INTERGAS CENTRAL ASIA

Low Carbon Development Program to 2033 for Intergas Central Asia, JSC

Astana, 2024

CONTENTS

INTRODUCTION

The updating of the regulatory framework in Kazakhstan demonstrates the country's commitment to achieving its goals to reduce greenhouse gas emissions.

Intergas Central Asia, JSC has provided invariable support and implemented new requirements and standards in its production activities in order to reduce its climate impact. In accordance with the decarbonisation goals at the level of Kazakhstan, as well as at the level of the Samruk-Kazyna Fund, QazaqGaz also sets a goal to reduce its carbon footprint by 10-12% by 2032 and will strive for carbon neutrality by 2060.

In accordance with the Concept of Low Carbon Development of Samruk-Kazyna National Wealth Fund JSC, the Samruk-Kazyna Fund sets the strategic goal of reducing emissions by 10% by 2032 compared to 2021 and strives to achieve carbon neutrality by 2060 according to the Deep Decarbonisation scenario.

The present Low Carbon Development Program for Intergas Central Asia, JSC (hereinafter, “the LCDP”) is based on the global challenge to combat the climate change and demonstrates the serious attitude and responsibility of Intergas Central Asia, JSC to this issue. It also confirms the company's commitment to reducing the greenhouse gas emissions in the course of its production activities and compliance with international climate agreements.

Within the framework of this LCDP, the document reviews the industrial results of the accomplished inventory of greenhouse gas emissions (Scope 1) and indirect emissions (Scope 2) of Intergas Central Asia. It further dwells on the Research aimed at determining the potential for reducing greenhouse gas emissions in the process of its production activities.

As the result of the inventory and research work, it became possible to obtain objective data on the company's greenhouse gas emissions. The potential for emissions reduction was evaluated, which step in its turn will allow taking the necessary measures to reduce the harmful impact on the environment and achieve the set goals for reducing greenhouse gas emissions.

This LCDP was prepared within the framework of additional agreement 655273/2022/1-3 to Agreement No.655273/2022/1 of 14 July 2022 between Intergas Central Asia, JSC and Green Bridge, LLP.

This LCDP comprises:

- data on greenhouse gas emissions, (Scope 1 and 2 in metric tons of CO_2 eq.);
- analysis of the ICA current potential;
- modeling of carbon regulation in line with various development scenarios.

ABBREVIATIONS

Abbreviation	Definition
CCUS	Carbon capture, utilization and storage technologies
ICA	Intergas Central Asia, JSC
GMI	Global Methane Initiative
HSE	Health Safety and Environment
RES	Renewable energy sources
SCC	Subsidiaries and affiliated companies
ICA	Intergas Central Asia, JSC
IPCC	Intergovernmental Panel on Climate Change – prepares a set of possible future climate change trends based on different levels of greenhouse gas emissions and other factors
IEA	International Energy Agency
BAT	Best available Technology
UN	United Nations Organization
GHG	Greenhouse Gas
LCDP	Low Carbon Development Program
FCCC	The United Nations Framework Convention on Climate Change (UNFCCC)
CO_2-eq	Sectorial metric measure used to assess and compare the volumes of greenhouse gas emissions with account of their climate impact
SDGs	UN Sustainable Development Goals
LCDP	Low Carbon Development Program
FER	Fuel and energy resources
GCU	Gas Compressor Units
SPP	Solar Power Plant

1.GENERAL INFORMATION ABOUT INTERGAS CENTRAL ASIA, JSC

1.1. Base technological operation parameters

Table 1. Basic information

Year of incorporation	1997
Place	The Head Office of the Company seats in Astana city
Ownership Structure	100% subsidiary of the NC QazaqGaz, JSC
Business Activities	The company is a subsidiary of the National Company QazaqGaz, JSC, and represents its interests in the field of trunk transportation of natural gas. The NC QazaqGaz, JSC is the main gas company of the Republic of Kazakhstan representing the interests of the state, both in the domestic and foreign gas market. In July 2018 pursuant to the Decree of the Government of the Republic of Kazakhstan, Intergas Central Asia JSC received the status of National Operator for the Main Gas Pipeline. Intergas Central Asia, JSC maintains domestic transportation and transit of natural gas through the territory of Kazakhstan via main gas pipelines with a total length of 20,612.63 thousand km. Of these, 7,007.32 km are main gas pipelines owned by third-parties, to which the company provides technical maintenance services, and 2,790.71 km are off-take gas pipeline-branches. Gas transmission is performed by 33 compressor stations equipped with 322 gas compressor units, further, the Company operates on contractual basis the compressor stations including CS-1 Bozoi, CS Karaozek, CS Korkyt-Ata, CS Aral, CS Turkestan. Intergas Central Asia JSC operates three (3) underground gas storage facilities. The largest of them is the Bozoi UGS facility (with an active storage capacity of 4,000,000 thousand m^3) located in the Aktobe region. The Poltoratskoye UGS facility is in the Turkestan region (with an active storage capacity of 350,000 thousand m^3), and the Akyrtobe UGS facility (with an active storage capacity of 300,000 thousand m3) is in the Zhambyl region. The Company comprises an engineering and technical center. The Engineering and Technical Center has all the necessary permits to perform testing work for technical diagnostics of equipment at production facilities and has advanced equipment from global manufacturers at its disposal, which allows it to perform high-quality and timely commissioning and diagnostic work at the facilities of the gas transportation system of the Republic of Kazakhstan.

Table 2. Basic technological parameters

№	Parameter	Value
1	Operation of compressor stations	33 CS
3	Main gas pipeline administration and management units forming production branches in the regions of operation	10 UMG (branches)
4	Gas compressor units	322 GCUs
5	Length of main gas pipelines (including 7 007 km of third-party GP)	20 612.63 km
7	Throughput capacity	203.5 bcm
8	Pipeline diameter	57–1 420 mm
9	Working pressure	3–9.81 MPa
10	Gas metering stations	5 GMSs
11	UGSs	Underground gas storages: Bozoi – 4 bcm Poltoratskoye – 0.35 bcm Akyrtobe – 0.3 bcm

1.2. Major technological processes

Determining the most energy-intensive areas of fuel and energy resource (FER) consumption allows us to identify the necessary measures for resource and energy conservation, the implementation of which will allow us to achieve the maximum effect in reducing GHG emissions.

Intergas Central Asia, JSC uses the following types of fuel and energy resources in the course of its business production activities:

1. *Gas* - natural gas, used for its own needs and process losses (SNiTP), as fuel for the operation of gas compressor units (fuel gas), for the operation of process equipment (starting gas for the turbo-expander of the gas compressor unit, etc.), for purging and cleaning of the cavity of dust collectors and pipelines, in boiler units for heating buildings and premises.

2. *Electric power*. The electric supply for compressor stations of main gas pipelines and other industrial facilities of JSC Intergas Central Asia is provided by:

- external power supply from the electric networks of Regional Electric Grid Companies;
- backup sources - power plants of the type like Caterpillar G-3516E, 11GD-100 and other ensuring autonomous operation of the compressor stations for a long time;
- emergency supply sources, including diesel-fired power plants that can take over the compressor shop load within 30 seconds for up to 250 hours of operation;
- guaranteed power sources consisting of storage batteries with corresponding converters that ensure stable operation of special group of electrical receivers (instrumentation and automation systems of gas turbine units, automated control systems, etc.) during transient conditions in the power supply system (voltage drops, frequency fluctuations, dead pauses).

The main consumers of electricity are process equipment facilities (gas compressor units, automatic gas cooling units, auxiliary compressor station equipment), pumps, ventilation equipment, cathodic protection systems, and external and internal lighting.

3. *Water*. Household and drinking water is used for sanitary and hygienic needs.

Technical water is used for watering green spaces on the territory of the Line Production Unit (“LPU”), as well as for technical and technological needs in the LPU repair shops.

4. *Thermal energy*. The main source of thermal energy for heating of the UMG facilities are its own gas boiler houses.

The main gas pipeline represents a single, integral process line that differs from other ones. The process equipment on various main gas pipelines (“MGP”) and compressor stations (“CS”) differs significantly. Thus, GCUs, which are operated in the western regions, consume a significant amount of fuel gas, and EGCUs, which are operated in the southern regions, consume a lot of electricity, but do not consume fuel gas. Also, different main gas pipelines are equipped with different brands of GCUs, with varying efficiencies, and therefore fuel gas consumption. The volumes of process gas consumption by the installed main and additional equipment also differ.

2.MAIN PREREQUISITES FOR THE DEVELOPMENT OF THE LCDP

2.1. Obligations of the Republic of Kazakhstan on Climate

According to the 2021 IPCC assessment, climate change will intensify in all regions in the coming decades, and without immediate and large-scale action to reduce GHG emissions, limiting warming to 2°C will be unachievable. In this regard, to implement the Paris Agreement, every five years all parties submit their climate action plans representing the nationally determined contributions (NDCs).

On 2 August 2016, Kazakhstan signed the Paris Agreement and ratified it on 6 December 2016. Before the official signing of the Paris Agreement in September 2015, Kazakhstan demonstrated its commitment to its goal by submitting its NDC under the UN Framework Convention on Climate Change, which envisages achieving the following goals:

- unconditional reduction of GHG emissions by 15% by December 2030 compared to 1990;
- conditional reduction of GHG emissions by 25% by December 2030 compared to 1990, subject to additional international investment, access to the Low Carbon Technology Transfer Mechanism, the Green Climate Fund and the Flexible Mechanism for Countries with Economies in Transition.

In December 2020, at the Climate Action Summit (organized by the UN, the UK, France in partnership with Chile and Italy), the President of the Republic of Kazakhstan K.K. Tokayev announced a new goal for achieving carbon neutrality by Kazakhstan by 2060, reaffirming Kazakhstan's commitments under the Paris Agreement. To implement the Paris Agreement, the Strategy for Achieving Carbon Neutrality of the Republic of Kazakhstan by 2060 (hereinafter, “the Strategy”) was developed taking into account global climate trends and in pursuance of relevant international obligations. The Strategy defines national approaches, the strategic course of state policy for the consistent transformation of the economy to ensure well-being, sustainable economic growth and equitable social progress and is adopted to ensure the coherence and coordination of governmental policies.

The President of the Republic of Kazakhstan adopted the Decree on 2 February 2023 No.121 "On approval of the Strategy for achieving carbon neutrality of the Republic of Kazakhstan until 2060".

The implementation of the Strategy for achieving carbon neutrality of the Republic of Kazakhstan is based on the following principles:

- focus, unity and integrity: all planned initiatives are pointed at achieving the goal and are consistent with each other;
- feasibility: suggests a technologically feasible but least expensive path to low-carbon development and achieving carbon neutrality;
- fairness of transition: creating new opportunities in regions affected by decarbonisation policies, with targeted support for the population;
- circular economy: an economy based on the use of secondary resources and the reduction of consumption;
- phased approach: the implementation of strategic initiatives through short-term and medium-term plans with a continuous analysis of previous stages and the entire strategic cycle;
- openness and interaction with society: broad involvement of all stakeholders at all levels of monitoring and decision-making, including representatives of central and local authorities, the quasi-

public sector, science, business (associations and enterprises), non-governmental organisations and local communities;

- rationality (balance): maintaining a balance between achieving the goal and ensuring security (economic, energy, social) and stability.

2.2. Global GCPC Challenge

Kazakhstan has joined the Global Carbon Pricing Challenge ("the GCPC"), which aims to cover 60% of global carbon emissions with a pricing system by 2030. Kazakhstan joins France, which became a GCPC partner in early April, as well as to the existing partners: Canada, Chile, Denmark, the EU, Germany, New Zealand, Norway, the Republic of Korea, Sweden and the UK, as well as Côte d'Ivoire.[1]

The GCPC is a leadership-level initiative announced by Canada at COP26 that aligns economic goals with low-carbon targets and promotes clean investment in innovation and technology. Through the GCPC, partners are provided with a platform for global collaboration and sharing of carbon pricing experiences.

The GCPC is led by an advisory committee of partner country representatives currently chaired by Canada's Climate Change Ambassador Catherine Stewart.

The Advisory Committee's decisions are based on the analysis and recommendations of the Technical Working Group, which includes global experts from Partner and Friendly organisations and international agencies. The work is supported by an independent Secretariat, which includes climate policy and communications experts from adelphi and the IETA.

2.3. Global Methane Pledge

The Global Methane Pledge (GMP) was launched at COP26 in November 2021 in Glasgow. The overall goal of the GMP is to reduce global methane emissions by at least 30% below 2020 levels by 2030, which would eliminate warming of more than 0.2˚C by 2050. The contribution of 2010-2019 emissions to warming relative to 1850-1900, estimated from radiative forcing studies, is: for CO_2 0.8°C; methane 0.5°C; nitrous oxide 0.1°C and fluorinated gases 0.1°C. When modelling pathways that limit warming to 1.5°C, global methane emissions are reduced by 34% (IPCC, CLIMATE CHANGE 2023, Synthesis Report).

Kazakhstan, as a country with diverse sources of methane emissions, can play an important role in reducing these emissions and take active participate in international efforts to combat climate change. According to the UNFCCC data for 2021, the energy sector accounts for the largest amount of methane emissions in Kazakhstan, followed by the agriculture and waste sectors, and other economic sectors (Figure 1).

The EBRD is an international financial institution that provides financial support and invests in projects in Europe, Central Asia and other regions. The EBRD's main objective is to support sustainable development, stimulate the private sector and promote economic reform. The EBRD supports private sector participation through policy reform, including the development of long-term low carbon development pathways. 64% of the EBRD's environmental investments are in the private sector.

The EBRD's activities to reduce methane emissions are part of the institution's broader strategy to support sustainable development and combat climate change. It contributes to achieving

[1] *https://www.gov.kz/memleket/entities/ecogeo/press/news/details/762638?lang=ru*

international climate goals and promoting sustainable development in the countries where the EBRD is active.

The European Bank for Reconstruction and Development provides strong support to the projects related to the production and use of biogas and biomethane. Biogas is a gas formed as a result of the biological decomposition of organic materials under anaerobic conditions (in absence of oxygen). Biogas mainly includes methane (CH_4) and carbon dioxide (CO_2), as well as small amounts of other gases.

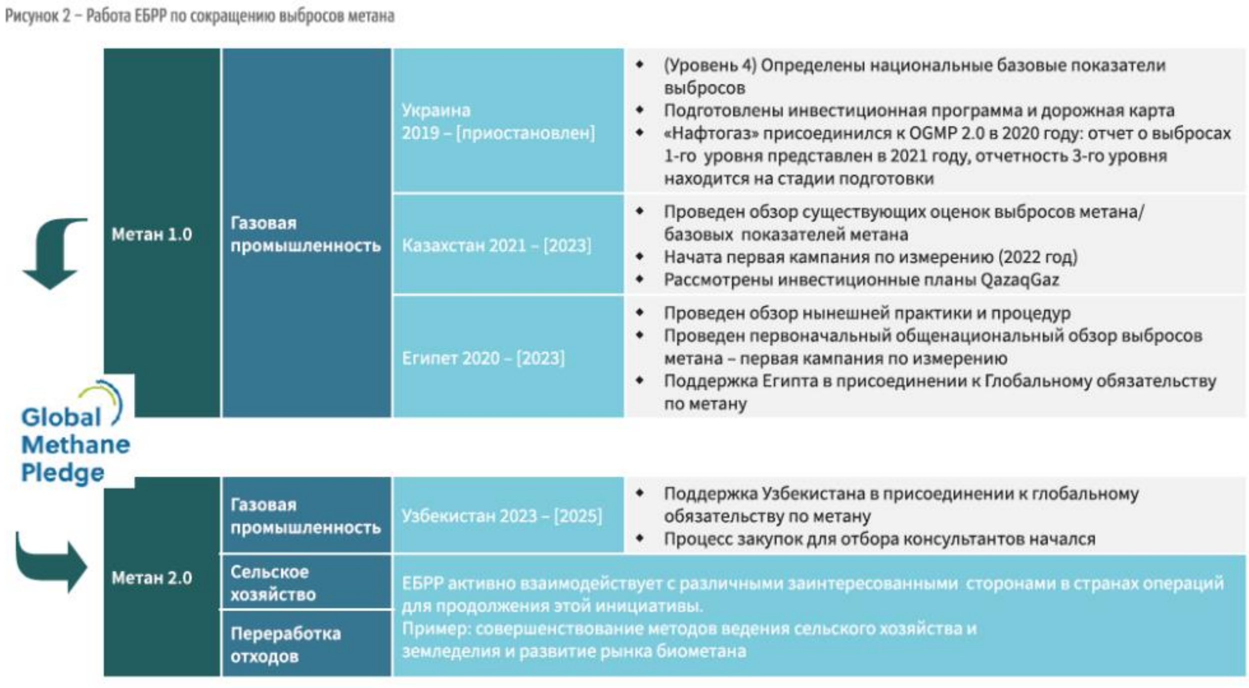

Figure 1. The EBRD activities to reduce methane emission[2]

The introduction of biogas and biomethane helps reduce methane emissions, which is an important step in combating climate change and achieving climate goals such as reducing the greenhouse effect and limiting global warming. The EBRD plays a key role in supporting such projects and stimulating the transition to a more sustainable and environmentally responsible energy sector.

2.4. The NC QazaqGaz goals for low carbon development

In line with the Low Carbon Development Concept of Samruk-Kazyna JSC, the Samruk-Kazyna Fund sets a strategic goal of reducing emissions by 10% by 2032 compared to 2021 and strives to achieve carbon neutrality by 2060 according to the Deep Decarbonisation scenario.

Currently, the GHG emissions of portfolio companies amount to 13.3% of those for the entire country according to 2021 data. At the same time, the share of QazaqGaz in direct CO2 emissions for the Fund group was 5.35% in 2021 and in indirect emissions - 0.7%. The share of QazaqGaz GHG emissions in 2021 amounted to ~2% of Kazakhstan's CO_2 emissions.

In setting decarbonisation goals, QazaqGaz also relied on goals at the level of the Samruk-Kazyna Fund in accordance with the Low Carbon Development Concept of Samruk-Kazyna, JSC.

[2] *https://qazaqgreen.com/journal-qazaqgreen/environmental-policy/1468/*

Samruk-Kazyna's Low Carbon Development Concept implies three possible decarbonisation scenarios. Each scenario assumes a reduction in the carbon footprint by reducing Scope 1 emissions and indirect emissions by increasing the share of renewable energy sources.

In line with decarbonisation targets at the level of Kazakhstan, as well as at the level of the Samruk-Kazyna Fund, QazaqGaz also aims to reduce its carbon footprint by 10–12% by 2032 and will strive for carbon neutrality by 2060.

In light of achieving low carbon development in Kazakhstan, gas will serve as a transition fuel when converting coal-fired power generation capacity. However, this also means that gas consumption and, accordingly, emissions from gas transportation will increase in the period up to 2032. An average annual increase in gas transportation volume by 0.6% per year can potentially lead to an increase in emissions by 8% by 2032 compared to 2019. Thus, to achieve the target of reducing emissions by -10% by 2032, the overall level of emissions reduction will have to be -18% by 2032 compared to 2019.

Actions aimed to reduce GHG emissions should include both, technical and organisational efforts. At the same time, organisational measures should be applied already at the initial stage, which include, among other things, the establishing a special organisational structure, employee training, and the introduction of economic incentives to improve energy efficiency (for example, the introduction of decarbonisation targets and related efficiency factors).

Technical measures to reduce emissions are divided into steps to reduce fugitive emissions and emissions from combustion at compressors. It should be noted that the potential introduction of a carbon tax in Kazakhstan will make these initiatives more economically attractive. The total potential from technical measures in the long term accounts 23%-59% of total emissions.

The most relevant action in the short term is considered the improvement of operational efficiency. Such actions have a relatively low cost of reducing GHG emissions (expressed in US dollars per ton of CO_2-eq. emissions avoided) and have a significant potential for reducing emissions. For example, according to forecasts by the EPA (Environment Protection Agency) in the United States, the implementation of the LDAR program can potentially reduce fugitive emissions by up to 63%, depending on the frequency of inspections.

Best practices for LDAR implementation include detailed written program and procedures, personnel training, quality assurance (including calibration protocols), internal and external audits, and maintenance of a database and software to store traceable data.

Such measures as electrification and transition to renewable energy sources, as well as financial instruments for offsetting emissions, are longer-term measures towards achieving the carbon neutrality goal, due to the higher cost of implementation and the lack of incentive mechanisms in Kazakhstan at the moment. The feasibility of these measures will depend on the level of state support, as well as the presence of supporting market mechanisms.

Base-line actions include:

Short-term initiatives:

- Development of a decarbonisation strategy and detailing of technical measures (up to 2030)
- Implementation of organisational measures (up to 2030)
- Implementation of the LDAR program
- Operational efficiency
- Transition to alternative fuels (2030-2040)

Long-term initiative:

- Gradual electrification of GCUs (2030-2040)
- Transition to renewable energy sources (starting with 2 EGPUs of the ICA) (2030-2060)

- Financial instruments for emission compensation (2030-2060)
- Offsets (2035-2060)[3]

The measures implemented to reduce greenhouse gas emissions by the NK QazaqGaz can be classified into three groups: technical/technological, organisational and compensatory.

Technical/technological measures are aimed at increasing the operational efficiency of the Company's activities by upgrading equipment and improving the technical output characteristics of production processes. Such measures may include replacing or upgrading equipment, introducing new technologies, types of fuel, improving existing technologies, automation, etc..

Organizational measures are aimed at improving the process of planning, coordination and monitoring of the Company's activities in managing GHG emissions by organizing processes and employees' work using certain methods and techniques. Such measures may include tracking the achievement of targeted indicators, structuring work processes, training personnel, implementing systems and practices aimed at resource/energy conservation, monitoring, analysis/ updating/ clarification of quantitative assessment methodologies, etc..

Compensatory measures are aimed at compensating for damage or improving the conditions of those affected by negative impacts through greenhouse gas emission reduction projects implemented outside the Company's perimeter. Such measures may include carbon offsets, the purchase of certificates and carbon units.

[3] *https://qazaqgaz.kz/ru/ekologicheskaya-otvetstvennost/dekarbonizaciya*

Table 3. Main groups of measures to reduce GHG emissions

№	Actions	Basic Principles	Examples
1.	Technical actions	Require capital investments; Involves upgrading or replacing existing energy-intensive equipment; Implementation of the latest energy-efficient and energy-saving technologies, reduction of loss of fuel and energy resources (“FER”); Must be carried out at the initial stage.	Implementation of the LDAR program; Replacement of dry seals on centrifugal compressors; Increasing efficiency on GCUs; Use of mobile compressor stations; Electrification of equipment.
2.	Organisational actions	No capital investment required; Have to be carried out at the initial stage; Necessary to create an organisational structure for actions management.	Setting up of an organisational unit for managing emissions reduction activities, in particular the formation of a separate department for the implementation of the decarbonisation strategy. Training of enterprise employees; Implementation of economic and organisational incentives for energy conservation and increased energy efficiency, as well as practical implementation of activities, for example, the introduction of centralised decarbonisation targets and related KPIs in the motivation system. Regulatory and financial support.
3.	Additional actions	Some initiatives require capital investment; Most relevant when it is not possible to completely reduce GHG emissions, for example, when achieving carbon neutrality More applicable in the long term.	Financial instruments for offsetting emissions (including potentially within the Fund structure); Offsets (in the form of forest planting).

3. CARBON FOOTPRINT OF INTERGAS CENTRAL ASIA'S PRODUCTS

GHG emissions by scope 1, 2 and 3. The scope of GHG emissions is derived to provide a comprehensive assessment of GHG emissions and to identify opportunities to reduce emissions at the industrial and off-site facilities. The concept of Scope has been used for over 20 years under the GHG Protocol.

The International Petroleum Industry Environmental Conservation Association (IPIECA), an international non-profit industry association representing the oil and gas sector within the UNFCCC and IPCC, has developed and supports Guidelines 28 for accounting for GHG emissions in the oil industry based on the GHG Protocol. These documents distinguish three Scopes (Figure 2):

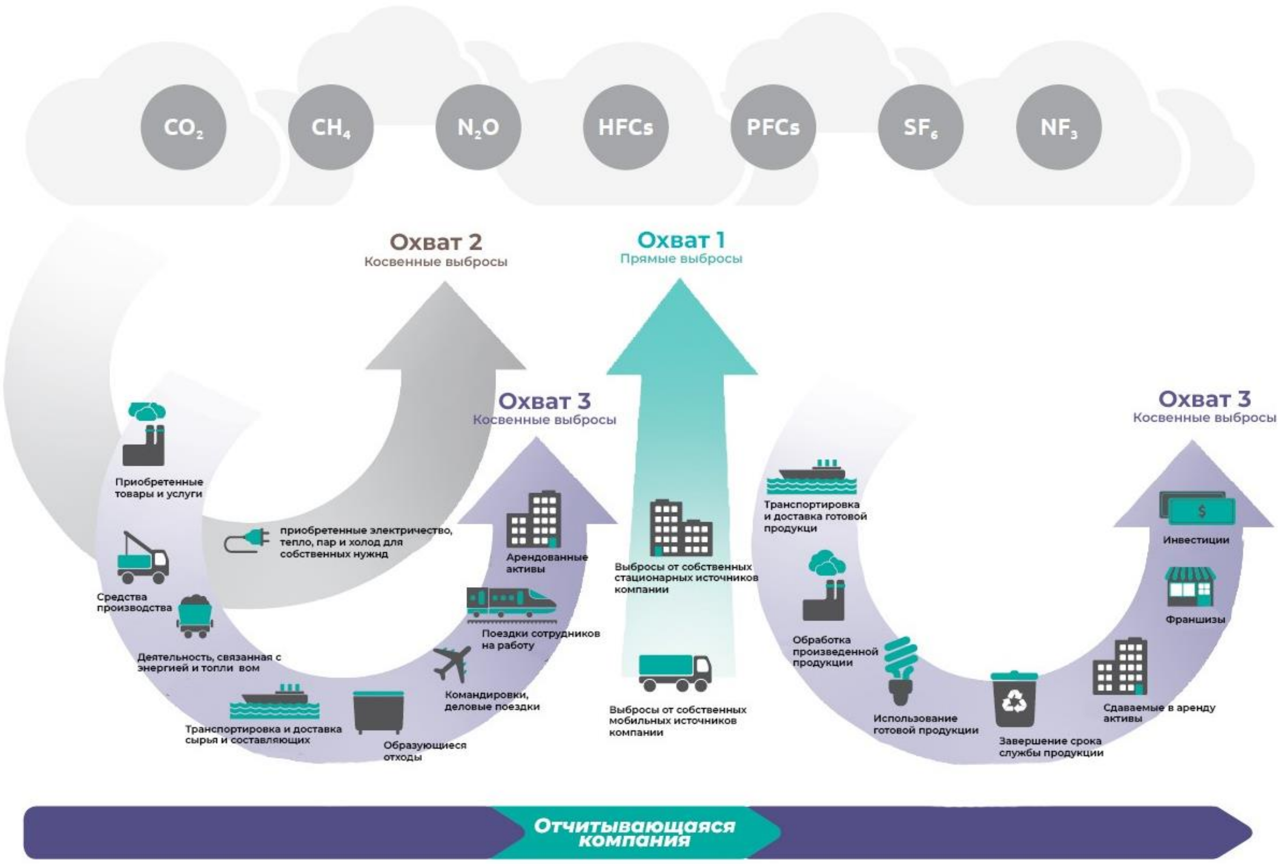

Figure 2. Scopes

Scope 1 — direct emissions: GHG emissions from sources owned or managed by the company. In accordance with the Environmental Code of the Republic of Kazakhstan, JSC ICA annually develops and submits to the authorized body a report on the inventory of greenhouse gas emissions (Scope 1).

Table 4. Total mass of direct greenhouse gas emissions in CO_2-eq.

Index	Units of measure	2020	2021	2022	2023
ICA, JSC	tns CO_2-eq	2 216 276	4 459 110	2 324 272	1 121 045

Table 5. Types of greenhouse gases included in the calculation of the total mass.

Index	Units of measure	2020	2021	2022	2023
Carbon dioxide (CO_2)	tns CO_2	839573	995020	574058	572 941
Methane (CH_4)	tns CO_2-eq	1372063	3458600	1747130	545 372
Nitrous oxide (N_2O)	tns CO_2-eq	4640	5491	3084	2 732

In the course of the ICA's operating activities the volume of direct emissions in 2023 amounted to 1,121 thousand tons CO2-eq, which is 75% less than in 2021. This is due to a change in the approach to calculating methane emissions, due to a change in emission factors in national guidelines for estimation of greenhouse gas emissions.

When converting methane and nitrous oxide values into tons CO_2-eq, current values of global emission factors were used:

- 2021: methane - 21, nitrous oxide - 310;
- 2022: methane - 25, nitrous oxide - 298;
- 2023: methane - 28, nitrous oxide - 265.

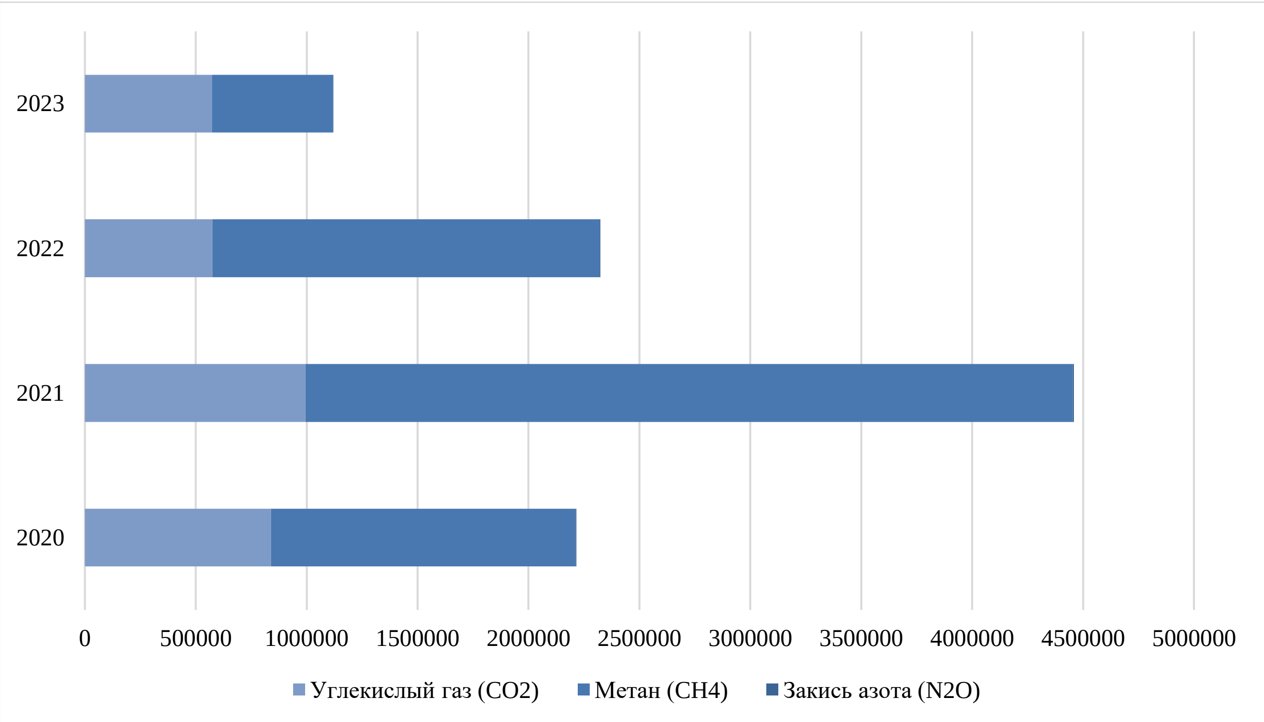

Figure 3. Total volume of direct greenhouse gas emissions by type of greenhouse gas, thousand tons CO_2-eq.

The estimate is made using methods based on the IPCC approach from 2006. Methane emissions in the emissions structure of ICA, JSC significantly exceed the indicators of other companies due to the use of a higher coefficient for developing countries, according to the IPCC methodology. This methodology implies coefficients for developing countries that are 2 times higher than for developed countries, and depends on the total volume of gas transportation by the company.

According to the results of 2023, the volume of gas transportation amounted to 49,798 mln m³. In terms of gas transportation directions, the plan was implemented as follows:

- to the domestic market, the plan was implemented for the reporting period by 89%, which is due to a decrease in the volume of natural gas consumption in most regions of the Republic of Kazakhstan;

- the actual volume of gas exports was 89% compared to the plan. The deviation was due to the lack of volumes in the Russian Federation from the Karachaganak field (counterparty KazRosGas), which was partially offset by an increase in gas transportation to China along the route from the Dombarovka GMS to the BS GP, that is 516.5 km long (counterparty is the NC QazaqGaz, JSC);

- for international gas transit, the plan was fulfilled at 83%.

The deviation attributed to the decrease in Russian gas transit, decrease in the volume of Uzbek transit to Tashkent, and the absence of Central Asian gas transit, which is partially offset by unscheduled transit of Russian gas to Uzbekistan and unscheduled transit of Russian gas to the Kyrgyz Republic (counterparty, the NC QazaqGaz, JSC). The corporate indicator TTR being the ratio of transmission to the distance per km, was 10 793 billion m^3*km or 75% of the plan, which is due to the transportation of gas along shorter sections, as well as the absence of Central Asian gas transit.

In terms of gas transportation to the domestic market, there is generally an upward trend with some decrease in 2023 due to lower gas consumption by industrial enterprises, as well as the expiry of the contract for gas transportation for QazaqGaz Exploration and Production, LLP in March 2023. In terms of gas transportation for export, compared to 2021, there was a decrease in volumes due to the lack of gas transportation volumes to the Russian Federation from the TCO (counterparty, Tengizchevroil) and Karachaganak (counterparty, KazRosGas) fields, as well as a decrease in gas exports to China (counterparty, the NC QazaqGaz, JSC). Compared to 2022, the increase in the volume of gas transportation for export is due to a longer gas transportation route to China (from the Dombarovka GMS to the BS GP, 516.5 km long, counterparty of JSC NK QazaqGaz. For the gas storage, there is a trend towards an increase in volumes, which is related to revised gas injection/withdrawal schedule in the Bozoi UGS.[4]

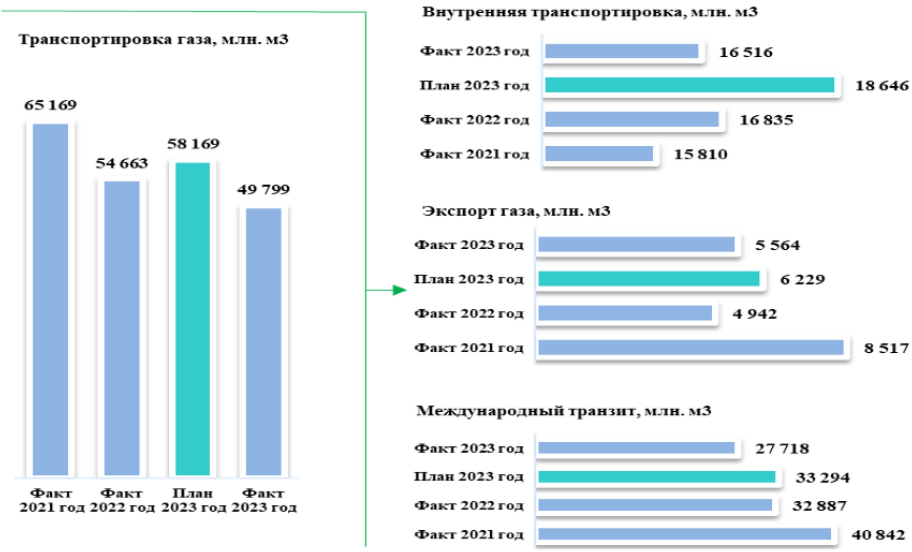

Figure 4. Volumes of gas transportation

The amount of greenhouse gas emissions by Intergas Central Asia, JSC depends on the market situation and gas transit volumes. According to the "Rules of state regulation in the field of greenhouse gas emissions and absorption", approved by the Order of the Minister of Ecology, Geology and Natural Resources of the Republic of Kazakhstan dated 28 March 2022 No.91

[4] *https://intergas.kz/ru/reports/88*

(hereinafter, "the Rules"), carbon quota units formed by reducing the capacity of the quota installation are not subject to sale and are subject to return to the reserve category of the National Plan for the issuance of an additional carbon quota. Carbon quotas are withdrawn annually in accordance with the requirements of the Ecological Code of the Republic of Kazakhstan, Art. 292[5].

In compliance with these requirements with the purpose to refund the carbon units in the state register of carbon units, Intergas Central Asia, JSC acquired additional quotas of carbon units for greenhouse gas emissions in accordance with Agreement No.870468/2023/3 dated 06.10.2023.

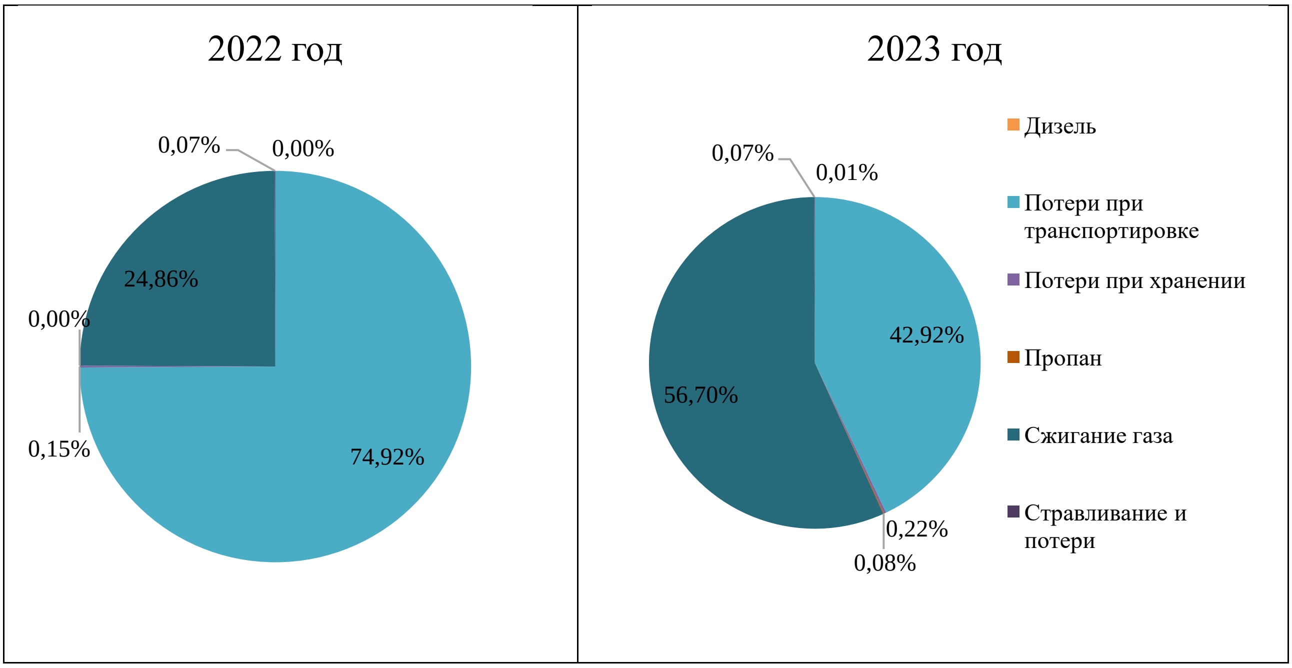

Figure 5. Volume of direct ICA emissions with breakdown for process type in 2022-2023, in % from t CO_2 eq.

Irrespective of the calculation method, the largest portion of ICA emissions is attributed to the categories of volatile emissions during transportation and gas combustion for own needs. Other processes (propane combustion, diesel combustion, as well as bleed volumes) account for less than 1%, so focusing on them within the framework of the low carbon development program is inappropriate.

The ICA low carbon development program is aimed at minimizing emissions from two main sources, the volatile emissions during transportation and gas combustion for own flow process consumption. The implementation of comprehensive measures to improve energy efficiency and optimize processes will reduce emissions and achieve the goals for carbon footprint reduction.

Scope 2 — Indirect energy emissions: emissions from the production of electrical or thermal energy used in the company's production processes and supplied by third parties.

Table 6. Electric power consumption for Intergas Central Asia, JSC, kW*hour[6]

Branch Name	**2021**	**2022**	**2023**
UMG Aktau	7 890 255	7 042 231	7 188 224
UMG Atyrau	12 589 989	8 868 527	9 138 798
UMG Uralsk	9 914 429	9 386 373	8 973 932
UMG Aktobe	12 749 673	12 114 007	12 351 529

[5] The Ecological Code of the Republic of Kazakhstan –IPS Adilet (zan.kz)
[6] Internal reporting (intergas.kz)

UMG Kostanai	504 964	517 576	490 979
UMG Shymkent	5 417 811	6 128 569	5 441 168
UMG Almaty	931 983	1 050 664	1 057 512
UMG Taraz	21 467 196	9 593 490	8 645 892
UMG Kyzylorda	1 870 868	830 727	363 364
ETC UGER	131 133	123 178	124 852
UMG Karaganda	881 679	694 466	896 123
TOTAL for ICA, JSC:	**74 350 480**	**56 349 810**	**54 672 373**

The main volume of 26% of electricity consumption in 2023 at Intergas Central Asia falls on compressor stations with electric drive units at UMG Shymkent and UMG Taraz. Electricity consumption for gas compression during the year is uneven and depends on the gas transportation mode modulated by the dispatch service.

The reduction in electricity consumption by the UMG Taraz was achieved taking into account the actual load of the EGCA CS-5 Taraz in accordance with the optimal gas transportation mode selected by the Central Dispatch Control Center on the BGR-TBA, BS MGP.

Table 7. Data for the Scope 2, Intergas Central Asia, JSC

Index	Unit	2020	2021	2022	2023
Annual consumption of purchased electricity	th. KWh	71 576	74 350	56 350	54672
Acquired thermal power supplied from TPP	GCal	484	520	483	463
Annual CO_2-eq emission	tons	70261	72990	55346	53995

Scope 3 — Other indirect emissions represent indirect emissions associated with the company's activities but originating from sources owned or controlled by other entities. Such sources of emissions include, for example, the production of feed inputs and fuel, the transportation of goods, and the use of manufactured products by consumers. In other words, GHG emissions from scope 3 include indirect emissions from value chain activities not included in scopes 1 and 2.

The indirect emissions under the Scope 3 of the GHG Protocol are divided into 15 different Categories. These 15 categories are split into two types of supply chain flows: upstream and downstream, respectively:

Category 1 – acquired goods and services;
Category 2 – means of production;
Category 3 – other indirect emissions from energy consumption;
Category 4 – transportation of feed inputs and acquired goods;
Category 5 – generated waste;
Category 6 – business trips and expenses of the employees;
Category 7 – employees' travel to place of operation;
Category 8 – leased assets;
Category 9 – transportation and delivery of finished products;
Category 10 – processing of produced intermediary products;
Category 11 – use of finished products;
Category 12 – expiry of the service life of the products;
Category 13 – leased assets for finished products;
Category 14 – franchises;
Category 15 – investment.

As you can see, estimation of Scope 3 emissions requires taking into account many factors and can turn to be a complicated process. ICA suppliers may not have their own emission management systems or may not provide information on emissions. To date, Scope 3 emissions have not been assessed for ICA, JSC.

4. MODELLING CARBON REGULATION TAKING INTO ACCOUNT DEVELOPMENT SCENARIOS

According to the decarbonisation strategy, the NC QazaqGaz, JSC will reduce its carbon footprint according to three scenarios[7]:

• The "Business as Usual" scenario assumes that current trends in the Company's activities will continue without a reference to the low-carbon development, and that government policy, technology and social preferences will continue to develop at the same pace;

• The Decarbonisation scenario assumes a reduction in GHG emissions while maintaining the current structure of asset operation through energy efficiency programs, reduction of leaks and gas flaring, and the use of low carbon energy through renewable energy projects. Given current carbon prices, this scenario was selected as the most promising for the period up to 2031. It is planned to achieve an approximately 2% reduction in direct emissions from gas flaring (CO_2 emissions) compared to 2023 levels. In addition, indirect emissions are expected to decrease by 33%;

• The Deep Decarbonisation scenario builds on the measures of the Decarbonisation scenario, including biomethane and hydrogen production projects, carbon capture and storage, and active development of climate projects. In addition, the scenario includes the modernization of centrifugal compressors through the use of dry seals and vents. As a result of the implementation of these measures, it is planned to achieve a reduction in direct emissions from fuel combustion (CO_2 emissions) of about 12% compared to 2019 levels, which will correspond to a reduction in indirect emissions of 33%.

The main directions of decarbonisation and low carbon development of Intergas Central Asia are fully consistent with the guidelines of JSC NC QazaqGaz.

4.1. BAU Scenario – Business as Usual

The baseline scenario was chosen to forecast the emission levels up to 2032 implying there are no special energy saving or energy efficiency actions implemented by ICA, in line with the Business as Usual concept. To determine the estimated values for 2032, the model relies on the extrapolated value of greenhouse gas emissions in 2021. According to the data presented, the volume of gas transportation should increase by 11%. The emission calculation methodology is the same.

Table 8. Business as Usual key estimates

#	Target Index	Unit	2021*	2032	Increase
1	Emissions under Scope 1	th. tns CO_2-eq	2 146 604	2 382 730	+11%
2	Gas transportation	mln.m^3	65 169	73 374	-
3	Fuel gas volumes	mln.m^3	320	480	-
4	Emissions under Scope 2	th. tns CO_2-eq	72990	85 398	+17%
5	Year consumption of purchased electricity	th KWh	74 350	86 990	

Note. For 2021, the value was recalculated using the 2022 methodology and modified coefficients for calculating greenhouse gas emissions.*

The baseline scenario is not considered as a decarbonisation scenario, but is used to simulate how the situation would develop in the absence of any action to reduce greenhouse gas emissions.

[7] *According to the Climate Risk Management Program for the NC QazaqGaz group of companies approved by the Decision of the Board of the NC QazaqGaz, Protocol No.25 dated 11 July 2024.*

4.2. The Decarbonisation scenario

The Decarbonisation scenario developed by the NC QazaqGaz, JSC assumes the level of GHG emissions in 2032 equal to the level of 2021 due to the use of technical means like extensive use of the LDAR program on pipelines and compressor stations, repair of GCUs in accordance with the energy efficiency initiatives of the NC QazaqGaz, the use of mobile compressor stations (MCS) during repairs, as well as replacement/ purchase of additional equipment (replacement of pneumatically driven vents, optimisation of line heaters, installation of sensors, installation of waste heat boilers, etc.). It is also assumed that emissions under Scope 2 will be reduced by 33% due to the purchase of electricity from renewable energy sources, including the transfer of two EGCUs to renewable energy sources.[8]

Table 9. Key instruments to achieve the target indicators for Decarbonisation scenario.

#	NC QazaqGaz Activities	Reduction effect, tns CO_2-eq	Action Description and Deadline	Subdivision responsible for implementation	Evaluation of applicability for ICA, JSC
1	Recovery and recompression of emissions in network / process gas: use of mobile compressors	189 959.039	Start of introduction of mobile compressor stations (MCS) during repair in medium term perspective up to 2030	Production and technical division	Implemented in the Actions Program for Energy Saving and Increase of Energy Efficiency
2	LDAR	107 068.5	Implementation of LDAR software to reduce fugitive methane emissions in the medium term beyond 2025	Production and technical division	Not implemented
3	Replacement of ineffective cathode protection terminals	11 742.9	Replacement of ineffective cathode protection terminals with stations of new generation level at 12 gas pipeline facilities by 2026	Production and technical division	Implemented in the Actions Program for Energy Saving and Increase of Energy Efficiency
4	Repair of gas compressor units	15 429.2	Improving the energy efficiency of gas compressor units in the medium term up to 2026.	Production and technical division	Implemented in the Actions Program for Energy Saving and Increase of Energy Efficiency
5	Improving the operational efficiency of power supply and lighting	9 713.4	Replacement of lighting with LED analogues at 48 ICA facilities (until 2027), automation of lighting control and repair of the lighting system at ICA.	Energy Service Department	Implemented in the Actions Program for Energy Saving and Increase of Energy Efficiency
6	Improving the operational efficiency of the use of boiler house equipment	1 046.9	Replacement of obsolete boilers at 11 facilities, insulation of attic covering with expanded clay at 9 facilities, insulation or replacement of insulation on sections of heating networks for 10 facilities, development and application of regime maps for the operation and maintenance of boiler equipment for 6 facilities and installation of	Energy Service Department	Implemented in the Actions Program for Energy Saving and Increase of Energy Efficiency

[8] *АО «НК «QazaqGaz» - Устойчивое развитие* *https://qazaqgaz.kz/ru/ekologicheskaya-otvetstvennost/dekarbonizaciya*

#	NC QazaqGaz Activities	Reduction effect, tns CO_2-eq	Action Description and Deadline	Subdivision responsible for implementation	Evaluation of applicability for ICA, JSC
			oxygen meters on boilers at one facility up to 2026		
7	Improving the operational efficiency of the use of process flow equipment	84 692.182	Compressor cleaning at 6 sites and the use of air pre-cooling for 4 GCUs, up to 2026	Production and technical division	Implemented in the Actions Program for Energy Saving and Increase of Energy Efficiency
Aggregate effect from all actions:		**starting from 416 738.10 tons CO2 -eq or 19 % from 2021 level***			

** The target indicators are set as the initial value of the interval (from) in connection with the consideration of possible fluctuations and uncertainties in calculating the effects of reducing GHG emissions as a result of the implementation of measures.*

It should be noted that within the framework of the energy audit of ICA conducted in 2020, about 253 energy saving and energy efficiency improvement actions were proposed for implementation. At the same time, the company included 148 actions in the investment program for the next 5 years (CONCLUSION No. 96-JSC ICA/2020 based on the results of the energy audit of Intergas Central Asia, JSC), which are currently being implemented under the Action Program for energy saving and energy efficiency improvement.

4.3. The Deep Decarbonisation scenario

The Deep Decarbonisation scenario, which is consistent with the concept of preventing global temperature increase by more than 1.5 degrees Celsius. It assumes a reduction in GHG emissions by 10-12% from the 2021 level due to technical actions listed in the base Decarbonisation scenario. It also includes compressor repairs (including replacing wet seals with dry ones on ICA compressors), as well as a gradual transition to biomethane in pilot projects. The Deep Decarbonisation scenario meets the Company's more ambitious goals and assumes a reduction in GHG emissions by 2032 by 29-39% from the 2021 level.

Table 10. Key instruments for achieving the targeted indicators under the Deep Decarbonisation scenario.

#	NC QazaqGaz Activities	Reduction effect, tns CO_2-eq	Action Description and Deadline	Subdivision responsible for implementation	Evaluation of applicability for ICA, JSC
Actions that are also listed in Decarbonisation scenario					
1	Recovery and recompression of emissions in network / process gas: use of mobile compressors	189 959.039	Start of introduction of mobile compressor stations (MCS) during repair in medium term perspective up to 2030	Production and technical division	Implemented in the Actions Program for Energy Saving and Increase of Energy Efficiency
2	LDAR	107 068.5	Implementation of LDAR software to reduce fugitive methane emissions in the medium term beyond 2025	Production and technical division	Not implemented
3	Replacement of ineffective cathode protection terminals	11 742.9	Replacement of ineffective cathode protection terminals with stations of new generation level at 12	Production and technical division	Implemented in the Actions Program for Energy Saving and Increase of Energy Efficiency

#	NC QazaqGaz Activities	Reduction effect, tns CO_2-eq	Action Description and Deadline	Subdivision responsible for implementation	Evaluation of applicability for ICA, JSC
			gas pipeline facilities by 2026		
4	Repair of gas compressor units	15 429.2	Improving the energy efficiency of gas compressor units in the medium term up to 2026.	Production and technical division	Implemented in the Actions Program for Energy Saving and Increase of Energy Efficiency
5	Improving the operational efficiency of power supply and lighting	9 713.4	Replacement of lighting with LED analogues at 48 ICA facilities (until 2027), automation of lighting control and repair of the lighting system at ICA.	Energy Service Department	Implemented in the Actions Program for Energy Saving and Increase of Energy Efficiency
6	Improving the operational efficiency of the use of boiler house equipment	1 046.9	Replacement of obsolete boilers at 11 facilities, insulation of attic covering with expanded clay at 9 facilities, insulation or replacement of insulation on sections of heating networks for 10 facilities, development and application of regime maps for the operation and maintenance of boiler equipment for 6 facilities and installation of oxygen meters on boilers at one facility up to 2026	Energy Service Department	Implemented in the Actions Program for Energy Saving and Increase of Energy Efficiency
7	Improving the operational efficiency of the use of process flow equipment	84 692.182	Compressor cleaning at 6 sites and the use of air pre-cooling for 4 GCUs, up to 2026	Production and technical division	Implemented in the Actions Program for Energy Saving and Increase of Energy Efficiency
Actions additional to the Decarbonisation scenario					
8	Purchase of carbon units and other additional actions (Section 5 of this LCDP)	70 000	Application of financial instruments for emission compensation in the long term - 2030-2060.	Procurement Department	Implementation in progress Intergas Central Asia, JSC purchased additional quotas of carbon units for greenhouse gas emissions in accordance with Agreement No.870468/2023/3 dated 06.10.2023. The cost of 1 quota was 397 Tenge. A total of 70,000 metric tons of CO_2 were purchased.
9	Transition to renewable energy sources	55591.27	The start of the transition to renewable energy sources in the long term set for 2030-	Production and technical division	Implementation in progress. With annual volume of purchased electricity for ICA, JSC in year 2023, or

#	NC QazaqGaz Activities	Reduction effect, tns CO_2-eq	Action Description and Deadline	Subdivision responsible for implementation	Evaluation of applicability for ICA, JSC
			2060 for the power supply of new facilities of the line facilities of the main gas pipeline (main valve stations, cathodic protection terminals, etc.).		54 672 373 KWh, the share of electricity from RES from the total consumption of energy is 0.24%.
10	Implementation of automated control systems, telemechanics to optimise gas flows in the Gas Transmission System	100492.74	The implementation of this action results in decrease of fuel consumption during mainline transportation.	Production and technical division	Not implemented
Aggregate effect from all actions:		**starting from 642 822.11 tons CO2 -eq or 30 % from 2021 level***			

**The target indicators are set as the initial value of the interval (starting from), with account of possible fluctuations and uncertainties in calculating the effects of reducing GHG emissions as the result of the actions implementation.*

The implementation of actions in accordance with the Deep Decarbonisation scenario will allow to reduce the gross GHG emissions by 30% by 2033 relative to the baseline level of 2021. Additional measures compared to the Decarbonisation scenario are discussed in Section 6 of this LCDP.

5. ASSESSMENT OF ECONOMIC EFFICIENCY

5.1. Gas Saving Activities

As part of the ICA energy audit conducted in 2020, about 253 energy saving and energy efficiency actions were proposed for implementation. At the same time, the company included 148 actions in the investment program for the next 5 years (CONCLUSION No. 96-JSC ICA/2020 based on the results of the energy audit of Intergas Central Asia), which are currently being implemented in the Actions Program for energy saving and energy efficiency. For 2022 and 2023, the energy efficiency of transportation is presented in Figure 6.

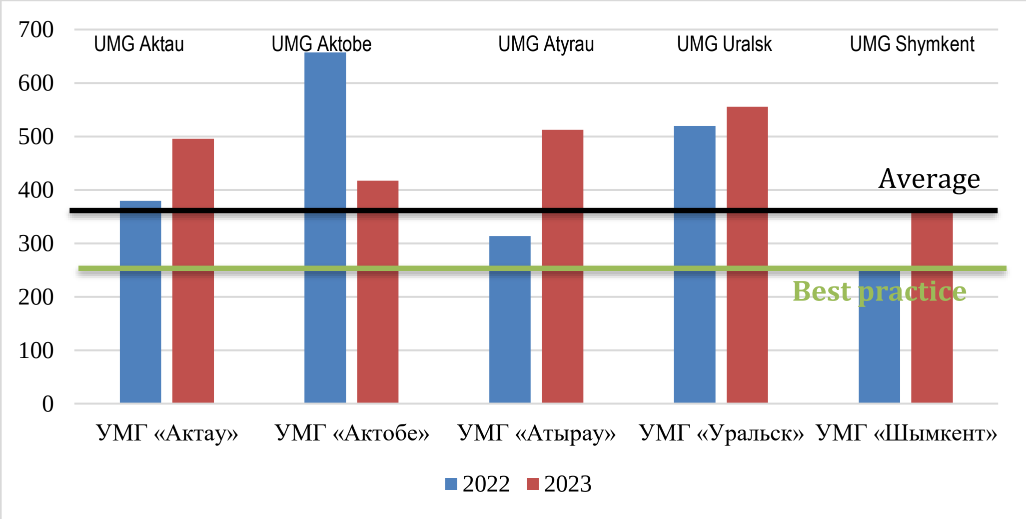

Figure 6. Energy efficiency of transportation with breakdown for quota entities of ICA, JSC tons of oil equivalent / billion m^3*km

The figure shows that there is potential for reducing greenhouse gas emissions in tons CO_2-eq due to the application of best practices in the field of energy efficiency for 2023.

Table 11. Potential for CO_2-eq reduction

Subsidiary name	**Transmission volume, mln m^3**	**G/ T/W bln m^3 * km**	**Gas combustion, th. m3**	**Energy consumption, KWH**	**Emission from gas combustion tns CO_2 -eq**	**Potential for cutting consumption of fuel, %***	**Potential for emission reduction, tns CO_2 -eq**
UMG Aktau	7 049	1 427	91 890	7 188 224	188 897	48,87%	23 081
UMG Aktobe	5 406	2 755	95 590	12 351 529	183 641	39,23%	18 013
UMG Atyrau	6 037	1 634	51 684	9 138 798	111 198	50,55%	14 053
UMG Uralsk	16 080	1 401	6 522	8 973 932	12 491	54,37%	1 698
UMG Shymkent	4 758	1 301	6 445	5 441 168	13 034	30,48%	993
Total:							**57 838**

Energy efficiency indicators significantly differ between various UMGs. This is conditioned by the varying terms for the service lives of the main gas pipelines. Along with that, the operation of limit-exceeding equipment and critical degree of wear of the assets, the significant part of the GCU are characterized with low efficiency rates. Also, the specific consumption of fuel and energy resources correlates with the repair work on the line facilities, since bleeding gas from the repaired section of the LF leads to significant gas losses. Climate conditions in the regions of operation also affect the running local main gas pipelines.

1. Saving of gas using mobile compressor stations (MCSs) during pipeline repairs

The MCS is a set of easily transported process units used to inject/ offtake natural gas. The equipment set includes two (2) mobile compressor units (MCUs), both comprising high-pressure compressor and a gas piston engine. The specific benefit of the MCS use lies in the mobility of the unit, which can arrive at any remote site and store gas where there is no possibility of its utilization. The use of the MCS helps solve problems of energy conservation and minimization of the volume of bleed gas with maximum economic and environmental effect.

The calculation of the cost and estimate of the savings effect from implementation of gas saving activities involving mobile compressor stations (MCS) during pipeline repairs is presented below.

CAPEX	OPEX	Annual savings of fuel and energy resources			Simple payback period, years
th. USD		physical units	tns standard fuel	th. Tenge	
2 122.24	424.4	52148.584	61013.84	857689.73	1.35

2. Replacement of ineffective cathodic protection method with new design stations and anode grounding devices at CSs

Currently, the main gas pipelines are generally equipped with aged first-tier models of cathode protection based on the scheme with a two-half-period rectifier (converters V-OPED) and the second tier models (with the replacement of inactive rectifying elements with controlled ones (V-OPE-TM). The third-tier cathode stations (based on pulse conversion) appeared relatively recently (in the current century) (corrosion protection stations like PKZ-AR, NGK-IPKZ, SKZ-UPK).

The calculation of the cost and savings from the projected action for replacement of the ineffective cathodic protection stations with new generation of protection stations and anode grounding devices at the CSs are presented below.

CAPEX	OPEX	Annual savings of fuel and energy resources			Simple payback period, years
th. USD		physical units	tns standard fuel	th. Tenge	
788.68	157.736	11921.4	1466.35	209476	2.05

3. Repair of gas transmission compressor units

This activity implies the overhaul of gas turbine engines NK-12ST that meet all the present day requirements towards the gas compressor units. The estimate of the cost and saving from this activity is listed below.

CAPEX	OPEX	Annual savings of fuel and energy resources			Simple payback period, years
th. USD		physical units	tns standard fuel	th. Tenge	
1526.5	305.3	7168.91	8387.63	118 129.32	6.12

4. Increase of operating efficiency of power supply and lighting

This action implies replacement of inefficient sources of lighting with LED analogues, and so facilitate saving due to decrease in energy consumption.

Significant potential for energy saving is attributed to the automation of control and regulation of the lighting. Such action allows to use rational approach to switching on and off of the lighting, harmonize and match the use of the artificial light with the natural daytime light.

Manual control of the lighting system at the CS Poltoratskoye does not allow to adjust it to the change of actual intensity of the natural light. The rational power control and regulation of cost for external lighting may be ensured through the following actions:

- tuning up of the technical lighting part of lighting installations;
- adjustment of coherent operation of lighting networks and lighting control and regulation systems;
- rational approach to set up of lighting operation.

The estimation of the cost and savings of the activity for replacement of the interior lighting with LED lighting is presented below.

CAPEX	OPEX	Annual savings of fuel and energy resources			Simple payback period, years
th. USD		physical units	tns standard fuel	th. Tenge	
231.7	46.34	1782.05	219.19	31313.18	3.6

5. Replacement of outdated boilers with contemporary energy-efficient boilers

The proposed action implies implementation for replacement of the outdated boilers with modern energy-efficient types letting to decrease the cost for generation of the thermal energy due to reduced consumption of natural gas.

The estimation of the cost and savings of the activity for replacement of outdated boilers with modern energy-efficient types is presented below.

CAPEX	OPEX	Annual savings of fuel and energy resources			Simple payback period, years
th. USD		physical units	tns standard fuel	th. Tenge	
154.69	30.938	298.386	349.06	4918.4	14.88

6. Using the system for flushing the flow part of the compressors of the gas compressor unit, flushing the axial compressor of the gas turbine unit

Contamination of the blade apparatus of the axial compressor of the gas turbine drive leads to a noticeable decrease in power net capacity and efficiency. According to numerous studies by General Electric, Westinghouse, Gazprom, compressor contamination reduces its productivity by 5%, and the net capacity of the GT by 13%, while the specific heat consumption increases by 6%. To reduce the impact of contamination and protect the blade apparatus from the erosive effect of dust, filter systems are installed at the compressor inlet, after which the residual dust content is 0.3-0.45 mg/m^3.

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CAPEX	OPEX	Annual savings of fuel and energy resources			Simple payback period, years
th. USD		physical units	tns standard fuel	th. Tenge	
160.29	32.058	10126.783	11848.34	166878.023	0.6

7. Implementation of automated control systems telemechanics to improve the gas flows in the gas transmission network

Reduction in fuel combustion volumes on main gas pipelines is achieved by:

- planning that reduces the number of unnecessary compressions/decompressions due to maximum alignment of gas throughput with demand at different sections of the gas pipeline;
- bringing compressors to the most efficient operating mode.

The estimation of the cost and savings of the activity is presented below.

CAPEX	OPEX	Annual savings of fuel and energy resources			Simple payback period, years
th. USD		physical units	tns standard fuel	th. Tenge	
1 132.72	226.544	4 201.82	516.82	95 717.54	5.61

5.2. Basic steps towards introduction of the efficient LDAR Program for ICA

ICA constantly carries out integrated supervision, diagnostics, monitoring, as well as data collection and analysis in order to reduce methane emissions into the atmosphere at its facilities. Research to identify potential leaks is carried out using a variety of methods, such as aerial surveys, vehicle surveys, and patrolling inspections. Anyway, all methods rely on the use of remote laser methane detector:

- Optical methane detector like OMD, RMLD, ELLI;
- Methane leak intensity tester, Hi Flow Sampler.

In this regard, a phased implementation of the LDAR system is proposed for ICA. In the context of changing regulatory requirements and the growing importance of environmental responsibility, it is extremely important to develop and implement an effective leak detection and response (LDAR) program. It is important to understand that LDAR programs are individual for each of the companies, but use uniform principles that ensure their effectiveness. Below are recommendations based on best practices defined in the US Environmental Protection Agency (EPA) guidelines and detailed industry methods for managing equipment leaks. According to estimates by the International Energy Agency, Kazakhstan's technical potential for reducing methane emissions is 78%, with about 64% of reductions possible through measures that will pay off financially. For the gas transportation and distribution segment, this value is slightly lower, but also amounts to 53.6%.[9]

1. Defining Goals and Designing the LDAR Program

It is necessary to clearly define the goals of the LDAR program, and the main metrics that should follow from the overall program to reduce the company's carbon footprint and comply with legal requirements. Among the main target metrics that can be enshrined in the program, companies use the following:

• Percentage of leak detection and percentage of leak repairs within deadlines set in the program.

• Reduction of emissions by years and compliance with monitoring frequency (monthly, quarterly).

• Number of trained personnel.

Table 12 Estimated reduction potential with various leak detection inspection frequencies.[10]

Span	Share from total reduction	Potential for ICA, tns CO_2-eq	Cost of implementation, th. USD/ MBTU	Cost of implementation, th. USD / th.m^3 CH4
1 a year	11.3%	99 031.85	-4.57	-163.606
1 halh year	23.6%	206 316.36	-3.33	-119.214

[9] U.S. Environmental Protection Agency | US EPA
[10] Расчет на основании IEA-methane-abatement-OILGASdat Methane Abatement - Energy System - IEA

1 a quarter	7.6%	66 021.23	0.02	0.716
1 a month	2.5%	22 007.08	20.55	735.69

Identification and labeling of equipment

It is deemed important to conduct a detailed analysis of the equipment used and ensure its all significant units and components are properly marked with the assigned unique identification labels.

It should be noted that different types of components in various applications will also vary in terms of leak potential (i.e., different causes and probabilities of leaks occurring and different leak rates if a leak does occur). Typically, most emissions resulting from fugitive leaks from equipment in a facility will come from a few large sources rather than from many small sources. Although any component could theoretically become a large leak source, the most likely large sources are:

- Compressor seal holes.
- Vacuum relief valves.
- Leaking intermittent emission systems.
- Leaking vacuum relief valves, sample hatches and gauging well covers on tanks equipped with a gas blanket.

Accordingly, these components require the utmost attention. Thus, Table 9 presents a sample list of the characteristics of the gas pipeline system. Valves and fittings make up the vast majority of the entire parts list (97.96%), but they account for only relatively small emissions (13.0%), while open lines, purge systems and compressor seals make up only a very small portion of the entire parts list (1.7%), but they account for 86.7% of all emissions.

Unfortunately, the components that pose the greatest risk of leakage are also often the most difficult to access and are therefore often excluded from leak testing, thereby losing a significant reduction opportunity. Ideally, facilities should strive to install easy-to-access monitoring windows, test lines, or permanently engineered instrumented monitoring solutions to simplify the process of self-testing these components.

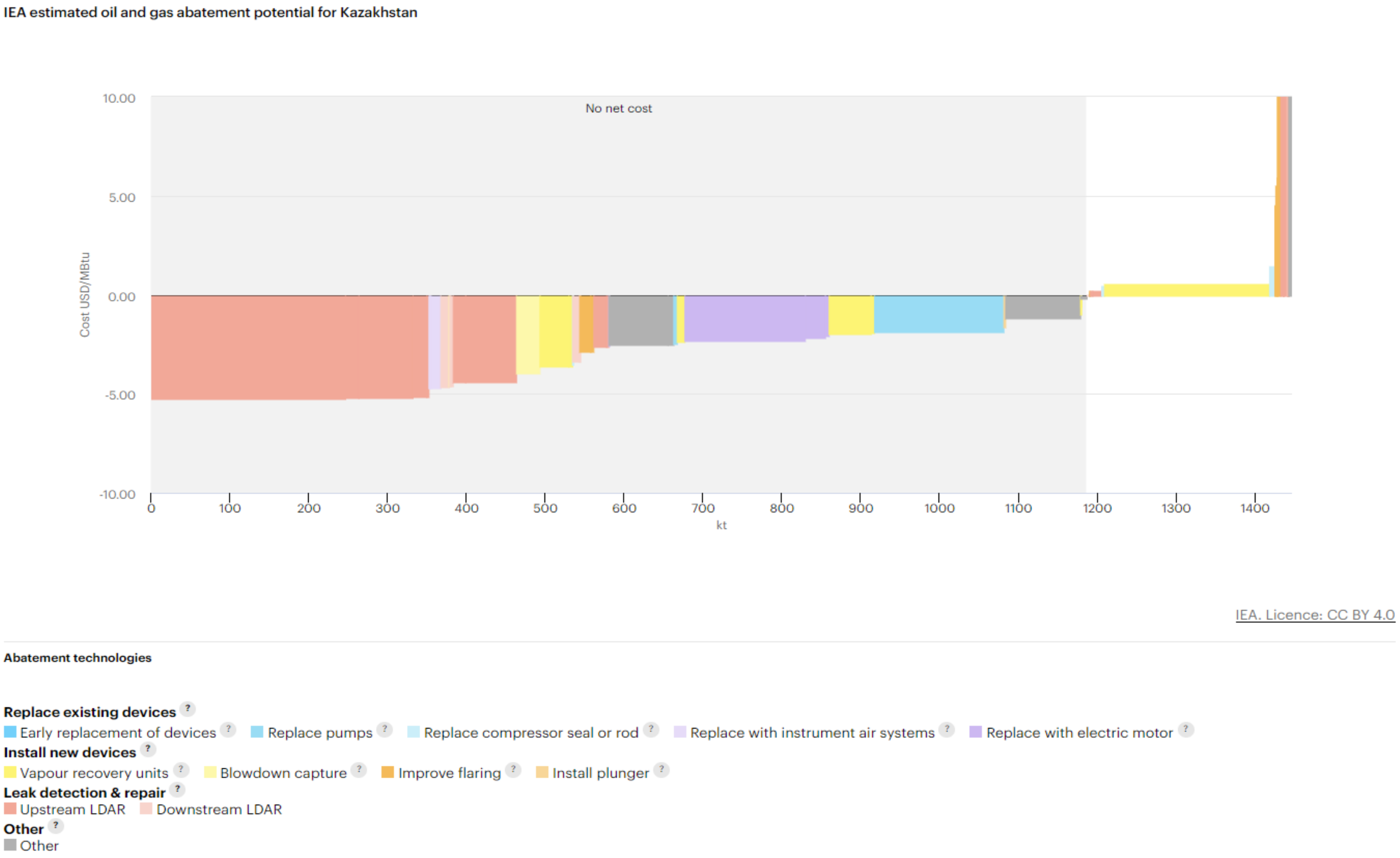


Figure 7. Methane emission reduction potential for Kazakhstan

Table 13. Example of Leak Statistics at a Gas Pipeline Facility

Basic category	Sub-category	Typical leak frequency (%)	Share in total parts list (%)	Share from all leaks cases (%)
Connecting parts	All	1.21	87.33	6.06
Valves	Control valves	14.65	0.27	1.34
	Isolation valves	3.98	10.36	5.63
Open lines	All	Н/д	1.33	28.27
Pressure dropping devices	All	14.65	0.20	14.21
Pressure regulation devices	All	16.28	0.30	0.25
Purging systems	Displacement / off-take station or compressor	73.53	0.08	18.38
	Piston compressor with damaged tightness	73.33	0.00	0.00
	Centrifugal compressor with damaged tightness	61.11	0.00	0.00
Compressor fittings	Piston compressor	86.11	0.06	10.62
	Centrifugal compressor	95.23	0.07	15.24
Flow meters	Flow metering orifices	20.19	0.00	0.00
	Other	2.63	0.00	0.00
Entire list	All	100	100.00	100.00

Source: According to research programs funded by a Canadian organization Canadian Energy Partnership for Environmental Innovation (CEPEI)

Thus, when developing this Program, it makes sense to set different testing span frequencies for different types of equipment. The testing span may also depend on the level of funding that the company has determined for itself.

3. Selection of research methods and equipment for leaks identification.

There is a wide range of measurement tools and methods that allow find leaks during surveys. The choice depends on the goals of the program for a particular company.

• Portable volatile component analyzers (Flame Ionization Detectors (FIDs), Photoion Detectors (PIDs)) for regular monitoring

• Infrared (IR) cameras, including for leak detection in hard-to-reach areas

• High-pressure ultrasonic gas leak detectors

• Smart sensors (for real-time leak detection)

• Visual inspection and organoleptic evaluation

The cheapest, but least effective is a visual inspection of equipment (including the use of soap solutions, search by smell), but this method can also be considered at the early stages of the program.

4. Personnel training

One of the most important aspects of developing and implementing an LDAR program is the personnel training, and both initial and contibuous training must be provided.

- **Initial training**: provide comprehensive training for the personnel on LDAR program objectives, inspection procedures, repair procedures, detection methods, regulatory requirements, hardware, and software.
- **Continuous training**: conduct regular upgrading courses and update staff on new technologies and regulatory requirements.

5. Introduction of a data storage system and a learning management system.

The best results from the implementation of LDAR programs are achieved by companies that have effectively established the storage of the information about implementation of the program, including the information on:

• equipment and components and attributed unique identification numbers;
• each performed testing with the date and time of such, results, causes of leaks, etc.
• method and testing techniques;
• leakage rates and volumes;
• and information on repairs.

The use of specialized software ensures the collection and processing of information is performed in a timely and speedy manner, however, depending on the goals and scale of the program, it is possible to use standard information processing tools or own corporate applications.

The information collected should be periodically analysed in terms of the causes of leaks, the main sources of emissions, the identification of patterns and the identification of best practices applicable to each station, main gas pipeline, etc.

In the course of the LDAR program implementation, it is critical to make this information available to operators, repair services, and other participants involved in the program. It is good practice to build and maintain a knowledge base on leaks and how to fix them.

6. Organisation of the quality control system and conducting audit of the program

Comparative experience in the implementation of LDAR programs by oil and gas companies has demonstrated that the best results are achieved when implementing processes that ensure quality control of the implementation of processes:

• Control of instrumental measurements;
• Quality control of repairs.

Depending on the goals of the program and its scope, it is possible to engage an independent auditor to confirm the results of the program/key metrics.

7. Regular monitoring and timely repair

Direct implementation of the activities involves regular scheduled inspections in accordance with the LDAR plan (e.g., monthly for high-risk equipment, quarterly for others) and timely repairs (e.g., within 5 days).

At the same time, each deviation should be recorded and analyzed from the point of view of the causes and the possibility of preventing a similar situation in the future.

Table 14 contains guidelines for the organization of directed (targeted) inspection and maintenance programs for various categories of facilities.

Table 14 U.S. EPA Documents from Natural Gas STAR Series for the conduct of Directed Inspection and Maintenance.

Наименование материала	**Capital Value (USD)**	**Assessed Payback**
Conduct Directed Inspection and Maintenance at Remote Sites, PRO Fact Sheet #901 [Reference booklet] (https://www.epa.gov/natural-gas-star-program/conduct-directed-inspection- and-maintenance-remote-sites).	<$1000	0–1 year
Directed Inspection and Maintenance at Gate Stations and Surface Facilities, Lessons Learned (https://www.epa.gov/natural- gas-star-program/directed-inspection- and-maintenance-gate-stations-and-surface-facilities).	$1000 – $10 000	0–1 year
Directed Inspection and Maintenance at Compressor Stations, Lessons Learned (https://www.epa.gov/natural-gas-star-program/directed-inspection-and- maintenance-gate-stations-and-surface-facilities).	$10 000 – $50 000	0–1 year

ICA constantly carries out comprehensive supervision, diagnostics, monitoring, as well as data collection and analysis in order to reduce methane emissions into the atmosphere at its facilities. Studies to identify potential leaks are carried out using a variety of methods, such as aerial surveys, vehicular surveys, and patrolling by foot waking. In this regard, it is proposed for ICA to take up a phased implementation of the LDAR system for the long term.

6. ADDITIONAL DECARBONISATION MEASURES FOR ICA

6.1. Acquisition and preservation of renewable energy credits and selective investments in nature-based solutions.

According to preliminary estimates of the Ministry of National Economy of the Republic of Kazakhstan, the implementation of this ambitious task will require $647.5 billion (according to the draft Carbon Neutrality Strategy of the Republic of Kazakhstan until 2060) over the next 40 years. At the same time, governmental funding are provided for the creation of a regulatory framework, as well as financial and physical infrastructure. Most of the funding, about 96.5% of the total, is expected from the private sector.

In Kazakhstan, by today, the basic legislative and regulatory framework for the development of the green finance market has been formed. The Environmental Code introduces a taxonomy of green projects, gives a legislative definition of green financing, specific tools for economic incentives for activities aimed at environmental protection. In December 2021, a taxonomy of green projects to be financed through green bonds and credits was adopted. The taxonomy provides clear definitions of the types and technologies of green projects, so that all market participants (banks, funds, investors, supervisory authorities, users) have the same basis for determining their tasks, programs and financial products, for example, the terms conditions for issuing green loans.

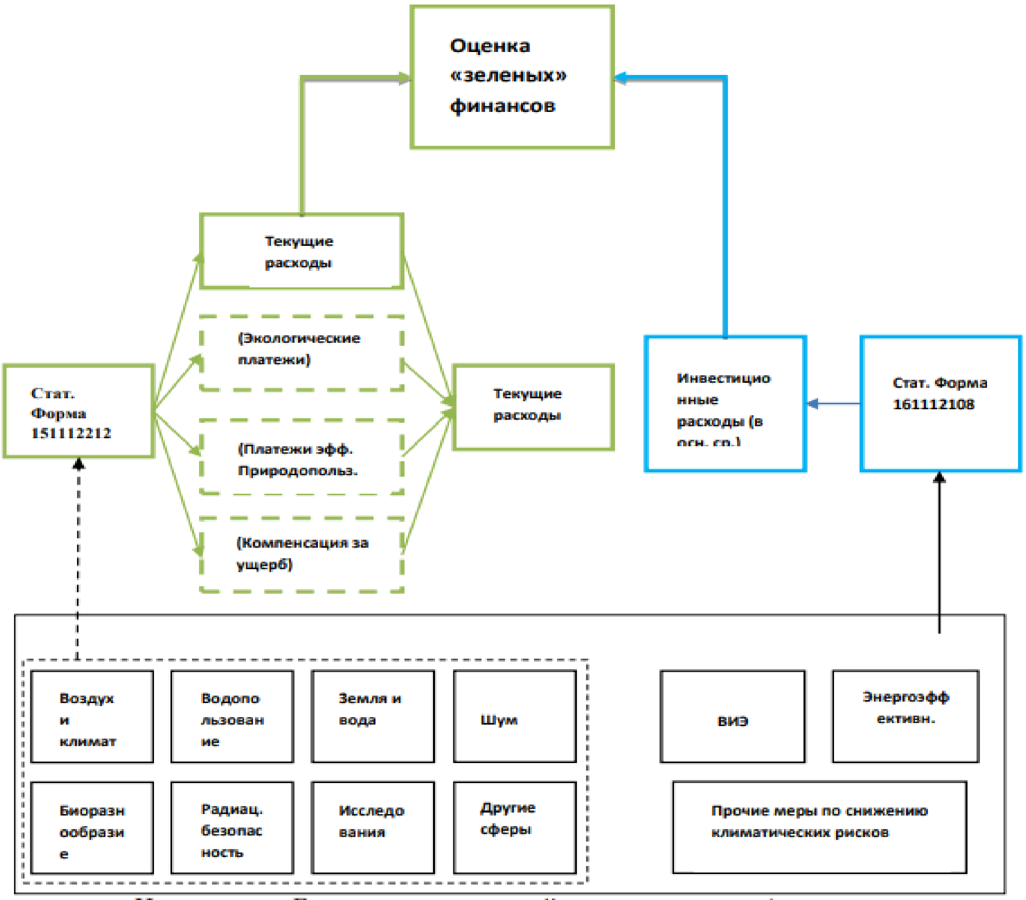
Together with Damu Entrepreneurship Development Fund, JSC, several financial instruments were tested to facilitate and increase their availability of green finance for SMEs in the energy efficiency and renewable energy (RES) sectors within the framework of UNDP and the Government of the Republic of Kazakhstan projects funded by the Global Environment Facility.

The instrument allowing to subsidise the principal debt and providing for repayment of up to 40% of the loan after the launch and acceptance of the project (technical verification), was introduced in 2022. Since 2018, the instrument of subsidising the interest rate on loans has been used, and 36 projects have been supported by paying an interest rate subsidy to the bank, reducing payments for debt financing.

One of the new tools is a loan guarantee (partial replacement of collateral). The principle is that the UNDP undertakes the obligation as a guarantor of debt repayment or performance of a contractual obligation on behalf of a green project to the bank in the event of default. Up to 85% of the loan amount for a period of 3 years is guaranteed. The guaranteed loan amount cannot exceed 350 million Tenge per project.

The combination of both instruments, a subsidy and guarantee makes it possible to support green projects that would otherwise be considered "high-risk" and for which the cost of borrowing would be prohibitive. As a result, the implementation of such a project would become impossible despite the environmental (reduction of CO_2 emissions), social (improvement of living conditions, creation of jobs) and economic (private investment) benefits of the project.

A good example of "green" financing is a comprehensive project for energy-efficient modernization and installation of renewable energy technology in the Zerenda Parus youth health camp. As a result of the measures implemented, electricity and heating bills were significantly reduced, and the savings were used to service the debt and reduced the cost of camp services. By improving the appearance of the buildings and ensuring the comfort of children during their stay in the camp, the "green" investments made the camp more competitive and allowed it to obtain a long-term contract with the state.



Источник: Бюро национальной статистики Агентства по стратегическому планированию и реформам Республики Казахстан.

Figure 8. Evaluation of green technologies

The most important element of the regulatory and legal framework is the "green" taxonomy of the Republic of Kazakhstan, which was prepared with the broad participation of Kazakhstan stakeholders and international organizations and entered into force on 1 July 2021. A prominent feature of the green finance model in Kazakhstan implies the leading role in the organization of green financing assumed by the Astana International Financial Center and incorporated under its structure of the Green Finance Center. At the same time, at the current, initial stage of development, the prevailing instrument is the issue of "green" bonds on the Kazakhstan Stock Exchange (KASE) with the participation of international financial institutions. The number of issues of such bonds, however, is still insignificant. Reviewing of statistical data on the financing of renewable energy projects, the share of which in the country's energy balance grew exponentially in 2019–2020, shows that the main source of funding is coming from development banks, including the national Development Bank of Kazakhstan ("the KDB"), and international institutions like the EBRD, AIIB, EDB, etc. At the same time, the share of renewable energy in the energy balance is still only about 3%, while coal (70%) and other types of fossil fuels still prevail.

The launching of the market and attraction of private investors presupposes the real and significant governmental support for green projects, an increase in the level of environmental awareness in the country, as well as consensus with energy consumers to implement a smooth energy transition, the development of new technologies and much more are needed. Therefore, it seems that Kazakhstan's transition to a low-carbon, circular and inclusive economy and the growth of green financing cannot be carried out in accelerated manner.

6.2. Investing in carbon dioxide (CO_2) capture and storage projects and exploring new ways to use the captured CO_2

CCUS/CCS (Carbon capture, usage and storage/ Carbon capture and storage) is the system for carbon capture, use and storage, which technologically represents the accumulation of gas directly at the source of its emission and allows its further usage.

So, in the United States 17 CCUS projects have been implemented as on 2022, resulting in reduction of greenhouse gas emissions to 22.7 million tons/year.

DAC (Direct Air Capture) is a system for direct capture of carbon from the air. Extraction of carbon dioxide from the ambient air using chemical (water alkaline solvent or sorbent) and physical (dehydration and compression) processes and its subsequent reinjection into the reservoir or feeding for the production of products.

Globally, up to day, 27 DAC installations have been commissioned worldwide, capturing about 0.01 million tons of CO_2 per year, with reinjection into the reservoir or re-direction to the production output.

Comparison of the main technologies for capturing CO_2 is presented in Figure 8.

Технология	Преимущества	Недостатки	Цена улавливания, \$/т CO_2	Масштаб	Извлечение CO_2, %	Потребление энергии, ГДж/тCO_2
Адсорбция	Зрелые технологии Низкая стоимость сорбентов Сорбенты можно регенерировать и использовать повторно	Высокие энергетические потери, вызванные необходимостью высокого давления для адсорбции CO_2 и температуры для регенерации сорбента. Периодическая регенерация сорбента легко приводит к быстрой деградации сорбента и его последующей замене	50-150	Большой	80–95%	4-6
Абсорбция	Большинство доступных растворителей дешевы и подходят для высоких температур.	Высокий расход энергии из-за регенерации сорбента Большие капитальные затраты, связанные с размером оборудования завода и высокоэффективным сорбентом	40-100	Большой	60-95	2.3–9.2
Мембраны	Высокая чистота и восстановление CO_2 Короткое время запуска и низкое энергопотребление Недорогое отделение CO_2	Низкая селективность для улавливания CO_2 Капиталоемкие для крупномасштабного применения Низкая активность наблюдается при концентрации CO_2 в потоке сырья менее 20% Не подходит для условий эксплуатации при высоких температурах. Сложность изготовления мембраны Короткий срок службы разделительной мембраны приводит к высокой общей стоимости	15-55	Маленький, средний	60-90	0,5-6
Криогенные технологии	CO_2 можно извлекать с высокой степенью чистоты Возможность работы при атмосферном давлении	Неэкономично для исходных потоков разбавленного CO_2 Состав сырья должен быть очищен от воды, чтобы предотвратить забивание льдом. Высокая потребность в энергии из-за охлаждения	55-130	Маленький, средний, большой	99,9	2,4-5,2

Источники: составлено по данным Singh J and Dhar DW (2019) Overview of Carbon Capture Technology: Microalgal Biorefinery Concept and State-of-the-Art. Front. Mar. Sci. 6:29. doi: 10.3389/fmars.2019.00029.

Figure 9. Basic technologies for CO_2 capture

Technologies for CO_2 capture, storage and productive use are at different stages of maturity, with most technologies, along the entire flow process chain as of 2021, are at the demonstration or large prototype stage.

Процесс улавливания	Достоинства	Недостатки
После сжигания	Более зрелые, чем другие альтернативные технологии Может легко встроиться в существующие установки	Низкая концентрация CO_2 влияет на эффективность улавливания
Перед сжиганием	Высокая концентрация CO_2 может повысить эффективность сорбции Возможность модернизации существующих заводов	Высокая потребность в энергии для регенерации сорбента Высокие капитальные и эксплуатационные расходы
Кислородное сжигание	Очень высокая концентрация CO_2, повышающая эффективность поглощения Уменьшение объема обрабатываемого газа и, следовательно, можно использовать оборудование меньшего размера.	Производство криогенного кислорода высокозатратно
Прямое улавливание из воздуха	Улавливание CO_2 из рассеянных источников Портативный и легко устанавливается на существующие объекты	Высокая стоимость изготовления систем DAC Высокое энергопотребление

Источник: Concawe, Technology Scouting - Carbon Capture: From Today's to Novel Technologies, 2020

ПРОЕКТ ОПЕРАТОР	СРАНА ВВОД В ЭКСПЛУАТАЦИЮ	ИСТОЧНИК CO2 ХРАНЕНИЕ, МЛН. Т/ГОД	ТИП ХРАНИЛИЩА ГЛУБИНА, М
Sleipner Equinor (Statoil)	Норвегия 1996	Газопереработка 1,0	Водоносный горизонт 800 - 1100
Snohvit Equinor (Statoil)	Норвегия 2008	Газопереработка, СПГ 0,7	Водоносный горизонт 2 600 – 2 700
QUEST Shell	Канада 2015	Нефтепереработка 1,2	Водоносный горизонт 2 000
Illinois Industrial Archer Daniels	США 2017	Производство этанола 1,0	Водоносный горизонт 2 100
Gorgon Chevron	Австралия 2019	Газопереработка, СПГ 4,0	Водоносный горизонт 2 500

Источник: Global CCUS Institute, The Global Status of CCUS Report, 2020

Figure 10. Examples of CO_2 capture technology

Carbon dioxide removal begins with carbon capture. CCUS is a proven technology with a steady trend for decreasing cost. The cost of CO_2 capture depends on the source of CO_2 and the method of its extraction. CO_2 sources are divided into transient and point-source, and atmospheric carbon (see diagram).

Highly concentrated sources typically have lower CCUS costs. The potential of CCUS as a technology solution can be assessed across the entire value chain. CO_2 can be captured at the emission source, such as a power plant, or can be captured directly from the air using membranes or solvents. The collected concentrated CO_2 can be transported through pipelines for subsequent use as a feedstock or for underground storage..

This review examines the CCUS technology portfolio as well as natural carbon adsorbents.

Technologies are divided into several groups like specialized carbon capture technologies, including the fossil fuel CCS technologies, direct air capture (DACCS), bioenergy using CCS technologies (BECCS); and carbon storage technologies like storage in mineralized aquifer rocks, enhanced oil recovery; and carbon use technologies.

While some CCUS technologies can be considered mature, such as CO_2 capture from high purity sources or EOR as a storage option, the implementation of integrated commercial CCS projects is still a matter of aspiration.

Large-scale CO_2 capture is being demonstrated in the power generation and some industrial sectors, with large-scale demonstration projects in operation or underway. However, much remains to be done to scale up and overcome the current lack of experience, in parallel with the development and integration of carbon capture, transport and storage infrastructure.

CCUS also facilitates the production of low-carbon hydrogen, which is expected to play a key role in achieving carbon neutrality.

This option is mainly relevant for countries with low-cost natural gas reserves and available CO_2 storage and could be attractive for a large part of the UNECE member countries located in the east.

The following steps are considered necessary for the successful development of CCUS projects:

- Set up of a register of depleted deposits suitable for CO_2 storage.

- Search for and data filing of mineralized aquifer rock formations, especially near emission sources, assessment of possible CO_2 storage volumes.

- Establishing of a register of large companies suitable for using CO_2 capture technology, and formation of clusters of companies based on geographic principles.

- Maintaining of mechanisms to stimulate the development of CCUS projects.

- Creation of pilot CCUS projects in various industries independently and in partnership with foreign companies.

Figure 11. Carbon capture, use and storage (CCUS)

6.3. Biomethane

This product has a lower carbon footprint along with high quality characteristics. According to the ExxonMobil 2022 Energy Report, by 2030, global demand for biofuels will increase by 73% compared to 2017, and the growth in demand for petrochemical products in such conditions will increase by 42%, for gasoline by 5%, for diesel fuel by 1% over the same period.

Biomethane (or green gas) is obtained from biogas, which is produced from various types of biomass, that is organic waste (primarily manure from farm animals), sewage sludge, plant waste, etc., usually by anaerobic fermentation or gasification. Biogas contains 50–70% methane, 25–50% CO_2, minor impurities of hydrogen sulfide, ammonia, nitrogen oxides and other compounds.

After cleaning biogas from CO_2 and impurities, biomethane is obtained, being a complete analogue of natural gas, only "extracted" from a renewable source. Accordingly, biomethane is able to functionally replace natural gas in all areas of application. It can be easily stored and supplied throughout the energy system, using the existing gas infrastructure. The use of biomethane in GCUs is a promising direction for reducing greenhouse gas emissions and improving the environmental friendliness of production.

Advantages of using biomethane in GCUs:

- Reduced greenhouse gas emissions: Biomethane is a carbon-neutral fuel, as its production and combustion does not result in the release of additional carbon dioxide into the atmosphere.
- Economic benefits: In some cases, the use of biomethane can be more economically advantageous than the use of natural gas, especially in regions with developed infrastructure for the collection and processing of organic waste.
- Creation of new jobs: The development of the production and use of biomethane creates new jobs in various industries, including agriculture, waste processing and energy.

Challenges of using biomethane in GCUs:

- Infrastructure: the use of biomethane in GCUs requires the availability of appropriate infrastructure, including organic waste collection and processing stations, gas pipeline networks and biomethane storage facilities.
- Technologies: it is necessary to implement technology improvements in order to obtain high-quality biomethane that meets GCUs requirements.
- Economic feasibility: the cost of producing biomethane may be higher than the cost of natural gas, which may make its use less economically viable.
- Regulation: a clear legislative framework needs to be developed to regulate the production, use and certification of biomethane.

6.4. Hydrogen

Natural gas will play an important role in the transition to a low carbon future in key markets in developed and developing countries, both through its use as a backup fuel for renewable energy capacity in electricity markets or to scale up the production of low-emission “blue” hydrogen, and through its continued use in sectors where decarbonisation is problematic (such as heavy industry). Gas will continue to act as a “bridge” in the transition in many ways.

Natural gas is the basis for the development of a new industry - hydrogen energy. Experts have confirmed that the most promising and economically viable method is to obtain hydrogen from natural gas.[11]

It is common to distinguish color gradations of hydrogen, corresponding to the degree of its environmental friendliness and the method of production. Currently, about 75% of the world's hydrogen production is "gray" hydrogen. To obtain it, natural gas is heated and mixed with steam, which is the cheapest and at the same time the least environmentally friendly way to produce hydrogen. In this process, a large amount of carbon dioxide is released. More than 20% of hydrogen is of the "brown" or "brown" type. It is obtained by gasification of coal. This method also leaves behind greenhouse gases. “Blue” hydrogen is obtained from natural gas, while harmful waste is captured for reuse. However, this method cannot be called perfectly clean, since carbon dioxide must be disposed of, which reduces the economic efficiency of energy. “Pink” or “red” hydrogen is produced using nuclear energy. To obtain “turquoise” hydrogen, natural gas is heated to 900 ° C in a vacuum. The by-product of this production method is solid carbon, which can be used in industry and easily disposed of.[12]

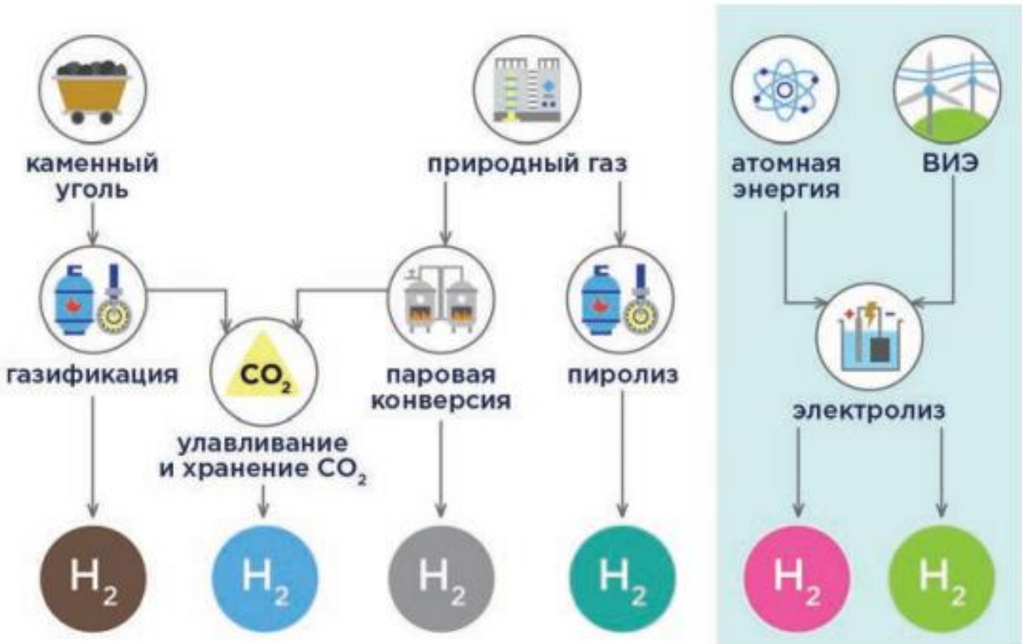


Figure 12. Ways of obtaining of hydrogen fuel

The production of pure hydrogen in the world is about 70 million tons of hydrogen per year. By that, 98% of hydrogen is produced from carbon fuel: from natural gas (76%) and coal (22%). To produce 70 million tons of hydrogen (the annual production of H_2 in the world) by electrolysis, about 3600 billion kWh (10% of the world's annual electricity production) will be required.

The most environmentally friendly is considered to be "green" hydrogen, as it is produced from renewable energy sources (RES) by water electrolysis. All that is needed for this is water, an electrolyzer and a large volume of electricity. It is "green" hydrogen that is being relied upon in alternative energy, since in the future it can completely replace fossil fuels.

[11] NC QazaqGaz, JSC, Sustainable development
[12] Hydrogen power generation: key development areas, revision of plans, investments (xn--80aaigboe2bzaiqsf7i.xn--p1ai)

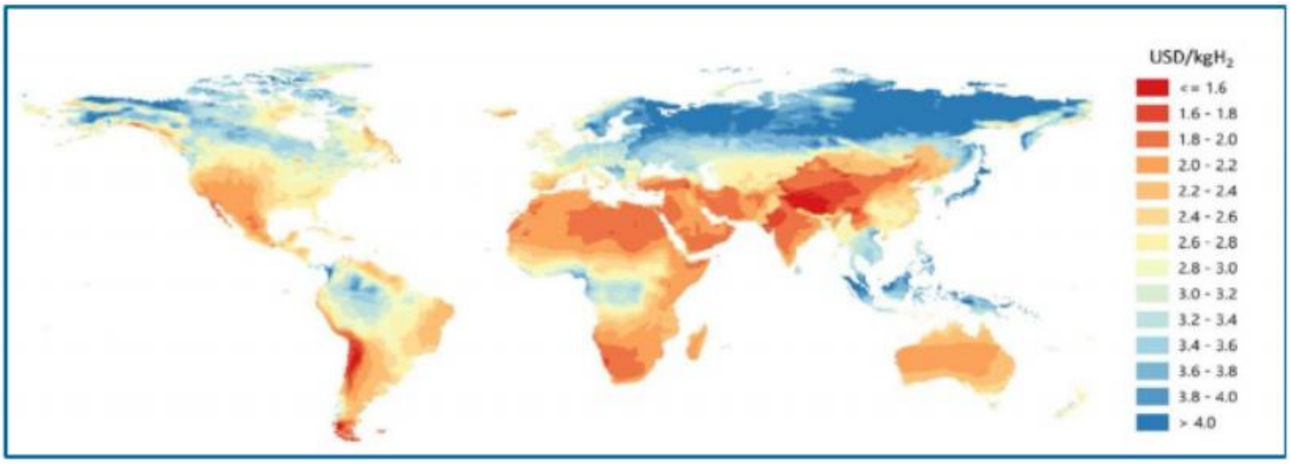


Figure 13. Hydrogen Cost Forecast for Energy Systems Based on Continental Wind and Solar Power Plants [13]

Figure 13 shows the International Energy Agency (IEA) forecast of the cost of producing "green" hydrogen for energy systems based on continental wind and solar power plants, taking into account the geographical features of different countries. According to this forecast, the cost of "green" hydrogen in the Republic of Kazakhstan will be quite high.

Today, the development of hydrogen energy is hampered by a number of serious barriers:

• high production costs of “renewable” and “low-carbon” hydrogen;

• lack of optimal and affordable technologies for transporting and storing hydrogen;

In particular, according to the Hydrogen Council for 2021, the production of blue and green hydrogen is accompanied by a high level of costs.[14]

A promising opportunity is to increase revenues from the production and sale of green and blue hydrogen. However, in the long term, this opportunity is not considered, as hydrogen will become a universal commodity by 2100, and it is expected that there will be no significant increase in profits or sales volume compared to the near and medium term.

6.5. Carbon offsets

Investments in offset programs occupy a special place in the decarbonisation strategies of US oil and gas companies. They can be divided into natural (Nature-based): investments in land use, forestry, soil enrichment and likewise, and technological (Technology-based), focused on energy efficiency and energy intensity, as well as the transition to other types of fuel, management of obsolete wells stock, waste disposal and reduction of fugitive emissions.

The basic concept of carbon offset is the assumption that the Earth has an indivisible atmosphere, and damage from pollution in a particular country affects the atmosphere as a whole. Therefore, it is possible to achieve carbon neutrality by compensating emissions, by financing a project to reduce emissions. According to the Environmental Code, carbon offset is construed as a reduction of greenhouse gas emissions and (or) an increase in greenhouse gas absorption achieved as a result of activities or types of activities in any sectors of the economy aimed at reducing greenhouse gas emissions and (or) increasing greenhouse gas absorption.

There are two types of carbon markets: the regulated carbon market and the voluntary carbon market.

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[13] *Source; The Future of Hydrogen,-IEA,2019*

[14] *Hydrogen energy: key development directions, revision of plans, investments (xn--80aaigboe2bzaiqsf7i.xn--p1ai)*

The regulated carbon market is under governmental control. Participants in this market are involved in trading carbon credits (carbon offsets) to meet their statutory obligations to reduce greenhouse gas emissions within the quota limits allocated internationally in accordance with international treaties. Emissions trading under this mechanism is provided for by the Paris Agreement (2016). However, an obvious disadvantage of the regulated carbon market is that it is limited by the borders of one state or region and is available only to a limited number of participants who meet certain legal requirements. Trading with carbon credits (carbon offsets) in the regulated carbon market can be carried out both within a country participating in the Paris Agreement and between countries on the basis of multilateral agreements.

The voluntary carbon market mechanism, on the contrary, allows any carbon emitters to offset their unavoidable emissions by purchasing carbon credits obtained as a result of implementing projects aimed at removing or reducing greenhouse gas emissions from the atmosphere. The voluntary carbon market is usually regulated by independent private Programs (Standards), which ensure equal access to the market, guarantee the quality of the carbon offsets provided and are aimed at stimulating participation in the trading of carbon credits. Notable examples of such Programs (Standards) are Verra and the Gold Standard.

According to the carbon offset concept provided for in the Environmental Code, the carbon offset mechanism is limited by the country's borders and is fully regulated by the state. Thus, a regulated market of carbon units operates in Kazakhstan. In addition, the Environmental Code limits the entities subject to quotas. Thus, the subject of quotas is recognized as the operator of a quota-covered installation, the volume of quota-covered greenhouse gas emissions of which exceeds 20,000 tons of carbon dioxide per year in certain sectors of the economy.

6.6. I-REC Certificates

An I-REC Certificate is a documented entry in the I-REC registry that a generating facility or group of generating facilities registered in the I-REC registry has produced electricity from a specific source (e.g. solar power). Generating companies sell their green certificates to intermediaries or end users – corporations that want to be able to claim that they have fully or partially switched to consuming renewable electricity.

Voluntary I-REC certificates confirm information about the fact of electricity production from a renewable energy source (RES). The certificate is tied to 1 MWh of clean electricity, the geographic location of the power plant and the time period of electricity generation. They are issued on the basis of an international standard developed by The International REC Foundation and are recognized by such international organisations as GHGP, CDP, RE100, ISO, etc. I-REC certificates are traded worldwide and are issued in 51 countries.

Companies that purchase I-REC certificates can, in accordance with international practice, declare a reduction in GHG emissions associated with the use of electricity within Scope 2. At the same time, “green” certificates allow companies producing “green” electricity to receive a new market mechanism for financial support through the sale of such certificates.

The issuer of I-REC certificates was approved by the Association "ECOJER", which maintains the records of registrants in I-REC, verifies documents confirming the origin of electricity from renewable energy sources, and issues certificates at the request of registrants.

By purchasing "green" certificates, ICA will demonstrate its commitment to sustainable development and ESG principles, it implements the progressive implementation of the corporate program to reduce the carbon footprint, providing financial support for the development of renewable energy sources.

6.7. Supporting SBTi initiatives

SBTi is an initiative that helps companies set GHG emission reduction targets in line with the recommendations set out in the assessment reports of the Intergovernmental Panel on Climate Change (IPCC).

SBTi (Science Based Targets initiative) is a global initiative that helps companies set science-based targets to reduce greenhouse gas emissions. For companies involved in natural gas transportation, participation in SBTi presents both challenges and opportunities.

Opportunities:

• **Reducing methane emissions**: SBTi can provide incentives for companies to implement technologies and practices that reduce methane leaks during transportation.

• **Improved efficiency**: SBTi can encourage companies to improve operational efficiency, which will reduce emissions associated with energy consumption.

• **Increased transparency**: Participation in SBTi will allow a company to publicly communicate its emissions reduction goals, increasing its transparency and credibility with investors and consumers.

• **Creating a competitive advantage**: Implementing science-based emissions reduction targets can create a competitive advantage for a company by being perceived as more responsible and sustainable.

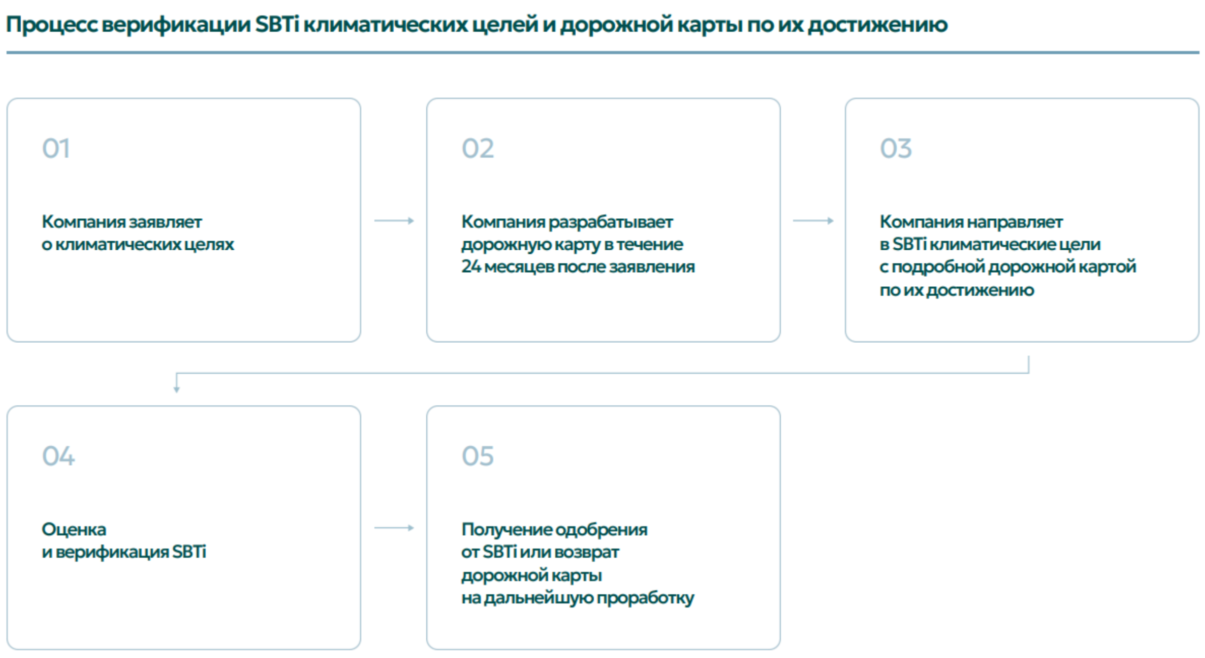

Figure 14 SBTi Verification Process

Participation in SBTi is a valuable step for a natural gas transportation company to enhance its environmental responsibility and sustainability. While the process requires effort and resources, the resulting benefits in terms of reduced emissions, increased transparency and competitive advantage make this initiative attractive to companies in the sector.

7. IMPLEMENTATION PLAN FOR THE DEEP DECARBONISATION SCENARIO FOR ICA, JSC

According to the Concept, the Samruk-Kazyna Fund sets a strategic goal of reducing emissions by 10% by 2032 compared to 2021 and aims to achieve carbon neutrality by 2060 under the Deep Decarbonisation scenario. The NC QazaqGaz is committed to low-carbon development goals, setting a goal to reduce its carbon footprint by 10-12% by 2032, and will strive for carbon neutrality by 2060. JSC ICA, as a subsidiary of the NC QazaqGaz in its role of a company engaged in the transportation and storage of natural gas, has significant leverage that can influence the achievement of these goals.

Table 15 Deep Decarbonisation Scenario for ICA JSC

Purpose	**Activity**	**Short-term perspectives**									**Long-term perspectives**	**Estimated potential for reduction in % of total emissions 2021 in CO_2-eq**
		2024	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033–2060**	
Reduction of methane emissions (Scope 1)	LDAR, repair of centrifugal compressors											от 5%
Reduction of emissions from combustions (Scope 1)	Implementation of the program of measures for energy saving and increasing energy efficiency	Deep Decarbonisation										от 15%
Reduction of emissions from power generation (Scope 1 and 2)	Transition to RES										Deep Decarbonisation	от 3 %
Additional actions	Offsets etc..											от 8%
	Financial instruments for offsetting emissions											от 4%

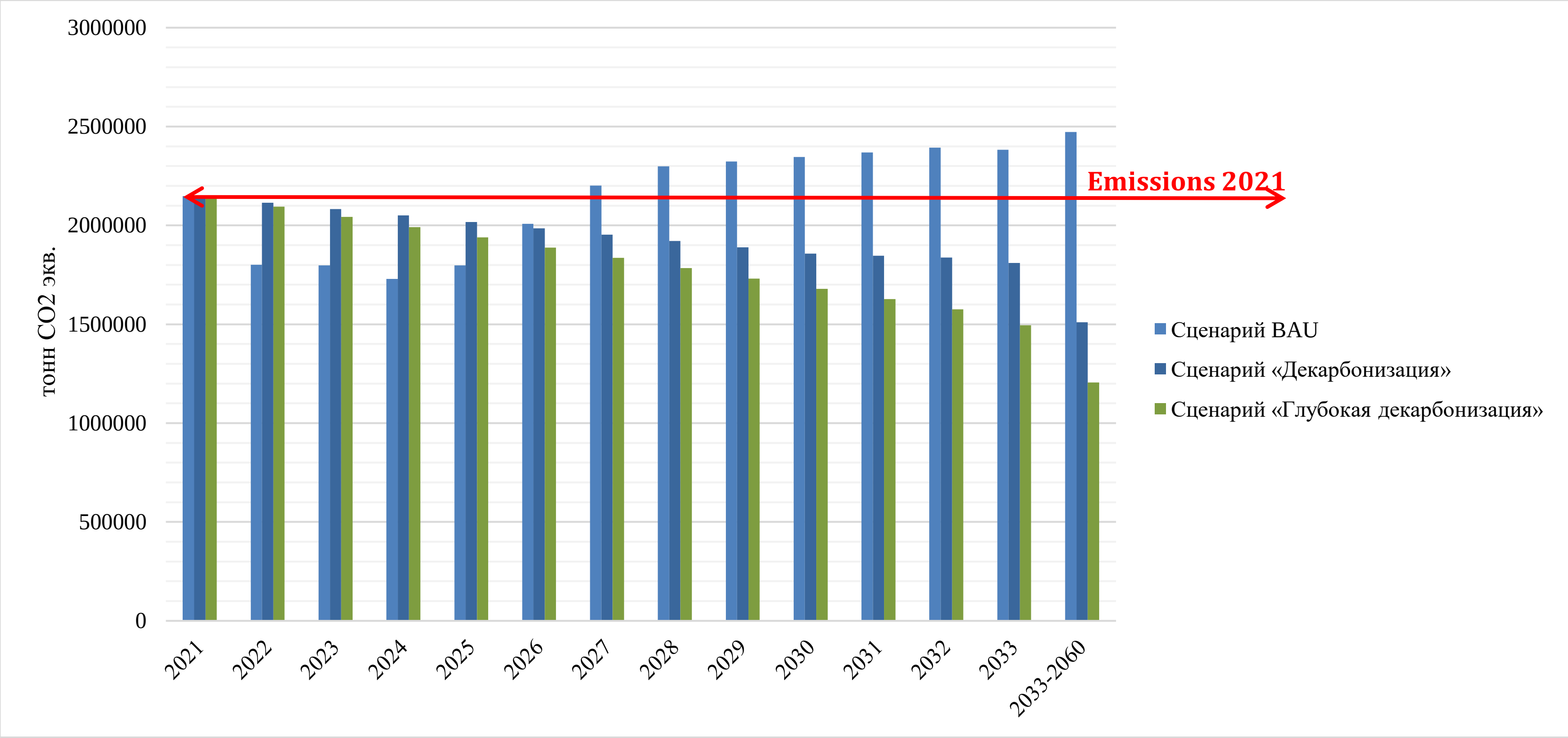

Figure 15. Scenario-based potential for reducing greenhouse gas emissions of ICA under three scenarios. (in tons CO_2-eq)
Blue- BAU scenaio
Dark blue- Decarbonisation scenaio
Green – Deep Decarbonisation scenaio

8.CONCLUSIONS

1. The current obligations of the Republic of Kazakhstan for reduction of greenhouse gases emissions that are stated in the Strategy for Achieving Carbon Neutrality of the Republic of Kazakhstan by 2060, adopted by the country within the framework of the Paris Agreement, commitments within the framework of the global GCPC initiative, as well as general global trends, including, for example, the Global Methane Commitment, emphasize the importance for each company in the Republic of Kazakhstan to develop and implement its own low carbon development program.

2. The NC QazaqGaz is committed to low carbon development goals, setting a goal to reduce its carbon footprint by 10-12% by 2032, and will strive for carbon neutrality by 2060. ICA as a subsidiary of the NC QazaqGaz in its role of a company engaged in the transportation and storage of natural gas, has significant leverage that can influence the achievement of these goals.

3. About 98% of ICA emissions fall within Scope 1 and the vast majority of such direct emissions are carbon dioxide emissions (CO_2) resulting from the combustion of natural gas at the GCU and direct methane emissions (CH_4) and it is their reduction that should become the focus of further development of ICA. In this case, it is possible to apply technical actions, organizational actions or compensation measures.

4. The main reduction of direct CO_2 emissions is possible due to the reduction of energy consumption (the main source of which is fuel gas). ICA has been effectively implementing an energy efficiency improvement program over the past few years, and its continuation is the key to reducing emissions. In addition to the measures already outlined in the program, it is necessary to pay attention in the medium and long term to the dissemination of best practices between structural branches, UMGs (equipment condition, repair schedules, operating modes, etc.), since there are significant differences in the energy efficiency of various UMGs.

5. To reduce direct emissions and CH_4 losses, the International Energy Agency considers it is most effective to apply the following:

- Development and implementation of a leak detection and elimination (LDAR) program.
- Electrification of the compressor station.
- Repair and replacement of gas compressor units (including the transition to compressed gas as a working gas).
- Use of vapor and emission capture technologies (including the use of MCS).
- Improvement of the flare system.

The implementation of such measures, according to the Agency's assessment[15], has the potential to reduce overall emissions in the gas transportation and storage segment by up to 50%.

6. The large-scale implementation of these actions would potentially require significant investments and may not be feasible for the Decarbonization scenario in a volume greater than that already planned, for example, under the Energy Saving and Energy Efficiency Measures Program.

7. The only activity not taken into account in the ICA's activities at the moment, is the development and implementation of a leak detection and elimination program (LDAR), which is advisable to consider in the medium term with gradual scaling.

8. Successful implementation of the LDAR program is possible if a number of requirements are met:

- Defining the objectives and designing the LDAR Program.

[15] *IEA – International Energy Agency*

- Identification and labeling of critical equipment.
- Proper selection of research methods and equipment for detection of leaks and conducting personnel training.
- Implementing a data storage system and a knowledge management system.
- Organizing a quality control system and conducting program audits, and regular monitoring and timely repairs.

9. Among other activities in the field of low carbon development, it is necessary to consider the development and use of renewable energy sources. For this purpose, it is advisable to attract external financing in the form of "green" loans. One of the existing mechanisms provides for debt subsidies with the repayment of a significant portion after the launch of the project and the provision of guarantees from UNDP. Active support for renewable energy projects is provided by development banks, including the national Development Bank of Kazakhstan, and international ones, the EBRD, AIIB, EDB, etc.

10. An actively developing area in global practice is CO_2 capture, storage and use (CCUS). There are currently no widely used commercially available technologies, but it is necessary to study the potential for their development and application for the needs of ICA, JSC. It is necessary to consider the possibility of using offsets that will allow achieving decarbonisation goals that cannot be achieved through technological and organizational measures.

11. By purchasing "green" certificates, ICA will demonstrate its commitment to sustainable development and ESG principles, it implements the progressive implementation of the corporate program to reduce the carbon footprint, providing financial support for the development of renewable energy sources.