereas 1.04% in the short-run. In this context, it is imperative to prioritize the embrace of renewable power sources in order to effectively reduce $CO_2$ emissions in Nigeria. Prior results from experiments further support this outcome Anyanwu et al (2023) and Wang et al (2023). The shift from fossil fuels to clean energy uses aids in reducing the negative impact on the Nigeria environment. Non-renewable energy uses will increase environmental degradation through $CO_2$ emissions.

The estimated coefficient of GDP shows that in the short-run, a 1% rise in GDP boosts $CO_2$ emissions by 1.98%. However, in the long run, the negative coefficient indicates that a 1% increase in GDP would increase $CO_2$ emissions by 0.02%. Our research discovered an association among economic growth and $CO_2$ emissions, following an inverse U shape pattern. This indicates that the association among revenue growth and $CO_2$ emissions in Nigeria can be reversed as the country's GDP continues to rise. The outcomes support the EKC hypothesis. This result was reinforced by previous empirical findings Uche, Das & Bera (2023) that revealed an inverse U shape relationship between economic growth and $CO_2$ emission. Economic growth is measured by the GDP. Increase in the GDP, or economic growth, assessments in a spike in emissions of $CO_2$ in Nigeria. As economic growth increases, several demands related to economic growth also increase. To meet the direct and indirect increasing demand of people, waste and garbage are produced more. Fossil fuel burning also increases in the industry, including manufacturing and transportation, to support the increasing economic growth. This suggests that environmental risk should be minimized by adopting environmentally friendly technology Nigerian industry as well as shifting from fossil fuel energy production to renewable energy in Nigeria. Economic growth should be supported through environmentally friendly activities that will reduce $CO_2$ and lead to sustainable development. Nigeria competitive capacity through sustainable economic development will increase globally.

In terms of trade openness, the positively significant coefficients indicate that a 1% increase in trade openness increases $CO_2$ emission by 0.20% (long-run) and 0.61% (short run). The results confirmed the pollution haven hypothesis in Nigeria. Prior findings from experiments further supported this outcome Emir, Udemba & Philip (2023). When the degree of trade increases in a nation, it means production as well as consumption increases, which is supported by the higher use of natural resources and enhanced pollution. Industries usually stress their priority on production efficiency over environmental sustainability. When industries prioritize production, it results in environmental degradation through air pollution, water pollution, deforestation, and habitual destruction in India. Moreover, expanded trade resulted in an upsurge in the utilization of transportation that required the use of fossil fuels, thereby increasing $CO_2$ emissions. Nigeria trade openness may have some economic benefits, but in other to achieve long lasting sustainable development, it required friendly environmentally activities which can be encourage through the use of modern technology.

ECM's estimate of the significance level at the 1% level, with a negative trend, indicates that the deviation from the long-term balance this year will be corrected at a rate of 54% through various channel such as agricultural industry, trade openness, economic

development and green power. In addition, the values of R2 and adjusted R2 for the long-term estimation are 0.9883 and 0.9821, respectively, indicating a high level of accuracy for the statistical regression model. It can be seen that the independent factors account for 98% of the variance in the change in the dependent variable. Model reliability was implemented using cumulative sum analysis (CUSUM) and summation of square (CUSUMSQ) based on residual regression (Figure 2). The estimated coefficients of the ARDL model are considered stable because the statistical line falls within the critical limits at the 5% significance level.

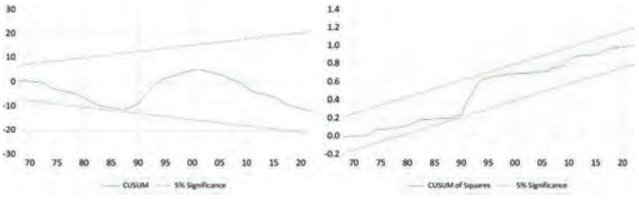


**Figure 2.** The results of CUSUM and CUSUMSQ tests

We went further in conducted additional experimental tests to validate the ARDL model used in this study. The diagnostic tests in Table 5 include the serial correlation test in addition to the univariate test. Analytical analysis shows that the residuals follow a normal distribution and that the model is reasonably well defined. In addition, there is no evidence of serial correlation and heteroskedasticity.

**Table 5.** The results of diagnostic tests

| Diagnostic tests | Coefficient | p-value | Decision |
|---|---|---|---|
| Jarque-Bera test | 2.2437 | 0.3282 | Normal residual distribution |
| Ramsey RESET test | 0.9843 | 0.3472 | The model is properly specified |
| Breusch-Godfrey LM test<br>Breusch-Pagan-Godfrey test | 1.8445<br>0.7698 | 0.1739<br>0.2794 | No serial correlation exists<br>No heteroscedasticity exists |

## Conclusions and Recommendation

Nigerian economy is significantly driven by the agriculture and trade sectors, which play a crucial role to encourage the expansion of the marketplace. On the other hand, there is a dearth of scientific and philosophical information about the influence that farming, the utilization of clean energy and trade accessibility has on carbon dioxide emissions. Additionally, the association among independent variables and $CO_2$ emissions has yielded mixed theoretical and empirical findings. This study addresses to what extent carbon emissions are affected by agricultural practices, economic expansion, and trade liberalization from 1970 to 2022. This research is built on a solid analytical framework provided by the scientific foundation underlying the Kuznets curves of runoff and pollution. We used ARDL as the diagnostic method. Cointegration tests confirm the existence of correlation between the variables in India. Furthermore, when looking at long-term data, it is clear that GDP and the use of renewable energy are associated with lower $CO_2$ emissions. Conversely, the agricultural sector and global events have increased $CO_2$ emissions. On the other hand, short-term analyses show that GDP, agriculture and international trade contribute to increasing $CO_2$ emissions, while renewable energy is effective in reducing them. The negative impact of agriculture, cross-border trade and economic expansion on the environment reflects the lack of environmental justice and the role of enhanced trade to contribute to the decline of the environment. The use of fossil fuels in agriculture leads to a significant increase in $CO_2$ emissions. Renewable energy is important for the agricultural industry. It is strongly recommended to implement solar energy systems, onshore wind power, efficient irrigation systems, project training and financial support in the agricultural sector to promote environmental sustainability. Government and those in power should celebrate the success of the transition from fossil fuels to clean energy. This can be done by increasing funding for research and development, and strengthening laws and regulations. To reduce the effects of trade opening and the impact of economic growth on the environment, it is necessary to promote the development of environmental industries that can transfer technical knowledge through all sectors of the economy. In order to facilitate an effective and efficient process of knowledge exchange, it is very important for recipient countries to increase their ability to absorb new information.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

## Peer-review

Externally peer-reviewed.

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## Conflict of interest

No potential conflict of interest was reported by the author(s).

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# FOOD SECURITY, CLIMATE CHANGE CONCERNS AND AGRICULTURE COMMODITIES

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**Abstract**

This paper aims to examine the impact of climate change concerns on agricultural commodity prices within the context of food security. We use the Climate Change Concerns Index to proxy climate change risk and agricultural commodities such as cocoa, coffee, sugar, corn, soybean, and wheat commonly traded in financial markets. We employ the quantile-on-quantile connectedness technique from January 3, 2003, to June 28, 2024. Our results show a reciprocal relationship between the news on climate change and the prices of agricultural commodities. While the prices of agricultural commodities affect climate change concerns during the high increases and decreases in agricultural commodity prices, climate change concerns affect the prices of agricultural commodities during more stable periods. Our results provide essential information to policymakers and investors.

**Keywords:** Food security; Climate change; Agricultural commodities; Connectedness

## Introduction

Sustainability and food security are two of our most critical global issues. Sustainability means protecting and using natural resources in a way that meets the needs of future generations. This concept includes not only environmental but also economic and social dimensions. According to the Food and Agriculture Organization (FAO) (2001), food security is a situation that exists when all people constantly have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Sustainable agricultural practices will increase food security by making more efficient use of limited resources such as land and water, creating more resilient agricultural systems that will reduce the effects of climate change, and finding solutions to problems such as poverty and unequal income distribution.

Food security has four pillars: availability, access, utilization, and stability, which are affected by changing climate. Among them, "access" indicates the ability to obtain food, including the

effects of food prices. Climate change may cause rises in food prices that affect mostly low-income consumers due to a lack of resources to purchase food (Mbow et al., 2019).

Significant increases and fluctuations in food prices have been observed in the last two decades, and three essential food crises have been encountered. The first crises emerged in 2007/2008 due to extreme increases in the prices of cereals, especially rice and wheat. According to FAO, the Food Price Index increased from 53.3 points in 2000 to 117.5 points in 2008. Two main reasons for this crisis are the drought experienced by underdeveloped countries and the increasing domination of multinational companies in international agricultural trade. In addition, the increase in oil-based input and supply costs and financial speculation triggered the crisis. The second crisis occurred at the end of 2010 and the beginning of 2011, and the Food Price Index increased to 131 points in 2011. But this time, the high food prices lasted five years until 2015. This crisis emerged with low yields and stocks caused by bad weather conditions in major grain-producing countries. The periods of these two food crises also coincide with the 2007-08 global financial crisis and the European debt crisis, respectively. The third and, for now, the last food crisis was observed in 2022, and the Food Price Index rose to 143.7 points. Although a decrease was observed in food prices due to uncertainties at the beginning of the COVID-19 pandemic, an increase was observed afterward due to the disruptions created by the pandemic in global supply chains[1]. In addition, the disruptions in the food supply chains caused by the Ukraine-Russia war triggered the crises since these two countries have significant roles in the production and export of agricultural products and fertilizers in the world[2].

As can be seen, significant increases in food prices are related to climate. Therefore, this paper focuses on the climate change factor causing a lack of food and threatening food security. We use the Media Climate Change Concerns (CCC) Index as a representative for climate change risk developed by Ardia et al. (2023), a daily index using news about climate change published by major U.S. newspapers and newswires to capture unexpected increases in climate change concerns and examines its impact on prices of mostly traded agricultural commodities including Cocoa, Coffee, Sugar, Corn, Soybean, and Wheat.

We employ the quantile-on-quantile connectedness technique and use daily data from January 3, 2003, to June 28, 2024. Our period consists of the COVID-19 pandemic and the Russian and Ukraine wars, which may cause high fluctuations in agricultural commodity prices because of distortions in supply chains. This paper contributes to the existing literature regarding its data and methodology. First, despite their strategic importance, the number of studies dealing with agricultural commodities is still insufficient. Second, this is the first paper to consider the media CCC Index as a factor in the prices of agricultural commodities. Our paper provides essential implications for policymakers and investors. The rest of the paper is structured as follows. Section 2 gives a brief literature review. Section 3 presents data and methods, followed by empirical results in Section 4. Finally, Section 5 concludes the paper.

## Literature review

This section focuses on how selected agricultural commodities and food security are related to climate change concerns, reflected in media news. Climate change concerns are shaping the beliefs of individuals, investors, and policymakers, ceteris paribus. To present inclusive studies, we dive into literature in two strands. In the first strand, studies investigate the relationship within the commodity markets, including energy, agriculture, metals, etc. The second strand demonstrates the association in the nexus between climate-related uncertainty, agricultural commodities, and food security.

The first strand investigates the commodity market, including its sectors such as agriculture, livestock, energy, and metal. In line with this, agricultural commodities were examined in terms of return and volatility transmissions among themselves (e.g., Lahiani, Nguyen, and Vo, 2013; Hernandez, Ibarra, and Trupkin, 2014; Gardebroek, Hernandez, and Robles, 2016; Umar, Jareño and Escribano, 2022). Hernandez, Ibarra, and Trupkin (2014) found that corn, wheat, and soybeans were strongly interdependent, while corn and wheat were found as volatility drivers by Gardebroek, Hernandez, and Robles (2016). The relationship between agricultural commodities and energy (majorly oil) was investigated (Nazlioglu and Soytas, 2012; Mensi et al., 2014; Cabrera and Schulz, 2016; Yip et al., 2020; Miljkovic and Vatsa, 2023; Ahmadian-Yazdi et al., 2024; Liu and Serletis, 2024). On the other hand, studies considered commodity market instruments altogether, and many of which tried to understand their spillover and connectedness dynamics (Tiwari et al., 2020; Bouri et al., 2021; Adeleke, Awodumi and Adewuyi, 2022; Cui and Maghyereh, 2024; Khan, Mejri and Hammoudeh, 2024). Contrary to the findings of Gardebroek, Hernandez, and Robles (2016) regarding the role of wheat, Bouri et al. (2021) found that among various commodities networks, cocoa, coffee, sugar, and wheat were the net volatility receivers, while soybean and corn were the net transmitters. Furthermore, Khan, Mejri, and Hammoudeh (2024) concluded that sugar was affected by positive and negative geopolitical risk shocks. Most of the studies also highlighted increased connectedness during black swan events.

The second strand gains importance due to climate change's direct and indirect impact on agricultural commodities and food security. In a recent study, Pham and Kamal (2024) studied the CCC index of Ardia et al. (2023) and various commodity markets (energy, agricultural, and precious metals) using conditional autoregressive value-at-risk and time-varying parameter tail risk connectedness. They found that since agricultural commodities were loosely connected and drove a relatively small portion of the overall connectedness within the network, they could be used for diversification and hedging. Another result from their study was corn and wheat act as net transmitters among other agricultural commodities, and clime risk impacts tail connectedness. In line with climate-related risks-agricultural commodities, Khalfaoui et al. (2024) investigated this from bearish to bullish market conditions with three various time horizons (short, medium, and long)

[1] The second goal of the UN Sustainable Development Goals is "Zero Hunger". According to the Sustainable Development Goal Report (2022), the number of people going hungry and suffering from food insecurity gradually rose between 2014 and the onset of the COVID-19 pandemic. (The Sustainable Development Goal Report 2022, available at: https://unstats.un.org/sdgs/report/2022/The-Sustainable-Development-Goals-Report-2022.pdf, accessed 10 October 2023.

2 Russia is third in wheat, second in sunflower oil production, following Ukraine, and first in raw sugar production in 2019. In addition, Russia is the world leader in wheat export in 2020 (FOA Yearbook 2022, available at: https://www.fao.org/3/cc2211en/cc2211en.pdf, accessed 10 October 2023).

and asymmetrical dependence results showed that agricultural commodities experience loss because of climate change. Moreover, Nam (2021) investigated the effect of climate uncertainty on 63 global commodities employing modified time-varying factor-augmented vector autoregression. As climate uncertainty created some obstacles to supply and demand, it increased the price of agricultural food commodities. Makkonen et al. (2021) examined the impact of temperature anomaly and macroeconomic variables on the returns of future contracts on agricultural commodities by using a quantile regression approach. They concluded that temperature anomaly significantly negatively impacted soybean, corn, cotton, and coffee returns while positively affecting soybean, corn, and cocoa in severe market conditions.

The gap in the literature is that climate-related studies have emerged recently compared to other topics. Therefore, studies have used different variables to represent climate change and various methods such as quantile regression, vector autoregression with time-varying parameters, conditional autoregressive value-at-risk, etc. At this point, our study contributes to the literature using a novel quantile-on-quantile connectedness approach. It allows us to investigate extreme market conditions in a bi-variate setting. In addition, the period covers essential dates such as the global financial crisis, the European debt crisis, the Paris Agreement, the COVID-19 pandemic, Russia, Ukraine, and the Palestinian-Israeli conflicts and uses the novel quantile-quantile connectedness. This study examines the connection of news-based CCC with agricultural commodities.

## Methodology and Data

We use the novel quantile-on-quantile connectedness approach of (Gabauer and Stenfors, 2024) to examine the connectedness of the CCC Index with agricultural commodities. The approach is the generalization of the quantile connectedness approach of (Chatziantoniou, Gabauer, and Stenfors, 2021), essentially combining two frameworks, quantile-on-quantile regression (Sim and Zhou, 2015) and dynamic connectedness (Diebold and Yilmaz, 2012). This approach captures the spillovers across various quantiles, thus relaxing the intrinsic assumption of positive correlation in time series. In addition, it enables the investigation of the interconnectedness of time series even when they are at distinct quantiles. This approach lets us compute dynamic total connectedness indices for directly and reversely related quantiles.

Our sample consists of the Media CCC Index developed by Ardia et al. (2023) and the prices of six commonly traded agricultural commodities: Cocoa, Coffee, Sugar, Corn, Soybean, and Wheat. Our data are at daily frequency covering January 3, 2003 –June 28, 2024. The commodities' prices are collected from Yahoo Finance, and the CCC index is obtained from Ardia et al.'s (2023) Website[1].

We analyze changes in the indices to meet the stationarity condition. The time series are plotted in Figure 1, and their summary statistics are given in Table 1. Cocoa shows the highest variance. JB statistics indicate that none of the indices follow a normal distribution at the 1% significance level. Moreover, the ERS unit root test results demonstrate that the indices exhibit stationarity at the 1% level. While the correlation matrix indicates a positive correlation between the agricultural commodities, the CCC has a negative correlation with them.

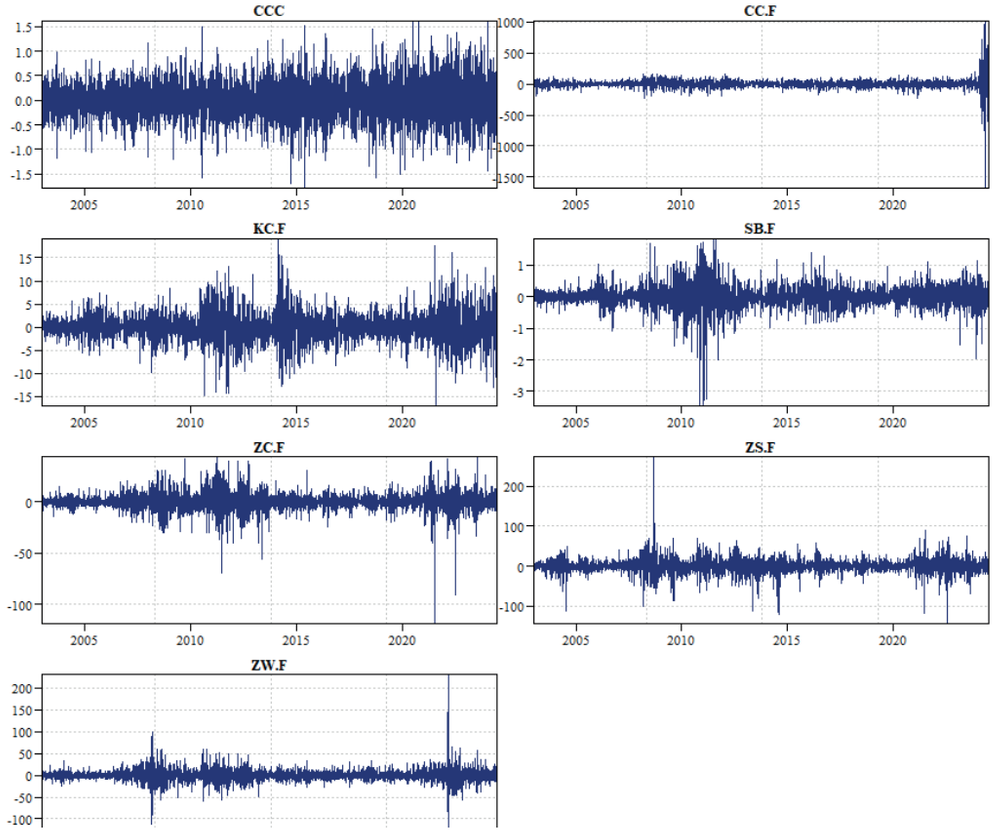



**Figure 1:** First-Differenced Data

**Note:** The daily series is from January 3, 2003, to June 28, 2024.

[1] Media CCC: https://sentometrics-research.com

**Table 1: Summary Statistics**

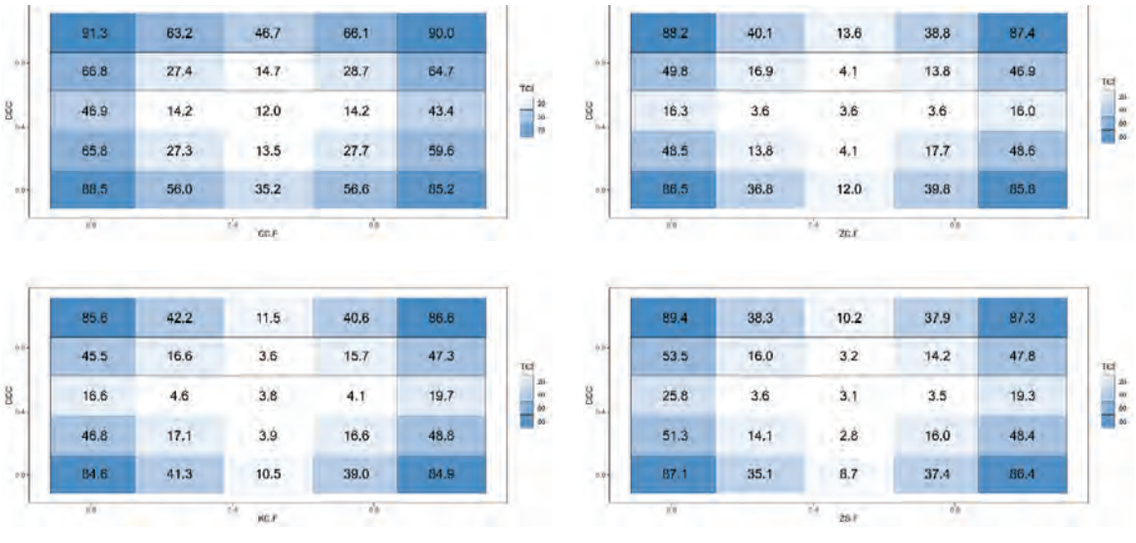
| | CCC | CC.F | KC.F | SB.F | ZC.F | ZS.F | ZW.F |
|---|---|---|---|---|---|---|---|
| Mean | 0.012** | 2.248** | 0.027 | 0.002 | 0.030 | 0.402 | 0.005 |
| Variance | 0.155 | 5191.926 | 9.358 | 0.131 | 75.188 | 301.764 | 193.987 |
| Skewness | -0.075** | -1.948*** | 0.129*** | -0.904*** | -1.084*** | 0.293*** | 0.533*** |
| Ex.Kurtosis | 0.964*** | 113.276*** | 3.453*** | 11.676*** | 15.631*** | 19.957*** | 28.262*** |
| JB | 167.8*** | 2263156.6*** | 2112.5*** | 24591.7*** | 43868.8*** | 70224.6*** | 140909.5*** |
| ERS | -22.1*** | -17.2*** | -27.1*** | -13.8*** | -28.1*** | -28.0*** | -28.7*** |
| Q(20) | 423.4*** | 253.5*** | 15.0 | 37.9*** | 7.6 | 14.2 | 59.3*** |
| Q2(20) | 405.6*** | 2091.7*** | 917.1*** | 1318.6*** | 268.3*** | 105.1*** | 2052.8*** |
| **Correlation** | CCC | CC.F | KC.F | SB.F | ZC.F | ZS.F | ZW.F |
| CCC | 1.000*** | -0.012 | -0.006 | -0.017 | -0.015 | -0.008 | -0.018 |
| CC.F | -0.012 | 1.000*** | 0.118*** | 0.072*** | 0.039*** | 0.050*** | 0.050*** |
| KC.F | -0.006 | 0.118*** | 1.000*** | 0.148*** | 0.110*** | 0.112*** | 0.105*** |
| SB.F | -0.017 | 0.072*** | 0.148*** | 1.000*** | 0.132*** | 0.119*** | 0.117*** |
| ZC.F | -0.015 | 0.039*** | 0.110*** | 0.132*** | 1.000*** | 0.384*** | 0.425*** |
| ZS.F | -0.008 | 0.050*** | 0.112*** | 0.119*** | 0.384*** | 1.000*** | 0.264*** |
| ZW.F | -0.018 | 0.050*** | 0.105*** | 0.117*** | 0.425*** | 0.264*** | 1.000*** |

Note: ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. JB stands for the normality test (Jarque and Bera, 1980) with the null hypothesis that a series has a normal distribution. ERS stands for the (Elliott, Rothenberg, and Stock, 1996) unit root test, testing the null hypothesis that a series has a unit root; Q(20) and $Q^2$(20) are the (Fisher and Gallagher, 2012) weighted portmanteau tests.

## Empirical Results

We estimate 200-day rolling window quantile vector autoregression (QVAR) models with a 100-step ahead forecast horizon for each pair (i.e., bi-variate cases), comprising the CCC index and one agricultural commodity index. The lag length for each model is determined by the Schwarz Information Criterion (BIC)[1].

Figure 2 depicts the averaged dynamic total connectedness indices for each pair across 25 quantiles, namely 1%, 25%, 50%, 75%, and 99%. The darker blue shades represent the more vital interconnectedness, whereas lighter blue colors turning white visualize weaker connectedness between the pairs. We determine the highest average total connectedness (91.3%) for the CCI-CC.F (Cocoa) pair at one of the reversely related quantiles. It is followed by CCC-ZS.F (Soybean) (89.4%) and CCC- ZC.F (Corn) (88.2%), respectively. We can also say that the total connectedness indices achieve their highest values at this same extreme quantile other than ZW.F (Wheat).




[1] We also conduct estimations for robustness using various combinations of window sizes (150- and 200-day), forecast horizons, and lag lengths determined by the Hannan-Quinn Information Criterion. The empirical findings obtained from these different settings exhibit qualitative similarity; therefore, we present below the results from the initial model specifications.

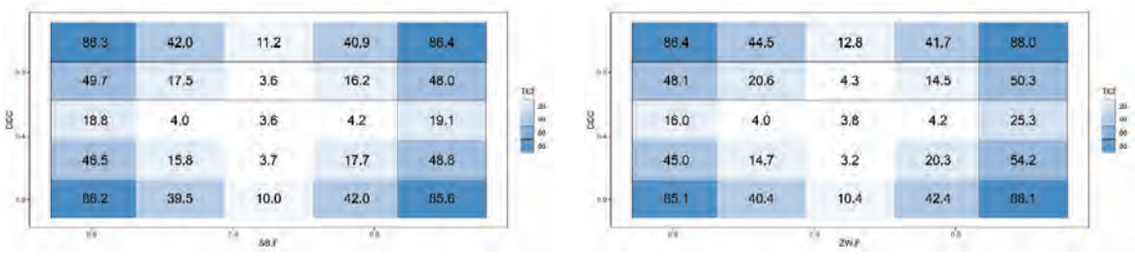



**Figure 2:** Quantile-on-Quantile Total Connectedness Indices
**Note:** The averaged dynamic total connectedness indices are based on a 200-day QVAR model. The quantiles are 0.01, 0.25, 0.50, 0.75, and 0.99.

Figure 3 shows the net directional connectedness across quantiles. The figure features a three-color gradient, incorporating blue for higher (positive) values, white for moderate values (around zero), and red for the lowest (negative) values. According to this figure, a reciprocal interaction in different quantiles, the CCC affects and is also affected. The positive values within the quantiles suggest that the CCC acts as a net transmitter, whereas negative values indicate that it acts as a net receiver in those quantiles. In general, agricultural commodities affect CCC in the lowest 1% and highest quantiles of 99%. In other market conditions, namely in quantiles of 0.25, 0.50, and 0.75, the situation is the opposite; CCC affects commodities.

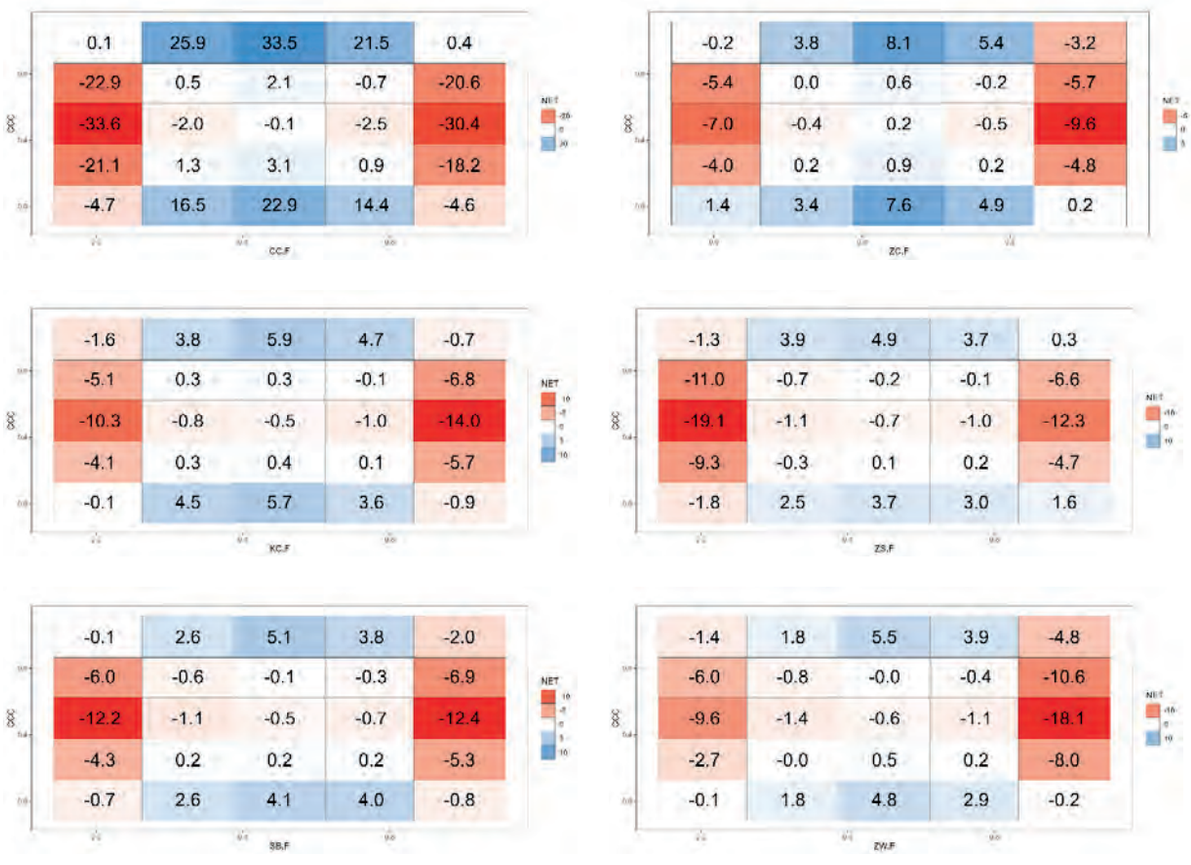



**Figure 3:** Quantile-on-Quantile Net Directional Spillovers
**Note:** The net directional spillover measures across quantiles are based on a 200-day QVAR model. The quantiles are 0.01, 0.25, 0.50, 0.75, and 0.99.

Figure 4 exhibits the directly- and reversely related dynamic total connectedness indices and their differences (ΔTCI) for pairs to capture the parallel and counter-directional shifts in interconnectedness among pairs over time. The times where the reverse TCI (red lines) surpass the direct TCI (green lines) indicate a pronounced negative correlation. The reverse TCI surpassing the direct TCI suggests a robust negative correlation between the series.

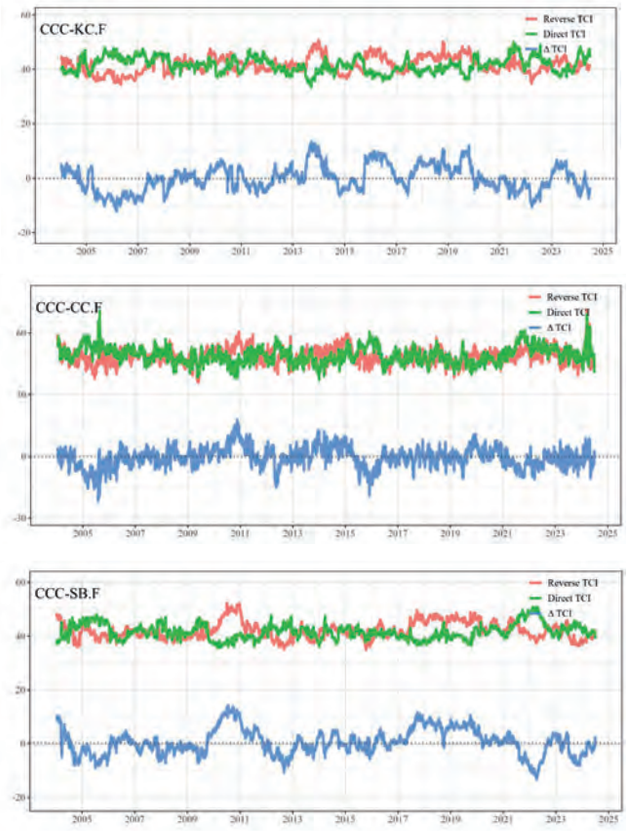



**Figure 4:** Dynamic Quantile-on-Quantile Direct and Reverse Total Connectedness Indices

**Note:** The dynamic directly- and reversely related quantiles total connectedness indices are based on a 200-day QVAR model.

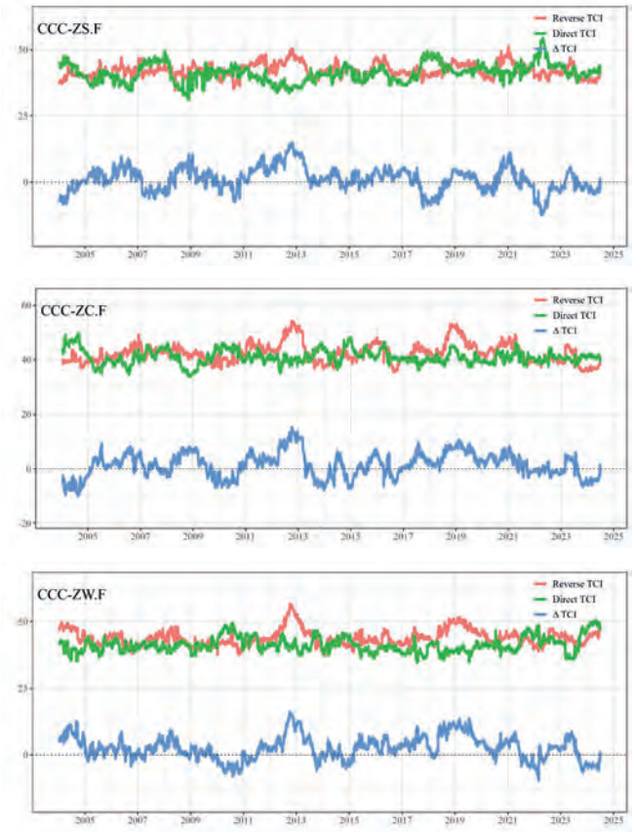



**Figure 4:** Dynamic Quantile-on-Quantile Direct and Reverse Total Connectedness Indices (cont.)

**Note:** See the notes for Figure 4.

## Conclusion

This paper examines the relationship between climate change concerns and agricultural commodities by employing a novel technique, quantile-on-quantile connectedness approach for the period from January 3, 2003, to June 28, 2024, including major global events such as COVID-19 pandemic and the Russian-Ukraine conflict.

Our results indicate that when there are very high decreases and increases in agricultural commodity prices, concerns about climate change increase. The CCC index is affected when the news reflects this situation. On the other hand, when fluctuations in agricultural commodity prices are more limited, news about climate change concerns affects agricultural commodity prices. In other words, concerns about climate change are always on the agenda and affect commodity prices. Increased climate change expectations can cause inflationary pressure on food prices, increasing the food security risk.

However, the large fluctuations experienced during and after the COVID-19 period increase concerns even more, and these realizations in prices create the expectation that the climate crisis will deepen. Although there is a mutual interaction, news about climate change concerns is written more after major price realizations, and this then gives investors and consumers the motivation to change their behavior, thus affecting prices again. A supply-demand imbalance, a significant risk within the scope of food security, can also cause sudden price changes. Necessary cautions should be taken to address the supply-demand imbalance and ensure food security to reduce climate change concerns.

As a result, this paper has important implications for policyholders. Climate change impacts agricultural production negatively by causing extreme weather events, droughts, and floods. Policymakers should develop sustainable agricultural practices to increase food security by creating agricultural systems that are more resilient to the effects of climate change. Governments can improve food security by developing policies that support sustainable agriculture and providing financial support to farmers. In addition, it offers important implications for investors and portfolio managers interested in investing in agricultural commodities. They should care about the impact of climate change news on the prices of agricultural commodities during the more stable market conditions.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The authors confirm being the sole contributor of this work and have approved it for publication.

## Peer-review

Externally peer-reviewed.

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## Conflict of interest

No potential conflict of interest was reported by the author(s).

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# EVALUATION OF GERMANY'S WIND ENERGY IMPLEMENTATIONS IN THE CONTEXT OF EU ENERGY POLICIES*

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## Abstract

This study initially discusses the researches conducted on wind energy in Europe. The general principles of European Union energy policies were mentioned, and then renewable energy policies were focused on. From 1970 to the present, many important steps have been taken that have led to the current position of Europe's wind energy. These critical efforts are addressed comprehensively. Germany, which has made significant contributions to the development of wind energy in Europe and plays a leading role in this field, has been selected as the country to be examined in this article. Germany stands out with its offshore wind energy technology due to its location in the North Sea. Detailed information was given about Germany's projects in recent years and planned for the future. This paper is a general analysis of the wind energy policies of the European Union, but also of Germany, which follows these policies.

**Keywords:** EU, Germany, Wind Energy, Offshore

## Introduction

When compared to onshore settings, offshore wind farms benefit from stronger and more consistent wind speeds, which results in improved energy efficiency. Because of the North Sea's exceptional wind conditions, turbines may run at higher efficiency rates, improving Europe's grid stability and energy security.

These wind farms supply local energy needs and lessen the need for long-distance transmission infrastructure because they are frequently located close to coastal areas with high population densities. The efficiency of energy supply is increased overall and energy losses are reduced due to the close proximity to industrial and urban hubs.

The growth of offshore wind requires regional cooperation amongst EU members. Cross-border initiatives that encourage energy integration, maximize resource usage, and fortify the EU's internal energy market include hybrid offshore wind farms that span multiple nations.

Additionally, offshore wind energy helps to diversify the energy supply in the region and lessen geopolitical concerns by reducing the EU's reliance on fossil fuels. Offshore wind improves Europe's energy security by lowering dependency on outside energy sources.

In Europe, the offshore wind industry contributes significantly to economic growth and job creation. Significant investments in technology, infrastructure, and human resources are needed to expand offshore wind farms, which creates job opportunities in a variety of industries, including manufacturing and research and development.

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The preservation of maritime biodiversity and ecosystems must be balanced with the growth of offshore wind in order to maintain environmental sustainability. To guarantee that offshore wind growth is in line with efforts to conserve the maritime environment, the EU sets stringent environmental laws. Prioritizing local community engagement also helps to guarantee equitable distribution of offshore wind benefits.

Germany's transition to renewable energy and its attempts to mitigate climate change depend heavily on wind energy, especially offshore wind energy. Germany's energy transition, or Energiewende[1], aims to cut carbon emissions and its dependency on fossil fuels. As a clean, sustainable energy source, wind energy is essential to this shift. Because offshore wind farms produce more energy than onshore wind farms due to the strong, steady winds encountered at sea, offshore wind energy is particularly significant. Germany meets its renewable energy ambitions for 2030 and beyond thanks to its large investments in offshore wind projects, which also significantly contribute to the country's economic growth, energy security, and climate goals.

The first section of this study provides an overview of the European Union's energy policies, detailing the guiding principles, the priority placed on renewable energy, and the key advancements made in wind energy. The second section examines the current state of offshore wind energy, which is particularly crucial for Germany. The final section outlines Germany's future goals in the development of offshore wind energy.

## 1. EU Energy Policy

This section examines the energy policies of the European Union. A particular emphasis is placed on renewable energy policies. This section covers the principles followed by the European Union on this matter, the importance it places on renewable energy, and the significant steps it has taken in wind energy.

### 1.1. General Principles of EU Energy Policy

Three guiding concepts form the basis of EU energy strategy. These are competitiveness, supply security, and sustainability. The implemented policies are grouped into seven key categories: renewable energy, energy efficiency and conservation, internal energy markets, energy supply security, environmental preservation, nuclear energy, and research and development. The presentation of the pertinent policies and an explanation of their purpose come first for each category, followed by an introduction that covers significant turning points in its development (Kanellakis, Martinopoulos, 2013, 1020).

The EU is a global leader in renewable energy technology research and implementation. However, according to a report published in 2021, the EU needs to further enhance its global competitiveness. Under the European Green Deal, renewable energy is a key component of the clean energy transition (European Commission, 2024).

Raising energy efficiency targets is crucial for Europe's energy transition. Efficient energy use reduces energy bills, decreases the EU's dependency on external resources, protects the environment, improves quality of life, and contributes to sustainable economic growth. To achieve these benefits, efficiency must be improved throughout the entire energy supply chain, from production to consumption (European Commission, 2024).

The European energy market is non-discriminatory, flexible, customer-focused, and competitive. It focuses on consumer protection, market access, transparency, regulation, interconnections, and supply security. The goal is to ensure a functional market with fair access, strong consumer protection, and sufficient interconnection and generation capacity (European Parliament, 2024).

Energy supply security is a recurring theme in national, European, and global energy strategies. In November 2000, the European Commission released a green paper titled "Towards a European Strategy on Energy Supply Security". The European Parliament and the Council emphasized the importance of reducing the risks associated with dependency. Since then, energy supply has been threatened by terrorist attacks, storms, accidents, blackouts, conflicts, and rising fuel prices. Hurricane Katrina in 2005 further complicated energy supply security, affecting not only oil production but also natural gas, transportation, refineries, and electricity infrastructure, impacting the entire energy system (Chevalier, 2006, 1).

The EU's broader resource efficiency goal, which includes the efficient use of all natural resources and the maintenance of strict environmental protection requirements, will include the implementation of the energy efficiency measures. The 2008 European Council and Parliament enacted the energy and climate change policy. This is a crucial first step toward the eventual objective of lowering global emissions by at least 50% below 1990 levels by 2050 when compared to levels of 2005 (Carvalho, 2012, 20).

Nuclear energy produces over 26% of the electricity generated in the European Union and is a low-carbon substitute for fossil fuels. But nuclear energy has grown quite contentious in the wake of the Fukushima tragedy in 2011 and the Chernobyl accident in 1986. EU regulation aims to ensure that nuclear waste is managed and disposed of securely, while Member States retain the autonomy to decide whether to incorporate nuclear power in their energy mix. EU policies are based on Articles 40–52 (investment, joint ventures and supplies) and 92–99 (nuclear single market) of the Treaty establishing the European Atomic Energy Community (European Parliament, 2024).

Since its inception, EU policy for research and technical development (RTD) has been a significant area of European legislation. A European framework program for research was added in the 1980s to further expand this policy. The majority of EU research funding in 2014 fell under the purview of Horizon 2020, a program that ensured the EU's competitiveness on the world stage and ran from 2014 to 2020. The current EU research and innovation program, Horizon Europe, was introduced in 2021 and is set to run from 2021 to 2027 (European Parliament, 2024).

[1] The Energiewende, or German energy transition, is a long-term energy and climate policy aimed at bringing Germany to a carbon-neutral energy economy by 2045. It is a large-scale economic and ecological enterprise prompted by scientific insights and ethical considerations with far-reaching economic and societal repercussions

Diversifying energy supply, integrating energy markets, and moving away from fossil fuels are among the main priorities of the EU. The importance of renewable energy in the energy policy of the European Union is vital. These practices will be discussed in the next subheading.

## 1.2. EU Renewable Energy Policies

It is widely acknowledged that the European Union (EU) is at the forefront of sustainable energy policies, particularly in relation to the development of renewable energy sources (Solorio, Jörgens, 2017, 48). The European Union encourages the broad use and sustainable application of renewable energy sources, such as geothermal, hydropower, wind, solar, and biofuels (IRENA, 2024). Sustainable development has emerged as a major policy in the EU in recent decades. It addresses challenges such as climate change, clean energy, sustainable transportation, sustainable production and consumption, conservation and management of natural resources, public health, social inclusion, demography and migration, and global poverty (Alvarez, 2023, 2).

Beginning with minor adjustments in the 1970s, the EU's renewable energy strategy has developed gradually over time. The single market agenda and the launch of global climate change initiatives propelled significant developments in the late 1990s. As time went on, these initiatives grew to become one of the biggest worldwide initiatives promoting the advancement of renewable energy. The evolution of the policy is a reflection of the increasing significance of renewable energy in the electricity (RES-E) and transportation (RES-T) sectors. The conflict between attempts to centralize regulation at the EU level and the aspiration of individual member states to preserve flexibility in their national support policies has been a major subject in the evolution of EU renewable energy policy. The 2009 Renewable Energy Directive (RED)[2], a significant step in unifying national policies across the EU, brought this tension to light (Solorio, Bocquillon, 2017, 23).

The European Green Deal (EGD), the EU's revised commitment to addressing climate and environmental concerns, is the most significant document outlining the EU's priorities in the field of energy and climate policy. The European Green Deal aims to keep economic growth and resource consumption apart because all regions of the EU are vulnerable to climate change-related disasters such as intense heat, floods, droughts, water shortages, melting glaciers, forest fires, windfalls, and agricultural losses. The European Green Deal, as the EU's new growth strategy, intends to change the EU into an equitable and prosperous society that lives in a modern and resource-efficient economy. Among other things, it presupposes the construction and renovation of buildings in a manner that conserves energy and resources, the preservation and restoration of ecosystems and biodiversity, the acceleration of the shift to intelligent and sustainable mobility, and the development of a wholesome, ecologically friendly food system known as "farm to fork" (Milek, Nowak, Latosinska, 2022, 2). In order to reduce net greenhouse gas emissions by at least 55% from 1990 levels by 2030, the European Commission has adopted a package of suggestions for climate, energy, transportation, and taxation policies within the EU (European Commission, 2024).

## 1.3. Development of Wind Energy in Europe

Following the first oil price shock in the early 1970s, interest in wind power resurfaced. This time, however, rather than mechanical energy, the primary focus was on electrical energy produced by wind power. By leveraging alternative energy technologies as a backup via the electrical grid, it became possible to supply a consistent and reliable power source (Ackermann, Söder, 2000, 317).

A turning point in the development of renewable energy was the Great Wind Revival that occurred in Europe in 1980. It signaled the comeback of wind energy as a practical and significant part of Europe's energy mix. With the help of government backing, grassroots efforts, and technological advancements, wind energy started to transition from a specialized technology to a key component of Europe's sustainable energy future (Ackermann, Söder, 2000, 318).

Once the oil embargo reignited interest in wind energy, two opposing – and frequently hostile – camps attempted to both commercialize and make wind energy viable. The fault lines in society were reflected in these camps. The current establishment's way of thought was represented by one side. In order to construct massive wind turbines, they promoted a centrally planned and managed program that worked through energy utilities or aerospace contractors (Gipe, Möllerström, 2023, 221).

The second camp, made up of a variety of businesspeople and political activists, felt that everyone should be able to contribute to the development of wind energy. They contended that building wind turbines gradually would be more appropriate for the knowledge and abilities available at the time, as well as for the small and medium-sized businesses that are most likely to be the driving force behind the growth of wind energy. They believed that wind energy should develop horizontally rather than vertically (Gipe, Möllerström, 2023, 222).

The field of wind energy technology advanced rapidly as well, reaching new heights. Before the year 2000, the first demonstration projects utilizing 2 MW wind turbines with a 74 m rotor diameter were put in place (Ackermann, Söder, 2000, 318).

Wind energy power plants underwent extensive testing and assessment in the 1990s in order to be ready to be used as a widely used technique for producing electricity for commercial use. New turbine designs with better performance and lower costs are being prompted by government and large industry assistance as well as new turbine generations (Bellarmine, Urquhart, 1996, 1748).

The "Strategy Document" released by the European Wind Energy Association (EWEA) in October 1991 sought to paint a picture of the actual opportunities presented by wind energy in the member states of the European Community for the general public, but particularly for decision-makers in the energy sector. The energy ministers of Denmark, the Netherlands, the United Kingdom, and Wind Energy Association provided funding for the

[2] On November 20, 2023, the EU/2023/2413 amending Directive came into effect. The majority of the directive's requirements must be incorporated into national law within 18 months, although other clauses pertaining to renewable energy permits have a shorter deadline of July 2024.

document's production in addition to DG XVII of the Commission of the European Communities (Sesto, Lipman, 1992, 36).

Directive 2001/77/EC on the promotion of electricity from renewable energy resources was passed by the EU in 2001. This Directive is referred to some commentators as "the single most globally significant case of legislation for wind energy." The EU Member States have developed the rudimentary national regulatory and economic systems to achieve renewable energy targets, building on the institutional framework of the Directive (Hagenbuch, 2009, 1598).

Though the Kyoto Protocol was signed in 1997, it wasn't until 2005 that it became legally obligatory after being approved by enough nations to reach the necessary number. Under the United Nations Framework Convention on Climate Change (UNFCCC), the protocol marked a historic worldwide agreement with the goal of lowering greenhouse gas (GHG) emissions in order to combat climate change. One of the main pillars of Europe's plan to reach these emissions targets swiftly became wind energy. As a viable substitute for conventional coal and natural gas power plants, it produced significant volumes of clean electricity without emitting carbon dioxide or other dangerous pollutants. Various regulations and incentive schemes were created by European governments to facilitate the expansion of the wind energy sector.

Although European Technology and Innovation Platform on Wind Energy (TPWind) was introduced in 2006 with strong policy support, the network came together to create the platform through the project UpWind[3], which was supported by the 6th EU Framework program. 43 partners from the European business and research groups were involved in the initiative. European Wind Associations (EWEA) and the European Academy of Wind Energy (EAWE) were the driving forces behind the UpWind application, and they continue to be important supporters to this day (Ricard, 2015, 12).

Since 1984, the EU has funded research and demonstration projects through framework programs. The 7th Framework Programme (FP7), running from 2007 to 2013, focused on research, technological development, and demonstration activities. It aimed to advance the Lisbon Strategy's goal of making the EU the most competitive, dynamic, and knowledge-based economy by 2010. FP7 introduced a new structure, increased budget, revised participation rules, and simplified implementation procedures, including the externalization of some administrative tasks. It comprised five specific programs: Cooperation, Ideas, People, and Capacities (European Commission, 2010). Projects to increase wind turbine efficiency, advance offshore wind energy technology, and improve wind energy system integration with the electrical grid were carried out under the auspices of these initiatives. In addition, FP7 sought to meet targets for renewable energy and boost Europe's competitiveness in the world wind energy market. Innovative innovations were developed as a result of the program's strengthening of partnerships in the field of wind energy among research institutes, universities, and industry organizations.

Adopted in 2008, the EU Strategic Energy Technology Plan (SET-Plan)[4] aims to direct funds for low-carbon technology research and innovation in Europe, thereby expediting the advancement and implementation of these technologies. In response to diminishing and dispersed funding of energy research in Europe, the Plan was considered an essential component of the EU policy portfolio. It aimed to combine limited resources to meet the energy and climate targets set in 2007 and beyond. The goal of the SET-Plan was to use extensive demonstration projects to take low-carbon technologies from concepts to the mainstream market (Skjærseth, Eikeland, 2021, 1-2).

With the goal of addressing the issues of combating climate change and securing energy supply, the Energy Act was ratified on November 26, 2008. It contains provisions pertaining to importing and storing gas. It includes provisions regarding electricity produced using sustainable resources. The Act addresses the transmission of electricity. It provides for payments to small-scale, environmentally friendly power producers. The Act includes regulations on the closing of wells and energy installations. It deals with the handling and getting rid of waste generated when nuclear plants are operating. The Act includes provisions related to petroleum-related licenses. It regulates access by third parties to pipeline improvements and oil and gas infrastructure. The Act requires reporting on topics related to energy. It outlines the obligations of the Markets Authority for Gas and Electricity. It includes provisions for reimbursements for heat produced from renewable sources. The Act regulates power and gas meters. It contains provisions for the safety of electricity. It includes regulations for the safety of hardware, software, and data concerning nuclear issues (Croner-i, 2010). In this regard, marine wind energy is a pertinent substitute since it is a clean, domestic, renewable energy source. The new generation Policy's three main goals – lowering greenhouse gas emissions, enhancing supply security, and boosting Union competitiveness – can all be significantly aided by maritime wind generation (EUR-Lex, 2012).

The implementation of instruments for collaboration between member states, such as statistical transfers, joint or coordinated support schemes, or collaborative projects, was suggested by the Renewable Energy Directive 2009/28/EC (deCastro, Salvador, 2019, 60). By 2020, 20% of Europe's energy must come from renewable sources, according to this rule. Since binding targets were established for every member state, wind energy has grown rapidly (European Parliament, 2024).

Europe's renewable energy regulations were greatly impacted by the 2008–2009 financial crisis. Following the crisis, many countries saw a significant decline in investments in wind energy projects due to deteriorating financial conditions. But to improve energy independence and fight climate change, the European Union created regulations in the wake of the crisis that encouraged investments in renewable energy, especially wind energy. In this situation, more robust financial instruments and support systems were put in place to lower obstacles for renewable energy initiatives (Blazquez, Galeotti, 2021, 1-2).

[3] Research to Improve the Design of Offshore Wind Energy Systems.

[4] Adopted in October 2023, the SET Plan modification communication will aid in harmonizing the initial strategic goals with the European Green Deal, REPowerEU, and the Green Deal Industrial Plan, which includes the Net-Zero Industry Act. It will guarantee a cohesive strategy for accomplishing the EU's decarbonization objectives, bolstering tactical net-zero energy solutions, and constructing a robust and sustainable energy future

Wind energy is one of the primary strategic energy technologies, according to the Commission. In order to bring a sizable portion of clean electricity to the European energy market and drastically lower the cost of electricity, the Commission, member states, and the wind energy industry launched the European Industrial Initiative on Wind Energy (EWI) in 2010. It is a ten-year plan for wind energy technology research and development (Radvialite, 2013, 1).

The European Commission approved the "A 2030 framework for climate and energy policies" green paper on March 27, 2013. The aim of the undertaking was to contribute creative, rigorously scientific policy analysis on specific topics to the discussion of the post-2020 energy and climate policy framework instead of tackling every issue in the package, concentrate on a technical or political "choke-point" while maintaining control and flexibility and guaranteeing timely delivery of results (Climate Strategies, 2023).

Energy presently accounts for 75% of the EU's greenhouse gas emissions, making it a crucial component in the objective of the EU becoming climate neutral by 2050. The European Commission has emphasized the necessity of decarbonizing at least six times quicker than anything accomplished internationally, raising the share of clean energy and renewable energy carriers, and enhancing energy efficiency in order to meet this goal. The SET-Plan oversees energy-related research and innovation activities in the EU. The FPs provide the majority of the financial support for these initiatives. The FP8, known as Horizon 2020 (H2020), replaced the FP7 and had a budget of EUR 79 billion. It was implemented from 2014 to 2020 (Calvo-Gallardo, Arranz, 2022, 5).

In addition to the variations in administrative and financial issues, H2020 differs from FP7 in three important areas: (1) H2020 prioritizes impact-oriented research above knowledge-oriented research; (2) it is more business-oriented than academic-oriented; and (3) it aspires to expand rather than deepen knowledge. To put it briefly, H2020 is all about connecting research to the market and society, as well as industry and innovation (Calvo-Gallardo, Arranz, 2022, 5).

As part of its commitment to building a low-carbon economy, the European Union's flagship research and innovation initiative, Horizon 2020, has given wind energy a prominent priority. Substantial financing was provided by the program to assist in the development of cutting-edge wind energy technology, such as grid integration, energy storage, and offshore wind farms. Innovation is critical to lowering prices, increasing efficiency, and boosting wind energy's sustainability, as highlighted by Horizon 2020. In order to meet the EU's targets for renewable energy and accelerate technological advancements, industry, research institutions, and public stakeholders were encouraged to collaborate on projects. These projects focused primarily on lowering greenhouse gas emissions and raising the proportion of wind energy in the energy mix.

EGD is the EU's plan for the green transition mandated by the Paris Climate Agreement. The EU's new growth plan, known as the EGD, was unveiled on December 11, 2019, by President of the European Commission Ursula von der Leyen. Its goal is to make Europe the first continent in the world to be carbon neutral by 2050, with net zero greenhouse gas emissions (European Commission, 2024). A few main goals have been the foundation of EU energy policy in recent years: environmental and climate protection, competitive economics, and energy security. Policy and economic decision-makers concurred that the European Green Deal must be implemented in this situation. The implementation of this plan ought to guarantee both rapid technical advancement and high environmental quality (Simionescu, Păuna, 2020, 3).

EGD plays a crucial role in accelerating the development of wind energy in line with the EU's goal of becoming carbon neutral by 2050. This deal increases investments in renewable energy by providing funding for wind energy projects and encourages the modernization of energy grids. Additionally, it develops strategies to boost offshore wind energy potential, with major projects planned in regions like the North Sea and the Atlantic. As the wind energy sector grows, the Green Deal aims to increase green jobs and a skilled workforce. Simultaneously, it supports the expansion of wind energy while considering environmental sustainability and biodiversity protection measures (EIPA, 2024).

## 2. Current Status of Germany about Offshore Wind Energy

Germany has long been interested in wind energy technologies. Today, under the new regulations, the Federal Network Agency launched its biggest offshore wind farm area tender to date in July 2023. Three North Sea zones with a combined capacity of 2,000 MW each and one 1,000 MW area in the Baltic Sea were included in the tender. The first round of bidding concluded with multiple zero-support proposals for the relevant areas, as was to be expected. In such a case, the modified Offshore Wind Act mandates a second round of bidding in which only bidders who submitted a zero-bid are permitted to take part. The bidders no longer compete to provide the least amount of funding in this round. Rather, what they bid is the price they are prepared to pay to secure the corresponding space and capacity (CMS, 2023).

According to recent data from Deutsche WindGuard[5], the offshore wind energy market in Germany is expanding significantly, with 377 MW added in the first half of 2024. With 73 more foundations built and 36 turbines starting to flow into the grid, there are now 29 offshore wind projects operational, totaling 8,858 MW of installed capacity spread among 1,602 turbines. There are two additional projects in construction right now (4coffshore, 2024).

In Germany, 29 offshore wind power farms were up and running by the middle of 2024 and installed offshore wind power capacity was approximately 8 gigawatts (GW). By the end of 2024, two further projects—Gode Wind 3 and Baltic Eagle—should be put into service. In 2023, the foundation installations for the two projects were already finished. Beginning in 2024, the turbines were installed, and many of them have already been put into service. For the Borkum Riffgrund 3 project, the foundations were

[5] Deutsche WindGuard is a German enterprise offering a wide range of wind energy-related services and knowledge. Established in 2000, the organization holds a significant position in the wind energy sector by providing an extensive array of technical and advisory services with the goal of maximising wind energy generation, guaranteeing security, and augmenting operational effectiveness.

erected toward the end of 2023, and the first turbines were put in the first half of 2024. In May 2024, OWP EnBW He Dreiht's foundation installation started. A final investment decision was taken in the spring of 2024 for the Windanker and NC 1-4 projects, in addition to these construction- related activities. By the end of June 2024, additional offshore wind energy projects had been awarded or had claimed grid connections (Wind Guard, 2024, 4).

A large offshore wind farm called Gode Wind 3 is presently being built in the North Sea off the coast of Germany. The wind farm, which is jointly owned by Ørsted and Glennmont Partners, is expected to have a 253 MW capacity. The project is anticipated to be operational in 2024, having started with a final investment decision in 2021. Twenty-three Siemens Gamesa SG 11.0-200 DD turbines, each with a rotor diameter of 200 meters and an 11 MW capacity, will make up the wind farm (NS Energy Business, 2024).

The Baltic Eagle offshore wind farm project is being built in the German state of Rügen, close to the Baltic Sea. It is a collaboration between Masdar and Iberdrola. With a 476 MW overall capacity, the wind farm should be operational by the end of 2024. When Baltic Eagle is finished, it will provide clean electricity to about 475,000 families and cut yearly CO2 emissions by almost one million tons (Baltic Wind, 2024).

With a capacity of 913 MW, Borkum Riffgrund 3, which is presently being built off the coast of Lower Saxony, Germany, will be the country's largest offshore wind farm when it is finished. This Ørsted-built offshore wind farm is noteworthy for being the first in Germany to be developed without subsidies, thanks to corporate power purchase agreements (CPPAs) with businesses like Google, Amazon, and BASF. Eighty-three Siemens Gamesa SG 11.0-200 DD turbines, each with an 11 MW capacity, will make up the wind farm. The first turbines were deployed in June 2024, after construction started in 2023. The project is expected to be fully operational by 2025 (Ocean Energy Resources, 2024).

OWP EnBW He Dreiht is an offshore wind farm that is being built in the North Sea, 110 kilometers west of Helgoland and 85 kilometers northwest of Borkum. When finished, it will have a 960 MW capacity and will be Germany's largest offshore wind farm. EnBW (Energie Baden-Württemberg AG) is developing the project, which should be operational by the end of 2025. The wind farm will be one of the first commercial installations of the advanced turbine model, Vestas V236-15.0 MW, with 64 turbines that can individually produce 15 MW of power. These turbines have massive monopile foundations that are 70 meters long, 9.2 meters in diameter, and weigh about 1,350 metric tons apiece (Maritime Executive, 2024).

As a component of their Baltic Hub strategy, Windanker is Iberdrola's third offshore wind farm project in the German Baltic Sea. The project, which is expected to cost about €800 million, is expected to start up in 2026. The 315 MW Windanker project will be made up of 21 Siemens Gamesa wind turbines, each with a 15 MW capacity. When the wind farm is fully operational, it will produce enough electricity to power roughly 315,000 households annually, which translates into a yearly reduction of about 500,000 tonnes of CO2 emissions (Offshore Wind, 2024).

The NC 1-4 project is a component of the larger North Sea cluster, an offshore wind farm situated in the North Sea of Germany. There are two primary stages to the development of the Nordseecluster: Nordseecluster A and B. Two offshore wind farms make up Nordseecluster A, which has a combined capacity of 660 MW; Nordseecluster B adds another 900 MW, bringing the total capacity to 1.6 GW. It is anticipated that these wind farms will provide 6.5 terawatt-hours of renewable energy per year. Key components of Nordseecluster A are now being built, and complete operations are anticipated by 2027 (Total Energies, 2024).

## 3. Future Prospects of Germany about Offshore Wind Energy

German government amended the Offshore Wind Energy Act (WindSeeG) in late 2020 with new expansion targets in an effort to raise installed power capacity. The combined capacity of offshore wind power facilities is expected to reach 20 gigawatts by 2030, and maybe reach 40 gigawatts by 2040. This will be accomplished by growing the number of tenders while also growing the power grid. To transfer energy from offshore wind farms to land, large-capacity connecting lines are required. This is another factor driving up the importance of using onshore wind, along with the increased prices and expenses associated with building offshore plants (EWE, 2024).

The expansion of offshore wind energy until 2037 is the main emphasis of a draft update to the area development plan, which was provided by the German Federal Maritime and Hydrographic Agency (BSH). With an ambitious plan to reach about 50 GW by 2035 – 10 GW more than the initial forecast – it is expected to surpass the previous legal target. In addition to meeting immediate needs, the plan creates the framework for reaching the long-term goal of 70 gigawatts by 2045. Future expansion sites have been discovered and assigned, mostly in locations close to existing shipping lanes (Review Energy, 2024).

With an installed capacity of 6.7 GW compared to 1.1 GW in the Baltic Sea, the majority of Germany's offshore wind turbines are situated in the North Sea. Considering that 14 of the 17 locations included in the Site Development Plan (Flächenentwicklungsplan) are in the North Sea, it appears that this tendency will probably continue. Technically speaking, the capacity of each individual turbine has been increasing. Existing turbines have an average capacity of roughly 5.3 MW, whereas those scheduled for commissioning by 2025 will have capacities ranging from 9.5 to 15 MW (with an average of roughly 11 MW) (Norton Rose Fulbright, 2023).

By 2035, the goal is for practically all of Germany's electricity supply to come from renewable sources in order to satisfy climate commitments and provide energy security. The German Bundestag passed extensive reforms in July 2022, relating to the EEG[6] and the WindSeeG, among other things, in order to accomplish this goal. Offshore wind energy is expected to grow faster if installation circumstances are adjusted and support measures are continuously put in place. Offshore wind turbines are expected to have an

[6] The German Renewable Energy Sources Act, or EEG (Erneuerbare-Energien-Gesetz), is a significant piece of law designed to encourage the growth of renewable energy in Germany. As part of Germany's efforts to move away from fossil fuels and nuclear energy and toward a more sustainable energy system, it was initially deployed in 2000.

installed capacity of at least 30 GW by 2030, 40 GW by 2035, and 70 GW by 2045 (Norton Rose Fulbright, 2023).

The planning of new offshore wind power projects now faces fewer regulatory roadblocks, and approval processes are become shorter and more digitalized in order to meet these objectives. Offshore wind energy bidding will undergo a significant organizational change in the future. The EEG's Section 2 simplifies the process of approving new offshore wind projects significantly. Until Germany's electricity generation is carbon neutral, this will see the construction and operation of renewable energy plants and related ancillary infrastructure declared to be in the overriding public interest and to serve public safety (Norton Rose Fulbright, 2023).

The Federal Government unveiled its national hydrogen strategy in June 2020, and offshore wind power plays a big part in it. The plan states that by 2030, 90–110 TWh of hydrogen will be required. Up to 5 GW of new green hydrogen generation capacity, including onshore and offshore energy generation, will be required within Germany to supplement imports. Offshore wind energy groups contend that in order to draw in more investment in projects, tendering volumes should be modified because the new offshore wind energy capacity is not yet represented in the offshore wind energy support auctions (Kerres, Sieler, 2020, 7).

The offshore wind energy support program has undergone multiple changes over time. In 2014, a feed-in premium took the place of the feed-in-tariff system at the federal level. Since 2017, technology-specific auctions for medium- and large-scale renewable plant projects have decided this feed-in premium instead of the law. A transition time was also included by the 2017 support scheme reform for offshore wind projects with projected commissioning dates of 2021–2025 that already had permits or were in advanced stages of approval in August 2016. A "central model" was put in place for projects that would be constructed after 2026. In the future, sites that are put up for auction to project developers will be pre-developed by the Federal Maritime Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie, or BSH) (Kerres, Sieler, 2020, 7).

By the middle of 2023, the government had set aside regions in the North Sea for the production of hydrogen offshore, paving the way for the conversion of 1 GW of offshore wind energy into hydrogen. A significant step toward creating a hydrogen economy as part of Germany's larger decarbonization objectives has been reached with this. Projects are also in progress to support the infrastructure required for the pipeline-based conveyance of green hydrogen from offshore production facilities to land (Clean Energy Wire, 2024).

Germany's offshore wind energy targets play a critical role in supporting green hydrogen production and accelerating the country's energy transformation. It is clear that offshore wind energy will continue to be important for Germany to achieve its climate neutrality goals in the coming years.

## Conclusion

The EU and its member states are among the regions that take the climate crisis most seriously today. The most important document defining the EU's priorities in the area of energy and climate policy is the EGD, the EU's updated commitment to tackling climate and environmental challenges. Since all of the EU's regions are susceptible to climate change-related disasters such extreme heat, floods, droughts, water shortages, melting glaciers, forest fires, windfalls, and agricultural losses, the EGD seeks to keep economic expansion and resource consumption apart. As the EU's new growth strategy, the European Green Deal aims to transform the EU into a prosperous and just society that coexists with a cutting-edge, resource-efficient economy.

Energy now contributes 75% of greenhouse gas emissions in the EU, making it an essential part of the goal for the EU to achieve climate neutrality by 2050. In order to achieve this target, the European Commission has stressed the need to decarbonize at least six times faster than anything achieved globally, increase the share of clean energy and renewable energy carriers, and improve energy efficiency. Wind energy has been given top priority by Horizon 2020, the European Union's flagship research and innovation initiative, as part of its commitment to creating a low-carbon economy

The Renewable Energy Directive 2009/28/EC recommended the establishment of mechanisms for cooperation amongst member states, including statistical transfers, joint or coordinated support schemes, or cooperative initiatives. This regulation states that by 2020, twenty percent of Europe's energy must come from renewable sources. Since each member state was given binding targets, wind energy has increased significantly. To improve energy independence and combat climate change, the EU has given importance to renewable energy types such as wind energy. The Commission states that one of the main strategic energy technologies is wind energy.

As the EU's largest economic power, Germany is making significant investments within the framework of both the EGD and the Renewable Energy Directive. At the EU level, Germany is one of the countries that invests the most in renewable energies and especially in off shore wind energy. Most of Germany's offshore wind turbines are located in the North Sea, where their installed capacity is 6.7 GW, whereas it is 1.1 GW in the Baltic Sea. This tendency is likely to continue, given that 14 of the 17 places included in the Site Development Plan (Flechenentwicklungsplan) are located in the North Sea. In a technical sense, the capacity of every single turbine has been rising. The current turbines are expected to be activated by 2025 and have an average capacity of around 11 MW, while the existing turbines have an average capacity of approximately 5.3 MW.

In order to meet environmental targets and provide energy security, nearly all of Germany's electricity supply is expected to originate from renewable sources by 2035. To achieve this, the German Bundestag passed a number of significant reforms in July 2022, including those pertaining to the WindSeeG and the EEG. It is anticipated that offshore wind energy would increase more quickly if installation conditions are modified and ongoing support measures are implemented. By 2030, at least 30 GW of offshore wind turbines should be erected; by 2035, 40 GW; and by 2045, 70 GW.

In summary, wind energy – especially offshore wind – is essential to Europe and Germany's energy policy and serves as the cornerstone of the country's shift to a sustainable, carbon-neutral future. Germany's efforts to decarbonize its energy system depend heavily

on offshore wind power because of its unparalleled efficiency, scalability, and capacity to deliver a steady and uninterrupted electricity supply. In addition to its positive effects on the environment, offshore wind energy development contributes significantly to economic growth, job creation, and Germany's continued global leadership in renewable energy technology. Germany is demonstrating its commitment to leading the world's clean energy transition by investing in cutting-edge energy solutions including green hydrogen, infrastructure modernization, and offshore wind farms. The nation's commitment to renewable energy ensures long-term energy security and economic resilience in addition to supporting its aggressive climate ambitions. Germany is setting the stage for a future that strikes a balance between economic growth, environmental sustainability, and energy independence by adopting offshore wind energy. This will make Germany an international leader in the battle against climate change.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The authors confirm being the sole contributor of this work and have approved it for publication.

## Peer-review

Externally peer-reviewed.

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# ASSESSING THE PREFERENCE AND UTILIZATION OF GREEN SPACES FOR SOCIAL HARMONY IN PESHAWAR

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## Abstract

This study aims to assess the preference and utilization of green spaces for fostering social harmony in Peshawar, Pakistan. Utilizing a simple observational approach, the research focuses on Hayatabad areas within the city. By visiting green & non green areas and conducting direct observations, the study seeks to determine the level of enjoyment and the number of people present in green spaces compared to non-green areas. This straightforward methodology aims to provide valuable insights into the perceived value and actual usage of green spaces for social activities and community interaction. By identifying areas with higher levels of engagement and enjoyment in green spaces, the research aims to highlight the potential role of such spaces in promoting social cohesion and harmony within urban settings like Peshawar. The findings of this study can inform urban planning efforts and policy decisions aimed at enhancing the availability and accessibility of green spaces to foster a more cohesive and peaceful community environment.

**Keywords:** Green spaces, Social harmony, Social interaction, Urban planning, Peshawar

## Introduction

Peshawar, a city steeped in history nestled amidst the Hindu Kush mountains, thrives as a cultural and economic hub for Pakistan's Khyber Pakhtunkhwa province (Government of Khyber Pakhtunkhwa, 2023). The rapid pace of urbanization has profoundly transformed cities worldwide, bringing both opportunities and challenges. While urban growth fosters economic development, innovation, and cultural exchange, it also poses significant obstacles to maintaining social harmony within diverse urban populations (World Bank, 2020). As cities expand, they become more heterogeneous, incorporating individuals from various ethnic, religious, and socioeconomic backgrounds. This diversity, while enriching, can create tensions if not managed effectively, making the preservation of social harmony increasingly complex. Social harmony, defined by UNESCO (2017) as a state of peaceful coexistence, mutual respect, and cooperation among individuals and groups, is critical to a city's overall well-being. It not only fosters an environment of understanding and inclusivity but also contributes to sustainable urban development. When social harmony is nurtured, it promotes collaboration across different sectors of society, encourages civic engagement, and strengthens the social fabric that binds communities together. On the contrary, the lack of it can exacerbate inequalities, contribute to social unrest, and weaken the resilience of urban areas in the face of economic, environmental, and political challenges.

In the context of Peshawar, a historically significant city in Pakistan, the need to foster social harmony is particularly vital. Peshawar has long been a melting pot of cultures, shaped by its strategic location as a gateway between Central and South Asia. Today, with rapid urbanization, the city faces complex dynamics stemming from its growing population, socio-political shifts, and the pressures of modern urban life. These changes are accompanied by an increasing

diversity of the city's inhabitants, making it essential to create a social environment where different communities can live together in peace and mutual respect.

Nurturing social harmony in Peshawar involves addressing issues such as equitable access to resources, inclusive urban planning, and creating platforms for dialogue among diverse groups. Such measures not only help in mitigating potential conflicts but also enhance a collective sense of belonging and shared identity. In doing so, Peshawar can strengthen its social cohesion, build resilient communities, and navigate the multifaceted challenges brought by urbanization. By focusing on fostering cooperation, understanding, and respect among its residents, Peshawar can emerge as a more inclusive and harmonious urban environment in the face of its growing diversity.

A compelling solution to the challenges of urbanization and social harmony lies within the natural environment itself: green spaces. These include parks, gardens, urban forests, and other public green areas, which act as essential components of urban infrastructure. These spaces offer much more than aesthetic appeal; they provide opportunities for relaxation, recreation, and social interaction, while serving as a vital connection between urban dwellers and the natural world (Fuller et al., 2007). The integration of green spaces into city planning has garnered increasing attention for their wide-ranging benefits, particularly in promoting mental and physical well-being, social cohesion, and environmental sustainability.

Research has consistently demonstrated the multifaceted advantages of green spaces, with numerous studies showing their capacity to reduce stress, improve mental health, and encourage physical activity (Kuo et al., 2001; van den Berg et al., 2010). These benefits are particularly crucial in densely populated urban environments, where residents often face the psychological pressures of fast-paced city life. Green spaces offer a refuge from urban stressors, enabling individuals to unwind and recharge. The positive effects on mental health are not limited to individuals; they ripple outward, influencing the broader community by fostering a sense of calm and well-being that permeates the urban fabric.

Moreover, green spaces have been recognized for their role in promoting social interaction and community building. Public parks and gardens act as communal spaces where people from various cultural, socioeconomic, and ethnic backgrounds can gather and engage with one another. These settings provide a neutral, inclusive environment where social barriers are diminished, and people can connect on a personal level, irrespective of their differences. By facilitating such interactions, green spaces foster a sense of community belonging, promoting social inclusion and reducing social isolation.

In cities where diversity is often accompanied by social friction, green spaces can serve as powerful tools for bridging divides and enhancing peaceful coexistence. They act as catalysts for interaction, where people of different backgrounds can come together, share experiences, and build meaningful connections. The informal, organic interactions that occur in green spaces contribute to a stronger sense of community, cultivating mutual respect and understanding. In this way, green spaces not only provide environmental and health benefits but also play a critical role in nurturing social harmony within diverse urban populations. As urban planners and policymakers seek solutions to the challenges posed by rapid urbanization, integrating green spaces into the urban landscape emerges as a practical and holistic strategy for enhancing social cohesion and fostering resilient, harmonious cities.

The potential of green spaces to enhance social harmony can be understood through several key mechanisms. Firstly, the calming effect of nature is well-documented, with numerous studies showing that exposure to green environments significantly reduces stress hormone levels and promotes overall well-being. This reduction in stress creates an atmosphere where individuals are more likely to engage in positive social interactions, fostering a sense of connection and cooperation among community members (Fuller et al., 2007). By offering an escape from the pressures of urban life, green spaces encourage relaxation and contribute to a more peaceful and harmonious social dynamic.

Green spaces also provide a platform for informal gatherings and unstructured social interactions. Unlike formal meeting places or structured events, public parks and gardens create opportunities for spontaneous encounters between people from different walks of life. These spaces act as neutral grounds where social barriers—whether cultural, economic, or generational—are less pronounced, allowing for greater understanding and empathy between diverse groups (Kuo et al., 2001). The organic nature of these interactions promotes social integration and builds bridges between communities, making green spaces an essential component in fostering social cohesion in urban environments.

Additionally, physical activity in green spaces contributes to social harmony through the release of endorphins, which are natural mood elevators. Activities such as walking, jogging, or playing sports in parks not only benefit physical health but also enhance mental well-being. The endorphins released during exercise help elevate moods, making people more likely to engage in positive, cooperative social behaviors. The act of exercising in a shared public space also fosters a sense of community, as individuals bond over shared activities, whether they are team sports, yoga sessions, or casual strolls.

Finally, the aesthetic appeal of well-maintained green spaces plays a subtle but crucial role in fostering a sense of community pride. Visually pleasing environments uplift the mood of residents, contributing to a more positive social atmosphere. Attractive and well-kept public spaces encourage people to spend time outdoors, enhancing opportunities for social interaction. Moreover, the aesthetics of a shared green space can inspire residents to take ownership of their environment, leading to community-driven initiatives for upkeep and preservation. (Hartig et al., 2014). This sense of collective responsibility not only strengthens community bonds but also instills pride in the shared urban landscape, further promoting social harmony.

By integrating these spaces into urban planning, cities can create environments that naturally foster community building, reduce social tensions, and promote peaceful coexistence. (White et al., 2013).

Peshawar, with its deep-rooted cultural heritage and diverse population, offers a distinctive case study for investigating the role of green spaces in promoting social harmony. The city's historical significance as a crossroad of civilizations, combined with its growing urbanization, presents both challenges and opportunities

for fostering social cohesion. As Peshawar continues to expand and diversify, the strategic incorporation and enhancement of green spaces throughout the urban landscape could play a pivotal role in nurturing a more cohesive, inclusive, and peaceful environment for its residents.

The cultural diversity and socio-political complexities of Peshawar make it an ideal setting to explore how urban green spaces can serve as catalysts for social integration and mutual understanding. By providing neutral and aesthetically pleasing environments, green spaces can break down social barriers and create opportunities for interaction among people from various backgrounds. The positive effects of green spaces, from stress reduction to promoting physical activity and social interaction, can be particularly valuable in a city like Peshawar, where the challenges of modern urban life are often juxtaposed with traditional communal practices. (Jennings and Bamkole, 2019)

This research aims to delve into the potential of green spaces to foster social harmony in Peshawar. Employing a simple observational approach, the study seeks to compare how residents utilize green spaces versus non-green areas and to assess the perceived value these spaces hold within the community. By observing social interactions, patterns of use, and resident feedback, this study will provide insights into how urban green spaces can be leveraged to enhance community cohesion and social well-being in a rapidly urbanizing city. Ultimately, the findings will contribute to broader urban planning strategies that prioritize social harmony alongside environmental sustainability, guiding Peshawar's path towards a more inclusive and peaceful urban future.

## Methodology

This study employed a simple observational approach to investigate the preference and utilization of green spaces for fostering social harmony within Hayatabad, a governmental township in Peshawar, Pakistan. Hayatabad was chosen as the case study area due to its relatively homogenous population and limited external variables that might influence social interaction patterns. This selection aimed to isolate the potential impact of green spaces on social harmony within a more controlled environment.

Data was collected through direct observations and surveys. Observations were conducted at different times of the day and week to account for variations in usage patterns. The number of people present in the green spaces and non-green areas were counted, and their activities were noted. Surveys were conducted to gather information on residents' preferences and perceptions of the green spaces.

The data collected was analyzed to determine the level of enjoyment and the number of people present in green spaces compared to non-green areas. Statistical tests were used to identify any significant differences in the usage and preference of green spaces versus non-green areas.

The results were interpreted to understand the role of green spaces in promoting social harmony. Areas with higher levels of engagement and enjoyment in green spaces were identified, and the potential implications of these findings for urban planning and policy decisions were discussed.

Here are the steps of the research methodology.

**1. Selection of Case Study Area:**

- Hayatabad, a government township in Peshawar, was chosen due to its relatively homogeneous population and controlled environment, minimizing external variables that could influence social interaction.

**2. Data Collection (Observations):**

- Direct observations were conducted at different times of the day and week. The number of people present in green and non-green areas was counted, and their activities were noted to analyze the usage patterns.

**3. Data Collection (Surveys):**

- Surveys were conducted to gather residents' perceptions and preferences for green spaces compared to non-green areas, providing insight into their value in promoting social harmony.

**4. Data Analysis:**

- The data was analyzed to determine the levels of engagement, enjoyment, and the number of people using green versus non-green areas. Statistical tests were applied to identify significant differences in usage patterns.

**5. Interpretation of Results:**

- The results were interpreted to understand the role of green spaces in fostering social harmony, focusing on areas with higher levels of engagement and enjoyment.

**6. Urban Planning Implications:**

- The findings were discussed in relation to potential urban planning and policy decisions, particularly regarding the strategic incorporation of green spaces to enhance social cohesion in Peshawar.




**Figure 1.** Research framework

Data collection occurred over a two-week period, with observations conducted during three time slots:

**Morning** (9:00 AM - 11:00 AM)

**Afternoon** (1:00 PM - 3:00 PM)

**Evening** (5:00 PM - 7:00 PM)

**Green Spaces:**

Bagh-e-Naran Park (Adjacent Non-Green Area: Nearby Residential Area)

Hayatabad Sports Complex (Adjacent Non-Green Area: Busy Road)

Shalman Park (Adjacent Non-Green Area: Commercial Market)

Tatara Park (Adjacent Non-Green Area)

Phase 6 Park (Adjacent Non-Green Area: Market)

| A | B | C | D | E |
|---|---|---|---|---|
| Location | Date (Weekday/Weekend) | Morning (Avg. People) | Afternoon (Avg. People) | Evening (Avg. People) |
| Bagh-e-Naran Park (Large) | WD (03/01/2023) | 50 | 180 | 350 |
| Bagh-e-Naran Park (Large) | WE (03/04/2023) | 70 | 220 | 400 |
| Hayatabad Sports Complex | WD (03/01/2023) | 20 | 40 | 60 |
| Hayatabad Sports Complex | WE (03/04/2023) | 30 | 60 | 80 |
| Shalman Park | WD (03/01/2023) | 40 | 45 | 70 |
| Shalman Park | WE (03/04/2032) | 50 | 65 | 90 |
| Tatara Park | WD (03/01/2023) | 30 | 30 | 50 |
| Tatara Park | WE (03/04/2023) | 40 | 45 | 65 |
| Phase 6 Park | WD (03/01/2023) | 3 | 10 | 25 |
| Phase 6 Park | WE (03/04/2023) | 5 | 15 | 30 |

**Figure 2**.Social activity levels in Hayatabad's green spaces (parks) and adjacent non-green spaces

## Analysis & Discussion

The data presents a compelling narrative about the critical role of green spaces in attracting visitors and fostering social interaction within urban environments like Hayatabad. A clear trend emerges from the analysis: green spaces consistently attract more visitors than non-green areas, regardless of the time of day or day of the week. This pattern underscores the intrinsic value of urban green spaces not just as aesthetic elements but as essential social hubs that contribute to the well-being and cohesion of the community.

**Visitor Trends in Green Spaces:** The trend is most evident in Bagh-e-Naran Park, the largest green space in the study. On weekdays, Bagh-e-Naran attracts a significant number of visitors: an average of 50 in the morning, 180 in the afternoon, and 350 in the evening. These numbers see a noticeable uptick on weekends, rising to 70 in the morning, 220 in the afternoon, and 400 in the evening. This increase in foot traffic during weekends is likely due to residents having more free time for leisure and social activities, reinforcing the notion that green spaces are sought-after destinations for relaxation and interaction.

Smaller parks, such as Shalman Park, exhibit similar trends, though the numbers are understandably lower. On weekdays, Shalman Park sees an average of 40 visitors in the morning, 45 in the afternoon, and 70 in the evening. These figures rise to 50, 65, and 90, respectively, on weekends. Despite its smaller size, the park still plays a vital role in providing a space for community gathering and interaction. The consistent attraction of visitors across different parks, regardless of their size, highlights the universal appeal of green spaces.

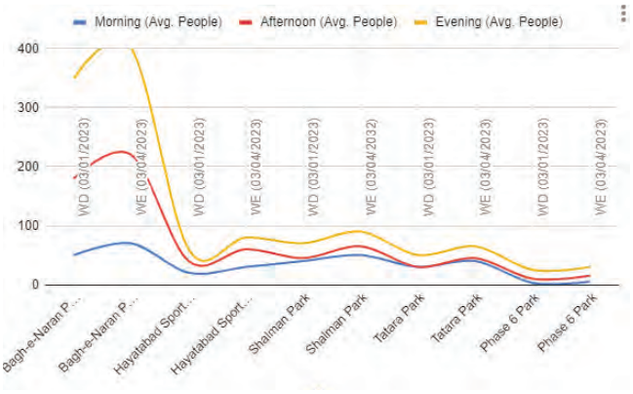


**Figure 3.** Size of a park and the number of visitors,

The data also implies that there is a direct relationship between the size of a park and the number of visitors, assuming the days and times are consistent. In other words, larger parks tend to attract more visitors than smaller ones when the day of the week and time of day are held constant.

**Park Size and Visitor Numbers:** One of the most significant findings from the data is the direct correlation between park size and the number of visitors. Larger parks, such as Bagh-e-Naran, consistently attract more visitors compared to smaller parks like Shalman Park, assuming that the day of the week and time of day remain constant. This relationship underscores the importance of allocating larger green spaces within urban areas, as they can accommodate more visitors and, by extension, provide more opportunities for social interaction and community engagement.

**Implications for Social Harmony:** The data suggests that green spaces serve as more than just recreational areas; they are crucial for promoting social harmony. By attracting large numbers of visitors, these spaces provide neutral ground where people from diverse backgrounds can come together, share experiences, and engage in unstructured social interactions. The fact that visitor numbers peak in the evenings and weekends, times typically associated with socializing and leisure, further supports the idea that green spaces are vital for fostering community ties and promoting peaceful coexistence in urban settings.

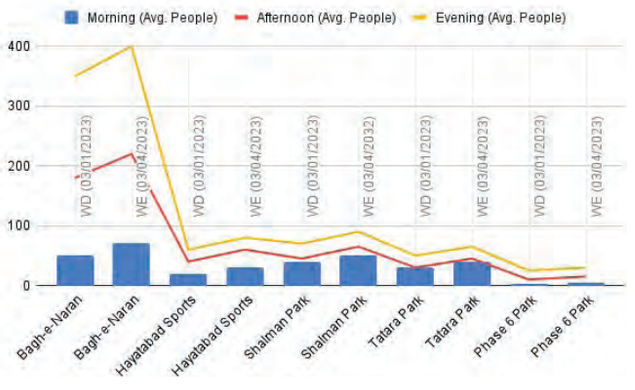


**Figure 4.** Number of visitors in green spaces

**Urban Planning and Policy Implications:** Given the clear relationship between green spaces, visitor numbers, and social interaction, urban planners and policymakers should consider the expansion and strategic placement of green spaces in cities like Hayatabad. Prioritizing the development of large, accessible parks can significantly enhance the social fabric of the community by providing residents with common spaces for leisure, recreation, and interaction. Additionally, the findings highlight the need for equitable distribution of green spaces across urban areas to ensure that all residents, regardless of socioeconomic status, have access to these vital social hubs.

The results of this study can also inform policies aimed at increasing social cohesion and reducing social tensions in rapidly urbanizing environments. By incorporating more green spaces into the urban landscape, cities can foster a sense of belonging and

connectedness among residents, leading to more harmonious and peaceful communities.

Green spaces, on average, see a higher number of visitors compared to non-green spaces throughout the week. This suggests a potential preference for parks and other green areas for social interaction, relaxation, or physical activity.

Weekends generally show a higher average number of people in both green and non-green spaces compared to weekdays, reflecting increased leisure time availability.

Evening time slots might show the highest average number of people in both green and non-green spaces, followed by afternoons and mornings. This suggests a potential preference for outdoor activities during cooler evening hours.

The larger park (Bagh-e-Naran) might consistently attract more visitors compared to the smaller park (Phase 6 Park) across all days and times, highlighting the potential influence of park size on visitor numbers.

## Conclusion

In conclusion, the research underscores the pivotal role that green spaces play in fostering social activity, enhancing community well-being, and contributing to the overall quality of urban life. The study's findings demonstrate that green spaces, particularly larger parks, attract significantly more visitors than non-green areas, suggesting that these spaces are crucial hubs for social interaction. Moreover, the evidence indicates that well-maintained parks not only serve as physical spaces for relaxation and recreation but also act as catalysts for building social connections, breaking down barriers between different community groups, and fostering a sense of belonging.

The relationship between park size and visitor numbers, as revealed by the data, highlights the importance of thoughtful urban planning. Parks that offer a variety of amenities cater to diverse age groups and interests, making them more attractive and multifunctional. This makes them ideal spaces for promoting social harmony, as they facilitate a range of activities, from casual socializing to structured events, which can further strengthen community ties.

Regular maintenance and the active programming of events within parks are also critical to their sustained success as social hubs. Clean, safe, and inviting environments, coupled with organized community events, can enhance the social value of these green spaces, creating opportunities for interaction, engagement, and a sense of ownership among residents. This not only promotes individual well-being but also contributes to broader social cohesion, as residents feel more connected to their community.

Given the findings of this study, urban policymakers and planners should prioritize the creation, maintenance, and strategic development of green spaces to support both physical and social health within urban environments. (Maas et al., 2009). As cities grow and evolve, green spaces must remain central to urban planning efforts, ensuring they continue to offer inclusive, accessible, and engaging environments that foster a harmonious and connected community.

## Recommendations

Increasing access to well-maintained and programmed green spaces can be a valuable investment for urban communities, as these spaces have been shown to promote social activity, physical health, and mental well-being (Kerishnan & Maruthaveeran, 2021). The presence of quality green spaces has been associated with a range of positive outcomes, including decreased rates of obesity, cardiovascular disease, and mental health issues. (Young et al., 2022) In a study of urban parks in Kuala Lumpur, researchers found that the restorative environment provided by these green spaces can help alleviate stress and foster a sense of self-restoration and rejuven ation (Mohamad & Hussein, 2020).

Furthermore, research suggests that the biodiversity of green spaces can influence their psychological restorative benefits. (Wood et al., 2018) A study in Bradford, UK found that urban parks with greater biodiversity were associated with stronger self-reported measures of psychological restoration, such as feeling "away from everyday life" and preferring the site (Wood et al., 2018). This highlights the importance of considering both the quantity and quality of green spaces in urban planning.

In light of these findings, the following recommendations are suggested for urban planning in Hayatabad and similar contexts

The study provides preliminary evidence that green spaces play a significant role in promoting social activity within communities. The findings indicate that access to well-maintained parks and green areas is crucial for fostering social interactions and improving residents' overall quality of life. Expanding access to these spaces encourages residents to engage in outdoor activities, whether through organized sports, casual gatherings, or recreational pursuits like walking, jogging, or picnicking. (White et al., 2013). These interactions not only help strengthen community ties but also contribute to a healthier lifestyle by providing opportunities for physical activity and mental relaxation. Therefore, urban planners and policymakers should prioritize the development of new green spaces and the enhancement of existing ones, ensuring they are accessible to all community members. (Maas et al., 2009)

The study suggests that larger parks tend to attract more visitors, which emphasizes the importance of size in park development. Future park planning should carefully consider the size of new green spaces and their potential to accommodate larger crowds. However, mere size is not sufficient; the incorporation of a variety of amenities and features is equally essential. Parks should be designed to cater to diverse age groups and interests, incorporating facilities such as playgrounds, sports fields, walking trails, fitness stations, picnic areas, and quiet zones for relaxation. Additionally, amenities such as restrooms, drinking fountains, and seating areas enhance the overall user experience. By providing a range of features, parks can become multi-functional spaces that serve as social hubs for the entire community, thereby maximizing their social value and promoting long-term engagement. (Sugiyama et al., 2008)

Regular maintenance of green spaces is critical to ensuring they remain clean, safe, and inviting for visitors. Parks that are well-maintained not only attract more visitors but also foster a sense of pride and ownership among community members. Investment in maintenance should include routine cleaning,

landscaping, repairs to facilities, and the safety of play areas. (Jennings and Bamkole, 2019).

Moreover, proactive programming can further enhance the social value of parks. Organizing community events, workshops, recreational activities, and cultural programs within these spaces can create opportunities for social interaction and strengthen community bonds. For instance, hosting seasonal festivals, fitness classes, or educational workshops can draw people to the parks and encourage them to engage with one another. Such initiatives can also foster a sense of belonging and commitment to the park, as residents actively participate in the stewardship of their shared environment. By promoting a vibrant community life through well-maintained and programmed green spaces, cities can significantly enhance social cohesion and well-being.

In conclusion, prioritizing the creation and maintenance of green spaces, considering park size and amenities, and investing in regular maintenance and programming are vital steps toward fostering social activity and community well-being. As urban environments continue to evolve, ensuring the availability of accessible and engaging green spaces will be essential for cultivating social connections and promoting healthier lifestyles among residents.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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# A GREEN GENDER ANALYSIS ON "WOMEN'S EMPOWERMENT STRATEGY DOCUMENT AND ACTION PLAN (2024-2028)" OF TURKIYE

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**Abstract**

This research examines the "Environment and Climate Change" policy area of the Women's Empowerment Strategy Document and Action Plan (2024-2028) of Türkiye in terms of gender perspective.

Conducted according to qualitative research methods and techniques, this research includes six themes: The existence of an approach that limits women to motherhood", "Avoiding the use of the term gender", "Special emphasis on gender-based data production", "Women's empowerment in the private sphere", "Environment and women" and "Green intersectionality".

Within the scope of the themes generated, while claiming to be inclusive, the document notably equates the concept of "woman" solely with motherhood and the responsibility of raising future generations and excludes women who are not mothers. It includes statements and activities aimed at empowering women within the private sphere. Furthermore, the strategic plans referred to in the document include activities related to the production of gender-based data, but the concept of gender is avoided. This suggests that the document was prepared with an attitude that accepts or defends the existence of gender inequality. The document also emphasizes that women are more affected by adverse environmental conditions than men, while their carbon footprint is lower. Moreover, when we examine the activities that have been implemented or are planned, the inclusion of statements focused on educating women – who already tend to have a lower carbon footprint—about climate change or raising their awareness appears to contradict the gender-based foundation of the document.

**Keywords:** Gender, climate change, environment, Türkiye, Women's Empowerment Strategy Document and Action Plan (2024-2028)

## Introduction

Climate change, often referred to as the climate crisis or climate emergency, highlights the shifts in the world's climate system due to global warming. It has become a key topic on many local, national, and international platforms. In addition to the geographical, physical and environmental impacts, climate change affects humanity globally, posing numerous threats, including health, poverty, food and water shortages, increased floods, extreme heat, more diseases, economic burden, etc. The threat to humanity has reached such levels that the World Health Organization (WHO) has classified climate change as the greatest risk to global health in the 21st century (WHO, 2015).

The risk posed by all these impacts is unequally distributed but is generally more significant for disadvantaged and vulnerable people in developing and developed countries (Kara, 2021;

The list of publications can be downloaded on the following website: https://www.ijhsdr.com/

IPCC, 2014; UN, 2019; CEE, 2009). From a sociological perspective, this unequal distribution is also evident between genders, as the impacts of climate change are gender-specific rather than gender-neutral. These effects can exacerbate the existing disadvantages faced by women, who often have fewer resources to cope with its consequences (WMO, 2024; Denton, 2002; Alston, 2013; UN, 2019; Kronsell, 2017).

## A Gendered Lens on Climate Change

It has been documented that women are more concerned about environmental issues and have higher risk perceptions than men (Aguilar, 2009; McCright and Dunlap, 2011; Xiao and McCright, 2012). It has also been underlined that women's limited access to educational opportunities, compared to men, and the male-dominated nature of public spheres like political and social decision-making processes make women more exposed and vulnerable to the consequences of climate change (UNFPA and WEDO, 2009).

Current literature states that climate change affects men's and women's health differently. In terms of mortality, women are 14 times more likely to die than men during natural disasters (SIA, 2008). Women are more likely than men to experience psychological illnesses, infectious diseases, and a higher risk of malnutrition (Enarson and Chakrabarti, 2009). Infections during pregnancy and subsequent anemia in the mother stemming from climate change are among the factors that lead to low birth weight, poor child development and increased child mortality (Charbit 2018: 319). In terms of violence, women are the victims of domestic and sexual violence in case of emergency conditions and disasters more than men (Sanz-Barbero et al., 2018; UN Women, 2020).

Last but not least, the Women's Environment & Development Organization, WEDO (2009), summarizes the effects of climate change on women by highlighting direct and indirect impacts as follows:

| Issue | Direct and Indirect Impacts on Women |
|---|---|
| Natural resources: food, water, fuel, land | • Increased household work burden and time spent on gathering water, food and fuel such as firewood (sometimes leading to lower school enrolment rates, decreased literacy rates, or early marriage)<br>• Increased hunger and calorie reduction<br>• Exposure to contaminated water sources<br>• In regions with restricted land rights, women are potentially forced off/without access to fertile land<br>• Loss of traditional land tenure |
| Natural disasters | • Lack of access to education/information about weather<br>• Restricted ability to respond (e.g., women are often unable to leave the house without a male companion)<br>• Lack of survival skills regularly taught to boys, such as swimming or tree climbing<br>• Women are regularly excluded from disaster recovery decision-making |
| Health | • Pregnant and lactating women, along with the very young and very old, are most vulnerable to health threats<br>• Increased lack of healthcare services, immunizations, family planning, reproductive health care in disaster zones<br>• Potential increase in maternal and infant mortality rates due to lack of care<br>• Lack of services and hygienic supplies in relief shelters for pregnant, lactating or menstruating women |
| Population growth | • Competition for increasingly scarce government and natural resources<br>• Most vulnerable populations (e.g., women) continue to be under threat<br>• High fertility rates impact women's health |
| Urbanization | • Settlements – sometimes informal – may be unhealthy and dangerous, lack water and sanitation and be built on vulnerable land<br>• Urban formal markets tend to benefit men<br>• Poor urban women lack health services<br>• Urban poverty projected to increase |
| Migration & displacement | • Women comprise at least half of the world's migrant populations, but their needs are not prioritized in migration policies<br>• Women often lack resources to move but may lack resources to cope at home after disasters<br>• Forced migration could exacerbate women's vulnerability and lack of access to resources and livelihood options |
| Household composition | • Rise in female-headed households (FHH)<br>• Limited resources for FHH in recovery/insurance programmes or funds that prioritize access for men<br>• Lack of land rights jeopardizing women's food and livelihood security<br>• Gendered divisions of labour reinforced<br>• Decreased numbers of women in some households due to female disaster mortality |
| Conflict & violence | • Conflict amplifies existing gender inequalities<br>• While men are more likely to be killed or injured in fighting, women suffer significantly from other consequences of conflict, such as rape, violence, anxiety and depression<br>• Higher levels of violence at home and in post-disaster relief shelters |

**Figure 1: Consequences of Climate Change, Resource: WEDO (2009)**

## The Case of Turkiye

On an international level, following the Millennium Development Goals (2015), the Sustainable Development Goals (UN, 2015) also address numerous challenges faced by people and the planet.. Out of the 17 goals, the 13th focuses on Climate Action and the 5th on Gender Equality, and these two goals intersect with one another. Furthermore, some progress is also made under the scope of the United Nations Framework Convention on Climate Change (UNFCCC). During the Conference of the Parties, COP 23, a gender action plan was created to support the implementation of gender-related decisions (UNFCCC, 2017).

Touching on the historical transformation relevant to our subject, the first international document to highlight the relationship between climate change and gender inequality is the UN Framework Convention on Climate Change, with the Paris Agreement being one of its key implementation tools. The preamble of the Paris Agreement, which was signed by Türkiye in 2016, statements to pay attention to gender equality and women's empowerment in the studies to be carried out on climate change (Paris Agreement, 2015).

Moreover, Article 10/c of the Stockholm Convention on Persistent Organic Pollutants prepared by the United Nations Environment Programme - UNEP, which includes regulations on the use of substances that adversely affect the environment and human health, also signed by Türkiye, states the following: "Develop and implement education and public awareness programmes on persistent organic pollutants, their effects on

health and the environment and their alternatives, especially for women, children and the least educated" (Stockholm Convention, 2004). Additionally, the Minamata Convention on Mercury, also developed by the United Nations Environment Programme - UNEP in 2013 in response to mercury's harmful effects on both the environment and human health and signed by Türkiye in 2014, also highlights the connection between women and the environment as follows in its preamble: "Being aware of the health concerns arising from the exposure of vulnerable populations, especially women, children and, through them, future generations to mercury, especially in developing countries" (Minamata Convention, 2013). Türkiye has been following these international decisions and goals when tackling the climate crisis with the National Climate Change Adaptation Strategy and Action Plan (2024-2030) and National Climate Change Mitigation Strategy and Action Plan (2024-2030) (Directorate of Climate Change, 2024).

Specifically, as documented above, the changes and issues that occur due to climate change also impact Türkiye, and Türkiye started to take action against its hazardous effects. It is predicted that the annual average temperature increase in Türkiye will be between 1°C - 2°C for the period of 2016-2040, between 1.5°C - 4°C for the period of 2041-2070, and between 1.5°C - 5°C for the last period of 2071-2099 (Demircan et al. 2017:2-3).

In line with the two interconnected themes of this research paper—gender and climate change—there are two "Women's Empowerment Strategy Document and Action Plan": one covering the 2018-2023 period and the other for 2024-2028. The former addresses gender and climate change indirectly, while the latter directly approaches these issues.

## Looking at the Former Document: Women's Empowerment Strategy Document and Action Plan (2018-2023)

The Women's Empowerment Strategy Document and Action Plan (2018-2023), prepared under the coordination of the Ministry of Family and Social Services - Directorate General on the Status of Women, is the first action plan prepared at the national level. It aims to strengthen women's participation in both social and economic life by reflecting gender equality in practices and policies and to ensure that they benefit equally from rights, opportunities and possibilities.

The Strategy Document and Action Plan includes activities to be carried out by relevant public/private organizations to promote women's empowerment. While preparing this Strategy Document and Action Plan, Article 5 "Gender Equality" of the United Nations 2030 Sustainable Development Goals (UN SDGs), which Turkey officially adopted on 25 September 2015, can be said to be Article 5 of the UN SDGs. It includes strategies and activities in the context of five main policies: education, health, economy, participation in decision-making mechanisms and media.

In this respect, the 2018-2023 Women's Empowerment Strategy Document and Action Plan only mentions gender equality as an umbrella term, and no article is directly related to gender and climate change. On the other hand, although an indirectly related article, in the health sub-dimension of the Strategy Document and Action Plan, "Women living in rural areas and working as seasonal agricultural labourers in Turkey women have disadvantages in terms of health services", there are indirect statements indicating that climatic conditions can negatively affect women.

## An Overall Evaluation of the Current Women's Empowerment Strategy Document and Action Plan (2024-2028)

With the expiry of the first action plan in 2023, the Women's Empowerment Strategy Document and Action Plan (2024-2028) was prepared under the coordination of the Ministry of Family and Social Services - Directorate General on the Status of Women. In addition to the UN SDGs, the main objective of the 12th Development Plan is stated as the following: "To ensure that women, who are indispensable elements of the family and society and who have a central role in raising future generations, receive the superior value they deserve and accelerate our development; benefit equally from rights, opportunities in all areas of life, especially in education and employment; live free from all forms of violence and discrimination; and increase representation and participation rates in all fields and levels". The 12th Development Plan is the last development plan covering the 2024-2028 period, prepared with the main objective of "a stable, strong and prosperous Türkiye that is sensitive to the environment, resistant to disasters, produces high added value based on advanced technology, shares income fairly and is stable" (12th Development Plan, 2024).

The 2024-2028 Strategy Document and Action Plan was prepared on five main policy axes: education, health, economy, leadership and participation in decision-making mechanisms, environment and climate change. Considering the 2018-2023 Strategy Document and Action Plan, the new plan emphasizes "Environment and Climate Change" differently. This focus, which aligns with the objectives of "climate action" in Article 13 and "accessible and sustainable water management" in Article 6 of the UN SDGs, forms the central theme of this study.

Based on this information, this research aims to examine the "Environment and Climate Change" policy area of the Women's Empowerment Strategy Document and Action Plan (2024-2028) of Türkiye in terms of gender perspective.

## Methodology

This research was conducted through the methods and techniques of the qualitative research paradigm, which focuses on analyzing non-numerical data such as a document, video or audio in order to reveal the concepts, opinions or experiences (Martin, 2010). As to the research design, the study used content analysis, a scientific approach to investigating social reality by classifying the message into verbal, written, and other materials and converting them into numbers or making inferences (Dey, 1995).

## Data Collection and Data Analysis

The data were collected through the document analysis method, which can be defined as the analysis of written materials

containing the phenomena or facts intended to be investigated (Yıldırım and Şimşek, 2016).

The study used qualitative data analysis, which consisted of three concurrent flows of activity: data reduction, data display, and conclusion drawing/verification (Miles et al., 2015). During data reduction, the data to be analyzed was read, and the analysis unit was determined under the codes of "women", "gender", "climate", "climate change" and "environment". As the text is in the Turkish language, these codes are "kadın", "cinsiyet", "toplumsal cinsiyet", "iklim", "iklim değişikliği" and "çevre". The identification of these codes was supported by the word cloud method in the MAXQDA qualitative data analysis software. The word cloud, as shown below, refers to the process of visualizing the most frequently used words in the examined sections of the strategy document. The visual indicates that the frequency of word usage increases with the size of the text.




**Figure 2: Word Cloud from MAXQDA**

These coding processes were categorized, and the reduced data were checked by three field experts (one from Social Work, two from Sociology and Gender). In the second step, data display, the data set was transformed into a visual figure. Finally, in the conclusion drawing/verification step, findings were derived from the data set, leading to associations and interpretations among the categories.

## Document Analyzed

The Women's Empowerment Strategy Document and Action Plan (2024-2028) is a 180-page document prepared under the coordination of the Ministry of Family and Social Services -Directorate General on the Status of Women.

This research examined the data in the sections between pages 4-36, which cover the introduction and general information of the document, and the section from pages 157-179, which focuses on the fifth policy area, "Environment and Climate Change." (Ministry of Family and Social Services, 2018).

The fifth policy area, "Environment and Climate Change" consists of 27 articles under the title of "Current Situation". The main objective of this title is defined as "to identify the effects of environment and climate change on women and girls and to ensure the activities are carried out within the framework of their needs."

Three strategies have been identified in line with this objective, and activities for each strategy have been developed. The responsible institution, related institution, implementation schedule and performance indicators are presented for each activity. The three related strategies are as follows:

1. Generating gender-based data, research and data analysis of adaptation and risk, and encouraging scientific studies by relevant institutions to determine the impacts of environment and climate change on women.

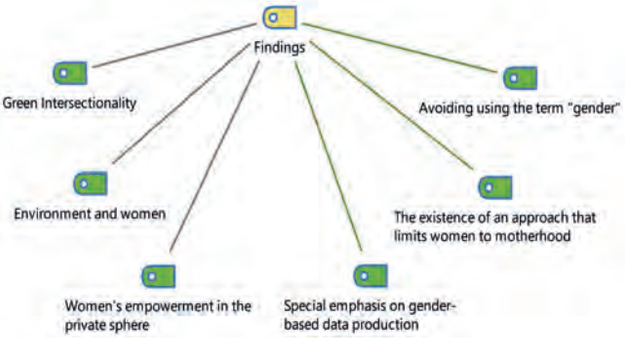
2. Ensuring effective participation of women in gender-sensitive planning, budgeting and implementation of environment and climate change policies.

3. Raising public awareness on the impacts of environment and climate change on women and girls (Ministry of Family and Social Services, 2024).

## Results and discussion

The findings were categorized into six themes. As shown in Figure 3, these themes are; "The existence of an approach that limits women to motherhood", "Avoiding the use of the term gender", "Special emphasis on gender-based data production", "Women's empowerment in the private sphere", "Environment and women" and "Green intersectionality".

**Figure 3: Findings**




**1. The existence of an approach that limits women to motherhood**

The "Introduction" includes a citation from the 12th Development Plan, where a woman is described as "the indispensable member of family and society with a central role in raising future generations". This approach limits women to motherhood by excluding all childless women (regardless of being married or not, as it is not mentioned), despite underlining that the plan is "inclusionary" (p.3).

These documents focus on the mission of raising moral generations, a vision that Turkish holds for women. Furthermore, they regard women as respectable primarily in their role as mothers, based on their fertility. This perspective aligns with Aktaş's study (1984), which argues that women are viewed primarily as entities essential to the home, focusing on the home-child-spouse trio, and are often addressed primarily in terms of

their sexuality. This view also parallels Durakbaşa (1998), who highlights the pressure of moral codes, such as family honor and dignity, exert on women. In modern femininity, the man is regarded as the modern subject associated with reason, while the woman is positioned as the "other," linked to nature in contrast to the male identity.

**2. Avoiding using the term "gender"**

Gender refers to more than one's biological sex, male or female, but rather the roles, responsibilities and duties that society attributes to that individual because they are male or female (Yaşin-Dökmen, 2016; Bhasin, 2003). During the socialization process, individuals respond to these attributions and often become trapped by gender roles due to the pervasive influence of patriarchal culture (Illich, 1996).

In the document analyzed, under the title of "Current Situation", Article 2 states that "the existence of the structural differences between men and women due to their roles in work and family life results in both sexes being negatively and differently affected by the climate change" (p. 157). Although the term underlined in the document refers to the term gender (*toplumsal cinsiyet* in Turkish), the term cannot be found in the document.

Furthermore, although this document is intended to promote gender equality, it appears to be written from a perspective that defends the existence of inequality and influences the activities and decisions accordingly.

**3. Special emphasis on gender-based data production**

Within Article 1, under the title of Strategies, the document puts special emphasis on gender-based data production. It is important to focus on gender-based data production, starting with knowing the difference between sex and gender and the correct relationship between the field where the data is produced and considering its contribution to changing inequalities (Leduc, 2009; Decataldo and Ruspini, 2016). Therefore, as underlined in the former article, using the term "sex" instead of "gender" is a deficiency of this document, even though the term "gender sensitive" is used frequently throughout the document.

**4. Empowering women within the private sphere**

The concept of empowerment, as defined in the introduction of the strategy document, refers to working towards enabling individuals, organizations or societies to have control over their own lives (Duyan, 2016). However, the expressions in the document on the concept of empowerment show that women are empowered within the home and in the private sphere and underline that women's empowerment is the basis for "strengthening the family". Moreover, under the heading Environment and Climate Change - Current Situation, the document includes statements suggesting that women are responsible for household water consumption (p. 157, item 4), the primary users of natural resources (p. 158, item 5), responsible for the elimination of polluted water and human waste (p. 158, item 6) and their contribution to the environment and climate change process is higher than other household members (p. 160, item 14). From this point of view, the strategy document reflects an understanding that women belong to the "private sphere" representing the household. It also indicates that women who are outside the "public sphere", as stated in Article 7 (p.158) of the document, face issues of unpaid labour due to gender inequality (Habermas, 1989; Karadağ, 2003). Therefore, although the strategy document aims to empower women to have control over their own lives, it appears to reflect an understanding that restricts this empowerment to the private sphere within the home and that society attributes to women.

**5. Environment and women**

The strategy document states that women are more affected by climate change and environmental pollution than men and have higher mortality rates due to air pollution (p.158). Furthermore, the document refers to the Organisation for Economic Co-operation and Development (OECD) report on Gender and Sustainable Development and suggests that women have a lower carbon footprint and, therefore, should take the lead in environmental and climate change efforts (p. 160). However, the studies in the literature and this document reveal that training and awareness-raising activities on environment and climate change have been carried out for women (p. 160- 161), although the carbon footprint of women is lower than that of men (Medina & Bruno, 2016; Ergas & York, 2012; Osorio et al., 2024). The strategy document contains activities related to providing training to women on environmental and climate change with a similar perspective regarding the activities targeted to be realized in the future (p.176). Although it includes activities on leadership (p. 171), the document is dominated by an understanding that women are more responsible for domestic roles.

**6. Green Intersectionality**

An analysis of the data under the heading "cross-cutting policy areas" of the strategy document suggests that some groups are defined as "groups requiring special policies" (p.13). These groups are listed as girls, women with disabilities, elderly women, women living in rural areas, women under temporary protection (TP)/international protection (IP), women under detention and conviction, women victims of violence, and poor women (Ministry of Family and Social Services, 2024). At this point, acknowledging studies that demonstrate women and girls are disproportionately affected by climate and environmental events highlights the relevance of the concept of intersectionality. This concept emphasizes that various identities can coexist within individuals, leading to unique experiences (Daniel & Dolan, 2020; Kara, 2021; OECD, 2022). However, upon examining the identified groups, it is notable that there is a lack of clarity regarding groups that intersect based on their needs, particularly those with different identities, such as "women with children who have special needs."

## Final evaluation

The analysis of the "Environment and Climate Change" policy area of the Women's Empowerment Strategy Document and Action Plan 2024-2028 of Türkiye in terms of gender perspective revealed six themes: The existence of an approach that limits women to motherhood", "Avoiding the use of the term gender", "Special emphasis on gender-based data production", "Women's empowerment in the private sphere", "Environment and women" and "Green intersectionality".

In summary, while the text was anticipated to be grounded in gender equality, it is significant that it was written from a perspective that accepts gender inequality. This conclusion underscores the necessity for such documents to be revisited through a gender equality lens.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The authors confirm being the sole contributor of this work and have approved it for publication.

## Peer-review

Externally peer-reviewed.

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## Conflict of interest

No potential conflict of interest was reported by the author (s)

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# DO WE TEACH ENVIRONMENTAL EDUCATION THE WAY WE SHOULD? A CRITICAL DISCOURSE ANALYSIS (CDA) OF SCIENCE SUBJECT TEXTBOOKS

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**Abstract**

Environmental education (EE) encompasses various scientific concepts such as climate, biodiversity, and sustainability, aiming to instill in individuals the ability to explore environmental issues and engage in problem-solving activities for environmental improvement. EE plays a crucial role in fostering environmental literacy among students, yet its representation in science textbooks published by the Sindh Text Books Board (STBB) needs critical examination in terms of learning by doing rather learning by knowing. This research therefore, critically analyzes the presence and frequency of EE-related content in selected textbooks across different grade levels through CDA approach. The context of this study focuses on Sindh, Pakistan which boasts diverse geographical features, wildlife, and climatic conditions. Data collection process involved analyzing nine science textbooks and conducting semi-structured interviews with five science teachers, three students, and two community members to gather more insights. Findings indicate a minimal integration of EE into the science curriculum, with only a few units or chapters dedicated to environmental topics across different grade levels. The paper concludes with a discussion on the discourse surrounding EE in science text books and proposes recommendations for enhancing and improving environmental education delivery in schools. This research also contributes to the ongoing dialogue on the importance of EE and its integration into educational policies and practices.

**Keywords:** Environmental Education, Critical Discourse Analysis & Science Text Books, climate, sustainability

## 1. Introduction

Science textbooks at lower secondary and secondary levels often adopt a traditional approach, primarily emphasizing theoretical aspects and disseminating established scientific facts (Boujaoude, 2021). This conventional approach, while valuable for building foundational knowledge, tends to neglect practical application and problem-solving skills crucial for fostering scientific inquiry and critical thinking (Hmelo-Silver et al. 2007). Consequently, students may struggle to connect abstract scientific concepts with real-world phenomena, hindering their ability to comprehend and engage with environmental issues effectively. Moreover, science

textbooks published by STBB Jamshoro, Sindh, fail to adequately address regional environmental diversity and highlight local scientific facts and discoveries.

Despite Sindh's rich ecological landscape, including diverse wildlife, geographical features, and climatic conditions, the textbooks overlook these unique attributes (Sharma, 2019). This omission not only limits students' understanding of their local environment but also fails to instill a sense of environmental stewardship and responsibility towards preserving regional biodiversity (Duru and Peker, 2020). The absence of local context in science textbooks undermines the relevance and applicability of EE to students' everyday lives. EE encompasses a wide range of scientific concepts, including climate, biodiversity, energy generation, consumption, and sustainability, aiming to empower individuals to understand and address environmental challenges (Disinger, 2014).

By integrating local environmental examples and case studies into the curriculum, textbooks can enhance students' connection to their surroundings and cultivate a deeper appreciation for their natural environment (Naidoo and Fisher, 2016). Additionally, incorporating local scientific discoveries and research findings can inspire curiosity and engagement, motivating students to explore scientific inquiry further (Cooper, 2019). Furthermore, the lack of emphasis on practicality and problem-solving in science textbooks hinders students' ability to apply scientific knowledge to real-world issues (Schwartz et al., 2009). EE is not just about learning facts but also about developing critical thinking skills and problem-solving abilities necessary for addressing complex environmental challenges (Raven, 2012). By integrating inquiry-based learning activities, hands-on experiments, and project-based assignments, textbooks can promote active engagement and empower students to become agents of positive change in their communities (Tilbury et al. 2017).

Eventually, science textbooks at lower secondary and secondary levels often prioritize a theoretical approach, overlooking the importance of practicality and problem-solving skills essential for environmental education. The failure to incorporate regional environmental diversity and highlight local scientific facts and discoveries further diminishes the relevance and effectiveness of EE in the curriculum. To address these shortcomings, text books should integrate local context, incorporate inquiry-based learning approaches, and emphasize practical application to foster environmental literacy and empower students to become responsible stewards of their environment.

## 2. An Overview of Environmental Education

EE encompasses a broad spectrum of scientific concepts, ranging from climate and biodiversity to energy generation, consumption, and the sustainability of all living organisms, including humans (Sund and Wickman, 2019). It serves as a process through which individuals can systematically explore environmental issues, engage in problem-solving, and implement precautionary measures to enhance environmental sustainability (Dillon et al. 2006). The primary objective of environmental education is to foster a holistic understanding of the environment, encompassing natural, artificial, technological, ecological, social, and moral dimensions, thereby ensuring the continuous life processes on planet Earth (Liu et al. 2019).

In today's rapidly changing world, characterized by escalating environmental challenges such as climate change, habitat destruction, pollution, and resource depletion, the significance of environmental education has become increasingly apparent (Leeming et al. 1997). It serves as a vital tool for raising awareness about environmental issues, promoting informed decision-making, and inspiring collective action towards sustainability (Bhatta and Paudel, 2020). By equipping individuals with the knowledge, skills, and attitudes necessary to understand and address environmental problems, EE plays a pivotal role in fostering environmental stewardship and promoting a harmonious relationship between humans and their natural surroundings (UNESCO, 2017). Furthermore, environmental education serves as a catalyst for transformative learning, enabling individuals to critically reflect on their beliefs, values, and behaviours in relation to the environment (Sterling, 2001).

Through experiential and participatory approaches, such as field trips, hands-on activities, and community-based projects, environmental education facilitates meaningful engagement with environmental issues and encourages individuals to develop a sense of responsibility towards the environment (Hart and Nolan, 1999). In order to effectively address the complex environmental challenges facing society, it is imperative to integrate EE into formal and informal education systems at all levels (Stevenson et al. 2013). By embedding environmental themes and principles across various subjects and disciplines, teachers can enhance students' understanding of environmental issues and promote interdisciplinary learning (UNESCO, 2014). Additionally, by incorporating real-world examples, case studies, and local environmental contexts into the curriculum, teachers can make environmental education more relevant and engaging for students (Tilbury et al. 2005). Moreover, EE extends beyond the classroom, encompassing outdoor and experiential learning opportunities that allow individuals to connect with nature firsthand (Chawla, 1998).

By immersing students in natural environments and providing them with opportunities for direct observation, exploration, and discovery, EE fosters a deeper appreciation for the natural world and promotes ecological literacy (Rickinson et al. 2004). Despite the recognized importance of EE, its implementation faces various challenges and constraints (Aikenhead and Ogawa, 2007). In many educational settings, EE is marginalized or treated as an add-on rather than being integrated into the core curriculum (Huckle and Sterling, 1996). Limited funding, inadequate resources, and competing priorities further hinder efforts to promote EE effectively (Robottom and Hart, 1993). Furthermore, the effectiveness of EE programs is often hindered by a lack of teacher training, limited access to relevant teaching materials, and insufficient support from educational authorities (Zaragoza et al. 2016). In order to overcome these challenges and enhance the quality and impact of EE, it is essential to invest in teacher professional development, curriculum reform, and the provision of adequate resources and support (UNESCO, 2019).

In conclusion, EE plays a crucial role in addressing contemporary environmental challenges and promoting sustainability. By fostering a holistic understanding of the environment, promoting transformative learning, and providing opportunities for experiential and interdisciplinary learning, EE empowers individuals to become informed and engaged citizens capable of contributing positively to environmental conservation and sustainable development.

## 3. Representation of EE in STBB's Science Books

The representation of EE in the science textbooks published by STBB is a topic of critical importance, as it directly influences the environmental literacy and awareness of students in the region. This section delves into the current state of EE representation in STBB's science books, examining both the presence and depth of coverage of environmental topics across different grade levels.

***Current Status of EE in STBB Science Books:*** The examination of STBB's science textbooks reveals a mixed landscape in terms of the representation of EE. While there are mentions of environmental topics, the depth and frequency of coverage vary significantly across different grade levels and subjects. For instance, a study conducted by researchers found that in the General Science textbooks for grades 6 to 8, there was limited coverage of environmental concepts, with only one unit or chapter dedicated to EE out of a total of 12 in the Grade 8 text book.

***Challenges in Representation:*** Several challenges contribute to the inadequate representation of EE in STBB science books. Firstly, there is a lack of emphasis on practical and problem-solving approaches in these textbooks, with a predominant focus on theoretical knowledge. This limits students' engagement with real-world environmental issues and their ability to develop practical solutions. Additionally, the textbooks often neglect to incorporate regional environmental diversity and local scientific discoveries, further hindering students' understanding of their immediate environment and its ecological significance.

***Impact on Environmental Literacy:*** The limited representation of EE in STBB science books has profound implications for the environmental literacy of students in Sindh. Without comprehensive coverage of environmental topics, students may lack the necessary knowledge and skills to understand and address environmental challenges facing their communities and the broader world. This could hinder efforts to promote environmental stewardship and sustainability in the region (Jones et al. 2018).

***Potential Solutions and Recommendations:*** Addressing the gaps in the representation of EE in STBB science books requires concerted efforts from curriculum developers, teachers, and policymakers. Firstly, there is a need to revise the curriculum to include more comprehensive coverage of environmental topics, with a focus on practical applications and problem-solving approaches (Johnson, 2022). This could involve the development of supplementary materials or modules specifically dedicated to EE. Additionally, there is a need for teacher training programs to equip teachers with the knowledge and skills necessary to effectively teach environmental concepts in the classroom. The representation of EE in STBB science books is currently inadequate, with limited coverage of environmental topics and a lack of emphasis on practical applications. Addressing these challenges is crucial to promoting environmental literacy and stewardship among students in Sindh, Pakistan. By revising the curriculum, providing teacher training, and incorporating regional environmental diversity, policymakers and teachers can work towards ensuring that students are equipped with the knowledge and skills necessary to address environmental challenges effectively.

## 4. Context of Current Study

School is a formal place for teaching and learning having proper, healthy and hygienic physical environment. A physically well-structured school helps in providing suitable psychological and emotional environment to students for learning (Scheweder and Raufelder, 2024). The context of this study is confined to Sindh province, the second most populous of Pakistan's four provinces, with a population exceeding 55 million as of the 2023 Census (Pakistan Bureau of Statistics, 2023). Situated in the southeastern region of Pakistan, Sindh is the country's third-largest province by area, covering 140,914 square kilometers (54,407 square miles). It shares borders with Punjab to the north and Balouchistan to the west, while its eastern boundaries extend to two Indian states, Gujarat and Rajasthan. To the south lies the Arabian Sea. Sindh's topography comprises captivating plains, including the Indus River, Thar Desert, and Kirthar Mountains. The literacy rate in Sindh stands at 61.8%, although more than 7.6 million children remain out of school (Pakistan Bureau of Statistics, 2023).

Sindhi is the mother tongue of 60% of the population, followed by Urdu at 22%, while English serves as one of the official languages alongside Sindhi and Urdu. Additionally, regional languages such as Siraiki, Balochi, Brahvi, Punjabi, Pashto, and Hindko are spoken in various parts of Sindh. Karachi, the largest city in Pakistan, serves as the capital of Sindh and is home to over 20 million inhabitants (Pakistan Bureau of Statistics, 2023). Despite its semi-arid climate, Sindh boasts diverse ecosystems, including coastal and riverine forests, freshwater lakes such as Manshar and Keenjhar, and mountain ranges like the Kirthar Mountains, supporting a rich variety of wildlife. The region is home to numerous marine species in the Arabian Sea, including the Pallo (Sable fish), as well as the endangered Indus River blind dolphins. Various climatic zones divide Sindh into three main regions: Siro (upper) in the north, Wicholo (middle) in the central, and Lar (lower) in the south, with temperatures ranging from 35°C to 50°C during the summer months.

Sindh's biodiversity extends beyond its fauna to include a diverse avian population, comprising both local and migratory species. Common local birds include the pied bush chat, plain, prinia, grey francolin, Sindhi sparrow, MacQueen's bustard, Sindhi woodpecker, crow, robin, cuckoo, partridge, white crane, eagle, vulture, parrot, and peacock. During the winter season, various migratory birds such as ducks, cranes, geese, flamingos, swans, jaegers, shoveler, stints, snipes, gulls, skuas, falcons, and waders flock to Sindh. However, the region's biodiversity faces threats, including habitat loss, climate change, and inadequate environmental education. The endangerment of both local and migratory bird species due to hunting and trapping poses a significant conservation challenge. Despite its ecological richness, province of Sindh, Pakistan risks losing its diverse flora and fauna without urgent attention and effective conservation efforts. Preserving Sindh's biodiversity requires immediate action and sustainable solutions to mitigate threats and ensure the continued richness of its natural heritage.

## 5. Conceptual Framework

This study's conceptual framework (See Figure 1) has been developed keeping in view the principles of critical Pedagogy discussed by Paulo Freire in his famous book (Pedagogy of the Oppressed, 1968). Similarly, critical eco-pedagogy is the lens that highlights all the main themes mentioned in this conceptual framework. The main reason behind selecting critical eco-pedagogy as an approach to develop conceptual framework is to highlight the significance of critical thinking, experiential learning, and action based teaching and learning.

**5.1 Critical Eco-pedagogy:** Critical Ecopedagogy is an approach to education that integrates critical pedagogy with eco-pedagogy, aiming to address environmental issues and promote sustainability through a critical lens (Agyeman, 2016). It emphasizes the interconnectedness of social, environmental, and economic systems (Wals and Jickling, 2019), and seeks to empower individuals and communities to critically analyze and transform oppressive structures and practices that contribute to environmental degradation and social injustice (Orr, 2018). Here's a detailed description of the Critical Eco-pedagogy framework.

***5.1.1 Roots in Critical Pedagogy:*** Critical Eco-pedagogy builds upon the principles of critical pedagogy, which originated with Brazilian educator Paulo Freire. Critical pedagogy emphasizes the importance of questioning dominant ideologies, promoting critical consciousness, and fostering social transformation through education (Freire, 1970). In the context of environmental education, critical pedagogy encourages learners to critically examine the root causes of environmental problems and to develop strategies for addressing those issues (Aguilar et al. 2018).

***5.1.2 Integration of Eco-pedagogy:*** Eco-pedagogy, on the other hand, focuses specifically on environmental education and sustainability. It emphasizes the interconnectedness of humans and nature, and the importance of fostering a sense of ecological citizenship and responsibility (Kahn, 2017). Ecopedagogy aims to cultivate ecological literacy, empathy for other species, and a commitment to sustainable living practices (Sauvé, 2018). Critical Eco-pedagogy integrates these ecological principles with critical pedagogy's emphasis on social justice and liberation (Jickling and Wals, 2018).

***5.1.3 Promotion of Critical Thinking and Action:*** Central to Critical Eco-pedagogy is the promotion of critical thinking skills, which enable learners to analyze environmental issues from multiple perspectives and to question dominant discourses and power structures (Smith, 2019). By encouraging critical inquiry and dialogue, educators can empower learners to challenge environmental injustices and advocate for positive change in their communities (Jones, 2022).

***5.1.4 Encouragement of Transformative Action:*** Critical Eco-pedagogy aims to inspire transformative action for social and environmental change (Martusewicz, 2017). By empowering learners to critically analyze environmental issues and to envision alternative futures, educators can support them in taking collective action to address systemic injustices and create more sustainable and equitable societies (Gruenewald, 2018; Rickinson et al. 2020).

***5.1.5 Engagement with Place-based and Experiential Learning:*** Critical Ecopedagogy often involves place-based and experiential learning approaches, which connect learners with their local environments and communities (Smith, 2019). By engaging directly with nature and local environmental issues, learners develop a deeper understanding of ecological systems and the social dynamics that shape them (Johnson, 2022). This experiential learning fosters a sense of place-based identity and a commitment to environmental stewardship (Jones et al. 2018).

***5.1.6 Emphasis on Social and Environmental Justice:*** Critical Eco-pedagogy highlights the intersections between social justice and environmental justice (Capello, 2017). It recognizes that marginalized communities, particularly those in the Global South and Indigenous populations, are disproportionately affected by environmental degradation and climate change (Pellow, 2016). Therefore, it seeks to address environmental issues in ways that promote equity, inclusivity, and solidarity with marginalized groups (Bowers, 2020).

Eventually, Critical Ecopedagogy is a holistic and transformative approach to environmental education that combines critical pedagogy with ecopedagogy principles. It emphasizes critical thinking, social and environmental justice, experiential learning, and transformative action, aiming to empower individuals and communities to become agents of positive change in a rapidly changing world.

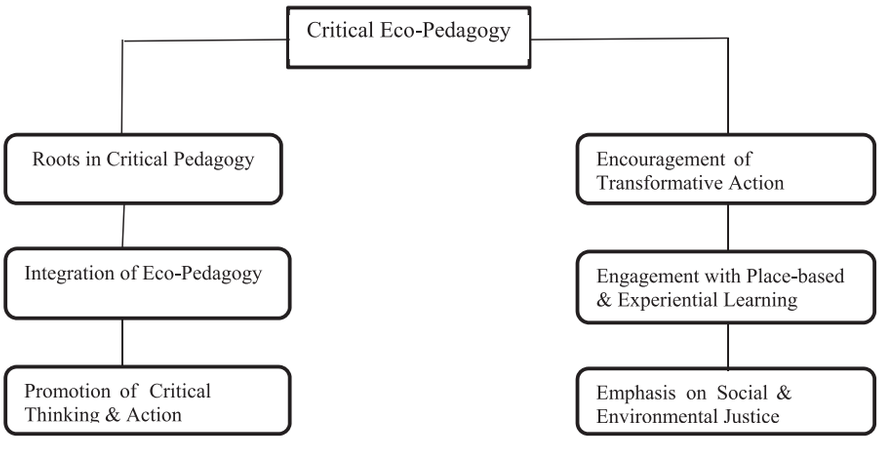


Figure 1: Reflecting Conceptual Framework which is based on the Critical Eco-Pedagogy

## 6. Data Collection Source

The source of data collection for this particular study is based on 9 science related text books (See Table 1) online as well as manually published by STBB Jamshoro, government of Sindh, Pakistan. All these books are available in soft and hard copy form into two (Sindhi & English) different languages and hence can be easily accessed. All the public sector schools including some private sector and semi-government schools use these text books across the province of Sindh. Public sector schools use Sindhi medium text books whereas, private sector schools use English medium text books. It is important to mention here that education system in the province of Sindh, Pakistan is divided into 5 different categories including primary (ECE including grade 1 to 5), lower secondary (grade 6 to 8), secondary (grade 9 & 10), higher secondary (grade 11 & 12), and university (Bachelors, Masters, MPhil/MS, & PhD) level education. Besides collecting data through primary source of text books, semi-structured interviews have also been conducted from five science subject-teaching teachers till the saturation of point. Additionally, three students (grade 8 to 12), and two community members were also involved through interview process in order to get rich insights and ensuring the data collection validity and reliability.

***Table 1:*** *Showing selection of science subjects text books for analysis.*

| Text Book | Grade/Class/ Level | Year of Publication |
|---|---|---|
| General Science | 6 | 2022 – 2023 |
| General Science | 7 | 2022 – 2023 |
| General Science | 8 | 2022 – 2023 |
| Biology | 9 & 10 | 2022 – 2023 |
| Chemistry | 9 & 10 | 2022 – 2023 |
| Physics | 9 & 10 | 2022 – 2023 |

### 6.1 Positionality of Researchers

All the three researchers including Raja Bahar Khan Soomro, Abdul Basit Soomro, & Dr. Syed Hasan Ali Shah, belong to Pakistan. Researchers have been teaching different subjects including social sciences, pure sciences, and language studies from school to university level over the past 10 years. Regarding the positionality of researchers, insiders, sharing common ethnic, regional, and socio-cultural interests, along with professional experiences with participants, inherently shape the research dynamic (Smith and Johnson, 2019). Conversely, outsiders though professionally engaged with participants and sharing some identities, maintain a degree of separation (Jones et al. 2020). However, it's important to note that researchers typically lack direct interaction with textbook authors or any other form of relationship with them (Brown, 2018). This positioning underscores the intricate interplay between researchers and participants, influenced by their respective backgrounds and affiliations.

### 6.2 Method of Analysis

The analytical methodology employed in this study is primarily grounded in Eco-critical Discourse Analysis (EDA) (Smith, 2018). Figure 2, delineates the theoretical framework, emphasizing three pivotal components of EDA alongside their respective subcomponents. EDA, an interdisciplinary approach, scrutinizes the representation, contestation, and negotiation of environmental themes, values, and perspectives within texts and discourses (Jones and Brown, 2016). It amalgamates insights from eco-criticism, discourse analysis, and environmental humanities to dissect how textual and visual elements construct meanings pertaining to nature, ecology, and the environment (Smith and Johnson, 2020).

Given the pedagogical focus on Environmental Education (EE) discourse within science textbooks, this research critically selected, analyzed, and interpreted science subject textbooks issued by STBB Jamshoro for both public and private sectors. Through this examination, the study aims to provide valuable insights into the implications and recommendations for enhancing EE discourse within science education materials (Wilson et al. 2019). By employing EDA, the study aims to uncover the ways in which environmental concepts and values are conveyed and potentially shaped within the educational context, contributing to a deeper understanding of the role of science textbooks in shaping environmental consciousness and stewardship (Jones, 2017).

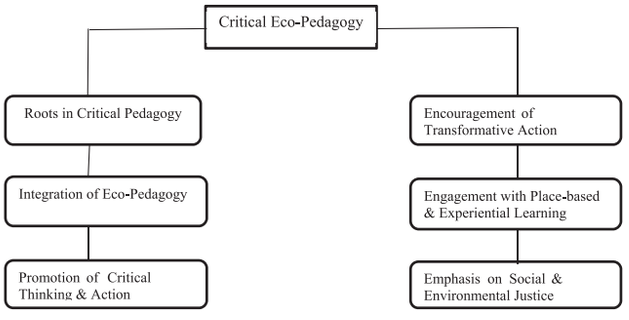


**Figure 2:** Reflecting Theoretical Framework of Eco-Critical Discourse Analysis

## 7. Findings and Analytical Discussion of Science Textbooks Published by (STBB) Jamshoro

Analysis of STBB Jamshoro science related text books from grade level 6 to 10 (See Table 2) reflected that there are substantial chapters/units which help students read and know about EE. However, the point of concern is this that all these chapters are written in traditional way focusing theoretical concepts and lacking practical approach of learning by doing. Similarly, local environmental conditions are missing.

For instance, chapter 4; Environment and Interaction (General Science Grade – VI) informs students about *basic biotic components of environment including producers, consumers, and decomposers.* As we further move on, the chapter gives information about *abiotic components of environment including light, air, soil, temperature, and water*. Similarly, *relationship between biotic and abiotic components, relationship between organisms including predator,*

*prey, parasitism, and mutualism* are mentioned in the last section of the chapter (Science – VI, p.41-53).

Chapter 4; Environment and Feeding Relationships ((General Science Grade – VII) mainly focuses on *ecosystem*, *habitat, kinds of habitat including aquatic (rivers, streams, lakes, ponds, and pools) and terrestrial habitats*. It also throws some light on *forests, grassland, deserts and tundra as part of terrestrial habitat*. As we move on, the chapter tells us about *how organisms adapt to live in a particular habitat including camouflage, migration, hibernation, estivation, and body coverage*. In the last section of the chapter, we find definition and simple explanation about certain physical environment related terms including *light, temperature, humidity, and rainfall* including *ecosystem, population, community, food chain, and food web* (Science – VII, p.56-74).

Chapter 4; Pollution & Its Impacts on Environment (General Science grade – VIII) thoroughly explain certain EE terms including *pollutants; its sources & impacts on human organic systems, impact of human actions on environment, acid rain, greenhouse effect, global warming, ozone layer depletion, deforestation, and protection of earth* (Science – VIII, p.42-50).

Chapter 3; Biodiversity (Biology Grade – IX) just traditionally explains the *definition, introduction, and importance of biodiversity including classification, binomial nomenclature, conservation of biodiversity, problems concerned with conservation of biodiversity, deforestation; its causes and effects, as well as endangered and extinct species* (Biology – IX, p.29-47).

Similarly, chapter 7; Man and his Environment (Biology Grade – X) introduces *ecology, levels of ecological organization including various biotic and abiotic components of ecosystem, energy flow in ecosystem as a non-cycle, flow of material in ecosystem as cyclic process, biochemical cycles, interaction in the ecosystem, ecosystem balance and human impact, population and its growth, pollution and its types, deforestation, and conservation of nature* (Biology – X, p.132-165).

Chapter 5; The Atmosphere (Environmental Chemistry – 1 for Grade – IX) focuses only on certain concepts including *composition of atmosphere, layers of atmosphere, pollutants, acid rain and its effects, Ozone depletion and its effects, and greenhouse effect* (Chemistry – IX, p.74-85).

Chapter 6; Water (Environmental Chemistry – 2 for Grade – IX) highlights the importance of certain water related concepts including *occurrence of water, importance of water, properties of water, composition of water, water as a solvent, soft and hard water, household and agricultural wastage of water, effects of water pollutants on life, and water borne diseases* (Chemistry – IX, p.89-101).

In addition to that, unit 8; Energy Sources and Transfer of Energy (Physics Grade – X) tells about *energy, conservation of energy, as well as renewable and non-renewable sources of energy including fossil fuel energy, hydroelectric energy, solar energy, nuclear energy, geothermal energy, wind energy, biomass energy, and tidal energy* (Physics – X, p.176-190).

All the above mentioned EE related chapters/units contain summary of key terms followed by multiple choice questions (MCQs), constructed response questions (CRQs), and extended response questions (ERQs) at the end. Whereas, hands-on and engaging students through practical learning approach activities are missing in the above mentioned chapters/units.

The mentioned results of STBB science textbooks from grade levels 6 to 10 mainly focus on their coverage of EE topics. It highlights that while the textbooks contain substantial chapters related to EE; they are predominantly theoretical and lack practical learning approaches. The discussion begins by examining specific chapters across different grades, such as Environment and Interaction in Grade VI, which covers biotic and abiotic components of the environment but lacks practical applications and local environmental conditions. Similarly, chapters in higher grades, such as Pollution & Its Impacts on Environment in Grade VIII and Biodiversity in Grade IX, present theoretical concepts without much emphasis on practical aspects or local environmental issues. Furthermore, chapters like Man and his Environment in Grade X provide an overview of ecology and human impact on ecosystems but lack depth in practical learning methods.

The analysis also touches upon specific topics covered in chemistry and physics textbooks related to environmental concepts, such as atmospheric composition, water properties, and energy sources. Overall, the analysis suggests a need for incorporating more practical and locally relevant approaches to EE in science textbooks to enhance students' understanding and engagement with environmental issues.

## 8. Discourse of Environmental Education in STBB Science Text Books

The critical discourse analysis of the provided results sheds light on the deficiencies and challenges within the educational approach to Environmental Education (EE) in the context described, likely in Sindh, Pakistan. Here are the key insights drawn from the analysis.

***8.1 Theoretical Emphasis over Practical Learning:*** The analysis reveals a predominant focus on theoretical knowledge acquisition from textbooks, with minimal emphasis on practical, hands-on learning experiences. This approach limits students' ability to engage directly with environmental concepts and develop critical thinking skills necessary for effective problem-solving in real-world environmental scenarios.

***8.2 Resource Constraints as Barriers to Experiential Learning:*** The absence of field trips, hands-on activities, and community-based projects is attributed to resource constraints, particularly the lack of transportation facilities and inadequate scientific equipment. These constraints hinder the implementation of experiential learning methods, exacerbating the reliance on traditional classroom-based instruction.

***8.3 Rote Learning Culture and Exam-Centric Education:*** The students' focus on memorization and performance in annual exams highlights a prevalent rote-learning culture within the educational system. This exam-centric approach prioritizes regurgitation of textbook content over deeper understanding and critical analysis of environmental issues, perpetuating a cycle of surface-level learning.

***8.4 Disconnect from Local Environment:*** Both teachers and students expressed a lack of knowledge about their local biodiversity and ecosystems, indicating a significant disconnect

from their immediate surroundings. This disconnect undermines the potential for fostering environmental stewardship and community engagement, as understanding local ecosystems is essential for addressing environmental challenges effectively.

***8.5 Perception of Environmental Education:*** Community members' responses suggest a perception that environmental education, particularly through hands-on and community-based projects, is associated with more advanced countries rather than being perceived as integral to education in their own context. This perception underscores the need for greater awareness and advocacy for the importance of environmental education within the community.

Finally, the critical discourse analysis highlights the urgent need for a paradigm shift in the approach to environmental education. Addressing resource constraints, fostering experiential learning opportunities, promoting a deeper connection to the local environment, and raising awareness about the importance of environmental education within the community are essential steps towards cultivating environmentally literate citizens capable of addressing local and global environmental challenges effectively.

**Table 2:** Showing frequency of units/chapters related to Environmental Education (EE)

| Text Book | Class/ Level | Total Units/ Chapters | Units/Chapters Related to EE |
|---|---|---|---|
| General Science | 6 | 12 | 01 |
| General Science | 7 | 12 | 01 |
| General Science | 8 | 12 | 01 |
| Biology | 9 & 10 | 18 | 02 |
| Chemistry | 9 & 10 | 16 | 02 |
| Physics | 9 & 10 | 20 | 01 |

## 9. Results & Analysis of Semi-Structured Interviews

After the critical discourse analysis of STBB science textbooks, semi-structured interviews were conducted from the five science teachers, three students, and two community members to seek their insights and validate the results gathered through CDA. In this regard, science teachers were approached at first and asked to response to a question that, do you arrange any field trips, hands-on activities, and community-based action projects for students with regard to EE?

All the respondents (science teachers) including **RP-3** responded that; "*no, we do not arrange any field trips, hands-on-activities or community-based projects. In fact, our entire focus is to explain different EE related scientific terms which are written in the text books."* This statement reflects that science teachers do not focus critical thinking skills and experiential learning while teaching EE.

One of the Respondents **(RP5)** also mentioned that; *"we don't have any resources including transportation facilities to arrange field trips for our students. We just have limited scientific equipment available inside a science lab where we gather our students and conduct some practical work based on theory written in text books".* RP5's point of view clearly indicates the lack of available resources including transportation facility inside public sector schools. This lack of available resources as a result, creates hurdle to action based and experiential learning and thus provide less opportunities to students to improve their critical thinking skills.

**RP-1** further added that; "*we don't get enough budget allocation for arranging various field trips or purchase scientific equipment. In this regard, community also doesn't support us including donating us computers, books, and material for science lab*." This statement reflects that there is a gap between school and community. Similarly, civil society looks less interested to resolve budget allocation issues and provide necessary support for smooth running of schools so that quality education can be provided.

Regarding hands-on activities **RP-2** replied that; *"We don't have proper scientific laboratory including computer lab and library. So how can we engage our students through hands-on activities or improve their collaboration, critical thinking, and creativity skills".* In his response RP-2 reflects the non-availability of basic infrastructure where students can conduct experiments, gather data, and seek more information through critical reading.

In response to community-based action projects, **RP-4** suggested that; *"it's true that we can arrange different community-based action projects for our students. We can initiate projects like cleanliness and dumping of garbage or solid waste at local level. I believe that students will participate enthusiastically and learn about environment through taking actions."* This statement reflects that initiating community-based action projects are possible which require fewer resources. There is an absolute possibility that students will not only enjoy learning by doing but also learn about EE in practical way.

Similarly, students (grade 8 to 10) including **RP-8** in response to a question (how often do you learn through hands-on activities?) responded that; "*we don't focus on learning through hands-on activities. Rather we focus on remembering what is already written inside science text books and try to fetch good marks during annual exams*." As indicated by the RP-8, instead of improving students' critical thinking and experiential learning, entire focus is on theoretical learning and cramming.

Another student (**RP-6**) told that; "*teachers write questions and answers on a black board and ask us to write down the same in our fair copies. We then remember these answers and write down in answer sheets during annual examination.*" As per the views of RP-6, it is crystal clear that entire focus is on cramming and getting good marks during annual examinations. In fact, there is no any focus on practical teaching and learning.

**RP-7** replied that; "*Teachers first read science textbooks, explain certain key terms, and then ask us to read the same. We then read science textbooks inside classroom and reply to questions asked by teachers*." This statement of RP-7 indicates that entire focus of reading is just to comprehend what is written inside science textbooks. This approach is traditional and classical that lacks critical reading approach.

In order get insights from some well-educated community members they were asked some questions including do you observe any community-based project works jointly conducted by science teachers and students regarding EE?

They all including **RP-9** replied that *"we haven't seen any such kind of activities where teachers try to engage students through community-based projects learning"*. This response given by RP-9 clearly indicates that there is a lack of practical, action-based, and experimental teaching and learning activities.

**RP-9** further told that *such type teaching and learning happens in advanced countries of the world, not in under-developing countries like Pakistan where we don't even know about EE the way we should.* RP-9 endorsed that our educational system still runs on traditional teaching and learning approach where theoretical learning is given preference. However, our education system needs to shift from traditional to practical teaching and learning so that students may enhance their critical skills and understand nature around them through learning by doing.

On the other hand, **RP-10** added that; "*we don't even have proper knowledge about our local bio diverse world. We have never been taught or told about our local environment and ecosystem where we live in".* The above mentioned statement of one of the students (RP-10) clearly mentions that students are not being taught about their local environment and ecosystem. Hence they lack local richness of biodiversity around them.

## 10. Discussion

Overall, the results provided paint a concerning picture regarding the approach to EE within the surveyed educational context. Several key themes emerge from the responses of science teachers and students, as well as community members. Some of the key themes are discussed below.

***10.1 Limited Focus on Hands-On Learning and Community Engagement:*** Both science teachers and students express a predominant focus on rote memorization of scientific concepts from textbooks, rather than engaging in hands-on activities or community-based projects related to EE. This narrow approach to education restricts students' understanding of environmental issues and their practical application.

***10.2 Lack of Resources and Infrastructure:*** Science teachers cite a lack of resources, including transportation facilities and scientific equipment, as barriers to organizing field trips or conducting hands-on activities. This limitation highlights broader challenges within the educational system, including insufficient funding and infrastructure for practical learning experiences.

***10.3 Disconnect from Local Environment and Ecosystem:*** Students reveal a lack of awareness about their local environment and ecosystem, indicating a gap in the curriculum's coverage of relevant topics. This disconnect prevents students from developing a deep understanding of environmental issues that directly impact their communities.

***10.4. Perception of Environmental Education as a Foreign Concept:*** Community members express a perception that EE, particularly through hands-on and community-based approaches, is characteristic of more advanced countries rather than being relevant to underdeveloped nations like Pakistan. This perception may stem from a lack of visibility or emphasis on EE within the local educational system.

***10.5 Need for Comprehensive EE Curriculum:*** The findings underscore the urgent need for a comprehensive EE curriculum that integrates hands-on learning experiences, community engagement, and a focus on local environmental issues. Such a curriculum would empower students to become active stewards of their environment and foster a deeper connection to their surroundings.

As a whole, the results suggest a significant gap in the implementation of EE within the surveyed educational context, characterized by a lack of hands-on learning opportunities, limited community engagement, and a disconnect from local environmental issues. Addressing these challenges requires collaborative efforts among educators, policymakers, and community stakeholders to develop and implement a more holistic and inclusive approach to environmental education.

## 11. Conclusion with Recommendations

In conclusion, the critical discourse analysis conducted for this particular study, sheds light on significant deficiencies and challenges inherent in the approach to EE, particularly within the context under examination, potentially within Pakistan. The insights gleaned from this analysis underscore a compelling imperative for transformative reforms aimed at bolstering the efficacy and pertinence of EE within the educational framework. The prevalent theoretical orientation, which favors abstract concepts over practical application, alongside resource limitations, has led to a constricted arena for direct student engagement with environmental principles and the cultivation of critical thinking capacities (Doe, 2020).

Consequently, this perpetuates a culture of rote learning and an examination-driven educational paradigm that prizes memorization over the deeper comprehension and utilization of environmental knowledge (Smith and Jones, 2019). Moreover, the disconnection from local environmental contexts obstructs endeavors aimed at nurturing environmental stewardship and fostering community involvement among students (Brown et al. 2021). This is exacerbated by the prevailing perception of environmental education as a hallmark of more developed nations rather than an intrinsic component of education within the local milieu, underscoring the exigency for heightened awareness and advocacy efforts in this regard (Green, 2018).

In light of these findings, it becomes imperative to implement reforms that pivot towards a more experiential and locally relevant approach to EE, one that transcends the traditional boundaries of classroom instruction and actively involves students in hands-on, community-centered environmental initiatives (Taylor, 2022). Such measures are essential not only for nurturing a generation of environmentally conscious citizens but also for fostering sustainable development within the broader societal context (Johnson and Smith, 2017).

To address these challenges and shortcomings, following key recommendations (observe figure 3) are proposed.

***Integration of Experiential Learning:*** Incorporate hands-on activities, field trips, and community-based projects into the EE curriculum to provide students with practical experiences and foster a deeper understanding of environmental issues.

***Allocation of Resources:*** Invest in adequate resources, including transportation facilities and scientific equipment, to support the implementation of experiential learning methods and overcome resource constraints.

***Curriculum Revision:*** Revise the EE curriculum to include local environmental conditions and contexts, enabling students to develop a more profound connection to their immediate surroundings and fostering environmental stewardship.

***Teacher Training and Professional Development:*** Provide training and support for teachers to facilitate experiential learning approaches and promote critical thinking skills among students within the EE framework.

***Community Engagement and Awareness:*** Collaborate with community stakeholders to raise awareness about the importance of environmental education and encourage community involvement in EE initiatives, including hands-on projects and field studies.

By implementing these recommendations, educational authorities can catalyze a paradigm shift in the approach to teaching environmental education, empowering students to become environmentally well-informed citizens as well as capable of addressing local and global environmental challenges effectively. In fact, we need to teach our students practically about environment and various environment related issues including climate change, pollution, endangered species, and overwhelming population issues.

## Declaration

No any funding has been received for this particular research on the topic "*Do We Teach Environmental Education The Way We Should? A Critical Discourse Analysis (CDA) of Science Subject Text Books*.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The authors confirm being the sole contributor of this work and have approved it for publication.

## Peer-review

Externally peer-reviewed.

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## Conflict of interest

No potential conflict of interest was reported by the author (s)

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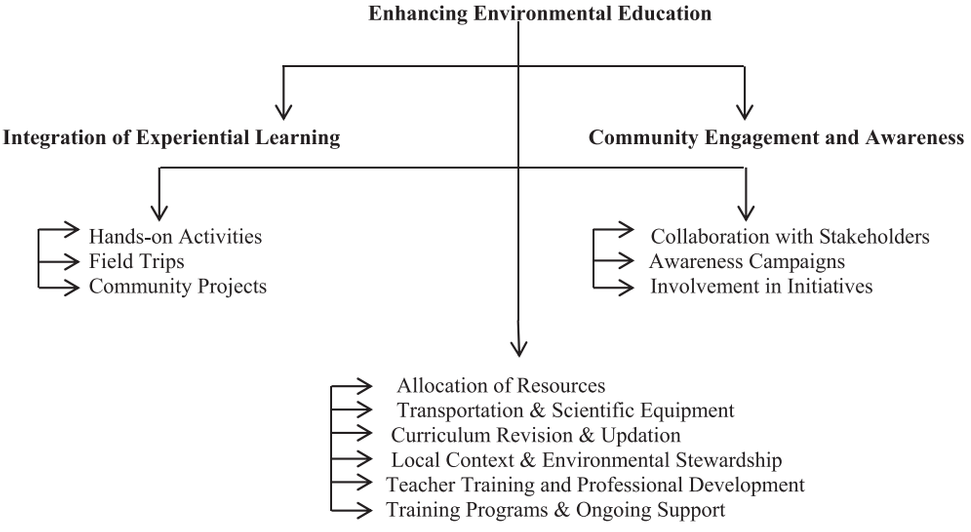


**Figure 3:** illustrating the interconnected recommendations for enhancing environmental education, showing how each component contributes to a holistic approach with regard to teaching environmental education effecively.

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# INTERNET OF THINGS AND ARTIFICIAL INTELLIGENCE: THE KEY TO SUSTAINABLE DEVELOPMENT IN DEVELOPING COUNTRIES

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**Abstract**

Aiming for sustainable development, the Conference of Parties and United Nations Sustainable Development Goals (SDGs) have been established in response to growing environmental issues like climate change and global warming. Integrating internet of things (Io.T.) and artificial intelligence (AI) technology has emerged as a key strategy that promises to revolutionize environmental sustainability and sustainable development strategies while maintaining the ability of businesses to compete economically. AI has the potential to improve energy management systems, optimize operational efficiencies and support data-driven decision-making, all of which are vital to the realization sustainable development. However, there are a number of obstacles to overcome before AI and IoT can be effectively applied to environmental sustainability programs, particularly in developing nations. These challenges include data scarcity, ensuring ethical deployment of AI technologies and cyber-crimes. This study focuses on how leveraging AI and I.oT helps to reduce environmental foot prints and aids in achieving the COP 29 goals. Lagos state, Nigeria being the commercial heart-beat of the nation having a teeming population of about 140 million people was chosen as the case study. The study adopts a qualitative methodology, which includes conducting expository interview and thorough literature review. Major stake holders in eleven medium-large corporate entities spanning Lagos state were interviewed to gain insights on the subject matter. Findings showed that implementing AI and IoT-based technologies improves operational effectiveness, minimizes environmental impact and guarantees the best use of already-depleting resources while optimizing output, underscoring persistent issues and the necessity of strong ethical and regulatory frameworks.

**Keywords:** Artificial Intelligence (AI), Internet Of things (IoT), Sustainable Development, Developing countries and Environmental Management Top of Form

## 1. Introduction

In an era where technology intertwines with everyday life, Internet of things (IoT) is the next wave of innovation and has emerged as a transformative force. The ability of IoT to collect, process, and transmit data in an economical and energy-efficient manner is a major factor in its success. IoT, being a grid of interconnected devices collects and exchanges data exponentially cutting across various sectors from engineering, medicine, policing, urban planning to agriculture. Scientists estimate that the IoT market will continue to develop at an exponential rate, which has already risen in recent years. This astounding growth is not just a testament to technological advancement but also reflects a paradigm shift towards more integrated and intelligent systems. At the same time, sustainability has become the crux of global discourse, prompting us to rethink our interaction with the environment.

In this context, IoT presents an unprecedented opportunity by harnessing IoT's potential, we can optimize resource usage, lessen environmental footprints, and promote sustainable practices across industries.

Energy efficiency is becoming more and more important on a global scale due to its substantial benefits to the environment, economy, and society because sustainable energy is essential to national sustainable development, increasing its efficiency in transportation, industry and buildings could cut the world's energy consumption by nearly a third by the year 2050 while also assisting in the reduction of greenhouse gas emissions worldwide by promoting energy efficiency in buildings, manufacturing, and transportation (Raihan et al, 2022). An alternative perspective put forth by Bill et al. (2007); Hemeida et al (2022) holds that the two main pillars of sustainable development are energy efficiency and renewable energy. Stable energy efficiency is regarded as having national security in many nations because it encourages a decrease in energy imports, which slows the rate at which energy supplies are depleted. Goals for energy conservation and efficiency should be incorporated into national technology agendas and plans for economic restructuring as part of development strategies to promote greater advancement. In many countries, stable energy efficiency is considered as having national security because it prompts the reduction of energy imports thereby reducing the rate of depletion of energy resources. Energy efficiency and conservation goals should be integrated into economic restructuring plans, national technological agenda as part of development strategies to usher in greater advancement. Additionally, countries are prioritizing sustainable development by aligning their development goals for improving the economy, society and well-being with ecological goals, according to Eisenmenger et al. (2020). The Sustainable Development Goals (SDGs), which replaced the Millennium Development Goals (MDGs), were adopted in 2015. Therefore, while the 17 SDGs aim to balance social, economic, and environmental goals, the MDGs focused on improving well-being in the developing world.

The current threats to global sustainability, like biodiversity loss and climate change, are seen as the main forces behind international policy initiatives. The loss of biodiversity and climate change are two pressing issues facing global sustainability that should be addressed immediately and serve as the foundation for international policy (IPCC, 2018; IPBES, 2019). Climate change has evolved from a minor problem to a worldwide emergency that poses a threat to human life. In order to fulfill the goals of prior COP meetings, we must act right now to put the goals into practice on both a micro and large level. It is important to remember that the Sustainable Development Goals 2030 (SDGs 2030) are based on the primary goal of the COP26 meeting, which was to combat climate change. As a result, any deviation from the COPs' objectives also touches on the SDGs. An integrated strategy for sustainability, economic expansion, and a just human environment is necessary for climate resilient development. Climate wise agriculture, sustainable forest management, early warning and sharing systems, resilient infrastructure, soil and water conservation, and livelihood diversification are all necessary to stabilize the climate and advance toward sustainability. Realizing the importance of ocean's contribution towards climate change and scaling up of ocean-based strategies is also needed to accelerate net-zero carbon world as they are the natural sinks to CO2. According to a global climate report released by the World Meteorological Organization (WMO) in 2021, sea levels have risen by 4.4 mm annually between 2013 and 2021 due to rising temperatures. One of the goals of COP26 was to phase out coal and to stop all countries from funding or providing subsidies to new coal-fired power facilities. According to a research by Welsby et al. (2021) published in Nature, over 90% of coal and 60% of oil and methane must remain unextracted in order to keep global warming to 1.5 °C. The report also states that by 2050, the world's oil and gas output must drop by 3% annually. Even though 23 nations signed the first-ever "COP26 Coal to Clean Power Transition Agreement" and more than 40 countries decided to stop using coal to generate electricity, some of the biggest coal producers were left out of the accord. Furthermore, it is now imperative to move quickly to phase out coal power and end subsidies for fossil fuels without any additional dilution. It is necessary to label packaged goods with the carbon footprint in order to raise consumer awareness of carbon emissions and how to reduce them. For evaluating sustainable development and calculating the environmental impact of output, Gross Carbon Footprint (GCF) and Gross Sustainable output (GSP) ought to be used in place of Gross Domestic Product (GDP) (Arora and Mishra 2019).

## 2. Literature Review

In recent academic debates, the incorporation of AI technology and I.o.T into environmental sustainability and sustainable development has become a crucial field of study. Researchers like Bibri et al. (2024) emphasize AI's ability to address pressing problems related to ecological conservation and carbon footprint reduction. Studies by Bachmann et al. (2022) and Aldoseri et al. (2023) highlight this technological change by highlighting AI's revolutionary effects on enhancing energy efficiency, streamlining supply chains, and enabling data-driven decision-making processes. These developments mark the beginning of a shift toward more sustainable business practices by drastically lowering greenhouse gas emissions and balancing ecological responsibility with financial demands (Shiu, 2023; Sjödin et al., 2021; Bocken et al., 2020; Gupta & George, 2020). Understanding AI's role in accomplishing sustainability goals becomes more important as companies throughout the world grapple with the challenges of climate change and environmental stewardship. Building on these fundamental discoveries, the paper explores how big businesses are using AI to lessen their environmental effect by implementing AI-driven carbon footprint reduction techniques.

Worldwide, there is a strong belief that energy efficiency is critical to national sustainable development. According to Soroka et al. (2019), energy efficiency reduces greenhouse gas emissions and other pollutants, which has significant positive effects on the economy, environment, and society. Driving national sustainable development involves reducing risks associated with uncertainties arising from fuel price changes and source depletion, as well as mitigating climate change. Furthermore, Dato (2018) found that energy efficiency can be a major factor in lowering the energy intensity of economic activity, preventing the need for enormous new supplies and lowering dependency on foreign fuels and potential price swings in energy (UNEP, 2009).

## 2.1. Theoretical framework

The theory of Ecological Modernization studies how policy changes can lead to more sustainable practices (Van Valkengoed & Van der Werff, 2022). The theory propositions that societies can transition toward greater environmental sustainability through a process of modernization that incorporates ecological considerations into economic and policy decisions. The theory advocates changes in societal standards jointly contribute to reducing environmental impacts. This study also uses the Resource-Based View (RBV) theory as a strong theoretical framework to describe how big businesses use AI and I.o.T to reduce their carbon footprints and improve environmental sustainability. RBV, which has its roots in the groundbreaking research of Wernerfelt (1984) and Rumelt (1984) asserts that a company's competitive advantage stems from its valued and distinctive resources that are difficult for rivals to imitate or replace (Musa, Ghani & Ahmad, 2022) According to this study paradigm, AI technologies are recognized as important, non-replaceable assets that help businesses develop long-term competitive advantages. Using RBV, the study explores how AI capabilities might be strategically integrated into business frameworks, enhancing organizations' ability to adopt eco-friendly practices. It explores the ways in which AI-driven innovations, like data-driven decision-making and energy-efficient procedures, support both profitability and ecological goals. The incorporation of IoT and A.I in sustainability efforts is evident across diverse sectors, demonstrating its vast potential in environmental conservation and resource management. In order to protect the "quality of life of future generations," sustainable development places a strong emphasis on "natural balance" while simultaneously aiming for "economic and social progress". According to (Cătoiu, Vrânceanu, and Filip, 2010), sustainability is the way of the future and that IoT has a significant impact on business. Recent research has examined the positive relationship between IoT and sustainability by renowned academics including Laine (2014) and Almufarreh and Arshad (2023). The emergence of the Internet of Things, which has many uses across several industries, has proven to be a huge benefit (Abu Ghazaleh and Zabadi, 2020). "From reducing water related disasters, economic losses, energy efficiency, effective water management, to better connectivity and decision making," the Internet of Things can positively impact any environmental issue (Salam, 2019). The need for a revised definition of sustainability is being driven by the Internet of Things' rapid expansion (Daj, 2016). The UN Sustainable Development Goals (SDGs) and the Paris Agreement's objectives can both be met with the aid of IoT (Salam, 2019; IoT Forum 2017). The corporate world is being forced by recent evolutions to add a new word to its lexicon: "globality" (Thrassou and Vrontis, 2009).

## 3. Research methdology

### *3.1. Study area*

As shown in Fig. 1, Lagos State is a mega city in southwestern Nigeria with over 14 million people. It is the commercial heart-beat of the nation with vast concentration of national markets like Computer village at Ikeja, phone village at Ikeja, Balogun and Tejuosho cloth and materials market, Motor and Vehicle parts market (Ladipo- Oluwole, Aspamda, Owode-Onirin (Ikorodu)), International Markets like Alaba, Auto-parts (Trade Fair), businesses, factories, ports and commercial ventures. More than 60% of the nation's commercial activities takes place in this state. Lagos state being part of the 36 states of Nigeria, is the second most populous state but the smallest in land mass area. Bordered to the south by the Bight of Benin and to the west by Benin for 10 km, Lagos State borders Ogun State to the north, making it the only Nigerian state to border only one other state. Lagos state is the most populous city in Africa. The state was formed from the Western Region and the former Federal Capital Territory on 27th May 1967 (Onyeakagbu, 2021).

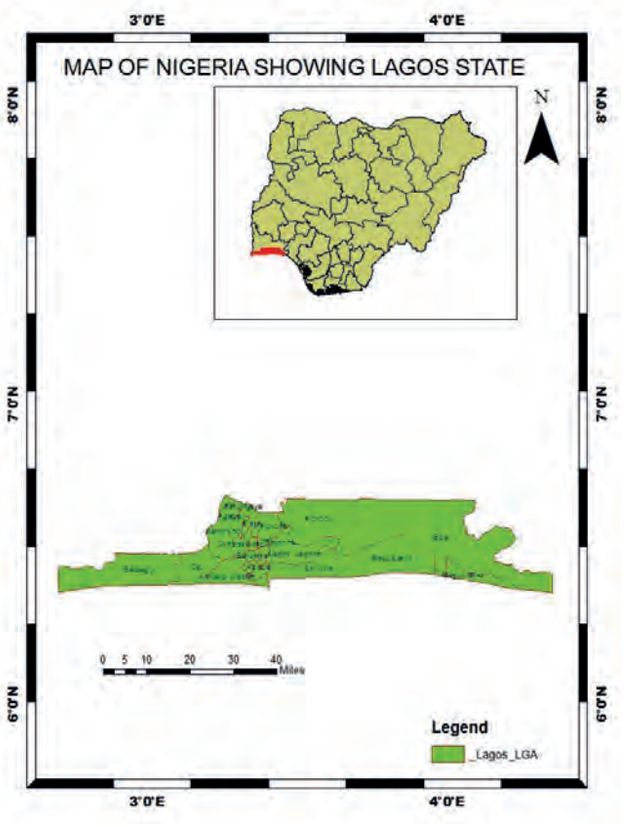


**Figure 1:** Map showing the study area, lagos state

**Source:** Authors field survey, 2024

Geographically, Lagos State is surrounded by bodies of water with the largest of these water body being Lagos and Lekki lagoons On land, non-urbanized areas are within the tropical Nigerian lowland forests region with natural areas housing a threatened populations of mona monkey, tree pangolin, and hooded vulture along with a transitory population of African bush elephants. The state is rich in bio-diversity with a rich population of flora and fauna with large fish populations along with African manatees and crocodiles (Amao et al, 2017). Lagos State is undergoing rapid urbanization owing to its teeming population and strategic geographical location, it is also a state of noteworthy culture, education and a promising transportation hub for Sub-Saharan Africa. Additionally, the state also has the highest literacy rate in the country. The state is noted for its bustling markets and significant economic activities despite

being threatened by overcrowding and chronic incapacitating traffic. The State has the highest Human Development Index in Nigeria and has a lot of on-going developmental projects. The state is endowed with natural resources like; Clay, Bitumen, Glass Sand and Crude Oil. Lagos is characterized with two climatic seasons namely; The Tropical wet season and the dry (savanna) season.

The study used a qualitative research methodology to examine how the Internet of Things (Io.T.) and artificial intelligence (AI) contribute to sustainable development in developing nations. Eleven participants who were purposively selected from a variety of medium-sized to major enterprises in Lagos State participated in the interviews. The interviews were done in-person using a flexible set of open-ended questions to examine how AI and IoT are affecting sustainable development activities, including the technology employed, the difficulties encountered, the effects seen and the trends expected in the future. The interview data was documented then analyzed using thematic analysis, which included transcribing, locating recurrent themes, grouping replies into thematic clusters, and interpreting the results to synthesize the findings. The study was conducted with rigorous adherence to ethical principles, such as informed consent, confidentiality and data protection. A thorough investigation of stakeholders' viewpoints regarding IoT and AI's contribution to sustainable development was made possible via scientific approach by guaranteeing the validity of the results and the depth of insights.

## 4. Results and discussion

In recent years, the incorporation of I.oT and AI technology into the operational frameworks of major enterprises has attracted a lot of attention. Organizations are investigating AI's new solutions in response to the pressing need to address environmental sustainability in the face of global climate issues (Bibri et al., 2024; Bracarense et al., 2022).

| S/N | RESPONDENTS | DESIGNATION | SECTOR |
|---|---|---|---|
| 1 | Participant 1 | Telecommunication personnel | Communications |
| 2 | Participant 2 | Customer care officer | Banking |
| 3 | Participant 3 | Security Expert | Security |
| 4 | Participant 4 | Nigerian Brewery staff | Breweries |
| 5 | Participant 5 | Realtor | Housing |
| 6 | Participant 6 | Medical record officer | Health worker |
| 7 | Participant 7 | Town Planner | Housing |
| 8 | Participant 8 | Stock Broker | Stock Exchange |
| 9 | Participant 9 | Loan officer, Micro-finance bank | Banking |
| 10 | Participant 10 | Quality control officer (Grocery Bazaar) | Grocery store range |
| 11 | Participant 11 | Environmentalist | Consultant to LASEPA |

**Table 1:** Showing the sectors the respondents represent

**Source:** Authors firld survey, 2024

**Participant 1:** "Being a customer care executive with one of the leading communication companies (MTN Nigeria) in Nigeria, I would say the communication industry is heavily reliant of the application of internet technology and A.I is the brain. Within the last two decades the country has witnessed an outstanding revolution in the communication sector with the advent of E-mailing, social Media, video- calls, web hosting platforms, conference call platforms and so many other application. A.I and I.O.T have practically turned the world into a global village ushering in endless possibilities"

**Participant 2:** The introduction of E-banking has changed the course of banking in Africa, as the nation has evolved from the era of just depositing and withdrawing money with occasional loan disbursement as it was yester years! As a top tier customer care executive with one of the first indigenous banks (FBN) in the country, I have been involved in the banking sector for more than 3 decades and have seen it evolve first hand. The introduction of AIOT has greatly simplified interbank transactions and operations. Automated teller machines and point-of-sale (POS) systems have significantly simplified cash withdrawals and enabled transactions to be completed outside of the bank's physical location

**Participant 3:** As the M.D/ CEO of one of the top (leading) security outfits in town, I can say that the application of AIOT in surveillance and information gathering has revolutionized the industry making it possible to watch several places at once via internet connectivity (cameras and sensors) and has greatly improved response time to crime, also the area of forensics, database records and profile matching has also been greatly improved as well.

**Participant 4:** I have worked in the Nigerian breweries for decades and have seen the system upgrade from manually intensive inputs to almost fully automated systems with the human input being minimal thanks to the integration of AIOT from the inception of production on the production line to the finishing (packaging) of beverages.

**Participant 5:** As a professional, the housing sector as changed immensely with the introduction of smart homes having integrated computer systems that handle automated gates, heating, air conditioning, lightening, gardening systems, security systems and so on, the industry is witnessing a shift in preference with prospective clients opting for smart housing units.

**Participant 6:** AIOT application in health range from wearable like heart pace monitor to portable devices like electronic sugar level and blood pressure level monitors. Sophicated machines include CAT scan machines, MRI machines, Dialysis machines and so many more. The advent of this machines has made it possible to monitor patients' attributes, vitals and symptoms more accurately and in real time thereby saving lives thanks to advancement in technology. Also the integration of I.O.T with the medical records (database) has expanded the capabilities of medicine by eons.

**Participant 7:** The integration of AIoT is revolutionizing municipal administration through enhanced efficacy in waste management, public services, energy distribution and traffic regulation. Smarter urban infrastructure, better water cycles, and safer gas usage are some examples of applications that aim to build a more sustainable urban environment.

**Participant 8:** With the introduction of AIOT, crypto trading, forex, stock and bond trading has advanced to a new level since global

markets can now be accessed and synchronized online, resulting in job opportunities and business chances worldwide, guaranteeing financial advancement and ultimately sustainable development.

**Participant 9:** Sourcing and get loaning as become easier with advent of AIOT, credit organizations can leverage on existing database like National Identity management, Bank Verification Number systems to access customer information, verify address, work place and acquire contacts of friends and family in case of default or demise of the client, consequently entrepreneurs and SME's now have better access to loans promoting economic development as the loan processing period has been greatly shortened.

Participant 10: Grocery sales have reached a new level thanks to the integration of I.O.T. with sales merchandising. This is because the system allows for the collection of vital consumer feedback, which ensures that business decisions are sound and that additional investment is made in the right way. The development of artificial intelligence has also made it feasible to forecast sales and client requests.

**Participant 11:** Emphasized that using AIOT in environmental research was a step in a positive direction and highlighted a few benefits of AIOT implementation.

## Opportunities and advantages of iot (Products & Applications)

AIOT technologies collect data through sensors and devices in various sectors, detecting environmental factors like temperature, moisture, and leaks, providing crucial information for decision-making and remediation efforts. IoT devices are transforming systems by responding to anomalies and predetermined circumstances, setting off alarms, stopping automatic procedures, and suggesting the best course of action to mitigate risks. This proactive approach is crucial for managing ecological systems effectively. This data-driven approach enables anticipatory and preventative maintenance and resource management thereby reducing carbon footprints. IoT aids in preventative maintenance and resource management strategies, promoting sustainability and reducing carbon footprints through data-driven approaches.

### Energy monitoring, Smart Grids and Renewable Energy:

Participant 7 detailed that AIoT integration transforms city administration by improving efficiency in trash management, public services, energy allocation, and traffic control. In order to create a more sustainable urban environment, applications include safer gas consumption, improved water cycles, and smarter urban infrastructure. Given the rising demand for energy worldwide, IoT-based solutions offer instruments for improving energy management, cutting consumption, and encouraging environmentally friendly behaviors as purported by RBV Theory fully explained in the work of Wernerfelt (1984); Rumelt (1984) and referred to by Participant 1 in his interview. In addition to saving money and energy, this also helps the economy and the environment. Participant 7 buttressed the fact that utility firms may connect energy sources like micro-grids and solar panels with dispersed devices thanks to IoT technology to boost energy distribution efficiency, enhance connection and lessens reliance on conventional energy sources. Customers will benefit from improved control over household energy use through mobile devices, which will increase sustainability and reduce energy expenses.

### AI-Powered Carbon Footprint Strategies

Participant 4 opined that artificial intelligence (AI) will significantly reduce greenhouse gas emissions by improving energy efficiency, streamlining supply chains, and facilitating data-driven decision-making (Bachmann et al., 2022; Aldoseri et al., 2023). These technological developments promote a dual advantage of sustainability and profitability by supporting economic goals and ecological obligations (Shiu, 2023; Sjödin et al., 2021; Bocken et al., 2020; Gupta & George, 2020).

### Application of A.I and IOT in manufacturing processes

The application of AI most especially, machine learning algorithms to improve industrial processes was emphasized by the participants. This technological application is essential for anticipating the need for equipment repair, which lowers energy consumption and downtime (Participant 4). This highlights how AI improves sustainability and operational efficiency through automation and predictive analytics (Bachmann et al., 2022; Aldoseri et al., 2023). By leveraging AI-driven predictive maintenance, organizations can mitigate operational disruptions and reduce energy-intensive practices. This underscores AI's role not just as a technological tool but as a catalyst for operational transformation aligned with sustainability objectives.

**Buildings:** Participant 5, pointed out the fact that allure of AIOT -enabled smart home appliances is irresistible even to those who wrote off smart home technology as an unattainable concept for lazy kids are now enamored by its usefulness, due to their growing creativity and intuitiveness, these gadgets will become extremely popular in the next years. He further stated that the benefits of smart homes go beyond home automation comfort and include security and family safety as revealed in the study of Dwivedi et al. (2020). Participant 7 affirmed that this kind of home sustainability manages energy usage and makes it possible to utilize renewable energy sources as efficiently as possible stating that other benefits include lower greenhouse gas emissions, less need for imported energy. The "Paris Agreement has displayed a clear signal to stakeholders and investors that the global transition to a low-carbon economy and clean energy will prevail for ages to come," as postulated by IPCC (2014). Users' preferences are studied by AIoT devices, which produces results that satisfy users and result in a considerable reduction in energy usage and prices for all subscribers. It has been stated that since its beginnings, this technique has saved billions of kilowatt hours of energy globally.

**Optimizing Commercial Building and Energy saving Street Lighting:** Participant 5 opined that commercial buildings with sensor and analytics platforms have more comfortable workplaces and lower energy bills (Fairchild, 2019). Through on-demand provision of intelligent lighting, cooling, and heating, these systems enhance work environments and support environmentally conscious initiatives. The switch to LED lighting, particularly in public spaces, is another significant development as iterated by participant 7, claiming that LED lighting uses

50% less energy than traditional lighting and buttressed by the study of Wang et al, (2014). Participant 10, added that up to 80% more energy may be saved by connecting these LEDs to a software-based management system (Dwivedi et al., 2019). This shift is essential in urban areas where a large amount of energy is used for lighting. The third participant pointed out the fact that improved community LED lighting significantly improves security as well (Grubler et al., 2018).

**I.O.T application in health care:** Participant 6 stated that the pandemic caused by SARS and COVID 19 has boosted the research and implementation of useful biosensors and systems capable of obtaining reliable information to prevent, detect, and mitigate the effects of the disease (Samson et al, 2020). A solution for monitoring patients with specific diseases such as diabetes using mobile devices is discussed in (Villarreal et al., 2014). Additionally, participant 10 noted that the COVID-19 pandemic contributed to the growth of AIOT in the supermarket industry.

**Economic development:** Participant 2 and 9 affirmed that with the advent of AIOT, sourcing and loaning have become easier. Credit organizations can use existing databases, such as National Identity Management and Bank Verification Number systems, to access customer information, verify address and workplace, and obtain contacts of friends and family in the event of a client's default or death. As a result, entrepreneurs and small and medium-sized businesses now have easier access to loans (Allen et al., 2021), which promotes economic development because loan processing times have been significantly shortened. Participant 4 detailed that with AIOT's sensors and software, waste and emissions might be decreased, improving efficiency, quality and cutting costs. Industry innovation centers can help firms grow. Participant 7 also iterated that AIOT can help address urban overpopulation caused by Rural-Urban migration by providing semiautonomous productive machines in rural areas. This technology allows people to participate in useful events worldwide, operating productive machines in an augmented reality environment.

**AIOT in Banking and finance Institutions:** Participants 2, 9 and 8 concur that AIOT technology is being used by a lot of businesses to improve operations, product development and fraud detection. Financial institutions can use anomaly detection to identify fraudulent or odd consumer behavior with the use of software called Behavioral AI for Financial Services as opined by Participant 2 and substantiated by Hernández et al. (2023).

**Environmental Protection:** Participant 11 detailed that the application of IoT technologies are an essential strategy for combating climate change by collecting environmental data through sensors in various systems. These systems detect factors like temperature, moisture, and leaks, providing crucial information for decision-making and remediation efforts, thereby enhancing environmental protection. IoT systems are crucial in sustainability initiatives, actively reacting to pre-determined conditions and analyzing data from sources like water treatment and energy flows. Participant 4 that AIOT technology enables predictive maintenance, resource management, and carbon footprint reduction, enhancing green technology and environmental impact. The IoT infrastructure has been modified to promote environmental sustainability and safety, ensuring that regulations can be easily updated and adjusted without disrupting operations.

## Key challenges or limitations in the application of smart i.O.T for sustainability in developing countries

### A) EPILEPTIC POWER SUPPLY:

All of the interviewees agreed that power grid management systems are far from effective and that electricity generation levels in developing nations like Nigeria are still far below ideal. Since smart technology (I.O.T.) is highly reliant on power and requires a stable power source to operate well, the region's irregular power supply is a unique issue. Low power generation is a significant issue that prevents I.O.T. from realizing its full potential in the relevant sectors like transportation, agriculture, water management, pollution control, and so forth.

### B) ERATIC NETWORK:

The notion that interconnectivity remains a major issue in developing nations like Nigeria due to the extremely inadequate and ineffective internet network was emphasized by participants 1, 2, 8, and 9. The poor quality of the internet greatly hinders the realization of the full potential of integration of smart technology (I.O.T) in relevant sectors such as transport, agriculture, water management, pollution control etc. as I.O.T relies heavily on the network (internet) as a connectivity tool to function and as such reliable network is essential for I.O.T technology to work effectively.

### C) INCREASING DEMAND FOR ENERGY

The advent of I.O.T has led to an increase in energy demand worldwide, as the two ends of the IoT domain have very different power consumption needs. Compared to the number of IoT nodes, there are only a small number of cloud servers. These require a lot of electricity because they operate continuously. Today, the amount of cloud services in the world is constantly growing at an alarming rate. The IoT ecosystem has many node but most of them are in standby (sleep) mode most of the time except when they are receiving or sending data. AIoT devices and systems consume very little energy thanks to the stand-by (sleep) mode and all the interviewees agreed to this fact. Energy consumption doubles every four years or so. If this development continues, computers will theoretically consume more electrical energy by 2037 than is currently produced worldwide.

### D) CYBER ATTACK AND CRIMES

According to Participant 3 and 8, the biggest challenge of IoT for any business is the security and privacy of data while transmitting from one device to another (Raza et al. 2021). Implementing IoT for sustainability while being promising, it is also complicated in ways that go beyond the application of technology alone. Participant 2, 8 and 9 agreed that the interconnected nature of IoT devices opens potential gateways for cyber-attacks. Participant 3 stated that from thier technical point of view, as the number of connected devices and sharing of information increase, so do issues. Security and privacy remain the top two issues (Dwivedi et al., 2020). As described by

Dwivedi et al. (2020), any bug in a single device can potentially affect an entire IoT system and compromise users' private data. Companies and thieves are making money from every kind of personal information (Labong, 2019). Malicious usage of their gadgets and data privacy are major concerns for users, what most people do not realize is how deeply identity theft can affect their lives. The effect of ID theft on victims is disastrous, taking hundreds of hours to clean up, being emotionally draining and leaving people feeling vulnerable (Weber 2015). Data is the new oil and data trafficking is becoming worse as internet fraud as yahoo-yahoo (internet scam) is now the order of the day in developing countries like Nigeria where young people devise plans and techniques to deceive other gullible internet users by breaking into their personal networks and sending money or credit. Addressing the prevalent cyber insecurity requires robust security strategies involving encryption, regular updates, and strong access controls which comes at a great cost adding to operational expenses.

**E) INTER-CONNECTIVITY AND DATA MANAGEMENT**

Participant 1 stated that a substantial challenge lies in ensuring interoperability among diverse IoT systems, leading to the adoption of open standards and middleware solutions for seamless communication. In addition, the deluge of data produced by Internet of Things devices necessitates efficient management approaches that include cloud storage and sophisticated analytics tools to handle and interpret data.

**F) LONG TERM RETURN ON INVESTMENT**

Participant 1 made mention of the fact considering the financial and economic aspect of IoT particularly the cost and long-term ROI, its implementation needs careful consideration. Organizations must evaluate areas where IoT could lead to substantial cost savings or revenue generation over time. Participant 11 stresses that environmental impact of IoT such as energy usage and resource consumption, raises concerns. However, in the words of Wang and Wang (2020) that energy efficiency fuels technological developments and is clearly realized by sectorial transformation and as such the adoption of energy-efficient devices and strategies to minimize electronic waste is critical.

**G) REGLATORY USAGE SUCCESS**

The first participant brought up the difficulties in implementing IoT due to skills shortages, data protection regulations, and regulatory compliance. IoT services are causing data trafficking, a revenue-generating crime. Users are unaware of the potential for identity theft, as they believe devices are private. Training staff and partnerships with IoT services are crucial to combat this issue, ensuring users' safety. However, there is no regulation for almost all consumer devices or the data they collect. Partner companies are often exempt from disclosure of user data, third parties, and storage methods. Companies may store data, but they have no legal grounds to sell or transfer it, resulting in a lack of transparency and security. Some companies are paying hundreds of thousands of dollars to pressure their governments to relax data privacy laws. Smart devices, like self-driving lawnmowers and smart heaters, enable companies to analyze user data for their benefit. However, the transmission of this information is not local to the user's device but is on the web for communication with the cloud since the web is used to enhance the functionality of smart devices and enable data transmission. Companies face challenges in security and privacy, as the collection and transmission of user information are mainly invisible to ordinary users but can be accessed by others. The biggest challenges of AIoT are security and privacy risks, which can be easily exploited by those with access. The possibilities seem endless and the risks involved are not to be taken lightly.

**H) LACK OF TECHNOLOGICAL KNOW-HOW (EXPERTISE)**

Every participant in the interview acknowledged that the difficulty in finding sufficient technical personnel would arise owing to the technical complexity of the Internet of Things system, which necessitates highly skilled personnel for system monitoring and maintenance (Raza et al, 2021). In developing countries like Nigeria where illiteracy percentage is up to almost 40 %, availability of experts to run and manage the IoT infrastructure is indeed a problem and the expedient need to train local indigenous man power to take up this responsibility is highly required and is key to solving the problem.

**I) LACK OF MAINTANACE CULTURE**

All the in interviewees concurred that Nigeria, being one of Africa's most populous nations, has a maintenance culture that is almost nonexistent, which adds to the large number of abandoned vehicles, buildings, machinery, and other equipment scattered around cities. The main cause of this lack of a maintenance culture is the pervasive use of dishonest behavior by officials at all levels who are in charge of ensuring that infrastructures are maintained and operated correctly. In order to shortchange the government, the officials either conspire with contractors or pocket money intended for maintenance. Prioritizing maintenance optimally is crucial, especially in the face of poverty, as it can hinder the efficient functioning of infrastructure and potentially lead to its deterioration.

## 5. Conclusion

In the upcoming years, reducing the energy consumption of the Internet of Things sector will be a major issue for the industry because energy conservation pays off handsomely. In order to connect items to the Internet while using minimal amounts of electricity, researchers must continue their work. According to Sharma et al. (2021), the Internet of Things (IoT) must be autonomous, energy efficient and able of use all kinds of energy, including vibration, heat, and light. It's not only profitability that motivates IoT and A.I manufacturers devoting a great deal of time, resources, and energy to discovering ways for the IoT industry to spend considerable money, time, resources and energy to discover ways for IoT industry to reduce its energy consumption. Battery life, legal compliance, and environmental awareness are all important factors driving this trend. Radio communications lowers capital installation costs because it does not require cables and is lighter. Battery- free products have lower operating costs. Renewable energy production reduces environmental impact by eliminating the need for batteries replacement. The future of the Internet of Things requires battery-free end nodes powered by renewable energy, highlighting the growing role of energy harvesting. For example, to reduce the load on the

national grid, innovative methods for converting ambient energy to electrical energy have been discovered. The search for passive energy sources to power Internet of Things devices is ongoing, thus optimizing energy consumption and use. Prospective developments and trends in IoT for sustainability point to a future where sustainable practices can be greatly improved on a worldwide scale. In coming years, connected devices are expected to play a major role in driving change. The public and private sectors will demand more connected devices for better energy distribution, accurate business forecasts, the benefits of green IT, and solutions to many of the region's environmental problems. As a result, overall production gains are anticipated to soar. Manufacturers are facing a higher chance of data theft due to emerging trends in AI and the Internet of Things. To stay secure, they must invest in secure devices and adapt to these advancements to protect their devices. In summary, IoT and AI play a huge part in sustainable development that spans several industries and sectors, including farming, water management, recycling, and many more. As a result, comprehensive strategies that incorporate security, interoperability, data management, cost-effectiveness, environmental considerations, regulatory compliance, workforce development and user acceptance are necessary for an effective and sustainable IoT implementation. AIoT have the potential to play a significant role in community management and stability through the development of smart cities. Taking a comprehensive approach to these challenges is essential if we are to fully grasp the potential of IoT and A.I. in advancing sustainability.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

## Peer-review

Externally peer-reviewed.

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No potential conflict of interest was reported by the author (s)

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# CLEAN ENERGY TRANSITION DILEMMA: FUTURE VALUE OF GREEN INVESTMENT IN AZERBAIJAN

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**Abstract**

Shifting to cleaner and greener energy sources is a hot-debated issue that requires determination and resolution to solve global warming. One of the natural resources-rich countries, Azerbaijan, has adopted the green agenda to reach alternative energy production, 30% in the energy mix, by 2030. To that end, this paper aims to identify hydrogen production perspectives, examine the future value of a green investment as a case study, the relationship between population growth and electricity production, and, lastly, the Azerbaijani people's opinions towards green transition. The statistical, comparison, correlation (Pearson and Spearman), financial management methods, regression (simple linear), and survey methods have been utilized. The survey was carried out among the people of Azerbaijan, and people courageously demonstrated their support for the transition to clean energy sources. Via correlation methods, the relationship between population growth and electricity production was revealed; one unit increase in the former bolsters the latter, 6.98 units. Financial examination of a 100 MW solar farm proved that investing in renewable energy sources in the country is a lucrative business, and the payback period for invested money is 4.8 years. The foreign exchange rate is stable, and the sensitivity to initial investment is 15%, which means only a 15% chance can overturn the investment. All these findings and results can attract investors to pour money into the green energy sector of Azerbaijan, where both sides will be in a win-win situation.

**Keywords:** Hydrogen, investment, green energy, solar, wind

## Introduction

The world we live in has gone through several significant changes and revolutions. Today, in the XXI century, all world governments agree to transform the way of life that is present into a cleaner and greener one. After coal, oil, and natural gas, the modern world is experiencing the fourth energy revolution, which, to a certain extent, can be called the green revolution. In the car industry, internal combustion leaves and is replaced by battery-powered vehicles. Utilization of coal, oil, and even natural gas is supposed to be substituted by renewable energy sources, such as wind and solar power. Recent research revealed that energy production through wind and solar power would not be carbon-free. According to the study, wind power emits 16 g of carbon emissions ($CO_2$), while solar power emits 40 g per kilowatt-hour production of electricity (DW Planet A 2021, DW Planet A 2023).

The elements necessary for wind and solar devices are common materials (aluminum, chromium, copper, silicon, etc.), critical metals (gold, molybdenum, titanium, etc.), and rare earth elements (dysprosium, neodymium) (Tleubergenova, 2023). Once these devices reach the end of their life-cycle, a huge amount of precious metals is going to be wasted. At this point, reuse and recycling issues arise, necessitating significant financial resources that exceed the cost of production. One of the precious elements of batteries is lithium which enables possible huge carbon emission in the extraction phase.

As to solar panels and their probable efficiency issues, Dinneen's study (2024), which brings this matter to the center stage, proved that the total efficiency of simple solar panel can reach only in laboratory settings to 27%. There is also an opportunity to add extra layers to cells, which is known as "tandem", to increase these panels' efficiency. However, this option also cannot increase the efficiency figure in a favorable way. The other option is to use perovskite on silicon cells, and tandem cells can increase the efficiency to 43%. Nevertheless, implementation of this process results in higher and higher production costs.

One of the most hot-debated issues in the transition to clean energy forms is related to hydrogen. In this respect, many scholars and scientists have explored the forms of hydrogen usage. Di Lullo et al. (2021) discussed the hydrogen economy and, in this respect, adding H2 increases transportation emissions as well as upstream emissions. Steam methane reforming (SMR) projects should be approved at a time when there were carbon capture, utilization and storage (CCUS) systems. Ahn et al. (2023) consider CCUS systems a bridging technology and note that 30-40% of natural gas is utilized in blue hydrogen production to dilute CO2, and the rest is concentrated with H2. Massarweh et al. (2023) explored hydrogen types and their respective CO2 emissions. Blue hydrogen is able to cause 4.02 kg CO2/kg fuel, while gray hydrogen can stand at 11.24 kg CO2/kg fuel.

Monetizing the blue hydrogen transition can be trouble in terms of investment. In this context, Santos et al. (2021) noted that surging oil production may pave the way for gaining additional money to finance natural gas resources. De Tommasi and Lyons (2022) investigated global hydrogen perspectives, including in the framework of the European Union. Before jumping and investing in this sector, an appropriate amount of demand should be determined. Besides that, the EU's climate policy and reduction of greenhouse gas emissions were the central topic of the research.

In terms of the viability of hydrogen, Nazir et al. (2020) discussed the best way for it and ended up finding a solution which stressed that steam methane reforming and auto-thermal reforming would be of significant value in the near future for greener life. According to Wallington et al. (2024) improved or enhanced efficiency in e-fuel synthesis, electrolyzers, and other necessary elements of transition might be realized by 2035. They highlighted that hydrogen-powered vehicles are less efficient (roughly 3-8 times) than their battery-powered rivals.

Green hydrogen disregards social and environmental impacts. In this direction, research conducted by Virens (2024) discusses hydrogen justice, energy poverty and includes a multidisciplinary strategy to incorporate both material and human-environmental impacts, thus not leaving out anything. Long-distance delivery of hydrogen can cause a 30% loss, and the regasification process demands a 5% loss (Umbach, 2023).

**Table 1.** Summary of literature review

| № | Study | Time | Country | Result |
|---|---|---|---|---|
| 1 | Ahn et al. | (2023) | Republic of Korea | 30-40% of natural gas is utilized in blue hydrogen production, and rest is concentrated with $H_2$ |
| 2 | De Tommasi and Lyons | 2022 | Ireland | Initially, hydrogen demand should be determined after that investment assessment is conducted |
| 3 | Di Lullo et al. | (2021) | Canada | Transmission lines and in this direct, policy recommendations were prepared |
| 4 | Dineen | 2024 | The United Kingdom | Solar power's efficiency was investigated |
| 5 | DW Planet A | 2021-2023 | Germany | An approximate amount of carbon emissions in electricity production via solar panels and wind turbines noted |
| 6 | Humbatova et al. | (2019) | Azerbaijan | According to research, 1% increase in electricity consumption of population diminishes their income by 20.5% |
| 7 | Massarweh et al. | (2023) | Qatar | Types of hydrogen and their respective $CO_2$ emissions were scrutinized |
| 8 | Nazir et al. | 2020 | USA, Spain | Examined which types of production line is viable for hydrogen production |
| 9 | Santos et al. | (2021) | Brazil | Increasing oil production in order to finance natural gas resources |
| 10 | Tleubergenova et al. | 2023 | Kazakhstan | Key minerals and elements for manufacturing of solar panels and wind turbines were determined |
| 11 | Umbach | 2023 | Germany | Blue and green hydrogen production costs were touched |
| 12 | Virens | 2024 | New Zealand | Discusses hydrogen justice and energy poverty |
| 13 | Wallington et al. | 2024 | USA | Compared battery- and hydrogen-powered vehicles. |

## Hydrogen production costs and requirements

Before delving into a comprehensive and detailed analysis, hydrogen types and production sources should be examined (see Table 2).

s seen from the table, blue hydrogen is produced from natural gas, and there is a CCUS system to keep carbon emissions. From this perspective, blue hydrogen can be called emission-free or minimum CO2 emission fuel. However, building CCUS systems increases blue hydrogen production costs. Per kg of blue hydrogen costs 1.50 USD; hence, a ton equals 1500 USD (Tleubergenova et al., 2023). Gray hydrogen is also produced from natural gas, similar to blue. However, the main difference is related to not using CCUS, which causes enormous carbon emissions and releases them into the environment. The green hydrogen production phase involves green energy sources, through which energy enters electrolyzers, and electrolyzers separate hydrogen and oxygen. Brown hydrogen is obtained from coal, which causes, of course, massive amounts of CO2 emissions and cannot be considered the best alternative energy form.

**Table 2.** Hydrogen and its types (Massarweh et al., 2023)

| Hydrogen type | Source | CO2 emissions |
|---|---|---|
| Blue hydrogen | Fossil fuels (primarily from natural gas) | Carbon capture and storage is utilized |
| Green hydrogen | From renewable energy sources | Minimum or zero emissions |
| Gray hydrogen | Fossil fuels (primarily from natural gas) | Carbon capture and storage is not utilized and thus causes $CO_2$ emissions |
| Brown hydrogen | Fossil fuels (coal) | Causes enormous $CO_2$ emissions |
| Purple hydrogen | Nuclear energy | Minimum or zero $CO_2$ |

The green hydrogen production phase involves green energy sources, through which energy enters electrolyzers, and electrolyzers separate hydrogen and oxygen. Brown hydrogen is obtained from coal, which causes, of course, massive amounts of CO2 emissions and cannot be considered the best alternative energy form. Dissimilar brown, purple hydrogen is produced through nuclear energy and generates zero or minimal CO2. Nevertheless, nuclear energy production itself and its side effects can be considered somewhat problematic.

Tleubergenova et al., (2023) highlighted that two million (mln) tonnes of green hydrogen require 30 gigawatts of power, while five mln 75 gigawatts and ten mln 150 gigawatts of power. When it comes to infrastructure-building expenses for wind and solar power, it should be stressed that 1 MW of solar power comes to a total of 1 mln USD, while wind power is 4.34 mln USD. It is already crystal clear that two mln tonnes of green H2 are going to demand 30 bln USD, while five and ten mln tonnes will require 75 and 150 bln USD, respectively. Blue and green hydrogen production costs are illustrated comprehensively in Table 3.

**Table 3.** Blue and green hydrogen production costs (EBRD, 2023)

| Azerbaijan | | | | The European Union | |
|---|---|---|---|---|---|
| Blue hydrogen | | Green hydrogen | | Green hydrogen | |
| Tone | Euro | Tone | Euro | Tone | Euro |
| 1 | 4620 | 1 | 2920 | 1 | 3670 |
| 2 mln | 9.24 bln | 2 mln | 5.8 bln | 2 mln | 7.34 bln |
| 5 mln | 23.1 bln | 5 mln | 14.6 bln | 5 mln | 18.35 bln |
| 10 mln | 46.2 bln | 10 mln | 29.2 bln | 10 mln | 36.7 bln |
| $H_2$ costs in Azerbaijan = Blue $H_2$ > Green $H_2$ | | | | | |
| Cost of $H_2$ = Azerbaijan green $H_2$< The European Union $H_2$ | | | | | |

Table 3 explicitly shows the production expenditures of blue and green H2. As a case study, 2, 5, and 10 mln tonnes of hydrogen production costs are compared. In every corner, green H2 outpaced its blue rival with respect to expenses; nonetheless, taking into account the CCUS building facility, the figure (blue hydrogen) will definitely increase because carbon capture transport and storage stands at 79 USD per ton of CO2 for hydrogen (Casey, 2023). Regarding hydrogen production in Azerbaijan, it should be emphasized that calculations in this respect show the average cost per ton of green hydrogen production is 2.92 euros while blue is much higher, 4.62 euros. In the European Union, the green H2 production cost per ton stands at 3.67 euros, much higher than that of Azerbaijan. Azerbaijan won the competition for green H2 production expenses and, therefore, can be a green exporter country for the EU. However, there are advantages and disadvantages to the production of H2 in Azerbaijan. Firstly, we must look at the advantages:

Taking into consideration the country's natural gas reserves (2.6 trillion cubic meters), blue hydrogen production is promising;

Having the integrated pipeline system called the Southern Gas Corridor may enable Azerbaijan to export hydrogen via this road;

Low-cost production might encourage all sides (Azerbaijan and the EU) to concentrate on hydrogen production and exportation issues in the near future.

## The disadvantages are the following:

The length of the pipeline starting from Azerbaijan and ending in Italy might increase the export price of hydrogen;

Hydrogen production is also dependent on the water resources of the countries. Water scarcity is one of the critical challenges that our world has faced. Unfortunately, Azerbaijan also has water scarcity;

Blue hydrogen export depends on natural gas export, and production depends on CCUS systems;

The exportation of hydrogen requires repurposing of the pipeline, and it demands commercial discussions with all stakeholders and shareholders.

## 4Ps of Azerbaijan's green horizon: Policy, potential, projects and perspectives

Achieving green energy production and securing a clean environment and growth are among the five national priorities the fossil-fuel-rich country Azerbaijan targets until 2030. According to International Finance Corporations' calculations, Azerbaijan has 157 gigawatts of wind energy potential in the Caspian Sea. Illustratively, renewable energy projects and potential are depicted in Figure 1.

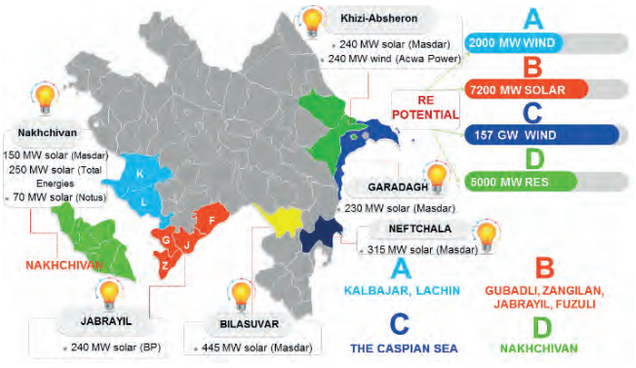


**Figure 1.** Renewable energy potential and projects (made by the author based on Guliyev, 2024)

**Table 4.** Companies invested in renewable energy in Azerbaijan (compiled by the author)

| Companies | Solar energy | Onshore wind | Offshore wind |
|---|---|---|---|
| Masdar (Portfolio of 10 GW) | 150 MW (Nakhchivan) | 1 GW | 2 GW |
| | 1 GW | | |
| | 230 MW Garadagh | | |
| Nobel Energy Management | 400 MW (Nakhchivan) | | |
| ACWA Power | | 1 GW | 1.5 GW |
| TotalEnergies | 250 MW (Nakhchivan) | 250 MW | |
| China Gezhouba Group Overseas Investment | 2 GW Renewable energy | | |
| Notus | 70 MW (Nakhchivan) | | |
| Fortescue Future Industries | 12 GW renewable energy and green hydrogen projects | | |
| bp | 240 MW (Jabrayil) | | |
| Czech Engineering | Solar energy project | | |
| SOCAR-ACWA Power | Battery storage systems | | |

It is evident from Figure 1 that Azerbaijan has 2000 MW of wind energy potential in the Kalbajar and Lachin districts, 7200 MW of solar in the Zangilan, Jabrayil, Gubadli, Fuzuli districts (the Eastern Zangezur and Karabakh economic regions). In the Nakhchivan region, it equals 5000 MW of renewable energy. In order to dive into more regarding companies that poured money into the renewable energy sector of the country, we need to look at Table 4.

Table 4 and Figure 1 show that Masdar is the most actively involved company invested in the clean energy field, with a portfolio of 10 GW. Before explaining the figure and table, it should be stressed that the Azerbaijani government is planning to achieve 30% clean energy in the electricity production landscape by 2030. The Nakhchivan, Eastern Zangezur, and Karabakh economic regions were declared "green energy zones" by the Azerbaijani state. Land areas for renewable energy use are exempted from tax by the government's decision; also, the import of electric cars is an exemption from value-added tax.

With the biggest share, Masdar has a leading role in Azerbaijan (Khizi-Absheron solar farm 240 MW, Garadagh solar 230 MW, Bilasivar solar 445 MW, Neftchala solar 315 MW, Nakhchivan solar 150 MW, 1 GW onshore and 2 GW offshore wind), followed by Acwa Power (Khizi -Absheron 240 MW wind farm, 1 GW onshore and 1.5 GW offshore wind farm), BP (Jabrayil district "sunrise" solar farm), Notus (70 MW solar in Nakhchivan), Total Energies (250 MW solar in Nakhchivan and 250 MW onshore wind), China Gezhouba Group Overseas Investment (2GW renewable energy projects), Fortescue Future Industries (12 GW renewable energy and green hydrogen production projects), and Czech Engineering (solar energy).

With respect to the green energy perspectives in Azerbaijan, the most remarkable issue is related to the exportation of clean energy to Europe. For this purpose, Azerbaijan, Georgia, Romania, and Hungary signed a declaration in 2022 on a "green energy corridor" stretching from Azerbaijan through the Black Sea and ending on the European Union's soil. 80% of the green electricity generated in the country is going to be delivered in the European direction. Azerbaijan, once called a pan-European gas supplier partner, will transform its name into a green partner.

## Future value of green investment in Azerbaijan

Now that we have explored green energy potential and companies invested in this sector, the next phase is going to question why invest in Azerbaijan's renewable energy field. Hence, the main focus areas will be the future value of the green investment, payback period, return on capital employed, internal rate of return of perpetuity, and sensitivity to the initial investment. For the case study, a 100 MW solar project, which generates approximately 208 mln kWh of energy, is taken. The power purchase agreement (PPP) would take the least amount, at 0.1 USD/per kWh. The interest rate in Azerbaijan is 8%, and we will calculate the future value of a 100 mln USD green investment in solar energy by 2030.

Future value of money invested now:

$$F=P(1+r)^n=100\times(1+0.08)^6=100\times1.5868=158.68 \text{ mln USD} \quad (1)$$

Where,

F – future value after n years

P – present or initial value

r – rate of interest

n – number of years

Our result shows a 50% increase in the investment value, increasing from 100 mln to 158.68 mln USD until 2030. Future value is quite positive and, therefore, attractive for investors. If the PPP value is 0.1 USD/per kWh, the annual total amount from a 100 MW solar farm will stand at 20.8 mln USD. That is why we have to analyze the internal rate of return of perpetuity.

Internal rate of return of a perpetuity:

$$\text{IRR a perpetuity}=\frac{\text{Annual Inflow}}{\text{Initial investment}}\times 100\% = \frac{20.8 \text{ mln}}{100 \text{ mln}}\times100\%=20.8\% \quad (2)$$

The calculation reveals that the annual IRR figure will be 20.8%. This is the second reason for investing in renewables in the country. In the next phase, we will cast light on the return on capital employed (ROCE) and, scrap value for a 100 MW solar farm is nearly 4 mln USD and lifecycle is 25 years):

$$\text{Average annual depreciation} = (100\text{-}4)\div25=3.84 \text{ mln USD} \quad (3)$$

$$\text{Average annual profit} = 20.8 - 3.84 = 16.96 \text{ mln USD} \quad (4)$$

$$\text{ROCE} = \frac{\text{Average annual profits before interest and tax}}{\text{Initial capital costs}}\times100\% = \frac{16.96}{100}\times100=16.96\% \quad (5)$$

Alternatively (average capital investment (ACI)):

$$\text{ACI} = \frac{\text{Initial investment + scrap value}}{2} = \frac{100+4}{2} = 52 \text{ mln USD} \quad (6)$$

$$\text{ROCE} = \frac{\text{Average annual profits before interest and tax}}{\text{Average capital investment}}\times100\% = \frac{16.96 \text{ mln}}{52\text{mln}}\times100\% = 32.61\% \quad (7)$$

The ROCE value is high enough for investing, 16.96%, and, through average capital investment calculation, this figure will be 32.61%. The last calculation is regarding sensitivity to the initial investment (net present value is 15 mln USD):

$$\text{Sensitivity to initial investment} = \frac{\text{Net Present Value}}{\text{Initial investment}}\times100\% = \frac{15}{100}\times100\% = 15\% \quad (8)$$

It means that a 15% increase in the initial investment cost would cause the net present value to fall to zero. However, foreign exchange risk is almost zero in Azerbaijan, which is why we can say the sensitivity formula is optimal. Concerning the payback period of a 100MW solar farm, it is calculated in the following:

$$\text{Payback period} = \frac{\text{Initial investment}}{\text{Annual profit}} = \frac{100}{20.8} = 4.8 \text{ years} \quad (9)$$

It is crystal clear from the formula that 4.8 years will be sufficient for earning an initial investment value for companies that invest in the green energy sector of Azerbaijan.

## The analysis of the relationship between population and electricity production

In the aftermath of examining clean energy potential and projects, the question arises: is there any relationship between electricity production and population growth? It is known that Azerbaijan produces most of its electricity through natural gas, approximately 90%. We are already familiar with green energy projects, and the main question that comes to mind for all of us is: Does Azerbaijan need a tremendous amount of energy? For that purpose, correlation analysis was conducted, and the formula is the following: (Coskun, Altunisik, & Yildirim, 2019):

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 (y_i - \bar{y})^2}} \quad (10)$$

Where,

r = Correlation coefficient

$x_i$ = Values of the x variable

$\bar{x}$ = Mean of the values of x variable

$y_i$ = Values of the y variable

$\bar{y}$ = Mean of the values of y variable

After conducting a correlation analysis, it was revealed that there was a strong correlation between variables, then carried out simple linear regression, and the formula is the following (Coskun et al., 2019):

$$Y_i = \alpha + \beta_i + \varepsilon_i \quad (11)$$

Where,

$Y$ = y coordinate;

i = observations

$\alpha$ = y intercept;

$\beta$ = slope;

$\varepsilon$ = error terms

[1] Deutsche WindGuard is a German enterprise offering a wide range of wind energy-related services and knowledge. Established in 2000, the organization holds a significant position in the wind energy sector by providing an extensive array of technical and advisory services with the goal of maximising wind energy generation, guaranteeing security, and augmenting operational effectiveness.

To scrutinize well the potential connection between electricity production and population growth, we compiled secondary data from the official statistical committee on generated energy in the country and the number of people between 2010 and 2022. To that end, the Pearson and Spearman correlations were utilized to identify and reveal the current connection between variables (see Tables 4 and 5).

Carrying out the two correlations aims to reduce any side and potential errors that can occur. In these correlations, the independent variable was the number of people in Azerbaijan, and the dependent was electricity generation. The process was conducted with the help of the SPSS 2022 software.

**Table 5.** The Pearson correlation

| | | Azerbaijan electricity production | Azerbaijan population |
|---|---|---|---|
| Azerbaijan electricity production | Pearson Correlation | 1 | .922** |
| | Sig. (2-tailed) | | .000 |
| | N | 13 | 13 |
| Azerbaijan population | Pearson Correlation | .922** | 1 |
| | Sig. (2-tailed) | .000 | |
| | N | 13 | 13 |

**. Correlation is significant at the 0.01 level (2-tailed).

**Table 6.** The Spearman correlation

| | | | Azerbaijan electricity production | Azerbaijan population |
|---|---|---|---|---|
| Spearman's rho | Azerbaijan electricity production | Correlation Coefficient | 1.000 | .956** |
| | | Sig. (2-tailed) | . | .000 |
| | | N | 13 | 13 |
| | Azerbaijan population | Correlation Coefficient | .956** | 1.000 |
| | | Sig. (2-tailed) | .000 | . |
| | | N | 13 | 13 |

**. Correlation is significant at the 0.01 level (2-tailed).

The tables above clearly demonstrate that the correlation between the two variables is strong. As already known, the correlation value ranges from -1 and +1, and our correlation is near 1, precisely 0.922 (the Pearson correlation) and 0.956 (the Spearman correlation). After seeing the vigorous connection, we must conduct regression analysis, and it is the following:

**Table 7.** The regression analysis

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | -42822.155 | 8549.675 | | -5.009 | .000 |
| Az population | 6.987 | .887 | .922 | 7.876 | .000 |

a. Dependent Variable: Azerbaijan electricity production

When Sig. value is less than p<0.05 value, it is considered valuable, and in this calculation (Table 7), the value (Sig .000) shows that the interconnection is extremely noteworthy The interpretation of simple linear regression is as follows:

(12)

$$Y = -42822.155 + 6.987 \times X + 8549.675$$

One unit increase in population growth fosters electricity production by 6.98 units. The number of people in Azerbaijan in the coming year is expected to grow. Thus, our research proved that additional energy will be vital for the country, taking into account the population forecast by 2030.

## The green energy survey among people

The last examination of our study is related to the survey questions conducted among people in Azerbaijan. We surveyed people to determine the people of fossil-fuel rich country thought about green energy transition. The answers of respondents (100 people) are illustrated in Figure 2.

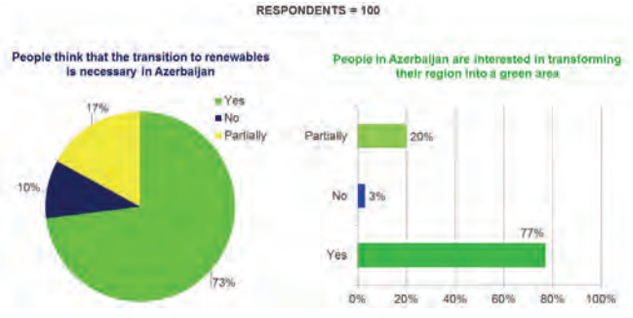


**Figure 2.** Survey questions regarding the green transition (made by the author)

It seems from Figure 2 that 73% of respondents are in favor of the necessity to shift to clean energy sources in the country. Only 17% of them partially support the ongoing process, and 10% do not accept this notion. Regarding their living areas, people are eagerly backing the idea of transformative changes, such as turning their residential areas or, more broadly, their districts into green spaces. In the survey, 77% of the respondents conformed to the transition process, 20% partially accepted, and only 3% did not support this action.

## Conclusion

Analyzing the green transition and investment within the framework of Azerbaijan showcased that the country has massive potential in terms of renewables, particularly wind and solar energies. The potential and projects of green energy have been depicted on the map of Azerbaijan. With respect to hydrogen perspectives, throughout research, the advantages and challenges of hydrogen production have been emphasized. In the perspective period, blue hydrogen production might be achievable, but green hydrogen production is possible. Even the comparison of the production cost of blue and green hydrogen in Azerbaijan and the EU demonstrates that the former is likely to have a lower production than the latter, and this cost-efficiency may push Azerbaijan into a hydrogen-based economy. Our research investigated the companies that invested in the green energy sector in the country, and the listed number of companies was ten, including the local State Oil Company.

Regarding the future value of green investment, our study has taken a 100 MW solar farm as a model. The results of the investigation showed that a 100 mln USD solar farm investment will continuously grow and likely be 158.38 mln USD by 2030. IRR of the perpetuity of our model was 20.8%, the ROCE value was 16.96% (via ACI 32.96%), the sensitivity to the initial investment was 15%, and the payback period was 4.8 years. All these calculations are attractive for any investors making money in a short period of time. The main question for investors may be, 'Where will we forward this electricity?' The green market where Azerbaijan is planning to export clean energy is the EU. On top of that, the growing population, increasing demand for electricity, and, above all, the expanding economy in the country will curb the vast amount of energy in the near future. To illustrate this notion, we conducted the correlation and regression between population growth and electricity production. Our calculations showcased that a unit increase in population growth triggers electricity production by 6.98 units.

Lastly, we targeted to learn the opinions of the people of Azerbaijan on the transition to clean energy sources. A majority of the surveyors (73%) fully supported the green energy transition, initiatives, and projects. The second question was related to transforming their living areas into green ones, and people withstood this idea again, voting yes 77%. These outcomes verify the possibility of the development of the renewable energy sector in Azerbaijan for the years and decades ahead.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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## Conflict of interest

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# REOPENING THE OLD CHAPTER IN BILATERAL RELATIONS: RUSSIAN-TURKISH COOPERATION IN CLIMATE CHANGE

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**Abstract**

Although there have been many ups and downs between Turkiye and Russia, it can be argued that stability and cooperation have dominated the relations between two countries in the post-Cold War period. Since the 2000s, there have been significant developments in the nature of the relations between Turkiye and Russia towards multidimensional and diversified cooperation, which are mainly focused on energy issues before. The tensions that have occurred between the two countries from time to time have been overcome within the framework of mutual dialogue, not preventing the positive course of the relations, and the cooperation continued to cover different areas.

Considering that two historic neighbors in the Eurasian region - Turkiye and Russia - are also two important actors of the international system and the issues on climate change became more visible on international level, this study examines the cooperation on environment and climate change, which is considered a relatively new area in terms of Turkish-Russian relations. The research results show that in spite of that energy trade is one of the determinative issues of Turkish-Russian relations, the fossil resources – trade – environmental problems and climate change nexus have remained in the background of relations between the two parties. The cooperation between two countries in this area has been limited with the Black Sea for a long time. While the Akkuyu Nuclear Power Plant has opened a new chapter, it has been determined that negotiations between the parties have become active recently within the scope of the UN Climate Change Conference (COP) and international regulations in the light of the increasing impacts of the climate change.

**Keywords:** Turkiye, Russia, energy, climate change, cooperation, environment

## Introduction

Parallel to global developments, it is observed that the scope of relations between countries has also changed. Problems encountered due to environmental pollution and climate change necessitate cooperation between states. It is certain that such problems, which are sometimes unpredictable, can be overcome with relatively less damage through initiatives between countries in the same region. This is also true for Turkiye and Russia.

Diplomatic relations between Russia and Turkiye have been established on June 2, 1920. More than 60 fundamental documents regulating interaction in various spheres of bilateral relations are in force between the countries.

The Treaty on the Basis of Relations between the Russian Federation and the Republic of Turkiye of June 3, 1993, No. 5099-1 (Kodeks Rossii, 1993) can be considered as a fundamental document in Russian-Turkish relations towards ecology. Article 11 notes that "the parties will develop, on a long-term basis, wide-ranging cooperation in the field of ecology," and states that in order to secure sources of financing for these projects, the parties will create favorable legal, economic, financial and commercial conditions.

The list of publications can be downloaded on the following website: https://www.ijhsdr.com/

It would be appropriate to mention The Agreement between the Government of the Russian Federation and the Government of the Republic of Turkiye on Sea Transport dated on 2010 (The Ministry of Foreign Affairs of the Russian Federation, 2014), which states in Article 11 that "The vessels of each Party shall take all necessary measures to prevent environmental damage on the territory of the State of the other Party in accordance with the relevant international rules and the legislation of the State of the other Party".

Traditionally, cooperation between the two countries on the environment and climate change has been limited to activities in the Black Sea basin. The Akkuyu Nuclear Power Plant has added a new dimension to Turkish-Russian relations in the field of energy cooperation that has long relied on fossil resource trade. This study examines the climate change and environmental issues in relations between the two countries. The first part of the study focuses on the cooperation between the two historical neighbors in the Black Sea basin. Another part of the study analyzes the cooperation within the framework of the Akkuyu Nuclear Power Plant, Turkiye's first nuclear power plant. The third part evaluates the initiatives taken by two countries in this field in recent years.

## Environmental Security of the Black Sea Region

In order to address security issues in the Black Sea, as well as environmental issues: taking joint measures to prevent and reduce pollution of the Black Sea marine environment, as well as its protection and preservation, on April 21, 1992 in Bucharest (Romania), representatives of Bulgaria, Georgia, Romania, Russia, Turkiye and Ukraine signed an international convention - the Convention on the Protection of the Black Sea from Pollution (The Commission on the Protection of the Black Sea Against Pollution, 2024), which entered into force in 1994. Additionally, it also includes the official documents as: Odessa Declaration (1993), Sofia Declaration (2002), Bucharest Declaration (2007), Sofia Declaration (2009), two strategic plans: Strategic Action Plan for the Rehabilitation and Protection of the Black Sea (1996), Strategic Action Plan for the Environmental Protection and Rehabilitation of the Black Sea (2009).

Specific measures are reflected in the following protocols ((The Commission on the Protection of the Black Sea Against Pollution, 2024): Protocol on the Protection of the Marine Environment of the Black Sea from Land-Based Sources and Activities; Protocol on Cooperation In Combating Pollution Of The Black Sea Marine Environment By Oil And Other Harmful Substances In Emergency Situations; Protocol on the Protection of the Black Sea Marine Environment from Pollution by Dumping.

In 2002, the Parties to the Convention signed The Black Sea Biodiversity and Landscape Conservation Protocol to the Convention on the Protection of the Black Sea Against Pollution, including the "List of Species of Importance for the Black Sea". The Parties to the Convention agreed to take all necessary measures to prevent, reduce and combat pollution of the marine environment of the Black Sea (The Commission on the Protection of the Black Sea Against Pollution, 2024). The Convention covers:

- Pollution from ships;
- Pollution caused by dumping (deliberate disposal of wastes or other materials from ships or aircraft, or from ships and aircraft themselves);
- Pollution from land-based sources;
- Pollution caused by or associated with activities on the continental shelf, including exploration and exploitation of natural resources on the continental shelf;
- Pollution from oil and other hazardous substances in emergency situations;
- Pollution from or through the atmosphere;
- Pollution from transboundary movement of hazardous wastes;
- Pollution from any source by hazardous substances and materials listed in the Annex to the Convention (Articles VI-XIV).

The Convention provides for cooperation in scientific research aimed at developing ways and means of assessing the nature and extent of pollution and its impact on the ecological system in the water column and sediments, identifying polluted areas, studying and assessing hazards and developing measures for their elimination; in particular, alternative methods of treatment, disposal, elimination or utilization of harmful substances. The Parties also agree to develop monitoring programs covering all sources of pollution, as well as to establish a pollution monitoring system for the Black Sea (Art. XV).

To achieve the objectives of the Convention, the Parties establish a Commission for the Protection of the Black Sea Marine Environment from Pollution, consisting of representatives of all States Parties and meeting at least once a year, and a Secretariat to support the Commission. The Convention defines the functions of the Commission and the procedure for convening meetings of the Parties (Articles XVII-XIX).

The ways to ensure security in the Black Sea region include joint activities between Turkiye and Russia, which were carried out at the regional level through the Blackseafor and Black Sea Harmony missions until 2015 (Rogov, 2019). One of the purposes of the Blackseafor's environmental mission is to combat environmental pollution. Since 2006, the Russian Navy began to participate in the Black Sea Harmony exercises, which were organized by Turkiye. The regular exercises within the frameworf of the Blackseafor maintain the high readiness of the sides as a valuable asset for deployment in humanitarian or environmental emergencies in the region, enhancing the countries' ability to coordinate and act promptly to tackle such predicaments (Ulusoy, 2001).

## New Agenda: Akkuyu Nuclear Power Plant

Akkuyu Nuclear Power Plant (NPP) is the first nuclear power plant in the Republic of Turkiye, which is currently the largest nuclear construction site in the world, which will provide electricity to more than 10 regions of Turkiye and more than 12 million consumers, including civil and industrial infrastructure facilities (Akkuyu Nukleer A.S., 2024). Within the framework of the project, all works are carried out in accordance with the intergovernmental agreement in cooperation with the Ministry of Energy and Natural Resources of the Republic of Turkiye, the Nuclear Regulatory Agency (NDK) and other specialized agencies of the Republic of Turkiye (Akkuyu Nukleer A.S., 2024a).

It is worth considering the fact that (Abdullayeva & Sanili Aydin, 2023) the commissioning of NPPs can replace annual emissions of 17 million tons of carbon dioxide from coal and gas generation, which has a positive impact on climate change not only in the country itself, but also in the region and the world. NPPs also produce electricity on average

20% cheaper than thermal power plants, and the reactor has a lifetime of 60 years with the possibility of extending it for another 20 years. It is also a plus that fresh fuel does not pose a radiation hazard, as many critics feared a repeat of the Fukushima story, since the NPP is located in a seismically active zone. According to the Akkuyu NPP project website, "the alpha radiation from both uranium isotopes found in the fuel, as well as the weak beta and gamma radiation from their short-lived daughter nuclides, are almost completely absorbed in the fuel element cladding, eliminating environmental impact. In addition, before being used at NPPs, uranium pellets undergo special treatment to reduce radiation hazards and improve their properties as fuel".

To ensure reliable protection of NPPs, active - systems operating on the electrical or mechanical basis of the reactor and designed to prevent or limit damage to nuclear fuel, fuel element cladding, equipment and pipelines containing radioactive products, which in case of an emergency limit the spread of released radioactive substances and radiation beyond the limits established by the project and their release into the environment; and passive safety systems, based on the design of the reactor, operate in 24/7 mode.

According to the Agreement between the Government of the Republic of Turkiye and the Government of the Russian Federation on cooperation in the field of construction and operation of the Akkuyu NPP in the Republic of Turkiye in 2010, decontamination and safe management of radioactive waste from the NPP is envisaged (Articles 3, 12) (Akkuyu A.S., 2024 b).

According to Rosatom CEO Alexei Likhachev (Vedmosti, 2024), the fuel was brought to the nuclear power plant in 2023, and the plant should enter commercial operation in 2025. Rosatom is also one of the main contenders for the construction of Turkiye's second nuclear power plant in the Turkish region of Sinop. The nuclear power plant is a new experience for Turkiye. In this sense, the environmental safety of the facility is provided in cooperation with Russian experts, which may develop relations between the two countries in the future.

## New Topics on the Old Agenda

As mentioned in the previous sections of the study, environmental and climate issues are relatively new issues in terms of Turkish-Russian relations. Environmental issues between Turkiye and Russia have been addressed mostly within the scope of the protection of the Black Sea water basin as two riparian countries.

The accident that occurred at the Chernobyl Nuclear Power Plant in northern Ukraine on April 26, 1986 and the nuclear fallout that resulted from this accident affected many countries, including Turkiye. The USSR did not make any statements about the accident in the first days. As a result of the increase in radiation levels detected in the two days following the accident, the entire world became aware of the Chernobyl accident. It showed that solving problems such as environmental pollution resulting from the Chernobyl accident requires national efforts as well as international cooperation and active participation at bilateral, regional and multilateral levels (Kilic, 2017). The accident has happened a short time before the collapse of the Soviet Union, which also enforced to focus on the unexpected environmental issues between Turkiye and Russia.

Although one of the main issues in relations between the two countries is fossil energy resources, the environment and climate change issues have not been prominently discussed for many years. It is obvious that the climate change policies of the countries contradict their commercial policies (Sakal, 2023: 145), especially when it comes to trade in fossil energy resources. In this sense, it is understandable that the fossil resources-climate change nexus has remained in the background in relations between Turkiye and Russia as Turkiye is the among first five oil and natural gas export markets of Russia. On the other hand, Russia is a major emitter of greenhouse gases (contributing to 4.5% of GHG emissions), and a leading global supplier of fossil fuels. Russia is vulnerable to the impacts of climate change from extreme events such as increase in the frequency and duration of droughts, extreme precipitation, floods, forest fire, degradation of permafrost in the northern region heat-waves, flash floods, coastal flooding, and increased erosion (World Bank Group, 2021a). Russia is ranked 63rd in 2024 Climate Change Performance Index (CCPI) – down four places and remaining among the very low performers. It receives a very low in all four CCPI index categories: GHG Emissions, Renewable Energy, Energy Use, and Climate Policy (CCPI, 2024a). Similarly, Turkiye is vulnerable to the impacts of climate change from extreme weather events and increase in temperature. These have consequences on the country's terrestrial, marine and freshwater ecosystems and increases the overall strain on the environment (World Bank Group, 2021b).

Turkiye drops nine ranks in 2024 CCPI to 56th, making it is a very low-performing country. The country receives a medium ranking in the Renewable Energy category, low in GHG Emissions and Energy Use, and very low in Climate Policy. Turkiye still heavily depends on fossil fuels for energy (CCPI, 2024b). In the light of this data, the climate change, as well as EU institutions and environmental protection regulations, have been determining in the long-term transformation of bilateral energy relations between Turkiye and Russia (Sakal, 2023).

In recent years, especially, forest fires, have made closer cooperation between the two countries on climate change inevitable. In fact, Russia and Turkiye are one the first countries, who provides support for each other in extinguishing the forest fires. In the Russian Federation, two firefighting helicopters allocated from the Ministry of Environment and Forestry were transferred to the Russian Federation on August 8, 2010 under the coordination of the Prime Ministry Disaster and Emergency Management Presidency regarding the forest and peat fires that lasted for weeks and affected some settlements, especially Moscow, with toxic smoke clouds. They participated in firefighting activities in the Ryazan region. In addition, upon the request of the Russian authorities, the Prime Ministry Disaster and Emergency Management Presidency sent 350 "backpack fire extinguishers" to the Russian Federation (Ministry of Foreign Affairs of Republic of Turkiye, 2010).

On March 15, 2024, Abidat Magomedova, Deputy Director of the Department of International Cooperation and Climate Change of the Ministry of Nature of Russia and Mohammed Levent Akici, Advisor to the Ministry of Environment, Urban Development and Climate Change of the Republic of Turkiye at the Embassy of the Republic of Turkiye in Russia discussed the environmental protection policy of Russia and Turkiye, as well as the prospects of cooperation between the two countries in the field of waste management, biodiversity conservation, protected areas management, joint study of Antarctica (Ministry of Natural Resources and Environment of the RF, 2024). The parties agreed to exchange concrete proposals on cooperation in the near future, and also supported the decision to develop a legal framework for joint work. Priority attention is planned to be given to the sphere of production and consumption waste management.

On April 11, 2024, Russia and Turkiye agreed to cooperate in waste management regulation: According to the mentioned agreement, the countries will exchange experience in waste management and engage in joint eco-education. This decision was made during a meeting between representatives of the Russian Environmental Operator (REO) and Mohammed Levent Akıcı, Counselor of the Ministry of Environment, Urban Development and Climate Change of the Republic of Turkiye at the Embassy in the Russian Federation (Russian Environmental Operator, 2024).

The meeting also saw the signing of a framework cooperation agreement with the operator of Turkiye's Zero Waste project aimed at supporting environmental projects. The participants also agreed to support eco-education and international congress and exhibition activities to raise awareness of the world community about the challenges in building a circular economy.

On June 6, 2024, during the XXVII St. Petersburg International Economic Forum (SPIEF), Russia and Turkiye signed an agreement on the creation of a textile recycling system (Russian Environmental Operator, 2024). The agreement was signed by Denis Butsayev, General Director of the Russian Environmental Operator (REO), and Abduljelil Sherifoglu, the founder of the Turkish company AJ International Group, which recovers and recycles used clothing and has collection and recycling centers in Turkiye, Saudi Arabia, the United Arab Emirates, Qatar, South Korea and other countries. The agreement provides for the creation and development of a system of collection, utilization of textile waste and textile recycling in Russian cities, in particular:

- The cooperation between REO and the Turkish company is aimed at improving the system of textile waste management, reducing the disposal of such waste and improving the environmental situation in Russia. Within the framework of the agreement, it is planned to launch a project implying the establishment of a textile waste utilization facility and an entire system for the collection of used textile products and textile waste recycling in the territory of the Russian Federation. The textile waste utilization facility is planned to be established in Moscow or the Moscow region.

- At the moment, AJ International Group has already started installing its boxes for accepting clothes from the population in cities near Moscow.

According to expert estimates, Russia generates more than 2 million tons of textile waste per year: an average urban resident throws away 15-17 kg per year, and no more than 1% of this volume of textile waste is recycled (Vedmosti, 2023). In order to reduce textile waste generation in the country, old clothes and used home textiles should be kept in circulation as much as possible, which this agreement will contribute to.

## Conclusion & Prospects

Both Turkiye and Russia are developing countries. Russia is one of the BRICS countries. Turkiye has already applied for the BRICS membership. Energy resources are the main input of the economic development, which is vital for carrying out economic activities. Russia itself is already one of the world's major oil and natural gas producers. Traditionally, Russia orientes towards low-cost natural gas power generation. However, although renewable energy sources are not considered as an alternative development option, Russia has started to invest in this field since the 2010s as a result of the obligations that have been undertaken due to increasing climate change and environmental problems.

Turkiye is an energy dependent country. It is investing in the renewable energy sector to reduce its energy dependency. However, this is an expensive and time-consuming process. In this sense, cooperation in the field of environmental issues and climate change has a lesser place in Turkish-Russian relations compared to other issues. The economic infrastructure of both countries has been shaped by fossil energy resources. Therefore, it is unrealistic to expect these countries to make rapid progress in the energy transformation in a short time. However, as mentioned, Turkiye and Russia, as two important actors of the global and regional economy and countries with large populations, are increasingly feeling the effects of climate change. Considering the fossil energy trade between the two countries, Turkiye and Russia need to develop and implement a more comprehensive and results-oriented action plan on climate change. Climate change is not an area that any country can combat alone. In this sense, it is predicted that mutual cooperation will produce more concrete results.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The authors confirm being the sole contributor of this work and have approved it for publication.

## Peer-review

Externally peer-reviewed.

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## Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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# AZERBAIJAN AS A REGIONAL LEADER IN GREEN ENERGY TRANSITION

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**Abstract**

Azerbaijan is at the crossroads between East and West hence its Geopolitical location is both its challenge and its major asset. This paper analyses the general state of relations of Azerbaijan with its largest and geopolitically most important neighbors as well as with other international players in order to see how Azerbaijan is able to maintain a balanced approach in foreign policy, maneuvering politically between the clashing geopolitical interests and ambitions of the different states in the South Caucasus. Hosting COP29 is absolute significant nuance for Baku embracing all world under climate change to Azerbaijan and spinning political and economic network alongside with multilateral regional diplomacy in the region. The economic growth of China leads its economy to supply goods not only via the sea and air trafficking, but also through the trans-Caspian way to Europe. In this regard, Within the New Silk Road Initiative Azerbaijan and China could accelerate some new bilateral and trade partnership. Furthermore, this new project not only makes Azerbaijan as a regional key factor in Caucasus but also in Trans Caspian area. And it would cause nations integration in whole region of this new project. Azerbaijan could get its new role in this project to play an essential role on Global Trade as a transit country. Many scholars argued that, due to its choices to foreign policy and strong focus to effective development of its economy, Azerbaijan vies to maintain an independent course. And this paper basically analyses Azerbaijan's political, economic approaches to Global and Regional Powers as well as its views to China as a new Global actor in its region, and impacts of The New Silk way Project at Azerbaijan-China Relations.

**Keywords:** Azerbaijan, China, South Caucasus, Green Energy, Regional diplomacy.

## Introduction

After the collapse of USSR along with other Post Soviet Countries Azerbaijan has also passed hard Economic transition period. Integration to Market Economy and opening up for world in the background of first Karabakh war with its neighbor country Armenia not only brought huge domestic problem to Azerbaijan it also made South Caucasian region one of the less corporative and instable region. Three Caucasian countries Armenia. Azerbaijan and Georgia have started for unsystematically without dealing regions interests started to make new independent policy. Under the Haydar Aliyev Azerbaijan have gained some credits from most of the western countries for an investment for Baku's fossil energy resources and via this "Oil Diplomacy" Azerbaijan guaranteed its early period of Sovereignty after the gaining Independence. BP, Chevron, Total, Exxon and some other oil companies started their businesses in Baku and it was clear signal to all world Azerbaijan economically and invest friendly country. The correct implementation of foreign policy towards regional as well as global powers exceptionally important for Azerbaijan. Due to, its complex geostrategic location between West and East produce naturally geoeconomic and geopolitical interests. Besides Azerbaijan protecting its national interests and the status of leading country in the region Baku is attempting to establish mutually beneficial relations with West, Islamic countries, The Turkic world, CIS countries as well as with China.

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Located in a favorable geographical location, Azerbaijan is the shortest transport and energy corridor connecting the West and East, North and South countries. As a result of the implementation of strategically important energy and transport-communication projects, Azerbaijan locates an important place in the architecture of European energy security. Azerbaijan is today the main initiator of cross-border projects.

## China-Azerbaijan Relations after the Cold War

Although Azerbaijan, which regained its independence in 1991, is a young country, it is the main participant and initiator of huge projects that play an important role in the life of the Eurasian continent. Apart from that, the fact that Azerbaijan has an ancient tradition of statehood also played an important role in the enrichment of its politics and diplomacy.

From the first years of independence, the national leader Heydar Aliyev highlighted three main factors in the foreign policy strategy of the modern Azerbaijani state: *responding to the challenges of the time, taking into account the geopolitical reality surrounding our state, and drawing conclusions from the rich statehood history of our nation.*

The People's Republic of China is one of the countries where the Azerbaijani government attaches great importance to the development of bilateral political and economic relations. China is a permanent member of the UN Security Council and is always in the spotlight with its economic development.

In the relations between the two countries, more attention is paid to economic relations. China and Azerbaijan are successfully cooperating in the "One Belt, One Road" project proposed by the Chinese leader in 2013. Hikmet Hajiyev, the head of the foreign policy affairs department of the Presidential Administration, who gave an interview to the Chinese TV channel "Phoenix", mentioned this issue in particular. Recalling that Azerbaijan was one of the first countries to support the "One Belt, One Road" initiative put forward by the President of the People's Republic of China, Xi Jinping, the assistant to the President said that this project had a positive effect on the general well-being of the countries located along the route, strengthened cooperation between them, and also promoted inter-civilizational dialogue. And thanks to this, the international community benefited from the ancient Chinese civilization: "We see this project as a cooperation, partnership and mutual prosperity that can bring prosperity to the countries along the route. Azerbaijan, located between the Caspian Sea and the Black Sea, is a natural connection connecting Central Asia and Europe," said H. Hajiyev said.

The transition to "green energy", which is one of the challenges of the modern era, can further strengthen China-Azerbaijani relations. China is one of the world leaders in purchasing energy from renewable sources. Making transition to "green energy" a priority area, Azerbaijan also partners with Chinese companies in this direction. China pays attention to Azerbaijan's clean energy reforms and highly appreciates the country's efforts towards ecological development. Currently, areas are selected for the construction of solar power plants with a Chinese company in Fuzuli. China's advanced manufacturing industry is famous all over the world. This means the end of the West's monopoly on technology.

## Active Participation of Chinese Green Energy companies in Karabakh Region.

Chinese companies are aware of the investment promotion measures implemented by Azerbaijan to promote infrastructure construction and improve the investment and business environment in the territories liberated from occupation. Chinese companies have gone on inspection trips to conduct research and have participated in projects such as supplying test equipment for "smart villages" and airports. Currently, some enterprises are actively promoting the investment and construction projects of photovoltaic power plants to help develop the local green economy. China is actively ready to promote and collaborate with Azerbaijan for Green Economy and indeed is one of the strategic partners in the region. Recent Chinese companies' activities in the Karabakh region is clear resemble of Beijing's support and clear partnership with Baku. China is eagerly applause to speeding up connections and modernizing infrastructure and services along the Trans-Caspian International Transport Corridor. China attaches great importance to the favorable geographical location of the "Middle Corridor" and positively evaluates its importance in strengthening regional relations, promoting regional economic development, and ensuring the stability of global industrial and logistics chains.The joint construction of "One Belt, One Road" fully corresponds to the "Middle Corridor" concept. In the field of transport communications, China and the region countries located along the "One Belt, One Road", including Azerbaijan, have common interests on this project.

Meanwhile, China is committed to speeding up connectivity along the Trans-Caspian International Transport Corridor, improving infrastructure and services, increasing the volume of China-Europe rail freight, easing and removing barriers to regional and international supply chains. The Chinese side is also willing to strengthen cultural and humanitarian ties, promote relations between the business, academic and non-governmental sectors of the two countries, and strengthen and diversify the social base to deepen bilateral cooperation.

## China-Azerbaijan: Close allies of "Green Energy"

China attaches special importance to "green energy" projects in Azerbaijan and is considering plans to invest in this field. The strengthening of multi-directional cooperative relations between Azerbaijan and China on renewable energy within the framework of the 29th session of the Conference of the Parties to the UN Framework Convention on Climate Change (COP29) in Baku also creates good opportunities for this. Chinese companies will be one of the main partners of Azerbaijan in the projects implemented in liberated territories. These areas have been declared Green Energy Zones and energy demand models have been developed. Based on that strategic approach, several sources for energy production have been identified in the Green Energy Zone, and negotiations are underway with foreign companies in the fields of electricity generation from renewable energy sources, use of electric vehicles, construction of solar panels, and the application and management of smart energy technologies. Among that business community, Chinese companies are also in the main line. Currently, China

is the world's leading country in the production of electricity from renewable sources, twice ahead of its closest competitor, the United States. In 2023, China's electricity generation from renewable sources has reached 1,000 gigawatts, which is 43.5 percent of the country's total generating capacity potential. About 40 percent of the world's renewable energy potential is provided by China, and in 2030 this number is expected to reach 44 percent.

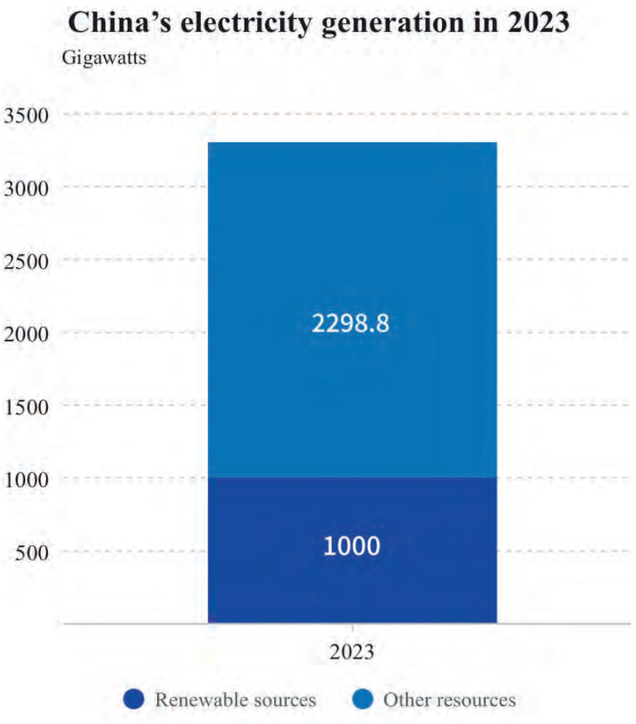


**Figure 1:** China, electricity generation in 2023

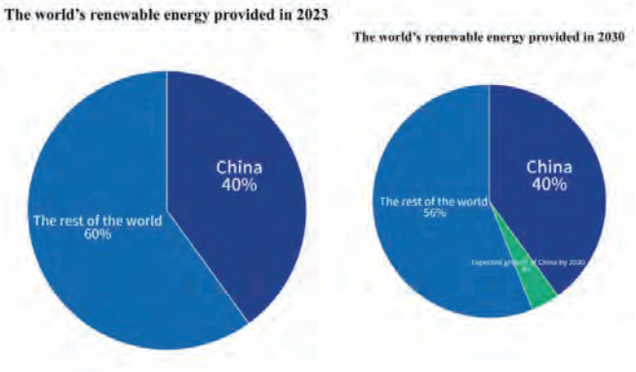


**Figure 2:** The Worlds renewable energy provided in 2023(2030)

From this point of view, Azerbaijan's "green hydrogen" alliance with such a country means the mobilization of great economic and political opportunities. Thus, the representation of Chinese companies as the most reliable and close allies in the construction of "green energy", which is part of Azerbaijan's modern agenda, will be a strong support in the transformation of our country from traditional energy resources to an exporter of "green energy" in the global trade sphere.



**Figure 3:** Global spatial distribution of national-scale rooftop photovoltaic power generation potential (the data) in the figure is from the Earth Big Data Supporting Sustainable Development Goals Report (2024).

## Conclusion

Its undeniable fact that upcoming world economy will be based on Green Energy and it can systematically influence all kind of industries. Azerbaijan as a regional leading country transferring its economy and industry to Green Energy and integrating to multipolar system. COP29 summit in Baku is clear evidence that Baku is attempting for diversification of its economic and energy policy for producing better collaboration model. Role of China through Belt and Road imitative is an alternative collaboration model for Eurasian hemisphere and encouraging all countries for better developing strategy. Unlike other fossil energy producing countries Azerbaijan become first country to shift its economy to green energy and it could be motivational model for other fossil producing countries. COP29 and future impact on regional policy for Azerbaijan will be very resilient and it will be tightening relations with China as they already become strategic partner.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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Externally peer-reviewed.

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# AN ASSESSMENT OF THE EUROPEAN GREEN DEAL, GREEN ECONOMY AND GREEN GROWTH IN EUROPE

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**Abstract**

The European Commission (EC) published the European Green Deal (EGD) in 2019 and determined it as a "new growth strategy" for the European continent. The EGD's ambitious objectives include increasing economic efficiency, ensuring social justice, and making Europe the first "climate-neutral" continent by 2050 in the world. The United Nations Environment Programme (UNEP) defined the green economy as "low-carbon, efficient use of resources, and socially inclusive". Similar to the concept of a green economy, the concept of "green growth" also aims to provide a balance between the economy and the environment. This study covers the implications of the EGD, Green Economy, and Green Growth and assesses the levels of green growth attained in the European Union (EU), between 2010 and 2022, and compares the European success to other selected economic groups in the world. The study covers a quantitative methodology consisting of the Green Growth Index (GGI) data and reports, the statistical figures are evaluated through a comparative perspective between the EU and other economic groups in the world. The study reveals that the EU recorded high levels of GGI and it is the leading economic group in three of the four indicators within the GGI, with the USA surpassing in one category.

**Keywords:** European Green Deal, Green Economy, Green Growth, United Nations Sustainable Goals, United Nations Environment Programme

## Introduction

The European Commission (EC) published the European Green Deal (EGD) on 11 December 2019 and determined it as a "new growth strategy" for the European continent. The EGD's objective is to increase economic efficiency and provide social justice simultaneously, and it aims to make Europe the first "climate-neutral" continent by 2050 in the world. (Laurent, 2020: p. 98)

The EC President Ursula von der Leyen emphasized the importance of the EGD and differed from the former Commissions' "wait-and-see" strategies, by re-stressing the European environmental determination at the global scale. Because efforts to preserve the global environment were not sufficient enough, there is more urgency today in terms of effective action across the world (Christensen and Olhoff, 2019)

We can define the EGD's key targets as the increase of the EU's Gross Domestic Product (GDP) and the reduction of Greenhouse Gas (GHG) emissions. According to the EC, GHG emissions have been reduced by 23% between 1990 and 2018 and the economy grew by 61% (European Commission, 2019).

Just like the "green economy", "green growth" also aims to provide sufficient goods and services in the face of the growing demand due to the global increase in world population and to decrease poverty as well (Adamowicz, 2022: 10).

The list of publications can be downloaded on the following website: https://www.ijhsdr.com/

The United Nations Environment Programme (UNEP) defines the green economy as "low-carbon, efficient use of resources, and socially inclusive". Public and Private Partnerships (PPP) are essential in providing a green economy, as they generate growth, employment and increase income in green economic activities, and provide efficient infrastructure that decreases carbon emissions and pollution as well. Thus, a Green Economy also increases energy and resource efficiency, prevents the loss of biodiversity, and preserves the ecological environment (UNEP, 2024).

Similar to the concept of a green economy, the concept of "green growth" was launched originally in 2005 during the "Fifth Ministerial Conference on Environment and Development" (MCED) where 52 Governments from the Asia and Pacific Region accepted to go beyond the non-effective discoursed regarding sustainable development and follow the way to "green growth". Within this context, they have launched the Ministerial Declaration on Green Growth (UNESCAP, 2008). This was also viewed as a path to achieve the United Nations's Sustainable Development Goals (United Nations, 2022).

Thus, we can say that the MCED's approach to green growth aimed to balance economic growth and environmental sustainability, by improving the efficiency of economic growth within the ecological system. In short, green growth seeks to provide a better harmony and balance between the economy and the environment. Just like the "green economy", "green growth" also attracted remarkable attention worldwide, as it aims to stimulate economic growth while preventing environmental degradation. It foresees to use of natural resources in a more rational way to avoid and prevent the loss of biodiversity. In general, we can say that policies of green growth aim to enhance economic development and to raise people's living standards by a rational use of goods and natural resources, raw materials, energy sources, and all products and services that will affect the well-being of humans and of all living beings.

## 1. Literature Review

The literature surrounding the European Green Deal (EGD) and its implications for environmental policies and economic growth presents a comprehensive exploration of the evolving sustainability landscape within the European Union. The foundational work by Clements et al. (2010) highlights the critical challenge of resource consumption in Europe, emphasizing the need for increased recycling. Their analysis underlined the role of eco-technologies and green jobs as pivotal components of the EU's cohesion policy, which aims to foster economic development while addressing environmental concerns.

Building on this, Bär et al. (2011) discussed the emergence of green economy discourses leading up to the Rio 2012 conference, advocating for Europe to assume a leadership role in environmental technology. They identified key sectors poised for growth under ecological constraints and emphasized the necessity of addressing skill gaps. This perspective aligns with the notion that while environmental and economic benefits of green technologies are widely acknowledged, the social dimensions must not be overlooked.

Simionescu et al (2020) asserted that the EGD aims to increase the use of renewable energy to achieve sustainable European economies. They analyzed the empirical evaluation of the relations between GDP, consumption of renewable energy and global competitiveness index (GCI). Their study found a positive effect of renewable energy consumption progress on GDP and GCI growth, and also a positive influence of economic growth on renewable energy consumption between 2007 and 2019 in the EU countries.

For Claeys et al (2019) The EGD should be presented as a re-allocation of resources, enhancing investment and labour in the primary economic sectors. In doing so, it also has to assist the weakest parts of the society. The EGD promotes the shift from fossil fuels to renewable energies, for example, the use of electric cars in practice. The EU should compensate low-income households for higher fuel prices and re-train coal miners for new employment opportunities.

Dolge and Blumberga (2021) analyzed economic growth in contrast to GHG emission reduction measures in the Green Deal context. Their findings indicated that GDP growth is the major contributor to GHG emission increase in countries with low-income levels and that decreases in energy intensity had the highest impact on GHG emission reductions. They also asserted that the current climate policies in the Baltics are not sufficient to achieve the EU's 2030 targets.

Hernandez Serrano and Zaveri (2020) proposed a multi-disciplinary approach to energy transition, suggesting that such a strategy would position the EU as a leader in sustainable energy systems. Their systematic review contributes to understanding how integrated policies can enhance the efficacy of the EGD.

Ortega Gil et al. (2021) further elaborated on the EGD's framework, analyzing its impact on life satisfaction across Europe. They revealed a reverse relationship between life satisfaction and environmental degradation, positing that the EGD serves as a transformative growth strategy aimed at addressing climate change while promoting economic equity. This ambitious plan not only targets greenhouse gas emissions but also introduces mechanisms for social inclusion, thereby linking environmental policy with broader socio-economic objectives.

In a similar vein, Bassi and Guidolin (2021) investigated the role of green jobs in resource efficiency among European SMEs. Their findings suggest a strong correlation between the adoption of resource-efficient practices and the presence of green jobs, emphasizing the need for longitudinal studies to further explore this relationship. This study highlights the potential for green jobs to stimulate sustainable practices within the service sector, which is often lagging in resource efficiency initiatives.

Rodríguez-Antón et al. (2021) contributed to this discourse by examining the circular economy's alignment with the Sustainable Development Goals (SDGs) within the EU context. Their empirical analysis suggested that the transition to a circular economy not only fosters job creation but also enhances sustainable consumption and production patterns, reinforcing the interconnectedness of environmental policies and economic growth.

Cifuentes-Faura (2022) provided a comprehensive overview of EU policies aimed at combating climate change, detailing the EGD's roadmap for achieving a resource-efficient economy by 2050. This includes various initiatives aimed at reducing emissions and promoting innovation, which are critical for creating new markets and employment opportunities. The emphasis on a decoupled

economic growth model signifies a substantial shift in policy direction, aiming to balance environmental sustainability with economic development.

Stanef-Puică et al. (2022) delved into the concept of green jobs, linking them to sustainable development and the green economy. Their literature review revealed that while the potential for green job creation is significant, disparities in economic development across regions may hinder equitable job distribution. This underscores the importance of targeted policies to increase employment in less economically developed areas.

Ionescu et al. (2022) explored the green economy's implications for economic development within the EU, proposing an econometric model to assess the effectiveness of sustainable development solutions. Their research highlighted the need for a unified approach among Member States to achieve the objectives of the Green Deal, particularly in addressing regional disparities and fostering innovation.

Finally, Presno et al. (José Presno et al., 2024) emphasized the critical role of renewable energy in achieving the EU's Energy Union goals. Their study advocated for increased investment in renewable technologies, suggesting that such investments are essential for fostering economic growth and job creation. They argued that the current economic challenges, following the COVID-19 pandemic, present an important opportunity for transitions toward a sustainable economy.

Leonardo et al (2021) asserted that the EU should be aware of the EGD's results abroad. They suggest that the EU needs to assist the neighbouring and partner countries of the EU in their geopolitical aspects of the EGD; including Russia, USA, China, Algeria, and Saudi Arabia.

Through this literature review, it becomes evident that the European Green Deal serves as a catalyst for transformative change, intertwining environmental policies with economic growth strategies across various sectors and regions within the EU. The collective insights from these articles emphasize the necessity for coordinated efforts to reach EGD's targets while ensuring social equity and sustainable development.

## Methodology

Quantitative and empirical data are analyzed in this paper, based on relevant green growth index reports and statistics. Additionally, these facts are evaluated by the author under the UN's SDGs and EGD's 2030 and 2050 objectives. Overall, these quantitative data are combined to assess the EGD impact on environmental policies and economic growth in EU member states.

## The Functioning of Green Economy and Its Impact on Green Growth

The EGD's objective to eliminate GHG emissions in Europe by 2050 is a revolutionary step in the energy sector in Europe and leads to fight against global climate change. EGD is also expected to bring geo-political consequences as it would change the European energy balance and the global markets as well. Oil and gas-producing countries are expected to be affected in the European neighborhood, especially energy supplier countries like Azerbaijan (Aydin, 2020) and thus European security for energy will also be affected, which would also change world energy trade relations by the use of the carbon border adjustment mechanism (Leonard et al, 2021).

Figure 1. below reflects the steps of a green economy, where EGD acts as a catalyst for "Green Growth" which contributes to the formation of a "Green Economy", that becomes a means of achieving sustainable development.

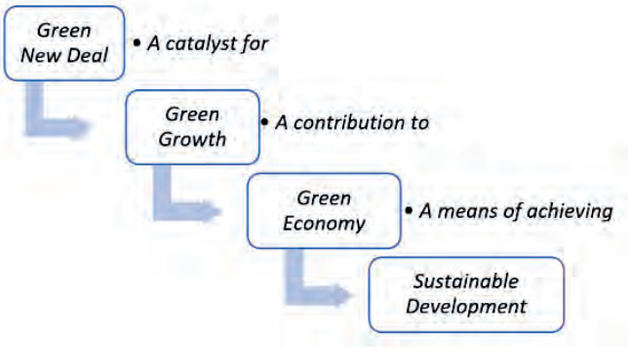


**Figure 1.** The Steps of Green Economy
**Source:** Adamowicz, 2022

**Table 1**. below reflects the principles of the green economy classified into three categories: namely by economic, environmental, and social levels.

| Type | Principles |
|---|---|
| Economic | Recognizes natural capital and values<br>• Integrated in economic development and growth models<br>• Internalizes externalities<br>• Promotes resource and energy efficiency<br>• Creates decent work and jobs data |
| Environmental | Protects biodiversity and ecosystems<br>• Invest in and sustains natural capital<br>• Recognizes and respects planetary boundaries and ecological limits<br>• Advances international environmental sustainability goals |
| Social | Delivers poverty reduction, well-being, livelihoods, social protection and access to essential services<br>• Is socially inclusive, democratic, participatory, accountable, transparent, and stable<br>• Is equitable, fair and just–between and within countries and between generations |

**Table 1.** The Principles of Green Economy
**Source:** Adamowicz, 2022: 11

The EU has been active in building the concept of sustainable development, however, its interest in green economy in its documents only emerged following the Rio+20 summit in 2012. The EC's green economy concept included an environmental action program where natural resources and the preservation of biodiversity were seen as life insurance. The EGD is the leading document of the EU regarding green economy, it was launched by the EC in December 2019. It covers key figures that represent ambitious objectives such as reducing at least by 55% the GHG emissions in 2030 compared to 1990, planting 3 billion trees in Europe by 2030 and making Europe the first climate-neutral continent by 2050 (European Commission, 2024).

Besides the EU, global action was also undertaken by the UN in 2015, at the UN World Conference in New York, the "Agenda 2030" was adopted by more than 190 countries engaged to include the 17 SDGs in their policies. The "Agenda 2030"'s goals replaced the

Millennium Development Goals, which were projected to be met by 2015. Current goals also cover many global issues such as health, poverty, education, hunger, social justice, and climate change.

The EGD aims to increase the production and share of renewable energy consumption and to reduce energy demand. The EU brought new regulations in transport, agriculture, and industry to reach these goals and also put restrictions on the use of residential energy. The EGD basic components are represented in Figure 2. below.




**Figure 2:** The European Green Deal and its Key Areas
Source: European Commission 2020, Communication on the European Green Deal

According to the EC estimations, €1 trillion would be needed to finance sustainable investments until 2030, therefore the EU introduced the EGD Investment Plan (EGDIP) to cover the expenses. The plan comprises both public and private funds, as well as 11 €500 billion from the EU Budget, and the rest would be funded by the investment program Invest EU (Fetting, 2020: 7). Figure 3 below reflects the budget of the EGD Investment Plan.

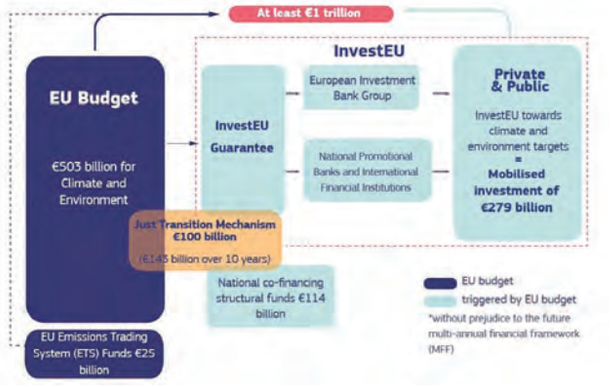


**Figure 3.** The European Green Deal Investment Plan

**Source:** European Commission

Invest EU is a continuation of the Investment Plan for Europe. All 13 of the currently available EU financial tools are combined under one roof with Invest EU. There are four major investment areas: (Fetting, 2020:7).

• "Sustainable infrastructure

• Research, innovation and digitisation

• Small and Medium Sized Enterprises

• Social Investment and Skills"

## The Green Growth Index Measurement in Europe and Selected Economic Groups

The "Green Growth Index" (GGI) measures countries' performances in achieving sustainability objectives, including SDGs and the Paris Climate Agreement targets. It comprises four dimensions:

1. Efficient and sustainable resource use,

2. Natural capital protection,

3. Green economic opportunities,

4. Social inclusion.

The Green Growth Index (GGI) scores range from 1 to 100, the classification is as below:

1-20 very low,

20-40 low,

40-60 moderate,

60-80 high and

80-100 very high green growth performance.

The GGI 2023 was published in October 2024, measuring European and global performance in achieving SDG targets. Our research focuses here on the European results and a comparison would be made with the rest of the world, by region.

Europe's trends in all dimensions are rising more significantly than other regions. As can be seen from Figure 4, Europe consistently achieved very high performance in the social inclusion dimension, passing from 80.97% in 2010 to 86.05% in 2022, increasing thus by 6.27%.

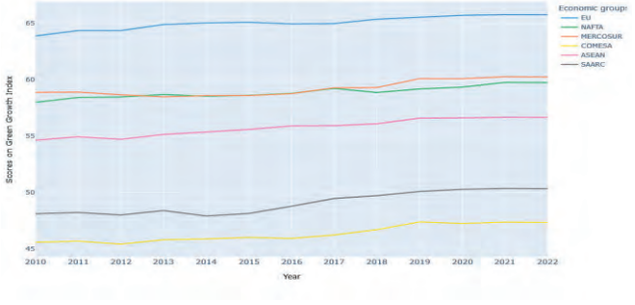


**Figure 4.** Trend in Green Growth Index Scores in Selected Economic Groups, 2010-2022
**Source:** Global Green Growth Index Technical Report

However, despite European ambitious targets, such as reducing emissions by 55% by 2030 and achieving net zero by 2050, the current reduction rates are rather inconsistent, in some sectors where GHG emissions increased in the post-pandemic period in transport and building sectors. To reverse the declining trend, the EU has introduced a range of policies, including the 'Fit for 55' package and revised targets for renewable energy and energy efficiency.

Figure 5. below reflects the general scores in GGI based on the four dimensions, where the USA and EU recorded high rates of improvement in green economic opportunities, with 76.29 % for the USA (represented in NAFTA), surpassing the EU's average. However, Europe had higher scores in the remaining three dimensions, where Switzerland, Austria, and Germany, with scores above 75%, contributed a lot to the EU's total high performance in efficient and sustainable resource use. In the protection of natural capital, especially in reducing GHG emissions and protecting biodiversity, Austria, Slovakia, Croatia, Czech Republic, Albania, and Germany have high scores exceeding 80%. Additionally, on the topic of social inclusion, Switzerland, Austria, Germany, Denmark, Sweden, the United Kingdom, Finland, Norway, the Netherlands, France, Belgium, and Spain have been the leading performers, with successes exceeding 90%. essential resources and services and social equity.

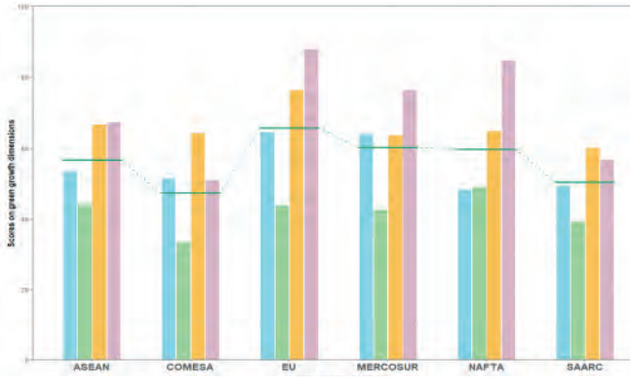


**Figure 5.** GGI and By Dimensions in the Selected Economic Groups, 2022

**Source:** Global Green Growth Index Technical Report

## Conclusion

The Green Growth Index scores of the countries by region, as reflected in Figure 4 indicate that most European countries' scores gather around the high range of scores, between 60 and 80% in 2022. African and Asian countries, had by contrast scores around the moderate range, between 40 and 60%. The situation in Asia is higher compared to Africa, where Japan and China had high scores while some other Asian countries also had scores above 60% such as Laos, Thailand, Bhutan, Georgia, and Nepal. However, the results for the Americas and Oceania countries tended to split above and below 60, corresponding to high and moderate performance, respectively.

Figure 4. and 5. represent the distribution of country scores, by selected economy groups and by the four green growth dimensions. Generally, the countries in Europe performed better in natural capital protection than other countries, despite Monaco, with a very low score of only 16.19%. Many European countries had high scores on green economic opportunities. The European countries excelled in social inclusion, with high and very high scores, without any country outliers. This region is approaching the sustainability goal of leaving no one behind.

Despite European high levels in GGI, the EU still has to carry and monitor a rigid implementation of environmental policies across the EU, to ensure that each member state is engaged and committed to the EGD's ambitious goals. Because the world has limited resources, all other economic regions and every single country also have to devote more to the global efforts of conducting a green economy while protecting the environment.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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Externally peer-reviewed.

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# COP 29 AND AZERBAIJAN: DIGITAL TECHNOLOGIES AND GREEN ENERGY IN GLOBAL CLIMATE GOVERNANCE

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**Abstract**

This study examines the pivotal role of COP29 in global climate governance, with a particular focus on Azerbaijan's contributions to the green energy transition and the integration of digital technologies in climate protection. COP, under the United Nations Framework Convention on Climate Change (UNFCCC), is a key platform for international cooperation in addressing climate challenges. With Azerbaijan hosting COP29, the event highlights the nation's growing involvement in the global transition toward sustainable energy, driven by its strategic focus on renewable resources like wind, solar, and hydropower. Azerbaijan's commitment to reducing its greenhouse gas emissions by 35% by 2030, aligned with its national policies, emphasizes its ambition to contribute significantly to global climate targets. The study also explores the integration of digital technologies-such as artificial intelligence (AI), Internet of Things (IoT), and blockchain – in monitoring emissions, optimizing energy systems, and fostering climate resilience. These innovations enhance the effectiveness of climate action by improving energy efficiency and transparency in climate finance. By examining Azerbaijan's policies and the potential outcomes of COP29, this paper provides a comprehensive analysis of the nation's role in advancing global climate cooperation and technological innovation in the context of green energy.

**Keywords:** COP29, Azerbaijan, green energy, digital technologies, climate governance

## Introduction

The Conference of the Parties (COP) is an annual series of high-level meetings organized under the framework of the United Nations Framework Convention on Climate Change (UNFCCC). Established in 1992 during the Earth Summit in Rio de Janeiro, the UNFCCC marked the first significant international effort to combat the growing threat of climate change (Vacchi, & others, 2021). The primary aim of the convention was to establish a global framework for addressing the causes and consequences of climate change, encouraging countries to take collective action to reduce greenhouse gas emissions and mitigate the global impact of environmental degradation. The first COP was held in Berlin in 1995, and since then, these meetings have become a platform for global leaders to negotiate agreements and strategies for addressing the climate crisis (COP1. Report of the Conference of the Parties on its first session,1995).

Over the years, the COP has evolved to encompass broader goals, including the establishment of financial mechanisms, promoting sustainable development, and enhancing adaptation efforts, particularly for vulnerable countries. The Paris Agreement, adopted at COP 21 in 2015, is one of the most significant milestones, setting out legally binding commitments to limit global warming to well below 2°C. COP meetings have served as a critical space for countries to reaffirm their commitments, adjust their targets, and introduce new measures to accelerate the green transition (Viñuales, Depledge, Reiner, & Lees, 2017). As the climate crisis intensifies, COP remains central to the international community's efforts to foster climate resilience and create a sustainable future.

In recent years, the significance of the Conference of the Parties (COP) has grown, especially as global climate challenges have intensified. A closer examination of recent COP conferences sheds light on the increasing importance of COP29. COP26, held from October 31 to November 12, 2021, in Glasgow, United Kingdom, marked a pivotal moment in global climate action. One of its primary goals was to strengthen international cooperation and renew commitments to reduce greenhouse gas emissions, with a focus on limiting global warming to well below 2°C, while striving for 1.5°C as outlined in the Paris Agreement. Key outcomes of COP26 included efforts to enhance resilience to climate impacts, reduce emissions across multiple sectors, and address loss and damage associated with climate change. The Glasgow Climate Pact emerged from this conference, emphasizing accelerated progress towards a sustainable and resilient future (BBC. COP26, 2021).

COP27, held from November 6 to November 20, 2022, in Sharm El-Sheikh, Egypt, took significant steps in addressing the impacts of climate change. The most notable achievement was the establishment of a loss and damage fund to support communities affected by climate-related disasters (UN. COP27, 2022). This conference also called for the acceleration of efforts to mitigate emissions and adapt to the changing climate. Looking ahead, COP28, scheduled from November 30 to December 12, 2023, in Dubai, UAE, promises to build on these efforts by emphasizing an equitable global energy transition and advancing international climate cooperation. Among its key initiatives is the UAE Accord, which highlights the importance of maintaining global temperature increases below 1.5°C, in line with the Paris Agreement. Additionally, COP28 will focus on enhancing climate finance, particularly for developing nations, and fostering sustainable development through its Action Agenda (UN. COP28, 2023).

In this regard, the purpose of this study is to explore the role of COP29 in shaping global climate governance, with a particular focus on Azerbaijan's contributions to the green energy transition and the integration of digital technologies in climate protection. The relevance of this topic is underscored by the increasing urgency to combat climate change and the pivotal role of international cooperation in driving sustainable solutions. This study contributes to the literature by providing a comprehensive analysis of COP29's global impact and highlighting Azerbaijan's position in the evolving green energy landscape.

## Key objectives of the COP: Fostering global climate cooperation

The Conference of the Parties (COP) is an annual international summit held under the United Nations Framework Convention on Climate Change (UNFCCC), established in 1992 during the Rio Earth Summit. As the world grapples with the growing climate crisis, COP serves as a crucial platform where global leaders, environmental experts, and stakeholders converge to negotiate climate policies and initiatives. Over the years, the primary objectives of COP have evolved, but the overarching goal remains the same: fostering international cooperation to address the causes and effects of climate change. This cooperation is critical for achieving key climate milestones, including reducing greenhouse gas emissions, adapting to the impacts of climate change, and supporting developing countries in their climate-related efforts.

One of the primary objectives of COP is to facilitate global consensus on reducing greenhouse gas emissions, which are the leading cause of global warming. Through initiatives such as the Paris Agreement, adopted at COP21 in 2015, nations have committed to limiting the global temperature increase to well below 2°C above pre-industrial levels, with efforts to further limit the increase to 1.5°C. To achieve these targets, COP facilitates the development and enhancement of Nationally Determined Contributions (NDCs), which outline each country's commitments to reducing emissions. COP provides a platform for countries to review, update, and strengthen these commitments periodically. The collaborative nature of COP encourages nations to increase their ambition levels, driven by the understanding that collective action is essential for curbing the worst impacts of climate change (Slakmon, Gideon, & Keynan, 2023).

Another key objective of COP is to enhance climate adaptation efforts, particularly in vulnerable regions that are already experiencing the devastating effects of climate change. While reducing emissions remains a core priority, adaptation measures are equally important for protecting communities, ecosystems, and economies from climate-related disasters such as floods, droughts, and rising sea levels. COP negotiations emphasize the need for developed nations to provide financial and technical assistance to developing countries to help them build resilience. Instruments like the Green Climate Fund, established at COP16 in Cancun, play a pivotal role in supporting adaptation projects in the Global South. At recent COP meetings, there has been an increasing focus on promoting nature-based solutions and innovative technologies to strengthen climate adaptation. By fostering cooperation among nations, COP enables the sharing of knowledge, resources, and best practices in adaptation strategies, ensuring that the most vulnerable populations are not left behind (Obergassel, Hermwille, & Oberthür, 2021).

Finally, COP aims to address climate finance, recognizing that the global fight against climate change requires significant financial investments. A central theme of COP negotiations has been the need to mobilize resources from developed countries to support both mitigation and adaptation efforts in developing nations. At COP15 in Copenhagen, developed countries pledged to mobilize $100 billion annually by 2020 to assist developing countries in their climate initiatives, a goal that remains crucial in subsequent

COP meetings. Climate finance enables developing nations to invest in renewable energy, build climate-resilient infrastructure, and implement low-carbon technologies. Furthermore, COP facilitates the creation of frameworks that ensure transparency and accountability in climate finance, encouraging countries to honor their financial commitments. In addition to public funding, COP also encourages the involvement of private sector investments, recognizing that a multi-faceted approach is essential to meet global climate targets (Wright, 2021).

To sum up, the key objectives of COP revolve around fostering global climate cooperation by addressing emissions reductions, climate adaptation, and climate finance. These objectives are interlinked, as effective climate action requires not only ambitious commitments but also the necessary financial and technical support to implement them. As the world faces increasing environmental challenges, COP continues to be a vital mechanism for driving international efforts to combat climate change, promoting a sustainable and resilient future for all nations. Through collaborative dialogue and shared responsibility, COP remains at the forefront of global climate governance.

## Global impact and benefits of COP 29

The 29th Conference of the Parties (COP29) under the United Nations Framework Convention on Climate Change (UNFCCC) will be held from November 11 to 22, 2024, in Baku, the capital of Azerbaijan. This international event provides a platform for nations from around the world to convene and discuss urgent climate-related challenges, while also collaborating on solutions for both mitigating and adapting to climate change. Azerbaijan's selection as the host for COP29 reflects the country's commitment to climate action on the global stage. President Ilham Aliyev has emphasized Azerbaijan's readiness to host the conference and reiterated the nation's dedication to implementing energy efficiency measures and contributing to international climate initiatives (Kazimbeyli, 2023). This decision highlights Azerbaijan's willingness to take an active role in combating climate change and underscores the importance of multilateral cooperation in addressing global environmental challenges.

As the host of COP29, Azerbaijan is expected to engage in comprehensive planning and coordination efforts to ensure the success of the event. The COP28 Presidency, in collaboration with the newly established COP29 Presidency, will work together to facilitate a transparent and inclusive preparatory process. This process aims to lay the groundwork for productive negotiations and meaningful outcomes during the conference in Baku. Azerbaijan's role as host comes at a critical time when international climate cooperation is needed more than ever to meet global climate goals and strengthen resilience against climate impacts. However, Azerbaijan's hosting of COP29 has also brought attention to the country's energy policies and the challenges it faces. The nation's plans to expand natural gas extraction have raised concerns among environmental advocates, who argue that such expansions could lead to an increase in carbon dioxide emissions and undermine global efforts to combat climate change (Gavin & Mathiesen, 2024). This situation underscores the need for Azerbaijan to balance its energy policies with its commitments to climate action and environmental sustainability.

In the lead-up to COP29, there is significant anticipation surrounding how Azerbaijan will navigate these challenges while also showcasing its commitment to climate action. The conference represents a unique opportunity for the country to demonstrate leadership on the international stage by addressing its energy-related challenges and aligning its policies with broader global sustainability efforts. Azerbaijan's energy policy, particularly its reliance on fossil fuels, will be scrutinized as the international community looks for clear signals of the country's dedication to transitioning towards greener alternatives. Nevertheless, COP29 offers Azerbaijan a platform to reaffirm its role in fostering international cooperation on climate change and to highlight its efforts in advancing the green energy transition. Through dialogue, cooperation, and action, COP29 has the potential to drive progress toward a more sustainable and resilient future ( Bichelman, 2023).

In addition to Azerbaijan's role, COP29 will likely focus on broader global priorities such as enhancing climate finance, particularly for developing countries, and ensuring an equitable energy transition. The conference is expected to catalyze international efforts toward fulfilling the goals of the Paris Agreement, particularly the commitment to limit global temperature increases to 1.5°C above pre-industrial levels. The event will also serve as a forum for discussing advancements in climate technologies and innovation, with a special emphasis on the role of digital technologies in monitoring and mitigating the impacts of climate change (Poynting, 2023). As the world faces increasing climate risks, COP29 represents a critical juncture for global climate governance, and Azerbaijan's role as host will be instrumental in shaping the outcomes of this pivotal event.

COP29, to be held in Baku, Azerbaijan, is expected to have a profound global impact by advancing the international climate agenda and reinforcing global cooperation to combat climate change. The conference will bring together world leaders, policymakers, scientists, and climate activists to engage in discussions on how to accelerate the implementation of climate goals outlined in the Paris Agreement. One of the primary global benefits of COP29 will be its potential to push nations toward more ambitious emissions reduction targets, particularly through enhanced Nationally Determined Contributions (NDCs). By providing a platform for countries to review and update their climate commitments, COP29 can catalyze more effective and coordinated international efforts to limit global temperature rise and avert the most catastrophic impacts of climate change.

Moreover, COP29 is likely to focus on addressing climate finance, a critical area for ensuring that developing countries have the resources needed to adapt to and mitigate the effects of climate change. One of the expected outcomes of the conference is the expansion and accessibility of climate finance mechanisms, such as the Green Climate Fund, to support vulnerable nations in building climate resilience (Green Climate Fund. ED remarks at plenary session, 2024). These financial commitments are crucial for bridging the gap between developed and developing countries, ensuring that all nations, regardless of their economic status, can participate in global climate efforts. COP29 could play a key role in ensuring that climate finance pledges are fulfilled, and innovative financing solutions are introduced to enhance the overall effectiveness of climate mitigation and adaptation strategies.

Additionally, COP29 will likely underscore the importance of a just and equitable energy transition, promoting renewable energy as a cornerstone of sustainable development. By focusing on the global transition from fossil fuels to cleaner energy sources, COP29 has the potential to influence national policies and promote investments in renewable energy technologies. The conference will provide a platform to highlight successful case studies and encourage cross-border collaborations on energy innovations. As Azerbaijan hosts the event, the country's position as a strategic energy hub will spotlight the challenges and opportunities of balancing fossil fuel dependency with commitments to green energy. Globally, COP29 can serve as a driving force for accelerating the green transition, fostering collaboration, and ensuring that all countries can benefit from the technological and economic opportunities arising from clean energy advancements.

## Azerbaijan's role in the Green energy transition

In recent years, Azerbaijan has increasingly focused on the diversification of its energy sector, recognizing the urgent need to transition from fossil fuels to renewable energy sources. As global efforts to combat climate change intensify, Azerbaijan's role in the green energy transition is becoming more prominent, with the country taking steps to reduce its carbon footprint and invest in sustainable energy solutions. Azerbaijan's renewable energy potential is vast, particularly in wind, solar, and hydropower. The country's geographical location offers favorable conditions for harnessing these resources. The Caspian Sea coastline, for instance, presents excellent opportunities for both onshore and offshore wind energy production, while the sunny climate in various regions of Azerbaijan is ideal for solar energy development. Hydropower has been a traditional renewable source for Azerbaijan, and while it remains an important component of the country's energy mix, there is growing interest in expanding the use of wind and solar energy. Azerbaijan's renewable energy transition is not only a response to global climate imperatives but also a strategy to enhance energy security by diversifying energy sources and reducing dependence on fossil fuels (Aghazada, 2024).

In line with global climate goals, Azerbaijan has committed to reducing its greenhouse gas emissions by 35% by 2030 compared to 1990 levels, as part of its Nationally Determined Contribution (NDC) under the Paris Agreement. This ambitious target highlights the country's commitment to playing a role in the global effort to mitigate climate change. To achieve this goal, Azerbaijan is focusing on the development of renewable energy projects and improving energy efficiency across various sectors (Minister: Azerbaijan will reduce heat-generating waste by 35 percent by 2030, 2016). In 2020, Azerbaijan announced its "Strategic Roadmap for the Development of Public Services and Utilities in the Field of Energy," which outlines key steps for promoting renewable energy and integrating it into the national grid. This roadmap serves as a guiding document for the country's long-term energy strategy, prioritizing investments in clean energy technologies and encouraging international partnerships in the renewable energy sector (Aghazada, 2024).

Azerbaijan's transition to renewable energy is not without challenges. The country's economy remains heavily dependent on oil and gas exports, which account for a significant portion of government revenue and foreign exchange earnings. This dependence poses a challenge to diversifying the energy sector, as shifting away from fossil fuels could have short-term economic repercussions. Additionally, the development of renewable energy infrastructure requires substantial investments, and Azerbaijan faces competition for international financing in a global market where many countries are seeking to expand their green energy portfolios. To address these challenges, Azerbaijan is actively seeking foreign investments and partnerships with international financial institutions, such as the European Bank for Reconstruction and Development (EBRD) and the Asian Development Bank (ADB), to fund renewable energy projects and related infrastructure. Furthermore, the government has also implemented regulatory reforms to attract private sector investments in the renewable energy sector (Dinçer, 2023). In 2021, Azerbaijan adopted a new law on the "Use of Renewable Energy Sources in Electricity Generation," which provides incentives for investors in the form of tax exemptions and guarantees access to the national grid for renewable energy producers (Law of the Republic of Azerbaijan on the use of renewable energy sources in the production of electricity. 2021). These policy measures are designed to create a more favorable business environment for renewable energy projects and to encourage both domestic and international investors to participate in Azerbaijan's green energy transition. Despite the challenges, Azerbaijan's green energy transition holds significant potential for transforming the country's energy sector and contributing to global efforts to combat climate change. The government's commitment to renewable energy development, coupled with its strategic location and renewable energy resources, positions Azerbaijan to play a leading role in the regional and global energy transition. By investing in renewable energy technologies, promoting energy efficiency, and fostering international cooperation, Azerbaijan is taking important steps toward a sustainable and resilient energy future.

Azerbaijan's "Azerbaijan 2030: National Priorities for Socio-Economic Development" has been aligned with the United Nations' 2030 Agenda for Sustainable Development, demonstrating the country's commitment to the international green energy transition (Azerbaijan 2030: National Priorities for socio-economic development, 2021). By integrating global sustainability goals into its national priorities, Azerbaijan aims to foster a balanced approach to economic growth while addressing environmental challenges. This alignment reflects Azerbaijan's dedication to promoting renewable energy, enhancing energy efficiency, and reducing carbon emissions in line with global climate objectives. The country's strategy highlights the importance of sustainable development as a key pillar of its long-term economic and environmental policies.

Azerbaijan's renewable energy potential is vast, particularly in offshore wind, with the Caspian Sea offering an estimated technical capacity of 157 GW. In partnership with international organizations like the World Bank, Azerbaijan is developing roadmaps for utilizing this capacity (Aghazada, 2024). Recent agreements with companies like Masdar and Fortescue Future Industries highlight plans to develop large-scale solar and wind projects, as well as green hydrogen initiatives, further demonstrating the country's dedication to sustainable energy

development. The country has also introduced key legislative frameworks to promote the use of renewable energy. A 2021 law provided a foundation for competitive bidding processes and incentivized the adoption of renewable energy technologies by prosumers. These efforts are part of Azerbaijan's broader vision to position itself as a "clean environment and green growth" country, with significant investments in energy efficiency, sustainable infrastructure, and international green energy collaborations

## The Role of Digital Technologies in the Protection of Climate Change

Digital technologies have increasingly become essential tools in addressing the challenges posed by climate change. From improving the efficiency of energy systems to enhancing environmental monitoring, digital innovations play a crucial role in protecting the planet and mitigating the impacts of global warming. The integration of digital technologies into climate action strategies is not only helping to track and reduce emissions but also facilitating the adoption of sustainable practices across various sectors.

One of the primary ways digital technologies contribute to the protection of climate change is through the monitoring of greenhouse gas (GHG) emissions. Advanced technologies, such as satellite imaging, Internet of Things (IoT) sensors, and big data analytics, enable real-time monitoring of environmental conditions and emissions levels. For instance, IoT sensors can be deployed in urban areas, factories, and energy plants to measure CO2 levels, providing accurate data that can inform climate policies and interventions. This data-driven approach allows governments and organizations to better understand their carbon footprints and adjust their operations to meet climate targets. According to a study by the International Energy Agency, the implementation of IoT and AI technologies in energy systems has the potential to reduce global CO2 emissions by up to 15% by 2030 (Perrone & Glena, 2022).

In addition to monitoring, digital technologies are pivotal in mitigating the effects of climate change by optimizing energy consumption and reducing reliance on fossil fuels. Smart grids, powered by artificial intelligence (AI) and machine learning algorithms, enable more efficient energy distribution by balancing supply and demand in real-time. These technologies facilitate the integration of renewable energy sources, such as solar and wind, into national grids, reducing the need for carbon-intensive energy production. The International Renewable Energy Agency (IRENA) estimates that digitalization in the energy sector could lead to energy savings of up to 30% by 2050, significantly lowering global emissions. Furthermore, AI-driven energy management systems can forecast energy demand and automatically adjust the output of renewable energy plants to meet fluctuations, enhancing the reliability of clean energy sources (Xiao & Su, 2022 ).

Digital innovations also play a critical role in climate adaptation, particularly in vulnerable regions that are already experiencing the adverse effects of climate change. Climate modeling tools, powered by AI, can simulate future climate scenarios based on current environmental data, allowing policymakers to design better strategies for disaster risk reduction. For example, machine learning models can predict the likelihood of extreme weather events such as floods, droughts, and heatwaves, enabling governments to take preventive measures and protect communities from climate-induced disasters. In agriculture, digital technologies are enhancing climate resilience through precision farming techniques. Sensors and drones provide real-time information on soil conditions and crop health, allowing farmers to make informed decisions that optimize water and fertilizer use, thus reducing the environmental impact of agriculture and improving food security in the face of climate change (Xie & others, 2024).

Furthermore, the role of digital technologies in climate change protection extends to social sustainability by promoting public awareness and engagement. Digital platforms, including social media, mobile apps, and online portals, are powerful tools for raising awareness about climate issues and mobilizing public action. For example, the use of mobile applications to track individual carbon footprints encourages citizens to adopt more sustainable lifestyles by providing them with real-time feedback on their energy consumption, transportation choices, and waste production. By making climate data accessible to the public, digital technologies empower individuals to contribute to global climate goals through personal actions, reinforcing the collective effort needed to combat climate change.

Recent trends in the role of digital technologies in climate protection focus on the integration of Artificial Intelligence (AI) and big data analytics into environmental monitoring and climate modeling. AI is now being used to process vast amounts of climate data, enabling more accurate predictions of weather patterns, sea level rise, and other climate-related events. For instance, machine learning algorithms can analyze satellite imagery to detect changes in deforestation rates, ice sheet melting, or urban heat islands, providing real-time insights into the environmental impact of human activities (Alestra, Cette, Chouard & Lecat, 2023). These data-driven insights help policymakers make informed decisions on climate adaptation strategies, enabling proactive responses to emerging threats. Additionally, AI is being employed in energy management systems to optimize the use of renewable energy sources, balance grid demand, and reduce energy wastage (Xie, H., & others., 2024).

Another key trend is the development of digital twin technologies for climate resilience and urban planning. Digital twins are virtual models of physical systems, such as cities or infrastructure, that can simulate various scenarios based on real-time data. For example, cities can use digital twins to predict the impact of rising sea levels or extreme weather events on infrastructure and urban planning. This allows for better preparedness and adaptive planning in the face of climate risks. Moreover, blockchain technology is emerging as a tool for enhancing transparency in climate finance, particularly in tracking carbon credits and ensuring accountability in global climate agreements. Blockchain enables secure, transparent tracking of carbon offsets and renewable energy certificates, providing a more reliable way to verify climate action efforts by governments and corporations (Table 1).

**Table 1. Newest Trends in Digital Technologies for Climate Protection**

| Trend | Description | Impact |
|---|---|---|
| AI and Big Data in Climate Modeling | AI and big data analytics are used to improve climate predictions and analyze environmental data for more accurate forecasting. | Improved accuracy in climate forecasting and better policy decisions based on reliable data. |
| Digital Twin Technologies | Digital twins simulate real-world systems, allowing for predictive urban planning and resilience building against climate risks. | Enhanced urban resilience and infrastructure planning in the face of climate challenges. |
| Blockchain for Climate Finance | Blockchain enhances transparency in carbon trading, tracking climate finance and ensuring accountability in emissions reductions. | Increased transparency and trust in carbon markets, ensuring credible climate action. |
| IoT for Real-Time Environmental Monitoring | IoT sensors provide real-time data on environmental factors like air quality, temperature, and CO2 levels, helping in adaptive strategies. | Real-time monitoring enables quicker responses to environmental changes and disaster risk reduction. |
| AI in Renewable Energy Management | AI systems optimize the integration of renewable energy sources, balancing grid supply and demand to reduce energy wastage. | Better efficiency in energy systems, promoting greater use of renewables and reducing carbon emissions. |

**Source:** It was prepared by the author through various analyses.

Looking to the future, the role of digital technologies in climate protection is expected to expand significantly as advancements in Artificial Intelligence (AI), blockchain, and Internet of Things (IoT) continue to evolve. AI is predicted to play an even more central role in optimizing energy systems, managing large-scale renewable energy grids, and refining climate models for better predictive accuracy. In the coming decades, AI-powered climate models could offer more precise long-term projections, enabling more proactive adaptation strategies. Additionally, blockchain is likely to become a standard in climate finance, ensuring transparency and accountability in carbon credit markets and international climate agreements. The growing integration of digital twin technologies will also enable cities and industries to simulate and test climate scenarios, improving resilience planning. As these technologies mature, they will be crucial in accelerating the global transition to a more sustainable, low-carbon economy, while also facilitating the development of smart cities, green infrastructure, and enhanced environmental governance.

## Conclusion

As a conclusion, COP (Conference of the Parties) plays a central role in fostering international collaboration to address climate change. The key objectives of COP have evolved over the years, emphasizing emissions reduction, climate adaptation, and climate finance. COP29, to be held in Baku, Azerbaijan, is expected to advance these goals, with a focus on global energy transition and increased climate finance mechanisms for developing countries. Azerbaijan has committed to reducing its greenhouse gas emissions by 35% by 2030 and is focusing on diversifying its energy sector. The country is leveraging its renewable energy potential, particularly in wind, solar, and hydropower. However, Azerbaijan's reliance on fossil fuels remains a challenge, and the country is seeking international partnerships and investments to overcome financial barriers and advance its renewable energy agenda.

In conclusion, Azerbaijan's role in the green energy transition is multifaceted, involving both domestic efforts to reduce emissions and international cooperation to promote sustainable energy solutions. While the country faces challenges related to its dependence on fossil fuels, it is making significant strides in diversifying its energy mix and investing in renewable energy infrastructure. As Azerbaijan prepares to host COP29, its leadership in the green energy transition will be in the global spotlight, offering the country a unique opportunity to demonstrate its commitment to climate action and to contribute to the global effort to build a more sustainable and climate-resilient world.

Digital technologies are increasingly playing a pivotal role in climate governance. Key areas of impact include real-time monitoring of greenhouse gas emissions, optimizing energy consumption, and enabling more accurate climate modeling. Technologies such as AI, IoT, and blockchain are revolutionizing climate strategies, enhancing transparency in climate finance, and promoting resilience against climate risks. In conclusion, digital technologies are indispensable in the fight against climate change, offering innovative solutions for monitoring, mitigating, and adapting to the environmental crisis. From enhancing energy efficiency and reducing emissions to improving climate resilience and fostering public engagement, digital tools are reshaping the way societies respond to the climate challenge. As the world moves towards achieving the Sustainable Development Goals (SDGs), particularly SDG 13 on climate action, the integration of digital technologies into climate strategies will be critical for ensuring a sustainable and resilient future. Governments, private sectors, and international organizations must continue to invest in and scale up the deployment of these technologies to accelerate global climate action and protect the planet for future generations.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The authors confirm being the sole contributor of this work and have approved it for publication.

## Peer-review

Externally peer-reviewed.

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## Conflict of interest

No potential conflict of interest was reported by the author(s).

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# COOKING A CHICKEN CURRY BY TRAVELLING ALL OVER THE WORLD: AN ETHNOGRAPHIC OBSERVATION OF CONSUMPTION AND ENVIRONMENTAL ASPECT

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**Abstract**

The purpose of this study was to develop a consumption diary by being a consumer in relation to our lifestyle and identity. This study was done by using the ethnographic observation method living in Lund, Sweden, with the help of the concept of commodity chain. Hence the main objective of this study reflects our everyday consumption activities and how a specific commodity could be addressed with the concept of commodity chain in a way where a big chain is involved and each chain involves extraction of natural resources, which affects our current discourse of environmental and ecological aspects.

**Keywords:** Ethnographic observation, consumption diary, environmental aspects, natural resources

## Introduction

Today I got up by hearing my door ring/calling bell early in the morning. As soon as I opened the door, I saw a man standing up with a big plastic bag. Yes, this is the bag I was waiting for the last couple of days. The man was from the EMS (Express Mail Service) office to hand it over. I got this bag while staying at my home here in Lund, Sweden, and this bag was sent by my parents, who are living in Dhaka, Bangladesh. This bag contains a lot of staff, which I am very much used to with my lifestyle or perhaps my identity. Defining identity is not an easy task, considering the fact that different scholars have different views on this concept. The later part of this paper would try to define and analyze lifestyle and identity issues. Staffs which I have got from the bag were coriander powder, green cardamoms, ginger powder, two shirts, and Ponds Vanishing (oil control) cream. Yes, "I am a consumer; as soon as I get out of bed, I start consuming" (Ryan and Durning, 1997:4). This paper would try to figure out what I have consumed over the last week (September 1st till September 8th 2024). One item or object is selected to see its geographical journey by using the concept of commodity chain and how this is connected with lifestyle and identity, how much labor was involved in different points along the chain, identity moments of greenhouse emission, and if there was any power relation involved in production and within the commodity chain.

## Consumption as lifestyle

Thorstein Veblen (1902), in his 'Conspicuous Consumption' stated that "in the earlier phases of predatory culture, the only economic differentiation is a broad distinction between an honorable superior class on the one hand and a base inferior class of laborers on the other hand" ( Veblen, 1902: 65). So, the general principle, more or less rigorously applied, is that the base industrious class should consume only what may be necessary to their subsistence.

In the nature of things, luxurious and the comforts of life belong to the leisure class. After that, Veblen (1902) stated that in the earlier stages of economic development, this restriction tends to disappear, at least formally, after a later peaceable stage has been reached with private ownership of goods and an industrial system based on wage labor or on the pretty household economy. What happened is that the leisure then not only consumes of the staffs of life beyond the minimum required of subsistence and physical efficiency, but this consumption also undergoes a specialization as regards the quality of the goods consumed. Hence, consuming freely the best staff is not because of their subsistence but also because these more excellent goods are evidence of wealth. It becomes honorific.

This could be associated with what Schor (1998) mentioned that consumption has a comparative or even competitive character. "As the workplace replaced by the coffee culture and the backyard barbecue, it becomes a social contact place, like who went where for a vacation or whether their kids were going to the dance class" ( Schor, 1998:10). This is the process where people start comparing each other and their desire to consume then depends on others. The thing is that what you consume or are supposed to consume does not depend on what exactly your needs are. What has happened is that in the new consumerism, 'lifestyle' aspirations are now formed by different points of reference, like a neighborhood has been replaced by a community of coworkers, where people always compare, on the other hand, our real life friends have been replaced by our 'media friends', we watched the way television families live, we read about the lifestyle of the celebrities and other public figures we admire; and then we consciously or unconsciously assimilate this information, which affects us( Schor, 1998).

## Visible lifestyle as consumption

New consumerism tends to believe that we can always upgrade ourselves and our things. Here we find the concept of how we buy speaks our volumes. The variations of choices and tastes have been increased in the new consumerism. We could see it from the Roseberry's (1996) discussion on the rise of Yuppie coffee. In the past Coffee in the United States was sold in cans in supermarkets, the roasts were light and bland, the choices were limited. (Roseberry, 1996: 764). The thing is that consumers were limited too. Now in the new consumerism or what Sharon (1998) would say in post modernity, different sort of coffees is widely available in the supermarket and widely consumed (Roseberry, 1996: 774).

The transformation of coffee could be understood a broad range of economic and social transformation, which associated with industrial revolution. As Sharon (1998) mention that urban lifestyle that represents both structural change and adaptation. In the early modernity commercial culture has generally shaped the public life of modern cities and these were formed around department stores, restaurant hotel public bar etc. So it was kind of back drop social change. But the period of late modernity or perhaps post modernity that began in the mid of 20th century (Sharon, 1998), shifted the growth of the 'consumer society'. Here in the late modernity all this restaurant, hotel, bar remains but what has happened is that a transformation of symbolic economy which is based on cultural symbol including offices houses, restaurants, and even streets. So here all these commercial objects were based on what mass people like or perhaps on the basis of lifestyle. Perhaps urban population is now divides by lifestyle, a lifestyle which is visible. So the strategies of urban redevelopment based on consumption focus on visual attractions that makes people spent money (Sharon, 1998: 832). What we have got is that 'visible lifestyle' which has become symbol of status. An example could be found from Schor's (1998) book, cloths, cars, wristwatch, living room furniture, and lipsticks are well known purveyors of social position. Mattresses, bed room curtains, foundation powders, and bank accounts on the other hand not what separates the items in the first list from those in the second. The thing is that first items are visible therefore these items have its exchange value when it comes to the "visible lifestyle". For instance, in the 'visible lifestyle' if we take an example from the academic work like if you write a very good paper which is not published, perhaps do not have the exchange value, or one would argue that it doesn't even have a use value at all even though to write that paper labor was embodied in it. So, it is a 'waste' thing.

The obvious result or consequence is to run for publishing so that people could see what you have written and it gets both use and exchange value. In this process you change your status in way where you become as a scholar to the society by showing that you have got lots of published paper. Even though someone like Veblen (1902) would argue that the use of the 'waste' is a technical term. He stated that an article or object may be 'useful' or 'wasteful' both and its utility to the consumer may be made up of use and waste in the most varying proportion. This could be an example to say that in the postmodern era or rather in the 'consumerism' not only the working class or base class believe that they have a stair to get up but also the educated people whose occupation perhaps according to Bourdieu(1979) is on the up in hierarchy also running for stairs to have their exchange value or perhaps for even more higher status. The major thing is that in the 'visible lifestyle' you can always try to change yourself to be changed and in the post modernity the urban population is now divided on lifestyle rather than race, ethnicity, or social class where consumption is the basis.

## Cultural capital as consumption

Sharon (1998) articulated that during the past 30 years, the meaning of urban lifestyles has changed from fairly stable prerogative of social status to a pursuit of cultural capital. Bourdieu (1979) stated that "knowledge of the social world has to be taken into account, a practical knowledge of this world which preexists and which it must not fail to include in its object" (Bourdieu, 1979: 465). What Bourdieu discovered is that a person's educational level and father's occupation revealed much about that individual, tastes in music, art, what kinds of shops they patronized and the type of cooking they do. So here money itself cannot account for that the preference in music or dressing or posture varies by class. Here from Bourdieu (1979) what we could find is that something contrary from the conscious experience of consumer preferences and testes as something that's just us, what we like and dislike is socially produced. So consumption, tastes create through what Bourdieu(1979) calls cultural capital. The knowledge has been assimilated from the

rich like what good and bad taste is, in this way a systemic or legitimate hierarchy of taste emerged, which is associated with cultural capital.

What Bourdieu(1979) coined is that 'habitus' like individual taste depends on personal experience. Bourdieu's( 1979) ideas of systematic or legitimate taste and also the cultural capital could be found form today's most modern or globalized world. For instance, if you go to any of a McDonalds anywhere around the world you would see that women are working in front or in the cash, hardly you would see any man working in front. This is the systematic taste which comes from the hierarchy that women should work in front. This idea is to somewhat associated with the 'thinking from the above', where idea comes from what 'above' people or perhaps the leaders think. At the same time women who are working in front they fall into the today's visible life style where women are being exposed to show themselves in front. Perhaps it could be associated with the term symbolic violence (Bourdieu, 1979).

It is also believed that even though these women are trained how to present themselves to the consumer, their everyday life, posture, out of their working place is not changed that much. Which could be associated with the term what Bourdieu (1979) called cultural capital. Perhaps it is true as Sharon (1998) stated that lifestyle has changed from the stable social status to pursuit cultural capital, it could be seen in other way around that people want to pursuit cultural capital is to get or to pursuit social status. Even though Bourdieu(1979) would argue that cultural capital is something which you have got inherently. It is obvious that people in the consumer culture or I would say in the 'capitalism' would try to achieve cultural capital with the help of ever rising advertisement (Featherstone, 1982). Hence, in the ultimate analysis it is inevitable that people would consume to get "cultural capital", to achieve their desire "visible life style". As Schor(1998) mentioned that the "identity of consumption relationship is a two way street, who we are not only affects what we buy, what we buy also affects who we become" ( Schor, 1998: 57). The more we have the more powerful, confident and socially validated we feel.

Mort(1986) mentioned that world perhaps moved beyond the conventional Marxist and socialist analysis and worker appears more consuming than producing, the answer could be found from Miller's(1995) statement that the global spread of the mass consumption of mass commodities means that people increasingly define themselves, their culture and their world by means of these commodities, rather than by means of the older frames such as kinship and ethnicity, which are themselves increasingly defined through consumption.

The idea of defining ourselves through consumption derives us to our current day's environmental crisis. When it comes to solve environmental crisis someone like Schor(1998) who talked about down shifting and then tried to figure out a portfolio of a down shifter like- buys organic fare, repair rather than buys, recycling and so on. What Schor(1998) tried is that to make the change by excepting the idea of "consumer" what we have now. Perhaps we could look at from the Marx's point of view. For Marx the system which has come to dominate is 'capitalism' where things are evaluated by exchange and monetary value. (Gare, 1995). We could see it from Marx's own writing "In the Bourgeoisie, all fixed, fast-frozen relations, with their train of an ancient and venerable prejudices and opinions, are swept away, all new formed ones become antiquated before they can ossify, all that is solid melts into air… the need of a constantly expanding market for its markets chases the bourgeoisie over the whole surface of the glob" (Marx and Engels, 1978:475). To solve our environmental problem perhaps we could rethink about our concept "consumer" by using Marx's notion of 'class' and 'class consciousness' in a way where all "consumer" would be on the whole as a "class" so we would define "consumer" or perhaps human being as a "class" who would essentially feel alienated from the consumption by being rejected or living with the vulnerable environmental condition that we have now these days like increasing hurricanes, earth-quake, flooding, drought. When this "class" would feel themselves alienated from mass consumption then the class consciousness would form (Marx, 1887) so that our social system of consuming could be changed in order to get a sustainable environment.

## Ethnographic observations

*Commodities which I have consumed over the last one week and how I feel of consuming these, messages and meanings*

Tooth paste, Tooth brash, Ponds Vanishing (oil control) cream, Body lotion, Milk, Bread, Orange Juice, Toilet paper, Cloths( T- Shirt, and pajama), Shoes, Laptop, Spices- Ginger, red chili powder, turmeric, cinnamon, coriander powder, Green cardamoms, Potatoes, edges, chicken, lamb, Tomatoes, cooking oil, micro web woven, Electric stove/burner, Bus, Car, books or papers, Gym, Wine, cola. I tried to put these commodities in order in a way by which one could recognize what I used to consume from early in the morning when I get up to later at night when I get down to bed. For instance, Tooth paste, Tooth brash, Ponds Vanishing (oil control) cream, Body lotion, Milk, Bread, Orange Juice, Toilet paper I use these commodities in the morning to get fresh and to have my breakfast. After that I put my clothes on and start using laptop. To prepare my lunch and dinner I use Spices- Ginger, red chili powder, turmeric, cinnamon, coriander powder, green cardamoms, Potatoes, edges, chicken, lamb, Tomatoes, cooking oil, micro web woven, and Electric stove/ burner, then I get out of my home either by car or by bus to go to gym or to hang around somewhere else, then come back home and drink a glass of wine or cola, and then afterwards I go to bed. Except from this consumption, I also used food commodities like Onion, Cake, biscuits, Chips, Milk, Cloths like cap, trousers, jacket, toiletries like soap, shaver, shaving foam, room furniture's like, cot, chair, bed cover, table, spoons etc. Please note that these commodities or objects have been consumed or used by me over the last week from 14th March to 19th of March. What I have noticed is that there wasn't that much variation in my consumption diary it was more or less same during the course of whole week. By using these commodities most of the case I felt that these are part of my everyday activity so I need these to consume, there was just only one or two commodity which I felt I should cut it off by being environmentally friendly. When it comes to messages and meaning of these commodities, I felt sometime I am bound to use these as I am habituated with these, some of these commodities were means to maintain my body,

and some were means to make my meals. Overall, what I felt is that I am in a process to consume these commodities, so I am just running with the motion to consume these commodities. At a glance when I looked at my consumption diary I felt, no I am not that much consuming, perhaps it is because I am not that much financially sound to consume more, as Ryan and Durning, 1997, stated by using one of their respondents view like " I don't usually think of myself as a consumer, though I don't spend much time worrying about environment"( Ryan and Durning, 1997: 4), but as soon as I heard the doorbell from the EMS(express mail service) man I started thinking about the commodity chain issues therefore I decided to pick one commodity from the above mentioned consumption diary, which is Green Cardamoms.

The reason behind of picking this spice of Green Cardamoms is that I believe this is connected with my lifestyle and it would be interesting to see its geographical journey by using the concept of 'commodity chain'. Before describing from where this commodity originally comes from and where this is being consumed, it would be conducive to see the definition of 'commodity chain'. A commodity chain is a method for tracing the origins of materials and labor that are embodied by everyday commodity goods. It considers the sequential processes used by manufacturing firms to gather resources, transform them into goods and finally distribute them to consumers. It attempts to reveal the concealed histories and geographies of the product before it has use value to the customer. It also illustrates clearly global inter-relations and dependencies. The analysis of commodity chains has developed within the framework of world-system theory, which was originally conceived by Immanuel Wallerstein and his colleges in the 1970s. The chain metaphor captures the separate yet interdependent nature of linked production processes that are needed to produce a final commodity for consumption (CPS, Lund University 2010 on commodity chain).

## Green cardamoms and its geographical journey

I come from Bangladesh and studying Lund University, Sweden. In my country I used to have spices foods and curries to have lunch and dinner. Green Cardamoms is one of those typical spices which we normally use almost all of our curries. When I came here in Sweden, I wanted to get green cardamoms from my nearby super market 'Willys' but they do not have this, I had to go to Malmo, which is the nearest big city from Lund to get this Green Cardamoms from one of very few Indian or Arabic Shops in Malmo. But somehow, I wasn't satisfied with the green Cardamoms which I got from Malmo. So, I asked my parents to send my special Green Cardamoms from my Country Bangladesh which I got from the bag handed over by the EMS guy this morning. When I got the packet of the Green Cardamoms, I tried to figure out its geographical journey. The chart below shows the geographical journey of a packet of green cardamoms.

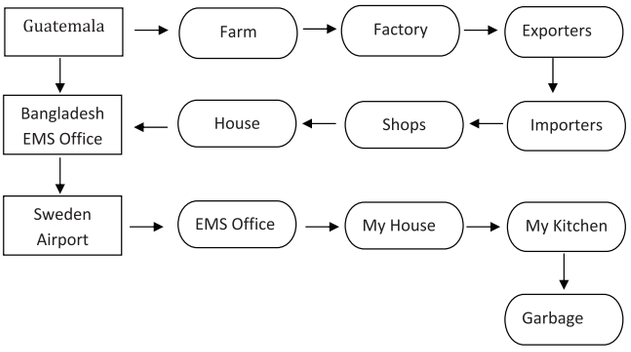


Chart shows that a journey of a pack of green cardamom's origin to my kitchen & garbage. I will elaborate the geographical journey in section of natural resources and green house involved in the chain.

## Green cardamoms, lifestyle and identity

I was born and raised in Bangladesh. I got my food habit from my social and cultural system. As Egan and his colleagues in Wilk(2006) found it more like a process of combination where food is richly cultural. In my culture, we have foods with spices especially with green cardamoms. Even though I have been living here in Sweden, but somehow, I wasn't able to change my food habits so spices, specifically is more like related to my lifestyle and perhaps my ethnic identity where I come from. Ethnic Identity or Identity has been defined in many ways in various researches. It is difficult to find a widely agreed upon definition of ethnic identity, so there is still confusion about this topic. In a number of articles, ethnic identity is defined as the ethnic component of social identity. Tajfel(1981:225) has defined it as "the part of an individual's self-concept which derives from his knowledge of his membership". Some writers focus on self-identification, while other focus belonging and commitment (Sing, 1977, Ting-Toomey, 1981). Some other definitions focus on cultural aspects of ethnic identity, like foods, values, languages ( Rogler et al 1980). For me, green cardamoms are a spice which I need to make my curries or foods, and I got this food habit from my family or society so it's more like related with my identity and lifestyle which I have had before, somehow I am not able to get out of this belonging even though now I belong to this (Lund, Sweden) society. So, I was desperate to get those green cardamoms and asked my parents to send it off to me from all the way back to Bangladesh as Cardamoms which I get from Bangladesh tests as it is which I like or I had before when I was in my country.

## List of located natural resources and the green house emission involved in the chain and Ecological aspects

If we look at the figure above, it says that the journey began from the farm in Guatemala, where poor farmer plants and grows trees and to plan they have to use chemical pesticides, and to make the soil soft they have to use tractor. Using tractor or chemical pesticides both are associated with energy and fuel, so it's the fossil fuel they use which is a natural resource. Once

green cardamoms are picked to go to the factory to get labeled and packet it goes by track which is made by Steel, and most probably comes from Korea. In the factory Green Cardamoms are packaged into plastic bag which is made my polyethylene, nylon, aluminum foil and polyester. Once it is packaged it goes to the exporters by big tracks which is again made my steel and run by either petrol or diesel. On its way to Bangladeshi importers, it comes through either Ships or airplane. These ships and airplanes are made by Steel and run by huge amount of fossil fuel, then it comes to the small shops in Bangladesh through small track, which is again made by steel and run by oil and these oils comes from Middle East through Big ships. My parents bought green cardamoms from the shop, they went there by there private car, which is again made by steel and run by natural gas. As in Bangladesh most of the private vehicles run by natural gas. Then my parents went to EMS office to send it off to me in Sweden by car. EMS office send it through Airplane, so it reached to Swedish EMS office and then was distributed to the local EMS office through car, finally the EMS man who came to my home in the morning hand it over to me, he also came by car. When I got green cardamoms in my hand I started cooking at my kitchen, I was cooking chicken curry which needs chicken, onions and cooking oil, chickens came from Brazil, cooking oil and spices came from Bangladesh and definitely from long chain, Onions came from Australia, and the Electric stove/burner was made in China. I realized, to make a curry in Sweden, Europe I had to visit all over the world in this planet. When it came to cooking, I turned on my eclectic stove/burner, which needs huge amounts of energy. Once I am done with my cooking, I went to throw my waste into garbage and the garbage bin was made by either very hard steel or road. It the process of making a curry I had to use lot of natural recourses, more specifically each time this single 'green cardamoms' traveled it consumed a lot of greenhouse gas which is completely against of our current and future ecological and environmental aspect.

## Labor involved in different points and manifestation of power relation along the chain

My 'green cardamoms' trees were planted in Guatemala and were picked by the farmers in the farm. Most of the case they earn less than 30 cents an hour. These farmers have very limited freedom when they grow trees as they need to use chemicals and sometimes these chemicals are harmful for their health as Ryan and Durning(1997) mentioned that " Some of the chemicals entered the farm worker's lungs" (Ryan and Durning,1997: 9). In each chain there were some other labors involved, track drivers, EMS guy for instance.

The thing is 'green cardamoms' is one of the most expensive spices in my country Bangladesh, considering the fact that it has a long chain to come down to my own country. But the fact is when we compare earnings of farmers, which is too less, with the finish product price which is too high, it suggests that the owner of the farmer or the exporters they are the one who decide what should be the finish products price and how much they are willing to pay for the farmers This is the power the owners have which they practice in real. It reminds us the Max's notion of surplus value (Marx, 1887) where labors don't get the extra amount of money which is added for the final price. This is the financial or the economic power the owners have which they practice with their farmers or in each chain of a certain commodity which also extract natural resources when it comes to exports and imports business and ecological aspect as well. Like the exporters some time can be a multinational company and they never care about the soil and the chemicals which they are using for the sake of soil, land and labor of the local area or region, which could be associated with ecological aspects and power.

## Conclusion

This was an attempt to see how our lifestyle is associated with our consumption which leads us to see our current discourse of environment and ecological issues. This was quite evident that a specific and very simple spice could have a big chain as green cardamoms were the case for this study. And this chain has something to deal with our natural resources and how they are being used in each chain. It has been a discourse that scholars have now been thinking about subsistence sort of consumption for the sake of our environment and ecology, this study would not suggest that this could be a solution to get rid of a big chain, perhaps this could be an idea from where scholars could go on to think something which could be more sustainable to sustain proper consumption.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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No potential conflict of interest was reported by the author(s).

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# MAPPING OUT VULNERABILITY: CLIMATE CHANGE AND THE SYRIAN REFUGEES IN LEBANON

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## Abstract

In Lebanon, the ongoing Syrian refugee crisis intersects with severe environmental transformations, creating a complex landscape of vulnerability. This research investigates the intersection of climate change and the Syrian refugee crisis in Lebanon, utilizing a Geographic Information Systems (GIS) approach to map out vulnerability and identify areas of critical concern. By analysing data on refugee hosting districts, food insecurity, climate resilience, water stations, and health facilities, the study aims to understand the complex interplay of these factors in shaping the vulnerability of Syrian refugees to climate-related impacts. Spatial exploration of data allows identification of hotspots of vulnerability, assesses the availability of essential resources, and evaluates the effectiveness of adaptation measures. The findings contribute to a deeper understanding of the challenges faced by Syrian refugees in Lebanon and provide valuable insights for policymakers and humanitarian organizations to develop targeted interventions and enhance resilience.

**Keywords:** Climate change, Syrian refugees, Lebanon GIS data, environmental transformations

## Introduction

As the effects of climate change become increasingly apparent, vulnerable populations around the world face disproportionate risks and challenges. The Mediterranean region, particularly its southern and eastern areas, is expected to face much harsher climate change effects than other parts of the globe. By 2100, temperatures in this region could increase by 3-5 degrees Celsius compared to the global average, and rainfall on the southern coast might decrease by 35 percent. Sea levels are predicted to rise by approximately 35 centimetres. Moreover, droughts are likely to occur more often and be more severe in the Mediterranean.

As an Eastern Mediterranean country, Lebanon is situated in a region highly susceptible to climate change impacts. Its mountainous terrain and coastal location make it vulnerable to extreme weather events like droughts, heatwaves, floods, and landslides. In addition, Lebanon is already facing chronic water scarcity due to its arid climate and high population density. Climate change is exacerbating this issue through reduced rainfall and increased evaporation.

In Lebanon, the ongoing Syrian refugee crisis intersects with severe environmental transformations, creating a complex landscape of vulnerability. Break out of Syrian Civil War in 2011 led to one of the greatest humanitarian crises in recent history. More than 350,000 Syrians lost their lives, while millions were injured and more than half of the Syrian population were displaced from their homes. This situation has had a severe impact on Lebanon, which

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is a neighbouring country and has received the greatest number of refugees in relation to its population in the world (Norvegian Refugee Council, 2023). While refugees constitute 22 percent of the total population in Lebanon, the influx of Syrian refugees has increased Syrian population by 40 percent (UNHCR, 2023). The influx of Syrian refugees has placed additional strain on Lebanon's resources, including water, energy, and infrastructure. This makes the country even more vulnerable to the effects of climate change.

In summary, Lebanon's unique geographic, environmental, and socioeconomic conditions make it a particularly important case study for understanding the impacts of climate change and developing effective adaptation strategies. This study seeks to examine the multifaceted impacts of climate change on Syrian refugees living in Lebanon, emphasizing how environmental stressors such as water scarcity, extreme weather events, and deteriorating agricultural conditions exacerbate their precarious situation. By mapping out these vulnerabilities, this study aims to illuminate the urgent need for targeted interventions and policies that address both humanitarian and environmental concerns. This intersectional analysis not only highlights the extent of Syrian refugees' resilience but also underscores the critical role that climate adaptation strategies play in safeguarding their future and enhancing community resilience within Lebanon.

The rest of the paper is organized as follows. Section 2 focuses on the unfolding of climate change in Lebanon and its negative outcomes. Section 3 elaborates literature on climate change and refugee vulnerability. Section 4 investigates the intersection of climate change and the Syrian refugee crisis in Lebanon, utilizing a geographic information systems (GIS) approach to map out vulnerability and identify areas of critical concern. Section 4 makes the concluding remarks and presents some policy implications for resilience and adaptation.

## Climate change in Lebanon

Lebanon is located in the Eastern Mediterranean and the Middle East (EMME) which is considered as a critical region where negative consequences of climate change are heavily felt by the regional societies. These negative consequences include quite high temperatures, intensive droughts and serious floods (Waha et al., 2017, p.1623; Lelieveld et al, 2012, p.667; Wehrey et al., 2023). As Rignall (2019, p.629) rightfully points out, the world has reached to a threshold regarding the disastrous global impacts of climate change whose weight are not felt evenly by the states and the people. While historically, states in the EMME region have relatively less contributed to carbon emissions when compared with the industrialized states, they have been the people of region to have suffered more from climate-related disasters. Societies in the region face numerous health risks such as respiratory and cardiovascular diseases which are mostly aggravated by increasing heat, poor air quality and decreasing of fresh water (Waha et al., 2017, p.1631).

Climate change in combination with rapid population growth and declining precipitation has particularly led to water stress in the EMME which has already been well-known as the most water scarce region (Terink, Immerzeel and Droogers, 2013, p.3055). The water resources of the region are expected to decrease further, reaching alarming levels which in return would cause significant political, economic and social changes (Chenoweth et al., 2011, p.1). Mahmoud (2024) underlines the fact that "the gap between water supply and water demand" in the region has been increased due to drought conditions triggered by climate change and that the stability of the region is highly dependent on whether the issue of water scarcity will be properly addressed, and water management will be improved or not. There has been increasing scholarly attention on the issue of water scarcity in the region and projections reveal important water shortages for most parts of the region in the future (Bou-Zeid and El-Fadel, 2002, pp.345-346). In fact, climate change is not the only cause of water shortage in the region. Rather it acts as a risk-multiplier through exacerbating the impact of "large-scale water management problems" in the region including over-pumping of the aquifers, increased irrigation in agriculture and water pollution (Terink, Immerzeel and Droogers, 2013, p.3055).

Within the EMME region, it is fair to suggest that relatively Lebanon has a more favorable climate when compared with most of the other states. However, in the last decades Lebanon has also had its share from global climate change problems which has been reflected through increase in temperature and decrease in rainfall averages (Taher, 2019, p.21). Halwani (2009) points out that Lebanon is clearly experiencing climate change phenomenon when its "meteorological and hydrological records over the past three decades" are taken into consideration. The negative effects of these records have intensified when combined with a significant increase in population size in the country. Climate change is estimated to have greater damaging consequences on Lebanese environment, economy, development, agricultural production and public health through time (Taher, 2019, p.20).

There are mainly four leading problems associated with climate change in Lebanon. The first one and the most urgent one to be addressed is declining water supplies. In fact, Lebanon is known with its abundant water resources supported by many river systems. In this regard, the country is stated to have a "relatively fortunate hydrological position" (Halwani, 2009). However, according to Bou-Zeid and El-Fadel (2002, p.348) while Lebanon possesses higher water resources per capita in comparison with other regional states, by the year 2025 it will not be able to meet its local demand. The volume of available water in Lebanon has been in a steady decline in the last four decades due to a combination of factors such as decreasing rainfall and snow cover, human interference, mismanagement and absence of public awareness on water use (Halwani, 2009). With annual increase in temperatures, Lebanon's mountains receive less snow each year leading to decreasing amount of ground water each year which in return threatens water supplies for consumption and agriculture (Wehrey et al., 2023). The 1975-1990 Civil War also played a devastating role on the water infrastructure in the county whose side-effects have continued to be seen on the water resources (Bou-Zeid and El-Fadel, 2002, p.349).

Another problem associated with climate change in Lebanon is air pollution. High dependence on fossil fuels has soared air pollution in the country. Wehrey et al. (2023) state that Lebanon has one of the highest health costs in the region, "$900 million annually", due to air pollution. Diesel generators which are widely used in the country in response to ill-management of electricity by the Lebanese authorities and heavy reliance of

Beirut's transportation system on carbon-emitting fuels have also contributed to climate change in the country (Wehrey et al., 2023). It is reported that Lebanon's electricity system is broken since 2019 and "8,000 diesel generators" have powered Lebanese leading devastating effects on air quality and public health (Cheeseman, 2024). Mishandling of wastes which leads to regular burning of trash and releasing of important quantities of toxic chemicals is the third leading problem associated with climate change in Lebanon. Lastly, wildfires and deforestation are closely associated with climate change in Lebanon. Wildfires have expanded in recent years in line with the increasing heat in the country. Wildfires combined with urban growth, diseases, insects and quarries have seriously threated Lebanese forests (Jezzini et al., 2023, p.2).

These above-mentioned problems associated with climate change are further exacerbated with growing population in the country. Lebanon has already been hosting Palestinian refugees when the country also opened its doors to Syrian refugees in the aftermath of the starting of the Syrian civil war in March 2011. The rapid increase in population have caused greater demand for already declining resources such as water. For instance, the Bekaa Valley is known to accommodate significant number of Palestinian and Syrian refugees in addition to local Lebanese which has stressed Bekaa Valley's water resources (Slaymane and Soliman, 2022, p.1). This stress on the Bekaa Valley's water resources is particularly reflected on the deteriorating water quality in the Upper Litani River Basin (Slaymane and Soliman, 2022, p.2).

In the meantime, mismanagement of the country for decades has had detrimental effects on environment and climate. Lebanon has been experiencing political and economic crises particularly since 2019 which has led ruling elites to ignore climate change concerns. Corruption and mismanagement of resources have heightened the impact of climate change in Lebanon and have made Lebanese people more vulnerable to climate crisis (Wehrey et al., 2023). The authorities have turned a blind eye to the waste contaminating drinking water, diesel generators spreading toxic chemicals, excessive use of groundwater and contamination of agricultural lands through irrigation with sewage water (Germanos and Azzi, 2024). According to Wehrey et al. (2023) poor governance and mismanagement of resources have impeded any meaningful climate action to take place in Lebanon and this situation has only worsened the negative consequences of climate change.

Overall, it is fair to suggest that climate change has constituted a further challenge to Lebanon's stability due to inconsistencies regarding the provision of basic services by the authorities such as access to clean water, breathable air and reliable sources of power (Al-Sarihi et. al., 2021, p.3). The consequences of climate change have seriously curtailed the wellbeing of the Lebanese people and the ruling elites need to develop policies and regulations to cope with these challenges to break the vicious circle with respect to instability in the country.

## Climate change and Vulnerable populations

While climate change has negative impacts on the humanity as a whole in terms of enjoyment of basic human rights such as access to drinkable water, shelter and sanitation, people in vulnerable contexts are subject to aggravated harms of it. According to the United Nations Human Rights Office of the High Commissioner (OHCHR, 2022), people may experience greater vulnerability in the face of climate change due to various factors including "geography, poverty, gender, age, indigenous or minority status, national or social origin, birth or other status and disability". For instance, inhabitants of less developed states, small island developing states, and those regions exposed to widespread droughts, floods and desertification are more affected from the severe consequences of climate change. The vulnerability of people living in climate change-fragile regions are further heightened with weak adaptive capacity and ill-management disaster risks of their states since they cannot practice their human rights effectively or in full sense.

Refugee communities are a significant component of vulnerable populations with respect to climate change. UNHCR (2024) state that refugee communities are largely located in "climate change hotspots, prone to the effects of climate change and natural disasters, which compromises their security and places them at risk of secondary displacement". It is pointed out that the regions and the countries which are most prone to climate risks are also the ones to collectively host "28 percent of all refugees" (UNHCR, 2024). OHCHR, (2022) report on the negative impacts of climate change on vulnerable populations suggests that climate change is not only an environmental crisis but also a social justice crisis that needs to addressed taking into consideration the link between climate justice and social equality. In fact, vulnerable communities facing harmful effects of climate change do not live only in less developed or developing parts of the world but there are also such vulnerable communities within countries located in the Global North.

The literature on the impacts of climate change mostly focuses on the vulnerability of specific regions or countries to climate change risks such as droughts in the Sahel region, precipitation in Norther Europe or heatwaves in the Middle East, yet there is relatively less research on the impact of climate risks on specific societies and communities (Broberg, 2017, p.103). Particular populations are highly vulnerable to climate impact due to a combination of geographical risks and neglect by national authorities (Wehrey et al., 2023). Challenges to climate change adaptation are greater in less developed or developing parts of the world due to already existing developmental problems. In such contexts, climate change acts as a "threat multiplier" intensifying present socio-economic complications, destabilizing livelihoods, and increasing the chance of tensions (Sanni et al., 2022, p.1). This is especially the case for relatively more vulnerable populations such as the refugees since negative consequences of climate change hurt them the most.

For instance, Congolese and Burundian refugees in Rwanda are frequently exposed to serious risks of climate-related disasters including floods and landslides (Dampha et al., 2022, p.42). Available lands for constructing refugee camps are considerably limited in the country leading refugee camps to be located in remote areas where climate risks are higher. Dampha et al. indicate that refugee camps in Rwanda are often hit by extreme weather events, and it is difficult to talk about any adaptation (Dampha et al., 2022, p.42). Another example is from Sudan which has been hosting more than 1 million refugees from different countries. Following the Tigray War (2020-2022) in Ethiopia, thousands of Ethiopian refugees sought shelter in Sudan. Most of these refugees settled in the Gedaref state, East Sudan where they experienced tough weather conditions such as "heavy rains, strong storms,

severe floods, and heat waves which resulted in over 50% loss of their shelters and belongings" (Ahmed et al., 2021, p.1). When poor welfare services were accompanied by the severe effects of climate change, there has been a significant increase in the vulnerability of the Ethiopian refugees. In their research Ahmed et al. (2021) clearly demonstrate that climate change risks have aggravated the challenges to the health, security and welfare of the Ethiopian refugees in Sudan.

Like the refugees in Rwanda and Sudan, Rohingya refugees in Bangladesh have also been exposed to climate disasters. Bangladesh with its dense population is regarded as the most vulnerable country to climate impacts in South Asia. The country has been hosting Rohingya refugees who fled neighboring Myanmar due to ethnic cleansing to seek settlement and safety in Bangladesh. The Rohingya refugee camps are predominantly located in flood-prone Cox's Bazar in Eastern Bangladesh (Malji, Obana, and Hopkins, 2022, p.946). Rohingya refugee camps in Cox Bazar were hit by climate tragedies including cyclones, flooding and landslides causing further humanitarian crises (Malji, Obana, and Hopkins, 2022, p.939). The climate risks faced by Rohingya refugees have been accelerated by the temporary nature of the Rohingya's housing which is not resistant to such climate disasters (Malji, Obana, and Hopkins, 2022, p.946).

Among the refugee-hosting states, Lebanon stands out for hosting the greatest number of refugees per capita in the world. Lebanon has been hosting approximately 1.5 million Syrian refugees who sought refugee in neighbouring countries including Türkiye, Jordan and Lebanon following the outbreak of the Syrian civil war by March 2011. Lebanon had already been hosting a significant number of Palestinian refugees since 1948 prior to the flow of Syrian refugees. Since the Palestinian refugee camps largely became permanent through time, in order not to experience the Palestinian refugee case again, the Lebanese government adopted non-encampment policy towards the Syrian refugees. According to Tiwari, Al Azzawi and Amir (2023, p.3), non-encampment policy aimed at ensuring that "the nature of the settlements could not be that of a permanent settlement". For this reason, the Syrian refugees have been scattered informally across Lebanon. Kikano and Lizarralde (2019, p.29) point out that non-encampment policy implemented by Lebanon led Syrian refugees to spread to roughly 2000 locations except for a few authorized camps.

Despite the spread of Syrian refugees throughout Lebanon, the highest share of the Syrian refugee population has been informally settled in Bekka Valley in eastern Lebanon mostly in precarious settlements such as shelters and tents (Tiwari, Al Azzawi and Amir, 2023, p.2). It is stated that around 42,000 illegal tents are spread to approximately 1500 locations across the country most of which take place in the North and mainly concentrated in the North and in the Bekaa Valley (Trovato, 2019, p.43). The Bekaa Valley is known to be predominantly agricultural accompanied by ill infrastructure and weak economy, which mainly accommodates shanty towns and temporary settlements constructed of wood and plastic covers (Tiwari, Al Azzawi and Amir, 2023, p.3). Settlements in the region mostly lack access to welfare services and face various risks. Roughly, one million Syrian refugees are registered with the United Nations High Commission on Refugees (UNHCR) who, although insufficient, can benefit from formal assistance whereas there are unidentified number of unregistered Syrian refugees who cannot benefit from any assistance triggering the extent of their vulnerability (Nabulsi et al., 2020, p.1).

The emergency shelters were built as temporary settlements, but due to prolongation of the civil conflict in Syria, they turned into permanent informal settlements with inadequate facilities (Tiwari, Al Azzawi and Amir, 2023, p.1). Syrian refugees living in such shelters are exposed to various vulnerabilities. These informal shelters do not meet basic standards of living. Kassem and Jaafar (2020, p.423) indicate that many Syrian refugees including "children, elderly, and immunocompromised individuals, have limited access to basic needs such as clean water and sanitation, robust medical support, and safe and nutritious foods". This low quality of living has had negative health consequences on the Syrian refugees and the vulnerability of the refugees further increased with climatic extremes in the country.

Lebanon already had political, economic, social and environmental problems prior to welcoming Syrian refugees (Kuscevic and Radmard 2020, p.417). A serious and sudden increase in population has placed an enormous pressure on the country's existing problematic infrastructure and services. For instance, settling of a large number of Syrian refugees in Bekaa Valley has constituted an important strain on the water and waste infrastructure in the region. The refugee settlements receive their water "by trucks, through the existing water network, or from new boreholes drilled close by" and "only a third of all Syrian refugees have access to tap water for more than two hours per day" (Kassem and Jaafar, 2020, p.424). Another inadequacy occurred in the field of energy. Lebanon's already limited energy supplies were negatively affected from additional demand with the coming of Syrian refugees (s and Collins, 2020, p.2).

Overall, climate change has clearly been aggravating the vulnerability of Syrian refugees who have already been exposed to various difficulties. Informal settlements are highly unresistant to devastating effects of climate-related disasters such as increasing temperatures, heavy winds, droughts and floods. In the meantime, it would be fair to suggest that unplanned growth of informal refugee settlements and the excessive use of energy, soil, water and waste infrastructures have heightened environmental degradation in the country (Trovato, 2019, p.44).

## GIS Analysis of Climate change and vulnerability in Syrian Refugee Hosting Districts in Lebanon

Lebanon's unique geographical location, environmental conditions, and socio-political context make it particularly vulnerable to the impacts of climate change. This vulnerability is further exacerbated by the ongoing Syrian refugee crisis. Bu understanding the complex interplay between climate change and refugee vulnerability in Lebanon, policy makers, humanitarian organisations, and researchers can develop effective strategies to mitigate impacts and build resilience. This section analyses key aspects of climate change and refugee vulnerability in Lebanese districts, utilising GIS data. GIS Overlay Analysis is conducted since, it is a powerful tool for analysing and visualizing the complex relationship between climate change and refugee vulnerability in Lebanon. By integrating various datasets, such as those on refugee

hosting districts, food insecurity, climate resilience, water stations, and health facilities, overlay analysis is expected to identify areas of critical concern and assess the potential impacts of climate change on vulnerable populations.

In order to conduct the overlay analysis, open-source GIS software QGIS is used. The hypothesis tested in this research is;

H: Refugee settlements in Lebanon are more vulnerable to the effects of climate change compared to local Lebanese communities due to inadequate infrastructure and resources.

The positioning of refugee settlements in relation to climate-risk zones and their proximity to infrastructure will highlight areas of vulnerability and the situation of refugees.

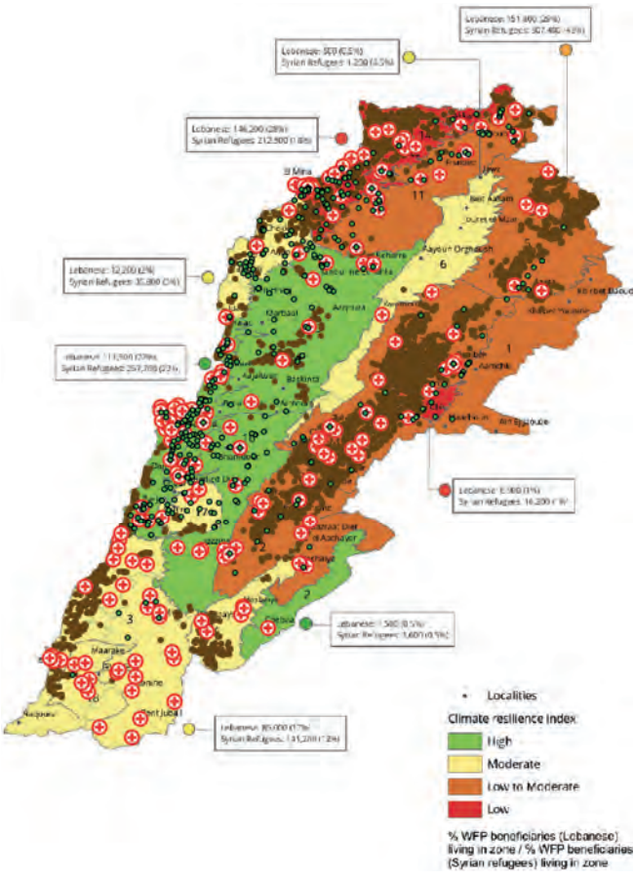
The geospatial data of informal refugee settlements, water stations, health facilities are collected from WFP Lebanon GIS Portal. Lebanon Climate Resilience Index, constructed by WFP Lebanon Country Office, is used a base layer. Refugee settlements and infrastructure data (water stations and health facilities) are overlaid on the base layer.

Figure 1 visualises findings of the overlay analysis. Base layer consists of colour-coded Lebanese regions, based on their climate resilience. Climate resilience is categorised into four levels: high resilience (green). moderate resilience (yellow), low to moderate resilience (orange), and low resilience (red). Percentage and number of of Syrian and Lebanese WFP beneficiaries receiving assistance in each region are also indicated. The significant number of WFP beneficiaries among both Lebanese and Syrian populations highlights the critical need for food assistance. Northern regions (i.e. Akkar, Tripoli), and eastern regions (i.e. Baalbek) show high dependence on food assistance. These regions are highly populated regions with poorer climate resilience, which suggests that both local and refugee populations in these regions are experiencing substantial food insecurity due to environmental stress, such as draught or poor agricultural productivity.

The second layer of the map displays the distribution of Syrian informal settings, represented by brown dots. Lebanon's non-encampment policy led to spread of informal settings over the region. Higher concentration of refugees' informal settings in regions with lower climate resilience potentially increases their vulnerability to climate related challenges such as draughts, floods, or poor agricultural conditions.

Finally, the third layer of the map shows the distribution of resources (i.e. water stations and healthcare facilities) across the regions of Lebanon. Red circles with crosses mark healthcare facilities while green dots represent water stations. Healthcare facilities and water stations are scattered across Lebanon, encompassing both urban and rural areas, as well as regions with low and high climate resilience. Yet, refugee settlements often appear in areas with limited access to hospitals and water stations, highlighting a disparity in infrastructure compared to more urbanised or Lebanese – majority areas. In addition, a higher proportion of WFP beneficiaries among Syrian refugees compared to Lebanese in regions of North Lebanon and Bekaa reflects greater economic vulnerability. Particularly, Akkar, Baalbek–Hermel, and the Bekaa Valley are marked by high population density, fewer healthcare facilities, and limited water stations, suggesting a strain on resources and potential challenges in accessing basic services. In conclusion, visualised data shown in Figure 1 supports the hypothesis that refugee settlements in Lebanon are more vulnerable to the effects of climate change compared to local Lebanese communities due to inadequate infrastructure and resources.

**Figure 1: Spatial Vulnerability of Syrian Refugee Settlements to Climate Change in Lebanon**




**Source for base map:** 'WFP GIS Portal (2022). 'Lebanon The Most Vulnerable Refugee Hosting Districts Map'(https://gis.lbn.wfp.org/portal/apps/sites/#/lebanon-gis-portal accessed 16.08.24).
Source for Syrian List of Informal Settlements, Water Stations, Health Facilities: WFP Lebanon GIS Portal (2022). LBN Data on Points of Interest. (https://gis.lbn.wfp.org/portal/apps/sites/#/lebanon-gis-portal accessed 16.08.24).

## Concluding remarks

In Lebanon, dire living conditions of the Syrian refugees are intertwined with increasing negative effects of climate change, resulting in a complicated scenario of vulnerability for the refugees. By employing a GIS overlay analysis, this research has mapped out the various dimensions of vulnerability that arise from both climate-related impacts and socio-economic challenges faced in the country. The findings indicate that the Syrian refugees in Lebanon are situated in precarious conditions, often living in informal settings with inadequate infrastructure and limited access to critical resources, such as clean drinking water and healthcare services. The geographic overlay of refugee settlements with climate resilience data underscores how these communities

are disproportionately affected by environmental stressors, including rising temperatures and diminishing water supplies. Such vulnerabilities not only threaten the immediate health and wellbeing of the refugee population, but also strain the already challenged resources of host communities.

Furthermore, this research underlines the urgent need for effective policy interventions that integrate humanitarian efforts with climate adaptation strategies. Policy makers and humanitarian organisations must prioritise targeted initiatives that address both the pressing climate change challenges and the sociopolitical dimensions impacting Syrian refugees in Lebanon. Such a comprehensive approach can facilitate improved resilience and better conditions, ultimately assuring to safeguard the wellbeing of one of the most vulnerable populations in the region.

In this regard, Lebanese policy makers should implement policies to reduce GHG emissions through adopting strict legislation and tax incentives and encouraging investments on renewable energy. In addition, steps should be taken to increase public awareness among the hosting community and the refugees regarding climate change. Obviously, it is not an easy task to adopt such measures in a proper way when the current Lebanese political and economic contexts are taken into account. The country has been experiencing serious political and economic stability. Moreover, at the first anniversary of the Hamas' October 7 attack on Israel and the following ongoing war in the Gaza Strip, Israel's attacks on Lebanon against Hizbullah targets have further complicated the political, economic, security and humanitarian situation in the country. In this context, developing effective adaptation strategies to protect both the hosting community and the refugees from the harmful impacts of climate, seems unlikely in the short-term. It is fair to suggest that effective management of the climate crisis requires institutional reforms, capacity-building and capital investment. Here, it is also in the responsibility of the international community to support Lebanese government in reducing the vulnerability of the refugees in the country and offering displaced people a dignified living.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The authors confirm being the sole contributor of this work and have approved it for publication.

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## Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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# THE ROLE OF CULTURE AND TRADITIONAL KNOWLEDGE IN CLIMATE CHANGE: INSIGHTS FROM JAMMU AND KASHMIR

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**Abstract**

Indigenous peoples furnish substitute lore for climate variation and change from their thriving proficiency and resource utilization mechanism. This research explores how culture and traditional knowledge can be exerted to surveil and respond to changing environmental circumstances. Jammu and Kashmir is known for its diverse ethnic groups throughout the region, forming part of the natural and cultural domain of unique scenery. The tribes in Jammu and Kashmir bring with them the traditional art and culture that sets this region apart from others. The lavish culture manifested by UT fascinates visitors. Jammu and Kashmir is avowed to be the 'Crown of India' and is regarded as a 'heaven on earth' due to its pristine elegance. The traditions and customs of the primitive era influence the ethnic lifestyle. External forces have not so far influenced the majority of them. The modest and elegant lifestyle prompts visitor's curiosity. This research demonstrates how Indigenous communities accumulate extensive information about their surroundings to shape their utilization of resources, as well as from beliefs and cultural values associated with this knowledge. This study emphasizes the importance of culture and traditional knowledge in shaping the perspectives on environmental change in Jammu and Kashmir among indigenous people, impacting local decisions on adapting to climate change.

**Keywords:** Culture, Indigenous people, Traditional knowledge, Jammu and Kashmir

## Introduction

It is now commonly acknowledged that the Earth experiences climate fluctuations due to both natural processes and human actions. According to contemporary consumption, "climate change" frequently encompasses a rise in the average surface air temperature, also referred to as "global warming". The climate change phenomenon will inevitably lead to severe catastrophic impacts. These effects include melting glaciers, sea levels elevating, and more frequent and severe climate extremes. Many researchers believe that climate change will pose such a serious threat that it could endanger the survival of humans on Earth. Strategies to address global warming are actions taken to decrease the susceptibility of social and biological systems to the impacts of climate change. Although emissions may reach a plateau soon, the effects of climate change will endure for a long time and strategies will require modification.

Strategies to address climate change are especially crucial in developing nations, as they are projected to experience the worst effects of climate change. This indicates that the distribution of adaptive capacity varies among regions and populations, with developing countries typically having lower adaptive capacity. The ability to adapt is strongly connected to the progress of society and economy. Adapting to climate change is expected to incur annual economic costs amounting to billions of dollars in the upcoming decades, with the specific sum required remaining uncertain. Contributing nations have pledged $100 billion annually through the

Green Climate Fund to aid developing nations cope with climate change by 2020. Human activity is leading to a rise in greenhouse gas emissions, which in turn is causing the Earth's surface to warm up more, resulting in various anticipated adverse effects. Up until now, previous worldwide initiatives to tackle issues linked to global warming appear to emphasize mitigation to decrease and ultimately stabilize. Keeping emissions controls intact in developed countries is a challenging task, especially during periods of robust global economic growth. Global energy consumption is predicted to increase. Due to insufficient advancements and challenging circumstances in lowering atmospheric greenhouse gas emissions, adaptation is increasingly becoming a more practical approach to minimizing susceptibility to the anticipated adverse effects of global warming.

Additionally, following the unsuccessful climate talks, it is clear that we must not rely solely on mitigation efforts. Nevertheless, to ensure our shared future, we need to incorporate both mitigation and adaptation in combating climate change. Nevertheless, the combination of adjustment and prevention is not a completely novel concept globally. There are numerous regions in the world where people continue to reside in harmony with nature, without causing any harm to it. They have acquired specific abilities to deal with sporadic natural increases. The ability to balance nature's power with human desire is referred to as traditional knowledge.

"Ecosystems have a strong influence on human culture, and altering them can greatly affect cultural identity and social stability. Different aspects such as human cultures, knowledge systems, religion, cultural heritage values, social interaction, and related civic amenity services (such as aesthetic pleasure, artistic and spiritual contentment, and intellectual progress) are included. Culture has consistently been impacted by the environment it is rooted in, reflecting the ecosystem's nature and conditions. Simultaneously, humans have consistently altered and moulded it. The swift decline of culturally momentous ecosystems and landscapes is causing social upheaval and marginalization in various regions globally." (Millennium Ecosystem Assessment, 2005:457)

"Cultural services and values are nowadays undervalued in landscape planning and management. These fields could benefit from a better understanding of the method by which societies manipulate ecosystems and then combine this with cultural, spiritual, and religious belief systems. This realization is reflected in the emphasis placed by many recognized international organizations such as UNEP (United Nations Environment Programme) UNESCO (United Nations Educational, Scientific and Cultural Organization) FAO (Food and Agricultural Organization) IUCN (International Union for Conservation of Nature) and WWF (World Wildlife Fund, Inc.) on "cultural landscapes", "cultural agroecosystems", world heritage sites, and the biosphere reserves. The ecosystem approach acknowledges the significance of a socio-ecological systems approach, and policies should allow for the involvement of local communities in natural resource management within the cultural landscape, incorporating local knowledge and institutions."

"Places and regions are products of human history, resulting from historical interactions within groups as they utilize and modify the natural terrain. They represent the history, identity, and values of the people who live there. The cultural concept of place is necessary for the quality of life of its inhabitants. Spatial planning and town planning are that is, cultural acts in that they recognize, invent and use the natural and cultural resources in line with society's aspirations for the future." (UCLG, 2015:12)

## Methodological considerations

To robustly investigate the role of culture and traditional knowledge in climate change a keyword-based examination of grey literature, peer-reviewed literature, and project websites was carried out. Search terms include Traditional Environmental Knowledge, climate change adaptation, indigenous knowledge, Native adaptation, Indigenous cultures, adaptive capability, and resilience. Relevant articles were filtered based on the following criteria: The consequences of climate change on Indigenous peoples, and local climate change adaptation techniques. Then, relevant publications were reviewed to define Traditional Environmental Knowledge, its components, the significance of each aspect in climate change adaptation, and, lastly, how Traditional Environmental Knowledge fosters socio-ecological robustness. Regarding research constraints, this study focuses primarily on the social and environmental consequences of climate change. The other issues are not within the parameters of this research. This study was mainly focused on the Indigenous communities of Jammu and Kashmir. The main reason behind the selection of these Indigenous people is their connection with nature, despite all these modernisation and technical advancements these people still prefer the lap of nature. Their livelihood is deeply rooted in nature. This research was carried out to understand how the recent climate changes have influenced the livelihood patterns of the Indigenous communities of Jammu and Kashmir.

## Traditional environmental knowledge

"Recognizing the importance of culture for sustainable development means exploring the connections between culture and the environment. Culture influences us to understand the environment and our relationship to it at a deep level. Care for future generations' well-being is already explicitly environmental; it should also be cultural." (UCLG, 2015:24)

Humans modify the ecosystems around them through cultural practices, values, and visions world. Human activities depend on and use "natural" spaces and biological resources otherwise they could disappear, such as agricultural heritage. Spaces and resources are carriers of culture partly as a reminder of history, practical knowledge, and identity (e.g. food heritage); contribute to aesthetic values (e.g. urban or rural landscape); and condition capacity for endurance. People's knowledge of the surrounding ecosystems is of immense value. Their practices have shaped the urban and rural landscape for centuries. This traditional knowledge should be recognized and used to better understand how cultures and ecosystems communicate and enter into dialogue with academic knowledge, especially in the context of regional development projects that may have an impact on the ecosystem. These forms of knowledge must be developed and shared to promote ecological thinking and values of sustainable development. Nature and culture developed side by side and are constantly creating an evolving balance. Cultural diversity and biological diversity are therefore closely related."

According to the World Intellectual Property Organization, traditional knowledge systems are "knowledge that is created, preserved and transmitted in a traditional and intergenerational context, which preserves and transmits it between generations and is an integral part of the cultural identity of the community that is recognised as the holder of the knowledge". In this way, traditional knowledge is bound to a single culture or society, acquired through many years of trial and error experience of the community. Generally, it is widely accepted that traditional knowledge represents an alternative way of thinking that has evolved due to the constant awareness of the requirement to protect oneself and one's family from changes in the local climate. In today's society where science plays a key role, many people believe that oral knowledge is unscientific, which is not true.

Traditional knowledge is also as scientific as any other form of contemporary knowledge because it developed on the same principles of experimentation and trial-and-error methods that are widely used in the sciences (especially the physical sciences). Historically, traditional people are prominently identified as particularly vulnerable to climate change. Many traditional territories are located in areas where the impacts of global warming are expected to be both early and severe. However, traditional people have learned the art of adapting to any changes in their climate and this knowledge or skills can help the current generation to combat the current form of climate variability. So, given the urgency to cope with climate change, the present study is an attempt to discover the traditional skills prevalent among the communities of Jammu and Kashmir that can help build a future course of action for the present generation.

The whole concept of civilization began when humans first appeared on Earth, started observing their surroundings, and tried to understand them based on their cognitive abilities and knowledge. Knowledge Systems have always been present in some way or another. It was once modular in ancient times and now is extensively compartmentalized in modern times. Labelling a knowledge system as traditional or outdated would be unfairly disregarding the historical significance and practicality it once held. The progress of a system or structure is typically assessed within a particular cultural and historical framework, within a specific time-space continuum in which it is situated. The Gujjars and Bakarwals are a community that has a deep connection with nature, their loyalty and connection to the environment is ancient, and they possess valuable historical and cultural legacies.

Gujjars and Bakarwals have experienced long-standing marginalization in both the socioeconomic and political aspects. Despite being marginalized, their contributions to the history, culture, and knowledge of Jammu and Kashmir have been significant. Regrettably, their input is frequently overlooked, devalued, and downplayed in the face of the prevailing culture and popular narratives. When discussing tradition versus modernity, it is common to make comparisons and distinctions between the two. They are frequently stigmatised for being seen as too traditional and outdated. Nevertheless, this argument is flawed and biased and requires a reassessment of their significant role in society and the fabrication of knowledge. Nevertheless, being marginalized does not mean they have nothing valuable to contribute to the creation of diverse knowledge for society. Gujjars and Bakarwals, the indigenous people of Jammu and Kashmir, continue to maintain their nomadic way of life despite recent developments. Yet, they have consistently been the primary guardians of important traditional and native knowledge regarding biodiversity, forest farming, medicinal plants, non-traditional cuisine, and the native environment of Jammu and Kashmir. As locals, they can assist in finding and recognizing plants linked to different ethnobotanical purposes, aiding researchers in conducting phytochemical research. In addition to their abundant traditional knowledge of biodiversity, they possess unique tribal cultural expressions that are diminishing and in need of instant perpetuation.

The Gujjar and Bakarwal communities have made numerous attempts to preserve the environment. The community maintains a delicate equilibrium and equation between the forest and its usage. In the Union Territory of Jammu and Kashmir, particularly Gujjars have assisted the Forest Department in identifying and removing illegal encroachments, as well as demarcating important forest zones. These tribes stay updated on forest activities by constantly searching for food for their livestock in the deeper parts of the forests, making them more knowledgeable about the area and its state. They have alerted authorities to the overcutting of forest trees and supported conservation initiatives. Moreover, they serve as guides in leading people to inhabitable areas and important forest resources while travelling along these routes.

Two Bakarwal communities, Megh and Mihngh, are famous for their skilled work with wool. Members of these tribal people produce woollen blankets. Furthermore, Bakarwal also crafts Namdas - rough woollen carpets adorned with vibrant floral patterns. They also create smaller blankets, called taru, which can be used as quilts. These quilts have cultural significance as they are traditionally given as wedding presents. Women also intricately embroider these handmade objects are their important cultural heritage and they bring them along when moving to Kashmir.

Gujjar community relies mainly on livestock for raising and production. Livestock is not merely a job for them; instead, it signifies a symbol of status for them. The greater the number of animals a family possesses, the more esteemed they are viewed socially. Yet, the community shows a preference for buffaloes over cattle because these animals are well-suited to the local environment and are strong and resilient. They can endure harsh conditions and produce higher levels of fat in their milk. They use buffalo milk to make Ghee, Butter, Curd, Lassi, Paneer, and Kaladi and sell the remaining milk. They are skilled in both animal rearing and healing. They preserve traditional technical knowledge and utilize natural herbs and shrubs to cure ailments in humans and animals. Using certain naturally occurring plants to treat animals also helps to lessen the financial strain. These customs have been carried down through generations. Despite the modern health facilities available, they continue to rely on their traditional methods of treatment, livestock rearing, and connections with their environment, thus balancing the old ways with the new.

As they are nomadic tribes, Gujjar and Bakarwal have access to a vast range of information regarding various plants and species, including their efficacy and utilization. During the accumulation of knowledge, they transfer it to the next generation. They know how to utilize medicinal herbs. The tribal community uses various forms of herbal preparation, including decoction, oil, paste, juice, powder, and extract, to cure respiratory diseases, gastrointestinal problems, infections, skin problems, diarrhoea, joint pain, dysentery, wounds, etc. They also utilize smoke and raw forms of the preparation.

These communities have been utilizing their traditional veterinary knowledge for generations, using plants to maintain the health and wellness of their livestock. To back up this claim, a thorough ethnobotanical study was carried out in 12 villages in district Poonch from July 2018 to March 2020. The study showed that farmers in the Doda district of Jammu and Kashmir and West's Darjeeling subdivision of Bengal use all parts of the Acorus calamus to manage gastrointestinal problems in sheep, cows, buffalos, and goats. These people also administer Allium cepa bulb powder orally to animals to treat snakebites. In some areas like the Bandipora district of J&K, individuals utilize softballs made from crushed Allium cepa bulbs and salt to treat cattle for anorexia, and cold, and to boost the oestrus cycle in cows. Furthermore, the entire plant is utilized and typically provided as fodder. Additionally, a blend of plant paste and water is administered to the pelvic area as a remedy for oliguria in buffalos, sheep, cows, and goats in Jammu and Kashmir. Some research also recommends using crushed fresh roots to address hoof inflammation, warts, weakness, and abscissions in cows in the area.

Sharma and Kachroo claim that Gujjars, as an ethnic group, possess their ancestral traditional knowledge of herbal medicine. Research in the district of Kishtwar has shown a positive connection between the presence of curative herbs and the occurrence of certain diseases. On the other hand, Swami and Gupta contend that medicinal plants are becoming increasingly significant as valuable bio-resources. Various types of plants are gathered for both eating and healing reasons, such as Kutwol, a wild plant commonly utilized for treating issues with bones and joints. Walnut bark, also called Dandas locally, is utilized for dental hygiene purposes. Chutyad, a wild herb, is utilized for promoting hair growth. Noon chai (Pink tea) is believed to offer numerous medicinal advantages. It aids in lowering stress, and boosting immunity, and is beneficial for pregnant women. Nevertheless, pregnant women typically consume ghee, sheera kadai, semolina sharbat, and eggs as part of their traditional diet. Kehwa or kodi chai is utilized for the remedy of cough, cold, fever, and body pains. Furthermore, the community utilizes rice paste or outer gourd covering as a treatment for mumps, a prevalent condition among children.

## The Significant impact of community-based projects to record climate change

Climate projections suggest that impacts are likely to be varied and heterogeneous across India. Some regions will experience more intense rainfall and flood risks, while others will experience less rainfall and drought, including spatial shifts in the pattern of rainfall. The Fifth Assessment Report further highlighted the loss of snow from the snow sheet and hypothesized that current glacier extents are out of balance with current climate conditions, suggesting that glaciers will continue to shrink in the future even without further temperature increases. This has a significant impact not only on the Himalayan ecosystem of the state of Jammu and Kashmir but also on several other areas in India and some areas in Pakistan-occupied Kashmir and beyond.

The global scientific consensus on the unequivocal nature of climate change and its link to increasing concentrations of greenhouse gas emissions is widely established. The regional climate projection indicates that climate variability will be manifested by changes in the frequency, intensity, spatial extent, or duration of weather and climate extremes, including climate and hydrometeorological phenomena. This is likely to pose a greater risk to human life and threaten the sustainability of the economy of several states in India. Indeed, the likely projection of hydrometeorological and geophysical hazards has the potential to derail the current growth strategy and deepen poverty among the vulnerable. The impacts of climate-induced extreme events (such as cloudbursts, enhanced glacier flow, and premature dry and wet days) could lead to loss of lives, livelihoods, property, and infrastructure and affect the state's economic growth and pro-poor initiatives. Due to its profile, climate change is an important issue for the state, as it is currently on a path of carbon-oriented development while being vulnerable to climate change due to a fragile ecosystem. Thus, in the above context, a comprehensive Climate Change Action Plan with an institutional framework to address both adaptation and mitigation concerns has been conceptualized by the Union Territory J&K to enhance climate resilience and resilience of sectors concerning local vulnerability conditions.

Jammu and Kashmir, situated in the delicate Himalayan ecosystem, experiences both natural climatic oscillations and human-driven changes from extensive urbanization that contribute to rising temperatures. The most significant issues the state will face in the upcoming decades are biodiversity loss and water scarcity as a result of climate change. Climate change poses a serious threat to species diversity, habitats, forests, wildlife, fisheries, and water resources in the region. Many wetlands in J&K, which support 20% of the region's known range of biodiversity, are being adversely affected. Climate change, which results in weather changes, is relatively unpredictable but could be important concerning the occurrence of various diseases, such as bird flu. As per the UNEP report, certain regions in the nation display moderate to high levels of vulnerability. INCCA's evaluation suggests that there could be a rise of 5 to 10 days in the average number of rainy days in the Himalayan area by the 2030s, with an increase exceeding 15 days in the eastern Jammu and Kashmir regions. There is a probable increase of 1-2 mm/day in the intensity of precipitation. This is expected to impact certain horticultural crops due to grazing, while livestock is likely to see advantages. The pace of glacier depletion is reported to be shifting due to factors such as winter precipitation, global warming, and human influence. The agricultural sector is most susceptible to being significantly impacted by temperatures, precipitation, and cold waves, causing increased vulnerability. There has been a recent rise in the food production deficit in Jammu and Kashmir. Rain-fed farming will be the most impacted as precipitation levels decline. Horticultural crops like apples have also experienced a decline in both production and actual area covered, largely attributed to a decrease in snowfall. Glacial Lake Outburst Floods (GLOFs) can lead to large-scale landslides and affect food security and thus nutritional health.

Jammu and Kashmir is a region full of mountains that is very vulnerable to the impacts of global warming and climate change. The significant impact of climate change and warming is being felt in Jammu and Kashmir as in worldwide patterns. Over the last couple of months, particularly in July 2022, there has been a rise in cloudbursts and flash floods. Destructive cloudbursts hit Baltal (Sonamarag), Doda, Poonch, Kathua, and many other areas in Jammu and Kashmir resulting in too many deaths, injuries,

and property damage. Some of the traits of climate change in Jammu and Kashmir include unpredictable rainfall, snowfall, and abnormally mild winters. The report states that the temperature in Jammu and Kashmir has risen by 1.2 degrees Celsius on average compared to the global increase of 0.8 to 0.9 degrees Celsius in the past century. Rising temperatures cause glaciers to melt and increase rainfall, potentially they are causing disaster in the state. The signs of climate change in Jammu and Kashmir include premature snowfall, winter heat waves, sudden downpours, and flash floods in the summer, all causing noticeable impacts in the Kashmir Valley. The initial sign of global warming in Jammu and Kashmir was a severe cloudburst flood in 2014. A report by the State Disaster Management Authority reveals that 300 individuals have lost their lives in Jammu and Kashmir due to various flash floods and cloudbursts since 2010. In 2022 alone, cloudbursts in Jammu and Kashmir killed nearly 40 people and injured many. The climate change toll is mounting and we should act to stop this growing anger. The unexpected increase in temperature has impacted life in Kashmir in multiple ways. Kashmir's monsoon season has caused significant damage to agricultural fields due to the persistent dry conditions. Valley farmers were cynical about being able to harvest any crops last year due to the lack of rainfall. The IMD reported that the valley experienced an 80% rainfall shortage the previous year due to the lack of significant western disturbances or Mediterranean moisture. Because of the arid climate and lack of water, irrigated rice, wheat, and mustard output may decrease by 6%, 4%, and 4% respectively. The food production deficit in Kashmir has increased to 4%, with vegetable production at a deficit of 3%, and oilseed production at 69%. Kashmir, once anticipated to yield large quantities of rice and wheat, is currently yielding limited amounts of these grains. If climate change persists at its current rate, Kashmir will soon have to import all its food from nearby states.

Jammu and Kashmir is the sole state in India with a historical background of saffron production for commercial purposes in the valley. The Kashmir Agriculture Department reports a 65% decrease in production over the last 20 years, dropping from 16 metric tons to 5.6 metric tons, as a result of inadequate irrigation and the impacts of climate change. Additionally, the arid weather will significantly impact the tourism sector in Kashmir. The lack of snow will lead to the shutdown of winter sports. Gulmarg, a renowned tourist destination in Kashmir, lures visitors globally; however, the absence of snow leads to an empty resort. The Thajwas Glacier, also called the Hidden Jewel of Kashmir, is melting quickly and is a popular tourist spot in Sonamarg. Two decades ago, this glacier covered a vast expanse and visitors could easily view it with just a short stroll. However, they now have to trek for kilometres to visit the glacier. Thirdly, it leads to the disappearance of both domestic and wild animals as a result of increasing temperatures impacting vegetation, grazing lands, food supplies, water availability, and other factors. Ecosystems may become inhospitable to certain animals, leading them to migrate beyond their typical ranges in search of food and suitable habitats, resulting in the death of other animals. Urbanization in the area has quickly expanded. Urban infrastructure development has surpassed boundaries in recent decades. The utilization of Jhelum floodplains for urban settlements indicates the level of urbanization.

Climate change is greatly impacting the traditional practice of transhumance for these people, as the timing and availability of pasture land are disrupted by changes in weather patterns, affecting their movement of livestock between high and low-altitude grazing areas. Increasing temperatures and shifting precipitation patterns result in decreased fodder supply for the livestock, impacting their well-being and output. Because of climate change, Gujjar and Bakarwals frequently need to move to higher elevations sooner to find grazing areas before the snow melts too quickly.

These vulnerable communities are especially susceptible to severe weather occurrences such as heavy snowfall or droughts, which can have a significant effect on their means of living. By carefully monitoring alterations in their surroundings, their first-hand experiences and expertise can offer a valuable understanding of the impacts of climate change in the Himalayan area. The community is becoming increasingly worried about shifts in recent weather patterns in those regions where the seasonal movement of livestock takes place. Contrasts between the traditional weather forecasting methods relied on by Indigenous communities in history indicate a shared agreement within transhumance communities that a shift has taken place. All the communities that were visited agreed about the variations in temperature and rainfall levels.

Nevertheless, some individuals think that these alterations are a result of God's retribution for the wrongdoings and offences of people. In general, climate change is currently taking place and is affecting many people in the state, especially transhumance communities, who are more at risk due to their reliance on livestock production which is greatly affected by weather. Shifts in rainfall levels also affect water sources and availability, as well as livestock productivity. This has resulted in heightened susceptibility to food and water shortages, affecting livestock directly and prompting the community to relocate to higher summer pastures in the Kashmir valley. The majority of older individuals in the community view this phenomenon as a problem resulting from the growing number of sins being committed by people. It is known as Kalyug, where people are consumed by greed, lack faith in God, and prioritize material possessions. They have ceased their worship activities as well.

Capital investment has increased in India because of the growth and modernization of industries. In recent years, there has been growth in the travel and tourism industry, transportation industry, as well as textile and construction industry. It serves as a powerful tool for economic development, however, it also has a significant impact on our environment which affects us in multiple ways.

According to Ground Report, in 2022, Kashmir experienced a severe heat wave that led to a shift in the groundwater levels. Initially, there was a noticeable drop, leading to a drought-like scenario in both North and South Kashmir. This was then followed by ongoing rainfalls, resulting in sudden floods. The unusual snowfall persisted in the rural areas and higher elevations of the Kashmir valley. The unexpected snowfall caused anxiety among nomadic tribes. The Gujjar and the Bakarwals were overwhelmed by the severe cold and snow-covered meadows, resulting in livestock casualties. Due to their nomadic lifestyle, Gujjars and Bakarwals do not have a permanent home of their own. During their migration, they reside in temporary shelters such as tents or sheds.

The nomads may not understand the terminology of climate change, but they have a sense of awareness about the climate due to their strong connection to nature. These nomadic herding communities have been observing the recent shifts in climate

because they are directly affected by them. In the past few years, their traditional economy based on livestock has faced unprecedented challenges due to urbanization and climate disasters. Due to growing urbanization, forest areas that once served as temporary shelters for tribal communities and grazing land for their animals are now being used for constructing government buildings and new projects. The traditional homes of Gujjar-Bakarwals in the forests are at risk due to changes in land use, as they were slow to establish ownership of private property. These wandering tribal people construct temporary shelters and dwellings close to forested regions where their animals can thrive, having no trouble finding food and remaining untouched by urban development.

The continuous decline in forest area in Kashmir, caused by both legal and illegal logging as well as human settlements in forests, is leading to more frequent interactions between humans and animals (Pervaiz: 2009). The joint impact of deforestation and water mismanagement has led to soil erosion, causing the frequent flash floods observed in Jammu and Kashmir (Crook: 1998). Political tension and military conflict between India and Pakistan in the region are both caused by and lead to environmental stress, as they struggle to control the natural resources of Jammu and Kashmir through fighting. If the conflict persists, these resources will become more limited (Edie: 2002). Across the globe, individuals are forced to leave their homes as the military seizes land (including bodies of water) for various purposes like bases, target ranges, weapon storage, and training areas. As a result, residents frequently face challenges in cultivating essential crops, particularly near the boundary line. They are increasingly relying on wild foods like bush meat and wild food plants for their survival. Simultaneously, displaced individuals typically gather firewood, edible plants, and other resources from nature in the new locations they have migrated to. This level of large-scale exploitation may not be sustainable, even in the short run. The scenario could worsen if these individuals do not have a good understanding of the best ways to manage resources in the area. Furthermore, when refugees go back to their native lands, they frequently depend significantly on natural resources before they can restore their usual way of making a living, such as farming. Additionally, in both Indian Kashmir and Azad Kashmir, humanitarian organizations frequently utilize large quantities of local wood for building projects (Shambaugh et al.: 2001). Timber production can be greatly impacted by armed conflict in various ways. The introduction of new roads in isolated forest regions allows for the growth of the illegal bush meat trade; meanwhile, logging practices frequently lower biodiversity and greatly affect the well-being of impoverished communities reliant on natural resources (Saundry: 2008).

Many said that the 2014 Kashmir floods were caused by the engulfment of flood plains by such unplanned construction. The rate of urbanization in Jammu and Kashmir is currently 27.3 percent. Tourism has affected the ecology in a way. The Jammu and Kashmir region is regularly portrayed by the state as the most desirable tourist destination. This display is mainly based on a photograph of a water landscape. The tourism industry's impact on land has caused a decrease in water resources due to mass pressure. Along with this, air and soil pollution has largely degraded the ecosystem of the region.

## Conclusion

In conclusion, given the lethal impact of global warming and its human-induced origins, everyone must take collective responsibility for preserving the environment. If this is not done, it could result in numerous catastrophic events that will seriously endanger the welfare of both present and future individuals. Climate change is seen as a significant danger to the future of the Earth. Modernization has been pinpointed as the primary reason for climate change. The world's nutritional and food security is anticipated to be impacted by climate change. The pastoral community is one of the poorest and most at-risk groups when it comes to climate-related disasters. The combination of land-use change and climate uncertainty is exacerbating the resilience of different social and ecological systems. The government must implement actions to safeguard vulnerable communities from the negative impacts of climate change.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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Externally peer-reviewed.

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# INTELLECTUAL CAPITAL, EXPORT PERFORMANCE, SUSTAINABLE PRODUCTION: ANALYSIS ON LEADING TURKISH EXPORTERS

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**Abstract**

Sustainable production reguires both domestic and foreign production along with technology and intellectual capital. Sustainable production and improving export performance have bidirectional relationship. Factors that improves the export performance may enable sustainable production. Achieving a sustainable production reguires high export volumes. Intellectual capital may one of the factors that may create value-added products and affect export performance. Intellectual capital or "brain-power" shows how important knowledge creation throughout the intengible assets, and creating value in order to reach firms strategic objectives.

This study aims to analyze the impact of intellectual capital on export performance, thus sustainable production, for leading exporters in a developing country, Turkiye. There are various methods along with a few studies evaluating the relationship between intellectual capital and export performance. It is observed that higher levels of intellectual capital are associated with superior export performance. Thus, it emphasizes the critical role of intellectual capital in enhancing value added creation, export performance and sustainable production. Based on the findings, the existence of a positive relationship between intellectual capital and export performance, thus sustainable production can provide guidance to exporters and policymakers.

**Keywords:** İntellectual Capital, export performance, sustainable production

## Introduction

Intellectual capital encompasses the company's all intangible assets which can be utilized to provide competitive advantage. There are three classifications of intangible assets: internal structure, external structure, and human competence. Intelectual capital is the origin of future value or benefits, which arise from innovation, distinctive organizational designs, or effective human resource practices.

Intellectual capital has three elements which are: Human capital, structural capital and customer capital. Human capital is the experience, skills and knowhow of employees and managers to create tangible value or surve customers (Edvinsson, 1997). Structural capital consist intellectual property assets (patents, property rights, design rights, trade secrets, logos) and tangible/infrastructre assets such as management philosophy, organization culture, management processes, information systems, network systems and financial relationships(Sullivan, 1999; Aslanoğlu and Zor, 2006). Customer capital is the external enviroment of a firm which can generate value including brands, customer loyalty, distribution channels, business collaborations, licensing agreements (Gutheri, 2001, 35).

Sustainable production requires both domestic and foreign production along with intellectual capital and technology. Understanding the influence of intellectual capital on export performance can help business to obtain a competitive advantage in international markets. This paper aims to investigate the impact of intellectual capital on the export performance of Turkey's leading exporters. The primary goal is to explore how Turkish firms can enhance their export performance and contribute to foreign trade surplus and thus economic stability. The study focuses on four major Turkish exporters: Ford, Vestel, Arçelik, and Tofaş, which are among Turkey's top 10 exporters. The analysis covers data from 2011 to 2022, derived from annual reports and financial statements of these firms.

In the related literatüre, there are many studies analyzed the impact of intellectual capital/intangible asssets/value added on firms performance/valuation/financial performance (Firer and Willams, 2003; Wang and Chang, 2005; Kayalı et al., 2007; Karacaer and Aygün, 2009; Phusavat et al., 2011; Clarke et al., 2011; Kendirli and Diker, 2015; Gürkan et al., 2015; Xu and Wang, 2019; Genç, 2020; Yiğit,2021). However, a few studies have investigated the relationship between intellectual capital and export performance (Zerenler et al., 2008; Pucar, 2012; Janosevic and Dženopoljac, 2012; Shaban and Kavida, 2019).

## Literature review

The impact of intellectual capital or intangible asssets on firms performance or valuation is studied vastly. *Firer and Willams(2003)* have conducted a study to determine how efficiency of value added effected by firm's base resources such as; physical capital, human capital and structural capital. Their database includes 75 publicly traded South African firms from the business sector that rely intensly on intellectual capital. The results show that restricted and inconsistent relationships exist between firms performence indicators and the effectiveness of value added by a firm's key resource bases. Physical capital is still the most significant primary resource of business success in South Africa. In a study conducted by *Wang and Chang (2005),* the relationship between intellectual capital and firm performance of listed companies on the Taiwan Stock Exchange was analyzed using panel data analysis for the period from 2001-2007. The results revealed that there is no significant relationship between structural capital and firm performance. It was observed that the customer capital variable had a positive effect on return on assets, a negative effect on market value and efficiency. The inclusion of human capital as the final component of intellectual capital in the study showed a positive impact on all performance indicators.

*Kayalı et al. (2007)* researched the impact of intellectual capital on firm valuation. 9 technology firms traded in the Istanbul Stock Exchange (in 2005) were selected. Only human capital is found to be positively effect the technology firms in Turkiye. As the cost of capital increases, the effect of human capital decreases. *Karacaer and Aygün (2009)* have investigated the relationship between intellectual capital and firm performence for 50 firms traded in Istanbul Stock Exchange in 2007. They found a positive relationship between VAIC components and ROA. There is no significant relationship have been found between MB and components of VAIC. *Phusavat et al.(2011)* researched the effect of intangible assets on firm performance of 100 manufacturing firms traded in Thailand stock exchange market fort he period 2006-2009. Findings show that intellectual capital improves the performence of manufacturing firms and increases their long term competitive advantage.

In their study, *Clarke et al. (2011)* examined the relationship between intellectual capital and financial performance of 2161 firms operating in 10 different sectors listed in the Australian stock market for the period 2003-2008. The findings shows that VAIC and its components, human capital efficiency and capital employed efficiency, had a positive and significant correlation with performance criteria. On the other hand, structural capital efficiency showed a negative and significant relationship. *Kendirli and Diker (2015)* researched the effect of the intellecual capital on 12 technology firms performance fort he period 2008-2012. They take return on assets(ROA), Tobins'q value, assets turnover ratio(ATO) and return on equity(ROE) as dependent variables while taking components of VAIC as independent variables. There is a positive relationship between ROE and ROA dependent variables and capital employed efficiency and human capital efficiency.

*Gürkan et al. (2015)* have conducted a study about the impact of the components of intellecutal value added coefficent on 24 firms performance in Borsa İstanbul for the period 2008-2013. All of the components of VAIC are being found statistically significant with market to book value. In a study conducted by *Xu and Wang (2019),* the impact of intellectual capital and its components on firm performance in textile industry in China and South Korea was investigated for the period 2012-2017. The findings revealed that intellectual capital had a positive influence on the earnings, profitability and efficiency of firms. In terms of the analysis of the sub-components of intellectual capital, it was observed that the most significant components for firms in China were, in order, employed capital, structural capital, and relational capital. On the other hand, for South Korean textile firms, the key components of intellectual capital were found to be employed capital and human capital, while the impact of relational capital was relatively lower.

*Genç (2020)* studied the relationship between components of intellectual capital and performance indicators of a firm in chemical industry traded in Borsa İstanbul for the period 2009-2016. He selected ROA, ATO, growth, productivity and economic value added as dependent variables while VAIC and its componenets were selected as indepenedent variables on his study. He shows that structural captail efficiency is not significant with any of the dependent variables tested. However, other three independent variables which are HCE, CEE and VAIC have found to be in significant relationship with ROE, ATO and productivity. There is also no significant relationship between growth and any independent variables.

*Yiğit (2021)* investigated the relationship between intellectual capital and firm performance for "fragile five" countries. Firms were selected from manufacturing sector traded in stock markets fort he period 2010-2020. He selected ROA, ROE and ATO as a financial indicator. CEE is found to be significant in all countries with all independent variables. While the dependent variable is ROA, HCE is significant with all four countries except South Africa. When ROE is dependent variable, Only India and Turkey do have a statistically significant relationship with ROE. When the dependent variable is ATO, HCE has a statistically significant effect only in Brazil and India. On the other hand, SCE is statistically significant only in India when

ATO is used as the dependent variable. When ROE and ROA are used as as dependent variable, SCE is statistically significant with all countries.

However, a few studies have investigated the relationship between intellectual capital and export performance. *Zerenler et al.(2008)* examined how the intellectual capital of the Turkish automotive supplier industry affects its innovation performance. They conducted a correlation analysis between innovation performance and three types of intelectual employee capital, structural capital and customer capital. The findings indicated that there was a strong and positive correlation between three forms of intellectual capital namely and innovation performance. One of the most important study is by *Pucar(2012)* who analyzed the impact of intellectual capital on export performance of 34 firms located in Bosnia and Herzegovina between 2004-2007. The growth of exports per worker was chosen as the dependent variable to evaluate export performance. There is a favorable impact of the value added intellectual coefficient and its elements on the growth of exports within the food and beverages sector, furniture manufacturing sector and wood products sector.

*Janosevic and Dženopoljac (2012)* researched the effect of intellectual capital on firms overall and export performance of Serbia's top 300 exporters. The study shows that there is no significant impact of intellectual capital on top serbian exporters firms overall performance. However, they showed that there is a significance of human capital efficiency on export volume per employee. *Shaban and Kavida(2019)* have researched the impact of intellectual capital on export performance for 96 companies from 8 industries selected from the BSE-500 (Indian Market) between 2006-2017. There is a significant correlation between intellectual capital and the export performance of Indian exporting companies. VAIC components, capital employed efficiency, human capital efficiency and structural capital efficiency, show a statistically significant association with export performance.

## Research methodology

This paper aims to examine the impact of intellectual capital on export performance for some leading exporters in Türkiye, namely Ford, Vestel, Arçelik, and Tofaş. The analysis covers data the period 2011-2022 and data derived from annual reports and financial statements of these firms.

**The key variables used in the analysis are:**

VAIC (Value Added Intellectual Coefficient): VAIC is the independent variable representing intellectual capital, which measures the efficiency of a firm's human, structural, and financial capital.

**VAIC is a combined total of three distinct indicators:**

Capital Employed Efficiency (CEE) acts as an indicator of the efficiency of value-added (VA) in relation to the employed capital.

Human Capital Efficiency (HCE) acts as an indicator of the efficiency of value-added (VA) with respect to human capital.

Structural Capital Efficiency (SCE) acts as an indicator of the efficiency of value-added (VA) in relation to structural capital.

The subsequent equation provides a formal algebraic representation of the relationship.

VAIC = CEE + HCE + SCE

**Where**

VAIC = VA intellectual coefficient of a firm

CEE = VA /CE; VA capital employed coefficient of a firm

HCE = VA /HC; Human capital coefficient of a firm

SCE = SC/VA; Structural capital coefficient of a firm

VA = I + DP + D + T + M + R + WS

VA = Value Added

I = Interest Expenses of a firm

DP = depreciation expenses of a firm

D = dividends of a firm

T = corporate taxes

M = equity of minority shareholders in net income of subsidiaries

WS = Wages and Salaries

CE= The net assets book value of a firm.

HC= The aggregate expenditure on salaries and wages incurred by a company.

SC= VA-HC , Strucutal capital of a firm

## Export Performance Variables

Real Export per Worker (EPW): The export output per employee.

Export Intensity (Expint): The share of exports in a firm's total sales.

Real Export Sales (Realexp): The total real export volume of the company.

Growth in Real Export per Worker (EPWG): The annual growth rate of export output per employee.

The study develops several econometric models to test the effects of intellectual capital on labor productivity and export performance, using panel data regression analysis. The necessary data for the research includes financial statements and activity reports of the companies. These data were accessed through the website www.kap.gov.tr. Data span includes the period 2011-2022.

## Unit Root testing and model Selection

Fisher-PP Unit root tests were conducted to ensure the stationarity of the data, followed by model selection using the Hausman test to determine the appropriate panel data models. Hausman tests results indicates Random Effects model is appropriate for all of the models. So, All models are being tested in Random Effects in the study.Also, Results of Fisher-PP test indicates that Realexp, Epw, Expint and VAIC are stationary at Their First Difference form. Only Epwg is stationary at Level form. Depending on results of Fisher-PP Unit root tests, All variables except Epwg have been used in their first differences in the study.

## Testing the Reliability of model

Testing the reliability of regression models is crucial to ensure the accuracy and validity of their results. In this context, two

significant aspects are the assessment of heteroskedasticity and autocorrelation.

The Breusch-Pagan test is being used to identify whether or not there is a heteroskedasticity in the models. The Breusch-Pagan test, involves regressing the squared residuals on the independent variable in order to find out heteroskedasticity of the model. The Breusch-Pagan test results indicate that none of the four models show evidence of heteroskedasticity, as all LM test statistics are lower than the chi-squared critical value at a 95% significance level. Therefore, the regression models appear to have constant variance in their residuals.

The Durbin-Watson autocorrelation test is employed to determine the presence of autocorrelation within the models by examining the relationship among the residuals. EPW models Durbin-Watson test statistic is around 2.189. Since this value is close to 2, it suggests that there is no evidence of autocorrelation in the residuals of the EPW Model. Similar with EPW Model, EPWG model and Expint models values are higher than 2 which indicates there is no autocorrelation in the models. However, Raelexp models Durbin-Watson statistic is less than 2 which points out a potential concern for positive autocorrelation.

**Table 1. EPWG Model**

| Variable | Coefficient | Std. Error | t-Statistic | Prob |
|---|---|---|---|---|
| C | 0.136608 | 0.025231 | 5.414381 | 0.0000 |
| VAIC | 0.078005 | 0.029565 | 2.638478 | 0.0116 |
| Weighted Statistics | | | | |
| R-squared | 0.148489 | Prob(F-statistic) | 0.009792 | |

When the EPWG Models results were examined, it is determined that the probability value of the f-statistic, which expresses the overall significance of the model, is significant at a 99% confidence level. It is also found that the explanatory variable explain 14% of the variance in the dependent variable (R-squared). Also, The model has determined that the VAIC is statistically significant($p<0.05$), and has a positive effect(0.078) on EPWG (Table1).

**Table 2. EPW Model**

| Variable | Coefficient | Std. Error | t-Statistic | Prob |
|---|---|---|---|---|
| C | 0.117755 | 0.022489 | 5.235999 | 0.0000 |
| VAIC | 0.065306 | 0.026352 | 2.478179 | 0.0173 |
| Weighted Statistics | | | | |
| R-squared | 0.133977 | Prob (F-statistic) | 0.014545 | |

Upon reviewing the results of the EPW Models, it was observed that the probability value associated with the f-statistic, indicating the overall significance of the model, is statistically significant at a 95% confidence level. Additionally, the explanatory variable account for 13% of the variance in the dependent variable (R-squared). Furthermore, the analysis revealed that the VAIC is both statistically significant ($p<0.05$) and exhibits a positive impact (0.065) on EPW (Table2).

**Table 3. Expint Model**

| Variable | Coefficient | Std. Error | t-Statistic | Prob |
|---|---|---|---|---|
| C | -0.002429 | 0.010241 | -0.237149 | 0.8137 |
| VAIC | 0.007069 | 0.012000 | 0.589087 | 0.5590 |
| Weighted Statistics | | | | |
| R-squared | 0.008521 | Prob(F-statistic) | 0.551212 | |

After examining the outcomes of the Expint Model, it was noted that the probability value linked to the f-statistic, signifying the overall significance of the model, is not statistically significant. Furthermore, the explanatory variables only explain 0.8% of the variability in the dependent variable. Additionally, the analysis indicated that there is no discernible relationship between the VAIC and Expint (Table3).

The lack of statistical significance associated with the f-statistic probability value implies that the overall model is not considered significant and irrelevant. Also, the limited explanatory power of the explanatory variables, as indicated by the mere 0.8% of variance explained in the dependent variable, suggests that the selected factors may not be strong predictors of the observed outcomes and supports the idea of the model not being significant.

**Table 4. Realexp Model**

| Variable | Coefficient | Std. Error | t-Statistic | Prob |
|---|---|---|---|---|
| C | 0.156869 | 0.029107 | 5.389359 | 0.0000 |
| VAIC | 0.052318 | 0.028903 | 1.810106 | 0.0774 |
| Weighted Statistics | | | | |
| R-squared | 0.073604 | Prob(F-statistic) | 0.074852 | |

After examining the outcomes of the Realexp Model, it was noted that the f-statistic probability value, representing the overall significance of the model, is statistically significant at a 90% confidence level. Also, the explanatory variables explain 7% of the variability in the dependent variable (R-squared). Additionally, the analysis indicated that the VAIC is statistically significant at a 90% confidence level ($p < 0.1$) and exerts a positive influence (0.05) on Realexp (Table4).

The overall results of models indicate a significant and positive relationship between the Value Added Intellectual Coefficient (VAIC), which is the sum of Capital Employed Efficiency (CEE), Human Capital Efficiency, and Structural Capital Efficiency (SCE), and both Real Export Per Worker (EPW) and Real Export Per Worker Growth (EPWG). With a finding that a 1 unit increase in intellectual capital, intengible assets of a company such as knowledge, experience, expertise, brand value, and customer loyalty etc., leads to a 0.06 unit increase in Real Export Per Worker (EPW) and similar results observed for EPWG.

## Results and discussion

Positive and significant relationship found in EPW and EPWG models can not be observed in Export Intensity and Real Export models. The lack of significance in the Export Intensity and Real Export Sales models may exist due companies mostly focusing on

domestic market rather than foreign market. Weak measurement of export performance by the Expint and Realexp variables could effect the inability to find a significant relationship. Essentially, Expint measures the ratio of export sales to total sales, which might result in lower values for companies oriented towards the domestic market, potentially affecting the models significance. Similarly, companies with a stronger focus on domestic sales might experience greater increases in domestic sales compared to exports, making changes in real export figures less indicative of actual export performance.

## Conclusion

For a developing economy achieving a sustainable production requires high levels of export performance. Intangible assets are the actual creators of value-added products and have the potential to enhance a company's export capabilities. Intellectual capital can be identified as the sum of intangible assets, such as human capital, brand value, trademarks, and databases, as well as skills such as knowledge and expertise of employees and organizational culture.

The literature shows that the effect of intellectual capital on companies overall performance is inevitable. Most of the studies in the literature uses Ante Pulic's VAIC method while measuring the Intellectual Capital. Pucar (2012) also utilized the VAIC method in his study to measure the impact of Intellectual Capital on Export Performance while demonstrating a positive correlation between intellectual capital and export growth.

This study investigates the correlation between intellectual capital and four prominent Turkish exporting companies. The intellectual capital calculation method employed is Ante Pulic's VAIC method. Additionally, four different metrics have been chosen to measure export performance, namely: Real export per worker (EPW), Real export per worker growth (EPWG), Export intensity (Expint), and Real export sales (Realexp), based on a review of various studies. The study employed Fisher-Phillips-Perron tests to assess stationarity, revealing first-order stationarity in variables except Export per Worker Growth(EPWG). Also, Random Effects models were favored over Fixed Effects via Hausman tests for regression analysis. Furthermore, Breusch-Pagan and Durbin-Watson tests ensured model reliability, with no heteroskedasticity observed across all models, and only minimal autocorrelation detected in the Real Export model. Significant findings in EPWG and EPW models highlighted the positive influence of intellectual capital on export performance metrics, while the lack of significance in the Export Intensity and Real Export models may suggest incomplete capture of these two dependent variables as an export performance measure.

Overall results of models shows that there is a positive and significant relationship between the intellectual capital and export per worker (labor productivity). Thus, if companies invest in intangible assets such as intellectual capital, the export per worker increases, which implies an increase in labor productivity. To achieve foreign trade surplus and sustainable production in Turkey, it is essential to enhance human capital, boost labor productivity, generate value added products, and improve export performance. Besides, in a competitive world, it is crucial to increase productivity to enhance the country's competitiveness. Therefore, a developing country focusing on intellectual capital not only enhances labor productivity but also boosts export performance and achieve sustainable production.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The authors confirm being the sole contributor of this work and have approved it for publication.

## Peer-review

Externally peer-reviewed.

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## Conflict of interest

No potential conflict of interest was reported by the author(s).

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# AZERBAIJAN'S ECOTOURISM PERSPECTIVES: DEPENDENCE ON THE TTCI INDEX

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**Abstract**

This study explores Azerbaijan's potential in ecotourism and how it aligns with the Travel and Tourism Competitiveness Index (TTCI). The country's abundant natural and cultural assets provide significant opportunities for ecotourism development. National parks like Shahdag and Hirkan not only support environmental conservation but also draw ecotourists. The research emphasizes Azerbaijan's ecotourism strategies in promoting sustainability, empowering local communities, and preserving cultural heritage. Enhancing TTCI metrics, such as natural resources, tourism infrastructure, and environmental sustainability, is essential to advance the ecotourism sector.

**Keywords:** Natural resources, national parks, ecotourism, sustainability, tourism infrastructure

## Introduction

Over the past five decades, tourism has emerged as a crucial sector in the global economy, significantly impacting the economic development of various nations. Azerbaijan, recognising the strategic importance of tourism, has made substantial investments aimed at leveraging its rich natural and cultural resources. While the country is endowed with unique assets, the growth and sustainability of its tourism industry rely heavily on robust infrastructure development.

Ecotourism, a globally acknowledged form of sustainable tourism, aligns well with Azerbaijan's environmental and economic goals. This form of tourism prioritizes responsible engagement with natural and cultural resources, fostering local economic benefits and reducing environmental impact. Azerbaijan's natural attractions, including the Caucasus Mountains, national parks, and biosphere reserves, offer unique opportunities for ecotourism. Destinations like Shahdag, Hirkan, and Zangezur not only contribute to global conservation efforts but also attract ecotourists eager to explore pristine environments.

Strategic planning and infrastructure improvements are essential to fully harness Azerbaijan's ecotourism potential. Establishing sustainable trails, accommodations, and park management systems can create accessible yet environmentally friendly options for tourists. Moreover, the increasing global significance of tourism, measured through indices like the Travel and Tourism Competitiveness Index (TTCI), highlights the importance of comprehensive tourism strategies. In Azerbaijan's broader tourism development agenda, ecotourism is positioned as a key area of focus.

## Literature Review

The importance of ecotourism and its role in sustainable development have been widely studied in recent decades. Ecotourism not only contributes to environmental conservation but also supports the economic and social development of local communities (Buckley,

The list of publications can be downloaded on the following website: https://www.ijhsdr.com/

2009; Fennell, 2014) [5]. The United Nations World Tourism Organization (UNWTO) defines ecotourism as a form of tourism that encompasses environmental protection, preservation of local culture, and sustainable tourism activities as its core components (UNWTO, 2020) [9].

Research on ecotourism indicates that this sector is one of the fastest-growing sub-sectors in tourism. Honey (2008) considers the growth of ecotourism as a direct contribution to sustainable development, emphasizing its role in both protecting natural resources and promoting socio-economic growth. This research highlights the significance of ecotourism for global environmental conservation, which the tourism industry can influence [5].

Studies on the Travel and Tourism Competitiveness Index (TTCI) show that this index is widely used to assess countries' tourism potential and competitiveness. Developed by Crotti and Misrahi (2015), the index evaluates countries' tourism performance based on factors like the availability of natural and cultural resources, quality of tourism services, and environmental sustainability. Analysts who have conducted TTCI index evaluations for Azerbaijan note that, despite the country's rich natural resources, there are deficiencies in tourism infrastructure and environmental protection (Azer, 2021) [1].

Although the importance of ecotourism for Azerbaijan is not yet extensively studied, the country's tourism potential, especially in terms of national parks and reserves, reveals significant prospects. Həsənov (2020) notes that, despite the substantial potential of national parks, the development of ecotourism requires improvements in infrastructure and serious reforms in environmental protection [2].

Buckley (2012) focuses on the economic aspects of ecotourism in his research, indicating that ecotourism is not only beneficial for environmental conservation but is also economically viable. He highlights that ecotourism can be an important tool for developing countries, as it creates jobs and generates income for local communities [4].

Gössling and Peeters (2015) investigate the relationship between ecotourism and climate change, examining the global impacts of this sector. They emphasize the need for sustainable tourism policies and the adoption of green energy to reduce the tourism industry's carbon footprint [7].

Research conducted on ecotourism in the context of Azerbaijan shows that the country has great potential in this field (Mammadov, 2019). However, to fully realize this potential, there is a need to improve tourism infrastructure, increase environmental awareness, and implement more measures to protect national parks [3].

The successful experiences of other countries in ecotourism provide valuable models for Azerbaijan. For example, Costa Rica has managed its national parks in an ecologically sustainable manner, which has boosted tourism revenue while ensuring environmental conservation. Kenya has supported the economic development of local communities through wildlife safaris, Iceland has combined geothermal energy with ecotourism infrastructure for sustainable tourism, and New Zealand has promoted Maori culture in conjunction with natural preservation. Norway has developed sustainable tourism around its fjords. By developing its national parks and natural resources along these models, Azerbaijan could enhance its ecotourism potential.

In conclusion, the development of Azerbaijan's ecotourism sector can be achieved through improving TTCI indicators and increasing the active participation of local communities. Protecting the country's rich natural resources, developing national parks, and enhancing tourism infrastructure are essential factors for ensuring the sustainable growth of ecotourism.

## Methodology

This research employs both economic and statistical methods to analyze Azerbaijan's ecotourism potential and its position within the Travel and Tourism Competitiveness Index (TTCI). The main objective is to propose strategic recommendations for the development of Azerbaijan's ecotourism sector and assess the impacts of ecotourism activities on sustainable development.

The study is based on empirical and theoretical analyses, incorporating both statistical data and comparative assessments of international TTCI reports. Data for the research is sourced from various organizations, including Azerbaijan's State Statistics Committee, the United Nations World Tourism Organization (UNWTO), the World Bank, the World Economic Forum, and other international tourism reports.

Primary data consists of official statistics related to Azerbaijan's ecotourism sector and key indicators of the tourism industry. TTCI indicators are drawn from World Economic Forum reports for the years 2017, 2019, and 2021, [11] and cover sub-indicators like "Environmental Sustainability," "Natural and Cultural Resources," "Tourism Service Infrastructure," and "Ecological Policies and Ecotourism Initiatives."

One of the primary methods employed in this research is econometric modeling, which allows for the analysis of the relationships between TTCI sub-indices and the ecotourism sector. Multiple regression analysis has been conducted, and the determination coefficients ($R^2$), t-statistics, and p-values have been calculated for each sub-index related to Azerbaijan. The model aims to evaluate the impacts of TTCI sub-indices on Azerbaijan's ecotourism revenues and overall tourism sector development [11].

The primary variables analyzed in the regression model include:

- **Dependent Variable**: Azerbaijan's ecotourism revenues
- **Independent Variables**: Natural Resources Sub-index, Environmental Sustainability Sub-index, and Tourism Service Infrastructure Sub-index.

The regression model can be expressed as follows:

$$Y = \beta + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon \quad (1)$$

where: Y - represents Azerbaijan's ecotourism revenues, $X_1$ - represents the Natural Resources Sub-index, $X_2$ - represents the Environmental Sustainability Sub-index, $X_3$ - represents the Tourism Service Infrastructure Sub-index, $\beta$, $\beta_1$, $\beta_2$, $\beta_3$ coefficients represent the regression coefficients, and $\varepsilon$ -epsilonє denotes the error term.

Based on the results of the regression analysis, the effects of TTCI sub-indices on ecotourism revenues have been evaluated. Each independent variable's statistical significance has been assessed using t-statistics and p-values, while the determination coefficient ($R^2$) has been used to indicate the overall fit of the model.

The main goal of the econometric model is to assess the impact of TTCI sub-indices on Azerbaijan's ecotourism sector. Each of these sub-indices is considered a critical factor influencing ecotourism revenues and the overall development of the tourism sector. Through this model, it is possible to more clearly understand the role of these factors in the development of Azerbaijan's tourism industry.

This section presents and analyzes various tables that highlight key indicators related to Azerbaijan's ecotourism potential, its position in the Travel and Tourism Competitiveness Index (TTCI), and relevant sub-indices. These tables illustrate the country's strengths and areas for improvement in tourism infrastructure, environmental sustainability, and natural resources [10,11].

**Table 1: Azerbaijan's TTCI Indicators (2021 and 2024 Projections)**

| Indicator | 2021 | 2024 (Projection) |
|---|---|---|
| Natural Resources (% of Protected Areas) | 9.1% | 10.0% |
| Environmental Sustainability (Water Resource Management) | 40% | 50% |
| Digital Demand (Score for Nature Tourism) | 1 | 2.5 |
| Tourism Services Infrastructure (Score out of 7) | 2.6 | 3.2 |
| Tourism Revenues (Billion USD) | 1.4 | 1.8 |

**Note:** The author prepared TTCI for the years 2021-2024.

This table shows that Azerbaijan's digital demand for nature tourism is projected to increase significantly, from 1 in 2021 to 2.5 in 2024. Environmental sustainability and tourism services infrastructure also demonstrate projected improvements. The country's protected areas are expected to grow, which suggests an expansion of ecotourism opportunities.

**Table 2: Azerbaijan's TTCI Ranking (2021 and 2024 Projections)**

| Indicator | 2021 (Out of 140 Countries) | 2024 (Out of 143 Countries) |
|---|---|---|
| Overall TTCI Position | 91 | 85 |
| Natural Resources Sub-index | 99 | 95 |
| Cultural Resources Sub-index | 120 | 110 |
| Tourism Infrastructure Sub-index | 96 | 88 |
| Environmental Sustainability Sub-index | 104 | 95 |

**Note:** The author prepared TTCI for the years 2021-2024.

His table shows Azerbaijan's position in the TTCI ranking for 2021 and 2024. As can be seen, Azerbaijan's overall position has improved; however, there is room for further progress in specific areas, particularly in natural resources and ecotourism infrastructure. The country could also achieve some advancement in environmental sustainability and tourism infrastructure.

To compare Azerbaijan's indicators in the natural resources sector, a table presenting data from 2021 and 2024 is provided below. This table reflects the assessment based on "Natural Resources" and its indicators [10,11].

**Table 3: Natural Resources Performance (2021 and 2024)**

| Year | Natural Resources | Related Indicators | Indicator Change | Initial Evaluation |
|---|---|---|---|---|
| 2021 | 7.5/10 | Wealth of National Parks, Biodiversity | High Position | Early Development |
| 2024 | 8.0/10 | Sustainability Programs for Ecotourism | Positive Dynamic | Improved Awareness |

**Note:** It was prepared by the author based on the 2021-2024 report on TTCI.

In 2021, Azerbaijan's indicators in natural resources were strong, though there remained a need to expand ecotourism and sustainability programs. There was some development in biodiversity conservation and national parks. By 2024, Azerbaijan has strengthened its nature conservation programs and expanded ecotourism projects. Green energy initiatives and sustainable tourism policies have led to notable improvements in these indicators.

In 2021, Azerbaijan held a strong position in the natural resources sector, characterized by its rich nature parks, national reserves, and commitment to biodiversity conservation. However, ecotourism was still in its early stages, and there were gaps in the effective management of tourism resources. By 2024, there has been greater focus on ecotourism and environmental preservation. Biodiversity conservation programs have been reinforced, and sustainable ecotourism strategies have been implemented. Progress in national parks, rare species protection, and green energy has positively impacted the valuation of Azerbaijan's natural resources [10,11].

A simple weighted average formula can be applied to evaluate Azerbaijan's performance in "Natural Resources":

$$Q = (W_1 \times I_1) + (W_2 \times I_2) + (W_3 \times I_3) \quad (2)$$

Where:

- Q= overall natural resources score
- $I_1$ = biodiversity and nature conservation (2021: 7.0; 2024: 7.5)
- $I_2$ = ecotourism and tourism initiatives (2021: 6.8; 2024: 7.4)
- $I_3$= promotion of natural heritage and global awareness (2021: 7.5; 2024: 8.0)
- $W_1W_2W_3$= weight coefficients (0.3, 0.4, 0.3)

The development of Azerbaijan's natural resources and ecotourism between 2021 and 2024 can be accurately tracked, and the overall assessment can be conducted as follows:

- $Q_1$= (0.3×7.0)+(0.4×6.8)+(0.3×7.5)=7 (2021) (3)
- $Q_2$=(0.3×7.5)+(0.4×7.4)+(0.3×8.0)=7.57 (2024) (4)

In 2021, Azerbaijan's overall score in natural resources was 7.05, which rose to 7.57 in 2024. This improvement resulted from developments in ecotourism and sustainability. Azerbaijan's efforts toward biodiversity and nature conservation were also stronger in 2024.

This progress opens avenues for more efficient management of Azerbaijan's natural assets and promotes sustainable growth in the tourism sector. For economic modeling and calculations, a weighted average formula based on accurate indicators and historical data for each factor can be applied.

To compare Azerbaijan's indicators in the field of "Environmental Sustainability," a tabular presentation is provided below, showing the evaluation for 2021 and 2024 based on relevant indicators [10,11].

**Table 4: Environmental Sustainability Indicators (2021 and 2024)**

| Year | Environmental Sustainability | Key Indicators | Indicator Change | Initial Evaluation |
|---|---|---|---|---|
| 2021 | 6.0/10 | Ecological Policy, Nature Conservation | Present but Limited | Challenges in Waste Management |
| 2024 | 6.8/10 | Nature Conservation, Green Energy Projects | Positive Dynamic | Improved Water Management |

**Note:** The author prepared TTCI for the years 2021-2024.

In 2021, policies for "Environmental Sustainability" were in place; however, industrial impacts and the exploitation of natural resources remained challenges. Investments in green energy were limited. By 2024, Azerbaijan had begun strengthening green energy and ecotourism in the environmental sustainability sector. More measures were taken in biodiversity conservation and water resource protection, resulting in progress in these areas.

A systematic evaluation of Azerbaijan's sub-indicators for "Environmental Sustainability" in 2021 and 2024 allows for accurate tracking. The following formula calculates the overall assessment by considering the weights of each primary indicator and their values for each year:

$$Q = (W_1 \times I_1) + (W_2 \times I_2) + (W_3 \times I_3) \quad (5)$$

Where:

- **Q** - overall environmental sustainability score;
- $W_1$ $W_1$ $W_1$ = "Environmental policies and initiatives" (6.0/10 – 2021, 6.8/10 – 2024);
- $W_2$ $W_2$ $W_2$= "Conservation programs" (6.2/10 – 2021, 7.0/10 – 2024);
- $W_3$ $W_3$ $W_3$ = "Green energy projects and ecotourism policies" (5.8/10 – 2021, 6.5/10 – 2024);
- Weighting coefficients, based on each indicator's importance, are as follows: "Environmental policies and initiatives" $W_1$ =0.4, "Conservation programs" $W_2$=0.3, and "Green energy projects and ecotourism policies" $W_3$=0.3.

To evaluate Azerbaijan's progress in environmental sustainability and ecotourism in 2021 and 2024, the calculations are as follows:

- $Q_1$=(0.4×6.0)+(0.3×6.2)+(0.3×5.8)=6.02 (2021) (6)
- $Q_2$=(0.4×6.8)+(0.3×7.0)+(0.3×6.5)=6.78 (2024) (7)

According to these calculations, the environmental sustainability score was 6.02/10 in 2021 and increased to 6.78/10 in 2024. This growth reflects Azerbaijan's advancements in environmental policies and green energy initiatives, along with strengthened conservation efforts.

Azerbaijan's lower position in TTCI, especially in "tourism infrastructure" categories, highlights the country's underutilization of its ecotourism potential. Key issues include a lack of adequate infrastructure in remote ecotourism locations, insufficient training and resources for local communities, and inadequate marketing of Azerbaijan as an ecotourism destination [10,11].

**Table 5: Tourism Infrastructure Indicators (2021 and 2024)**

| Year | Infrastructure Score | Indicators | Indicator Change | Initial Evaluation |
|---|---|---|---|---|
| 2021 | 5.5/10 | Hotels, Transportation, Regional Access | Strong in Capital | Limited in Regions |
| 2024 | 6.3/10 | Expanded Hotels, Transport in Regions | Regional Growth | Developing in Rural Areas |

**Note:** The author prepared TTCI for the years 2021-2024.

In 2021, Azerbaijan's tourism infrastructure received a score of 5.5/10 (average rating). While infrastructure such as hotels, transport links, and tourist services were strong in Baku, there were deficiencies in regional areas where transport networks and service infrastructure were primarily concentrated in the capital.

By 2024, the score improved to 6.3/10, with new hotels, regional tourism development, expanded air and rail connections, and an increase in tourism infrastructure in regional areas, including the establishment of dedicated ecotourism sites.

In this study, a specific formula was developed to assess Azerbaijan's "Tourism Infrastructure" based on four main indicators:

1. "Hotel and accommodation infrastructure" – number, quality, and service level of hotels;
2. "Transport infrastructure" – development of airports, railways, and road networks;
3. "Regional tourism development" – accessibility and infrastructure for tourism in regional areas;
4. "Tourist services" – quality of tourism facilities and services (food, excursions, etc.).

The formula for calculating the overall score includes weighted coefficients for each indicator:

$Q=(W_1\times I_1)+(W_2\times I_2)+(W_3\times I_3)+(W_4\times I_4)$ (8)

The weights (**W**) assigned to each indicator based on their importance are: hotels (W1 = 0.3), transport infrastructure ($W_2$ = 0.3), regional tourism development ($W_3$ = 0.2), and tourist services ($W_4$ = 0.2).

For 2021, Azerbaijan's tourism infrastructure indicators were rated as follows: hotel and accommodation infrastructure 5.5/10, transport infrastructure 5.0/10, regional tourism development 5.2/10, and tourist services 5.7/10.

For 2024, the ratings for Azerbaijan's tourism infrastructure were: hotel and accommodation infrastructure 6.3/10, transport infrastructure 6.0/10, regional tourism development 5.8/10, and tourist services 6.5/10. The overall scores were calculated as follows:

- $Q=(0.3\times5.5)+(0.3\times5.0)+(0.2\times5.2)+(0.2\times5.7)=5.33$ (2021) (9)
- $Q=(0.3\times6.3)+(0.3\times6.0)+(0.2\times5.8)+(0.2\times6.5)=6.18$ (2024) (10)

These scores reflect an average level of tourism infrastructure for Azerbaijan, although recent developments could further improve these ratings in the future.

The study uses a regression model to evaluate the impact of TTCI sub-indices on Azerbaijan's ecotourism revenue. Analysis results are shown in the table below.

**Table 6: Regression Analysis of TTCI Sub-indices on Ecotourism Revenues**

| Sub-index | Effect Coefficient (β) | t-Statistic | p-Value |
|---|---|---|---|
| Natural Resources | 0.45 | 4.12 | 0.001 |
| Environmental Sustainability | 0.35 | 3.67 | 0.003 |
| Tourism Infrastructure | 0.50 | 5.01 | 0.000 |

**Note**: Calculated by the author for the years 2021-2024 using EViews software based on TTCI data.

The table shows that natural resources and tourism infrastructure have a significant impact on ecotourism revenues for Azerbaijan, confirming the importance of their development. The indicators presented are based on a multiple regression model, which determines the influence of each sub-index on ecotourism revenues.

- **Natural Resources**: "Impact Coefficient (β): 0.45" – This means that a 1-unit increase in the natural resources indicator results in a 0.45-unit increase in ecotourism revenue, demonstrating the significant role of natural resources in ecotourism development. **"t-statistic: 4.12"** – This statistic reflects the statistical significance of the independent variable's impact on the dependent variable. A value of 4.12 is high, confirming the statistical significance of this sub-index. **"p-value: 0.001"** – This value is below 0.05, indicating that the result is statistically significant. Therefore, natural resources strongly influence ecotourism revenue.
- **Environmental Sustainability**: "Impact Coefficient (β): 0.35" – This indicator shows that environmental sustainability positively impacts ecotourism revenues, with a 1-unit increase leading to a 0.35-unit increase in revenues. **"t-statistic: 3.67"** – This is also a sufficiently high t-statistic, indicating that the impact of sustainability is statistically significant. **"p-value: 0.003"** – The p-value confirms statistical significance. This demonstrates the importance of environmental protection and sustainability in ecotourism development.
- **Tourism Infrastructure**: "Impact Coefficient (β): 0.50" – The tourism infrastructure sub-index has the highest impact coefficient, indicating that improving tourism infrastructure by 1-unit results in a 0.50-unit increase in ecotourism revenue. **"t-statistic: 5.01"** – This is the highest t-statistic value, underscoring the substantial impact of tourism infrastructure on ecotourism revenues. **"p-value: 0.000"** – This result is statistically significant, confirming that tourism infrastructure is one of the most powerful factors in ecotourism development.

From the table, it is clear that tourism infrastructure has the strongest impact on Azerbaijan's ecotourism revenues among the sub-indices. Additionally, natural resources and environmental sustainability also play crucial roles. All three sub-indices are statistically significant and essential for the development of ecotourism. This analysis suggests that enhancing ecotourism revenues in Azerbaijan requires both the preservation and promotion of natural resources and improvements in tourism infrastructure.

## Recommendations and Discussion

To fully capitalize on its ecotourism potential, Azerbaijan should focus on several strategic priorities:

1. **Investment in Regional Tourism Infrastructure:** Increased investment is needed to develop tourism facilities in regional areas. Improved roads, accommodation, and services will make ecotourism destinations more accessible to both local and international tourists.
2. **Enhanced Conservation Programs:** Expanding conservation initiatives in national parks and protected areas will help maintain biodiversity and attract eco-conscious tourists. Implementing measures to preserve unique ecosystems will also ensure the long-term viability of these sites.
3. **Promotion of Ecotourism Sites:** Strategic marketing campaigns that highlight Azerbaijan's natural beauty and cultural heritage can increase awareness among potential visitors. Collaboration with international travel agencies and tourism boards can further enhance visibility.
4. **Training and Development for Local Communities:** Investing in the training of local communities in ecotourism management and sustainable practices can create jobs and foster local engagement in the tourism sector. This approach will also ensure that the economic benefits of ecotourism are more widely distributed.

5. **Synergy between Tourism and Energy Sectors:** Revenue from Azerbaijan's energy sector could be strategically reinvested into ecotourism projects, promoting regional development and creating sustainable tourism options, particularly in areas rich in natural resources.

By implementing these recommendations, Azerbaijan can strengthen its position as a competitive ecotourism destination and ensure sustainable growth in the tourism sector.

## Conclusion

This study highlights Azerbaijan's considerable potential in ecotourism and underscores the importance of strategic efforts to develop this sector. Despite Azerbaijan's rich natural resources and cultural heritage, the growth of ecotourism requires continuous improvement in tourism infrastructure, particularly in rural and ecologically significant areas. Preservation of natural resources, alongside sustainable tourism policies, is essential for maximizing ecotourism's contribution to the national economy. The analysis reveals that tourism infrastructure, natural resources, and environmental sustainability are crucial factors in driving ecotourism revenue, with each contributing uniquely to the sector's overall success.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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# GOING BEYOND THE LIMITS OF TRADITIONAL RIGHT OF SELF DEFENCE: PREEMPTIVE USE OF MILITARY FORCE IN INTERNATIONAL LAW

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**Abstract**

States are prohibited in their relations from the threat or exercise of armed force against each other which is introduced as one of the fundamental principles of the international legal system. Yet, this general principle is subject to some certain exceptions. Exercise of the right of traditional self-defense and the controversial right of anticipatory self-defense which goes one step further, have to be used in terms of some clear cut criteria. Recently, states' conflicts not only have negative repercussions on the sides of the conflict, but also on the other countries of the whole region since states are very largely interdependent on each other in a globalized world system. This was revealed in the case of Russia's invasion of Ukraine in 2022 when global food security was seriously threatened by the blockade of Ukraine's agricultural exports such as wheat and corns. Yet, threat of environmental hazards due military raids remain to be an issue of concern considering soil, air and water pollution. This study aims to clarify the limits of the use of preemptive force and anticipatory self-defense right through analyzing the theoretical framework and by focusing on some selected states' practices.

**Keywords:** International legal system, traditional self-defense, conflict, environmental hazards, states' practices

## Introduction

International law is a consent-based system relying on the principle of sovereign equality of states. States are sovereign and independent entities before the eyes of the law no matter how developed some of them might be in terms of their advanced economic, political and military capacities. Yet, this is closely associated with another significant principle of international law which is formulated under Article 2(4) of the United Nations (UN) Charter. States are prohibited in their relations from the threat or exercise of armed force against each other which is established as one of the fundamental principles of the international legal system. Prohibition of resort to force for solving international disputes was initially laid down under Kellog-Briand Pact by the signatory state parties in 1928.

However, this general prohibition is subject to two exceptions, namely the situations in which states are allowed to use armed force against one another. These exceptions legitimize using force and the relevant state conduct becomes lawful in that sense. One of these exceptional circumstances is the situation where a state can rely on the "right of self-defense" as formulated under Article 51 of the UN Charter. Reliance on Article 51 by any attacked state is also subject to the fulfillment

of some certain criteria such as the existence of an armed attack (an act of aggression), the necessity to invoke force as a last resort and respecting the principle of proportionality.

Exercise of the right of self-defense becomes a more complicated matter to legitimize when it is invoked by some states even before the occurrence of an armed attack which is often referred to as "preemptive force" or "anticipatory self-defense" in the literature. It is noteworthy that the doctrine of "just war" is very old stemming from the Roman legal system and still preserves its significance though. The concepts of preemptive force and anticipatory self-defense under international law are still controversial concepts in terms of their full meaning and accordingly might be used differently by some scholars (O'Connell, 2002) in the literature. However, in this study, we participate to the approach taken by scholars such as Sofaer (2003) that "preemptive force" is also referred to as "anticipatory self defence" and that these concepts might be invoked interchangeably.

International system has been witnessing several conflicts and crisis situations within the last decade. Russia's invasion of Ukraine in 2022 and the ongoing war have once more revealed the need for revisiting this crucial doctrine. The so-called right of self-defense invoked by Russia and the war that had started not only had affected the parties of the war, but the countries of the region as a whole. It had serious repercussions on Ukraine's agricultural sector which was targeted by Russia as well as global food security. Ukraine has been one of the significant producers of agricultural products such as wheat and corn among Russia. The ongoing war had blockaded Ukraine from fully exporting its grains to the rest of the world. Although some temporary measures were taken to solve the food crisis, still Ukraine was not able to return to the same or similar maritime export levels it had possessed before the Russian aggression for its agricultural products.

Hence, in times when conflicts between states do not only affect the parties but the whole region and might even amount to a food crisis and jeopardize food security due to the high interdependence of the countries in a globalized world, this study seeks to clarify and revisit the concepts of anticipatory self-defense and preemptive force under international law. In that regard, the study will start by providing a brief analysis of the preemptive force referred to initially as anticipatory self-defense and its emergence within the pre-UN Framework. Secondly, the focus will be put on the UN Charter's Framework and how the traditional right of self-defense is formulated and interpreted under the Charter. Last but not least, some selected state practices which cover the exercise of preemptive force will be analyzed through the lenses of whether or not these were justified to the international community under the relevant criteria introduced by international law.

## Preemptive use of Force in the pre-UN Charter Era

States are bound with bilateral and multilateral treaties in terms of their practices within their relations. In addition to the legally binding written texts signed between states, their actual practice and even code of conduct in bilateral or multilateral relations may end up as the norm of universal applications in time and be classified under customary international law (American Society of International Law, 2006; Malanczuk, 1997). More precisely from a historical perspective, states' interaction with each other either in terms of political relations or armed confrontations have the capacity to establish shared norms and rules in interstate relations.

In the 19th Century when the UN Charter's legal constraints were not present in the global governance system, preemptive use of force was widely considered as a legitimate way of self-defense by the states. There was an understanding that under specific conditions states may appeal to preemptive use of force in line with the norms and rules set by customary international law. Moreover, this right of law was referred to as the principle of "anticipatory self-defense" mostly cited in the literature with the Caroline Incident of 1837 (Kelly, 2003). The affair took place when the British armed forces attacked an American vessel in United States (US) sovereign area in order to prevent it deliver military equipment to the anti-British rebels in Canada. The operation was a successful military move on behalf of the British authorities however it ended up with the death of two American citizens. Accordingly, US Secretary of State Daniel Webster submitted an explanation stating that; *"(...), necessity of self-defense was instant, overwhelming, leaving no choice of means, and no moment for deliberation (....), and that the British force even supposing the necessity of the moment authorized them to enter into the territories of the United States at all, did nothing unreasonable or excessive; since the act justified by the necessity of self-defense, must be limited by that necessity, and kept clearly within it."* (Yoo, 2003; Sapiro, 2003)

The Caroline Incident Case has led to two significant conclusions in the literature. Firstly, the responding state has to ensure that there is an imminent threat and no means for a diplomatic choice. Secondly, the response must be properly proportional with respect to the threat directed against the responding state. Although there is no consensus on the precise definition of an imminent threat, it does not only cover temporal closeness but also includes a strong probability that threat will materialize (Yoo, 2003). Moreover, in cases of ongoing armed attacks, the aggrieved state may not need to wait for new attacks to be carried out against it before giving any response relying on true evidences. In spite of these conclusions, states have generally approached the legality of anticipatory self-defense doctrine with reluctance. Gray (2004) argues that states' intention have mostly been on restricting the right of self-defense to cases where a military attack has taken place and there is no other choice left. The reason for this unwillingness to exercise anticipatory self-defense is closely linked with the uncertainty on the legal status of the right for use of force. Mostly states do not have tendency to initiate a military move that may be unacceptable by the large majority of other members of the international community. However as Sapiro (2003) concludes the views in the literature, imminence of a military move by another state brings together a necessity for preemptive action and when accompanied by a proportionate response then it would be permissible.

## UN Charter Era and the Interpretation of the Article 51 of the Charter

Until the end of Second World War, military conflicts between states were guided by customary international law providing the broad limits of warfare. However, customs, norms and principles did not prove to be effective in preventing wars. This has become a widely shared perception among the states especially after the destruction caused by the two world wars. The coalition of 26

countries composed of signatory states of the Declaration by the UN in 1942 intensified efforts in order to create a global system that will deter states from devastative military confrontations. The UN Charter was initially signed by 50 states in 1945 setting the rules for legitimate self-defense with the aim of ending warfare under a collective security framework (Brownlie, 1991).

Within the foundation of the UN, states' right to use military force was limited to a great extent. More precisely, the UN Charter provides that members of the Organization should approach and solve all disputed issues between each other peacefully. Article 2(4) of the Charter formulates that, *"All Members shall refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any state, or in any other manner inconsistent with the Purposes of the United Nations"* (UN Charter, 1945).

There are two exceptions to the Article 2(4) of the UN Charter that paves the way for legitimizing states' referral to military power. One of these exceptions requires the specific authorization of the United Nations Security Council (UNSC) under Chapter VII while the other one refers to actions and practice being conducted within the limits of self-defense responding to attacks directed to the territory of a UN member state. Within this framework provided by the Charter, the UNSC has been given the competence to specify threats against peace and belligerent moves of states (Ackerman, 2003).

On the other hand, the Article 51 of the UN Charter provides as follows: *"Nothing in the present Charter shall impair the inherent right of individual or collective self-defense if an armed attack occurs against a Member of the United Nations, until the Security Council has taken measures necessary to maintain international peace and security. Measures taken by Members in the exercise of this right of self-defense shall be immediately reported to the Security Council and shall not in any way affect the authority and responsibility of the Security Council under the present Charter to take at any time such action as it deems necessary in order to maintain or restore international peace and security"* (UN Charter, 1945).

Article 51 provides a potential authorization for resorting to armed force which is prohibited in general terms, merely for self-defense in case of a military offensive. The interpretation of the Article is controversial. However, it is generally accepted that the attack has to be about to start or already started to be considered as a legitimate case for self-defense of the state in danger. Otherwise, an earlier preemptive reaction has to necessitate the UNSC's approval relating to the particular affair. States have not been given the right to attack other states' sovereign area due to the fact that the state concerned has been developing plans or weapons that is thought to be used in an imaginary operation (O'Connell, 2002). In other words, the general acceptance on the Article 51 rules out preemptive practices (Brownlie, 1991).

According to Byers (2003) a strict interpretation of the Article 51 might amount to the view that any right of preemptive self-defense is prohibited under the framework of UN. A more tolerant interpretation might be built upon the fact that the Article 51 makes a reference to the "inherent right of individual self-defense" leading to the argument that states' right of self-defense that used to exist within the framework of customary international law still exists during the UN era (Gray, 2004; Chayes, 1991).

The Nicaragua vs. US Case of 1986 is a reflection of the widely shared perception towards the legitimacy of preemptive actions in international law. Upon Nicaragua's application to the International Court of Justice (ICJ) against the US due to its military acts in Nicaragua, the Court ruled that the US should immediately end its military activities and use or threat of force (The ICJ, 1984). The ICJ held that using military force would be legitimate only if there is an armed aggression. In case of an escalation where there is no armed attack, the attacked party has to reply with less harmful measures other than military acts or ask the UNSC's permission for use of armed force. Hence the ICJ's statement limits the utilization of force in self-defense merely in cases where a military aggression has already taken place (Alexandrow, 1996). Mullerson (1991) and Bothe (2003) emphasize that according to the Court an armed aggression may also be realized through "*the sending by or on behalf of a state of armed bands, groups, irregulars which carry out acts of armed force against another state of such gravity as to amount to an actual armed attack"* on an indirect basis.

Several critical questions have been put forward in the literature about the actual meaning of the wording "beginning of an armed aggression". Does the party in danger has to wait until the armed attack takes place even if there has been a high possibility for the occurrence of the attack? What would happen if there is a strong possibility that the state will no more be able to respond after the potential attack? Within this perspective, the argument of preemptive strike relies on the fact that states facing a potentially imminent attack, shall be provided with the opportunity to take relevant and proportional actions. It's seen that anticipatory self-defense is accepted to some degree under international law that a state may initiate preemptive self-defense if there exist sufficient supporting proof of potential threats and an intensified attack as well. Hence a military attack might have been considered to take place although it has not yet reached the sovereign area of the state in danger (Gray, 2004).

## An Overview of Selected Preemptive use of Force Practices during the UN Era

States' consent is a *sine qua non* for the formation of international law. As sovereign and independent entities, states are only bound with rules and norms when they opt for it (Malanczuk, 1997). As Arend (2003), quoted from the Lotus Case: *"International law governs relations between independent states. This, consent based conception of international law has an important significance for an examination of post–UN Charter practice regarding the preemptive use of force. If states are sovereign, under the logic of the Lotus Case, they can do as they choose unless they have consented to a rule restricting their behavior."*

The literature includes two different perspectives on the limitations brought forward by the Article 51. On the one hand, there is a view defending that the Article 51 explicitly limits referral to military force only in cases where an armed attack took place. This perspective labels preemptive acts as unlawful unless the state in danger has become attacked. On the other edge of this argument, there is a rejection of the restrictive and narrow interpretation. Accordingly, it is advocated that, the Article 51 enables states in danger, to take some conditional measures before the actual aggression takes place and does not remove the

anticipatory self-defense right inherent in customary international law (Sofaer, 2003). In the remaining part of the article, selected relevant acts during the UN era will be exemplified.

## The Cuban Missile Crisis

In 1962, the US Government faced the fact that the Soviet Union (SU) was providing offensive weaponry to Cuba. The US perceived it as a threat against the existing *status quo* and decided to prevent the SU from transporting the military equipment to Cuba through a naval blockade. The American President Kennedy declared that, the US Government was defending their national security along with North and South Americas (Kelly, 2003).

Sauer (2004) describes the American quarantine as a violation of the Article 2(4) of the UN Charter. The Cuban affair was discussed in the UNSC without any objection to the classification of anticipatory self-defense. Members of the UNSC decided not to impose any coercive measures on the US decision of naval blockade. US policy during the Cuban Crisis was criticized by several states but they certainly did not take any legal or diplomatic actions against it. These developments would lead to a conclusion that the doctrine of anticipatory self-defense had witnessed considerable acceptance (Sauer, 2004). The US's policy of not allowing Soviet military installments in Cuba have succeeded without use of military force but rather through a diplomatic peaceful solution.

## The Six-Day War

Israel erupted war against the United Arab Republic (UAR) in 1967, which had an ephemeral life span founded by Egyptian and Syrian states. Israeli attacks were also directed at Jordan and Iraq at the same time. The attacks succeeded in defeating the target Arab countries. Israel's military campaign was based on the argument that those states had been planning to invade Israel and there was a necessity for anticipatory self-defense. On the contrary, the defeated Arab states and the SU argued that Israel acted as the first side to use military force and initiate the armed attacks and first referral to military force was not legal. Even the US, a country that is more sympathetic to Israel's objectionable policies, abstained itself from debating anticipatory self-defense (Sauer, 2004).

## Israeli Attack on Osirak Reactor

Iraqi state's nuclear program and the progress achieved at the end of 1970's caused a deep concern for Israeli governments. In 1981 Israeli Air Force destroyed the Iraqi Osirak nuclear reactor in Baghdad being constructed by French and Italian corporations. The Iraqi Government considered the attack as an act of aggression. On the contrary, Israeli Ambassador declared that, *"Israel was exercising its inherent and natural right of self-defense, as understood in general international law and within the scope of Article 51 of the UN Charter."* The Ambassador also justified Israel's actions by stating that Israel resorted to force, only when all the diplomatic channels failed. Despite the official statements from Israeli state, every representative at the UNSC condemned the bombing. The majority of the representatives refuted the argument that the attack would be considered as a preemptive strike and perceived it as an act diminishing the UNSC's competence (Kelly, 2003).

Moreover, even the minority of the representatives who supported the legitimacy of Israeli act as an anticipatory operation concluded that Israeli state had not met the necessity criteria for an attack to be justified as preemptive self-defense. The UNSC representative from Sierra Leone defended the view that *"the plea of self-defense is untenable where no armed attack has taken place or is imminent."* He continued as; *"The Israeli action, was carried out in pursuance of policies long considered and prepared and was plainly an act of aggression."* Britain's delegate at the UNSC raised their perspective by the following declaration; *"It has been argued that the Israeli attack was an act of self-defense. But it was not a response to an armed attack on Israel by Iraq. There was no instant or overwhelming necessity for self-defense. The Israeli intervention amounted to a use of force which cannot find a place in international law or in the Charter and which violated the sovereignty of Iraq"* (Arend, 2003). The bombing of the nuclear facility even before it became operational did not find international support.

## Preemption in the Bush Doctrine

The terror attacks on September 11, 2001 targeted at the World Trade Center in New York and the Pentagon building in Washington, DC. caused 3.000 deaths. The US Government immediately declared that the Iraqi State should be disarmed due to doubts on further threat and the Taliban regime in Afghanistan should be annihilated since they were hold responsible for the terror attacks. There were some doubts that Iraq under Saddam administration was producing nuclear weapons. The Iraqi War that took place between 2003 and 2011 was the first manifestation of the concept declared by the US President George W. Bush and labelled as "preemptive strike doctrine". The doctrine was announced in the 5$^{th}$ chapter of the US National Security Strategy (NSS) released in 2002. As it was laid out in this strategy, the main idea of the framework was to stop potential enemies before they pose a threat or use weapons of mass destruction against the US and allied states. Instead of acting in a reactive way, the strategy prioritized anticipatory action (US NSS, 2002). The most significant feature of the US NSS was the preemptive strike approach aiming at the initial referral to force before the enemy. Within the framework of an already controversial self-defense norm in international law, the US Government's approach of initial strike policy and ignorance towards the imminence criteria paved the way for more complexity.

There were two options for the Bush Administration; the first one was seeking for a solution within the UN framework and the second one was acting unilaterally. The American government followed both of the options by utilizing the UNSC in the search for Iraqi nuclear weapons, but at the same time acting preemptively in Afghanistan and Iraq (Sauer, 2004). The US approved the UN Convention of 1999 on the suppression of financing terrorism obliging signatory states to control and prevent funding of terror organizations (Murphy, 2003).

The UNSC pointed out the right to invoke self-defense in the context of the terror attacks against the US (UNSC 2000; 2001). Moreover, NATO member states had the opinion that the terrorist attacks provoked the provisions relating to the collective self-defense mechanism of the Alliance. Therefore, the Organization

applied the Article 5 of its Treaty meaning that an attack against the US was an attack against the all member states (Gray, 2004). The US demanded from the Afghan regime to give in the leader of the terrorist *Al-Qaeda* Organization and requested permission to conduct investigations in Afghanistan. However, when Taliban refused the US demand, the US by the coalition and military support of the UK, France, Germany, Canada and Australia initialized the operation in Afghanistan on October 7, 2001 (Gray, 2004). The US and the coalition forces showed evidences to the UNSC to the connection of *Al-Qaeda* Organization with the terrorist attacks. Here, it is noteworthy to remember that, as the strikes and the armed operation of the Allies continued in 2002, massive amount of damage were given to the civil society of Afghanistan being either killed or injured under the heavy aerial bombings.

The UNSC Resolutions regarding the terrorist attacks can be considered as a support of anticipatory cases where after the occurrence of an armed attack, there is still strong evidence that more threat is imminent and other attacks are being planned (O'Connell, 2002). States mostly refrain from making arguments that can lead to doctrinal controversy while declaring their claims on the necessity of self-defense. But rather, they put forward arguments which will attract approval from the widest possible range of world states. (Gray, 2004) However, in the recent decades, the international community witnessed that the US, has used anticipatory self-defense against Libya, Panama, Iraq, Afghanistan and the Sudan. In 1986, the US for justifying its strike against Libya, relied on the need to prevent the possible future terrorist acts. At that time, several countries criticized the US for acting against the UN Resolution which declared the military act as a violation of the UN Charter with the exception of the British, French and Australian governments. They had preferred to support the American stance by withstanding the UN Resolution. The US and its allies in 1989, acted in a similar way in case of the American military operation in Panama against the UNSC's draft Resolution stating the act to be in violation with international law (Yoo, 2003).

Moreover, the US in its letter which it had submitted to the UNSC before the raid against Afghanistan, had stated that the inquiry it had been conducting was in early stages and that they might have been finding out in future that their self-defense could require some further actions regarding other organizations and other states. In 2002, President Bush in one of his statements declared that the war against terrorism was just starting by putting emphasis on the 'Axis of Evil' including Iraq, Iran and North Korea. The US put forward an argument that those three states were developing weapons of mass destruction (WMD) which brings together the possibility of being used either by themselves or supplying to terrorist formations (Gray, 2004). This argument was supported in the 2002 NSS of the US, with a focus on preemptive acts (Gardner, 2003). According to the US approach to preemptive self-defense; the UNSC approval or actual realization of a military offensive from another party are not prerequisites along with the dismissal of the proportionality rule (Yoo, 2003).

On the other hand, although indirectly related, Iraq's invasion of Kuwait in 1990 was a violation of international law. The UNSC had adopted Resolution 660 mentioning its disapproval of Iraq's actions demanding withdrawal from Kuwait. In other relevant resolutions, the UNSC particularly demanded the reestablishment of regional peace and security. Consequently, Iraqi government's resistance against compliance with the UNSC Resolutions had paved the way for military involvement of the allied states. (Taft IV and Buchwald, 2003; Yoo, 2003; Dienstein, 2001) On April 1991, Iraq officially accepted the conditions of the UNSC Resolution 687 that constituted the terms for ending the skirmish in the Gulf region. Following this, Iraq had resisted the inspections carried out by the UN Special Commission regarding its nuclear weapons materials. Hence in the Resolution 1441 of the UNSC, it was stated that Iraq was in material breach of earlier resolutions (Yoo, 2003). These incidents facilitated the US putting forward new arguments in which it was seeking some kind of legal grounds to rely on. The American representative to the UNSC announced that Iraqi Government's continuing violations with the UNSC Resolutions would end up with other states' defensive actions against the threat (Gray, 2004).

At that time, there had been separate and several attitudes between the states on the international stage concerning referral to military force in the Iraqi case and whether or not there were any legal grounds for an operation. The NATO members were divided into two. France and Germany were opposing the military operation choice while the UK, Spain and some Eastern European states were in favor of a military operation. Russia and China were also rejecting the use of force. The US relied on the so called authorization of the UNSC Resolutions and self-defense while the UK and Australia ever abstained from using the wording of preemptive self-defense for legal justification of the invasion of Iraq. They chose to rely on the UNSC Resolutions reflecting their doubt considering the preemptive self-defense approach. Otherwise they would first need to prove that there was an imminent threat of an attack against the US and allies but also that had been caused by Iraq's alleged nuclear arsenal (Gray, 2004). Eventually, the coalition states drove Saddam Hussein from power but they have not found any WMD in Iraq which they had relied the biggest percentage of their claims on. The UN inspectors found nothing in Iraq that constituted an imminent threat (Franck, 2003).

In 2003 the UN Secretary General Kofi Annan put forward his evaluation on problematic issues concerning the preemptive self-defense concept; *"Article 51 of the Charter prescribes that all States, if attacked, retain the inherent right of self-defense. But until now it has been understood that when States go beyond that, and decide to use force to deal with broader threats to international peace and security, they need the unique legitimacy provided by the UN. Now, some say this understanding is no longer tenable, since an "armed attack" with weapons of mass destruction could be launched at any time, without warning, or by a clandestine group. Rather than wait for that to happen, they argue, States have the right and obligation to use force preemptively, even on the territory of other States, and even while weapons systems that might be used to attack them are still being developed. According to this argument, States are not obliged to wait until there is agreement in the Security Council. Instead, they reserve the right to act unilaterally, or in ad hoc coalitions. This logic represents a fundamental challenge to the principles on which, however imperfectly, world peace and stability have rested for the last 58 years. My concern is that, if it were to be adopted, it could set precedents that resulted in a proliferation of the unilateral and lawless use of force, with or without justification. But it is not enough to denounce unilateralism, unless we also face up squarely to the concerns*

*that make some States feel uniquely vulnerable, since it is those concerns that drive them to take unilateral action. We must show that those concerns can, and will, be addressed effectively through collective action" (UN, 2003).*

## Russian Invasion of Ukraine

In 2013 Ukraine witnessed civilian protests against the government's rejection of establishing further economic ties and an association agreement with the European Union (EU). The pro-Russian Ukrainian President had to leave his country following the increasing tension between his supporters and the pro-reformers. In 2014 following the domestic political unrest in Ukraine, Russia annexed the Crimean region. Russian military intervention and annexation of Crimea was defended by the Russian President Vladimir Putin with reference to the protection needs of the Russian speaking population in Crimea and southeastern part of Ukraine. There were a series of referendums first in Crimea then in Donetsk and Luhansk regions in which they decided to become independent entities and be recognized by Russia. These developments were followed by armed clashes between the Ukrainian army and separatist military forces within Ukraine (Council on Foreign Relations (CFR), 2024).

It has to be noted that, one of the factors that Russian political leadership manipulated for justifying Ukrainian war was recognition of the so-called Donetsk and Luhansk Republics by Russia on February 21, 2022. The recognition decision was followed by the annexation of four Ukrainian regions namely Donetsk, Luhansk, Zaporizhzhia and Kherson (BBC, 2022). The United Nations General Assembly (UNGA) condemned Russian annexation of Ukrainian sovereign territory on October 2022 (UN, 2022). The Secretary General of the UN announced that President Putin's act to recognize independence of Donetsk and Luhansk is in violation of Ukrainian sovereignty (UN Press Release, 2022).

After the government change in 2019 and the election of President Zelensky in Ukraine, the country's NATO membership goal was reiterated. Ukraine's NATO membership desire was unacceptable for the Russian Government based on the fact that, two countries share a common history and an economic or political move towards the West would eventually lead to Ukraine's integration with transatlantic security architecture led by the US. In addition to that, NATO's potential existence in the geographic proximity was perceived as a security threat for Russia. On February 2022, Russian government decided to start a large scale invasion of Ukrainian sovereign territory and named the military move as a special operation. Ukraine has received financial and military equipment support from the Western countries in general and the US in particular whereas Russia had to face strict financial restrictions and embargoes due to the invasion. According to the UN estimate, more than 10.000 Ukrainians including civilians have lost their lives and around 8 million people had to leave Ukraine along with the internally displaced citizens counting to 4 million (Ray, 2024).

Russia's argument that there were secret Ukrainian plans for an armed attack against the Donbas region were publicized with the purpose of fulfilling the imminence criteria for self-defense (Allison, 2023). Russian President Vladimir Putin qualified the invasion of Ukraine as *"a preemptive move against potential aggression"* emphasizing that his country was facing threat posed by NATO (Aljazeera, 2022). Putin further blamed the Western countries and defended that; *"(…) they have always been seeking the dissolution of our country. This is very true. It is unfortunate that at some point they decided to use Ukraine for these purposes. (…) We launched our special military operation to prevent events from taking this turn. This is what some US-led Western countries have always been seeking. To create an anti-Russia enclave and rock the boat, threaten Russia from this direction. In essence, our main goal is to prevent such developments"* (President of the Russian Federation, 2022). It has to be emphasized that, at the time when the Russian military offensive to Ukraine was launched, there were not any armed attacks towards Russia from the Ukrainian side. This invalidates Russian arguments of a preemptive military campaign (Alanur, 2023). Allison (2023) similarly argues that Russia's military invasion of Ukraine is a violation of the UN Charter and its Article 2(4).

Russia applied military blockades to Ukraine's national ports and prevented exportation of food as well. Since Ukraine was one of the two major grain producers and exporters in the world along with Russia, this had resulted in the deepening of global food crisis that has been taking place due to changing climate conditions (Lin et al., 2023). In 2023, shelling between the parties has caused the bombing of Europe's biggest nuclear facility namely the *Zaporizhzhia*. International Atomic Energy Agency (IAEA) had to invite parties to establish a "*nuclear safety and security protection zone*" in order to prevent a nuclear environmental disaster (CFR, 2024).

The war between Russia and Ukraine led to economic, social, humanitarian and environmental costs for both states. Although the influence on the natural environment cannot be determined exactly due to the ongoing war and the threats posed, according to one of the rare field studies conducted, soil, water and air have been polluted as a result of the armed conflict. Bombings have caused increased amounts of heavy metal in the environment whereas vegetation was diminished due to abandoning of agricultural fields (Solokha, 2023).

## Conclusion

All states are sovereign equals and are prohibited from threat or exercise of use of armed force in their relations and interactions. The international system expects the states to initially solve their disputes through every possible peaceful means. Hence, resort to force is limited only to certain situations and is allowed to be invoked as a last resort. Accordingly, the use of the traditional right of self-defense and going a step further, the right of the use of anticipatory self-defense which is still controversial in the literature even in terms of its existence, are subject to the fulfillment of certain criteria as revealed in the above-mentioned cases.

However, as the examined states' practices had put forward, states use preemptive force and tend to rely on the exercise of anticipatory self-defense right when they are invading other countries' territories. It is quite interesting to note that some of these states such as the US and Russia are among the permanent members of the UNSC. One has to note that each case has to be decided on its own merits. Yet, one also has to underline that the

fulfillment of the criteria of anticipatory self-defense on behalf of the state making the first move and relying on the said right, is not a very easy task to prove to the international community. This might still keep its controversy and mystery in terms of whether or not the relevant state conduct was fully accepted to be lawful by the majority of other countries before the eyes of international law even if much time has passed by.

Globalized world system reveals the fact states in the 21st century, have largely and significantly become interdependent on one another. This means that currently, a conflict does not negatively affect merely its sides, but also might have accompanying serious repercussions on the countries of the whole region. That was revealed strongly by Russia's invasion of Ukraine in 2022 which led to the blockage of most of Ukraine's agricultural exports in the form of grains such as wheat and corn. Yet it is seen that the lawful or unlawful exercises of the right of self-defense might eventually have serious consequences on jeopardizing the global food security and bring forward a negative impact for the rest of the world countries. So that the states are expected to cautiously calculate the whole criteria in terms of the fulfillment of the self-defense right when they do rely on it since otherwise might affect the whole world's security and order.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The authors confirm being the sole contributor of this work and have approved it for publication.

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# REVISITING EU MIGRATION POLICY WITH POSTFUNCTIONALISM: SHIFTING FOCUS FROM SUSTAINABILITY

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**Abstract**

European integration has achieved its foundational goal of peace on the basis of the core values such as democracy, the protection of human rights and the rule of law. Apart from these values, the problem of democratic deficit in the European Union (EU) has been one of the main issues that scholars and Eurocrats have tried to solve. However, the various current crises in and around the EU have led to the question of democracy deficit no longer on the agenda and to the failing solidarity among member states that have been damaging those values in implementing its policies. This paper aims to analyze the politicized approaches of EU member states in the migration field. It firstly sheds light on the ineffectiveness of EU migration policy from a new theoretical perspective, postfunctionalism; and secondly shows that the EU has failed to reduce inequalities in a sensitive issue of migration, despite of its commitment to the United Nations (UN) Sustainable Development Goals (SDGs). The paper is based on qualitative methodology with international media analysis of the years between 2015 and 2024. It is argued that EU member states have followed democratic mass politics at the expense of ignoring the UN refugee regime and the goal of reducing inequalities, serving party ideologies rather than EU core values, and promoting identity issues as a tool to combat migration.

**Keywords:** EU migration policy, postfunctionalism, politicization, reducing inequalities, SDG10

## Introduction

Prior to the middle of the 2000 s, the democratic deficit was a prominent issue in European studies. However, since the mid-2000s, the EU started to experience a continuous wave of crises, such as the Constitutional Treaty crisis, the Eurozone crisis, the rise of populism, the migration crisis, Brexit and COVID-19. Efforts to deal with these multiple crises have reduced the EU's ability to act as a superior authority over its member states. The EU's declining superiority has brought differentiated integration models in many fields and this new trend has become inexplicable with the first and second waves of European integration theories. To fill this gap in the literature, postfunctionalism is currently emerging as a grand theory which shows that the main assumptions of functionalism, intergovernmentalism and constructivism in particular are unable to explain today's politicised EU decision-making processes. Instead of

spill-over effects, interest-based bargaining mechanisms and social learning processes, the theory argues that regional integration is directly linked to the mass politics of states in politicized areas.

According to Leuffen, Rittberger, and Schimmelfennig (2022), the politicized areas in the EU mainly consist of migration, social systems, and defense policy, which represent the central areas of the sovereignty of nation-states. Since 2015, however, migration, among other things, has been a central point of contention within the EU member states and is increasingly developing into a politicized foreign policy instrument for the Union. Although the EU Council finally reached an agreement on the 'Regulation on Asylum and Migration Management and Asylum Procedures' on June 8, 2023, this flexible system still shifts the burden under the externalization method mainly to EU border states and third countries in the context of the securitization of migration.

The EU, which promotes normative values such as human rights and the rule of law and at the same time deepens the integration process with the motto of creating unity in diversity, is violating the fundamental principles of international law, to which it has always referred, in its approach to migration. Although the EU emphasizes in the subheading on international partnerships on its official website that it will implement the UN's SDGs in all its policies and encourage EU countries to do the same, it seems that the migration policy pursued is diametrically opposed to the principle of reducing inequalities (SDG10). Against the background of these developments, this study attempts to analyze the EU migration policy and the politicization of the issue of migration at the EU level in the light of the basic assumptions of postfunctionalist theory such as party ideologies, mass democratic politics and the mobilization of national identities and so on show how member states both disrupt the integration process and violate international norms in politicized areas.

Methodologically the paper is based upon qualitative analysis by examining the international media sources on EU member states' migration policies to test the three assumptions of postfunctionalism. The time interval for media analysis is identified for the years between 2015 and 2024 since the high number of asylum seekers at the borders of Europe was considered 'migration crisis' by the EU.

The analytical framework of the article is based on the main assumptions of post-functionalism, which underlines the EU's failure to act in solidarity with member states in politicized areas. In this regard, the first part of the article explains the theory of postfunctionalism and its main approaches. The emergence and development processes of EU migration policy are then discussed in order to show how the policy has developed over time. Finally, in the analysis part, the considerations on political developments in the member states and their effects on the EU migration policy are evaluated within the scope the abovementioned three assumptions of postfunctionalism.

## Postfunctionalism

Postfunctionalism is the most recent European integration theory criticizing both nefunctionalism and liberal intergovernmentalism. For those theories, European integration is an elite-driven process. Liberal intergovernmentalism asserts that domestic interests are primarily protected and represented at the European level. On the other hand, neofunctionalism emphasizes the role of common European mechanisms like policies and institutions to achieve peace in the region. Therefore, interest groups and political elites at domestic and EU levels have determining roles within the integration. There is no specific role of the European public in these two theories (Börzel and Risse, 2008, 217).

Postfunctionalism gives an important place to the role of the public in policy-making processes. The theory can be explained with three assumptions. The first one assumes that democratic mass politics deeply influence regional integrations. This assumption challenges both neofunctionalism and liberal intergovernmentalism. As a second assumption of theory, the structure is shaped by culture and identity, as it is shared by sociological institutionalism (Leuffen, Rittberger and Schimmelfennig, 2022). Finally, the third assumption states that national identities are mobilized and self-determination demands of the public are promoted. The assumptions and their reflections on various policy fields are explained and discussed below.

## Democratic Mass Politics

European integration theories stress the role of technocratic elites (neofunctionalism), national interests (intergovernmentalism), economic interests (liberal intergovernmentalism), or a top-down or bottom-up European identity construction process (sociological institutionalism). Differently from those integration approaches, postfunctionalism is centered upon democratic politics supported by the masses. Political or economic elites have no determining role in policy areas; however, they can be shaped by the masses' demands. The tools of this method have been using public opinion, political behavior, elections, and referendums (Leuffen, Rittberger and Schimmelfennig, 2022).

The states are different from the versions that existed twenty years ago. There have been reversals from democratization processes and democratic practices are used as tools for different goals or manipulated easily by the political elites. The public has learned to use democratic practices to the benefit of itself. However, the masses do not reflect any sensitivity to protect the rights of the disadvantaged groups and take care of the demands of the majority. This trend has considerable impacts on the EU such as confronting the politicization of migration, economic, security and health policies in member states (Leuffen, Rittberger and Schimmelfennig, 2022). The enlargement policy, migration flows, Brexit, COVID-19 and the Russia-Ukraine war can be counted as developments triggering postfunctionalist approaches in the EU.

Hooghe and Marks (2008), Börzel and Risse (2008, 217), Leuffen, Rittberger and Schimmelfennig (2022) agree on the point that democratic mass politics and the politicization of European integration have began with the Maastricht Treaty in 1993. They argue that the politicization process has been an important threat to the European integration project and the EU has insufficient iniatitives to halt this process. Democratic mass politics has been directly influenced by national political parties and their ideologies, which are the subject of the second assumption of postfunctionalism.

## Party Ideologies Matter

Hooghe and Marks (2008) argue that the politicization process in the EU has led to the fall of supranationalism and the rise of renationalization in the European continent. The authors claim that politicization created a 'gal/tan cleavage' in place of leftist/rightist cleavage in history. 'Gal' shows the new party initiatives of green/alternative/libertarian, and 'tan' shows the traditionalist/authoritarian/nationalist parties. On the other hand, Börzel and Risse (2008, 219) argue that populist parties have no clear ideology like leftist or rightist, and this fact should be taken into consideration.

The main problem in Europe does not seem to be the cleavages between the left and the right against the integration project. The new agenda is about the criticisms against migration, supranationalism, and elite-driven projects in many parts of the world. Hooghe and Marks (2018) state on this topic that a 'transnational cleavage' has been creating big gaps between the elites and the masses, the well-educated and the illiterate. These cleavages are politicized by the new political elites no matter what ideology they have or have not. It is because of that leftist or rightist or even green parties can develop populist discourses to be elected. Hudson and Puetter (2019) warn that the ruling parties in European countries are 'not constrained but circumvented' by the Eurosceptic parties since the 2010s. This trend has left no space for supranational attempts by the governments, overemphasizes the role of national identitites and poses an existential threat to European integration.

## Mobilization of National Identities

Cosmopolitan and nationalist backgrounds have differentiated identity politics in Europe. Postfunctionalism argues that the cosmopolitans have only a limited chance to exist and that it has become difficult to realize this in the European integration process. Well-educated elites in Europe take a supranational view and try to pursue common policies, but mass politicization thwarts these efforts and the nationalist attitude is becoming more influential all over Europe. Therefore, the political parties need to change their programs and adapt themselves to the new politicization era (König, 2018).

Hooghe and Marks (2009) draw attention to the distorting role of self-determination over the European identity construction process. They emphasize that citizens watch and control the authority of the country and they demand 'self-rule'. Even though self-rule seems to be offering new freedoms to society, it has the power to ruin a regional integration like the EU (Hooghe and Marks 2009: 2). To diagnose the impact of politicization on European integration, this paper takes EU migration policy as a case study. The section below includes the historical background of the policy, the recent regulations, and developments in the field.

## EU Migration Policy

EU migration policy is officially based on the UN refugee regime including the 1951 Genova Convention and the 1967 Protocol. It was first placed under the Justice and Home Affairs pillar with the 1993 Maastricht Treaty. With its emphasis on migration policy, the Treaty marked a turning point in the history of European integration. The wars in the Balkans in the 1990s had a considerable impact on the EU and the Temporary Protection Directive was adopted by the Council of the EU in 2001. Refugees from the Balkans were granted temporary protection status in many European countries. As needs have changed, so have efforts to create a common asylum and migration system. However, the EU member states have not been following a common migration policy although the 2009 Lisbon Treaty abolished the pillar regime and offered a common asylum system. 27 Member States are signatories to the Refugee Convention, nevertheless the migration policy instruments are not in line with the principles of the Convention.

The Syrian civil war in 2011 has become another turning point in the EU asylum system. It played an important role in determining special quotas for each member state. However, this quota policy under the Dublin Regulation did not save the thousands of refugees fleeing war in their countries. The 1.3 million asylum-seekers at Europe's borders, as shown in Figure 1 below, was the main reason why then-German Chancellor Angela Merkel announced the 'EU Agenda for Migration' in 2015 to relocate refugees from Europe's hotspots (Toygür and Benvenuti, 2016). Populism and the rise of far-right politics in Europe have become great obstacles to the implementation of the Agenda. The European Commission acted directly under the impact of the domestic political environment of member states and started to work on a proposal for a New Pact on Asylum and Migration.

**Number of asylum seekers in Europe surges to record 1.3 million in 2015**

*Annual number of asylum applications received vy EU-28 countries, Norway and Switzerland, 1985 to 2015*

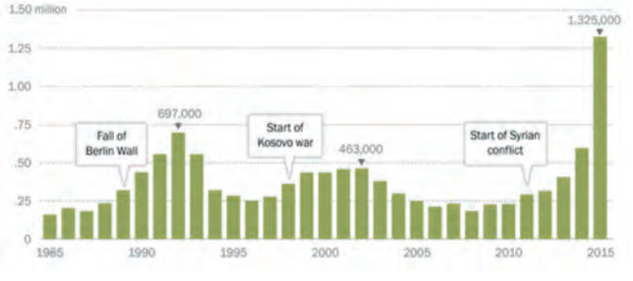


**Figure 1:** REFUGEES IN EUROPE UNTIL 2015 (Pew Research Center, 2016)

## EU Pact on Asylum and Migration (2023)

In September 2020, a draft law entitled 'New Pact on Asylum and Migration' was proposed as the basis for the EU Pact on Asylum and Migration. The fire and unknown number of deaths at the Moria camp in Lesvos, Greece, in 2020 prompted the EU to take more measures to protect the lives of refugees. The Pact introduced a reward system to encourage member states to accept refugees, especially unaccompanied children. As the Pact did not include rules on the resettlement and repatriation of refugees, it was not based on basic international refugee standards. Following this approach, the EU has focused on signing readmission agreements and implementing return policies since 2020 (Barthoma and Çetrez, 2021). The Pact also aimed to increase the budget of the European Border and Coast Guard Agency, FRONTEX, because the EU has considered the migration phenomenon as a security threat.

Although it was expected that the draft law of the EU Pact on Migration and Asylum would solve the crises in the aftermath of the migration influx, it has not happened. It took three years

for EU member states to agree on a limited number of common points, and the EU Pact on Migration and Asylum came into force in 2023. Despite the fact that the EU Charter of Fundamental Rights protects human rights, including the rights of refugees, the Pact has established a flexible system of migration management within EU countries. Readmission and return agreements with third countries such as Jordan, Lebanon, Türkiye, Egypt and Tunisia have been on the agenda of migration policies since 2011. The results of these EU policies can be seen in Table 1 below.

**Table 1: REFUGEES IN EUROPE 2015-2024 (Çebi, 2024)**

| Year | Number of migrant influx |
|---|---|
| 2015 | 1.046.336 |
| 2016 | 373.643 |
| 2017 | 184.344 |
| 2018 | 137.080 |
| 2019 | 121.303 |
| 2020 | 97.170 |
| 2021 | 130.236 |
| 2022 | 180.686 |
| 2023 | 274.404 |
| 2024 | 27.770 |

The Pact stressed the 'protection of the EU borders' and decreasing the number of asylum-seekers rather than prioritizing their human rights. It brought new policies that can be explained under five mechanisms, such as the Screening Procedure for asylum seekers, a new Asylum Procedures Regulation, the appointment of a Return Coordinator, a new Crisis and Force Majeure Regulation and a Voluntary Solidarity Mechanism (European Commission, 2024).

The first mechanism, the Screening Procedure, will start after the arrival of non-EU irregular migrants. It is clear that this procedure will lead to more detentions or arrests. The second mechanism, the Asylum Procedures Regulation, will create a faster system than the refugee application procedure. However, this regulation will lead to a de-Europeanisation of the asylum system. The third mechanism, with the appointment of the EU Return Coordinator on 2 March 2022 to maintain a common European return system, will increase the number of returned migrants. The fourth mechanism, known as the Crisis and Force Majeure Regulation, will be used to change the rules governing asylum. EU member states have agreed that they can suspend international refugee standards in exceptional circumstances such as natural disasters, wars, and infrastructure failures like pipeline explosions. However, this approach can easily normalize the use of emergency measures and undermine the rights of refugees. Then it can result in disproportionate responses like denying people access to asylum. Finally, the fifth mechanism, the Voluntary Solidarity Mechanism, agreed by 23 EU member states and associated countries, will support member states through the relocation of asylum seekers and financial contributions. Although around 1000 asylum seekers were relocated from Cyprus, Greece, Italy, Malta, and Spain in 2023, this mechanism opened the way for opt-outs from the migration policy (European Commission, 2024).

The mechanisms described above have not contributed to following a common migration policy. Until recently, it has had the opposite effect, accelerating the politics of national identity and the nationalization of EU migration policy. The policy goals and instruments have no emphasis on the UN's SDGs and do not serve specifically to SDG10, namely reducing inequalities. According to the data provided by Eurostat on SDG 10-Reduced Inequalities in 2024, the EU has been in progress in reducing inequalities within and among countries. This SDG goal is seeking progress in several areas such as income levels, poverty rates, urban-rural gaps, disparities in household income per capita, migration, asylum, and social inclusion. The 2024 report shows that the EU has been increasing its capacity to combat poverty and economic inequalities within and across the member states, but has no advancement in migration, asylum, and social inclusion policies over the five years (Eurostat SDG 10-Reduced Inequalities, 2024). In this vein, the section below discusses the ineffectiveness of EU migration policy as a product of the populist policies in the member states through postfunctionalist assumptions.

## EU Migration Policy through the Lens of Postfunctionalism

In this section of the paper, the main assumptions of the postfunctionalist theory are applied to the populist and anti-immigrant policies of the EU member states. This application makes it possible to understand why there is a change in the policy-making capacity of the EU in the migration field. Besides, the main reasons why the EU has been turning back from its commitment to be loyal to the principles determined under the UN's SDGs are discussed with several examples from the EU member states. This section will be divided into three parts examining the assumptions suggested by postfunctionalism. In the first part, the role of democratic mass politics in migration is analyzed using concrete examples of referendums in various EU member states. In the second part, the role of party ideologies on migration is illustrated using examples from EU member states, where it is observed that populist discourses undermine the role of ideologies in party politics. The final part uses political parties' populist discourses about national sentiment in EU member states to illustrate how national identity mobilization affects migration.

## The Role of Democratic Mass Politics on Migration

The main focus of postfunctionalism theory is popularly supported democratic politics. According to the theory, economic or political factors do not determine policy areas, but they can be influenced by the demands of the masses. The primary instruments of this approach have been elections, referendums, political behavior, and public opinion. Additionally, the theory implies that the European states and their democratic practices changed in the 2000s. The recent failure of democratization has made it easy for political elites in Europe to manipulate or take advantage of democratic practices. The European citizens also are well-informed

about the democratic procedures and how to take advantage of them. Majoritarianism has been replacing plural democracy and the rights of disadvantaged groups cannot be protected, rather the needs of the vast majority are met.

In a similar vein, it is evident that some political parties back referendums on immigration laws and portray themselves as advocates of direct democracy. In addition to caring about public opinion, political leaders were motivated by this tendency to win the next elections and bolster their legitimacy for the following term. There are numerous historical examples of leaders holding referendums on migration-related issues in an attempt to legitimize their administration and win elections. For instance, Prime Minister Moraviecki of Poland intended to hold a referendum on moving asylum seekers within the EU on October 15, 2023, the same day as Poland's parliamentary elections (Hollander, 2023).

In the past, there have been other instances of EU member states holding referendums to affect EU-level immigration and asylum policies. Hungary, for example, voted in 2016 to end mandatory refugee distribution. In the referendum, the people were asked whether or not they wanted the EU to decide on the resettlement of non-Hungarian citizens in Hungary without the consent of the National Assembly. The referendum was declared invalid because the voter turnout requirement of at least 50% was not met. However, it was a significant attempt to influence EU policy on migration, with 98% of participants voting 'no' to the question (Yılmaz, AA, 2016).

Unexpected issues, though, might surface following the referendums. For instance, former British Prime Minister David Cameron negotiated new membership terms for his nation in anticipation of a vote to stay in the EU in 2016 by using the possibility of a referendum on the country's membership. It turned out, however, to be a poor decision with disastrous results of Brexit (Hollander, 2023). In this regard, Moraviecki's above-mentioned plan, which favored his Law and Justice (PiS) party, also failed. Despite winning just over 35% of the vote, PiS lost its parliamentary majority and was unable to hold on to power (Tilles, 2023).

Populist party leaders sharing power frequently use opinion polls to legitimize their positions or to give voice to the migration agenda, regardless of whether they are successful or receive the intended outcomes. The public nature of migration makes it challenging to represent disadvantaged groups at the EU level. Therefore, when it comes to pursuing a common migration policy or fostering a sense of solidarity among Member States in the field of migration, the EU poses a significant barrier to the realization of the principle of reducing inequalities outlined in the UN's SDG10.

## The Role of Party Ideologies on Migration

Party ideologies have played a decisive role in shaping migration policy in EU countries until 2010. While left-wing parties previously advocated a more inclusive migration policy that emphasized human rights and social integration, right-wing parties previously advocated for stricter border controls and limited immigration and portrayed migration as a threat to social cohesion (Zankina & Ivaldi, 2024). Currently, however, political leaders in Western democracies are more responsive to public opinion.

As post-functionalism suggests, the main problem in Europe is not the division between left and right against the integration project, but rather the criticism of migration, supranationalism, and elite projects. Hooghe and Marks (2018) define this new phenomenon as a 'transnational divide' that leads to major conflicts between opposing groups. All political parties, irrespective of their beliefs, now have a tendency to create populist rhetoric in order to win elections, which leads to these disputes.

As immigration has become a very sensitive issue in EU countries, parties of all ideological backgrounds, including mainstream parties, have begun to adapt their policies to voters' preferences. Therefore, when a significant portion of the electorate expresses concern about immigration, political parties today tend to incorporate tougher immigration policies into their agendas, manifestos, discourses, and/or propaganda in order to gain or retain support.

On the other hand, as suggested by Saylan and Aknur (2021) it would be an overstatement to claim that mainstream parties have undergone radicalization in every aspect and have become indistinguishable from populist radical parties. However, it is evident that populist radical right-wing parties have established themselves as significant players within the political party landscape in numerous countries, and their extreme policy suggestions have influenced various sectors considerably. These parties have effectively pressured mainstream parties to incorporate their rhetoric and policy ideas, which were previously deemed radical, particularly concerning migration.

For instance, then Dutch Prime Minister Mark Rutte started publicly embracing Party for Freedom (PVV) leader Geert Wilders' anti-immigrant views in his party's policies and speeches in order to stay competitive with Wilders, who was very close to him in the polls. He said before the 2017 election that immigrants who did not fit in with Dutch culture should either adapt appropriately or leave the country (BBC, 2017). Similarly, the compatibility of Islamic and Swedish cultures has been the subject of heated discussions in Sweden. By using populist rhetoric to link immigrants to the nation's rising crime rate, the center-left Swedish Democratic Party has risen to the third position in the Swedish parliament. The party made it clear in its manifesto that the country's borders should be better guarded, that only those who respect the law, Swedish culture, and society are welcome, and that they want more immigrants to go back to their home countries (Yağmurlu, 2022).

Putting aside debates over ideology, Hudson and Peter (2019) note that since the 2010s, Eurosceptic parties have not restricted but rather circumvented the ruling parties in European countries. This trend threatens European integration and deprives governments of space for supranational ambitions. This is evident in the allocation of seats in the European Parliament (EP), where a number of groups – particularly right-wing and far-right parties – can be categorized as populist. At the latest EP elections, the right-wing European Conservatives and Reformists group and the far-right Identity and Democracy group won the most seats and the highest share of seats almost equal to 18.2% (Göçmen, 2024).

As per Zankina and Ivaldi (2024), the results of the 2024 elections for the EP validated concerns about a right-wing political shift in the next five years and the rise of a right-wing populist group. The writers also stress that the radical right-wing populists

have made great strides and will continue to hold a majority in the new parliament alongside po-European parties, despite the fact that their outcomes differed by nation and region.

The increase in Eurosceptic leaders and parties in both national parliaments and the EP will have an impact on the EU's decision-making process (van Rij, 2024). This also offers them the opportunity to weaken the EU's legislative and political decision-making powers for further integration and common policies, particularly in the area of migration. This role of party ideologies and tendencies will also negatively affect the EU's ability to act in line with its commitment to the UN's SDGs.

## The Role of Mobilization of National Identities on Migration

According to postfunctionalism, cosmopolitans have a limited chance of surviving, and European integration has made this difficult to accomplish. Elites with higher levels of education aim to implement common policies and have a supranational perspective. Mass politicization, however, thwarts these initiatives, and the nationalist mindset then prevails. As a result, political parties are modifying their platforms and adjusting to the new political landscape. In the current political climate, where populist parties are growing, this is taking place. As suggested by Hooghe and Marks (2009), citizens are now calling on the government to exercise 'self-rule'. However, the EU's regional authority and future integration are destroyed by the demand for self-rule.

The mobilization of national identities is actually being used as a defense against the EU's proposed migration policies. Currently, EU states are shifting away from cosmopolitanism and toward a stronger focus on their national identities. National identity and its fundamental components are deftly incorporated into the discourses and party platforms of populist parties in particular. Initially, populist parties portray themselves as the voice of the people, in contrast to the alleged elite who favor lax immigration laws. To establish a personal connection with voters, they frequently employ emotive language and anecdotes.

For example, Matteo Salvini, the leader of the Northern League refers to immigrants as 'misfits', while Le Pen, the leader of the National Rally calls them 'invaders' who are merely a burden. Some like Geert Wilders, the leader of the PVV, even go so far as to refer to them as 'scums' or 'Trojan wooden horse of terrorism', as Hungarian Civic Alliance leader Victor Orban puts it. According to Akbaba (2018), all of these leaders' word choices are meant to demonize and dehumanize the migrants.

As Pankowski (2010) notes, populist party leaders constantly use the strategy of 'weaponizing language' to portray migrants as a threat to national identity, culture, and security. Echoing the anti-migrant weaponizing language, the populist party leaders often invoke national identity in their discourses and propose migration policies to establish connections to the culture of the common and ordinary and to appear as ordinary citizens. These are especially evident in their election platforms and/or manifestos, which primarily contain references to and sentiments of nationalism. Before the general elections in the Netherlands, for example, PVV leader Geert Wilders systematically emphasized Dutch traditions and culture by promising to change the country's broadcast language from English to Dutch, work more closely with Flemish people in Belgium, with whom they had close cultural ties in the past, implement a national anthem, and, last but not least, forbid wearing Islamic attire and customs in public (Abka, 2021).

Leaders of populist parties in several EU nations have made claims and made promises that follow the same pattern. Take the Alternative for Germany (AfD) in Germany, for instance. It focuses on the need for migrants to assimilate culturally and linguistically, the prohibition on the building of new mosques if they are funded by foreign nations, and the prohibition on the use of Islamic customs and attire in public areas (Söylemez, 2021). Similar assumptions are made by the Danish People's Party (DF), which holds that being Danish is inextricably linked to being a member of the monarchy, the Evangelical Lutheran Church, and the use of the Danish language—all of which are regarded as essential elements of democracy. The DF, like the AfD, places a strong emphasis on the value of immigrant integration (Aknur, 2021).

The emphasis on national identities has eventually led to increasing calls for stronger migration policies, such as more physical barriers and patrols to stop particularly illegal immigration. As demonstrated by the examples of Poland's detention of refugees (Euractiv, 2020) and Hungary's installation of barbed wire fences to prevent refugees from crossing the border from Serbia (BBC, 2016) populist rhetoric and discourse have ultimately resulted in the implementation of more stringent border controls and migration laws.

The leaders of populist parties, always presenting themselves as protectors of national sovereignty against alleged foreign invaders, have finally begun to criticize the EU's attempt to establish a common migration policy, saying it undermines not only the national but also the European values. Accordingly, they also began to portray themselves as defenders of European values, culture, and civilization with slogans such as 'Europe for Europeans', 'Pure Europe', and 'white bastion of civilization' in contrast to the idea of 'unity in diversity'. Akbaba (2018). As a result of this tendency to defend European culture, populist leaders redrew the borders not between EU member states, but between natives and immigrants. Both nationally and within the EU, the focus on identities has resulted in marginalization. Building an inclusive model that takes into account underprivileged groups and fosters a sense of solidarity is therefore getting harder at the EU level.

## Conclusion

As postfunctionalism suggests, EU citizens and bureaucrats have learned from previous crises how to influence EU policymaking. This article noted that democratic procedures are now being used as a tool against the common policies of populist parties. As one of the most significant crises facing the EU, migration has become a politicized area of EU policy, especially given the political orientations of leaders at the national level.

It can be observed that both the global and regional crises have encouraged the rise of nationalism and the politicization of issues within the EU. One of the biggest problems facing the EU in the 1990s was the problem of democratic deficit in EU policy-

making. This problem was mainly due to the fact that EU citizens were not effectively represented by the EP, which led them to distance themselves from the EU policy-making mechanism. Today the problem of the democratic deficit has been reduced by the greater involvement of the EP in EU legislation. However, the more the democratic deficit is reduced, the more European integration and its ability to make collective decisions will be damaged as long as democracy is limited to the voices of the masses. This damage is visible in the EU migration policy, which has been politicized by the results of the political parties' discourses, the referendums and opinion polls of the populist parties opposed to elite projects, and finally by the opt-out systems used by EU member states where Euroscepticism and anti-immigrant sentiment prevail.

In summary, all these internal challenges make it impossible for the EU to manage migration flows from third countries in a normative and coherent manner with international migration management systems. The international migration management systems are essentially based on the principle of reducing inequalities, which the EU cannot take into account in these circumstances since the populist leaders are very successful in provoking the masses, but the masses only represent the majority, while leaving out the disadvantaged groups behind.

## Authors' note

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## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The authors confirm being the sole contributor of this work and have approved it for publication.

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# CLIMATE JUSTICE AND THE EASTERN MEDITERRANEAN ARAB STATES: THE CASES OF EGYPT AND JORDAN

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**Abstract**

At the opening of the 27th Conference of the Parties (COP) Climate Summit in Sharm El-Sheikh, Egypt, United Nations (UN) Secretary General Antonio Guterres (07.11.2022) stated: "we are on a highway to climate hell with our foot on the accelerator." It would not be wrong to suggest that the distance on this highway is closing faster in the Eastern Mediterranean Arab States (EMAS) including Egypt, Jordan, Lebanon and Syria. These states have been greatly exposed to the negative impacts of climate change such as very high summer temperatures, declining precipitation, floods, droughts and decreasing water supplies. Yet, neither they are the major contributors to the climate crisis nor they have sufficient resources to cope with its consequences by themselves. Noticeable asymmetries have had their mark on the current international order regarding climate change. Globally, they are the industrialized nations of the global North to have contributed to climate change greater extent with their cumulative carbon emissions and the hydrocarbon rich Arab Gulf states continue to exploit fossil fuel revenues in the neighborhood. When compared with the developed states of the global North and the Arab Gulf states, EMAS suffer more from the climatic shocks and are less prepared to respond. Even within these states, consequences of climate change are unevenly felt. Referring to the concept of 'climate justice' with a special focus on the ordinary citizens of EMAS, this paper seeks to question to what extent climate action related responsibilities have been undertaken by national governments and the international community.

**Keywords:** Climate change, climate justice, Eastern Mediterranean Arab States (EMAS), Egypt, Jordan

## Introduction

At the opening of the 27th Conference of the Parties (COP) Climate Summit in Sharm El-Sheikh, Egypt, United Nations (UN) Secretary General Antonio Guterres (07.11.2022) stated: "we are on a highway to climate hell with our foot on the accelerator." It would not be wrong to suggest that the distance on this highway is closing faster in the Eastern Mediterranean Arab States (EMAS) including Egypt, Jordan, Lebanon and Syria. These states have been greatly exposed to the negative impacts of climate change such as very high summer temperatures, declining precipitation, floods, droughts and decreasing water supplies. Yet, neither they are the major contributors to the climate crisis, nor they have sufficient resources to cope with its consequences by themselves. Noticeable asymmetries have had their mark on the current international order regarding climate change. Globally, they are the industrialized nations of the global North to have contributed to climate change greater extent with their cumulative carbon emissions and the hydrocarbon rich Arab Gulf states continue to exploit fossil fuel revenues in the neighborhood. When compared with the developed states of the global North and the Arab Gulf states, EMAS suffer more from the climatic shocks and are less prepared to respond. Even within these states, consequences of climate change are unevenly felt. Referring to the concept of 'climate justice' with a special focus on the ordinary citizens of EMAS, this

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In all these states, combatting climate change has been far from being a priority. The ongoing war in Syria has contributed and accelerated the negative impacts of climate change. In Lebanon, forest fires have become a common phenomenon attracting less attention than the political deadlocks in the country. Jordan has been under serious threat of unprecedented levels of water scarcity. When it comes to Egypt, despite some ambitious projects such as developing wind energy and greening tourist destinations, the country's climate profile has remained poor. On the national front; EMAS governments have adopted several initiatives to cope with climate change in recent years. But these top-down initiatives are mainly elite-led projects to benefit ruling elites from green finance and they do not take into consideration the needs of their citizens. On the global front; while some members of the international community have adopted emission commitments within their own borders or regions, they have taken hesitant steps to address the problem in other regions of the world. This paper argues that progress in addressing climate change can only be achieved through unified efforts by policy makers at national, regional and global levels to develop coherent and consistent strategies. Encouraging greater equality in terms of curbing climate vulnerability of those people living in disadvantaged regions such as the EMAS is one of the leading challenges for the international community in the 21st century.

This study consists of four sections. In the first section, the focus is on the unfolding of climate change within the context of the EMAS. The second section elaborates on the concept of climate justice; its emergence, evolution and main claims. The third section addresses climate governance by two states among the EMAS: Egypt and Jordan. Lastly, the fourth section points out climate action related responsibilities by the international community regarding the EMAS.

## Climate Change in the EMAS

The Intergovernmental Panel on Climate Change (IPCC) (2023) points out that human-induced climate change has caused extensive destructive impacts on nature and people across the globe, that are unevenly spread across regions and communities. The disproportionate negative effects of climate crisis are mostly felt by those vulnerable communities who have historically had the least contribution to climate change when cumulative greenhouse gas (GHG) emissions are taken into account. According to the United Nations Environment Program (UNEP) (2023), "the Mediterranean region is warming 20% faster than the global average". The region takes place "in a transition zone between the arid climate of North Africa and the temperate and rainy climate of central Europe" and is closely influenced by "interactions between mid-latitude and tropical processes" (Giorgi and Pierro, 2008, p.90). As a result, even slight changes in the general circulations considerably alter the Mediterranean climate, making the region potentially exposed to climatic changes (Giorgi and Pierro, 2008, p.90). The situation becomes more critical when we move to the eastern Mediterranean as the region has been subject to increasing harmful consequences of climate change including heat waves, aridity conditions, forest fires, declining rainfall and air pollution. These negative effects are aggravated when combined with existing political, economic and social shortcomings, and weak capacity of the governments to respond in terms of mitigation, adaptation and resilience to climate change. This is particularly the case in the Eastern Mediterranean Arab States (EMAS) including Egypt, Jordan, Lebanon and Syria. Vulnerable groups in the EMAS such as "people suffering from the sickness, the elderly, children, and in general the urban population" are estimated to feel the worst outcomes of this process (Lelieveld et al., 2012, p.682).

EMAS are increasingly exposed to very high summer temperatures, declining precipitation, droughts and floods under climate change, which in return leads to declining agricultural production, migration flows from rural to urban areas, health problems (Paz, Majeed and Christophides, 2021) and accelerating pressure on resources. To make matters worse, high-fertility rates in these states place further burden on water and food supplies. Vulnerability to climate-related risks of the EMAS populations is not only higher when compared with many other regions, but also it is remarkably greater than that of the hydrocarbon rich Arab Gulf monarchies. Yet, even though the Arab Gulf monarchies have severe water scarcity, they "consume more water per capita than the global average" (Waha, Krummenauer and Adams et al., 2017, p.1624). Through the hydrocarbons they extract and sell, these monarchies have highly contributed to global carbon emissions. Nevertheless, fossil fuel rents have enabled them to purchase adaptive capacity against climate change in terms of food imports and seawater desalination (Mason, 2019, pp.627-628). In a stark asymmetry, while having contributed very slightly to climate change through their historical cumulative carbon emissions, the EMAS have had greater share from the negative consequences of climate change and their adaptive capacities against climate change have remained very limited. This situation presents uneven and unfair conditions to EMAS citizens in comparison to those of global north or Arab Gulf. Even within the EMAS, visible inequalities exist in terms of responsive capacities of different socio-economic groups. Vulnerable segments of society (poor, women, children, elderly, refugees…) continue to suffer from the worst consequences of climate change.

## Climate Justice: Placing Ethics at the Heart of Climate Action

The term 'climate justice' gained prominence by the early 2000s, emerging out of a broader term, 'environmental justice'. Coinciding with the sixth session of the United Nations Framework Convention on Climate Change (UNFCCC) conference at the Hague (COP 6) in 2000, the first climate justice summit was organized by the Rising Tide[1] network as an alternative to official talks attracting attention to the 'real victims' of the climate change, the people in the developing world (Whitehead, 2014). At the official level, the term 'climate justice' was for the first time indicated in the Paris

1. Rising Tide is a grassroots international network of groups and individuals who take direct action to confront the root causes of climate change and to promote local, community-based solutions to the climate crisis. For more details, view https://risingtide.org.uk/

Agreement (2015). It stated: "Noting the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity, recognized by some cultures as Mother Earth, and noting the importance for some of the concept of 'climate justice', when taking action to address climate change" (Paris Agreement, 2015).

Climate justice advocates were initially inspired by the mass resistance taking place in the global south against fuel companies to prevent climate change such as the Ogoni people's battle against Shell in Nigeria (Paris Agreement, 2015). They have viewed the outcomes of climate change as an illustration of inequality in the contemporary world. In this context, it is suggested that while industrialized countries are considered as largely responsible for climate change, developing countries face its negative consequences. Despite not being responsible from most historical emissions, developing countries have to cope with its disproportionate consequences with their limited capacity and resources. According to 2018 report by the World Bank, whereas the US and Europe contributed 26% and 22% of global cumulative GHG respectively, the African continent just contributed 3.8% (World Bank, 2018). As it is mentioned in the IPCC 2023 (p.8) report, adaptation to climate options and their implementation remain limited in the developing countries and current global financial flows are insufficient to eliminate these limitations. The destructive impacts of climate change on low-income countries are multidimensional and besides triggering natural disasters, they prevent quality education, intensify existing gender inequalities, provoke conflict, destabilize governments, and force people to leave their homelands (Walsch 2019, p.40).

The disproportionate outcomes of climate change are not only observed among developed and developing parts of the world. Asymmetries are also seen among people within the same country or even within the same city. Despite having contributed least to increasing temperatures, less privileged people in their societies due to a number of factors are likely to suffer greater from the outcomes when compared with more privileged people whether in developed or developing states who have contributed greater to the problems. Similar uneven outcomes can also be viewed for older and younger generations. While older generations have contributed greater extent to global warming, younger generations are likely to be worse affected from climate change. United Nations Development Program (UNDP) classifies three main aspects of climate justice as structural inequalities (race, ethnicity, gender, disability…), socioeconomic inequalities and intergenerational inequity. Accordingly, it maintains that climate justice is about determining climate-related responsibilities in accordance with the amount of contribution to the problem while addressing the three categories of inequalities (UNDP, 2023). Against these disproportions, climate justice seeks to place ethics at the heart of climate action. Admitting the fact that action is to be taken by every region, every country, every community and every individual, climate justice aims to distribute climate-related responsibilities in a fairer way prioritizing human rights and equality. In this regard, climate justice pursues solutions that would overcome embedded injustices in global, national and societal levels. While no one is immune to global warming, the level of risk depends "on trends in vulnerability" (IPCC 2023, p.15). As Boyd et al. (2021, p.1367) rightfully suggest "the scale and magnitude of the impacts of an extreme event are a product of socio-political processes that create vulnerability" and there is need for addressing these vulnerabilities in order for the first step towards transformation is to be taken.

The concept of climate justice has become popular with the campaigns and demonstrations of grassroots movements in the 2010s in different parts of the world. Friends of the Earth International (FoEI) helped hundreds of thousands of people to mobilize around the world, calling for climate justice on the eve of the UN COP 21 climate change summit in 2015 (FoEI, 2015). Mary Robinson Foundation for Climate Justice has promoted various campaigns on climate justice to raise awareness about the vulnerable people subjected to negative outcomes of climate change. The International Institute of Climate Action and Theory (IICAT) has also encouraged the international struggle for climate justice through its emphasis on the disproportional negative impact of global warming. Climate justice movement proved its transnational strength in 2019 with its reinforced mobilization capacity through Extinction Rebellion (XR) and Fridays for the Future and their actions across the globe (Almeida, 2019, p.975). Equality, fairness, participation, access to resources and information, and protection are the leading themes to be employed in the definitions of climate justice by these grassroots movements (Shaw, 2016, p.508).

## Climate Governance by the Egyptian and the Jordanian Governments

Historically, the EMAS have been referred as "low-ambition, low-emission" countries regarding climate governance with their governments and ruling elites frequently downplaying the outcomes of climate change (Chibani, 2022). While there are some distinctions among the policies adopted by the governments of EMAS, in recent years, there have been greater interest among the governments in the region with respect to adopting policies to cope with climate crisis including GHG emission reduction assurances, renewable energy investments and carbon taxes. According to IPCC (2023, p.32), effective climate action requires "political commitment, well-aligned multilevel governance, institutional frameworks, laws, policies and strategies and enhanced access to finance and technology". Among them, inclusive decision-making processes prioritizing equity and justice occupy a central place in reducing vulnerabilities and climate risks. Policymakers should pay attention to contextual inequities based on gender, ethnicity, disability, age, location and income (IPCC, 2023, p.32). Climate governance is mainly based on two pillars: mitigation and adaptation. Mitigation includes measures to limit or slow down climate change, whereas adaptation is about making necessary adjustments to cope with negative consequences of climate change or at least to reduce its harmful effects.

Egypt continues to be one of the most vulnerable countries to climate crisis due to several reasons such as visible reduction in average flow of the Nile River which constitutes Egypt's leading water supply, the threat of inundation of fertile lands in the Nile Delta from sea level rise, decreasing crop yields due to increasing temperatures and decreasing irrigation capacity (Smith, 2014, p.59). Egypt ratified the UNFCCC in 1994, submitted its Nationally Determined Contribution (NDC) in accordance with the Paris Agreement in November 2015 and ratified Paris Agreement on 29th June 2017 (Egypt's Second Updated Nationally Determined

Contributions, 2023). Investing in renewable energy has been Egyptian government's most ambitions mitigation strategy against climate change. Egyptian Ministry of Electricity and Renewable Energy released Integrated Sustainable Energy Strategy to 2035 in 2015, which paid special attention to renewable energy aiming renewable energy capacity to constitute 42% of power capacity by 2035 (IRENA, 2018). Egypt has heavily invested in wind energy projects to curb GHG emissions such as "the Zafarana wind farm with 700 wind turbines and a total capacity of 545 MW, Gabal El Zeit wind farm with a total capacity of 580 MW" (Gebaly, Nashwan, Khadr and Shahid, 2023, p.3). Other than wind energy, Egypt has developed its hydro, solar and biomass energy sources which led to "the installation of solar water heaters (SWHs) in new cities, solar industrial process heat systems (SIPHS), wind farms and photovoltaic (PV) applications in water pumping, cold stores and desalination plants, as well as biogas digesters in rural areas" (IRENA, 2018, p.21).

Egypt has also introduced two ambitious projects: the regreening of the Sinai Peninsula and the development of the Suez Canal Economic Zone. The regreening of the Sinai Peninsula project aims to restore vegetation to the Sinai Peninsula reducing moisture loss between the Mediterranean Sea and the Indian Ocean thus encouraging rainfall (Chibani, 2022). On the other hand, the Egyptian government seeks to turn Suez Canal Economic Zone into "a global hub for the production of green hydrogen and ammonia" (Chibani, 2022). Furthermore, Egypt hosted COP27, the 2022 UN Climate Change Conference, designating Sharm ek-Sheikh as the venue. Prior to the event Egyptian officials signed the Sharm Green City Project Agreement to turn Sharm el-Sheikh into an environmentally sustainable tourist destination by eliminating single-use plastics, installing solar-powered lighting systems, planting thousands of mangrove trees, and moving "smokestacks that currently lie within the city limits to the desert area instead" (Asi, 2022). During the COP27, Egyptian President Abdel Fattah El-Sisi emphasized that Egypt was hosting the event "on behalf of African nations" (Asi, 2022).

Despite the large-scale projects and significant investment in renewable energy, Egypt's climate governance record remains poor. According to Climate Action Tracker, Egypt's climate targets and policies are "highly insufficient," since "Egypt's climate policies and commitments are not consistent with the Paris Agreement's objectives and lead to rising, rather than falling, emissions" (Climate Action Tracker: Egypt, 2023). Egypt is Africa's second largest natural gas producer and expansion of natural gas production and exports has overshadowed investments in renewable energy to large extent (Climate Action Tracker: Egypt, 2023). Projects introduced by ruling elites in terms of climate action in the country have so far not changed anything for ordinary Egyptians. Climate action is led in a top-down manner without cooperation with civil society. Egyptian authorities prioritize green finance, climate finance from developed countries (Climate Action Tracker: Egypt, 2023). As Chibani (2022) suggests; climate change mitigation projects in Egypt display monopolization of climate change finance by political and military elites who are not much concerned about potential effects of them on the people.

When it comes to Jordan, Jordan is a relatively small and stable nation when compared with its neighboring states. However, the country has been coping with severe economic challenges whose negative impact on the Jordanians has heightened with climate change (El-Sharif and Muasher, 2024). Jordan ratified UNFCCC in 1993 and Jordanian governments have been issuing National Communications within the framework of the UNFCCC since 1998 which provide detailed information about the country's GHG emissions, climate change effects, and present climate actions. (El-Sharif and Muasher, 2024). Creation of a Climate Change Directorate is one of the initiatives to address climate change in the country. The Climate Change Directorate was introduced in 2014 within the Ministry of Environment "to oversee Jordan's climate change strategies as well as to represent the country at the international level" but it has so far remained understaffed and underfinanced (El-Anis and Poberezhskaya, 2023, p.8).

Jordan presented its first NDC in 2015 and enacted Climate Change By-Law (No. 79) in 2019 to present a national legal framework for climate-related actions (Updated Submission of Jordan's 1st Nationally Determined Contribution, 2021). The By-Law confirmed the status of Ministry of Environment as the leading authority in climate change policies with National Climate Change Committee responsible for coordination, and formalized climate change debates in the country (El-Anis and Poberezhskaya, 2023, p.8). Initiatives for adaptation and resilience include Climate–Smart Agriculture Action Plan, Amman Resilience Strategy, Amman Climate Plan (a Vision for 2050) and Amman Green City Action Plan (Updated Submission of Jordan's 1st Nationally Determined Contribution, 2021). Climate–Smart Agriculture Action Plan seeks to contribute to Jordanian farmers' adaptation and resilience to climate change at the national level, whereas the other three local plans put forward by the Greater Amman Municipality aim at reducing GHG emissions and to enhance resilience of Amman, the capital of Jordan (Updated Submission of Jordan's 1st Nationally Determined Contribution, 2021).

In addition, Jordanian Ministry of Environment (Dec.2022) launched Climate Investment Mobilization Plan to encourage climate responsive projects to involving the private sector and to promote Jordan as an attractive destination for climate investments. Within the context of this Plan, Jordan has been able to attract attention of climate investors for the Aqaba-Amman Water Desalination and Conveyance Project, whose success according to El-Sharif and Muasher (2024) will depend on financial achievement through public-private partnership. Overall, Jordan has introduced promising climate action policies and initiatives, but the real challenge is implementation in a proper and coherent way and the accomplishments have yet to be seen (El-Anis and Poberezhskaya, 2023, p.3).

## Climate Action Related Responsibilities by the International Community

With respect to global climate action, the international community has two leading responsibilities: encouraging countries to make commitments in reducing their own GHG emissions in a fair way and ensuring the provision of financial and technical assistance to developing countries for climate change mitigation and adaptation. The international community is expected to support green transformation in developing parts of the world though sharing technology and resources and monitoring them in the protection of vulnerable groups (Al-Mailam, Arkeh and

Hamzawy, 2023, p.19). The Paris Agreement recognizes the principle of 'common but differentiated responsibilities,' meaning that while all countries are responsible from climate action, this would take longer time and may depend on financial and technical assistance in the case of developing countries (Paris Agreement, 2015).

COP, also known as UN's annual climate change summit, has been held since 1995 and is widely accepted as the planning platform for the international community in combatting climate change. However, COP has also been subject to widespread criticisms as the agreements made by countries to reduce their emissions are not binding and there are no concrete penalties for not meeting the targets (Asi, 2022). The latest COP, the 28th held in Dubai, United Arab Emirates, from November 30 to December 13, 2023 saw the launch of 'loss and damage' fund aimed at supporting developing countries in combatting the effects of climate change. In this regard, while COP28 presented an important mechanism that would encourage reparations by the developed world responsible from historical cumulative emissions, to developing world facing the destructive consequences of climate crisis, it lacks significant details to be called as a comprehensive plan (Kanbergs, 2023). Other than the 'loss and damage' fund, the COP 28 had two accomplishments; an agreement by participant countries to transition away from fossil fuels and the publication of an assessment and monitoring of the global progress in mitigating climate change, referred to as the Global Stocktake (Nasser, 2023). The 2023 Global Stocktake points out that current climate action is insufficient for limiting global warming to 1.5°C and underlines urgent need for "tripling renewable energy capacity globally and doubling the global average annual rate of energy efficiency improvements by 2030," while "accelerating efforts towards the phase-down of unabated coal power" (UNFCCC, 2023).

In order for international community to increase its impact on climate action and to support vulnerable communities, it should do more than just setting pledges. A potentially effective step can be through the establishment of a reward and punishment mechanism in which countries exceeding emission quotas are penalized and those payments could be used to fund climate finance (Nasser 2023). But, here again there is the challenge of enforcement of such a mechanism. Another contribution to vulnerable countries and vulnerable societies in support for climate action would be through the development of climate debt swap deal. Most of the developing states face debt burdens to international financial institutions such as the World Bank and the International Monetary Fund (IMF) and this situation makes it more difficult for them to adopt mitigation and adaptation initiatives (Schulz and Idriss, 2023). Debt swaps for climate are not new, but they can be restructured to offer solution to debt distress of the vulnerable states and a way of directing additional resources to climate (UNDP, 2023). Alternatively, climate-conditional grants or grant/loan combinations can be more effective in supporting climate investment in recipient countries since they are targeted solely for climate investment and they cannot be redirected to debt service or other spending purposes (Chamon, Klok, Thakoor and Zettelmeyer, 2022).

## Conclusion

This study analyzed climate action taken by Egypt and Jordan among the EMAS and the international community within the context of 'climate justice' debate. 'Climate justice' seeks to attract attention to disproportionate impacts of climate change on the vulnerable communities and the responsibility of the governments and the international community to take necessary climate action for securing these communities. Located in the eastern Mediterranean, the most rapidly warming region in the world, Egypt and Jordan have been highly subject to negative consequences of climate change. The climate-induced harmful consequences have particularly been felt by the ordinary Egyptians and Jordanians, when these consequences are combined with the existing political, economic and social shortcomings in their countries.

In the last two decades, both national governments and the international community have taken steps to contribute to mitigation, adaptation and resilience to climate change. Yet, the momentum and properness regarding the implementation of relevant climate action policies and initiatives have lagged behind the speed of harmful effects of climate change on vulnerable communities. The national governments and the international community need to undertake greater climate action to reduce the vulnerability of communities such as those in Egypt and Jordan.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

## Peer-review

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# STRATEGIC APPROACHES PROMOTING SUSTAINABLE DEVELOPMENT IN SOLID WASTE MANAGEMENT BASED ON CIRCULAR ECONOMY: A LITERATURE REVIEW

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**Abstract**

The escalating global population and swift urbanization have expressively increased the capacity of municipal solid waste (MSW) all over the world, leading to several defies counting health issues, climate change, and social discrepancies. Policymakers are obstinately exploring actual and viable solutions to discourse solid waste management (SWM). The circular economy (CE) benevolences a critical approach for organized and favorable solid waste management. This investigation highlights the indispensable elements for scheming MSW management structure prejudiced by (CE) principles. The (CE) exemplary focuses on the ideologies of (4R) Reduce, Reuse, Recycle, and Recover. The analysis underscores the significance of amenities for cataloging and waste grouping, waste treatment progressions, and the retrieval of treasured possessions from waste. It also deliberates the regulations and the oddity of policies in (SWM), referencing illustrations from developed nations. Additionally, the study deliberates the economic, social, and environmental extents of the circular economy. It provides insights to achieve sustainable development using a CE-driven system for (SWM), supporting for environmentally viable business observes, environmental impartiality, and the enrichment of social well-being. The research distinguishes inclusive commercial societies that have comprised the circular economy, determined towards sustainability. It climaxes the ingenuities by well-known worldwide administrations to lessen waste fabrication, incorporate substantial recycling and reprocess into their maneuvers and products. The research bids visions into a system that indorses societal affluence and harmony.

**Keywords:** Sustainable Development, Waste Recovery and Recycling, Circular Economy, Literature Review

## 1. Introduction

The increasing amount of solid waste accumulation poses an extremely complex challenge that needs to be addressed immediately. The World Bank estimates that at least 33% of the total of 2.01 billion tonnes of (MSW) produced annually worldwide is not managed in an environmentally responsible way (Sikder et al., 2024). According to Nevrlý and Smejkalov (2021), this negligence of natural resources increases detrimental effects on ecosystems,

making it necessary to explore new paths to meet material as well as energy needs while preventing resource depletion. A strong solid waste management system presents a viable way to produce energy and secondary materials without endangering the health of the ecosystem. This means making the shift to a circular economy-based strategy, in which materials are recycled in a closed-loop system to reduce the production of waste.

Comparing emerging countries to OECD countries, solid waste management is more difficult because of low recycling infrastructure, low scientific consciousness, high costs, and inadequate strategies (Budihardjo et al., 2022). Various obstacles face urban waste management worldwide, such as inadequate systems for waste separation and recycling, an inability to initially separate both wet and dry waste, and a lack of knowledge regarding the composition of solid waste system (Kumar & Agarwal, 2020). As a result, the growing amount of landfills is a serious concern because some of them take centuries to completely decompose, and leachate leaks contaminate the environment, water, and soil, putting public health at risk. If not recycled properly, everyday objects can take a long time to decompose (Devi et al., 2024). Comprehending the composition of MSW—which normally include 44% food and green waste, 17% cardboard, 12% paper and plastics, 5% glass, 4% metal, 2% wood, rubber and leather (2%), and other materials (14%)—is essential to streamlining the waste sorting process. (Sondh et al., 2022). An ineffective mixed waste separation, collection, and transportation upset the balance of the environment, highlighting the significance of waste segregation in lowering landfill volumes and reducing pollution. Each step of the process—reusing and recycling, sorting and collection of waste, recuperation of waste, and final disposal—improves the effectiveness of the system as a whole. At every level, local government and policy play a crucial role. Gasification, incineration, and pyrolysis are examples of thermochemical conversions that are practical for producing energy from waste; however, in order to maximize input quality, proper waste pre-treatment is required (Letcher, 2020). The division of waste and sorting involves the use of a variety of techniques, including eddy current separation, magnetic separation, trommel screening, and air separation, and manual sorting (Funari et al., 2023). These techniques highlight the significance of recycling and separation in order to divert materials from landfills. The United Nations synchronizes waste management objectives with sustainable development goals, acknowledging solid waste management as a critical concern (Sharma et al., 2021). It is estimated that by 2050, there will be approximately 2.4 billion tonnes of CO2 equivalents annually due to climate change. This highlights the circular economy potential management of waste driven to address sustainable development and financial stability, while protecting human rights and natural assets.

Through the efficient use of natural resources and the production of commodities, Circular Economy (CE) offers a way to reduce the burden on the environment. Its main benefit is that it promotes growth in all areas—economic, social, and environmental (Ghisellini et al., 2016). Adoption of CE is encouraged by many nations in an effort to restore the environmental and economic health of their regions (Herrador & Van, 2024). CE reduces the negative effects of extraction, emissions, and disposal while minimizing pressure on global resources by circulating resources within local economies (Chowdhury et al., 2022). Numerous stakeholders, including companies, politicians, and environmental organizations, generally hold the view that a CE-centric economy is unavoidable in the long run (Almulhim, & Al-Saidi, 2023). According to Lei et al. (2021) this model is perceived as a structured sustainable development framework that attempts to recover critical factors of sustainability.

It is essential to regularly evaluate CE practices in the social, economic, and environmental domains in order to track advancements in sustainable waste management. A strong waste management model requires the cogent growth of these three pillars. Using the 4Rs (Reduce, Reuse, Recycle, and Recover) as a framework for waste management, this study critically analyzes a number of aspects of managing municipal solid waste (MSW) in a circular economy. The collection, sorting, recycling, reuse, and recovery of valuable materials are prioritized. In order to create an effective waste management model, this study explores the harmonious growth of social, environmental, and economic dimensions, whereas prior research has mostly concentrated on the environmental aspect. One important component of a circular economy (CE) is material recovery from waste, which includes obtaining valuable resources like electricity, fuel, oil, fertilizer, animal bedding, and valuable metals. Leading companies and organizations that have embraced the principles of circular economy provide smaller organizations with inspiration to adopt more efficient waste management practices and vision.

## 2. Methodology

The literature survey was conducted using a methodical approach with the goal of gathering precise and pertinent studies. Using terms like “Circular economy,” “circularity,” “solid waste management,” “MSW management,” “three pillars of circular economy,” “sustainable waste management,” and “exergy,” among others, the process involved looking for research articles from diverse websites including, Science Direct, Springer, Google Scholar, Official websites and Research gate. The articles that came up in these searches were carefully assessed by reading the titles and abstracts. A shortlist of articles that closely matched the current study was created in order to conduct a more thorough analysis. To make the final selection in the detailed examination, the research articles’ entire texts were carefully examined. Furthermore, a search was conducted through the shortlisted papers’ references to find more pertinent research articles. A summary of earlier efforts in SWM that attempted to accomplish sustainability through various tactics. In order to guarantee consistency in waste management procedures, Section 2 of the review concentrates on the function highlighting the effectiveness of solid waste and subsequent organization. The concepts of the four Rs of solid waste and its management, including Reuse, Reduce, Recycle and Recover are covered in Section 3. The significance of these ideas in developing a solid waste management framework that is effective in promoting a circular economy is emphasized in this section. The society, environment and economy, the three pillars of the circular economy—are examined in Section 4 with reference to (MSW) systems. It also emphasizes the goals of influential people around the world who support incorporating a circular economy concepts into waste management procedures.

## 3. Results and Discussions:

Table-1 Key components and scope of earlier studies in the fields of SWM and circular economy

| Study approach | Significant structures | References |
|---|---|---|
| SWM and applications towards Waste-to-energy | • MSW is considered to be a source of sustainable energy.<br>• Various wastewater methods are appropriate for various types of waste.<br>• Diverse techniques are used to manage waste: inert waste is dumped in landfills, mixed MSW is burned, organic waste is anaerobically digested, and wood, tires, and plastics are pyrolyzed. | (Kaur et al., 2023; Zhou & Zhang, 2022; Akinshilo, 2019) |
| Green Economy | • Economic growth, reducing poverty, and preserving the environment are the main goals of the green economy.<br>• Emphasis is placed on the ideas of waste pyramid, industrial ecology, and CE.<br>• A cohesive set of rules and policies for waste management can support the development of a green economy. | (Zhironkin & Cehlar, 2022; Adamowicz, 2022; Muljaningsih et al., 2022) |
| A system for managing waste in the circular economy. | • Its main goal is to combine solid waste management and the CE concept.<br>• Serious problems with the environment and human health are the result of ineffective waste management.<br>• CE strategies such as recovery, recycling, repurposing, restoring, reuse, etc., can promote economic growth. | (Smol et al., 2020; Fatima et al., 2020) |
| Environment and CE | • The public should be encouraged to learn about green logistics and CE.<br>• Reducing resource usage and waste at the source should receive more attention.<br>• The operation of a closed-loop economy is superior to that of a linear economy. | (Li et al., 2022; Sariatli, 2017; Bhattacharjee, & Cruz, 2015) |
| CE | • One important method for evaluating the ecological well-being of products is life cycle assessment, or LCA.<br>• Environmental effects are contrasted with circularity indicators.<br>• With the expansion of CE's structure, there is a great deal of room for expansion in the green industrial parks and industrial economy. | (Bossek et al., 2021; |
| System for managing solid waste based on the circular economy | • The application of CE in systems that handle solid waste can assist in reducing the issues associated with waste accumulation and generation. Because MSW is an amalgamation of wastes, it must be properly sorted before being sent to the treatment facility.<br>• To fully utilize waste's potential for recycling and valuable recovery, infrastructure must be provided by effective strategies and policies.<br>• Using contemporary assessment instruments like energy analysis, environmental sustainability in a CE can be evaluated in terms of its social, economic, and environmental aspects. | Current Study |

### 3.1 Waste grouping and organizing stations

Reducing waste generation and implementing efficient waste collection systems are both necessary to address the challenges of waste management. In certain countries, waste collection is typically managed by private entities or local authorities; however, organizing waste collection and indulgencing it for the purpose of salvaging remains a significant for nations worldwide (RamHormozi, 2019). Complex challenges related to waste management (Nzeadibe and Adama, 2015) necessitate the establishment of transferring waste properly for addressing the growing waste predicament. Existing management of solid waste facilities frequently lack the resources needed to function efficiently, with inefficiencies in the use of resources like labor and vehicles (Salazar-Adams, 2021).

Waste is collected using a variety of techniques, such as vehicle-based collection with notification signals, central waste collection points, from initial collection to final disposal. Urban and rural waste collection rates differ, with higher rates generally seen in high-income nations relative to low-income nations because of disparities in infrastructure, waste management effectiveness, and waste education. Waste collection rates are also influenced by an area's level of development within a nation; in general, urban areas have higher rates than rural ones because waste collection is frequently seen as an urban amenity (Kaza et al., 2018). Many nations have privatized waste management systems, frequently with government subsidies, to address the complexity of waste collection and administration. By involving private agencies, this has increased efficiency and service quality. Additionally, privatization can lessen the burden on local and state government agencies. As facilities for transient storage where municipal solid waste (MSW) is gathered before being sent to recycling or waste-to-energy facilities, waste transfer stations are essential to waste management. Unloading from trash trucks, inspecting, removing hazardous materials, compressing, and transferring to larger vehicles are important duties at waste transfer stations (Lebank, 2020). In order to reduce transportation expenses as the time for shifting as well as the amount of waste increase, waste transfer stations are ideally located close to recycling and treatment facilities (Yousefloo & Babazadeh, 2020). Modern technological innovations like the Internet of Things (IoT) have the potential to greatly improve solid waste management systems' efficiency. As shown in Moscow (Maiurova et al., 2022), digitalization of waste disposal networks can maximize resource utilization and enhance overall system performance. Effective waste management requires waste sorting. A range of methods including hand picking, air density separation, metal extraction, and electrostatic techniques are employed to manage various waste materials. In order to prepare waste for additional processing and recycling, these separating techniques are necessary as shown in figure.




**Figure-1** Waste progresses through stages of collection, segregation, and sorting, ultimately arriving at a suitable waste treatment facility, following a structured pathway outlined in waste management protocols.

**Source:** (Sondh et al., 2024)

### 3.2 Manual Sorting

Large objects like rocks, wood, and oversized clothes must be separated from other waste materials during the sorting process at the source. This technique uses simple tools like big tables or belt conveyors and is usually performed by workers using their hands.

A popular method for sorting municipal solid waste is handpicking, which works especially well for getting rid of things like plastic made from PVC and e-waste. Concrete, wood, glass, and rocks are frequently found in construction and demolition waste (Lawson, 2020). Although manual sorting requires a lot of time and labor, it is an efficient way to separate waste and recover valuable materials. This method, which mainly uses human resources, is common in nations where cheap labor is easily accessible. After the waste has been emptied, it must be spread out and disposed of (with precautions taken), with visible waste being manually separated for reuse, collected and stored, and any leftover debris must be disposed of (Liang et al., 2024).

### 3.3 Air density separator

Fans or blowers are used in this garbage division process to speed up the procedure. By producing an upward airflow, the fan helps separate materials according to their differing densities. The force of the airflow and the way the materials are introduced into the air column, determine how effective this method is. Another important consideration is moisture content, since water can make some materials clump and fall, which can interfere with the sorting process ("Solid Waste Management," 2022). Techniques for separating air further can be divided within zigzag and wind shifter types of separators. These techniques efficiently separate metals and more substantial wastes from materials with lightweight including plastic bottles and various categories of plastic.

### 3.4 Trommel screening

This screening, sometimes referred to spinning visuals, are physical transmission devices that are frequently used for material separation in the solid waste treatment sector (Mousavi et al., 2024). These screens are made out of a cylindrical drum with a surface covered in a web-like structure made of meshes in different sizes. The mesh of the trommel enables the separation of particular waste sizes as it rotates, creating a heap, for example, of manure. Waste that exceeds the mesh's allowable size is stopped at the trommel's back end (Chen et al., 2010). For a trommel to operate smoothly, effectively, and safely, human resources are needed. Both wet and dry garbage can be processed by these devices. Objects are raised with lifting bars on an inclined drum and then dropped to descend further. To help with separation, elevating bars also give the objects a shake. Trommel screens are used in the municipal solid waste (MSW) industry to classify particles into fixed sizes. Trommels improve the quality of other solid waste derived from fuel by eliminating inorganic materials such as ash and water from grouped light solvents (Goli et al., 2021). Three major sets of materials are usually obtained from the MSW after it has been inspected at the sorting plant: (i) Refuse Derived Fuels (RDFs), which consist of combustible materials; (ii) large-sized materials, such as stones, metals, electronic material, etc.; and (iii) inert or delicate materials.

### 3.5 Metal Separation

A large percentage of mixed waste is composed of plastics, paper, elements, e-waste, and food particles in sorting stations. For a number of reasons, metal separation is an essential stage in waste separation facilities (Elisha, 2020). To begin with, it helps separate premium materials. Second, the effective running of later operations like crushing, visual sorting, and RDF production depends on the removal of metals. Current separation and magnetic separation are two methods for metal separation that are frequently used (Sniatala et al., 2023). While eddy current separation creates repulsive forces in non-ferrous metals, which cause them to be ejected from the waste stream, magnetic separation uses magnets to attract and separate ferrous metals from the waste stream. By effectively removing metallic materials from mixed waste, these methods facilitate subsequent procedures and increase the effectiveness of waste management as a whole (Xavier et al., 2023).

### 3.6 Magnetic Separation

This method allows the removal of gathered metal by using an electromagnet to activate or deactivate. It is noteworthy that this technique is not applicable to all metal separations (Ding et al., 2021). The device is made up of a permanent electromagnet mounted on a rotating drum that draws magnetic tools from the belt conveyor. Besides that, non-iron metallic are not affected by magnetic fields and have no ferrous content. Copper, aluminum, and stainless steel are a few examples of materials that have little to no magnetism. A further drawback is that non-magnetic materials containing minute magnetic particles will not be captured (Fitzgerald, 2013). Larger magnetic objects may also unintentionally collect undesirable materials like paper, plastic, and food scraps. In mixed recycling streams, where materials are gathered and separated prior to processing, this problem is especially prevalent.

### 3.7 Eddy Separation

Eddy current separation is a widely employed technique for the separation of non-magnetic materials, like aluminum, present in electronic waste. In order to differentiate non-ferrous metals according to their conductivity, this method uses electromagnetic induction. This method involves using a conveyor belt to transport a mixture of non-magnetic materials in a predetermined size range to the eddy current separator (Smith et al., 2019). This method is effective because it delivers material fast and guarantees uniform distribution in a single layer. After that, the material travels to the main pulley separating substances zone, where non-metals are driven away from the host substance (Anastassakis, 2018). Rejected non-ferrous metals are routed through carefully positioned splitters to collection belts or bins. According to Huang et al. (2021), the speed at which average plastic, aluminum, and copper rudiments separate from desiccated biodegradable is greatly impacted by fine-tuning the rotor rapidity, provender amount, and girdle speed. Non-metallic materials fall freely into non-ferrous areas, while brass ingredients are drawn to the strong magnetic power created inside the separator.

### 3.8 Separation by electrostatics

Electronic waste, or e-waste, is the term for disposed of or abandoned electronic items, including laptops, TVs, cell phones, batteries, and more. The generation of e-waste has increased noticeably in recent years, but efficient disposal techniques are

still difficult to come by because of the intricacy of electronic waste components. Numerous hazardous metals, like lead, polybromine, cadmium, the element lithium, mercury, and retardants, are found in e-waste. These metals can cause serious health problems, including damage to the different parts of the body like, liver, kidneys, heart and brain. Although, E-waste can further be divided into semiconductors, conductors, and insulators. Effective recycling of these components appears to be possible with electrostatic separation (Tilmatine et al., 2009). With this method, conducting and insulation substances found in e-waste are effectively recycled. Disassembly, disposal, and final treatment are usually steps in the e-waste disposal process. The first step in separating valuable and hazardous components is disassembly (Oke, & Potgieter, (2024). Materials are broken down to liberate them from substances and separate them in subsequent processing. Materials that have distinct charges are attracted to or repelled from each other according to the electrostatic charges principle, which underlies electrostatic separation. In separators, conductive elements fascinate contradictory indicted matters, like metal drums, and separate them from through the use of attractive forces (Aksa et al., 2013). Printed circuit boards (PCBs) are essential parts of e-waste because, according to Waste from Electrical and Electronic Equipment (WEEE), they contain a considerable amount of valuable metals (Hamerski et al., 2019). PCB electrostatic separation turns out to be a successful method for recovering value products (Jha et al., 2024).

### 3.9 Balers and compactors

Space constraints resulting from accumulating waste are a common challenge faced by waste management organizations. Thankfully, developments in technology provide some relief from this problem. Users can use balers and compactors, among other tools, to minimize the amount of space that waste takes up. Press channels, pressing chambers, tying devices, and power units are the four main parts of a baler. The procedure is filling a hopper with waste, which the baler then compresses into bales, or bundles. The amount of waste is greatly decreased by these bales, which helps with recycling and makes waste easier to handle. Balers are used in many different industries, such as manufacturing, recycling plants, retail stores, and institutions. Round and square waste balers are the two most popular varieties (Shang et al., 2021). The effectiveness of handling, aggregation, transportation, and storage procedures all depend heavily on bale density (Shah and Darr, 2016). In a similar vein, compactors are essential for reducing waste volume and, consequently, the amount of space needed in landfills. Compactors not only minimize volume but also provide the benefit of reducing fire hazards, smells, and rodent infestation.

## 4. Policies for Waste Management, Reuse, Recycle

Within a nation or region, peace is fostered by an environmentally friendly municipal solid waste (MSW) management system. By applying the principles of reduce, reuse, and recycle, adopting a circular economy-based strategy for handling municipal solid waste presents a chance to lower natural resource consumption and protect the ecosystem (Li et al., 2021). According to Cunha (2024) this is in line with the Sustainable Development Goals (SDGs) of the United Nations, including " "Ensure Sustainable Production and Utilization Patterns" (SDG-12) and "Take immediate action to mitigate the effects of climate change" (SDG-13). Creating a framework of laws and policies is essential to creating a waste management system that works. Using circular economy techniques is the main way to achieve sustainability in MSW management. Recycling—often referred to as "misplaced resources"—contributes significantly to sustainable waste disposal by lowering waste effluence, restoring usable resources, and conserving energy (Sondh et al, 2024).

### 4.1 Policies regarding Waste Management

A robust policy framework put in place by individuals and local authorities is essential to an effective SWM structure driven by the circular economy. This structure places a strong emphasis on infrastructure development, law enforcement, awareness raising, and institution setup. Serving waste management states like Germany, which implemented policies advocating waste reduction and recovery, can teach developing and underdeveloped nations a lot (Wilson, 2023). As demonstrated by Latin American nations that emphasize public sector engagement, public involvement is essential for efficient waste management (Félix-López et al., 2023). Under these arrangements, the government acts as if it were a business, seeking to maximize profits at the expense of preserving the environment and the welfare of the populace. Due to energy scarcity, European nations have reduced the amount of waste sent to treatment plants by using waste as a source of energy. Waste recovery is Portugal's top priority, as evidenced by Decree Law No. 178/2006 (Dinis et al., 2023). Finland prioritizes resource-wise urban development to lessen its impact on the environment, while Germany has focused on sources of clean energy since the 1990s under its "Energiewende" policy. Finland's HINKU initiative seeks to improve both social and environmental health by reducing emissions by 80% by 2030 (Hirvilammi et al., 2023). Technological developments are essential to solid waste management because they make sustainable and affordable solutions possible. Achieving sustainable development goals requires policies to keep up with technological advancements.

### 4.2 Waste reuse and Recycle

Sorting and segregating waste is an essential step in categorizing waste according to how it will be treated in the end. A number of factors, including its potential for reuse, waste can be sent to a landfill, treatment facility, or recycling plant after it has been sorted. Prioritizing recycling and waste reuse is crucial for resource conservation and environmental protection on a global scale (Cudjoe et al., 2021). By lowering the demand for virgin resources in the production of commodities, reusing items like metals, plastics, and paper helps protect natural resources and improve environmental health (Tang et al., 2020). According to Nevrlý and Smejkalov (2021), achieving "zero-waste" can be facilitated by optimizing recycling rates, and continuous research and innovation endeavors to introduce circularity into the economy. Concrete blocks can be made from a variety of recycled solid waste components, including recovered

concrete, crushed brick, and waste glass (Luhar et al., 2019). A nation's income level and the extent of its recycling practices are frequently correlated (Moroke et al., 2019). Compared to middle-class and lower-class countries, high-income countries usually have more developed waste management systems, which results in higher recycling rates (Ferronato et al., 2019). On the other hand, inefficient collection systems, weak waste management programs, and low levels of public awareness impede recycling initiatives in middle-class and lower-income nations (Munir et al., 2021). Because of laws that restrict landfill disposal, allow private companies to participate in waste collection, and impose fines on non-recycled waste, Germany, Austria, South Korea, Wales, and Switzerland have some of the highest recycling rates in the world (Gray, 2017). Waste must be collected, sorted, recycled, treated, and disposed of as part of an efficient municipal solid waste (MSW) management system (Cohen et al., 2021). Every step is important, and if any are inefficient, the system as a whole could be compromised. Natural resource exploitation is a common pressure on developing nations to meet waste management requirements and raise living standards. In order to address these issues and put suitable waste management strategies into practice, effective policymaking and governance are essential (Bui et al., 2022). To meet waste management targets and advance sustainability, recycling units must be integrated into waste management systems. In order to have the desired effect on waste management systems, public-private partnerships are essential (Cheng et al., 2023).

### 4.3 Waste dealing ability and Recovery

The efficient functioning of a circular economy (CE) depends on reducing waste capacity and disposing of waste properly. In the past, landfilling was the most common way to dispose of waste, which resulted in the buildup of massive waste mountains in many urban areas and serious health and environmental risks (Liu and Liu, 2021). Growing environmental consciousness has led to the development of a variety of waste disposal techniques, which can be broadly categorized into two categories: thermo-chemical methods (which include incineration, gasification, and pyrolysis) and biochemical methods (which include anaerobic digestion and composting) (Li et al., 2016). Decomposing organic matter, especially food waste, makes up the majority of the Organic Part of MSW (OFMSW), which accounts for 40–70% of all MSW generated worldwide (Ali et al., 2017). Even though biochemical methods are good at reducing waste volume, they can take a long time—25 to 40 days—to treat waste, mostly organic material. On the other hand, they simplify waste management by providing flexibility in the periodic addition of raw materials (Nanda and Berruti, 2021). In contrast, thermo-chemical procedures entail a significant amount of heat, energy and can route waste at temperatures between 350 and 1500 °C more quickly than biochemical techniques. These procedures have the potential to reduce waste volume by 75–90%, but they frequently cause environmental problems by releasing pollutants like dioxins, furans, NOx, SOx, and PAHs (Munir et al., 2021; Kumar and Samadder, 2017). By changing the operating conditions and process parameters, efforts are being made to reduce these emissions (Upadhyay et al., 2019). Due to the oxygen-starved environment needed, pyrolysis provides a solution to emissions like NOx, SOx, PAHs, and dioxins; however, it also produces contaminants like toxic metals and nitrogen (Sipra et al., 2018; Hasan et al., 2021). In order to maximize waste management while reducing environmental impact, research projects investigate a variety of waste handling procedures, such as pyrolysis, gasification, composting and anaerobic digestion, (Sondh et al., 2024). Waste disposal techniques can be improved and made more ecologically friendly and efficient through continuous innovation and improvement, which will aid in the shift to a sustainable and circular economy.




**Figure-2.** An illustration comparing the technical characteristics of different waste treatment techniques, including composting, anaerobic digestion, gasification, incineration, pyrolysis, and landfills.

**Source:** (Sondh et al., 2024).

## 5. Municipal Solid Waste Management focused on a Circular Economy.

According to Mhatre et al. (2021), in order to promote sustainability objectives in a country, circular economy (CE) models and policies ought to be incorporated into MSW management teams. The Fernandes et al., (2023), defined sustainability in 1987 as meeting current needs without jeopardizing upcoming cohorts' ability to encounter individual. The foundation for attaining sustainability in MSW management systems is the CE framework, which is based on three main pillars: environmental health (Environmental Aspects), social upliftment (Social Aspects), and economic development (Techno-Economic Aspects) (Gadaleta et al., 2022). The realization of sustainability necessitates the strong support of all three pillars. To create a dependable and effective framework, policymakers must work together in concert. Sustainable development initiatives within a country or region can be supported by a workable framework that places a high priority on a robust environment, society, and economy. As Fig. 4 shows, each of these elements adds unique characteristics to the CE.

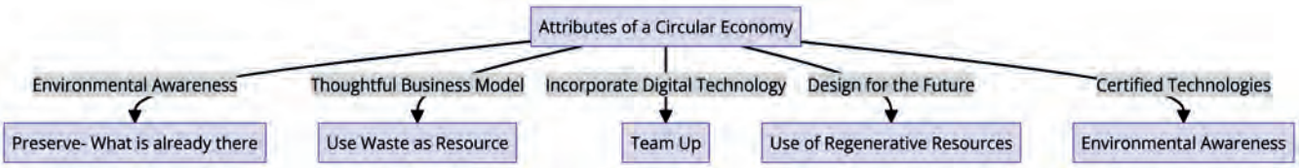


**Figure-3.** Attribute of a circular economy supporting SWM system involving economic, social and Environmental aspects
**Source:** Authors own idea

### 5.1 Economical aspect

Key components in demonstrating a business's sustainability efforts are the sharing and handling of product specifics, the possibilities for reuse, and the recycling procedures. Effective methods for sustainability are essential for the long-term health of a business, claim Leising et al. (2018). Nishitani et al. (2022), suggested, Material Flow Cost Accounting (MFCA) as a way to improve material efficiency and lessen the detrimental effects of resource exploiting by lowering production costs. According to Lassi (2020), growth in the economy is sustainable if it maintains or increases social welfare compared to its current levels in the future. This highlights the significance of resource ecological preservation and recycling in business models. Waste-to-Energy (WtE) facilities, which exclusively use non-recyclable waste to optimize the advantages of the (CE) paradigm, have a substantial impact on economic dynamics. According to the World Banking Group (Kaza et al., 2018), thermal incineration—a technique with a significant commercial presence worldwide—processes about 11% of municipal solid waste (MSW). Subsidies from the government for garbage removal, electricity and heat sales, and slag revenue support WtE incineration plants, which have high initial investment requirements but offer stable, substantial profits and low operating costs (Xin-gang et al., 2016). Numerous elements, including plant size, waste type, lifecycle, and operational availability, affect a WtE facility's development cost (Santosos et al., 2019). These prices vary across countries, which reflects disparities in resource availability and technological preparedness. Wu (2018) observes that WtE developments in China are significantly more expensive than those in the U.S. and Europe. Variations are also observed in Ethiopia, Vietnam, and Sri Lanka (Daily, 2017; Wu, 2018). With significant revenue from the generation of electricity in places like China (70–85%), WtE plants typically see an exciting ascend on investments (RoI) of 18–25%.

Economically, the (CE) is propelled by a dedication to environmentally sustainable company strategies and standards. This strategy places a focus on creating fresh supplies from utilized content and effectively managing the resources that are already available. Business ethics, which concentrate on proper behavior and procedures to ensure wider success, play a critical role in steering decisions towards economic recurrence.

### 5.2 Social aspect

By focusing on engagement with the community, equal opportunity, and improved public health, the circular economy encompasses essential social dimensions that improve solid waste management. In addition to reducing waste, initiatives that support recycling and repurposing materials also open up job opportunities, especially in areas with low incomes where jobs in waste gathering and processing can boost the local economy (Morais et al., 2022). By encouraging a culture of environmental responsibility and improving community involvement in sustainable practices, educational initiatives play a crucial role (Repp et al., 2021). Additionally, implementing circular economy waste management techniques can result in less pollution, cleaner cities, and improved community health (Dinca et al., 2022). Residents, companies, and governments must work together to implement this strategy, which will strengthen community ties and increase everyone's commitment to sustainability.

### 5.3 Environmental aspects

The circular economy (CE) framework incorporates ecological factors into solid waste management by encouraging material reduction, reuse, and recycling, resulting in reduced production of trash and worsening of the environment (De melo et al., 2022). In this paradigm, waste is viewed as an asset that can be constantly recycled back into production processes, rather than an end product (Kurniawan et al., 2021). This approach reduces dependability on virgin commodities, greenhouse gas emissions, and energy consumption, all of which contribute to a reduction in industrial activities' overall environmental footprint. The CE seeks to strike a balance between economic development and environmental sustainability by focusing on ecosystem restoration and regeneration through adheres to such as material recuperation and the secure return of biological substances to the environment (Vence et al., 2021). Furthermore, it promotes preservation of biodiversity and decreases pressure on landfills, which aligns with worldwide sustainability goals aimed at mitigating climate change and improving environmental health.

### 5.4 Key inputs of Circular Economy for Sustainable development

A circular economy (CE) can achieve success when implemented across various societal levels. Large-scale industries and well-known brands can facilitate this shift by serving as exemplary models for those transitioning from a linear to a circular economy.

The diagram illustrates a conceptual model for a Circular Economy (CE), which is intertwined with sustainable development principles and the management of solid waste. Central to this model is the CE's objective to enhance resource efficiency and reduce waste by adopting regenerative practices that promote the reuse, repair, refurbishment, and recycling of products and materials.

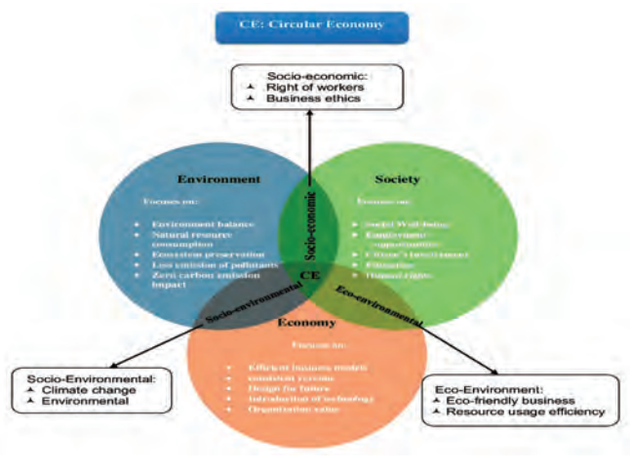


**Figure.4:** The three fundamental pillars of the circular economy encompass social, environmental, and economic dimensions

**Source:** Authors own idea

The model outlines how CE interacts with socio-economic, eco-environmental, and socio-environmental aspects. In the realm of sustainable development, the economic dimension is centered on adopting efficient business models and technologies that foster a closed-loop system, crucial for decreasing solid waste quantities and enhancing their management. The social dimension highlights the generation of job opportunities and overall well-being, which involves creating positions in the waste management industry and fostering education about recycling and reuse. From an environmental standpoint, CE advocates for the preservation of natural resources and strives to achieve zero carbon emissions, in line with practices that reduce environmental pollution. The socio-environmental perspective considers wider issues such as climate change and environmental justice, promoting a fair distribution of the environmental advantages and challenges associated with waste management. Collectively, the diagram conveys how the circular economy framework is inherently connected to achieving sustainable development goals, especially in optimizing the management of solid waste to realize economic, social, and environmental gains.

### 5.5 Practical outcomes of this analysis

The existing solid waste management framework is currently inadequate for addressing the prevalent challenges in waste processing. Efforts to overhaul this system have been ongoing for more than ten years. Various solutions have been proposed by scientists and relevant authorities. A Circular Economy (CE) approach to solid waste management holds significant promise for addressing issues related to climate change, energy consumption, prolonged use of materials, and social welfare. Supported by robust strategies and efficient policies, this system could facilitate smoother operations. Transitioning from a linear to a closed-loop economic model enhances the potential for economic growth with stability as a key aspect. Moreover, reusing materials within this system can alleviate environmental stress. Implementing a CE approach in solid waste management could enforce a zero-waste policy, thereby fostering sustainability within the waste management sector.

## 6. Conclusion and Policy recommendation:

Adopting a circular economy model in solid waste management is essential for sustaining progress in the context of increasing waste dilemmas. This study underscores the importance of integrating economic, social, and environmental approaches to improve the efficiency and effectiveness of waste management systems. Embracing circular economy principles such as reduction, reuse, recycling, and recovery allows local governments to lessen environmental degradation and conserve resources. The research advocates for strong policy frameworks and innovative technologies to support the implementation of these principles. In essence, a circular economy-based approach in SWM not only aids in achieving sustainable development but also creates a resilient infrastructure capable of addressing future environmental predicaments and meeting community demands.

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Abdul Rasool Khoso conceived the research idea, designed the study protocol, and supervised data collection and analysis.

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## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

The authors confirm being the sole contributor of this work and have approved it for publication.

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No potential conflict of interest was reported by the author (s)

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This Special Issue of the International Journal of Humanities and Social Development Research (IJHSDR) is dedicated to the 29th Conference of the Parties (COP29) to the UN Framework Convention on Climate Change held in Baku, Azerbaijan, from 11 to 22 November 2024.

We are deeply honored and thankful that the Guest Editors for this Special Issue on Global Strategy for Sustainable Development: Innovation, Modelling, and Alliances have accepted our invitation to organize it and have been able to compile the articles for this issue. They have done an excellent job of including a wide variety of perspectives in helping to move the field forward. It is a pleasure to recognize several key professionals who have served in various capacities for IJHSDR. We are proud to say that we achieved this goal.

We take this opportunity to also express our heartfelt thanks to all organizers, authors and reviewers who contributed to this issue. Wishing you the best of luck in all your future endeavors.

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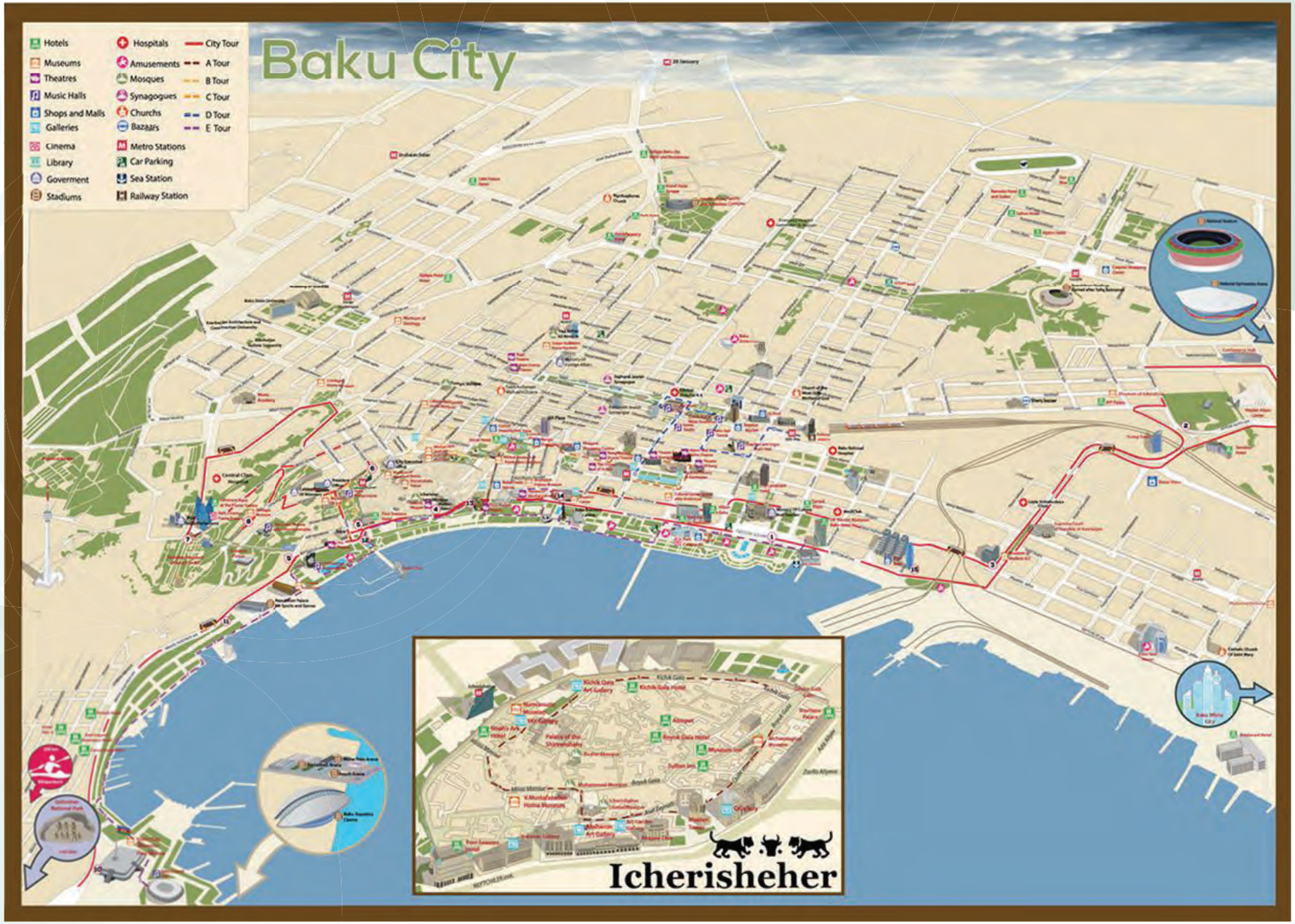
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