On the Carbon Neutral Policies and Low Emission Scenarios Of the Republic of Azerbaijan

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DOI: 10.22178/pos.126-20

LCC Subject Category: L7-991

Received 27.12.2025
Accepted 27.01.2026
Published online 31.01.2026

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Abstract. The paper is devoted to the study of carbon-neutral pathways in the Republic of Azerbaijan, the national context of climate change combat, and environmental security issues. It analyses low-emission greenhouse gas (GHG) development scenarios for the Republic of Azerbaijan in the XXI century and optimal pathways for the country's transition to a green economy. Since § 19 of Article 4 of the Paris Agreement defines a task for each country-Party of the Agreement, to formulate and communicate long-term low greenhouse gas emission development strategies (LT-LEDS), preparation of such a strategy is of high priority for each Party of the Agreement. Given the significant share of energy-sector emissions in Azerbaijan's total emissions, the paper focuses mainly on the energy and environmental characteristics of the decarbonisation scenarios in Azerbaijan.

Keywords: climate change; carbon neutral pathway; mitigation measure; greenhouse gases (GHG); sustainable development; renewable energy; GHG inventory.

INTRODUCTION

The XXI century witnesses unprecedented global change in search of affordable, scalable solutions to reduce dependence on fossil fuels, with serious consequences for the environment and climate. The World Meteorological Organisation (WMO) has confirmed that 2024 is the warmest year on record [1]. Since the global average surface temperature was 1.55°C (with a margin of uncertainty of ± 0.13 °C) above the 1850-1900 average, according to WMO's consolidated analysis of the six datasets. According to reliable climate models, without significant climate action, the world is headed for a temperature rise of 2°C to 2.9°C above pre-industrial levels this century, which is well above the safety limits established by scientists [2]. In the last 50 years, the number of recorded climate disasters has increased fivefold, and economic losses have increased sevenfold. Like the availability of land, minerals, water, etc., carbon emission capacity is one of the scarcest elements of natural resources. Research evidence shows that if effective policies and actions are not taken immediately, there will be an irreversible global ecological catastrophe and massive economic losses, with the total cost of inaction exceeding $1,266 trillion from 2025 to 2100. Developing countries urgently need to implement comprehensive and practical climate actions because they are already experiencing the negative impacts of climate change, driven by geographical and climatic conditions, high dependence on natural resources, and limited adaptive capacity.

Regarding the term "environmental security, in 1987, a UN sub-organisation – The World Commission on Environment and Development (WCED, also known as the Brundtland Commission) published the report "Our Common Future" that launched the concept of sustainable development and for the first time introduced globally the term "environmental security" [3].

Nowadays, the environmental security concept is a pivotal component of international environmental policy, as more countries have adopted a new development pathway to understand and effectively implement their environmental policies, including climate change resilience. A series of dedicated conferences followed on the eve of the new millennium: the International Conference on Environmental Security and Sustainable Development in Moscow in 1997 and in Paris in 2002, aimed at drawing the international community's attention to preserving biodiversity and

ensuring environmental safety as key priorities of environmental policy.

Actually, the main global environmental problems are air and water pollution, water quality, biodiversity and climate change. To effectively respond to the various global and regional ecological security challenges, almost all countries, international organisations, and leading scientific centres of the world call for concentrated global cooperation between governments, international organisations, and stress the importance of collaboration between all stakeholders at all levels, broader involvement of the private sector, non-governmental organisations, etc. All these activities further strengthen the role of environmental diplomacy in modern international relations.

Among global environmental problems, climate change is the most challenging and will require rapid, effective international action. The Intergovernmental Panel on Climate Change (IPCC), which has proven itself a serious scientific platform responsible for advancing the UN science base in the relevant field, already predicted that this process would lead to a global disaster if global warming exceeded 1.5°C relative to pre-industrial levels.

It is known that the consistent rise of average temperature is mainly due to anthropogenic factors [3–5]. The greenhouse gases are water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases (HFCs, PFCs, NF_3, SF_6). As a result of anthropogenic activity, the volume of carbon dioxide, methane, nitrogen oxides, and fluorinated gases with high heat-generating potential has been increasing since industrial times, and their carbon gas equivalents are used as units of measurement to calculate the volumes of all these gases [6]. Joseph Fourier first described the mechanism by which these gases produce a thermal effect in 1827, based on research using appropriate calculation methods.

Observations over the recent decades have shown that, as a result of global climatic changes, storms, mudflows, blizzards, floods, warm winds, hurricanes, and precipitation are increasing in scale and intensity across various regions of the globe; this is evidenced by large-scale forest fires in 2021-2024 across the EU, Turkey, Russia, the USA, and other countries, as well as by heavy rains and floods in the EU, Pakistan, and eastern Turkey over the last few years. It is no coincidence that the 6th Assessment Report (AR6) by the Intergovernmental Panel on Climate Change (IPCC) emphasised that in the XXI century, the average annual temperature worldwide could rise by at least 3°C if states do not take concerted action to reduce emissions. This report is clear: if the international community does not take serious, practical measures to reduce greenhouse gas emissions, humanity will move from a 4°C to a 5°C temperature rise, which could result in an apocalypse [7]. Here are some parts of this report, describing the Possible Climate Perspectives:

a) The global surface temperature will continue to rise, at least until the middle of the century, taking into account all emission scenarios. In the absence of significant reductions in carbon dioxide (CO_2) and other greenhouse gas emissions in the coming decades, global warming in the 21st century will exceed 1.5°C and 2°C;

b) Many changes in the climate system are now intensifying in direct connection with the increase in global warming. These changes include an increase in the frequency and intensity of extremely hot days, sea heat, and heavy rainfall; agricultural and environmental droughts in some areas; and an increase in intense tropical cyclones, a decrease in Arctic sea ice, snow cover, and permafrost.

c) Ongoing global warming is expected to strengthen further global water circulation, including the intensity of global monsoon rains, floods and droughts.

RESULTS AND DISCUSSION

The report mentioned that emissions of greenhouse gases from burning fossil fuels, deforestation, and other human activities can disrupt the environmental security of our civilisation. Carbon dioxide levels in the air are currently at their highest level for at least the last 2 million years.

Moreover, the report predicted the most significant, drastic, and irreversible changes in Earth's systems, which could have dire consequences and are of greater concern to scientists. In terms of physical research, the report recommends reducing CO_2 and other greenhouse gas emissions to zero in the near future as an effective way to mitigate global warming driven by anthropogenic activities [3, 5, 8]. Actually, scientists' calculations show that since 1850, due to anthropogenic activities, 2.400 billion tons of CO_2-equivalent greenhouse gases have been emitted worldwide,

and they have remained in the atmosphere for hundreds of years, creating a cumulative warming effect. In such a situation, scientists have calculated that if only an additional 400 billion tons of CO_2 equivalent greenhouse gases are released into the atmosphere, the probability of keeping the average annual temperature rise at 1.5°C will be only 66% [9]. Given that about 50 billion tons of CO_2-equivalent greenhouse gases are emitted into the atmosphere globally each year, it is essential to assess the severity of this problem and address it urgently to combat global warming [9]. Global annual emissions amounted to about 35 billion tons of CO_2 equivalent in 1990 and have continued to rise steadily since then. To limit global warming to 1.5°C, the IPCC states that countries must halve global greenhouse gas emissions by 2030 and achieve net-zero emissions by 2050 [10].

In light of the global climate change efforts, UNFCCC (United Nations Framework Convention on Climate Change), as an effective international mechanism, as well as other climate change related treaties - the Kyoto Protocol and Paris Agreement embedded international norms aiming to stabilise GHG concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system, in a time frame which allows ecosystems to adapt naturally and enables sustainable development [11]. It's namely the Paris Agreement that set out a global framework to avoid dangerous climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C. It also aims to strengthen countries' ability to address the impacts of climate change and to support their efforts. Regarding these efforts, the Nationally Determined Contribution (NDC) is the pivotal document for each country-Party to the Paris Agreement, in which each country must declare a target for reducing its national emissions and for adapting to the impacts of climate change [12]. According to Article 4, § 2, each Party is required to prepare, communicate and maintain successive Nationally Determined Contributions (NDCs) documents that it intends to achieve. Parties shall pursue domestic mitigation measures to achieve the objectives of such contributions.

Moreover, under Article 4, § 19, of the Paris Agreement, Parties should strive to formulate and communicate long-term low-emission, low greenhouse gas development strategies (LT-LEDS). Taking this norm into consideration, Parties are invited to communicate these strategies to the Secretariat of the UNFCCC by 2020, in accordance with clause 35 of decision 1/CP 21 of the UNFCCC [12]. Actually, long-term low-emissions development strategies (LT-LEDS) are a crucial policy tool that can help place short-term actions in the context of the long-term structural changes required to transition to a low-carbon, climate-resilient economy by 2050. Besides that, they can help explore the consequences of policy choices for integrated socio-economic objectives [13]. LT-LEDS should be mainstreamed into the national policy process and serve as a valuable framework for structuring national policy debates in a transparent, productive, and ambitious manner.

Another critical article of the Paris Agreement is Article 13, which establishes an Enhanced Transparency Framework (ETF) designed to build trust and confidence that all countries are contributing their share to global efforts. In fact, the Katowice Conference of the Parties to the UNFCCC (COP24) held in 2018 outlined a new framework for all countries by adopting a detailed set of modalities, procedures, and guidelines (MPGs) to operationalise it. Through detailed guidance on the reporting / review / consideration processes for the information to be submitted, and by making these reports publicly available, the ETF will enable tracking of progress made by each country–Party of PA. In this way, it will be possible to compare a country's actions against its plans and ambitions as described in its NDCs. Upon adopting the ETF format, the Parties agreed at the CMA.3 (Conference of Parties during the COP26 in Glasgow) to provide standard reporting tables for national GHG inventories; common tabular formats (CTF) for tracking progress towards NDCs and climate finance, technology transfer and capacity building; outlines of the Biennial Transparency Report (BTR), national inventory document and technical expert review report; and a training programme for the technical review experts [14].

Actually, all developed countries, and not only they, have been consolidating to accelerate the twin green and digital transitions and the associated transformations of their economies, industries, and societies, with a view to achieving climate neutrality by 2050; this encompasses the transition to greenhouse gas neutrality of the energy and mobility sectors by 2050 at the latest, while boosting their competitiveness, resilience, and utility for citizens and society. For example, the European Climate Law requires the EU econ-

omy and society to become climate-neutral by 2050 in a socially fair and cost-efficient manner and, as an intermediate target, to reduce net greenhouse gas emissions by at least 55% by 2030 (compared to 1990 levels) [15]. In this regard, despite the ongoing turbulence in the EU energy market due to sanctions against Russia for its war in Ukraine, EU countries and some other developed countries have been at the forefront of climate science. They committed to continue delivering knowledge to enable efficient long-term decarbonisation pathways and transitions to climate neutrality. The proper and efficient transition to climate neutrality comprises various sectoral decarbonisation pathways, including rural and, particularly, urban resilience scenarios. It's no coincidence that among the COP27 Presidency (7-18 November 2022, Sharm el-Sheikh, Egypt) initiatives, one of the most remarkable, in terms of GHG reduction and climate change adaptation, and SDGs implementation, was Sustainable Urban Resilience for the next Generation (SURGE). Thus, contributing to building sustainable, inclusive and resilient urban systems, the work of the SURGe Initiative is guided by the following overarching ten principles:

Low-carbon: reducing emissions and benefiting from cost savings from decreased energy use and improved energy and resource efficiency;

Resilient: strengthening the capacity of city systems and their inhabitants to maintain continuity through shocks and stresses and recover faster, while positively adapting and transforming towards urban sustainability, taking into account the management of internal and international migration into cities.

Nature-positive: Harnessing the potential of Nature-Based Solutions (NBS) to improve cities' socio-ecological resilience and wellbeing;

Fair, equitable, and inclusive: needs to reach the most vulnerable communities to climate change impacts by establishing social dialogue and participatory processes for co-design and prioritised implementation;

Multi-level climate governance and climate planning: recognising the importance of collaboration between local, regional, and national governments and harnessing the cross-scale and cross-disciplinary relationships necessary for climate action to raise the ambitions of the NDCS;

Integrated: Leveraging co-benefits of investment in adaptation and mitigation measures while building on existing support, initiatives, and partnerships to leverage their impact and lessons learned;

Locally-led and culture-positive: Customise approaches depending on local contexts of new, rapidly developing cities, while recognising that culture and heritage represent both an asset to be protected from climate impacts and a resource to strengthen the ability of communities to pursue transformative change;

Circular: promoting a circular value chain in buildings and construction, as well as in supply and disposal infrastructure systems, aiming to drastically reduce emissions and waste, while promoting innovation, affordability, ensuring food security, energy efficiency, and local development.

Financing-enabling: centred on capacity building, technology transfer, enabling frameworks and delivering solutions to support and enhance existing and innovative finance channels and mobilising finance at scale while accelerating access for local and regional governments;

Health-promoting: recognising the importance of health and wellbeing as an input to resilience, the power of health arguments to motivate change, and the significant economic and social co-benefits available from health-aware climate action.

Passing to the regional context of environmental security in terms of climate change impacts, one of the most vulnerable regions in the world in this regard is the South Caucasus, which is linked to its physical and geographical position. Severe negative impacts of climatic changes in the region include increasing aridity, fluctuations in the Caspian Sea level, and more frequent extreme weather events (e.g., severe droughts, floods, and hailstorms), making almost all economic sectors climate-sensitive. Nowadays, most countries in the region are already experiencing rising temperatures, increasing water scarcity, more frequent droughts and forest fires, and accelerating desertification. In particular, the climate-sensitive economic sector in the region is agriculture, and this problem necessitates global and regional cooperation to implement effective mitigation and adaptation measures, given regional food security and the fact that the majority of the region's population depends heavily on the agriculture sector for their livelihoods.

In this region, Azerbaijan is particularly vulnerable to the impacts of climate change. According to weekly drought monitoring data from NASA's GRACE satellites, the country has been experiencing a severe drought across underground water and terrestrial humidity. Moreover, according to the UNDP report on climate change impact projections, due to drought caused by climate change over the period 2021-2050, the country's water supply will decrease by 23% [16]. In April 2022, "Azercosmos" OJSC prepared and submitted to the government an assessment report, "Impact of global climate change on the Republic of Azerbaijan", which presents a satellite-based assessment of climate change impacts. The report evaluates the effectiveness of climate change measures by monitoring the effects of mitigation and adaptation measures using high-frequency satellite imagery from the "Azersky" satellite. The main results of the satellite monitoring confirm the scale of the predicted processes associated with climate change. These results could be summarised as follows:

1) In the winter season of the years 2017-2021, up to 30% of field reductions were recorded in snow drifts;

2) According to the results of monitoring the mirror surface of water bodies over the past 5 years, there has been a decrease by 4.3%, and throughout the country by 2%. However, the area has increased by 7-10% compared to 2021.

3) Based on an analysis of satellite imagery, researchers observed a decrease in the Kura River's water surface area. They found that over the past two years, the river's width has narrowed by 40–60 meters in some sections. As the river's water level declined, researchers recorded seawater intrusion into the Kura River near the village of Arabgardashbeyli in the Salyan district, located 45 km from the sea.

4) Compared to the last 20 years, dry areas have increased, and by 2021, the territories being subjected to a very severe drought have grown by 15%.

5) Based on data processing over the past 20 years, 6% more areas with a high risk of drought have been identified in the country [16].

Actually, all these climate change impacts could seriously undermine progress that has been made in the socio-economic and environmental activities of Azerbaijan during last 30 years, if the country will not timely implement effective climate change mitigation and adaptation measures, elaborate and proceed low emission and climate resilient development pathway including transition to the green economy, as it requires contemporary global environmental security standards [5, 17].

Acknowledging global climate change challenges, Azerbaijan has already outlined clean environment and green growth as a priority among five national priorities in the "Azerbaijan 2030: National Priorities for Socio-Economic Development" document, approved by the relevant Order of the President of the Republic of Azerbaijan issued on February 2, 2021. This strategic document was adopted to meet the national commitments to the United Nations' 2030 Agenda for Sustainable Development, as well as the Paris Climate Agreement and consists of the following priorities:

a) sustainably growing competitive economy;

b) society based on dynamic, inclusive and social justice;

c) competitive human capital and modern innovations space;

d) great return to territories liberated from occupation; and

e) clean environment and "green growth" country [18].

Realisation of the last priority necessitates clear understanding and analysis of all effective strategies, policies, measures, scenarios of climate resilience, decarbonisation prospective and the mentioned monograph of the author - "Low emission development outlook and its role in the environmental security system of the Republic of Azerbaijan" is an attempt towards detailed analysis of the long-term low GHG emission development scenarios, their classification in terms of GHG reduction potential and effectiveness in terms of SDG implementation, as well as their role in the environmental security of the country.

By the way, "Azerbaijan 2030: National Priorities for Socio-Economic Development" outlined a new target to double Azerbaijan's GDP by 2030 under a new 10-year development plan, which requires an average annual growth rate of 7% [19].

It's remarkable that, from the very beginning of the implementation of the Sustainable Development Goals, they have become of high importance for Azerbaijan [20]. Actually, the country is among the few countries worldwide and

the first in the South Caucasus region to have submitted its third Voluntary National Report (VNR) on the implementation of the 2030 Agenda [21]. Scoring 72.4 out of 100 points possible on the SDG achievement index, Azerbaijan ranks 55th out of 165 countries in the 2021 Sustainable Development Report, with the best result in the region. These reports highlight Azerbaijan's progress in areas such as poverty reduction, healthcare, nutrition, women's labour force participation, clean water and sanitation, access to energy, internet usage, conservation of threatened species, and improvements in population welfare and the sustainable development of cities and communities. Azerbaijan, along with crude oil and natural gas, has recently become an electricity exporter. Today, the country exports electricity to 4 neighbouring countries. In the meantime, the actual domestic electricity consumption level tends to rise due to population growth and economic development.

Let's recall, in chronological order, the main steps the country has taken in climate change cooperation. After joining the United Nations Framework Convention on Climate Change (UNFCCC) in 1995, in 1997 the late president Heydar Aliyev, taking into account the urgency of the problem related to climate change, issued Decree No. 560 dated April 30, 1997 "On measures to ensure the implementation of the commitments made by the Republic of Azerbaijan in accordance with the United Nations Framework Convention on Climate Change, approved by the Republic of Azerbaijan on January 10, 1995" establishing the State Commission on Climate Change in the country. On 11.03.2020, by Decree of the President of the Republic of Azerbaijan, Ilham Aliyev, a new composition of the State Commission was determined [22]. The establishment of this State Commission, under the chairmanship of the Deputy Prime Minister of the Republic of Azerbaijan, strengthened consistent institutional and legislative efforts to combat climate change in Azerbaijan. Thus, a special Working Group comprising specialists and experts from state bodies was formed to organise and facilitate the commission's work. Therefore, along with the Ministry of Environment and Natural Resources, relevant specialists from the Ministries of Economy, Energy, and Agriculture, the State Statistics Committee of the Republic of Azerbaijan, and other state bodies were involved in the Working Group. On July 23, 2020, the State Commission held its first meeting and adopted several important decisions. The Government of the Republic of Azerbaijan designated the Ministry of Ecology and Natural Resources (MENR) as the responsible and coordinating body to regularly inform the commission of relevant activities. Over the past period, the Republic of Azerbaijan has prepared and submitted its First National Communication (NC) (2000), Second National Communication (2010) and Third National Communication (2015), as well as its First Biennial Updated Report (BUR) (2014), Second Biennial Updated Report (2018) to the Convention Secretariat. The last, the Fourth National Communication, was officially submitted to the secretariat in 2021 and its first BTR in 2024 [23]. The country submitted its INDC (Intended Nationally Determined Contributions) document on 19.01.2017, in which it officially set a target of a 35% reduction in GHG emissions by 2030 compared with the base year (1990), taking into account national circumstances, development priorities, and interests. The NDC2 for Azerbaijan revised its commitment to a 40% reduction in emissions by 2050, compared to 1990 levels, conditional on international support [24]. The sectors identified for mitigation measures include energy, industrial processes and product use, agriculture, land use, land use change and forestry, and waste. At last, NDC3 Azerbaijan enhanced its previous commitment to a 40% reduction in emissions by 2035 compared to 1990 levels, but shifted the unconditional target to a conditional one [25].

As it mentioned above, the actual paper contains some updated results of the author from [5] on the greenhouse gas (GHG) emission pathways, i.e. scenarios (projections) in Azerbaijan for the following decades, taking into account the current NDC targets, on the base qualitative analyses, using of the extraordinary LEAP (Low Emissions Analysis Platform) modelling technique for evaluation of the emission reduction effects of the relevant mitigation policies and measures [26]. Each scenario is based on mitigation policies, measures, and assumptions in the relevant sectors (corresponding to the 2006 IPCC Guidelines and AR4 emission factors [27]) for reaching the net-zero emission target. Moreover, the study will analyse the mentioned scenarios in terms of their role in the country's environmental security.

To conduct a comparative analysis of all these GHG emissions development options, three GHG emission development scenarios will be presented: Business as Usual (BAU) Scenario, Realistic

Low Emission Development Scenario (RLEDS), and Best Low Emission Development Scenario (BLEDS). Let's bring some definitions of these development scenarios:

The Business as Usual (BAU) Scenario is a projection of the level of GHG emissions that would result if future development trends follow past trends and no changes to climate change mitigation policies and measures occur. The scenario assumes that governments implement no climate change strategies, policies, or measures and introduce no green transition–related changes in technology, economics, or other areas. The Business as Usual (BAU) Scenario is later used as a benchmark for the scenarios below and for separate mitigation policies and measures, to assess their GHG-reduction potential and effects qualitatively [5]. Here below in the paper, to evaluate the GHG emissions reduction of mitigation actions or their overall total effects within the Realistic Low Emission Development Scenario (RLEDS) or within the Best Low Emission Development Scenario (RLEDS), we'll provide a comparative analysis of each mitigation action vis-à-vis the BAU Scenario based on LEAP calculations. Hence, the BAU Scenario serves as a benchmark for our modelling analysis and is elaborated based on official statistical and other available data from past years. That's why, for the years following the first scenario, the BAU Scenario corresponds to development under existing conditions, without implementing any mitigation policies or measures.

Here's the LEAP projection of the BAU Scenario, taking into account long-term assumptions on the national economy development:

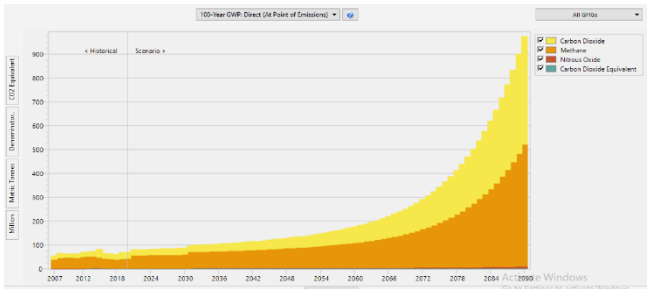

Figure 1 – GHG emissions projection in the BAU Scenario, LEAP

As shown in Figure 1, under the BAU scenario, GHG emissions will reach 87.9, 134.9, and 974.1 million tons of CO_2 equivalent (including removals) in 2030, 2050, and 2095, respectively. The scenario assumes that there are neither abatement policies nor significant changes in technology, green economic transition, or climate change policies, so that normal circumstances can be expected to continue unchanged.

The Realistic Low Emission Development Scenario (RLEDS) projects greenhouse gas (GHG) emissions for individual sectors or the entire economy, depending on the underlying assumptions. The scenario accounts for all mitigation policies and measures that authorities have formally adopted and financed and that remain effective or under implementation (classified as a With Measures (WM) scenario under the definitions of the 2006 IPCC Guidelines [28]). It also includes mitigation measures that authorities have not yet formally adopted or financed, but have agreed to implement to meet national emission-reduction commitments (classified as a With Additional Measures (WAM) scenario). As defined, RLEDS in some or all sectors comprises both "with measures" (WM) and "with additional measures" (WAM) scenarios, corresponding to the relevant policies and measures. Here's the LEAP projection of this scenario, taking into account national circumstances and implemented mitigation actions, as described in detail in the above-mentioned monograph [4].

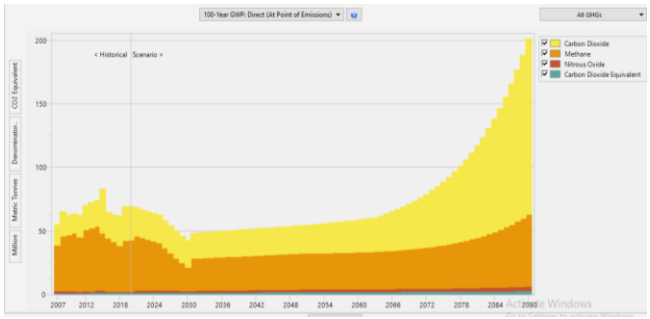

Figure 2 – GHG coverage projection within the RLED Scenario (LEAP model)

According to Figure 2, which describes the RLED Scenario, GHG emissions reach 42, 54.2, and 201.2 million tons of CO_2 equivalent (including removals) by 2030, 2050, and 2090, respectively, which are much lower than the BAU Scenario's relevant indicators in those years.

The Best Low Emission Development Scenario (RLEDS) is a projection of GHG emissions in one or more sectors, or across all industries, that accounts for all RLEDS mitigation policies and measures, with additional assumptions added to

reach a net-zero emission level by some year in the future. In fact, the scenario is based on the necessary conditions and assumptions for achieving net-zero emissions in the future. This scenario, in some sectors or across all industries (depending on the assumptions in place), should be considered the most needed and essential pathway for each country in light of the Paris Agreement and the aforementioned Conference of the Parties decisions.

By the way, the term "low-emission development" and the abbreviation "LEDS" (i.e., low-emission development strategy) first appeared in some documents of the United Nations Framework Convention on Climate Change (UNFCCC) in 2008 [29]. Despite this, the term "low-emission development" still lacks a formal definition; it's actually used broadly by specialists to describe forward-looking national economic development plans or strategies that encompass low-emission and/or climate-resilient economic growth. Such a strategy can add value to existing climate change and development-related roadmaps, strategic documents, and related materials.

Below, to be laconic and focus more on the country's decarbonisation scenario (i.e., the BLED Scenario), we'll provide a more detailed description of the LEAP calculations only for the Best Low Emission Development (BLED) Scenario.

Best Low Emission Development (BLED) Scenario. In this section, for brevity, we'll consider only mitigation strategies, policies, and actions related mainly to the Energy sector; all other mitigation actions are given in [5, 17].

Best Low Emission Development (BLED) Scenario includes all the mitigation policies and measures of the Realistic Low Emissions Development Scenario (RLEDS), in the Energy sector, which are as follows:

1) Reduction of Associated Petroleum Gas (APG) emissions in the oil production (mitigation measure, implemented by SOCAR);

2) Reduction of leakage in the gas distribution system via modernisation of the whole system (mitigation measure, implemented by "Azerigas" Production Association of SOCAR);

3) Oil and natural gas production. Flaring gas volume reduction within the Azeri-Chirag-Guneshli (ACG) project (mitigation action, being implemented by BP (Azerbaijan));

4) BP 10-year sustainable emissions reduction Plan;

5) BP South Caucasus Pipeline expansion (SCPX) offset project;

6) Oil and natural gas production Drilling process - Application of new technologies (implemented by SOCAR);

7) Oil refining production process optimisation action at Heydar Aliyev Oil Refinery (implemented by Heydar Aliyev Oil Refinery (SOCAR));

8) Electric power industry. Mitigation measures to improve energy efficiency in electricity generation (being implemented by "Azenerji" LLC). All actual mitigation measures in the field of the electric power industry could be grouped as follows:

1) Rehabilitation of obsolete power plants;

2) Construction of new stations with high energy efficiency;

3) Reconstruction of transmission and distribution networks;

4) Improve energy efficiency in the demand sector.

5) Construction of power plants based on renewable energy sources;

6) Improve tariff policy.

Besides the mentioned mitigation measures, let's additionally propose the following GHG reduction assumptions in the Energy sector within the Best Low Emission Development (BLED) Scenario:

1) Annual oil production reduction by 1% beginning from the first scenario year within the global trend of reduction of oil production;

2) Annual wood consumption decreases by 3% in the Commercial and Public sectors of the country beginning from the first scenario year.

3) Natural gas production reduction by 1% beginning from the first scenario year;

4) Natural gas leakages reduction up to 1% by 2050;

5) Annual gas consumption in the Household decreases by 1% from the first scenario year.

6) Annual decrease of motor gasoline consumption by 1% in the Household, Agriculture (Forestry, fishing) since the first scenario year;

7) Annual decrease by 5% of the thermal energy production and its gradual substitution by renewable energy production according to the relevant state programs;

As well as the following assumptions in the Transport sector:

1) Annual decrease by 5 % of the diesel consumption in the transport sector since the first scenario year;

2) Annual decrease by 2 % of motor gasoline consumption in the transport sector since the first scenario year;

3) Annual decrease by 1% of the LPG consumption in the transport sector since the first scenario year;

4) Annual decrease by 2% of the CNG consumption in the transport sector since 2030;

5) Completion of the electrification of the National Railroad System by 2030.

All these assumptions are quite feasible given the overarching policies and measures to green the economy (expanding the use of renewable energy sources, green hydrogen production, energy efficiency measures, climate-smart technologies, etc.) incorporated into the five national priorities outlined in "Azerbaijan 2030: National Priorities for Socio-Economic Development".

To measure the overall effect of mitigation policies and measures within the Best Low Emission Development Scenario (RLEDS) in the Energy sector, we'll provide a comparative analysis of GHG emissions reductions generated under the BLEDS and the BAU Scenario via LEAP modelling. For this purpose, all the above-mentioned assumptions and measures have been analysed and modelled in LEAP and included in the BLED Scenario.

Upon modelling all the mitigation measures and assumptions in all sectors, we'll get the following graph and table reflecting the GHG coverage of the GHG emissions within the BLED Scenario:

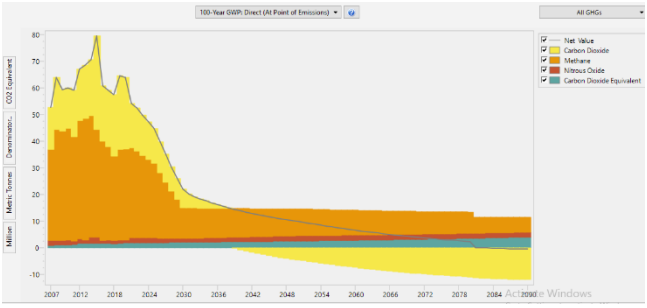

Figure 3 – GHG coverage projection within the BLED Scenario (LEAP model)

The tables corresponding to the mentioned Figure 3 is as follows:

GHG	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
CO2	16.7	16.3	15.2	14.1	13.1	11.8	10.5	9.3	8.1	7.0	5.2	4.3
CH4	33.8	32.5	31.0	29.5	28.1	24.5	21.0	17.7	14.6	11.7	11.5	11.4
N2O	2.0	2.0	1.9	1.8	1.8	1.7	1.6	1.6	1.5	1.4	1.4	1.5
CO2 eq.	1.8	1.8	1.8	1.8	1.9	1.9	1.9	1.9	2.0	2.0	2.0	2.0
TOTAL	54.3	52.5	49.9	47.3	44.7	39.8	35.1	30.5	26.1	22.0	20.1	19.2

GHG	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
CO2	3.5	2.8	2.1	0.5	0.9	0.3	-0.3	-0.8	-1.3	-1.8	-2.2	-2.6	-3.0
CH4	11.3	11.2	11.1	11.1	11.0	10.9	10.8	10.8	10.7	10.6	10.6	10.5	10.4
N2O	1.5	1.5	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.9
CO2 eq.	2.0	2.1	2.1	2.1	2.1	2.2	2.2	2.2	2.2	2.2	2.3	2.3	2.3
TOTAL	18.3	17.6	16.9	16.2	15.6	15.0	14.4	13.9	13.3	12.8	12.4	12.0	11.6

GHG	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058
CO2	-3.4	-3.8	-4.1	-4.4	-4.6	-5.0	-5.3	-5.6	-5.9	-6.1	-6.4	-6.7	-7.0
CH4	10.4	10.3	10.2	10.2	10.1	10.0	10.0	9.9	9.8	9.7	9.6	9.6	9.5
N2O	1.9	1.9	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
CO2 eq.	2.3	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.7
TOTAL	11.2	10.8	10.5	10.2	9.9	9.6	9.2	8.8	8.5	8.1	7.8	7.5	7.2

GHG	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071
CO2	-7.2	-7.5	-7.7	-7.9	-8.2	-8.4	-8.6	-8.8	-9.0	-9.2	-9.4	-9.6	-9.8
CH4	9.4	9.3	9.3	9.2	9.1	9.0	9.0	8.9	8.8	8.8	8.7	8.6	8.6
N2O	2.0	2.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9

CO2 eq.	2.7	2.7	2.8	2.8	2.8	2.9	2.9	2.9	3.0	3.0	3.0	3.1	3.1
TOTAL	6.9	6.6	6.3	6.0	5.7	5.5	5.2	5.0	4.7	4.5	4.3	4.1	3.8

GHG	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081
CO2	-9.9	-10.1	-10.2	-10.4	-10.5	-10.7	-10.8	-10.9	-11.1	-11.4
CH4	8.5	8.4	8.4	8.3	8.3	8.2	8.1	8.1	8.0	6.0
N2O	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
CO2 eq.	3.2	3.2	3.2	3.3	3.3	3.4	3.4	3.4	3.5	3.5
TOTAL	3.6	3.5	3.3	3.1	2.9	2.8	2.6	2.5	2.3	0.0

CONCLUSIONS

As seen in the last table corresponding to Figure 3, i.e., the projection of the BLEDS, in this scenario, GHG emissions reach a net zero level in 2081, i.e., all emissions by sources and removals by sinks become equal. For each country, it's essential to have a GHG pathway that leads the nation to carbon neutrality. By the way, according to the relevant methodology of calculation of total effects of the above-mentioned mitigation policies, measures, as well as assumptions within this pathway, the year of net zero emissions could be earlier or later than 2081, depending on the relevant assumptions that could be strengthened or weakened, dictated by the national circumstances of the socio-economic development.

Moreover, within the BLEDS pathway, Azerbaijan could successfully reduce its emissions to 86% below 1990 levels by 2050, well below the 2035 goal of a 40% reduction. "40% reduction" target by 2035 has been included in the NDC3 of the country, which was submitted to the Secretariat of UNFCCC on the eve of the COP30 in Belem (Brazil) on November 10-21, 2025. As in the RLEDS, within the BLEDS, we observed that an essential part of the mitigation potential lies in the Energy sector's policies, actions, and assumptions. To strengthen the legal and institutional framework for decarbonisation and climate resilience, first of all, it's necessary to establish the MRV (Measurement, Reporting, Verification) system related in the previous §s, as well as establish the ETF (Enhanced Transparency Framework) for effective implementation of goals of NDC documents and enlarge participation of the country in the global climate change efforts. For this purpose, the government of the Republic of Azerbaijan undertakes the necessary measures based on the best international experience [4, 17].

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