Ministry of Natural Resources, Ecology and Technical Supervision
of the Kyrgyz Republic

Technology Needs Assessment Report

Part II
Mitigation Technologies Prioritization

Supported by

GREEN CLIMATE FUND

CTCN
CLIMATE TECHNOLOGY CENTRE & NETWORK

UN environment programme | copenhagen climate centre
supported by UNOPS

Bishkek, January 2023.

Technology Needs Assessment for Mitigation Technologies

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Abbreviations

BAU	Business as usual – scenario without measures
BUR	Biennial Update Report under UNFCCC
CFC	Climate Finance Centre in the MNRETS
CNG	Compressed Natural Gas
CTCN	UN Climate Technology Centre and Network
FOLU	Forestry and Other Land Use
GCF	Green Climate Fund
GEF	Global Environment Facility
GDP	Gross Domestic Product
GHG	Greenhouse Gases
HPP	Hydropower Plant
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Process and Products Use
LTS	Long Term Strategy for Climate Neutrality by 2050
MCA	Multi-criteria analysis
MNRETS	Ministry of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic
MSW	Municipal solid waste
NATCOM	National Communication under UNFCCC
NDA	National Designated Authority
NDC	Nationally Determined Contribution
NDP	National Development Programme
NDS	National Development Strategy of the Kyrgyz Republic for 2018-2020
NSC	National Statistic Committee of the Kyrgyz Republic
RCP	Representative Concentration Pathway
SWG	Sectoral Working Group
TAP	Technology Action Plan
TFS	Technology Fact Sheet
TNA	Technology Needs Assessment
TPP	Thermal Power Plant
UNEP	United National Environment Programme
UNEP-CCC	UNEP Copenhagen Climate Centre
UNIDO	United Nations Industry Development Organization
UNFCCC	United Nations Framework Convention on Climate Change
WM	Scenario "With Measures", which will be implemented funded by the national finance
WAM	Scenario "With Additional Measures", which can be implemented under condition of international support funding

Chemical formulas and units used

CO_2	Carbon dioxide
CH_4	Methane
N_2O	Nitrous oxide
HFC	Hydrofluorocarbons

Gg	Gigagram = 1,000 tons, 1 kiloton
kWh	KiloWatt-hours
MW	MegaWatt
TW	TeraWatt
GCal	GigaCalories
TCE	Tons of coal equivalent
TOE	Tons of oil equivalent
J	A joule is a unit of measure for energy and heat amount in the International System of Units (SI).

Decimal prefixes to the units used

Factor	Prefix		Symbol		Measure
	Russian	International	Russian	International	
10^1	дека	deca	да	da	Increase of the original unit by 10 times
10^2	гекто	hecto	г	h	- hundred times
10^3	кило	kilo	к	k	- thousand times
10^6	мега	mega	М	M	- million (10^6) times
10^9	гига	giga	Г	G	- billion (10^9) times
10^{12}	тера	tera	Т	T	- trillion (10^{12}) times
10^{15}	пета	peta	П	P	- quadrillion (10^{15}) times
10^{18}	экса	exa	Э	E	- quintillion (10^{18}) times
10^{21}	зетта	zetta	З	Z	- sextillion (10^{21}) times
10^{24}	иотта	yotta	И	Y	- septillion (10^{24}) times

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Executive Summary

This Technology Needs Assessment Report presents analysis and outputs of the prioritisation of the mitigation technologies in the Energy and Waste sectors undertaken in the Kyrgyz Republic (Kyrgyzstan) in 2022 with the support from GCF and UNEP CCC.

Chapter 1 Introduction provides information about the TNA project and existing policies on climate change and technology frameworks. It also describes briefly the national circumstances, including the country's geography, climate, natural resources, demography, economy, social development, etc.

The chapter also provides information on the National GHG Inventory data from the Kyrgyz Republic BUR 1, NATCOMs and mitigation measures mentioned in the updated NDC. Finally, it provides information on the subsector selection and the future GHG emission projection till 2050, as well as the NDC-defined mitigation measures.

Chapter 2 is devoted to the institutional arrangement for the TNA and the stakeholder involvement. It presents the National Steering Committee, and the Sectoral Working Groups (with corresponding TORs annexed to Part I of TNA Report on Mitigation). It provides information about the National TNA Coordinator and the team of National Consultants. It also provides the overall assessment of the stakeholder engagement. Gender equality provisions within the TNA project are also given there.

Chapter 3 Describes the technology prioritisation in the Energy Sector, providing information about the GHG emissions of the energy sector also including the projections of future GHG emissions under three business-as-usual scenarios.

The decision-making context and an overview of the existing energy technologies are also presented in the same chapter. The list of the energy specific technologies options is presented there, too, as well as the long list for the multi-criteria analysis (MCA). This chapter also presents the selection criteria and the detailed steps of the TNA process, as well as MCA matrixes. The following major steps have been taken in the assessment process:

- Established an organizational structure and facilitated stakeholder engagement
- Defined implications of climate change for the country’s development priorities and strategies
- Prioritized sectors and subsectors and selection criteria
- Identified of technologies as high priorities for climate change mitigation

The results of the technology prioritisation in the Energy Sector include the following:

1. Natural gas for household heating instead of coal
2. Insulation of existing buildings
3. Energy efficiency stoves for residential sector

Chapter 4 provides information about the TNA in the Waste Sector and its GHG emissions data as per sources,the future GHG emission projection until 2050 and mitigation measures proposed in BUR 1, NATCOMs and updated NDC.

After the overview of existing in the waste sector technologies, the chapter provides information on the mitigation technology options, presenting the corresponding long list, criteria and the weights, MCA matrixes and a short list of prioritised technologies including the following:

1. Mechanical and biological treatment of MSW
2. Use of organic waste as raw material for biogas plants
3. Use of organic waste from wastewater treatment for biogas plants

In addition, several other mitigation technologies options discussed within the TNA process were included into the pipelines of both sectors for further elaboration and resource mobilization initiatives.

The implementation of these technologies would require strengthening of the policy framework through the development of supporting strategies, laws, regulations, and other documents to speed up the deployment of these technologies. For this, a stocktaking exercise to analyse existing gaps and barriers to improve enabling frameworks will be undertaken. Arising recommendations for improvements to deploy and diffuse prioritised mitigation technologies in the Energy and Waste sectors will then be accumulated into the Technological Action Plans (TAP). To mobilise financial resources in order to start its implementation, GCF format Concept Notes will be additionally developed based on the TAP.

Kyrgyzstan has committed to implement policies and measures aimed at low-emission development, corresponding to the Long-Term Strategy for Carbon neutrality till 2050 currently under development in the Kyrgyz Republic. Activities related to mitigation in the context of climate change are already being implemented in the framework of national and state programmes, national and regional programmes and plans.

Chapter 1 Introduction

1.1 About TNA Project

GCF funded UNEP CCC implemented on behalf of the CTCN project "Technical Guidance and Support to Conduct a Sectoral Technology Needs Assessment (TNA) and a Technology Action Plan (TAP) for the Kyrgyz Republic" was launched in 2021. It has three relevant GCF Readiness areas of interest:

- Capacity Building
- Strategic frameworks,
- Investment pipeline development.

This Readiness Support project aims at establishing a climate technology framework in the country to help it achieve a steady climate resilient socio-economic development. This will be done through developing a comprehensive Sectoral TNA and ending with TAP for the prioritised by the Sectoral Working Groups (SWG) mitigation technologies. This work will support the country in achieving its international climate targets stated in the Updated Nationally Determined Contribution (NDC), the Third National Communication and the Green Climate Fund (GCF) Country Programme by utilizing and disseminating and deploying the most appropriate climate technology solutions.

The project targets the country's key economic sectors – agriculture, energy, water and solid waste management, since they can hardly meet the country's socio-economic development and climate resilience objectives due to being dependent on outdated technologies. It addresses a number of barriers preventing the country from utilizing modern technologies in these sectors:

1. A comprehensive system to develop and implement a sectoral TNA is lacking among concerned country stakeholders. There is no formal coordination mechanism to oversee and structure these efforts.
2. The country lacks a strategic framework to improve sectoral expertise in climate technologies. It needs to identify and prioritise the most appropriate technologies for different sectors of the economy but does not have a methodology to do so and has no action plan to deploy climate technologies on the ground.
3. No robust climate sensitive technology-project proposals are being formulated in the country, which leaves it lacking funding inflows into its climate-technology projects and further delays climate-technology deployment.

At present, the Kyrgyz Republic has a number of country programmes and national strategies to achieve its international climate targets and commitments. However, major sectoral, policy, institutional, financial, technological, as well as capacity challenges prevent the country from strengthening its climate-change preparedness. In this context, the TNA project aims to develop an effective mechanism for coordination between key national stakeholders to strengthen the capacity of the private sector stakeholders to deploy climate technologies.

This Readiness project complements planned and ongoing GCF-supported initiatives in the Kyrgyz Republic, also considering activities that identify development needs already formulated in national development strategies and assessing national policies, existing sectoral plans in the context of the country's economic, social and environmental development priorities. Such synergies with on-going climate work and economies of scale will be achieved through a robust stakeholder engagement process, sharing resources and inputs through communication strategies, training and round table dialogues, utilizing existing tools such as GCF monitoring tools, and increasing the engagement of the private sector. A dedicated training will be delivered to the private-sector representatives with the objective of facilitating a climate-responsive technology market formation in the Kyrgyz Republic.

The TNA project in Kyrgyzstan cover four sectors: Water Resources and Agriculture for adaptation and Energy and Waste for mitigation.

The outputs of the project in each of the sectors will include the following:

1. Technology Needs Assessment Report with identified priority technologies to deploy and diffuse in Kyrgyzstan
2. Barrier Analysis and Enabling Frameworks Framework, providing information on the existing legal, policy, capacity, financial, social and other gaps and constraints that prevent selected technologies being introduced and disseminated
3. Technological Action Plan that presents a set of actions to be undertaken to promote selected technologies in Kyrgyzstan
4. Concept Notes on the project proposals for GCF funding

These outputs will present a number of strategic, long-term, participatory transformational measures across the four identified and prioritized sectors and contribute meaningfully to climate-resilient and low-carbon growth planning ongoing in the Kyrgyz Republic.

To implement the project, UNEP-CCC has established a group of national consultants, as well as brought in international expertise.

1.2 Existing national policies on technological innovation, climate-change mitigation and development priorities

1.1.1 National circumstances

Geography and climate

The Kyrgyz Republic (KR) is located in the centre of the Eurasian continent, the northeast of Central Asia. The area of the territory is 199.95 thousand km². It stretches from west to east - 900 km, from north to south - 450 km. The Kyrgyz Republic borders four states: the Republic of Kazakhstan, the People's Republic of China, the Republic of Tajikistan, and the Republic of Uzbekistan.

KR is located within the Tien Shan and Pamir-Alai mountain ranges. All the variety of landscapes and natural and climatic conditions of the Kyrgyz Republic are combined into four natural and climatic zones: valley-foothill zone up to 1,200 m, mid-mountain zone from 1,200 to 2,200 m, high-mountain zone from 2,200 to 3,500 m, and nival zone above 3,500 m.

The climate of the Kyrgyz Republic is extremely continental, mostly arid, slightly smoothed by increased cloudiness and precipitation due to the high-mountainous relief. The climate peculiarities are determined by the location of the republic in the Northern Hemisphere in the centre of the Eurasian continent, as well as the distance from significant water bodies and close proximity with deserts.

The average annual temperature of the Kyrgyz Republic for the period from 1885 to 2010 has increased significantly, while the rate of temperature change is nonlinear and has increased significantly in recent decades. Therefore, if the average annual temperature growth rate during the observation period in the republic was 0.0104°C/year, then for the period 1960–2010 the rate has more than doubled and amounted to 0.0248°C/year, and throughout the period 1990–2010, the rate has already reached 0.0701°C/year.

In general, precipitation has changed insignificantly, but in recent years, there have been sharp changes in certain regions, both upward and downward. So, over the entire observation period, the amount of annual precipitation in the republic increased slightly (0.847 mm/year), but during the last 50 years, the growth has significantly decreased (0.363 mm/year), and in the last 20 years, there has even been a slight downward trend (-1.868 mm/year).

State Structure

The Constitution states that the Kyrgyz Republic is a sovereign, democratic, legal, secular, unitary, and social state. State power in the Kyrgyz Republic is based on principles of the division of power between legislative, executive, and judicial branches and their reconciled functioning and cooperation. The President of the Kyrgyz Republic is the head of the State embodying unity of the people and state power. The President is elected every six years. Jogorku Kenesh - the Parliament of Kyrgyz Republic is the supreme representative body implementing legislative power and control functions within their competence. Executive powers in the Kyrgyz Republic implemented by the Cabinet of Ministers, which includes ministries, state committees, administrative and local state bodies. Judicial powers are exercised through constitutional, civil, criminal, administrative, and other forms of legal proceedings. The judicial system of the Kyrgyz Republic consists of the Supreme Court and local courts. The Constitutional Chamber operates within the Supreme Court.

Demography

The population of the Kyrgyz Republic amounted to 6,747,323 people (50.4% women) as of January 1, 2022. The share of the population under the working-age (0-15 years) was 34.7%, the portion of the working-age population (men aged 16-62 and women aged 16-57) was 56.8%, and the percentage of the population over working age (men at the age of 63 years and older and women - 58 years and older) was 8.5%. The percentage of the rural population was 66.1% (49.4% of women), and the urban - 33.9% (52.5% of women). The average annual population growth in 2022 was 1.7%.[1]

Due to the mountainous terrain, the population of Kyrgyzstan is extremely unevenly distributed over the territory of the republic. The number of inhabitants per 1 km^2 in the same year was 34 people. Generally, the population lives and carries out most of the economic activity within the low mountains, inter montane basins, and mountain valleys.

Natural resources

Agricultural lands, in 2021, accounted for 33.8% of the country's land balance, lands of settlements - 1.4%, lands of specially protected natural areas - 5.9%, forest lands - 12.7%, water resources - 3.8 %, land for industry, transport, etc. - 1.2% and state reserve lands - 41.2%. In 2022, the area of arable land was 1,287 thousand hectares, with 79.9% of them being irrigated. The area of rangelands accounts for 10,604.thousand ha or 84/8% of agricultural lands. [2]

Kyrgyzstan is the only country in Central Asia, whose water resources are mostly formed on its territory, and this is a hydrological trait and advantage. The republic's water resources are concentrated in glaciers, lakes, rivers, and groundwater. As of 2013-2016, there are 9,959 glaciers with a total area of 6,683.9 km^2 on the territory of the Kyrgyz Republic, including 6,227 glaciers larger than 0.1 km^2, with a total area of 6,494.0 km^2 and 3,732 glaciers smaller than 0.1 km^2, with a total area of 189.9 km^2. The water reserves concentrated in the glaciers of Kyrgyzstan amount to about 760 billion m^3. The area of glaciation has decreased by 16% as a result of climatic influences over the past 70 years.[3]

There are 1,923 lakes with a total water surface area of 6,836 km^2 on the territory of Kyrgyzstan. The estimated water reserves in the lakes of the republic are 1,745 km^3. There are more than 3,500 large

[1] National Statistic Committee. Population. http://www.stat.kg/ru/statistics/naselenie/
[2] National Statistic Committee (NSC). Areas of Agricultural lands as per types of use. http://www.stat.kg/ru/opendata/category/131/
[3] Water Resources Service under the Ministry of Agriculture. https://www.water.gov.kg/index.php?option=com_content&view=article&id=228&Itemid=1274&lang=ru

and small rivers in the Kyrgyz Republic. About 2,000 rivers are over 10 km long, and their total length is almost 35 thousand km. The potential reserves of fresh groundwater in the Kyrgyz Republic are estimated at 13 km^3.

According to the National Forest Inventory, the forest area of the Kyrgyz Republic is 1,116.56 thousand hectares or 5.6% of the total area of the country. Under natural conditions, there are 30 species of wooden vegetation of all groups of tree species typical for middle latitudes: conifers, hard-leaved, soft-leaved walnut, fruit, pome, stone fruit, and more than 17 species of shrubs.

The Kyrgyz Republic possesses sufficient reserves of fuel including 44 deposits with reserves of 1.411 billion tons, including brown coal - 1.083 billion tons, bituminous coal - 327.8 million tons, coking coal - 120.9 million tons. In 2020, the coal production amounted to 2,677.7 thousand tons. Industrial reserves of oil and gas are insignificant. Hence, oil is estimated at 88.5 million tons, extractable - 11.16 million tons, and natural gas - 5578.9 million m^3 and concentrated in the south of the country in seven deposits. In 2020, oil production amounted to 239.2 thousand tons, and gas production - 22.4 million m^3.[4]

However, the development capacity of the fuel and energy complex is not sufficiently used, and the share of energy imports is 21.4%, which has a negative impact on the reliability of energy and fuel supply to the country and regions. The total consumption of fuel and energy resources in Kyrgyzstan in 2020 accounted: coal – 2,138.3 thousand tons; oil - 177.5 thousand tons; gas - 314.6 million m^3; petrol – 545.1 thousand tons, diesel - 518.5 thousand tons; fuel oil – 61.7 thousand tons, electricity – 12.7 TWh; thermal energy – 2,9 million Gcal.[5]

The main type of renewable energy resource in Kyrgyzstan is hydropower, which, according to the Institute of Water Problems and Hydropower of the National Academy of Sciences of Kyrgyz Republic, amounts to 245.2 TWh, of which the technically feasible potential for development is 142.5 TWh, and the economic (production)) capacity - 60 TWh. The level of development of the gross potential of hydropower resources is 6%, technical - 10%, economic (production) - 24%.

For the rational use of the high potential of solar energy, as well as wind energy, it is necessary to assess their economic potential using modern advanced methods. The potential of geothermal springs is still being used mainly, for health-improving purposes in the sanatorium-resort zones of the country's regions.

Economy

According to the World Bank classification, Kyrgyzstan is included in the lower middle income countries. The year 2020 was marked by COVID-19 pandemic impact on the GDP, which negatively influenced the development of the national economy. Thus, GDP, in 2020, amounted to 7,740.5 million US dollars (12.7% less than in 2019) and the consumer price index was 106.3% relative to the previous year's prices. The share of industry in total GDP was 14.5%, agriculture - 13.6%, construction - 10%, trade and catering - 17.5%, transport and communication – 5.9%, state governance, defence and social safety – 7.1%, education – 6.8%, healthcare – 2.8% and 21.8% other.[6] In 2020, GDP per capita was 1,230.9 USD (13.9% less than previous year).

In 2020, Kyrgyzstan's imports amounted to 3,718.9 million USD (25.5 % less than in 2019) and exports remained practically at the same level of 1, 973.2 million USD.[7] The number of employed in the population in 2020 amounted to 2.4452 million people, and the unemployment rate weas 5.8%.

[4] Ibid.
[5] Ibid.
[6] NSC. GDP by types of economic activities. http://www.stat.kg/ru/statistics/nacionalnye-scheta/
[7] NSC. External economic activities. http://www.stat.kg/ru/statistics/vneshneekonomicheskaya-deyatelnost/

The actual final consumption of households per capita, in 2020, amounted to 79.1 thousand Soms ($957.1), and monetary income per capita 56.8 thousand Soms ($687.2) a year. The value of the subsistence minimum on average per capita in 2020, was 5,625.4 Soms per month ($68.1) and the value of the food basket of the minimum consumer budget - 3,483.1 Soms per month ($42.1).[8]

1.1.2 National development strategies

The further description of the main national strategies will be done with the focus on the TNA project targeted sectors.

The main development priorities and directions of the Kyrgyz Republic are presented in the **National Development Strategy for 2018-2040 (NDS).**[9] It is a comprehensive document that defines the goals and vision of social and economic development of the country.

In the introductory section it states that (i) the complex and rapidly changing economic and geopolitical situation in the world and in the region, (ii) the digital transformation that has embraced the main spheres of social life and sectors of the global economy, and (iii) the growing pressure of humanity on the Earth's ecosystem, expressed in changes in the global climate and demography, require the formation of a new model of national development.

NDS promotes economic activities that ensure poverty reduction and social progress and do not exceed the limits of environmental sustainability of natural ecosystems, requiring more effective planning and management of the country's transition to sustainable development through various elements of "green development" and the introduction of measures for climate-change mitigation. For this, activities will be aimed at preservation and restoration of the natural environment, landscapes, ecosystems and biodiversity through expansion of ecological networks. The expansion of green areas is one of the key elements in reducing the risks of climate change, land degradation and air pollution.

NDS aims for Kyrgyzstan to have a competitive economy that is focused on the application of innovative and environmentally friendly nature-saving technologies, an economy that is diversified, balanced and inclusive, with a favourable investment environment.

NDS also promotes Innovative Economy as the only possible way of development. It states that Kyrgyzstan needs a new type of industry - high-tech, compact, environmentally friendly. The time of giant factories has passed, and now is the time for smart and mobile enterprises focused on technological solutions to win. Part of practical priority solutions will be the technological upgrade of all municipal enterprises responsible for the maintenance of basic infrastructure: lighting, garbage, water, sewage in key cities.

The vision of NDS is that Kyrgyzstan will form production, information and social ecosystems, and build a new model of the economy, based on harmonious coexistence with nature. The country's economy will be well diversified, included into the system of international division of labour with high added value, clean energy and organic agriculture.

In the Energy sector, NDS provides for modernization and deployment of energy efficient technologies as well as large-scale implementation of programmes on energy efficiency and energy saving. For this the Government will look for the assistance to companies and financial institutions to convert the economy to highly efficient energy technologies as soon as possible. The first step will be a major technological upgrade of the municipal utility companies responsible for the maintenance of basic infrastructures - lightning, waste, water, and sewage. These reforms will begin with two cities - Bishkek and Osh.

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[8] NSC. Living standards of population. http://www.stat.kg/ru/statistics/uroven-zhizni-naseleniya/

[9] Endorsed by Presidential Decree as of 31 October 2018 # 221/

NDS states that autonomous energy supply systems using solar, wind and hydro and geothermal energy, will contribute to greater energy independence. Implementation of the planned projects will make it possible to increase the capacity of the energy system of Kyrgyzstan by at least 10% within 5 years or by 385 MW. For this purpose, the state will create maximum favourable conditions for the import of technical equipment, and for guarantees for electricity sales, both in terms of volume and price.

The priority of the national local development is to improve the infrastructure of the settlements. The task to develop solid waste management systems and recycling infrastructure is also clearly mentioned among the priorities for the local development in Kyrgyzstan. Best practices in waste management and recycling will be used in the largest cities of the country. Particular emphasis will be placed on the creation of landfills using technologies that ensure minimal risk to the environment and people. It provides for the establishment of landfills in nine cities using modern technologies by 2040.

To achieve all the above-mentioned goals, the digitalization and modernization process will cover the country's key social (education, health, environment), economic (energy, agriculture, industry, services) and political spheres (prevention of corruption, fair elections).[10]

In 2021, to implement NDS, the **National Development Programme of the Kyrgyz Republic until 2026 (NDP)** was developed[11] which sets the national development priorities for the period.

Under the section on setting the scene for development it states that the key task of the state in the medium term will be the formation of an environment necessary and sufficient for the realization of each person's potential.

NDP says that Kyrgyzstan has huge water resources - about 47 km^3 of surface river runoff. However, with this enormous hydropower potential, the Kyrgyz Republic has one of the most energy-intensive economies. The reasons are the low level of technological development of the economy and politicization of the pricing process in the energy sector. This generally affects the lack of investment interest in this sector and the lack of efficiency in the use of energy resources. The lack of investment in hydropower assets in recent years has led to a significant increase in coal production and consumption.

NDP emphasises that it is necessary to reduce the degree of dependence of the country on carbon energy sources. One of the acceptable solutions is a larger-scale development of hydropower and the transition to alternative energy sources, taking into account changes in the internal structure of energy consumption and technological modernization of the economy, especially under the context of climate change.

The NDP section “Special Development Priorities” stresses development areas, i.e. “Modernization of Cities” and “Sustainability of Environment and Climate change”.

On the modernization of cities it planned to develop environmentally sustainable public transport based on electric traction and gas motor fuel. Large and medium-sized public transport should serve at least 80 percent of urban passenger traffic. In each city of the country the project "Safe City" efficiently regulating city traffic will be implemented. It is also mentioned that it is planned to upgrade water supply and sewage systems using the most modern technologies. Most cities need to build wastewater treatment systems, and the existing infrastructure needs to be fundamentally upgraded. All territorial centres will carry out modernization of urban exterior lighting systems using energy-saving technologies and automation of outdoor lighting control. A waste management programme will be initiated in all urban settlements. The issues of secondary use of waste, minimization of its formation, safe collection, recycling and neutralization must be resolved systematically throughout the country.

[10] National Development Strategy of the Kyrgyz Republic for 2018-2040. Section II, chapter 2.2.
[11] Presidential Decree as of 14th October, 2021.
http://www.president.kg/ru/sobytiya/20898_prinyata_nacionalnaya_programma_razvitiya_kirgizskoy_respubliki_do2026_goda

Within the priority on sustainable environment and climate change it is planned to undertake policy measures to minimize the negative environmental consequences of the economic activities, increasing the effectiveness of requirements and incentives for environmental protection. As a cross-sectoral approach ii is planned to develop and support environmentally-oriented business, integrate the principles of green economy into the sectoral policies, and to deploy low-waste, resource-saving technologies.

Priority actions will be aimed at reducing the volume of waste through recycling, reuse, safe disposal. There is a need to encourage a transition to alternative sources of energy and to improve the energy efficiency of technologies to reduce emissions in the heating and municipal systems sector. Control over wastewater treatment plants in towns and economic entities with support for the introduction of modern technologies, will be strengthened. At the same time, an important role should be given to informing and involving the public in the problem of safe waste disposal.

NDP says that state policy will be aimed at the conservation and restoration of the natural environment, ecosystems, preservation of glaciers, landscapes and biodiversity. For this, the specially protected natural areas, which provide protection for various species of flora and fauna, will be expanded. In order to avoid increasing the degradation of forest ecosystems, measures will be taken to preserve growing forests and increase the area of forest land.

NDP also stresses that the promotion of environmental education, upbringing and awareness on the principles of sustainable consumption and production, starting from kindergartens and schools, will form a generation of citizens with a positive environmental outlook and awareness of their responsibility for the conservation of the natural-resource potential of the country.

To foster the low-emission development, NDP emphasises a need to develop a legal framework for climate policy, which should include national and sectoral legislation. It states that it is also necessary to develop monitoring, based on national climatic statistics and an established national monitoring, reporting and verification system (MRV). In addition, projects will be developed and implemented to mitigate climate change and aimed at reducing greenhouse gas emissions.

1.1.3 Legal frameworks, policies and actions related to technological development

The enabling frameworks of Kyrgyzstan for technologies development, deployment and dissemination include laws, policies and technical regulations. Among the laws are the following:

- Law of the Kyrgyz Republic "On Innovation Activities" # 128 of 26 November 1999
- Law of the Kyrgyz Republic "On the Fundamentals of Technical Regulation in the Kyrgyz Republic" dated 22 May 2004 # 67;
- Law of the Kyrgyz Republic "On High Technology Park of the Kyrgyz Republic" dated 8 July 2011, # 84.
- Law of the Kyrgyz Republic "On Science and on the Basis of the State Scientific and Technical Policy" # 103 of 16 June 2017.
- Law of the Kyrgyz Republic “On Electronic Governance” # 127 of 19July 2017.
- Law of the Kyrgyz Republic “On the Scientific and Technical Information System” # 108 of 8 October 1999.
- Law of the Kyrgyz Republic “On Competition” # 116 of 22 July 2011.
- Law of the Kyrgyz Republic “On State Support for Small Business” # 73 of 25 May 2007.
- Law of the Kyrgyz Republic “On the Protection of Entrepreneurs Rights” # 15 of February 1, 2001.
- Law of the Kyrgyz Republic "On Secret Inventions" # 79 of 23 January 2006.
- Law of the Kyrgyz Republic «Patent Law» # 8 of 14 January 1998.

Among the actual policies relevant for technological development the following could be mentioned:

1. The National Development Strategy 2018 - 2040.
2. The National Development Programme of the Kyrgyz Republic until 2026.
3. The Concept of Scientific and Innovative Development of the Kyrgyz Republic until 2022. [12]
4. The Strategy for Sustainable Development of Industry of the Kyrgyz Republic for 2019-2023[13]
5. The State Programme for Development of Intellectual Property in the Kyrgyz Republic for 2017-2021[14]"
6. The Regulation on the Procedure of Establishment and Activities of Expert Commissions on Technical Regulation"[15]
7. The Concept of Digital Transformation "Digital Kyrgyzstan - 2019-2023.[16]
8. Decree of the President of the Kyrgyz Republic "On urgent measures to enhance the implementation of digital technologies in public administration of the Kyrgyz Republic"[17]
9. The Plan of activities for digitalization of governance and development of digital infrastructure in the Kyrgyz Republic for 2022-2023.[18]
10. The Programme of the Education Development in the Kyrgyz Republic for 2021-2040"[19]

The National Development Strategy for 2018-2040 provides for Kyrgyzstan to actively pursue reforms to create a competitive economy through the creation of a truly attractive framework for entrepreneurs and the application of innovative and environmentally friendly technologies. Presenting the future economy vision NDS runs that Kyrgyzstan will have a competitive economy that is oriented towards the application of innovative and environmentally friendly technologies, an economy that is diversified, balanced and inclusive, with a favourable investment environment.

The National Development Programme till 2026 reads that the Government policy will aim to overcome the situation of geo-economic constraints and limited energy, financial and technological resources, and that this priority is a strategic one for the Kyrgyz Republic. Concerning the energy sector NDP says that, with its vast hydropower potential, the Kyrgyz Republic has one of the most energy-intensive economies. The reasons are the low level of technological modernisation of the economy and the politicisation of the tariffs in the energy sector. NDP provides for a wide range of digital technologies deployment and dissemination in the state governance systems, economy, banking, education, health care, science, etc. Among others it points out that adaptation and mitigation measures need to be applied in the agricultural sector in the face of climate change. In addition to the use of climate-resilient technologies and varieties, it is advisable to widely implement climate-risk insurance instruments in agricultural activities. It also says that given the global trends associated with a warming climate, projections of declining freshwater resources, and the uneven distribution of freshwater throughout the country, the development of sustainable irrigation is particularly urgent.

Technical regulations establish product safety indicators, while the application by the manufacturer of the standards included in the relevant lists ensures that the requirements of the technical regulations are met. The technical regulation documents relevant for the TNA targeted sectors include the following:

1. Technical Regulation "On Safety of Buildings and Structures.[20]

[12] Resolution of the Government dated 8 February 2017 # 79.
[13] Resolution of the Government dated 27 September 2019, No. 502.
[14] Resolution of the Government dated 6 July 2017 No. 424.
[15] Resolution of the Government # 565, 4 August 2006.
[16] Resolution of the National Security Council as of 14 December 2018 # 2.
[17] As of December 17, 2020 UP # 64.
[18] Order of the Cabinet of Ministers of the Kyrgyz Republic № 2-r, dated January 12, 2022.
[19] Resolution of the Government # 200 as of 4 May 2021.
[20] Law of the Kyrgyz Republic # 57 as of 27 June 2011.

2. Technical regulation “On Drinking Water Safety". [21]
3. Technical Regulation “On Safety of Building Materials, Products and Constructions”. [22]
4. The Action Plan for the Application of Technical Regulations of the Customs Union in the Kyrgyz Republic. [23]
5. The Technical Regulation "On Safety of Medical and Veterinary Products for Laboratory Diagnostics in Artificial Conditions (In-vitro)". [24]
6. Technical Regulation "On safety of construction of buildings of various purposes from quickly erected constructions and materials". [25]

The National Information Fund of Technical Regulations and Standards of the Kyrgyz Republic contains 28,952 active standardisation documents.

1.1.4 Legal and policies frameworks and actions related to climate change mitigation

1.1.1.1. Legal frameworks for the Energy Sector to mitigate climate change

The Kyrgyz Republic has developed and adopted a number of laws and government decrees, as well as strategic documents in the field of energy. Among these the following should be mentioned:

- **Law of the Kyrgyz Republic "On Energy"** # 56, dated October 30, 1996. The main goal of the law is to increase the economic efficiency and reliability of the energy sector, as well as protect the interests of producers and consumers. The law also stipulates that energy efficiency and energy conservation must be taken into account in the process of developing national energy programmes.
- **Law of the Kyrgyz Republic “On Electric Power Industry” #** 8, dated January 28, 1997. The law is aimed at ensuring reliable, safe and uninterrupted supply of electricity and heat and improving the quality of services provided to all consumers, creating a competitive environment and forming an energy market, encouraging the development of the private sector and attracting investment.
- **Law of the Kyrgyz Republic "On Coal"** # 18 dated February 3, 1999**.** The law is aimed at the creation of a regulatory and legal framework that meets international standards to ensure an increase in the economic efficiency of the coal industry, protect consumer rights, create favourable conditions for attracting investment and increasing production volumes.
- **Law of the Kyrgyz Republic "On Oil and Gas"** # 77dated June 8, 1998.The objectives of this Law are to create a regulatory framework that meets international standards to ensure an increase in the economic efficiency, reliability and safety of the functioning and activities of organizations in the oil and gas industry, protect the rights of consumers and producers, and create favourable conditions for attracting investment in the oil and gas industry to intensively increase their production.
- **Law of the Kyrgyz Republic "On Subsoil" #** 49, dated May 19, 2018. This law is also related to energy, because it also regulates relations in the field of fossil fuels. The law determines the procedure for state legal regulation, the competence of state authorities, local state administrations and local self-government bodies, the rights and obligations of individuals and legal entities, as well as liability for violation of the legislation of the Kyrgyz Republic in the field of subsoil use.
- **Law of the Kyrgyz Republic "On Transport"** # 89 dated July 8, 1998, regulates relations in the field of transport and notes that the state regulation of the work of transport is carried out through the development of a unified state policy in the field of development of all types of transport, legal support, licensing, taxation, lending, financing and pricing, the implementation of investment, a unified social and scientific and technical policy, control over the implementation by transport

[21] Law of the Kyrgyz Republic # 34 as of 30 May 2011.
[22] Law of the Kyrgyz Republic # 18 as of 29 January 2010.
[23] Resolution of the Government dated 29 March 2017 # 184.
[24] Resolution of the Government dated 5 April 2013 #173.
[25] Resolution of the Government dated 2 August 2010 #143.

enterprises and carriers of the legislation of the Kyrgyz Republic. The state programme for the development of transport, which determines, among other things, the volume of reduction of greenhouse gas emissions in the sector, is developed by the state transport authority and submitted for approval by the Government of the Kyrgyz Republic at least once every 5 years. (Art.5)

- **Law of the Kyrgyz Republic "On Road Transport" #** 154dated July 19, 2013.The law regulates relations arising from the provision of services by road transport, which is part of the transport system of the Kyrgyz Republic. It defines the general conditions for the carriage of passengers and baggage, cargo, respectively, by trucks, buses, cars, including the use of car trailers, car semi-trailers, as well as the general conditions for the provision of services to passengers, charterers, consignors, consignees, carriers, charterers at transport facilities and infrastructures.
- **Law of the Kyrgyz Republic "On Railway Transport"** # 121 dated July 18, 2016**,** regulates public relations between carriers, government agencies, passengers, consignors (senders), consignees (recipients), other individuals and legal entities in the course of transportation of passengers, baggage, cargo, cargo luggage and mail by rail.
- **"Air Code of the Kyrgyz Republic" #** 218 dated August 6, 2015, establishes the legal framework for the use of the airspace of the Kyrgyz Republic and activities in the field of civil aviation in order to meet the needs of the population of the Kyrgyz Republic in safe air transportation. The purpose of state regulation and supervision of activities in the field of civil aviation and the use of the airspace of the Kyrgyz Republic is to ensure safe air transportation and aviation operations.
- **Law of the Kyrgyz Republic "On Energy Efficiency in Buildings"** # 137, dated July 26, 2011 (updated June 20, 2019). The law regulates the energy performance of buildings in the Kyrgyz Republic during design and construction (for new buildings), as well as during major repairs (for existing buildings). The law is in line with European Union (EU) best practice and is based on the key requirements of the EU Energy Performance in Buildings Directive (EPBD). The Law contains a number of important provisions to create an effective institutional and general regulatory framework, such as:
  - Appointment of a government body responsible for improving the energy performance of buildings;
  - Minimum Energy Efficiency Requirements (MEER) for new and renovated buildings;
  - Regular inspection of heating and hot-water systems;
  - Issuance of Energy Efficiency Certificates (EECs);
  - Demonstration of EECs;
  - Expert accreditation, independent oversight and awareness raising.
- **Law of the Kyrgyz Republic "On Energy Saving"** # 88 dated July 7, 1998. The law aims to improve energy efficiency in the production, transmission and distribution of energy. The law includes a number of important provisions to create an effective institutional and regulatory framework for energy efficiency.
- **Law of the Kyrgyz Republic "On Renewable Energy Sources (RES)" #** 283 dated December 31, 2008. The purpose of this Law is the development and use of renewable energy sources, improvement of the energy structure, diversification of energy resources, and improvement of the social situation of the population, ensuring energy security of the Kyrgyz Republic, environmental protection and sustainable development of the economy. It should be noted that the law provides for fundamentally important provisions for the development of RES, in particular, exemption from customs duties for installations and equipment for the production of RES, as well as the fact that tariffs for energy from RES should ensure cost recovery and reimbursement of investments within a period not exceeding 8 years. However, for the practical implementation of the law, it was necessary to develop by-laws and provide a mechanism for the implementation of specific steps, including a methodology for calculating the tariff for different producers of "green" electricity, taking into account profitability and environmental benefits. In this regard, in 2012 amendments were made to the Law in order to improve economic mechanisms to stimulate the use of renewable energy sources

(RES), including small hydropower plants, to attract investment. The amendments provide for the establishment of premiums to the tariff for electricity generated from renewable energy sources and small hydropower plants for the payback period of projects using renewable energy sources. This surcharge will be implemented by multiplying the maximum of the current electricity tariffs by the appropriate coefficient approved for each type of RES.

It should be noted that, given the fact that most of these documents are outdated or inefficiently applied, at the initiative of the President of the Kyrgyz Republic, from 2021, the entire legal framework of the country is now under revision.

1.1.1.2. National Policy for the Energy Sector to mitigate climate change

The National Development Strategy of the Kyrgyz Republic for 2018-2040 (NDS) in chapter 3.3.Priority sectors of development, the section "Industrial potential of the country" states that the priority will be the transition to the use of high-quality fuels, combined with expansion i the use of alternative energy sources. This installation promotes an important mitigation task for the development of renewable energy sources in our country.

In the chapter Priority directions for the period up to 2023, section VI "Primary steps of the medium-term stage", subsection 6.1 "Implementation of development goals", a number of objectives mitigating by nature are set, among which we note the following:

- Objective 7.8. Increasing power generating capacities referring to hydropower
- Objective 7.10. Renewal and modernization of power equipment and power networks aimed at reduction of energy loss
- Objective 7.11. Modernization and implementation of energy efficient technologies
- Objective 7.12. Expanding renewable energy sources use
- Objective 7.13. Substitution of coal for heating purpose by natural gas supply
- Objective 7.14. Expansion of transport and logistics infrastructure
- Objective 7.20. Development of infrastructure for waste disposal and recycling
- Objective 7.17. Expansion of green spaces promoting wide scale tree planting
- Objective 13.2. Implementation of the Safe Road project improving traffic regulation systems.

Additionally, in subsection 6.2. "Practical Steps for Regional Development" presents a number of specific actions for all regions with quantitative indicators that are clearly mitigating in nature.

The next document that should be taken into account when developing mitigation measures is the **Concept of Green Economy in the Kyrgyz Republic #** 2532-VI dated June 28, 2018, and the Green Economy Development Programme for 2019-2023 to implement the Concept.

The green economy development programme is to create the basis for the introduction of "green" economy approaches in the development of priority sectors of the country. At the same time, the Programme identified the following priority areas for the development of the green economy:

1. Green energy
2. Low carbon environmentally friendly transport
3. Sustainable tourism
4. Municipal waste management
5. Green cities

A separate section of the Programme is devoted to describing support for the transition to an inclusive green economy. In particular, it defines the goal of introducing sustainable financing for green-economy activities in the banking and microfinance sectors, by bringing the financial system to the standard of compliance with the requirements of international climate funds for the subsequent use of domestic and international financial potential. It also talks about the need to introduce green incentives through fiscal instruments.

The main and the only valid document so far establishing the strategic base for the sustainable development of the energy sector in Kyrgyzstan is the National Energy Programme of the Kyrgyz Republic for 2008-2010 and the Strategy for the Development of the Fuel and Energy Complex until 2025 (NEP). The NEP is a key political document that defines the goals, objectives and main directions of the medium-term and long-term energy policy of the state, and establishes the mechanisms for its implementation. The main priority of the energy strategy of the Kyrgyz Republic is the rational and efficient use of natural fuel and energy resources. In 2021, the Ministry of Energy prepared the Concept for the Development of the Energy Industry of the Kyrgyz Republic until 2040, but it is still under consideration and has not been adopted.

All of the above tasks set for the development of the country have a significant mitigation potentialand they serve as the basis for the developed mitigation measures of the updated NDC KR.

In 2021, the Kyrgyz Republic expressed its political commitment and ambition in its climate change mitigation agenda in the updated **Nationally Determined Contribution[26] (NDC)** to Paris Agreement UNFCCC.

NDC mitigation goals read as follows: *In 2025, the Kyrgyz Republic will reduce its GHG net emissions by 16.63% from the level of BAU scenario emissions, and in case of international support - by 36.61%. In 2030, GHG net emissions in the Kyrgyz Republic may be reduced by 15.97% of emissions under the BAU scenario, and under conditions of the international support - by 43.62%.*

The updated NDC presents the mitigation goals and measures as well as targeted GHG emissions reduction by 2025 and 2030 (see table 1.1).

Table 1.1. Kyrgyzstan NDC mitigation goals and measures in TNA target sectors.

Energy Sector			
Goals	Measures[27]	Targets, thousand tons of CO_2 eq.	
		2025	2030
1. Reduce current GHG emissions	1.1. Reducing coal consumption through gas supply to households in the country (WM)	809.979	971.247
	1.2. Replacement of passenger vehicles with internal combustion engines for electric vehicles (WAM)	444.990[28]	423.181[29]
	1.3. Improving traffic management and developing cycling infrastructure (WM)	253.037	747.963
	1.4. Reducing electricity losses during transmission (SM)	13.668	13.668
	1.5. Reducing electricity losses during distribution (WM)[30]	10.888	30.275
	1.6. Replacement of buses with internal combustion engines (ICE) for	7.967	14.734

[26] Endorsed by the Coordination Council on Climate, Ecology and Green Economy Development meeting chaired by the Prime Minister on 24 September 2021.
[27]The measures presented were collected and discussed during the consultations of the first round of sectoral technical meetings. The calculation methodology was presented, discussed and agreed upon in the second round of technical meetings with sectoral stakeholders.
[28]UNDP assessment.
[29]UNDP assessment.
[30]In brackets is the scenario to which this measure applies: WM –with measures as Kyrgyzstan own funds; WAM – with additional measures on a condition of external funding.

Energy Sector			
Goals	Measures[27]	Targets, thousand tons of CO_2 eq.	
		2025	2030
	buses with gas engines in the city of Bishkek (WM)		
	1.7. Reconstruction and improvement of the heat supply system of the city of Bishkek (WM)	3.357	3.357
	1.8. Replacement of ICE buses for buses with gas engines in the city of Osh (WAM)	2.749	4.416
	1.9. Expansion of the trolleybus fleet by replacing buses with internal combustion engines in the city of Bishkek (WAM)	0.882	0.882
	1.10 Replacement of buses with internal combustion engines for buses with gas engines on suburban routes in the city of Bishkek (WAM)	Not Assessed (NA)	2.501
2. Increasing energy efficiency	2.1. Scaling up the installation of energy efficient stoves in households (WM)	772.449	886.314
	2.2. Improving the energy-efficiency of small boiler houses by replacing coal-fired boilers with gas ones (WAM)	402.203	1,223.697
	2.3. Construction of new buildings according to energy efficient Building Codes (WM)	14.552	16.866
	2.4. Improving the Energy Efficiency of Existing Buildings (WAM)	NA	10.868
3. Development of renewable energy sources (RES)	3.1. Expansion of the use of biogas plants (BGP)[31](WAM)	187.666	1,311.980
	3.2. Increasing the capacity of existing Hydropower Plants (HPP) (WM)	98.935	98.935
	3.3. Electricity generation at existing private small hydropower plants (WAM)	2.737	2.737
	3.4. Expanding the use of solar thermal collectors (WAM)	NA	78,400
	3.5. Construction of new HPPs (WAM)		64.606
	3.6. Construction and launch of new small hydropower plants (WAM)	NA	49.796
	3.7. Development of geothermal energy (heat pumps) (WAM)	NA	38.590
	3.8. Solar Energy Development (WAM)	NA	13,000
	3.9. Wind Energy Development (WAM)	NA	3.594
4. Strengthen the national MRV system and introduce new technologies	4.1. Improving Policy and Legislation for NDC(WAM)	NA	NA
	4.2. Development and implementation of the MRV system in the sector (WAM)	NA	NA

[31]The development of the use of Biogas Plants (BGP) includes the potential of entities dealing with organic waste in all sectors, but must be taken into account in the reporting of the Energy Sector under the general category "Fuel Combustion" and refers to the "With Additional Measures" scenario.

Energy Sector			
Goals	Measures[27]	Targets, thousand tons of CO_2 eq.	
		2025	2030
	4.3. Increasing the capacity of employees and awareness of the population, taking into account the interests of women, youth and vulnerable groups (WAM)	NA	NA
	4.4. Conducting a technology needs assessment for the development of multi-scale RES (WAM)	NA	NA
Remarks: All listed measures with mitigation potential are divided into two categories according to scenarios: (a) "With measures" (WM), which are supported by the internal financial resources, and (b) "With additional measures" (WAM), for which it is necessary to mobilize international support to finance. It should be noted that the measure to expand the use of BGP at landfills and wastewater treatment plant is represented by an estimated mitigation potential, the implementation of which, as expected, will begin in 2025.			

Waste Sector			
Goals	**Measures**	**Targets, thousand tons of CO_2 eq.**	
		2025	**2030**
1. Reduce current GHG emissions	1.1. Implementation of systems for separate collection and disposal of waste (WM)	NA	NA
	1.2 The Development of Waste Recycling (WAM)		
2. Development of RES	2.1. Installation of Biogas plants at solid waste landfills (WAM)	Assessed in the Energy Sector	Assessed in the Energy Sector
	2.2. Installation of BGP at wastewater treatment plants (WAM)	Assessed in the Energy Sector	Assessed in the Energy Sector
3. Strengthening the national system of MRV and introducing new technologies	3.1. Improving Policy and Legislation for NDC implementation (WAM)	NA	NA
	3.2. Development and implementation of the MRV system in the sector (WAM)	NA	NA
	3.3. Increasing the capacity of employees and awareness of the population, taking into account the interests of women, youth and vulnerable groups (WAM)	NA	NA
	3.4. Conducting an technology needs assessment for waste management and BGP in the urban economy (WAM)	NA	NA
Remarks: All the measures identified in the course of stakeholder consultations so far have mainly regulatory character and do not directly lead to reductions in GHG emissions and are not assessed (NA). The development of biogas plants at landfills and wastewater treatment plants in the cities of Bishkek and Osh is not supported, in the short term, by investment projects and, accordingly, refers to the WAM scenario, and their expected mitigation potential is estimated starting from 2025 in the Energy sector. At the same time, the use of organic waste from landfills and sediments from treatment plants in Bishkek and Osh cities to generate energy will reduce emissions of methane from the "Waste" sector, which will be used in BGP to produce bioenergy.			

1.3 Sector Selection

The TNA handbook was referenced to complete the TNA process. Following the handbook, a review of national GHG inventory was carried out based on the available inventory report. While conducting the assessment in 2022, National Inventory Report for 1990-2020 of the drafted NATCOM 4 of Kyrgyzstan was the only source of GHG inventory and hence that was referenced. Since the target sectors for mitigation TNA were already defined at the stage of the project design and clearly mentioned in the GCF approved project Concept Note, this section presents all the sectors' GHG emission data, as well as key categories alongside the development programmes and policies of Kyrgyzstan. The sectoral policies and plans described in brief to present the expected GHG emissions projections, long-term mitigation potential, and socio-economic development priorities.

1.1.5 An overview of sectors and GHG emissions and removals status, trends and projections

The 2020 National GHG Inventory data provide the following information on the GHG and precursor gas emissions and removals in Gg (= thousand tons) of gases by emission source categories (see table 1.2.).

Table 1.2. 2020 GHG Inventory Report [32]

Categories	Net CO_2	CH_4	N_2O	HFCs CO_2 eq	NO_x	CO	NMVOC	SO_2
Total National Emissions and Removals	-2896.028	183.610	8.270	227.723	27.160	223.276	33.248	48.329
1 - Energy	7155.292	18.478	0.338	0.000	26.401	201.391	31.911	48.312
1.A - Fuel Combustion Activities	7137.417	4.848	0.338		26.401	201.391	17.721	48.312
1.B - Fugitive emissions from fuels	17.875	13.629	0.000		0.000	0.000	14.190	0.000
1.C - Carbon dioxide Transport and Storage	0.000				0.000	0.000	0.000	0.000
2 - Industrial Processes and Product Use (IPPU_	904.452	0.000	0.000	227.723	0.006	0.032	1.220	0.006
2.A - Mineral Industry	892.999	0.000	0.000		0.000	0.000	0.000	0.000
2.B - Chemical Industry	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.C - Metal Industry	0.024	0.000	0.000	0.000	0.003	0.015	0.000	0.000
2.D - Non-Energy Products from Fuels and Solvent Use	11.429	0.000	0.000		0.000	0.000	0.000	0.000
2.E - Electronics Industry	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.F - Product Uses as Substitutes for Ozone Depleting Substances				227.723	0.000	0.000	0.000	0.000
2.G - Other Product Manufacture and Use	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.H - Other	0.000	0.000	0.000		0.003	0.016	1.220	0.006
3 - Agriculture, Forestry, and Other Land Use (AFOLU)	-10960.100	140.741	7.659	0.000	0.448	16.495	0.000	0.000
3.A - Livestock		137.704	0.554		0.000	0.000	0.000	0.000
3.B - Land	-10960.100		0.000		0.000	0.000	0.000	0.000
3.C - Aggregate sources and non-CO_2 emissions sources on land	0.000	3.036	7.106		0.448	16.495	0.000	0.000
4 - Waste	4.328	24.392	0.272	0.000	0.305	5.358	0.118	0.011
4.A - Solid Waste Disposal		16.235			0.000	0.000	0.000	0.000
4.B - Biological Treatment of Solid Waste		0.075	0.005		0.000	0.000	0.000	0.000
4.C - Incineration and Open Burning of Waste	4.328	0.624	0.011		0.305	5.358	0.118	0.011
4.D - Wastewater Treatment and Discharge		7.458	0.256		0.000	0.000	0.000	0.000
Memo Items								
International Bunkers	224.220	0.002	0.006	0.000	1.017	0.672	0.134	0.060
1.A.3.a.i - International Aviation (International Bunkers)	224.220	0.002	0.006		1.017	0.672	0.134	0.060

[32] Ministry of Natural Resources, Ecology and Technical Supervision. 2022. IPCC GHG Inventory Software Data Base.

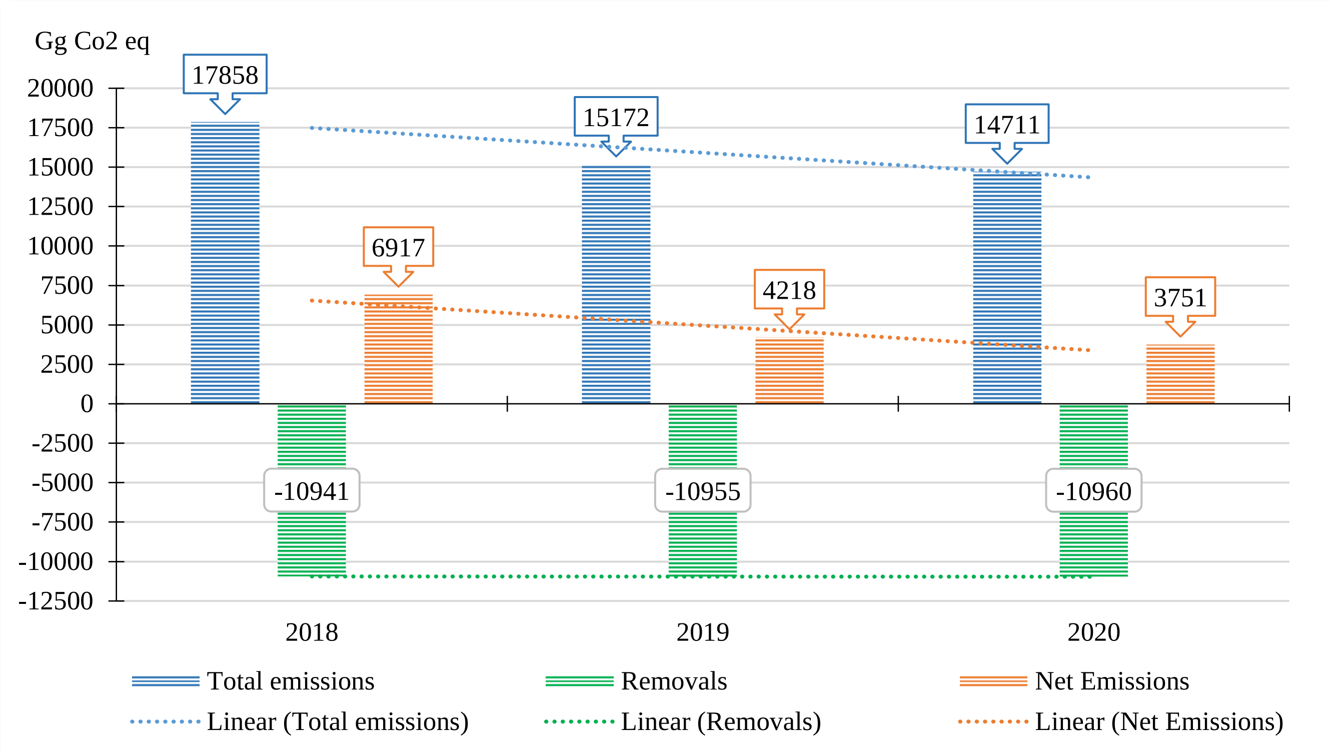
The 2020 values of the GHG emissions and removals in Gg CO_2 equivalent as per sectors is presented in table1.3.

Table 1.3. GHG emissions and removals in 2020 as per sectors

Year	Energy	IPPU	Agriculture	FOLU	Waste	Total
2020	7648.189	1132.175	5329.990	-10960.100	600.936	14711.290

In the recent period 2018-2020, Kyrgyzstan GHG emissions trends showed a decrease. Thus, total GHG emissions in 2020 amounted to 14,711.290 Gg CO_2 eq., which is 17.62% lower than in 2018, removals amounted to 10,960.1 Gg CO_2 (+0.17% from 2018), and , respectively, net emissions amounted to 3,751.190 Gg CO_2 eq., which is 45.77% lower than in 2018 (See fig. 1.1).

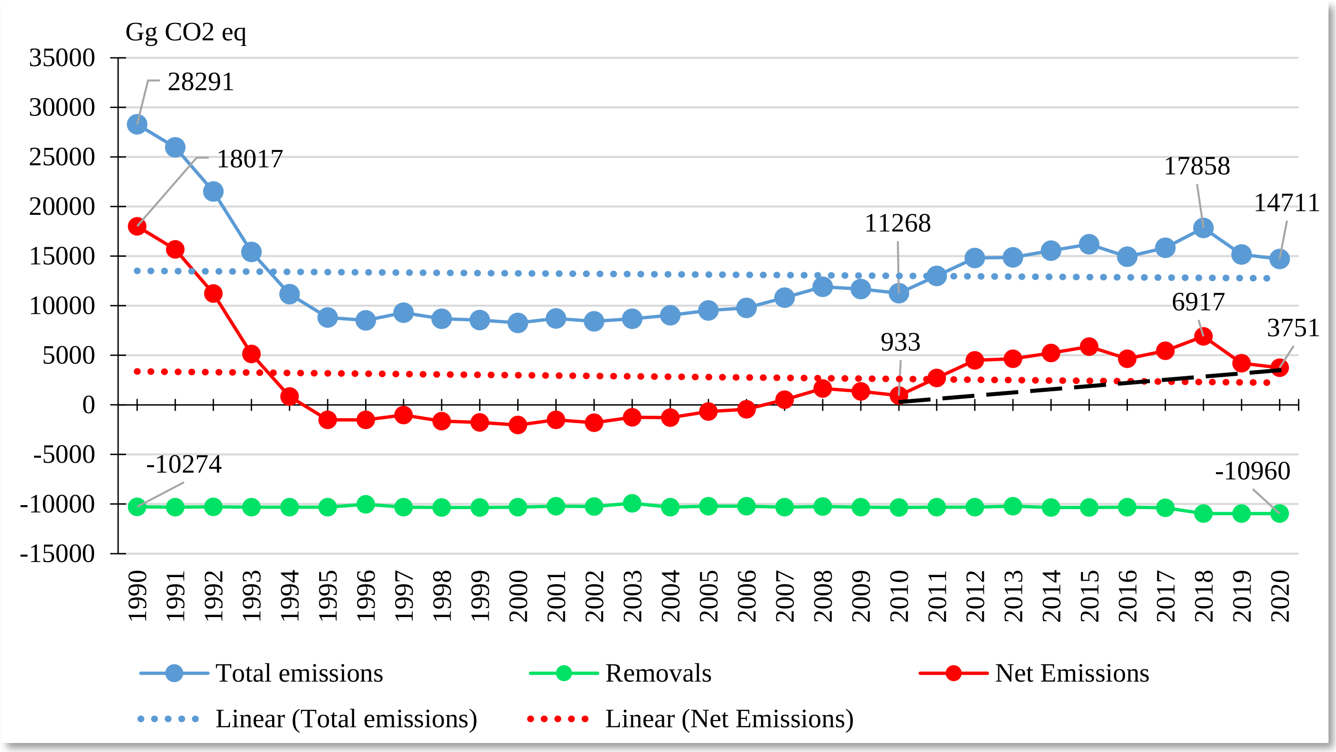
Figure 1.1. General emission trends in the period 2018-2020 [33]



This decreasing trend in emissions is estimated worldwide as temporary, which will be reversed as the economy recovers from the negative impacts of the coronavirus pandemic. Although in the context of Kyrgyzstan this situation appears to be a continuation of the general downward trend in total GHG emissions since the base year 1990. See fig. 1.2.

Figure 1.2. The dynamic and trends of total and net GHG emissions and removals in the Kyrgyz Republic in the period 1990-2020[34]

[33]According to: MNRETS. GEF-UNEP. 2022. National Inventory Report on GHG emissions and removals in the Kyrgyz Republic in the period 1990-2020. Bishkek.
[34]According to: MNRETS. GEF-UNEP. 2022. National Inventory Report on GHG emissions and removals in the Kyrgyz Republic in the period 1990-2020. Bishkek.



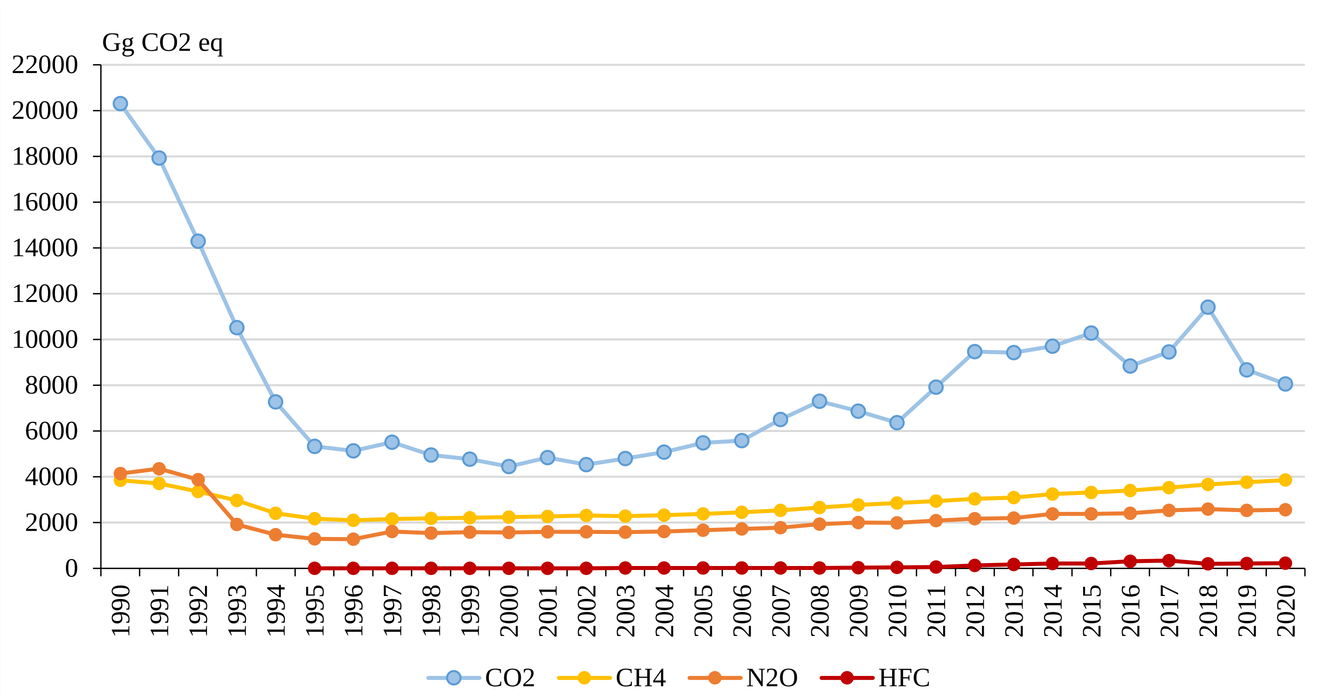
It should be noted that the linear declining trends have become flatter for both total and net emissions. As seen in figure 1.2, the total GHG emissions have decreased by 48% since 1990, and net emissions by 79.8%. At the same time, absorption increased by 6.7%, mainly due to recalculations of forest area inventory data during the regular forestlands inventory.

Consideration of this generally positive general trend in GHG emission reduction over 30 years in the context of the last decade are less optimistic. Thus, total emissions in 2020 increased by 30.56%, and net emissions by more than 300% in comparison to those in 2010 (black dotted line trend in the figure 1.2).

The impact of the COVID-19 lockdown resulted in GHG emission reduction. Thus, in 2020, compared to 2018, carbon dioxide (CO_2) emissions decreased by 29.36%, nitrous oxide (N_2O) emissions by 1% each, and methane (CH_4) and HFC emissions increased by 5.3% and 17 .57% respectively. Dynamics of emissions of various types of greenhouse gases in CO_2 equivalent in the period 1990-2020 are shown in fig. 1.3.

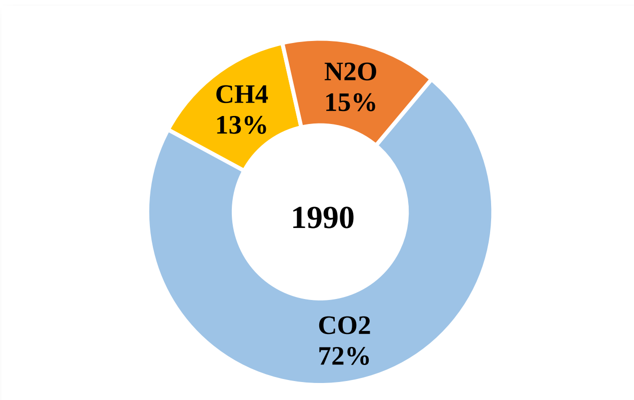
Figure 1.3. Dynamics of GHG emissions for 1990-2020[35]

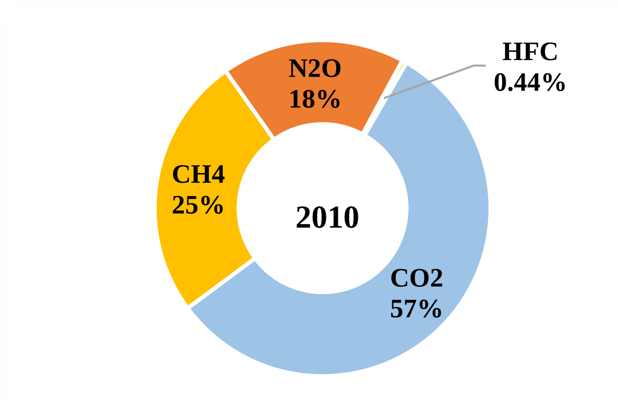
[35]According to: MNRETS. GEF-UNEP. 2022. National Inventory Report on GHG emissions and removals in the Kyrgyz Republic in the period 1990-2020. Bishkek.



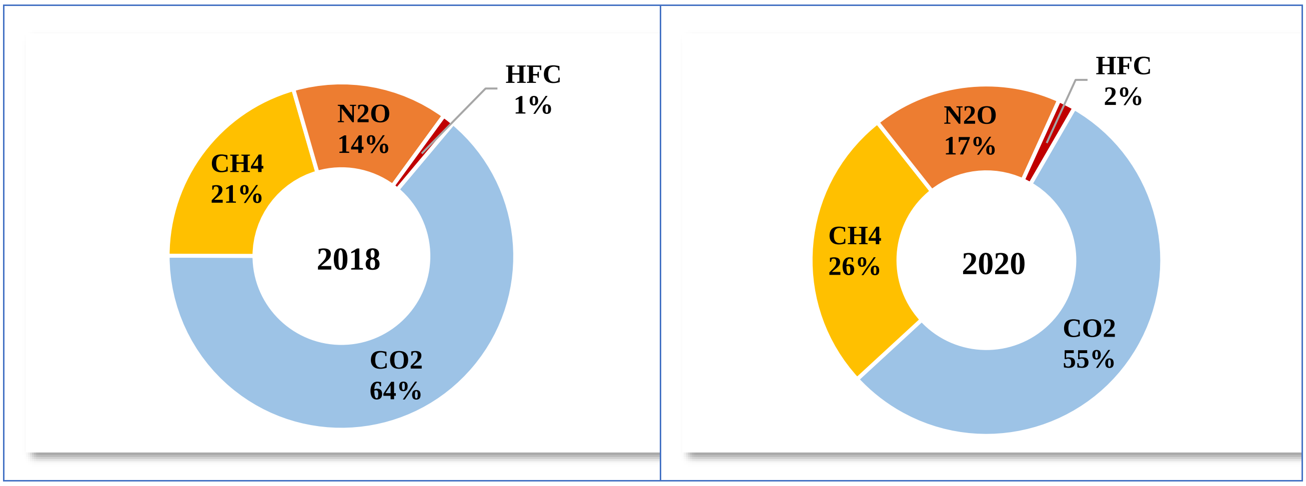
As seen in Figure 1.3, emissions of all greenhouse gases have not yet reached the level of 1990, with the exception of methane (CH_4), whose emissions have already exceeded the level of 1990. In addition, the aggregate values of HFC emissions have increased significantly, from 4 Gg CO_2 eq. in 1995 to 228 Gg CO_2 eq. in 2020, which is mainly due to improved data collection on the activity of equipment containing HFCs. The structure of emissions for various greenhouse gases in 1990, 2010, 2018 and 2020 is shown in fig. 1.4.

Figure 1.4. Percentage of emissions of different greenhouse gases in different years.[36]





[36]According to: MNRETS. GEF-UNEP. 2022. National Inventory Report on GHG emissions and removals in the Kyrgyz Republic in the period 1990-2020. Bishkek.



As can be seen in the figure, in 2020 the share of carbon dioxide decreased by 17 percentage points, the share of nitrous oxide by 2 points, and the share of methane almost doubled and HFC emissions appeared.

During the 4th round of the National GHG Inventory (NGHGI 4), the main sources of emissions of various greenhouse gases were also analyzed. Thus, the main sources of carbon dioxide (CO_2) emissions in 2020 were the following sectors: Energy (88.73%), IPPU (11.22%) and Waste (0.05%). (See table 1.4).

Table 1.4. CO_2 emissions by emitting sectors (in Gg) in the period 2018-2020[37]

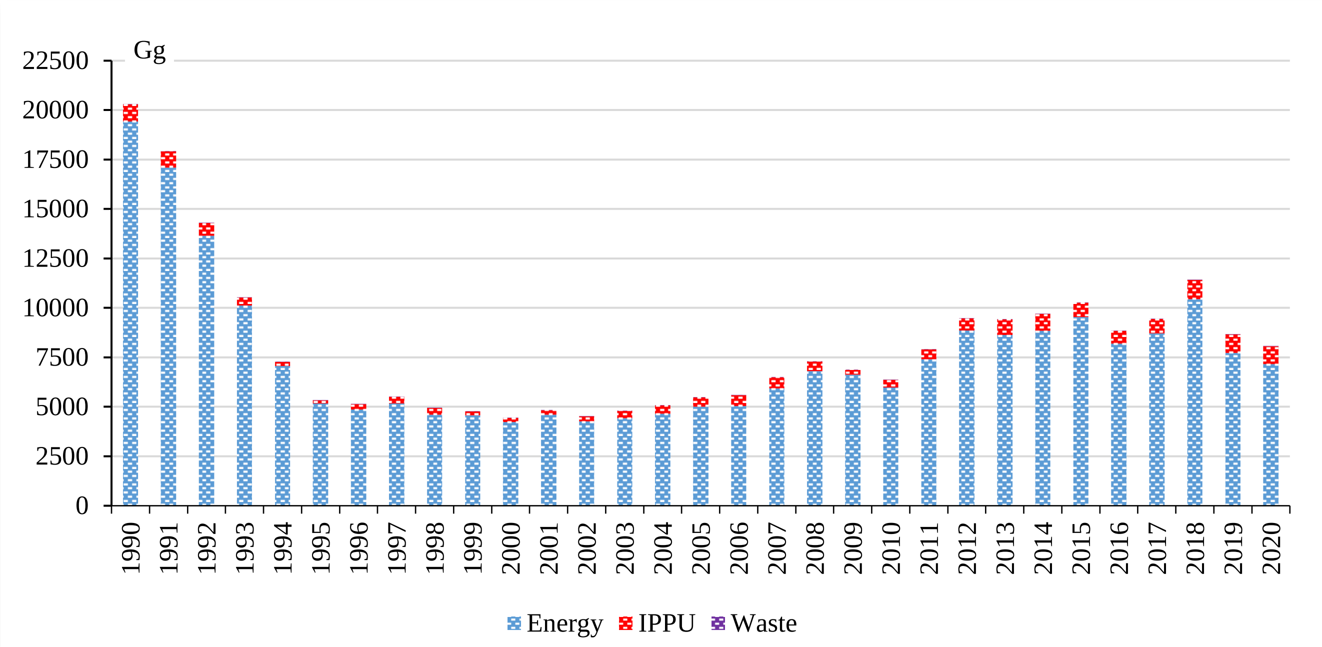
Year	Energy	IPPU	Waste
2018	10442.593	968.864	4,398
2019	7718.313	949.191	4.209
2020	7155.292	904.452	4.328

At the same time, the trends in CO_2 emissions by sectors in 2020 compared to 2018 were multidirectional: in the Energy sector, emissions decreased by 63.17%, while in the IPPU and Waste sectors, CO_2 emissions increased by 3.77% and 22.52% respectively.

The recalculations of CO_2 emissions by sectors since 1990 have been carried out, the dynamics of the corresponding emissions by the main emitting sectors being shown in fig. 1.5.

Figure 1.5. Dynamics of carbon dioxide (CO_2) emissions in the period 1990-2020 by main sources.[38]

[37]Ibid.
[3838] According to: MNRETS. GEF-UNEP. 2022. National Inventory Report on GHG emissions and removals in the Kyrgyz Republic in the period 1990-2020. Bishkek.



As noted above, in 2020 CO_2 emissions as a whole decreased across all sectors compared to 1990: by 31.58% in the Energy sector, by 6.65% in the IPPU sector and by 1.58% in sector "Waste".

The methane (CH_4) emissions estimate identified the main emitting sectors, which include the Energy, Agriculture, and Waste sectors. In 2020, the main contribution to the total emissions was made by the "Agriculture" sector - 76.65%, the share of the "Waste" sector was 13.28%, and the share of the "Energy" sector was 10.06%. (See table 1.5).

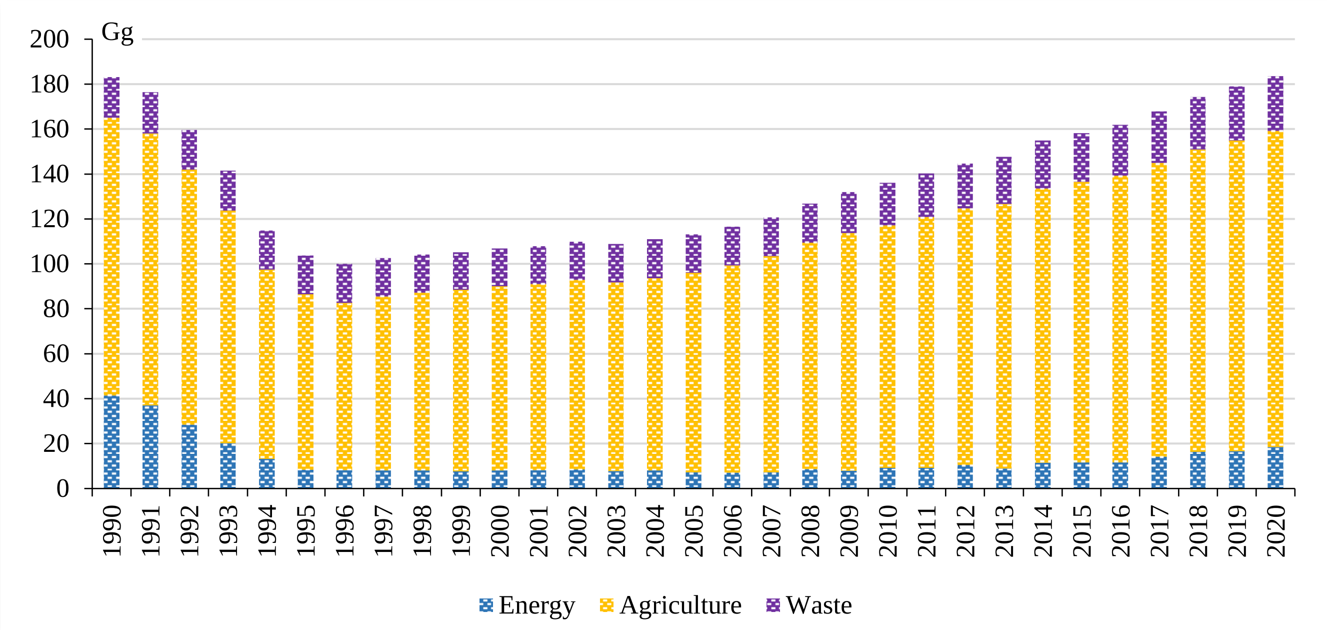
Table 1.5. CH_4 emissions (in Gg) by sectors in the period 2018-2020[39]

Year	Energy	Agriculture	Waste
2018	16.377	134.478	23.506
2019	16.572	138.269	24.142
2020	18.478	140.741	24.392

Compared to 2018, methane (CH_4) emissions in 2020 increased by 12.83% in the Energy sector, by 4.66% in the Agriculture sector and by 3.77% in the Waste sector %. NGHGI 4 also recalculated the time series of CH_4 emissions by source for the period 1990-2020. The dynamics of emissions is shown in fig. 1.6.

Figure 1.6. Dynamics of methane (CH_4) emissions in the period 1990-2020 by main sources.[40]

[39]Ibid.
[40]According to: MNRETS. GEF-UNEP. 2022. National Inventory Report on GHG emissions and removals in the Kyrgyz Republic in the period 1990-2020. Bishkek.



Compared to the base year 1990, methane (CH_4) emissions decreased in the Energy sector by 55.33%, but increased in the Agriculture sector by 13.77% and in the Waste sector by 34.70%.

The inventory carried out identified the main sources of nitrous oxide (N_2O) emissions, which include "Agriculture", "Energy" and, in some years, the IPPU sector. At the same time, the Agriculture sector is the main one in terms of nitrous oxide emissions, its share in 2020 was 95.77%, and the share of the Energy sector was 4.23%. In 2020, no N_2O emissions were reported from the IPPU sector. (See table 1.6).

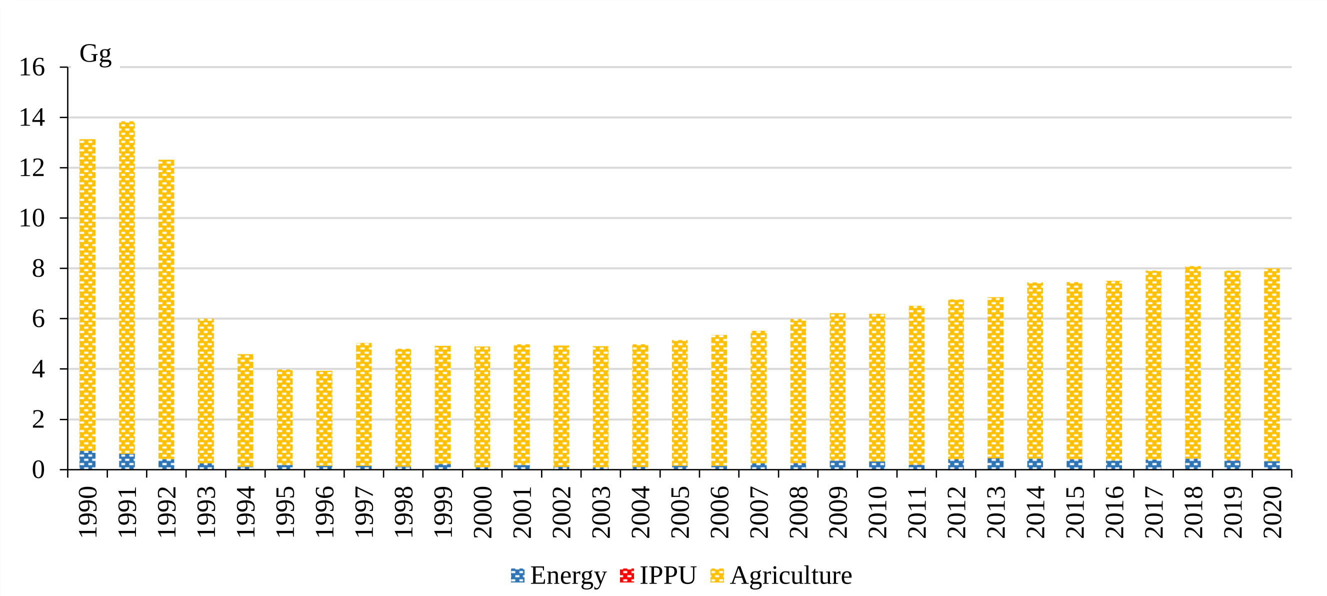
Table 1.6. N_2O emissions by sectors (in Gg) in the period 2018-2020[41]

Year	Energy	IPPU	CX
2018	0.442	0.0000	7.653
2019	0.365	0.0100	7.537
2020	0.338	0.0000	7.659

Compared to 2018, nitrous oxide (N_2O) emissions in 2020 decreased in the Energy sector by 23.44% and remained almost unchanged (+ 0.09%) in the Agriculture sector. NIPG4 also recalculated the time series of N_2O emissions by source for the period 1990-2020. The dynamics of emissions is shown in fig. 1.7.

Figure 1.7. Dynamics of nitrous oxide (N_2O) emissions in the period 1990-2020 by main sources.[42]

[41]Ibid.
[42]According to: MNRETS. GEF-UNEP. 2022. National Inventory Report on GHG emissions and removals in the Kyrgyz Republic in the period 1990-2020. Bishkek.



Compared to the base year 1990, nitrous oxide (N_2O) emissions decreased in the "Agriculture" sector by 38.16% and in the "Energy" sector by 54.67%.

The results of the assessment of total GHG emissions by sources and removals by sinks in CO_2 equivalent for the reporting period 2018-2020 presented in table 1.7.

Table 1.7. Total GHG emissions and removals by main source categories.[43]

Year	Energy	IPPU	Agriculture	FOLU	Waste	Total CO2 eq.
2018	10923.480	1162.553	5196.342	-10941.371	576.037	17858.411
2019	8179.574	1160.496	5240.242	-10954.624	592.087	15172.400
2020	7648.189	1132.175	5329.990	-10960.100	600.936	14711.290

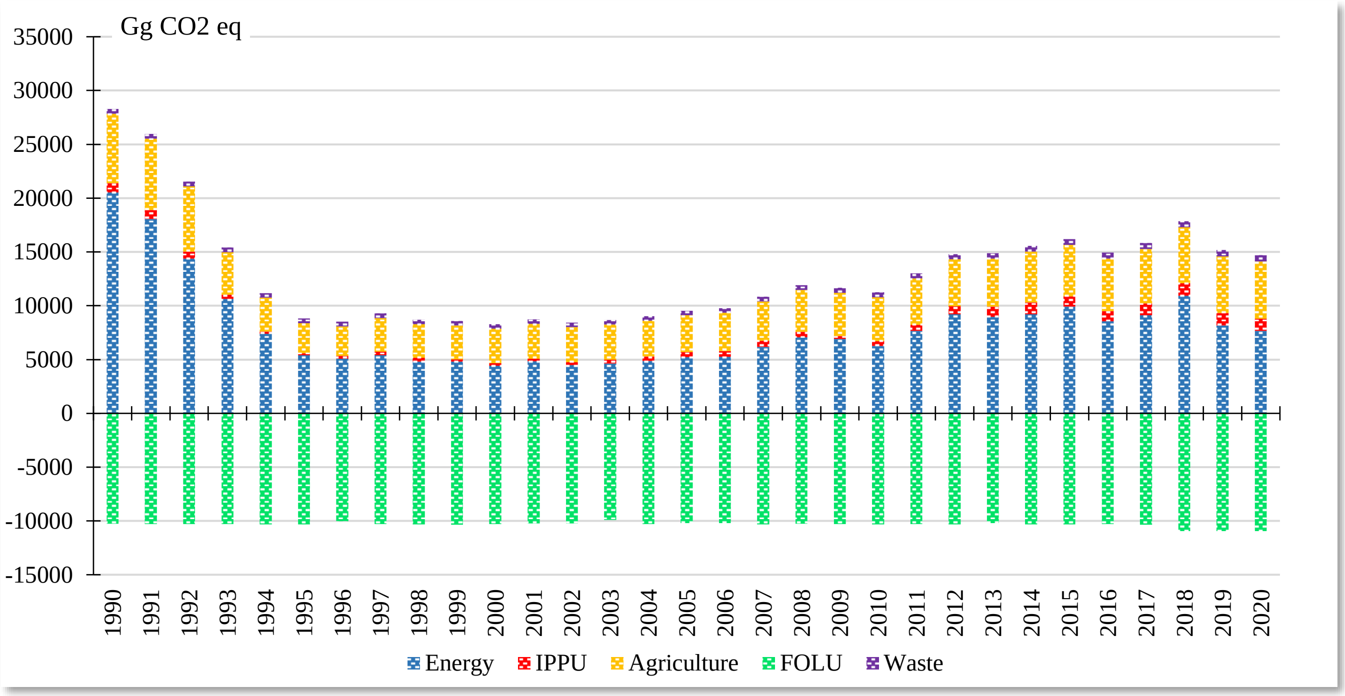
As can be seen from the table, the total emissions of the emitting sectors show different dynamics. Thus, emissions from the Energy and IPPU sectors decreased by 29.98% and 2.61%, respectively. Conversely, emissions in the "Agriculture" sector increased by 2.57%, and in the "Waste" sector - by 4.32%. The absorption of carbon dioxide by forests and perennial plantations remained almost unchanged (+0.17).

Recalculation of the time series of emissions from the base year 1990 shows trends in emissions by sector. The results of the recalculation of the contribution of the sectors to total emissions in CO_2 eq. and absorption are presented in fig. 1.8.

Figure 1.8. Dynamics of GHG emissions and removals by sectors in the period 1990-2020[44]

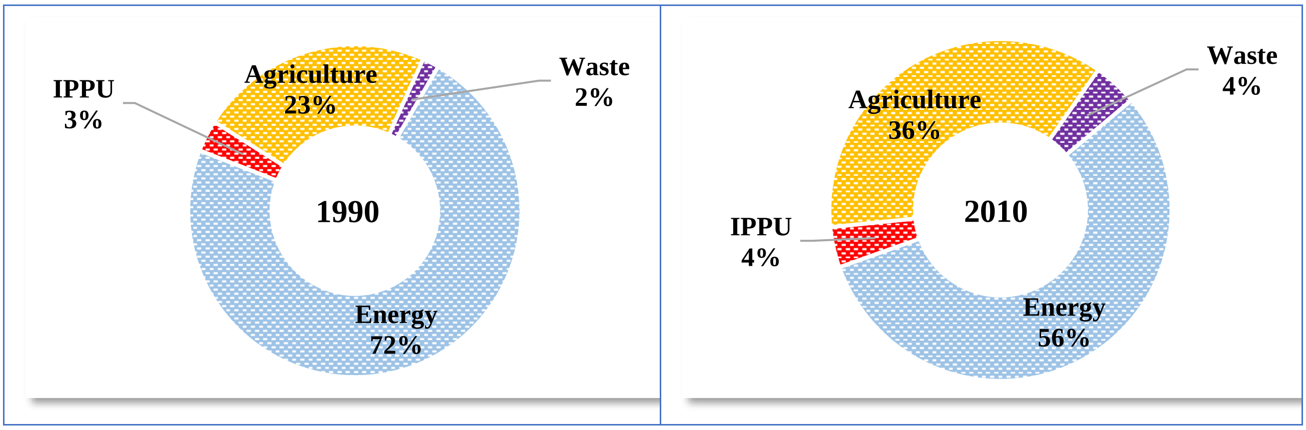
[43]Ibid.

[44] According to: MNRETS. GEF-UNEP. 2022. National Inventory Report on GHG emissions and removals in the Kyrgyz Republic in the period 1990-2020. Bishkek.

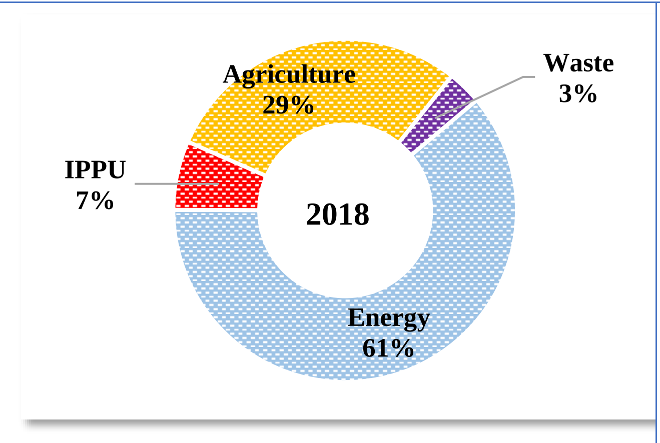


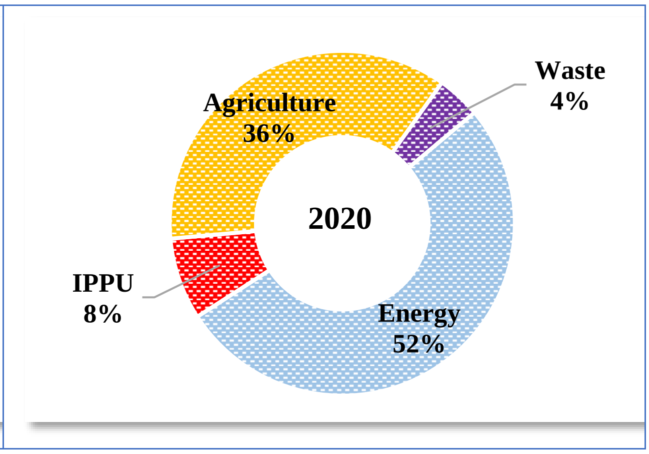
Energy and agriculture have always made the largest contribution to Kyrgyzstan's GHG emissions. Thus, in 2020, the share of emissions from the Energy sector in the total volume of total emissions was 51.99%, the share of agriculture was 35.23%, the share of emissions from the IPPU sector was 7.70%, and the share of the Waste sector was 4 .08%. The percentage composition of emissions by emitting sectors for individual years is shown in fig. 1.9.

Figure 1.9. GHG emissions composition by sources.[45]`



[45]According to: MNRETS. GEF-UNEP. 2022. National Inventory Report on GHG emissions and removals in the Kyrgyz Republic in the period 1990-2020. Bishkek.





The following key categories of GHG emission were identified by the NGHGI 4. (See tab 1.8 and table 1.9).

Table 1.8. Kyrgyzstan key categories of GHG emissions in 1990-2020 by Approach 1 Levels assessment. [46]`

IPCC Category code	IPCC Category	Green-house gas	2020 Ex,t (Gg CO_2 Eq)	|Ex,t| (Gg CO_2 Eq)	Lx,t	Cumula-tive Total of Column F
3.B.1.a	Forest land Remaining Forest land	CO_2	-7490.450	7490.450	0.292	0.292
3.B.2.a	Cropland Remaining Cropland	CO_2	-3469.650	3469.650	0.135	0.427
1.A.3.b	Road Transportation	CO_2	2961.466	2961.466	0.115	0.542
3.A.1	Enteric Fermentation	CH_4	2810.239	2810.239	0.109	0.652
3.C.4	Direct N_2O Emissions from managed soils	N_2O	1508.876	1508.876	0.059	0.711
1.A.4	Other Sectors - Solid Fuels	CO_2	1437.588	1437.588	0.056	0.767
1.A.1	Energy Industries - Solid Fuels	CO_2	1199.483	1199.483	0.047	0.813
2.A.1	Cement production	CO_2	854.266	854.266	0.033	0.847
3.C.5	Indirect N_2O Emissions from managed soils	N_2O	610.462	610.462	0.024	0.870
1.A.3.e	Other Transportation	CO_2	362.773	362.773	0.014	0.884
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CO_2	359.318	359.318	0.014	0.898
4.A	Solid Waste Disposal	CH_4	340.938	340.938	0.013	0.912
1.A.4	Other Sectors - Gaseous Fuels	CO_2	332.286	332.286	0.013	0.925
1.B.2.a	Oil	CH_4	176.164	176.164	0.007	0.932
3.A.2	Manure Management	N_2O	171.633	171.633	0.007	0.938
1.A.1	Energy Industries - Gaseous Fuels	CO_2	170.990	170.990	0.007	0.945
2.F.1	Refrigeration and Air Conditioning	HFCs	157.856	157.856	0.006	0.951

Table 1.9. Kyrgyzstan key categories of GHG emissions in 1990-2020 by Approach 1 Trend Assessment. [47]`

[46]According to: MNRETS. GEF-UNEP. 2022. National Inventory Report on GHG emissions and removals in the Kyrgyz Republic in the period 1990-2020. Bishkek.
[47]According to: MNRETS. GEF-UNEP. 2022. National Inventory Report on GHG emissions and removals in the Kyrgyz Republic in the period 1990-2020. Bishkek.

IPCC Category code	IPCC Category	Greenhouse gas	1990 Year Estimate Ex0 (Gg CO_2 Eq)	2020 Year Estimate Ext (Gg CO_2 Eq)	Trend Assessment (Txt)	% Contribution to Trend	Cumulative Total of Column G
3.B.1.a	Forest land Remaining Forest land	CO_2	-6850.850	-7490.450	0.124	0.262	0.262
3.B.2.a	Cropland Remaining Cropland	CO_2	-3415.270	-3469.650	0.069	0.145	0.407
1.A.3.b	Road Transportation	CO_2	2824.570	2961.466	0.062	0.130	0.537
3.A.1	Enteric Fermentation	CH_4	2510.217	2810.239	0.059	0.125	0.662
3.C.4	Direct N_2O Emissions from managed soils	N_2O	2633.558	1508.876	0.025	0.053	0.715
2.A.1	Cement production	CO_2	591.522	854.266	0.019	0.040	0.755
1.A.1	Energy Industries - Solid Fuels	CO_2	2889.157	1199.483	0.016	0.033	0.788
1.A.1	Energy Industries - Liquid Fuels	CO_2	2575.481	106.026	0.011	0.024	0.811
3.C.5	Indirect N_2O Emissions from managed soils	N_2O	909.996	610.462	0.011	0.023	0.834
1.A.4	Other Sectors - Solid Fuels	CO_2	5049.286	1437.588	0.010	0.021	0.856
1.A.1	Energy Industries - Gaseous Fuels	CO_2	2648.369	170.990	0.010	0.021	0.876
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CO_2	262.017	359.318	0.008	0.017	0.893
4.A	Solid Waste Disposal	CH_4	218.446	340.938	0.008	0.016	0.909
1.A.4	Other Sectors - Gaseous Fuels	CO_2	390.187	332.286	0.007	0.014	0.923
2.F.1	Refrigeration and Air Conditioning	HFCs	0.000	157.856	0.004	0.009	0.932
1.B.2.a	Oil	CH_4	113.678	176.164	0.004	0.008	0.940
1.A.3.e	Other Transportation	CO_2	1108.646	362.773	0.003	0.007	0.947
3.A.2	Manure Management	N_2O	200.620	171.633	0.003	0.007	0.954

1.1.6 GHG emissions projection till 2050

The projection of Kyrgyzstan's future GHG emissions and removals for NATCOM 4 was conducted in synergy with the process of the updating of the Nationally Determined Contribution (NDC) consultation process supported by the UNDP Climate Promise project and the NDC Partnership initiative.

A historical correlation analysis of the dynamics of the main development factors and GHG emissions was carried out to develop the projection of future emissions. Data on changes in the country's GDP and population were used as indicators of these factors. (See fig. 1.10 and 1.11).

Figure 1.10. Dynamic of the total GHG emissions and population in the period of 1990-2020[48]

[48] Ibid.

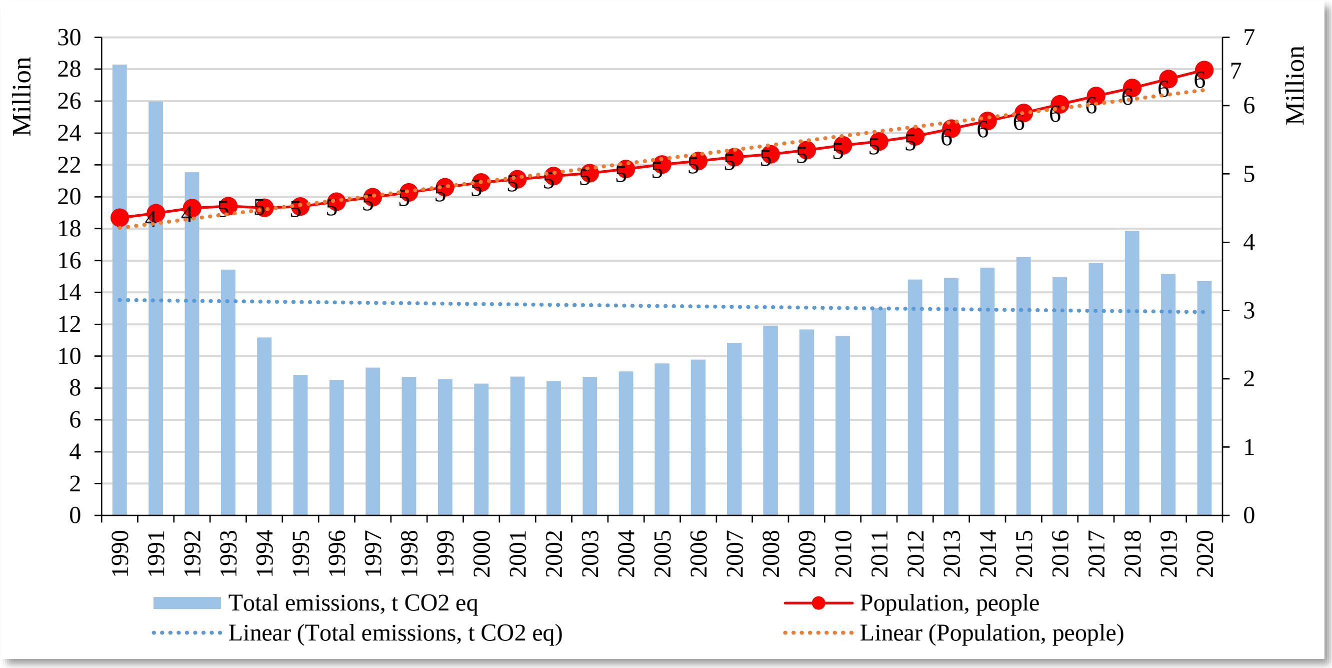
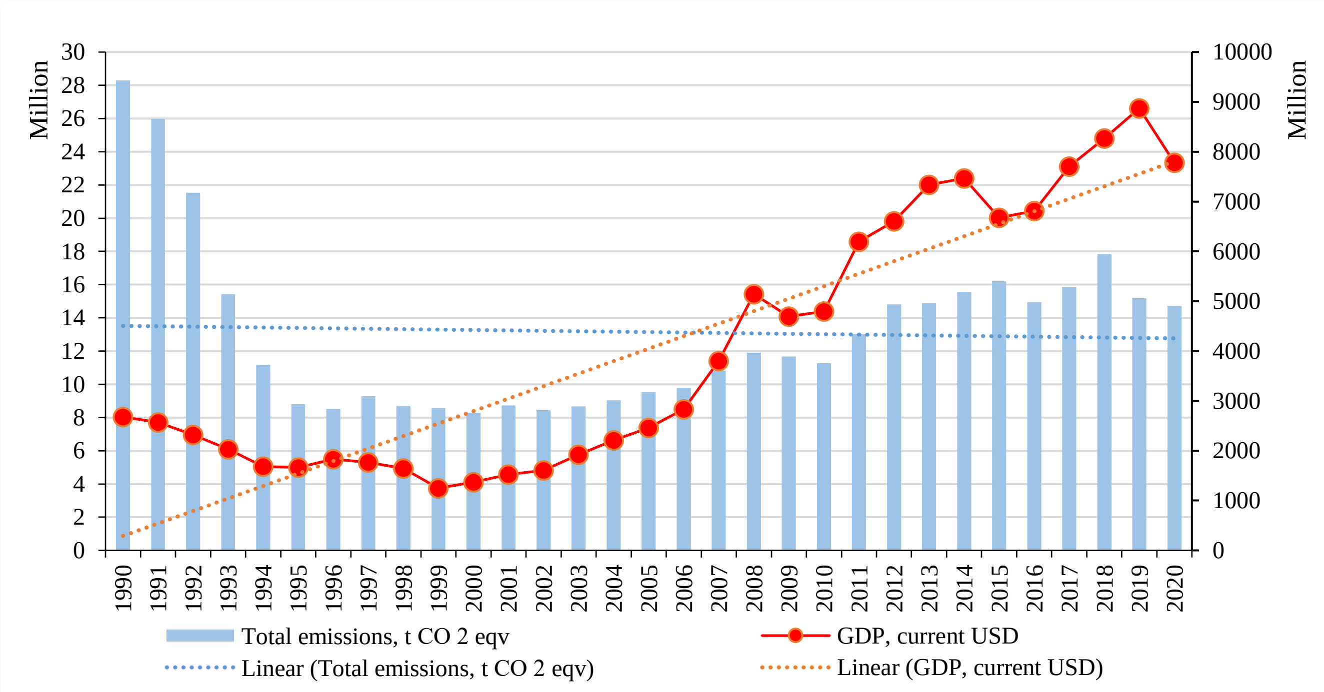


Figure 1.11. Dynamic of the total GHG emissions and GDP in the period of 1990-2020[49]



To determine correlations, analyses were conducted for all sectors as well as for national total and net emissions. As a result, the trends with the highest linear trend determination coefficient (R^2) were selected. The correlation trends of GHG emissions and GDP per capita in the time series 1990-2020; 1996-2020; 2000-2020 and 2006-2020 were examined.

The development scenarios for future GHG emissions in the Kyrgyz Republic were based on the identification of correlations of GHG emissions with the main development factors, i.e. GDP growth, which characterises the growth of the country's economy and population growth, which determines the

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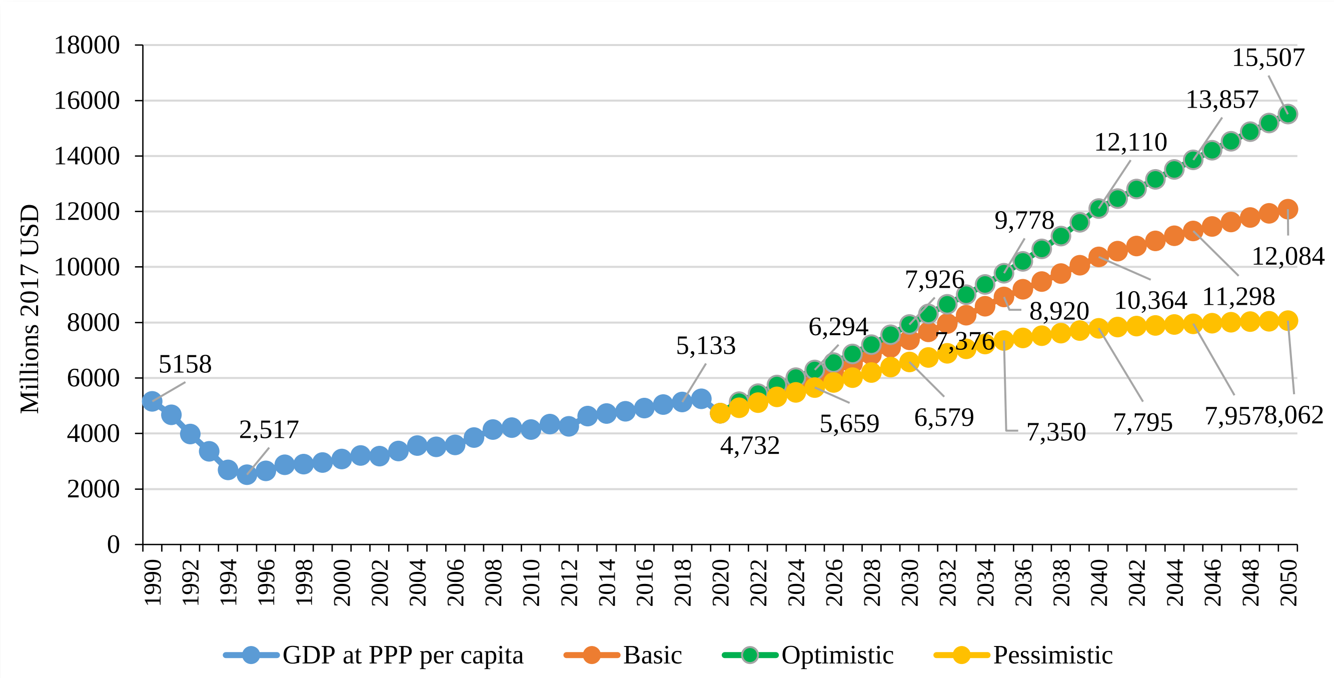
[49] Ibid.

growth of household consumption. Note that the same factors were used to project future GHG emissions in the previous NATCOM 3 and to prepare the assumed INDC in 2015.

This time the analysis combines both of these factors into a single GDP per capita indicator. The values of this factor modelled to 2050 were used to determine the correlation and a linear historical trend equation for the period 2000-2020. Calculations and modelling of GDP at PPP were carried out for three scenarios: (1) baseline, (2) optimistic and (3) pessimistic, reflecting given parameters of economic growth and demographic changes. (See fig. 1.12).

Figure 1.12. Dynamic of the GDP PPP per capita in the period of 1990-2020 and its projection till 2050 as per three scenarios. [50]



Given the GDP fall between 1990 and 1996, the best-fit time series correlation trend for total CO_2e equivalent emissions with PPP GDP per capita in US dollars in 2021 was identified as the basis for projecting future emissions. The highest correlation coefficient of determination (R2), ranging from 0.82 for IPPU Sector to 0.94 for Agriculture Sector was obtained for the 2000-2020 correlation trends for the time series. Therefore, to simulate future emissions for the business-as-usual scenario, i.e. "no action", appropriate linear trend equations were used for all sectors (see Figure 5.3), except for the FOLU sector.

This approach of using linear trend equations is rather simplistic and has only been used to demonstrate the need for mitigation actions and low-carbon development strategies in Kyrgyzstan as a contribution to achieving the Paris Agreement goals and the low-carbon transition to carbon-neutral development by 2050. More sophisticated multifactor future emission projection models will be applied in the future as national patterns of future economic development, consumption patterns and social development evolve, also taking into account the deviation of different development factors and their indicators. Consequently, as models become more sophisticated, projections of future emissions will also change.

Scenarios of future GHG emissions of sectors without mitigation measures or so called business-as-usual (BAU) scenarios were calculated using the linear trend equations of the above correlations of sectoral emissions and GDP per capita trends at PPP. Future sectoral emissions were calculated under

[50] Ibid.

the three BAU scenarios: the Baseline, the Optimistic and the Pessimistic. The projection data for the two targeted sectors is given below.

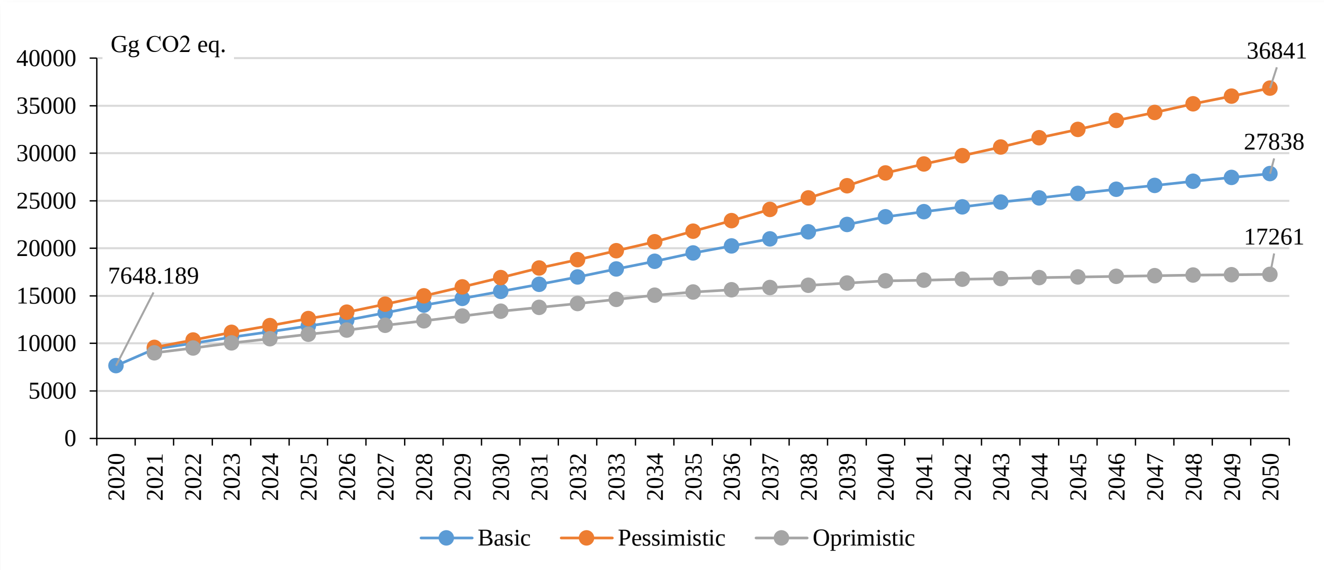
The values for the future GHG emissions in Gg CO_2 equivalent in the Energy Sector under the three scenarios until 2050 are provided in table 1.10.

Table 1.10 The projected GHG emissions for the Energy Sector till 2050 as per scenarios.[51]

Year	Scenarios			Year	Scenarios		
	Basic	Pessimistic	Optimistic		Basic	Pessimistic	Optimistic
2020	7648.189	-	-	2036	20232.737	22900.84	15617.87
2021	9387.713	9585.757	9002.573	**2037**	20971.212	24075.41	15851.65
2022	10008.295	10352.91	9512.679	**2038**	21731.005	25299.99	16086.88
2023	10650.245	11158.71	10033.66	**2039**	22512.191	26576.62	16322.57
2024	11228.121	11869.54	10482.92	**2040**	23314.838	27907.41	16557.82
2025	11824.072	12609.84	10939.63	**2041**	23849.920	28844.43	16652.29
2026	12438.761	13282.04	11404.66	**2042**	24342.289	29737.89	16748.07
2027	13216.081	14125.23	11878.68	**2043**	24845.558	30657.53	16824.78
2028	14026.731	15007.85	12362.22	**2044**	25303.321	31604.42	16902.98
2029	14729.090	15932.29	12855.72	**2045**	25771.220	32500.66	16982.81
2030	15456.672	16901.04	13359.56	**2046**	26190.781	33422	17043.57
2031	16210.662	17916.56	13770.45	**2047**	26619.371	34286.19	17105.96
2032	16992.171	18806.34	14187.48	**2048**	27057.336	35173.21	17170.03
2033	17802.554	19731.73	14611.61	**2049**	27443.507	35996.9	17214.8
2034	18643.158	20693.71	15044.08	**2050**	27837.987	36841.16	17261.2
2035	19515.348	21774.29	15386.15				

The evolution of future emissions of the Energy sector up to 2050 under the three scenarios is shown in fig. 1.13.

Figure 1.13. The Energy Sector emissions projection to 2050 under the three scenarios.



[51] Elaborated by authors.

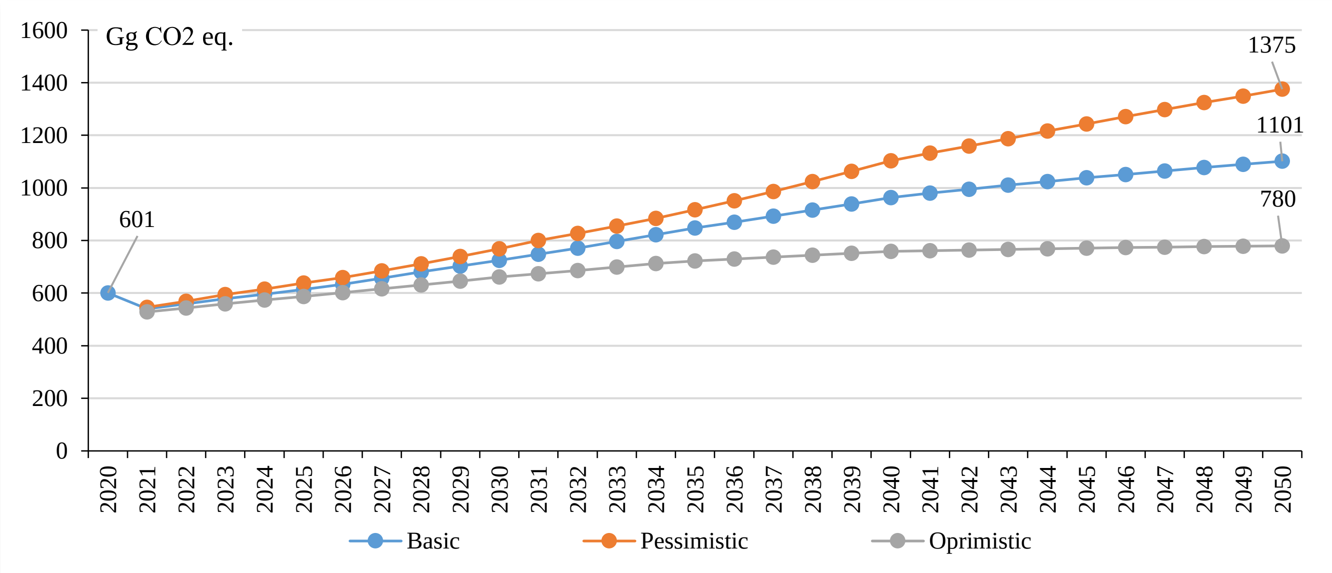
The values for the future GHG emissions in Gg CO_2 equivalent in the Waste Sector under the three scenarios until 2050 are provided in table 1.11.

Table 1.11. The projected GHG emissions for the Waste Sector till 2050 as per scenarios.[52]

Year	Scenario			Year	Scenario		
	Basic	Pessimistic	Optimistic		Basic	Pessimistic	Optimistic
2020	600.936			**2036**	869.956	951.115	729.579
2021	540.069	546.093	528.354	**2037**	892.419	986.843	736.691
2022	558.946	569.429	543.870	**2038**	915.530	1024.093	743.846
2023	578.473	593.940	559.718	**2039**	939.293	1062.926	751.015
2024	596.051	615.562	573.383	**2040**	963.708	1103.406	758.171
2025	614.179	638.081	587.276	**2041**	979.984	1131.909	761.045
2026	632.877	658.528	601.421	**2042**	994.961	1159.086	763.958
2027	656.521	684.176	615.840	**2043**	1010.270	1187.060	766.292
2028	681.180	711.024	630.548	**2044**	1024.194	1215.863	768.670
2029	702.544	739.144	645.560	**2045**	1038.427	1243.124	771.099
2030	724.676	768.611	660.886	**2046**	1051.189	1271.150	772.947
2031	747.611	799.502	673.384	**2047**	1064.226	1297.437	774.845
2032	771.383	826.567	686.070	**2048**	1077.548	1324.419	776.793
2033	796.034	854.716	698.971	**2049**	1089.295	1349.474	778.155
2034	821.604	883.978	712.126	**2050**	1101.294	1375.155	779.567
2035	848.134	916.847	722.531				

The projection of future emissions of the Waste sector up to 2050 under the three scenarios is shown in fig. 1.14.

Figure 1.14. The Waste Sector emissions projection to 2050 under the three scenarios.



1.1.7 Process and results of sector selection

Since the sector for the TNA had been identified on the stage of the TNA project design, the subsectors were debated and agreed upon for the mitigation technologies selection and prioritisation on SWG sessions.

This choice also corresponds to the set of key categories of emission sources. Out of 17 key categories assessed by levels (table 1.6.) 8 are assigned to the Energy Sector:

[52] Elaborated by authors

1. Road Transportation
2. Other Sectors (Commercial/Institutional/Residential) - Solid Fuels
3. Energy Industries (Combined Heat and Power Generation) - Solid Fuels
4. Other Transportation (Off-road)
5. Manufacturing Industries and Construction - Solid Fuels
6. Other Sectors (Commercial/Institutional/Residential) - Gaseous Fuels
7. Oil (Fugitive emissions)
8. Energy Industries - Gaseous Fuels

Out of these 8, two are attributed to the Transport Sub-sector, 2 – to the Energy Generation Industries, 2 – to Commercial/Institutional/Residential, one – to solid fuels consumed by Manufacturing Industries and Construction and one – for Oil fugitive emissions.

One category of GHG emission sources, i.e. “Solid Waste Disposal” of the Waste Sector is also attributed to the Kyrgyzstan key emission categories.

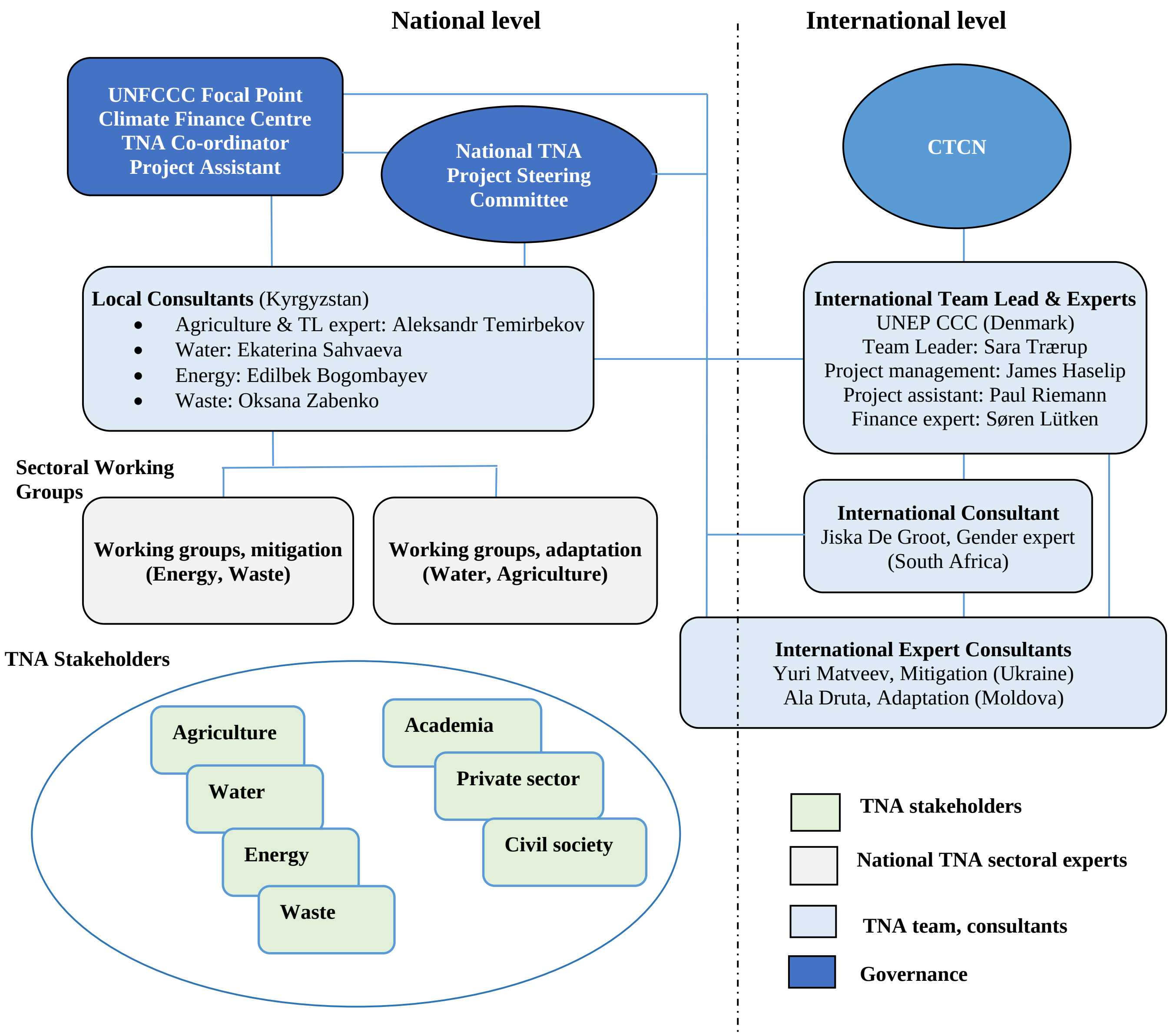
Thus, the final selection of the subsectors agreed upon was the following:

- Energy Sector: Energy Generation, Transport, Energy Efficiency and
- Waste Sector: Solid Waste Disposal, and Wastewater Treatment and Discharge.

Chapter 2 Institutional arrangement for the TNA and the stakeholder involvement

Institutional arrangements for the TNA project implementation in Kyrgyzstan are presented on the figure 2.1.

Figure 2.1. Institutional arrangements for the TNA project[53]



2.1 National TNA team

To facilitate effective activities of the project, Term of References have been developed for the National Steering committee and the Sectoral Working Groups on the initial stage of the project (see Annex III and IV in the Part I TNA Report on Adaptation).

[53] Developed by authors.

2.1.1 The National Steering Committee

To provide oversight of the process ongoing the National TNA Project Steering Committee (NSC) has been formed including all the main stakeholders as members (see fig 2.1):

1. Ministry of Natural Resources, Ecology and Technical Supervisions
2. Ministry of Energy
3. Ministry of Transport and Communications
4. Ministry of Agriculture (MoA)
5. Ministry of Economy and Commerce
6. Water Resources Service
7. State Agency for Architecture, Construction and Communal Utilities
8. Bishkek City Hall.
9. Climate Finance Centre.

The NSC acts as an advisory and oversight body to coordinate TNA Project activities at sector and national levels to ensure a comprehensive approach. The NSC has the responsibility to monitor and conduct quality control over timely implemented activities under the Project and guide it at the highest level.

Throughout the project's implementation, the Steering Committee's role will be to discuss and deliberate on project outcomes and results, provide recommendations, technical oversight and strategic advice to the GCF NDA on various Project-related subjects, ensuring Project alignment to the national and sectoral level development and climate-related priorities. It will also ensure TNA Project contribution and complementarity to the overall national low carbon and mitigation planning processes of Kyrgyzstan, while avoiding overlap or duplication with other under implementation initiatives.

The NSC provides the functional management in performing the responsibilities under the project through:

- Assuring project implementation according to its Project Document and work plans.
- Ensuring transparency in the use of funds;
- Examination of other activities that may occur in coordination with the implementing agency.

Table 2.1. The TNA project National Steering Committee members.[54]

#	Name	Position	Contacts
1.	Beksultan Ibraimove	Deputy Minister of Natural Resources, Ecology and Technical Supervisions, NSC Chair, UNFCCC Focal Point	Tel. E-mail: ibraimov.beksultan@gmail.com
2.	Kanat Abdrahmanov	Deputy Minister of Economy and Commerce, NSC Member	Tel:+996 (0312) 62-41-76, Fax:+ 996 (312) 66-18-37, mail@mineconom.gov.kg
3.	Tilek Aitaliev	Deputy Minister of Energy, NSC Member	(0312) 904040 (+1006) 0 551 109 776 t.aitaliev@nehk.ehergo.kg
4.	Almaz Turgunbekov	Deputy Minister of Transport and Communications, NSC Member	Tel. 996 (312) 314 385/ Fax:996 (312) 312811, 315071 315090
5.	Murat Baidyldaev	Deputy Minister of Agriculture (MoA), NSC Member	0555 220723 (assistant)
6.	Mirbek Akmataliev	Deputy Director of the State Agency on Architecture, Construction and Communal Utilities, NSC Member	Tel. 610305, e-mail: drpv00@mail.ru

[54] Developed by authors.

#	Name	Position	Contacts
7.	Adbybai Dzhailobaev	Deputy Director of the Water Resources Service under MoA, NSC member.	E-mail: djailobaev1961@mail.ru basssein@mail.ru
8.	Maksatbek Sazykulov	Deputy Bishkek City Mayor, NSC Member	Tel. (0312) 97-91-95 (+1025). E-mail: bishkek@meria.kg
9.	Dastan Abdyldaev	Director of the Climate Finance Centre	E-mail: dastan.abdyldaev.kg@gmail.com

2.1.2 The National TNA Coordinator

The function of the National TNA Coordinator has been assigned by the UNFCCC Focal Point to the Climate Finance Centre (CFC) under the Ministry of Natural Resources, Ecology and Technical Supervision (MNRETS). Mr. Ruslan Iliasov, CFC Director, performs as project coordinator implementing da-to-day synchronization of the different sectors targeted by the project in terms of organization of the national stakeholders engagement and organization of the project events, including national workshops, sectoral working group sessions, expert team coordination meetings and communications with other governmental, municipal, academia, business, and civil society organizations. To better organize facilitation of the project implementation on behalf of the Ministry a group of sectoral counterparts has been established within CFC. (See table 2.2).

Table 2.2. Project Implementation Coordination Group of MNERTS.[55]

#	Name	Sector	Contacts
1.	Mr Aibek Karabaev, CFC Specialist	Agriculture	E-mail: aibekusa@yahoo.com T. 0776831189, 0556 831189
2.	Mr. Ermek Esengeldiev, CFC Specialist	Energy	E-mail: ermek.esengeldiev90@gmail.com T. 0 556 08 40 00
3.	Ms. Ainura Dzhumalieva, CFC Specialist	Waste	T. 555 56 20 00 E-mail: ainuradjm@gmail.com adjumanaliyeva@gmail.com
4.	Mr. Nurlan Abyshev, CFC Specialist	Water	E-mail: raimkulova.asel@mail.ru T. 0552761576
5.	Ms. Zamira Naimanbaeva, CFC Gender Specialist	Gender equality and inclusion	T. 770 058 505 Е-почта: zamiranaimanwork@gmail.com
6.	Mr. Dostukbek Obodoev, CFC Specialist	TNA project facilitator	T. (+996) 704464646 Email: dostuk.obodoev.88@mail.ru

2.1.3 The Sectoral Working Groups

Sectoral Working Groups (SWG) on Agriculture and Water Resources were established according to the request letter from the UNFCCC focal point and in close consultation of TNA Coordinator and Team with the Ministry of Agriculture. It included representatives of the line ministry, academia, private sector, national farmers' organizations and NGOs, and international development partners supporting agricultural sector of Kyrgyzstan. (See table2.3. and table 2.4).

Table 2.3. Members of the Energy Sectoral Working Group.[56]

#	Full name	Organization, position	Contacts
1.	Esengeldiev Ermek	Center for Climate Finance, Expert, MPRETN	0556 08 40 00 ermek.esengeldiev@gmail.com

[55] Developed by authors.
[56] Compiled by authors.

#	Full name	Organization, position	Contacts
2.	Dastan Akbaraliev	Agencies for development and investment. Specialist. City Hall of Bishkek	0708 312996 d.akbaraliev@meria.kg
3.	Nurbekov Atay	Ministry of Energy of the Kyrgyz Republic, Leading Specialist, Department of Energy Efficiency, Energy Saving and Development of RES	0555 700 494 otdelvie21@mail.ru
4.	Esengulov Mirbek Omurbekovich	Ministry of Energy of the Kyrgyz Republic, Chief Specialist of the Department state policy in the electric power industry	0553 009 375 mirbek-es@yandex.ru
5.	Musabekov Nurmat	Ministry of Transport and Communications of the Kyrgyz Republic.Leading Specialist of the Road Transport Department of the Road and Railway Transport Department	(0312) 314067 0551 130688 nurmatm@gmail.com
6.	Samarets Svetlana	OJSC Electric Stations. Deputy Head of PTO of Bishkek CHPP	0555 771 607 es@infotel.kg
7.	Zhdanova Angela	OJSC Electric Stations. Ecologist of Bishkek CHPP	0554 944014Anjela.zhdanova@yandex.ru
8.	Aidar Atakanov	LLC Gazprom Kyrgyzstan. Development Manager	0772 163 738 aidarbek.atakanov@gmail.com
9.	Vedeneva Tatiana	Center for RES and EE.The president	(0312) 533 763 0555 755306 info@creeed.net
10.	Kazakova Eleonora	RES Association. Chairman	vienergy.kg@gmail.com
11.	Kunduz Karbasheva	Chairman of the Association of Wind and Solar Power Plants. JSC "Kyrgyz Wind system" Deputy Director	0755 741718 info@pogruz.kg
12.	Iskembaev Azamat Zhakypovich	Bishkek Solar LLC. General director	0501 138 393 bishkeksolarre@gmail.com
13.	Artur Madumarov	LLC NEW-TEK Kyrgyz-Germany, Deputy Directors	0770 050 551 a.madumarov@newtek-schmid.com
14.	Obozov Alaibek Zhumabekovich	NAS KR, Laboratory of RES, Doctor of Technical Sciences, Professor	0559 190 606 obozov-a@mail.ru
15.	Abduvaliev Maksat.	IVPGGE NAS KR, Head. Hydropower Laboratory	0550 056 442 abduldaev59@mail.ru
16.	Bogombaev Edilbek	Energy expert, OTP project	0553 919114 edilb@mail.ru

Table 2.4. Members of the Waste Sectoral Working Group.[57]

#	Full name	Organization, position	Contacts
1.	Mederaliyev Einar Dzhumabekovich	MNRETS KR, Department of Environmental Protection	0505502402 0772 160758 (WhatsApp) einvironment@mnr.gov.kg
2.	Ulanbekov Talantbek Ulanbekovich	City Hall of Bishkek, head of the OBO department	0505002007 ulanbekovtalantbek@gmail.com
3.	Asylbaev Chyngyz Kanatbekovich	Director of Municipal enterprise "Bishkek sanitary landfill"	0559233233 mp_bsp@mail.ru
4.	Maatkulov Abas Atantayevich	Deputy Director for Planning and Development of the Municipal Enterprise "Tazalyk"	0312 345-102, (reception) 0312 345-073, (general department), 0555080810

[57] Compiled by authors.

#	Full name	Organization, position	Contacts
			mptazalyk@mail.ru abas1609@mail.ru
5.	Karimov Alibek Abdyganievich	Specialist of the department for the development and monitoring of housing and communal services of Gosstroy	0312 312-924 Common department ali.k.7189@mail.ru
6.	Orozbakieva Shayyrgul Galievna	Leading Specialist of the Department for the Development of Drinking Water Supply and Sanitation at the State Agency for Construction Architecture and Housing and Communal Services	0312 312-924 Common department orozbakieva@mail.ru
7.	Dzhumanalieva Ainura Satybekovna	Climate Finance Centre under the Ministry of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic	555 56 20 00 ainuradjm@gmail.com adjumanaliyeva@gmail.com
8.	Moldokulov Kurmanbek	Bishkek Development Agency, Director	0557-858888 kurmanbek78@gmail.com
9.	Kulmurzaeva Aisuluu Kuvatbekovna	Bishkek Development Agency	0505043044 aisuluukulmurzaeva@gmail.com
10.	Bakirov B.Zh.	Bishkek Development Agency	0999117709 Bakytbek.bakirov.76@mail.ru
11.	Sultambaev Medetbek Oroskulovich	ARIS? Senior Monitoring and Evaluation Specialist	MSultanbaev@aris.kg, 30-17-78 add. 197 0702803251
12.	Baidakova Natalya Sergeevna	CSR Central Asia Environmental Safety Expert	0700 204-734 wastenet.grants@gmail.com
13.	Vedeneva Tatiana	Centre for RES and EE. The president	0312 533-766? 0555 755306 info@creeed.net
14.	Mamatbekov Daniyar Zhumabekovich	LLC "Bivtor"/ Senior manager	0770 900-248, 0772 032-620 mdj_1988@mail.ru
15.	Dzhumaliev N. process engineer	LLC "Eco technologies" waste disposal company	0 507–62–42–12, 777–62–42–12 ecotechnologies17@mail.ru
16.	Tkachev Andrey	LLC "Fluid"	element_krsu@mail.ru +996(559)000104
17.	Shevchenko Valery	Industry Consultant	hhol.kz@mail.ru 0555510633
18.	Zabenko Oksana	TNA expert	ksana_ks@mail.ru

In the first sessions of both SWGs it was decided that any additional resource persons could be invited to the SWG as members if they expressed interest and could provide relevant information on the technology innovations.

2.1.4 The Consultants Team

The National Consultants' Team included experts in adaptation and mitigation, possessing considerable experience in the targeted sectors, and also experience in the development of the latest NC, BUR and NDC of Kyrgyzstan, thus, fully aware of the current climate actions of Kyrgyzstan. (See. Table2.5).

Table 2.5. National consultants.[58]

#	Name	Position	Contacts
1.	Edilbek Bogombaev	Mitigation in the Energy Sector	Tel. +996 553919114

[58] Compiled by authors.

#	Name	Position	Contacts
			E-mail:
2.	Oksana Zabenko	Mitigation in the Waste Sector	Tel. +996 551740342 E-mail:

2.2 Stakeholders engagement process followed in the TNA – Overall assessment

A broad stakeholder consultation process involving technical experts from different sub-sectors considered for adaptation and mitigation was initiated in the beginning of the TNA process. The first session of the National Steering Committee for TNA project was conducted on 20 July 2022 and the Inception workshop engaging all the relevant stakeholders was conducted 21 July 2022.

The National TNA Coordinator, National Implementation Group and National Consultant Team conducted regular coordination meeting to debate TNA project ongoing, emerging issues and steering measures. The minute of all the events were developed as appropriate and file in CFC archive.

The whole TNA process envisages stakeholders as the major contributor towards the implementation of the TNA. Hence every step involved a large share of consultation with the stakeholders for making valuable decisions towards finalizing the report. The list of relevant stakeholders was identified by national consultants in close cooperation with the National TNA Coordinator and line Ministry. Identified stakeholders include government institutions and departments with responsibility for policy formulation and regulation in relevant sectors (i.e. Energy and Waste), private and public sector industries, business associations, technology end users and/or suppliers within the private sector, relevant academic institutions and experts, as well as international development partner organizations. The extended list of stakeholders represents in the Annex I

The pool of stakeholders engaged in TNA involves policy-making governmental agencies (Ministry of Natural Resources, Ministry of Economy and Commerce, Ministry of Energy, Ministry of Transport and Communications, State Agency for Architecture, Construction and Communal Utilities under the Cabinet of Ministers, Agency for Communities Development and Investment), research institutions (Institute for Water Metering, Institute for Economy and Energy, Kyrgyz State University for Construction and Architecture, and the Institute of Automatics and Informational Technologies of the National Academy of Sciences), NGOs (Association of Renewable Energy, Centre for Energy Efficiency and Renewable Energy Sources, Association of Wind and Solar Electrical Stations), Municipal organizations (City Hall of Bishkek, Bishkek Sanitary landfill, Bishkek Tazalyk (waste collection and transportation), Bishkek Vodokanal (drinking water supply and sanitation)), private sector organizations (LLC Fluid Biogas, JSC Electrical Stations Bishkek Heat and Energy Plant, LLC Bishkek Solar, JSC Kyrgyz Wind Systems).

The TNA process included active stakeholder engagement activities and the dialogue with stakeholders engaged in the TNA process was built upon:

- the functioning of the Sectoral Working Group and project Steering Committee was carried out according to the developed and validated ToRs, including overall sectoral TNA process coordination, additional relevant stakeholders engagement, discussion and quality assurance of all the delivered drafts by the national consultants and their final approvals as well as alignment of all deliverables to the national development priorities.
- conducting regular Sectoral Working Groups sessions, workshops to discuss the implementation of the state policy in the field of climate change mitigation, along with consultation and validation of documents and decision taken under TNA process;
- international and national consultants consulting and providing methodological support to the TNA team and other engaged in the TNA process representatives of governmental, academic and business organizations

- developing common communication platforms among all relevant projects aimed to contribute to climate-change initiatives such as the UNDP project on the development of the NDC Implementation Plan and Long-Term Strategy for Carbon Neutrality till 2050, UNDP/GCF National Mitigation Planning project.

Technology Fact Sheets prepared by the national consultants with support and in consultation with sectoral stakeholders were circulated among the Sectoral Working Groups members and relevant stakeholders for comments, recommendations and addressed in the final version of produced TFSs shared with SWG members and considered during the technology prioritisation exercise.

The implementation of the first phase of TNA in climate mitigation of Energy and Waste sectors was maintained highly participatory for ensuring the country driven process. Throughout the TNA process, the engaged stakeholders interacted and discussed topics supporting TNA process in an objective fashion, directed towards identification, appraisal and selection of relevant to prioritised sectors' climate mitigation technologies. The national consultant team received effective support from stakeholders in gathering sectoral data, getting needed expertise in the discussed topics, making decisions to meet the objectives of TNA project.

2.3 Consideration of gender aspects in the TNA process

The Kyrgyz Republic has achieved near gender parity in education enrolment and literacy rates. However, it fares poorly in the key global indicators of women's labour force participation, women's leadership, and the maternal mortality ratio. Women's economic participation remains low at 48.2% compared to 75.7% for men. Women's political empowerment is also low with only 16% of seats in the Parliament in 2018. The maternal mortality ratio is extremely high at 76 deaths per 100,000 live births. These persistent areas of gender inequality resulted in a ranking of 91st in a total of 189 countries in the 2017 gender inequality index (GII). The country has an overall composite score of 0.392 based on its progress in the key indicators on maternal mortality, adolescent birth rate, gender parity in secondary education, and political representation. This puts the country behind many other former Soviet Union countries in the region: for example, Kazakhstan is 43rd in the GII, Armenia is 55th, and Uzbekistan is 59th.[59]

The Kyrgyz Republic has ratified several key international conventions on human rights and gender equality. These include the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) on 10 February 1997, and the Optional Protocol of CEDAW (OP-CEDAW) on 22 June 2002. In 2000, the country submitted its first report on the implementation of the CEDAW Convention to the CEDAW Committee.

The Constitution of the Kyrgyz Republic, amended in 2010, enshrines the principles of inalienable human rights and gender equality but fails to recognize discrimination on the grounds of sexual orientation, gender identity, or disability.

The Law "On State Guarantees of Equal Rights and Equal Opportunities for Men and Women" was passed in August 2008. This law is the most significant, comprehensive piece of legislation designed to ensure equality between women and men. The law prohibits acts based on traditional or customary laws that contravene the principles of equality it enshrines. It also sets out provisions for ensuring its effective implementation, including requiring state bodies and local government authorities to submit annual evaluation reports for the systematic collection of statistical data, and for enforcement processes where alleged breaches of the law can be formally reviewed.

[59] ADB. Kyrgyz Republic country gender assessment. 2019.

The Kyrgyz Republic's first long-term **National Gender Strategy (NGS) on Achieving Gender Equality by 2020** was adopted in 2012 in compliance with CEDAW. The NGS outlines the following five pivotal areas for achieving gender equality: (i) strong, effective institutional mechanisms; (ii) economic empowerment; (iii) an education system that promotes gender equality; (iv) access to justice for women; and (v) gender-equitable political participation. The NGS is further elucidated through national action plans on gender equality.

The Gender Policy Department of the Ministry of Labour and Social Development oversees the implementation of the NGS. The National Council for Gender Development was established in May 2012 as an advisory body chaired by the Deputy Prime Minister. It comprises ministers, deputy ministers, and heads of provinces.

Integrating a gender approach into the analysis and decision-making processes in the field of climate change is important due to the fact that women and men react differently to changes in the state of the environment and may be affected in different ways according to the consequences of climate change. In households, especially those in rural areas, the main burden in the field of the availability and delivery of water for domestic needs and the provision of fuel for heating and cooking falls primarily on women and children. As climate change increases, these challenges become more complex. Women often face difficulties when it comes to accessing financial resources, capacity building activities and technology transfers. At the same time women are often underrepresented in climate-change decision-making at all levels. This severely limits their ability to contribute to the implementation of solutions and apply their knowledge.

However, existing statistics and research do not fully identify gender aspects in all climate-change related areas. It is necessary to consider the role of women in the development of policies, not only as recipients of policy, but also as important agents of its development and implementation. At the institutional level, activities are carried out to achieve gender equality, including gender analysis and the development of gender-responsive measures as part of the movement towards sustainable development. During the development of NC 3 and 4 and NDC, the following issues were identified that need to be addressed:

- The indicators of the effectiveness of government policies are gender and environmentally insufficient and, ultimately, lead to asymmetry in the concentration of wealth and greater inequality, including gender inequality;
- There is a gap in living conditions between urban and rural areas, and persistent trends in the dilapidation of infrastructure in the regions. The increase in social inequality as a result of these problems will lead to the inequitable distribution of the risks associated with climate change, and increase the burden on the most vulnerable populations, including women.
- Women are often a key part of communities, families and the local economy. As a result, it is women who primarily feel the devastating effects of environmental changes, and, to a large extent, experience the ability of communities to adapt to them;
- Women play a crucial role in biodiversity conservation and the management of water, land and other natural resources at local level. While environmental degradation has severe consequences for everyone, it primarily affects the most vulnerable, who are mostly women and children;
- At local government level, the exclusion of women from decision-making on access to natural resources, such as water, land, etc. is observed;
- Institutional arrangements for the transfer of knowledge and security in local communities (medical obstetric stations, hospitals, schools, etc.) are financed by a leftover principle and not ready for the challenges of climate change;

- The lack of gender analysis of the consequences of climate change and other aspects of environmental crisis leads to the absence of a clear picture of the risk distribution for different social groups;
- Lack of constructive mechanisms for equitable access to natural and social resources in the context of the challenges of climate change will lead to a sharp increase in social conflicts. According to the research in the national communications, the peak of reducing water availability in the region is predicted for the period from 2050 to 2100. Thus, we already need to see women as important participants in the resource governance system and reduce conflicts to lessen the dramatic effects of climate change.[60]

Therefore, on the path to sustainable climate resilient development and «green growth», the long-term development programmes should be developed on the basis of inter-agency cooperation, taking a minimization of environmental risks, the natural ecosystems conservation and the gender component into account.

There is a different level of gender influence in the process of technology implementation for the mitigation in energy and waste sectors, since the engagement of the stakeholders was fully coordinated by the sectoral CEO and less by TNA Coordinator. Therefore, preparation of TNA report and setting of the entire TNA process included different involvement of women, and the entire process of TNA report preparation was gender balanced.

Thus, National Consultants Team comprises two national female experts for Water and Waste sectors, i.e. 50%. The Project Implementation Coordination Group under the Ministry of Natural Resources, Ecology and Technical Super vision includes 3 women (50%).

The composition of the SWG on Energy was also gender-sensitive, evidently due to the fact that the invitation to participate there, was fully under sectoral governmental bodies' responsibility. Thus, participation of women in the Energy SWG was 32 %. At the same time the share of women in Energy-sector stakeholder engagement as a whole was 25%. The Waste sector SWG had 30% women and the total women's involvement into TNA in the Waste Sector was 21%.

Nevertheless, the composition of groups engaged in TNA process has allowed free expression of thoughts and ideas by both men and women experts and sectoral specialists, and equal participation in the decision-making process of the TNA mitigation component.

Additionally, to encourage a gender-sensitive approach in the TNA activities and results, a special criterion "Gender Equality and Social Inclusion" was included in the set of selection criteria for all the sectors.

[60] State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. UNEP. GEF. Third National Communication of the Kyrgyz Republic under UNFCCC. 2016.

Chapter 3 Technology prioritisation for the Energy Sector

Identifying, assessing and evaluating technologies for climate change mitigation is a complex, dynamic process that cuts across scales, sectors, and levels of intervention. Technology development and transfer is an area of increasing priority on the international climate-change mitigation agenda.. Methodological and operational aspects of technologies in the area of climate-change mitigation are rather well developed.

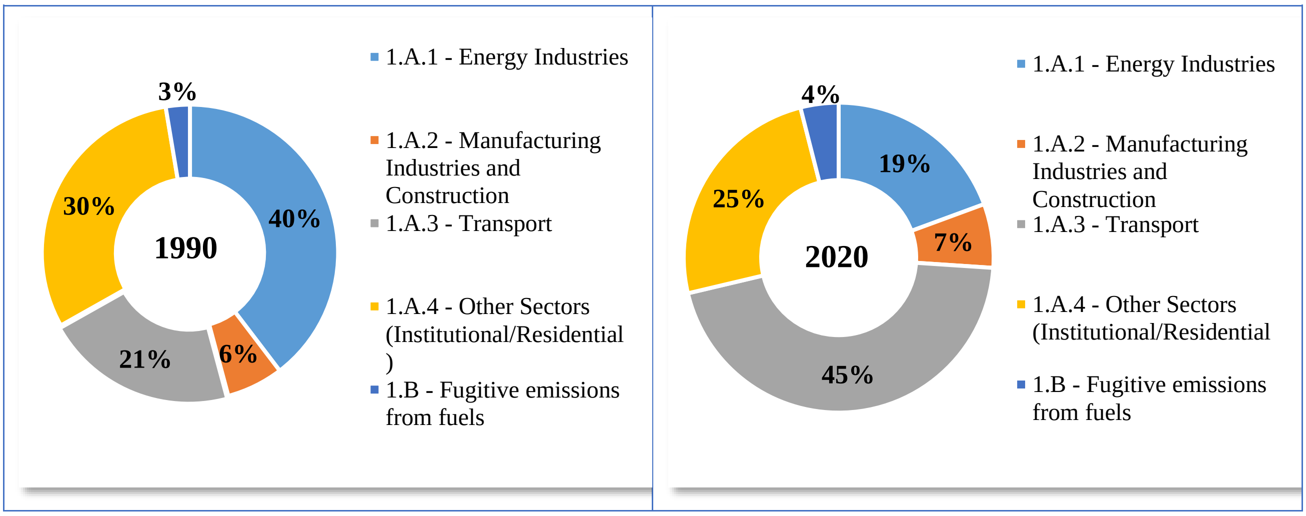
In the transfer of mitigation technology it is imperative to ensure that they address the key sector emitters and key GHG-emission categories identified in a country. Therefore it is vital to identify and assess technologies against appropriate criteria when prioritizing technologies. [61]

It should be noted that the main guiding factors for the mitigation technology needs assessment for energy and waste were determined by the set of mitigation measures and the volume of reduced GHG emissions as defined in NATCOMs and updated NDC.

3.1 GHG emissions trends and projections in the Energy Sector

In the Kyrgyz Republic, the economy has undergone major transformations since gaining independence in 1991. After the collapse of the Soviet Union, many types of industrial production were lost. This process was accompanied by a period of hyperinflation and unemployment, significant external migration and a sharp increase in poverty. The structure of fuel consumption and, correspondingly, GHG emissions has changed significantly since the end of the Soviet era. The dynamics of changes in GHG emissions by subsectors is shown on fig. 3.1.

Figure 3.1. GHG emissions by energy sectors of the Kyrgyz Republic in 1990 and 2020 for comparison[62]



The inventory shows that in 2020 the total GHG emissions from the Energy sector amounted to 7,648.189 Gg CO_2 equivalent. At the same time, emissions of CO_2 equivalent of the energy industry 1.A.1 amounted to -1,482.937 Gg, emissions from industry and construction 1.A.2. - 509.768 Gg,

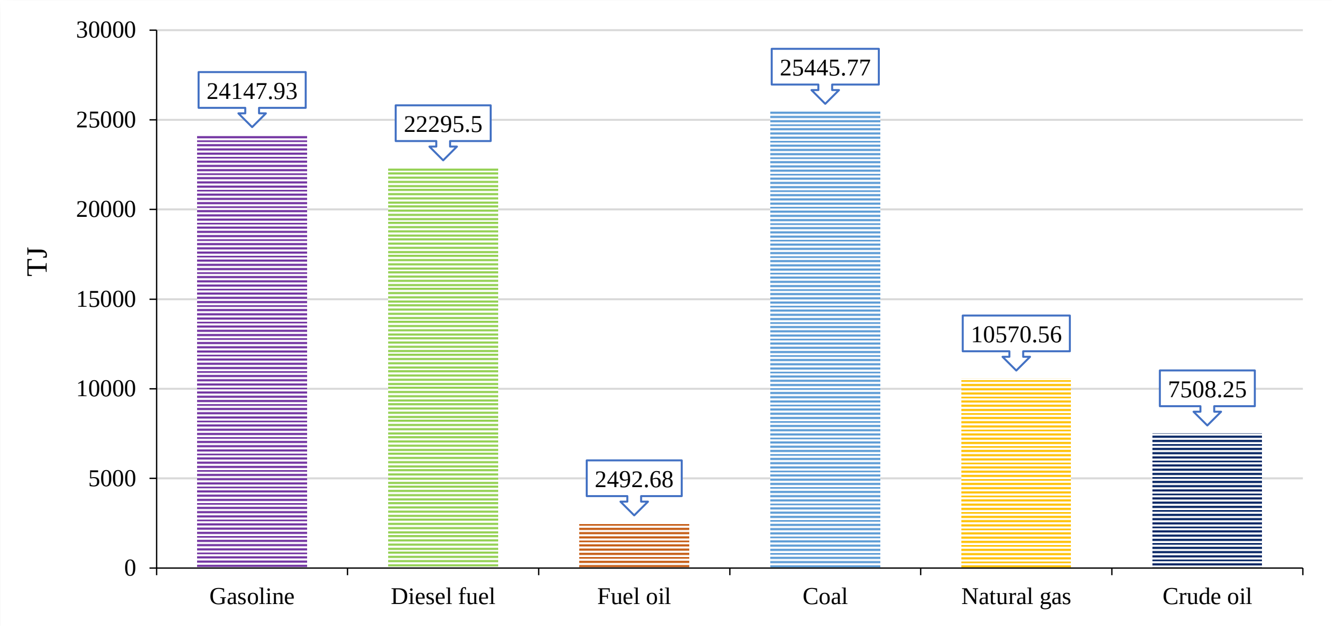
[61] Sara Trærup and Riyong Kim Bakkegaard. 2015. Determining technologies for climate change adaptation/ UNEP DTU Partnership.

[62] Data from the National GHG Inventory 4

transport emissions 1.A.3. – 3,460.716 Gg, emissions from other sectors, including housing 1.A.4. – 1,890.675 Total fugitive emissions 1.B.- from fuel amounted to 304.090 Gg.[63]

The volumes and structure of consumption of fossil fuels by types in the Kyrgyz Republic in 2020, the combustion of which emits GHGs, are shown in fig. 3.2 below. The total consumption of fossil fuels amounted to 92,460.69 TJ per year .[64]

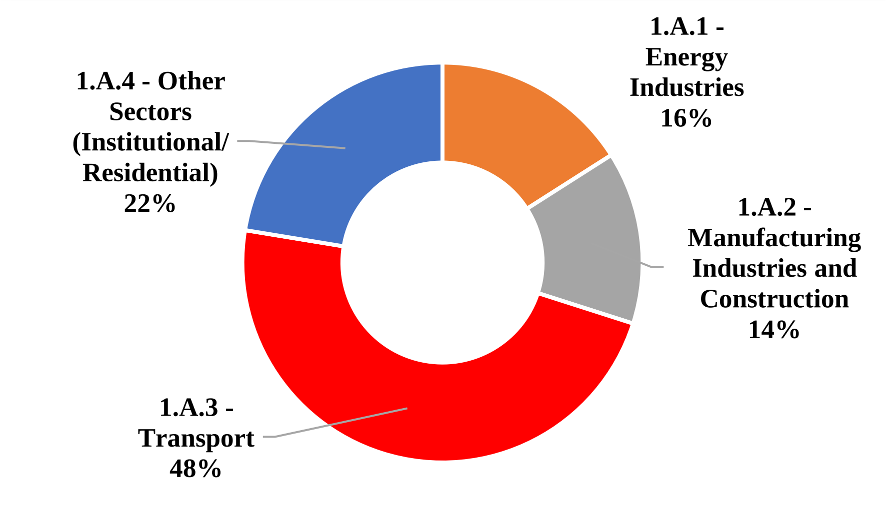
Figure 3.2. Fossil-fuel consumption by type in the Kyrgyz Republic 2020.[65]



The main consumption was of gasoline and diesel - more than 50%, coal consumption - 27%, natural gas accounted for more than 11% of the total energy consumption. The largest amount of fossil fuels is consumed by the transport sector - 48%, the housing sector - 22%, the electricity and heat generation sector - 16%, industry and construction - 14%. Fig. 3.3 below shows the structure of fossil-fuel consumption by energy sector.

Figure 3.3. Fossil-fuel use by sector in the Kyrgyz Republic in 2020.[66]

[63] Data from the National GHG Inventory 4.
[64] http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/
[65]http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/
[66] Fourth National Communication. Kyrgyzstan 2020



Power generation

In the Kyrgyz Republic, the total installed electric capacity in 2020 amounted to 3,94 MW, including: 3,30 MW at large HPPs; 862 MW - an TPP on coal, fuel oil and gas fuel; and 53 MW - at small HPPs. The total installed capacity of possible prospective HPP cascades for construction is 6,45 MW, with an average annual output of more than 25 TWh electricity per year [67].

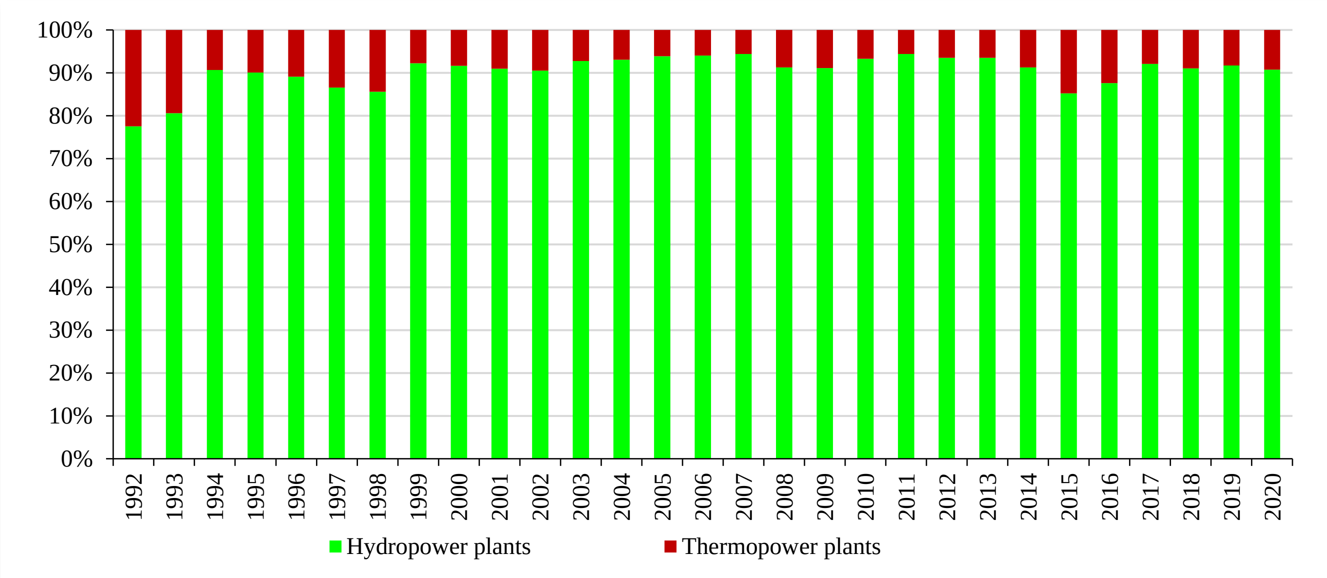
Kyrgyzstan is a mountainous country and has a large hydropower potential. The total hydropower potential of the Kyrgyz Republic is 142.5 TWh, but the percentage of potential development is only 10%.[68] In this regard, electricity is mainly generated at hydroelectric power plants and partly at thermal power plants. At the same time, the Bishkek TPP (920 MW installed capacity) operates in a combined mode, generating electricity and heat, while the Osh TPP and other small boiler houses provide heat during the heating period. Electricity generation in 2020 amounted to 15.40 TWh, including: 9% generated by thermal power plants and 91% generated by hydroelectric power plants[69]. Heat generation in 2020 amounted to 3.31 $Tcal_{th}$.

In 2020, the share of electricity generated by hydropower plants (HPP) made up 91 % and only 9% was produced by thermal-power plants (TPP). Gas and electric consumption meters are installed at all consumers, as well as for heating and hot-water supply, mainly in the housing sector.

In the period 1990-2020 the share of electricity generation at thermal power plants (TPP) was changing (fig. 3.4). Thus, in 1992, TPPs produced 2.69 TWh or 22.5 % of total electricity production, and in 2000 – 1.25 TWh or 8.4 %, and by 2011 – 0.85 TWh (5.6 %), in 2018 – 1.41 TWh (8.9 %), and in 2020 – 1.43 TWh of 9.3 % of total electricity generated in Kyrgyzstan.[70]

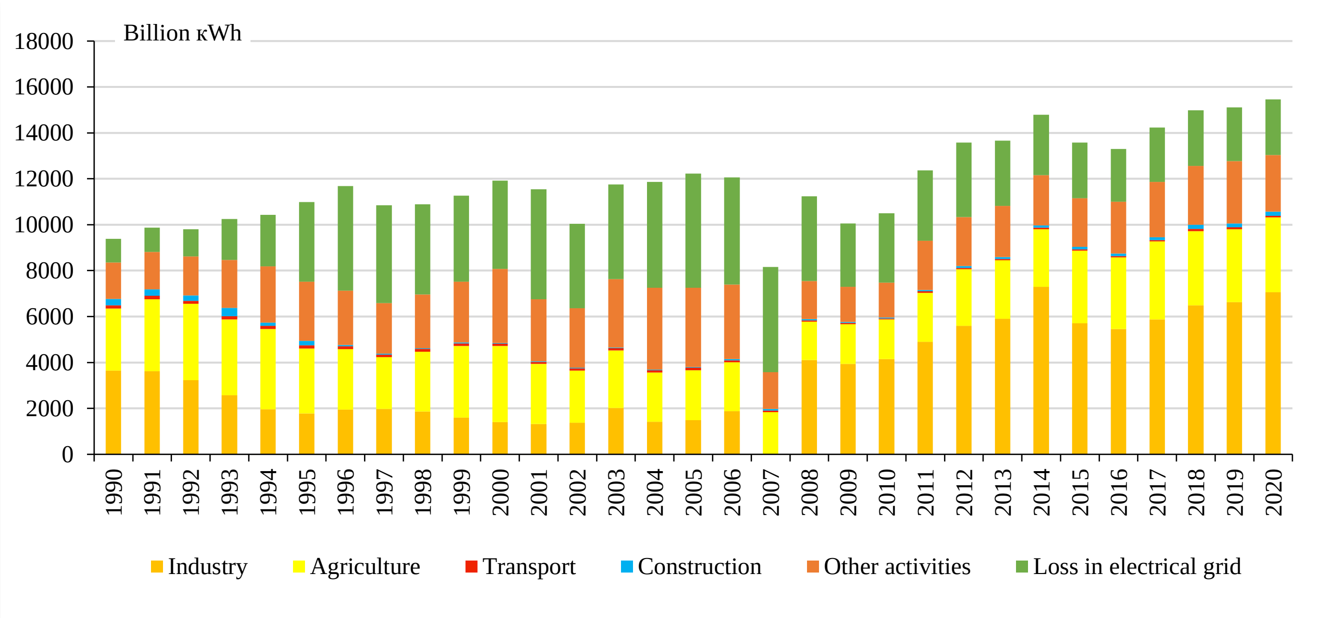
Figure 3.4. The shares of the electrical power produced by power plant type in 1990-2020 [71]

[67] https://www.irena.org/-/media/Files/IRENA/Agency/Events/2018/Oct/4-Kyrgyzstan-country-presentation-Beknur-Maratbekov.pdf?la=en&hash=E5334BFA69F762D756C02EA2BC7D248CF67A570D
[68] https://www.unescap.org/sites/default/files/Session_2_Kyrgyzstan_Kasymova.pdf
[69] http://www.stat.kg/ru/statistics/promyshlennost/
[70] NSC. Fuel and Energy Balance 2020. http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/
[71] NSC. Electrical power generation data since 1992. http://www.stat.kg/ru/statistics/promyshlennost/



The share of losses in the structure of electricity consumption is high. Thus, while in 1990-1992 the losses did not exceed 13%, in the period 1995-2008 they were over 30%, reaching 41.5% in 2001 and 40.7% in 2005. Since 2011, there has been a slight decrease in losses (25%), although the total amount of losses exceeds social sector consumption or the total consumption of such sectors as agriculture, transport, and construction. In 2020, power-grid losses accounted for 15.7% of overall consumption (fig. 3.5).

Figure 3.5. Electricity consumption balance by main economic sectors for 1990-2020 [72]



The Renewable Energy Sources (RES) potential in the Kyrgyz Republic is estimated preliminary per year: at 490 GWh of solar energy from solar power plants; 22.5 GWh of solar energy for hot water supply; 44.6 GWh of wind power for WPPs; biomass for biogas production 1300 GWh; small HPPs

[72] NSC. Electrical balance of the economy sectors. 1990-2018. http://www.stat.kg/ru/statistics/promyshlennost/

up to 8 GWh.[73] However, this potential is used by less than 1% and exclusively by small hydropower plants.

In the National Development Programme of the Kyrgyz Republic until 2026 [74] it is indicated that it is necessary to reduce the degree of the country's dependence on hydrocarbon energy sources. One of the acceptable solutions is a more large-scale development of hydropower and the transition to alternative energy, considering changes in the internal structure of energy consumption and technological modernization of the economy, especially climate change processes. In the near future. it is planned to build cascades of large HPPs, renewable energy technologies will also play a certain role in the future energy system of the Kyrgyz Republic.

Current feed-in tariffs related to RES are set with a multiplying factor of 1.3[75] from industrial level 2.52 KGS/kWh (about 0.03 USD/kWh)[76], regardless of technology (solar energy, hydropower, biomass, wind, geothermal energy). Asian Development Bank estimates that this amount is below the global average levelized cost of electricity from utility-scale renewable energy technologies in 2019. And it is very likely that the current feed-in tariffs will not generate any investments in solar and wind energy in the Kyrgyz Republic.[77].

In addition, that Programme indicated that, from a financial point of view, the energy sector is in a critical condition and remains unattractive for investors. It is necessary to take a step that is difficult but necessary for the sustainability of the sector - a gradual increase in tariffs. Currently, tariffs in the energy sector are social rather than economic. Tariffs are too low to support the development of the renewable energy market and the energy sector of the republic as a whole.

The structure of GHG emissions (in CO_2 eq.) in the Energy sector by source categories in 2018-2020 is shown in fig. 3.6.

Figure 3.6. Energy sector emissions by categories of sources in 2018-2020[78]

[73] https://www.irena.org/-/media/Files/IRENA/Agency/Events/2018/Oct/4-Kyrgyzstan-country-presentation-Beknur-Maratbekov.pdf?la=en&hash=E5334BFA69F762D756C02EA2BC7D248CF67A570D

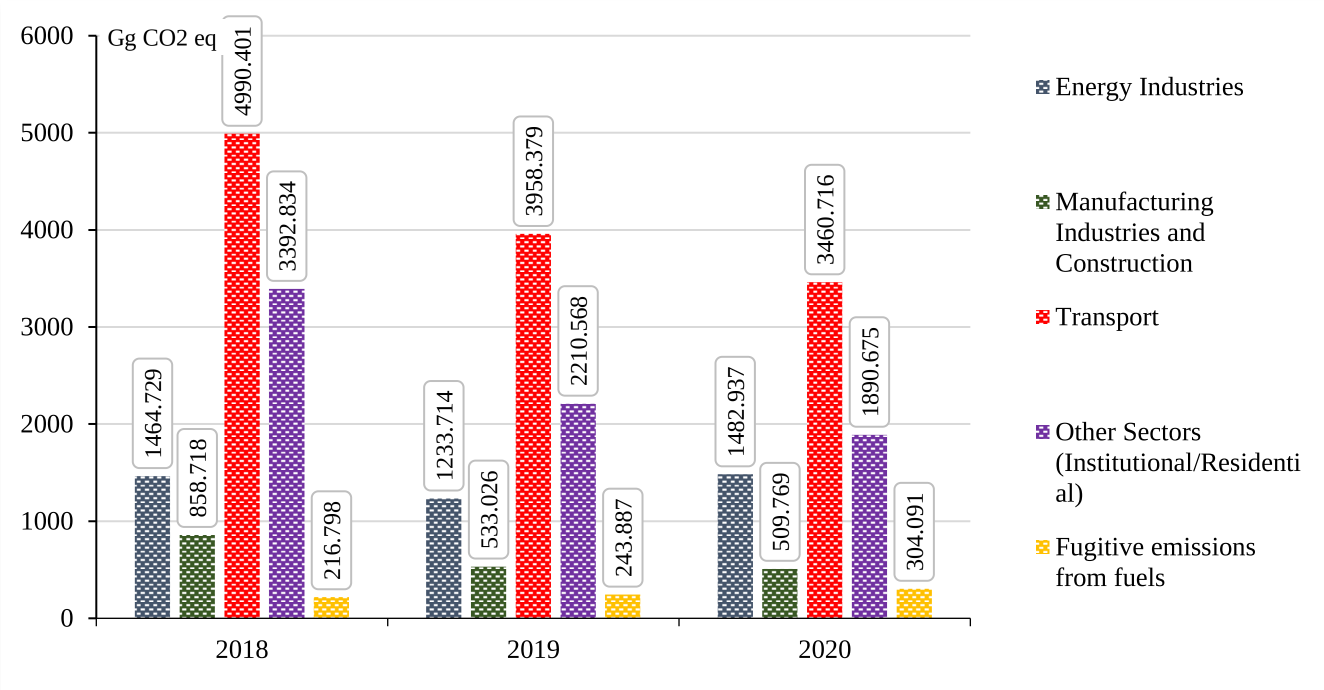
[74] http://cbd.minjust.gov.kg/act/view/ru-ru/430700

[75] http://cbd.minjust.gov.kg/act/view/ru-ru/111946

[76] http://cbd.minjust.gov.kg/act/view/ru-ru/158785

[77] Master Plan for Complex Development of the Energy Sector of the Kyrgyz Republic. ADB report 2022

[78] Ministry of Natural Resources, Ecology and Technical Supervision. 2022. IPCC GHG Inventory Software v 2.54. Data.



Fugitive emissions from fuel

Fugitive emissions of methane in the Kyrgyz Republic occur during the extraction of coal, oil and gas, as well as the operation of the gas supply system (accidental emissions leaks, emissions during repair work, technological losses). According to official data, fugitive emissions from transmission and distribution systems amounted to 7.5% in 2020. Kyrgyzstan imports natural gas from Russia through the territory of Kazakhstan and Uzbekistan. The total length of the gas supply system with main gas pipelines and networks is 4195 km.

Currently, 30% of the total number of consumers in the Kyrgyz Republic have access to natural gas. LLC Gazprom Kyrgyzstan plans to supply gas to about 400 settlements and more than 845 thousand apartments and households by 2030, the length of inter-settlement gas pipelines can reach almost 2,750 km, distribution gas pipelines in settlements more than 4,400 km. The level of gas supply to households of the country can reach 60%.[79] The volume of coal production in the Kyrgyz Republic in 2020 amounted to 2.67 million tons[80], which is mainly mined in a quarry. When it is mined, methane is also released. The republic produces 22.4 million cubic metres of gas and 239.2 thousand tons of oil [81], which also contribute to fugitive methane emissions.

Combustion of fuel in mobile installations

The transport sector in the Kyrgyz Republic includes railways, roads, air and a small number of pipelines at the oil production sites. Since 1990, the transport sector of the republic has undergone significant changes due to the collapse of the USSR, a bad economic environment, and significant structural changes in the economy. The total volume of transportation in 2021 fell by 3.5 times compared to 1990. In 2021, the share of road transport in the total freight turnover amounted to 51.46%; 38.28% rail transport; 9.6% of main pipeline transport; and 0.79% air transport. The transport sector accounts for 48% of the total fuel consumption in the country.

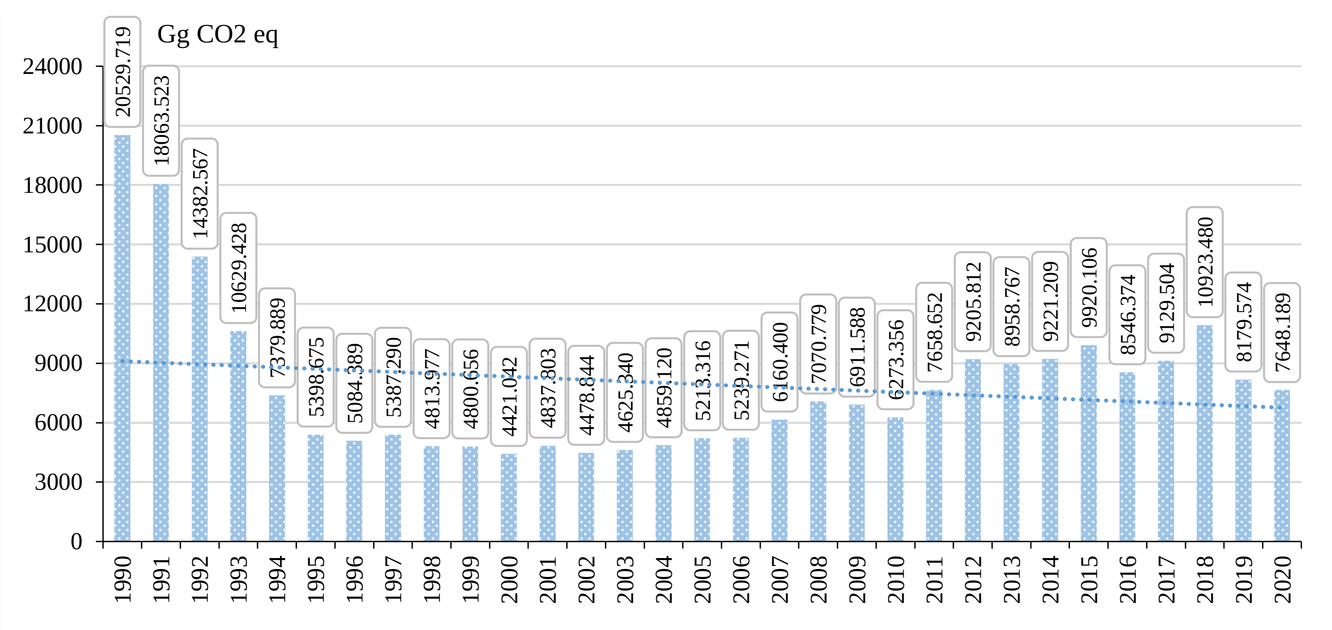
Combustion of fuel in road transport

[79] https://kyrgyzstan.gazprom.ru/about/project/genshema/
[80] http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/
[81] http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/

Fuel used in road transport in Kyrgyzstan includes: CNG, gasoline, diesel fuel. At the same time, the LNG market is just beginning to develop. Now its consumption is about 80-100 thousand tons of imports in 2021. This is not more than 10% of the consumption of petroleum products[82]. Kyrgyzstan annually imports 98% of gasoline and 92% of diesel fuel[83]. The Kyrgyz Republic lacks its own fossil fuel and energy resources for the production of petroleum products. as well as large storage facilities for liquid fuels.

The dynamic and the main trend of the total GHG emissions in the Energy sector in 1990-2020 in Gg CO_2 equivalent is given on fig.3.7.

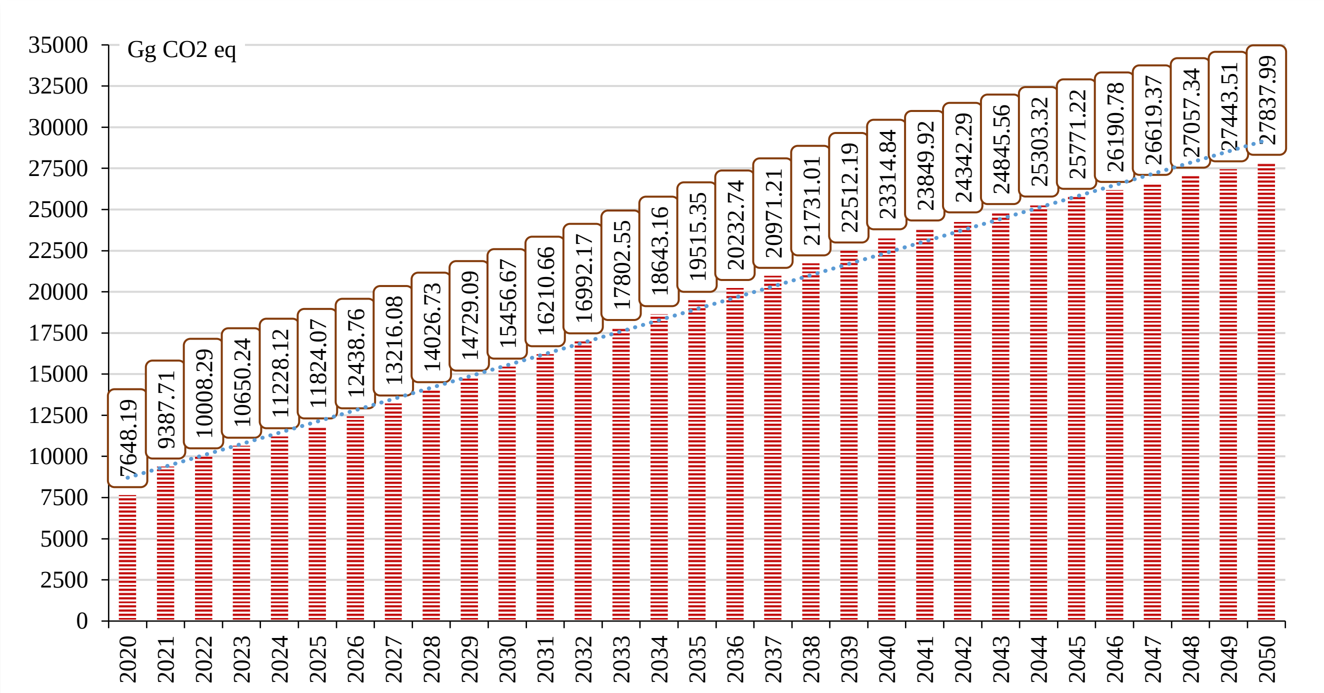
Figure 3.7. GHG emissions in the Energy Sector in 1990-2020 (Gg CO_2 eq.) [84]



The projection of the future GHG emissions in the Energy Sector until 2050 as per Basic BAU scenario is shown on fig.3.8.

Figure 3.8. Projection of GHG emissions in the Energy Sector until 2050 in a BAU scenario [85]

[82] https://24.kg/biznes_info/213001_sjijennyiy_gaz_mojet_pomoch_kyirgyizstanu_vyiyti_iztoplivnogo_krizisa/
[83] http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/
[84] Ministry of Natural Resources, Ecology and Technical Supervision. 2022. IPCC GHG Inventory Software v 2.54. Data.
[85] Ministry of Natural Resources, Ecology and Technical Supervision. 2022. Draft Fourth National Communication under UNFCCC.



Mitigation measures in the Energy Sector

The updated NDC defined different mitigation measures (also regulatory and capacity building), in this section we present the direct mitigation measures leading to GHG emission reductions and the estimated values for each of them. Those measures were developed in 2021 and included in the updated NDC (see Table 3.1). All these measures are aimed at achieving the main mitigation objectives in three areas: (1) reduction of current emissions; (2) improvement of energy efficiency and (3) development of renewable energy sources.

Table 3.1. Mitigation measures of the updated NDC of the Kyrgyz Republic for the Energy Sector.

Goals	Measures[86]	Target indicators, Gg CO_2 eq.	
		2025	2030
Energy			
1. Reduce current GHG emissions	1.1. Reducing coal consumption through gas supply of households in the country (WM)	809.979	971.247
	1.2. Replacement of passenger vehicles with internal combustion engines for electric vehicles (WAM)	444.990[87]	423.181[88]
	1.3. Improving traffic management and developing cycling infrastructure (WM)	253.037	747.963
	1.4. Reducing electricity losses during transmission (WM)	13.668	13.668
	1.5. Reducing electricity losses during distribution (WM)[89]	10.888	30.275
	1.6. Replacement of buses with internal combustion engines for buses with gas engines in the city of Bishkek (WM)	7.967	14.734

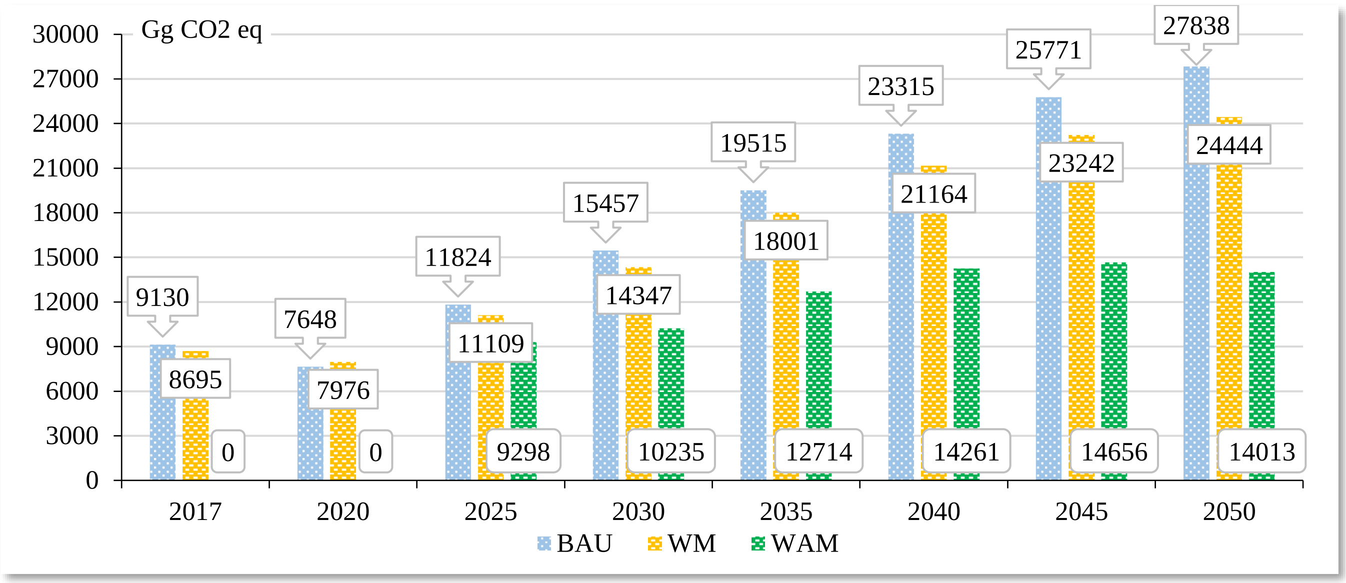
[86]The measures presented were collected and discussed during the consultations of the first round of sectoral technical meetings. The calculation methodology was presented, discussed and agreed upon in the second round of technical meetings with sectoral stakeholders.
[87]UNDP assessment.
[88]UNDP assessment.
[89]In brackets is the scenario to which this measure applies: WM – with measures on the internal resources; WAM – with additional measures on condition of external recourses mobilization/

Goals	Measures[86]	Target indicators, Gg CO_2 eq.	
		2025	2030
	1.7. Reconstruction and improvement of the heat supply system of the city of Bishkek (WM)	3.357	3.357
	1.8. Replacement of ICE buses for buses with gas engines in the city of Osh (WAM)	2.749	4.416
	1.9. Expansion of the trolleybus fleet by replacing buses with internal combustion engines in the city of Bishkek (WAM)	0.882	0.882
	1.10 Replacement of buses with internal combustion engines for buses with gas engines on suburban routes in the city of Bishkek (WAM)	Not assessed (NA)	2.501
2. Increasing energy efficiency	2.1. Scaling up the installation of energy efficient stoves in households (WM)	772.449	886.314
	2.2. Improving the e - efficiency of small boiler houses by replacing coal-fired boilers with gas ones (WAM)	402.203	1,223.697
	2.3. Construction of new buildings according to energy efficient Building Codes SNiP (WM)	14.552	16.866
	2.4. Improving the Energy Efficiency of Existing Buildings (WAM)	BUT	10.868
3. Development of RES	3.1. Expansion of the use of biogas plants (BGU)[90](WAM)	187.666	1,311.980
	3.2. Increasing the capacity of existing HPPs (WM)	98.935	98.935
	3.3. Electricity generation at existing private small hydropower plants (WM)	2.737	2.737
	3.4. Expanding the use of solar thermal collectors (WAM)	NA	78,400
	3.5. Construction of new HPPs (WAM)	NA	64.606
	3.6. Construction and launch of new small hydropower plants (WAM)	NA	49.796
	3.7. Development of geothermal energy (heat pumps) (WAM)	NA	38.590
	3.8. Solar Power Development (WAM)	NA	13,000
	3.9. Wind Energy Development (WAM)	NA	3.594

The volume of the reduced GHG emissions is calculated for 2025 and 2030 and evidently does not cover all the mitigation potential of the sector, however, this is the main contribution to the NDC mitigation targets. The projection of future GHG emission in BAU and two mitigation scenarios is presented in fig. 3.9.

Figure 3.9. Projection of the future Energy Sector GHG emissions till 2050 in three scenarios

[90]The development of the use of Biogas Plants (BGU) includes the potential of entities dealing with organic waste in all sectors, but must be taken into account in the reporting of the Energy Sector under the general category "Fuel Combusted" and refers to the "With Additional Measures" scenario.



However, those measures identified within NDC update exercise are only launching the process of decarbonization of the Kyrgyzstan economy and mark the starting point to develop Long Term Strategy for Carbon Neutrality by 2050.

At the same time the NDC already contains a lot of mitigation technologies, which were included in the long list of technology options for the TNA analysis.

3.2 Decision context

The decision context for TNA decision making was marked by the UNDP Climate promise II, NDC Partnership project supporting Kyrgyzstan President initiative to reach carbon neutrality by 2050. The project currently provides support to develop the enhanced NDC Implementation Plan and Long-Term Strategy for Carbon Neutrality (LTS) until 2050. The first consultation with the TNA Energy expert engaged in that process showed high interest and willingness of the UNDP team to be involved in TNA process too. Evidently, energy and waste sector solutions for technology development, transfer, deployment and dissemination are expected to become integral parts of both above mentioned documents. Thus, it was decided to coordinate the TNA project with NDC Implementation Plan and LTS on carbon neutrality by 2050 development.

The process of technology selection in the TNA project in Kyrgyzstan was divided into the following stages:

1. Analysis of the Energy and Waste Sectors' current GHG inventories, emissions projections and mitigation capacities and measures identified and conducted so far.
2. Analysis of the targeted sectors’ enabling frameworks, specific characteristics of the sectors operations, also mapping stakeholders to determine the demand on technology.
3. Identification of priority subsectors having mitigation capacities to deploy climate mitigation technologies there.
4. Overview of past experience in deployment of new technologies in the sectors.
5. Study of existing technologies in the Energy and Waste Sectors, based on international and relevant national experience.
6. Selection and creation of the extended list of technologies by the national consultants, also gathering proposals from the sectors’ stakeholders and compiling long list of mitigation technologies from open sources.

7. Detailed discussion of each technology with a team of national experts and in the sessions of Sectoral Working Groups.
8. Formation of the short lists of technologies recommended for MCA exercise and preparation of Technology Fact Sheets.
9. Prioritisation of short-listed technologies using the MCA Matrix Tool.
10. Discussion of the MCA result and corresponding recommendations on SWG and preparation of the TNA Reports.
11. Presentation of the selected technologies to the TNA Project National Steering Committee.

The national context of decision-making process on technologies prioritization in the Energy Sector has some specific features:

- Significant share of clean electricity in the country energy mix.
- Practically 100 % access to electricity.
- Huge and growing level of coal consumption by the households.
- Low energy efficiency of the residential sector both multistorey buildings and private houses.
- Growing number of road vehicles.
- Nearly 100 % of gas and petrol import from abroad.
- In the period 2010-2020, from 73.4 to 23.4% of consumed coal was imported.
- Low quality of locally mined coal (low calorific value)
- Outdated equipment on the hydropower and thermal power plants
- Outdate technologies in the energy distributing companies.
- Uneconomic populistic tariffs for electricity discouraging investment into new technologies in the sector.
- Gaps in legal frameworks and clearly formulated sectoral policy.
- Weak institutional and human capacities in the sector.

All the above-listed features were duly taken into account by the members of SWG during the decision-making process on technology prioritisation.

It should be noted that one of the major factors in decision making about the technology assessment was determined by the NC 3 and NDC-defined mitigation measures for the sector.

3.3 Overview of existing technologies in the Energy Sector

It should be noted that mitigation is not the first priority in the national climate action agenda, Kyrgyzstan being a low GHG emitting country. On the other hand, certain emission-reduction techniques and technologies are already known and proven in the country.

The economy of the Kyrgyz Republic has undergone significant transformations since independence in 1991. The implementation of new monetary and fiscal policies, coupled with several structural and institutional reforms, has led to economic growth and relative stability. The energy sector of the Kyrgyz Republic has achieved certain results through reforms and restructuring. The sector has a new payment discipline with fees for electricity, hot water, heating and natural gas. However, there is cross-subsidization, electricity sales subsidize heat consumers. The tariff policy in the fuel and energy complex is socially oriented, not economic. Energy companies are in a difficult financial condition and have to sell energy at low tariffs and do not cover their costs.

Heat supply to the population remains one of the main problems today. In 2021, the level of district heating in the Kyrgyz Republic is 15.5% of the housing stock, of which 13.64% [91] in cities where

[91] http://www.stat.kg/ru/statistics/zhilishnyj-fond/

multistorey residential and public buildings are provided with heat supply. Heat supply to the urban residential sector of the republic was carried out both from large centralized heat sources, such as thermal power plants (in Bishkek, Osh) and district boiler houses, as well as from medium and low power local heating boiler houses. Thus, the Bishkek Combined Heat and Power Generated Plant uses 37.6% coal, 28.4% natural gas, 17.7 % fuel oil out of the total consumption of the country[92].

The population of the Kyrgyz Republic, which does not have access to centralized local heating systems, uses 52.5% of coal and 55.2% of natural gas out of the total consumption of the republic [93]. On average, the population consumes about 928 thousand tons of coal [94] per year and the transition to natural gas will give a real reduction of 971 Gg CO_2 eq[95] emissions annually, if the "Gas supply Programme of the Kyrgyz Republic until 2030." financed and implemented by LLC Gazprom Kyrgyzstan [96] is completed by 2030, and gas supply reaches 60% of the entire territory of the Kyrgyz Republic. The option of heating a house or apartment based on a gas boiler is considered the most convenient, modern and environmentally friendly option, because less fuel is burned and less GHG is emitted.

The annual amount of livestock waste in the Kyrgyz Republic on average in farms is about 7 million tons. According to forecasts in 2030, the volume of food waste at landfills in Bishkek and Osh will amount to 123.6 thousand tons / year. On average, the volume of wastewater in Bishkek is 116,736.9 thousand cubic metres per year. The volume of waste from the food industry of the Kyrgyz Republic in 2030 will amount to 84 thousand tons / year.[97] This is organic waste that can be processed anaerobically in biogas plants and produce biogas. Methane contained in biogas, as well as collected methane from landfills and wastewater, is burned to generate heat and electricity.

An assessment of the gross potential of small rivers in the Kyrgyz Republic revealed the possibility of building an SHPP with a total capacity of 333 MW, with a generation of 1.7 TWh, of which for the period up to 2030. it is technically possible to build 42 small HPPs with an installed capacity of 157 MW with a gradual increase in generation to 774 million kWh.[98] Expected reduction in emissions by 2030 49.796 thousand tons CO_2 eq.

The transport sector is responsible for 44.1% of GHG emissions in Kyrgyzstan, and in cities like Bishkek for 75% of air pollutants [99]. The compressed natural gas (CNG) can be used as an alternative to conventional gasoline and diesel fuel. CNG vehicles are considered safer than gasoline vehicles. CNG vehicles are less polluting and more efficient. Thus, the possible purchase of 1,158 CNG buses by 2030, will result in an expected reduction in emissions of 19.5 thousand tons of CO_2 eq. for pilot projects in Bishkek and Osh[100].

The use of electric public transport such as trolleybuses and electric buses also results in a reduction in air pollution from exhaust gases from public transport, allowing abandonment of the use of old buses, and stimulates the population to use public transport and refusal to use personal transport. It is possible to reduce GHG emissions by 2030 7.05Gg. CO_2 eq [101].

In the Kyrgyz Republic, 40% of urban households use inefficient coal-fired stoves/heating boilers for heating. So 57% of individual houses in Bishkek and 66% in Tokmok use solid fuel. The low efficiency

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[92] http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/
[93] http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/
[94]Updated Nationally Determined Contribution of the Kyrgyz Republic. 2021
[95] Updated Nationally Determined Contribution of the Kyrgyz Republic. 2021
[96] https://kyrgyzstan.gazprom.ru/press/about-company/2019/09/224/
[97] Updated Nationally Determined Contribution of the Kyrgyz Republic. 2021
[98] Updated Nationally Determined Contribution of the Kyrgyz Republic. 2021
[99] Updated Nationally Determined Contribution of the Kyrgyz Republic. 2021.
[100] https://www.oecd-ilibrary.org/sites/0d471c2b-ru/1/4/2/index.html?itemId=/content/publication/0d471c2b-ru&_csp_=a4d486947a2940556f614d84916c71f3&itemIGO=oecd&itemContentType=book#tablegrp-d1e26939
[101] Updated Nationally Determined Contribution of the Kyrgyz Republic. WB 2021.

of such heaters entails a 20-30% increase in coal consumption compared to more efficient models. Inefficient technologies exacerbate the negative effects of coal use (on health and the environment, smog). According to the NSC, on average, the population of the Kyrgyz Republic burns 929 thousand tons of different quality every year. The use of energy-efficient stoves with an efficiency of 70% for private households will reduce coal consumption by an average of 35 % [102], which will seriously affect the reduction of emissions.

Proper thermal insulation has always been the most effective method for achieving energy savings and reducing energy costs in buildings. Public buildings in the Kyrgyz Republic consume about 850 GWh/year of energy, which is 10% of the country's primary energy consumption (10% of national energy consumption and 11% of total coal consumption). This sector of public buildings is one of the largest end users of energy[103]. Bringing 1.635161 million m^2 of public buildings by 2030 up to class "B" for energy efficiency, it is possible to obtain savings of 146 GWh / year, and the reduction of GHG emissions in the amount of 10.86 Gg.CO_2 eq.[104]

In fact these technologies have a huge potential for further diffusion across the country to become wide-spread and contributing to decarbonisation of Kyrgyzstan.

3.4 Mitigation technology options for the Energy Sector

The overview of existed relevant technologies and international best practices recommended to be applied for the Energy Sector climate change mitigation [105] was carried out. Different sources of information on mitigation technologies: http://climatetechwiki.org/ and technology handbooks available at www.tech-action.org, under “Publications”. Factsheet examples, as well as links to additional materials are available at www.tech-action.org, under “Resources”. (See Chapter 6. List of References).

In the result, a first preliminary List of Technology Options was developed (table 3.2) and presented at the first session of the Sectoral Working Group, including options from the CTCN and UNEP CCC.

Table 3.2. List of mitigation technology options collected for SWG debate

#	Technologies
Energy generation subsector	
1.	Power production subsector
2.	Hydropower Plants
3.	Small hydropower
4.	Solar energy (hot water)
5.	Solar photovoltaic (electricity)
6.	Wind power plants
7.	Biogas for heating and electricity
8.	Use of Geothermal water for heating
9.	Natural Gas Combustion for cooking and heating
10.	Natural Gas Combined Cycle Plants for heating and electricity
Transport subsector	
11.	Vehicles with compressed natural gas engines
12.	Electric vehicles +hybrids+Plug-in hybrids
13.	Electric public transport

[102] 97409-WP-P133058-Box391503B-PUBLIC-RUSSIABN-Heating-Sector-Assessment-Report-Rus-KYR. WB 2015
[103] Roadmap-for-Implementation-of-Energy-Efficiency-in-Public-Buildings-of-Kyrgyz-Republic. WB 2019
[104] Updated Nationally Determined Contribution of the Kyrgyz Republic. 2021.
[105] Used Resources. CTCN site: https://www.ctc-n.org/collection/climatetechwiki?f%5B0%5D=taxonomy_term_page_objective_facets%3A14912&f%5B1%5D=taxonomy_term_page_sectors_facets%3A14957.. UNEP CCC site: https://tech-action.unepccc.org/tna-database/?fwp_tna_database_type=tna_fact_sheet

14.	Electric railway transport
Energy consumption in the residential and office buildings subsector	
15.	Insulation in buildings
16.	Energy-management systems in buildings
17.	Use of air conditioning split systems for heating
18.	Energy-efficient street and house lighting
19.	Energy-efficient construction
20.	Geothermal heat pumps for space heating and cooling and water heating
21.	Energy-efficient coal combustion for heating

In total, 21 of the mitigation technologies for the Energy Sector in Kyrgyzstan were circulated among the members of SWG for informing and afterwards presented at the first session of the Energy Sector SWG. Fruitful debate resulted in the preselection of 15 technology options (see table 3.3) for the Long List for the next round of analysis and engagement of the additional sectoral specialists for consultations to further develop Technology Fact Sheets.

Table 3.3 The Long List of Technology Options debated and adopted for MCA by the Energy SWG.

#	Technology
1.	Natural Gas Combustion for heating instead of coal
2.	Biogas plants for heating and electricity
3.	Small hydropower plants
4.	Solar collectors for heat water
5.	Hydropower Plants
6.	Solar photovoltaic panels farms
7.	Wind power farms
8.	Compressed Natural Gas engined buses instead of gasoline for public transport
9.	Electric public transport (trolleybuses, trams, buses)
10.	Electric cars
11.	Electric railway transport
12.	Energy-efficient stoves for the residential sector
13.	Insulation in buildings
14.	Energy-efficient construction
15.	Energy-management systems in buildings

After additional consultations with the specialists and other stakeholders the TFS were developed for each of the above options.

3.5 Criteria and process of technology prioritisation

Multi-Criteria Analysis (MCA) is used to assess the importance of a technology for climate change mitigation and prioritize the technologies. MCA facilitates the participation of stakeholders and hence allows normative judgments, while incorporating technical expertise in the mitigation technology assessment. Based on the assessment, mitigation technologies are prioritized to indicate which technologies should be implemented first. MCA is useful when comparing multiple options across a multiple set of criteria. A prioritization exercise could be done comparing multiple technologies to solve a concrete mitigation problem. MCA can also be used to prioritize technologies applied to solve different problems, which ideally should work towards the GHG emission reduction.

Assessing mitigation technologies using MCA usually involves combinations of some criteria which are quantified in monetary terms, and others for which monetary valuations do not exist. It also allows for a mix of quantitative and qualitative criteria, with the result that the quality, form and format of information may even differ within the same assessment of technologies. Wherever it is possible to quantify costs and benefits in monetary terms, then this data should be included in the MCA.

Multi-Criteria analysis (MCA) provides a structured framework for comparing a number of mitigation technologies across a number of criteria. A major benefit of using MCA for prioritizing technologies is the ability to include the preferences of stakeholders involved in the process, emphasizing the importance of having appropriate representation of stakeholders during the prioritization process.[106]

In order to compare different technology options and to identify what makes one technology better or more appropriate than another and more worthy of implementation, the criteria used in evaluating each technology option were defined. The final selection of criteria depends on the national climate change mitigation context and priorities.

After consultations with national consultants team and project implementation group, as well as with SWG, six different categories for criteria were identified reflecting the Cost of deployment and multiple benefits: Economic; Social; Environmental; Climatic and Institutional. These different categories include 15 criteria for estimation further potential to the technology deployment and diffusion as well as the general meaning of technology for sustainable development.

All suggested groups and criteria correlate to the general TNA manuals and include both 'qualitative' (expert estimations based on the own knowledge and experience) and 'quantitative' (variables such as cost or years) measures.

Category of Cost criteria include the following three criteria:

- Capital investment is related to the needed finance resources to procure transport and install a technology;
- Operation and technical service costs are linked with the daily and regular expenditures emerging during a technology exploitation for energy, other consumables, if any and for periodical technical services.
- Cost of GHG reduction on average.

Category of Economic criteria include the next four criteria:

- Expected lifetime of the technology option.
- Productivity of a technology.
- Resource efficiency factor.
- Market potential reflects expected level of possible application of a technology within the country under certain assumptions.

Social criteria group includes the following criteria:

- Number of beneficiaries
- Jobs criterion reflects number of jobs created after the possible dissemination of a technology in the country.
- Gender equality and social inclusion criterion displays the contribution of a technology to any improvement of women and vulnerable groups.

Environmental group of criteria includes two criteria:

- Pollution reduction reflects expected contribution of a technology to the reduction of air pollution.
- Impact on biodiversity shows the estimated level to which new technology will disturb local biodiversity, including flora and fauna species, as well as local ecosystems.

Climatic category includes the most relevant for mitigation criterion:

[106] Sara Trærup and Riyong Kim Bakkegaard. 2015. Determining technologies for climate change adaptation/ UNEP DTU Partnership.

- Reduced GHG emissions

Institutional category includes two criteria:

- Complexity to implement
- Alignment to national development priorities.

The set of criteria, measurement units and weights assigned to each criterion is shown in table 3.4.

Table 3.4. Climate-change mitigation technology assessment criteria, their index and weight.

Category	Criterion, unit of measurement	Weight, %
Costs	Capital investment, $ mln	15
	Operation and Maintenance costs, ave. $/MWh	5
	Cost of the GHG emission reduction, ave. $/t	10
Economic	Lifetime, years	5
	Productivity, bln. kWh	10
	Resource-efficiency factor, %	5
	Market potential, $ mln for sold kWh	5
Social	Number of beneficiaries, kWh per capita	5
	Jobs, number	5
	Gender equality and social inclusion, from very low to very High (the score - 20-100)	5
Environmental	Reduced air pollution, thousand t	5
	Impact on biodiversity from very low to very High (the score - 20-100)	5
Climatic	Reduced GHG emissions, t CO_2 eq/year	10
Institutional	Complexity to implement from very low to very High (the score - 20-100)	5
	Alignment with the national development priorities from very low to very High (the score - 20-100)	5

The comparison, scoring, weighing and priority identification within MCA is done with the application of three matrix tool: Performance Matrix, Scoring Matrix and Decision Matrix. The first matrix is filled in with the actual data from the TFSs. The second one – with the scores and the third one with weighted scores, which serve the basis for decision making on the priority of technologies.

To allow the comparison of different criteria that are assessed using a variety of scales, it is important to arrive at one common scale of measurement, i.e. to normalize the values in the performance matrix. This will result in a scoring matrix, in which the scale is the same for all criteria: 0-100. For each criterion, the most preferred option will have a score of 100, while the least preferred will have the score of 0. The scores for the remaining options will reflect differences in the strength of preference. The values on the performance matrix can be normalized using formula (a) is preferred value is higher, and (b) if preferred value is lower:

(a)

$$Yi = \frac{Xi - Xmin}{X\,max - Xmin} * 100$$

(b)

$$Yi = \frac{Xmax - Xi}{X\,max - Xmin} * 100$$

Here: Yi – score option i ; Xi – performance of option i ; X max and X min - the highest and the lowest performance among all the options.

These calculations were repeated for each criterion of the preselected technologies assessment. Taking into account the lack of accurate and clear information about some of the actual costs and benefits, other data from the implemented selected technologies, the criteria were ranked and the performance of the technology was taken into account by categorizing information in the selection of technologies, knowledge and expert opinions. The matrixes of MCA analysis for each technology for each criterion in the selected sector are presented in table 3.5, 3.6, 3.7.

Table 3.5. Performance Matrix

Performance Matrix

№	Technologies / Criteria	Costs			Benefits												
					Economic				Social			Environmental		Climatic	Institutional	
		Capital investment, $ mln	Operation and Maintanance costs, ave. $/mWh	Cost of the GHG emissions reduction, ave. $/t	Lifetime, years	Productivity, bln. kWh	Resource-efficiency factor, %	Market potential, $ mln for sold kWh	Number of beneficiaries, kWh per capita	Jobs, #	Gender equality and social inclusion	Reduced air pollution, thousand t	Impact on biodiversity	Reduced GHG emissions, t CO2 eq/year	Complexity to implement	Alignment with the national development priorities
1	*Big Hydropower Plants (High Nar 235,7 MW b 2030)*	728	11,34	102,76	30	11,415	40	1379,952	278414,6	2000	medium	3,473	very high	64,606	very high	high
2	*Small hydropower*	145,6	60	2,92	30	0,4325	60	24,22	10548,78	500	very low	2,677	low	49,796	medium	very high
3	*Sun collectors for hot water*	9,9	40	0,126	15	0,49	55	15,092	31,3	200	high	4,215	very low	78,4	low	high
4	*Solar photovoltaic (electricity)*	298,5	50	22,96	25	0,088	18	4,939	56,91	300	medium	0,698	low	13	very low	high
5	*Wind power plants*	900	65	69,23	20	0,6912	40	38,7	80,278	300	very low	0,193	high	3,594	medium	high
6	*Biogas for heating and electricity*	56	27	0,0426	25	0,78	60	43,68	90,59	300	very low	70,536	medium	1311,98	medium	very low
7	*Natural Gas for heating instead of coal*	758	4,064	0,7804	30	10824,3	90	606160,8	1257177,7	1000	high	52,217	medium	971,247	low	very high
8	*Insulation of existing buildings*	310	0,1406	0,781	30	107982,3302	70	6047,010	17916,43	500	medium	0,584	very low	10,868	low	high
9	*Building's energy management systems*	14	0	7,3887	20	0,02442	30	1,367	2,837	100	very low	0,1018	very low	1,895	high	low
10	*Energy efficient construction*	175,6	0,1373	16,866	30	0,6388	50	35,7728	74,1927	1000	low	0,906	very low	97,148	low	high
11	*Energy efficient stoves for Residential sector*	10	0	0,0179	20	1613,046	70	90330,6034	187345,701	100	high	30,002	medium	558,049	low	very high
12	*Compressed natural gas driven buses*	75	1	3,846	20	75,184	25	46000	75,184	500	low	1,048	very low	19,5	low	medium
13	*Electric vehicles*	266	1	0,6285	15	0,784	50	9880	0,784	50	medium	22,751	medium	423,181	very high	medium
14	*Electric public transport*	37	1	5,24	10	88	85	6200	88	690	low	0,379	very low	7,05	medium	high
15	*Electric railway transport*	300	4	8,01	30	200	30	325	0,01	200	very low	2,0134	medium	37,45	high	very high

Table 3.6. Scoring Matrix

Scoring Matrix (For each criterion scores should vary from 0 to 100)

№	Technologies / Criteria	Costs			Benefits												
					Economic				Social			Environmental		Climatic	Institutional	
	$Y_i = \frac{X_i - X_{min}}{X_{max} - X_{min}} * 100$ $Y_i = \frac{X_{max} - X_i}{X_{max} - X_{min}} * 100$	Capital investment, $ mln	Operation and Maintanance costs, ave. $/mWh	Cost of the GHG emissions reduction, ave. $/t	Lifetime, years	Productivity, bln. kWh	Resource-efficiency factor, %	Market potential, $ mln for sold kWh	Number of beneficiaries, kWh per capita	Jobs, #	Gender equality and social inclusion	Reduced air pollution, thousand t	Impact on biodiversity	Reduced GHG emissions, t CO2 eq/year	Complexity to implement	Alignment with the national development priorities
1	*Big Hydropower Plants (High Nar 235,7 MW b 2030)*	19,32	82,55	0,00	100,00	0,01	30,56	0,23	22,15	100,00	60,00	4,66	20,00	4,79	20,00	80,00
2	*Small hydropower*	84,75	7,69	97,18	100,00	0,00	58,33	0,00	0,84	23,08	20,00	3,53	80,00	3,66	60,00	100,00
3	*Sun collectors for hot water*	100,00	38,46	99,89	25,00	0,00	51,39	0,00	0,00	7,69	80,00	5,72	100,00	5,84	80,00	80,00
4	*Solar photovoltaic (electricity)*	67,58	23,08	77,67	75,00	0,00	0,00	0,00	0,00	12,82	60,00	0,72	80,00	0,85	100,00	80,00
5	*Wind power plants*	0,00	0,00	32,64	50,00	0,00	30,56	0,01	0,01	12,82	20,00	0,00	40,00	0,13	60,00	80,00
6	*Biogas for heating and electricity*	94,82	58,46	99,98	75,00	0,00	58,33	0,01	0,01	12,82	20,00	100,00	60,00	100,00	60,00	20,00
7	*Natural Gas for heating instead of coal*	15,95	93,75	99,26	100,00	10,02	100,00	100,00	100,00	48,72	80,00	73,96	60,00	73,99	80,00	100,00
8	*Insulation of existing buildings*	66,28	99,78	99,26	100,00	100,00	72,22	1,00	1,43	23,08	60,00	0,56	100,00	0,68	80,00	80,00
40	*Building's energy management systems*	99,54	100,00	92,83	50,00	0,00	16,67	0,00	0,00	2,56	20,00	-0,13	100,00	0,00	40,00	60,00
10	*Energy efficient construction*	81,38	99,79	83,60	100,00	0,00	44,44	0,01	0,01	48,72	40,00	1,01	100,00	7,27	80,00	80,00
11	*Energy efficient stoves for Residential sector*	99,99	100,00	100,00	50,00	1,49	72,22	14,90	14,90	2,56	80,00	42,38	60,00	42,45	80,00	100,00
12	*Compressed natural gas driven buses*	92,69	98,46	96,27	50,00	0,07	9,72	7,59	0,01	23,08	40,00	1,22	100,00	1,34	80,00	60,00
13	*Electric vehicles*	71,23	98,46	99,41	25,00	0,00	44,44	1,63	0,00	0,00	60,00	32,07	60,00	32,16	20,00	60,00
14	*Electric public transport*	96,96	98,46	94,92	0,00	0,08	93,06	1,02	0,01	32,82	40,00	0,26	100,00	0,39	60,00	80,00
15	*Electric railway transport*	67,41	93,85	92,22	100,00	0,19	16,67	0,05	0,00	7,69	20,00	2,59	60,00	2,71	40,00	100,00
Criteria weight		*15*	*5*	*10*	*5*	*10*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*10*	*5*	*5*

Table 3.7. Decision Matrix

Decision Matrix: Weighted Scores

№	Technologies / Criteria	Costs			Benefits												Score	Rank
					Economic				Social			Environmental		Climatic	Institutional			
		Capital investment, $ mln	Operation and Maintanance costs, ave. $/mWh	Cost of the GHG emissions reduction, ave. $/t	Lifetime, years	Productivity, bln. kWh	Resource-efficiency factor, %	Market potential, $ mln for sold kWh	Number of beneficiaries, kWh per capita	Jobs, #	Gender equality and social inclusion	Reduced air pollution, thousand t	Impact on biodiversity	Reduced GHG emissions, t CO2 eq/year	Complexity to implement	Alignment with the national development priorities		
1	***Big Hydropwer Plants (High Nar 235,7 MW b 2030)***	289,86	412,77	0,00	500,00	0,10	152,78	1,14	110,73	500,00	300,00	23,31	100,00	47,87	100,00	400,00	2 938,56	**14**
2	***Small hydropower***	1271,32	38,46	971,75	500,00	0,00	291,67	0,02	4,20	115,38	100,00	17,66	400,00	36,56	300,00	500,00	4 547,02	**9**
3	***Sun collectors for hot water***	1500,00	192,31	998,95	125,00	0,00	256,94	0,01	0,01	38,46	400,00	28,59	500,00	58,40	400,00	400,00	4 898,67	**7**
4	***Solar photovoltaic (electricity)***	1013,65	115,38	776,70	375,00	0,00	0,00	0,00	0,02	64,10	300,00	3,59	400,00	8,48	500,00	400,00	3 956,93	**13**
5	***Wind power plants***	0,00	0,00	326,35	250,00	0,01	152,78	0,03	0,03	64,10	100,00	0,00	200,00	1,30	300,00	400,00	1 794,60	**15**
6	***Biogas for heating and electricity***	1422,31	292,31	999,76	375,00	0,01	291,67	0,03	0,04	64,10	100,00	500,00	300,00	1000,00	300,00	100,00	5 745,23	**4**
7	***Natural Gas for heating instead of coal***	239,30	468,74	992,58	500,00	100,24	500,00	500,00	500,00	243,59	400,00	369,79	300,00	739,92	400,00	500,00	6 754,15	**1**
8	***Insulation of existing buildings***	994,27	498,92	992,57	500,00	1000,00	361,11	4,99	7,13	115,38	300,00	2,78	500,00	6,85	400,00	400,00	6 084,00	**2**
9	***Building's energy management systems***	1493,09	500,00	928,26	250,00	0,00	83,33	0,00	0,00	12,82	100,00	-0,65	500,00	0,00	200,00	300,00	4 366,86	**11**
10	***Energy efficient construction***	1220,76	498,94	836,02	500,00	0,01	222,22	0,03	0,03	243,59	200,00	5,07	500,00	72,71	400,00	400,00	5 099,37	**5**
11	***Energy efficient stoves for Residential sector***	1499,83	500,00	1000,00	250,00	14,94	361,11	74,51	74,51	12,82	400,00	211,88	300,00	424,52	400,00	500,00	6 024,12	**3**
12	***Compressed natural gas driven buses***	1390,29	492,31	962,74	250,00	0,70	48,61	37,94	0,03	115,38	200,00	6,08	500,00	13,44	400,00	300,00	4 717,52	**8**
13	***Electric vehicles***	1068,42	492,31	994,06	125,00	0,01	222,22	8,15	0,00	0,00	300,00	160,34	300,00	321,57	100,00	300,00	4 392,08	**10**
14	***Electric public transport***	1454,33	492,31	949,17	0,00	0,81	465,28	5,11	0,03	164,10	200,00	1,32	500,00	3,93	300,00	400,00	4 936,41	**6**
15	***Electric railway transport***	1011,12	469,23	922,21	500,00	1,85	83,33	0,27	0,00	38,46	100,00	12,94	300,00	27,14	200,00	500,00	4 166,56	**12**
Criteria weight		*15*	*5*	*10*	*5*	*10*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*10*	*5*	*5*	*100*	

3.6 Results of technology prioritisation

Taking into account the lack of accurate and clear information about some of the actual costs and benefits, other data from the implemented selected technologies, the criteria were ranked and the performance of the technology was taken into account by categorizing information in the selection of technologies, knowledge and expert opinions. The results of the assessment of each technology for each criterion in the selected sector are presented in table 3.8.

Table 3.8. The results of the mitigation technology options assessment as per score and rank.

#	Technology	Score	Rank
1	Natural gas for heating instead of coal	6 754,15	1
2	Insulation of existing buildings	6 084,00	2
3	Energy efficiency stoves for residential sector	6 024,12	3
4	Biogas for heating and electricity	5 745,23	4
5	Energy efficient construction	5 099,37	5
6	Electric public transport	4 936,41	6
7	Sun collectors for hot water	4 898,67	7
8	Compressed natural gas driven buses	4 717,52	8
9	Small hydropower	4 547,02	9
10	Electric vehicles	4 392,08	10
11	Energy management systems in buildings	4 366,86	11
12	Electric railway transport	4 166,56	12
13	Solar photovoltaic (electricity)	3 956,93	13
14	Big Hydropower Plants (High Nar 235,7 MW b 2030)	2 938,56	14
15	Wind power plants	1 794,60	15

Taking into account the discussions and outputs of the SWG debate, it was decided that the first three will be considered as the priority mitigation technology options in the national Energy Sector, including the following:

1. **Natural gas for heating instead of coal**
2. **Insulation of existing buildings**
3. **Energy efficient stoves for residential sector**

The seven remaining technologies were proposed by SWG to compile into the sectoral pipeline of mitigation technologies options to be used for any corresponding project proposal development (see. tab 3.9).

Table 3.9. Pipeline technology options for further resource mobilization.

#	Technology
1.	Biogas for heating and electricity
2.	Energy efficient construction
3.	Electric public transport
4.	Sun collectors for hot water
5.	Compressed natural gas driven buses
6.	Small hydropower
7.	Electric cars

3.7 Sensitivity analysis

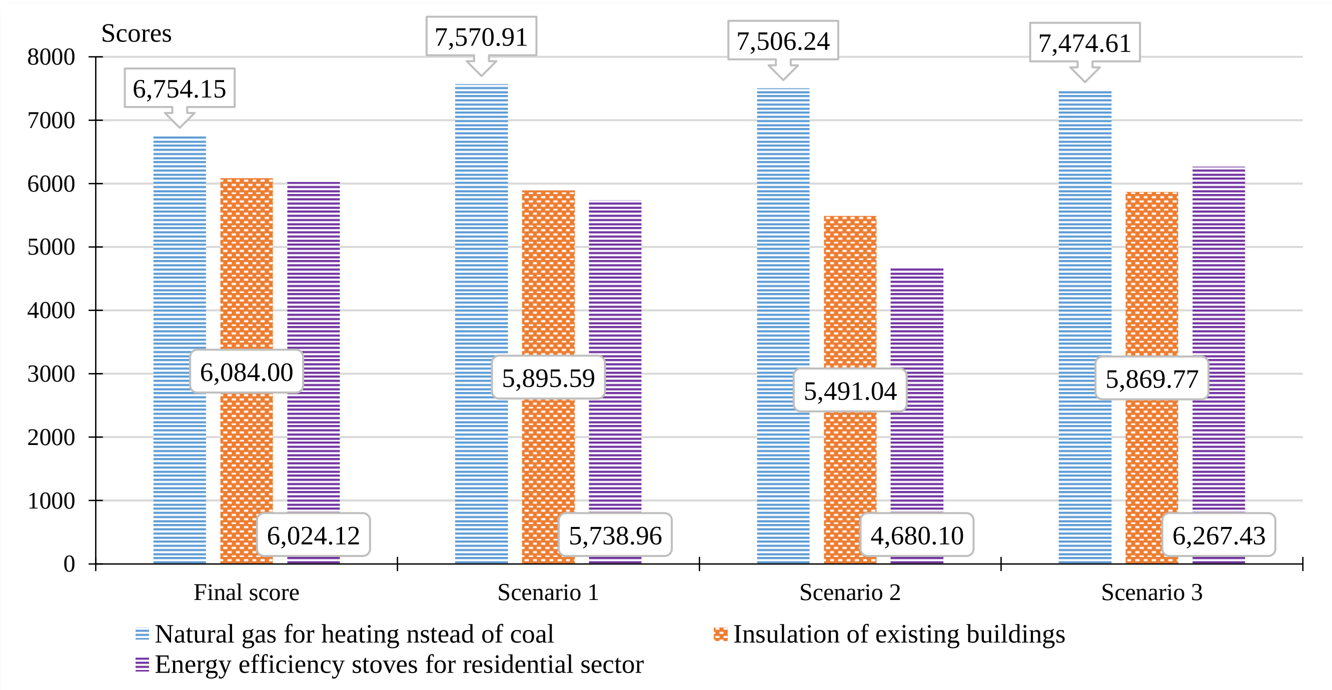
The sensitivity analysis was conducted to test the results of technology prioritization depending on the chosen weights of different criteria using the following three alternative scenarios:

1) Equal weights for all fifteen criteria;
2) Relatively higher weight of economic and social criteria (70%) and lower weight of environmental and climate-related criteria and institutional criteria;
3) Relatively lower weight of economic and social criteria (30%) and higher weight of environmental and climate-related criteria and institutional criteria;

In all tested scenarios the three selected technologies received the highest scores. However, under Scenario 3 the "Energy efficient stoves for residential sector" technology achieved a higher score and ranks as the second priority.

The general conclusion is that changing the criteria weight has virtually no effect on the choice of the priority technology. (See fig.3.10).

Figure 3.10. The final score of three selected technologies and the values of the sensitivity analysis under three scenarios.



Chapter 4 Technology prioritisation for the Waste Sector

In the transfer of mitigation technologies it is imperative to ensure that they address the key emitters in the sector and key GHG emission categories identified in a country. Therefore it is vital to identify and assess technologies against appropriate criteria when prioritizing technologies. [107]

As in the Energy Sector, the prioritization of the climate change mitigation technologies for the Waste Sector was determined by the national GHG inventory data and mitigation measures as defined in NATCOMs and NDC.

4.1 GHG emission trends and projections in the Waste Sector

In 2020, total GHG emissions in the Waste sector were 600.936 Gg CO_2e equivalent and increased by 4.32% compared to 2018. Methane emissions from category 4.A - Solid Waste Disposal in the Unmanaged Landfill subcategory (57%) and methane and nitrous oxide emissions from source category 4.D - Wastewater Treatment and Discharge (39%) accounted for the key share of total emissions. GHG emissions under source category 4.C.2. - Open waste incineration accounted for 3% of the sector's total emissions, emissions under category 4.B - Biological treatment of solid waste - 1%.

The results of the inventory of GHG and precursor gas emissions of the Waste Sector in 2020 are presented in the sectoral reporting table 4.1.

Table 4.1. 2020 GHG emission of the Waste Sector by gas and categories of sources, (Gg).[108]

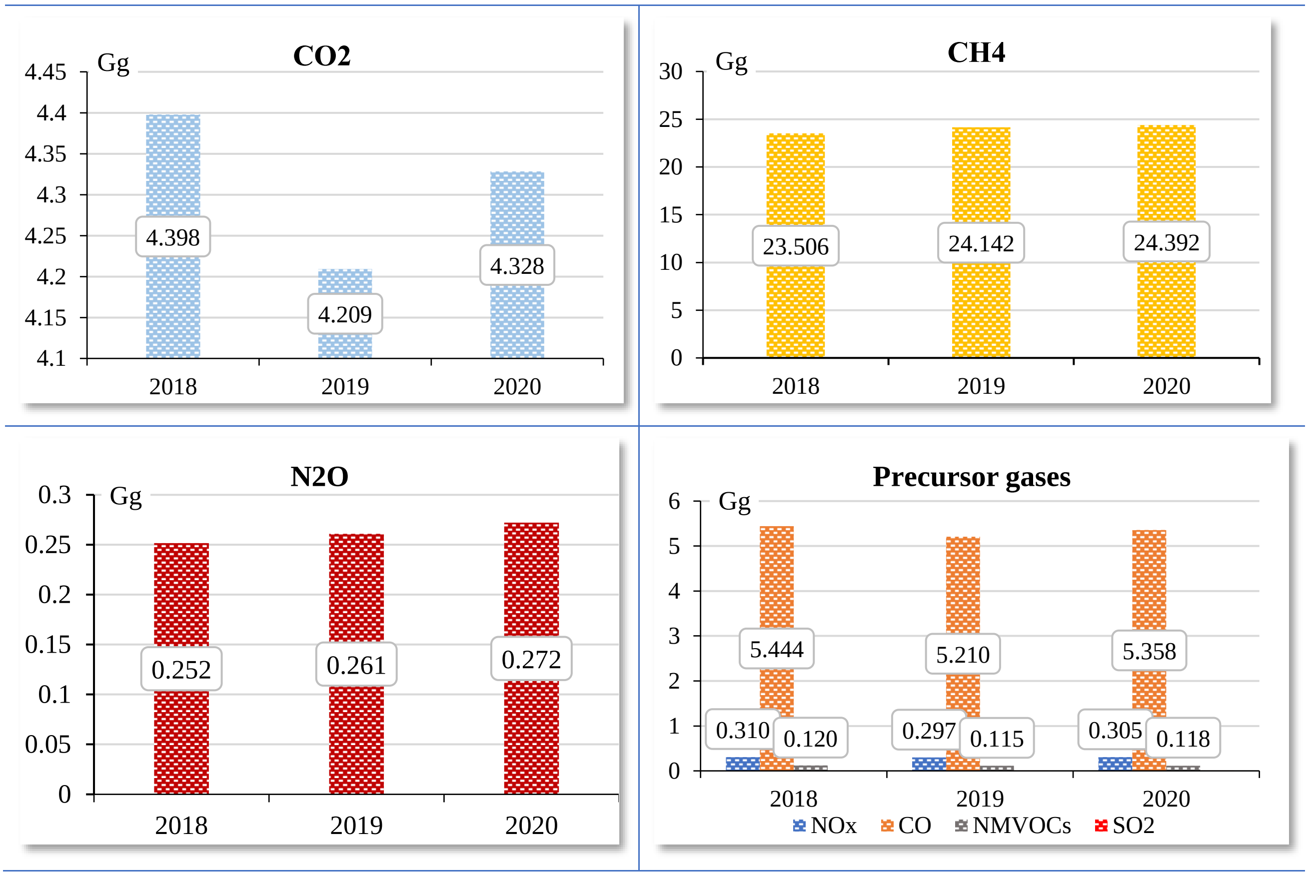
Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
4 - Waste	4,328	24,392	0,272	0,305	5,358	0,118	0,011
4.A - Solid Waste Disposal	0.000	16.235	0.000	0.000	0.000	0.000	0.000
4.A.1 - Managed Waste Disposal Sites				0.000	0.000	0.000	0.000
4.A.2 - Unmanaged Waste Disposal Sites				0.000	0.000	0.000	0.000
4.A.3 - Uncategorised Waste Disposal Sites				0.000	0.000	0.000	0.000
4.B - Biological Treatment of Solid Waste		0.075	0.005	0.000	0.000	0.000	0.000
4.C - Incineration and Open Burning of Waste	4.328	0.624	0.011	0.305	5.358	0.118	0.011
4.C.1 - Waste Incineration	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.C.2 - Open Burning of Waste	4.328	0.624	0.011	0.305	5.358	0.118	0.011
4.D - Wastewater Treatment and Discharge	0.000	7.458	0.256	0.000	0.000	0.000	0.000
4.D.1 - Domestic Wastewater Treatment and Discharge		6.888	0.256	0.000	0.000	0.000	0.000
4.D.2 - Industrial Wastewater Treatment and Discharge		0.571		0.000	0.000	0.000	0.000

During the period 2018-2020, the sector's emissions by different gases varied differently. Thus, in 2020, carbon dioxide (CO_2) emissions decreased by 1.58%, nitrous oxide (N_2O) emissions increased

[107] Sara Trærup and Riyong Kim Bakkegaard. 2015. Determining technologies for climate change adaptation/ UNEP DTU Partnership.
[108] MNRETS. GEF UNEP. 2022. IPCC Inventory Software V2.54 Data Base.

by 8.16% compared to 2018 and methane (CH_4) emissions increased by 3.77%. The level of precursor gas emissions remained almost at the same level. (See fig. 4.1).

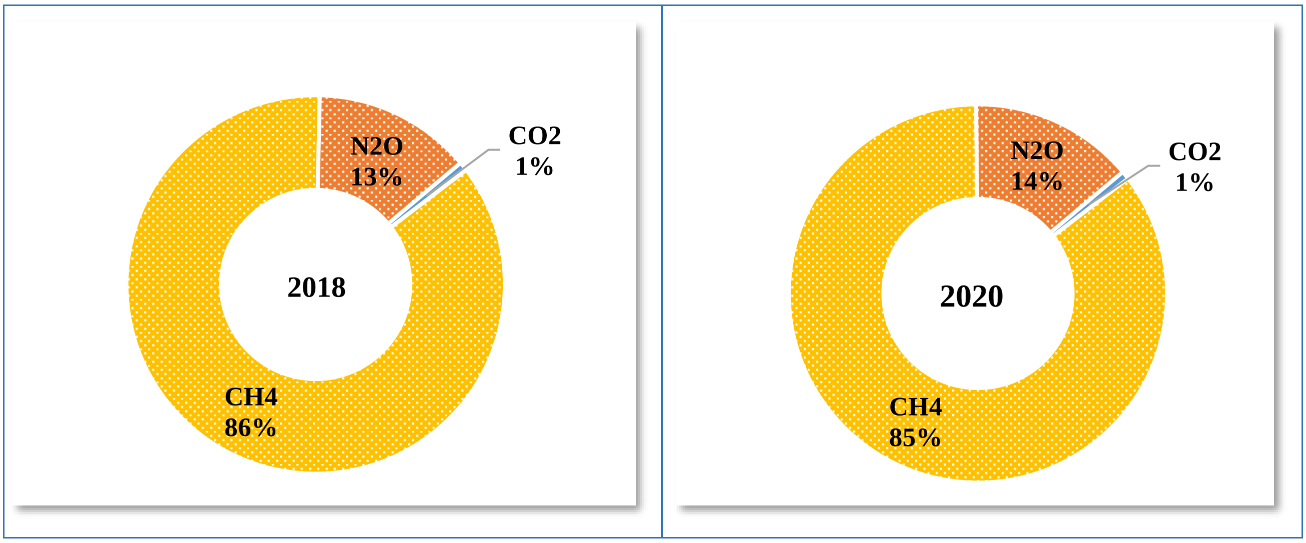
Figure 4.1. Greenhouse gas and precursor gas emissions of the Waste Sector for the period 2018-2020.[109]



The proportional structure of emissions of the different greenhouse gases by share in total GHG emissions of the sector has not changed much between 2018 and 2020 (see fig. 4.2).

Figure 4.2. Structural composition of GHG emissions of the Waste Sector in 2018 and in 2020.[110]

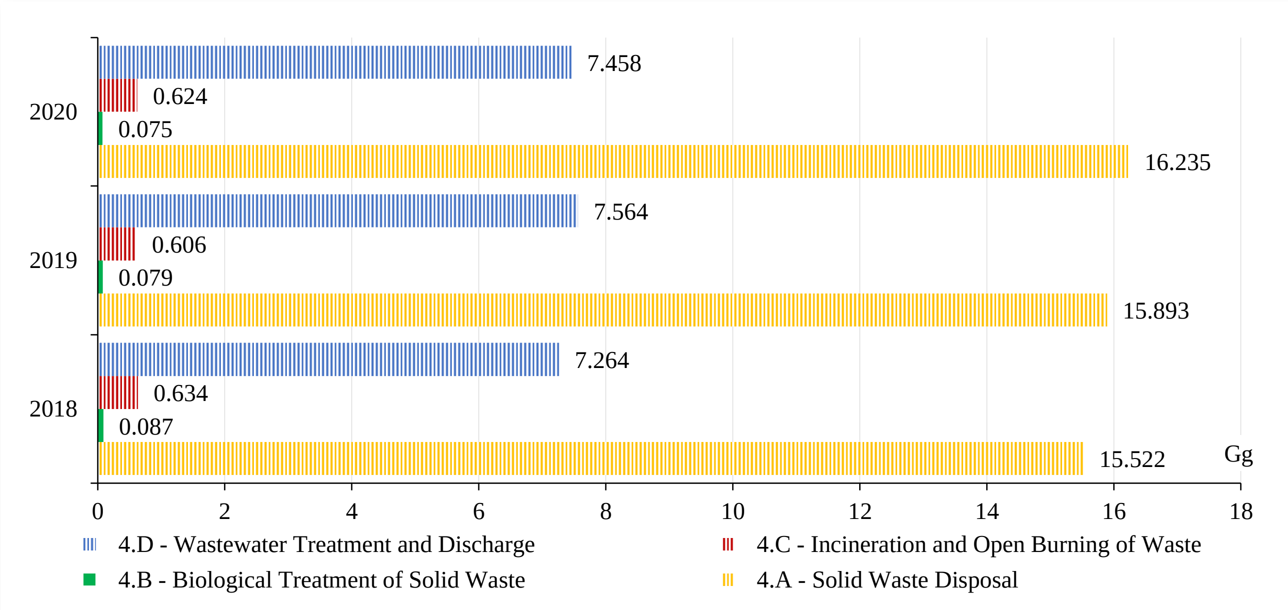
[109] Ibid.
[110] MNRETS. GEF UNEP. 2022. IPCC Inventory Software V2.54 Data Base.



The main and only source of carbon dioxide (CO_2) emissions from the Waste Sector was Category 4.A - Incineration and Open Burning of Waste, whose emission values are shown in Figure 4.2.

However, methane (CH_4) was emitted from all emission categories under the Waste Sector (see fig. 4.3).

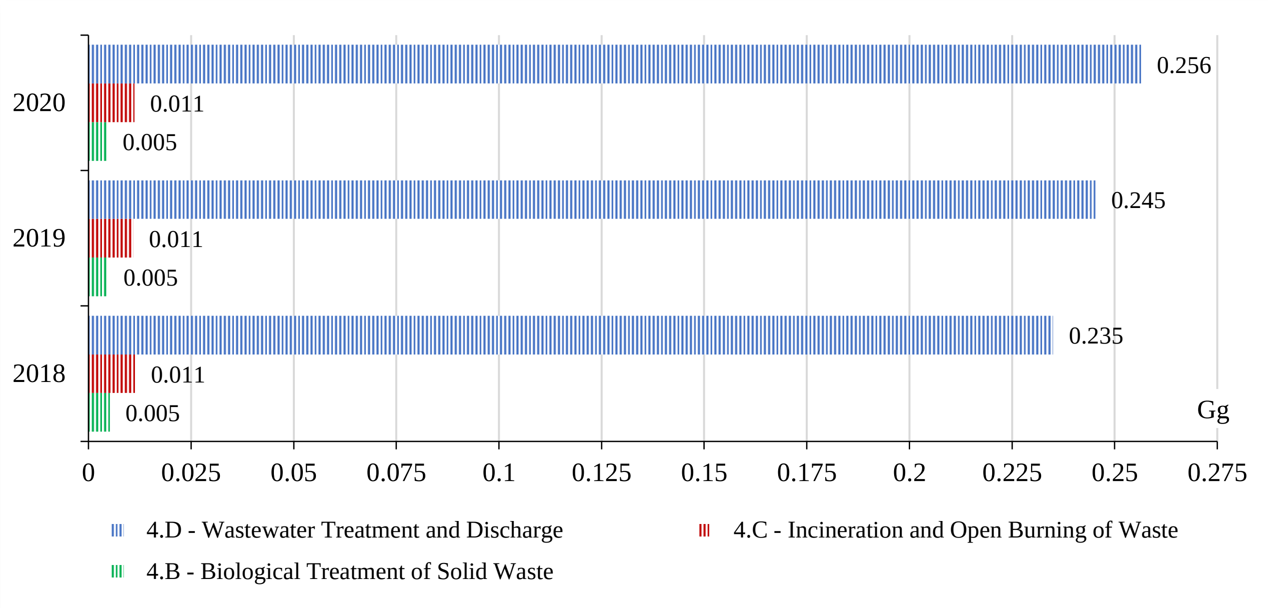
Figure 4.3. Methane (CH_4) emissions by source category for 2018-2020.[111]



The sources of the Waste Sector Nitrous Oxide (N_2O) emissions were Categories 4.B - Biological Treatment of Solid Waste, 4.C - Incineration and Open Burning of Waste and 4.D - Wastewater Treatment and Discharge (see fig. 4.4).

Figure 4.4. Nitrous oxide (N_2O) emissions by source for the period 2018-2020.[112]

[111] Ibid.
[112] MNRETS. GEF UNEP. 2022. IPCC Inventory Software V2.54 Data Base.



The source of precursor gas emissions was category 4.C - Incineration and open burning of waste.

Transition to a new methodology for GHG emissions inventory (IPCC. 2006) within the Waste Sector national inventory made it necessary to recalculate the whole time series of greenhouse gas emissions since 1990. The data on recalculation of GHG emissions of the sector for 1990-2020 are presented in table 4.2.

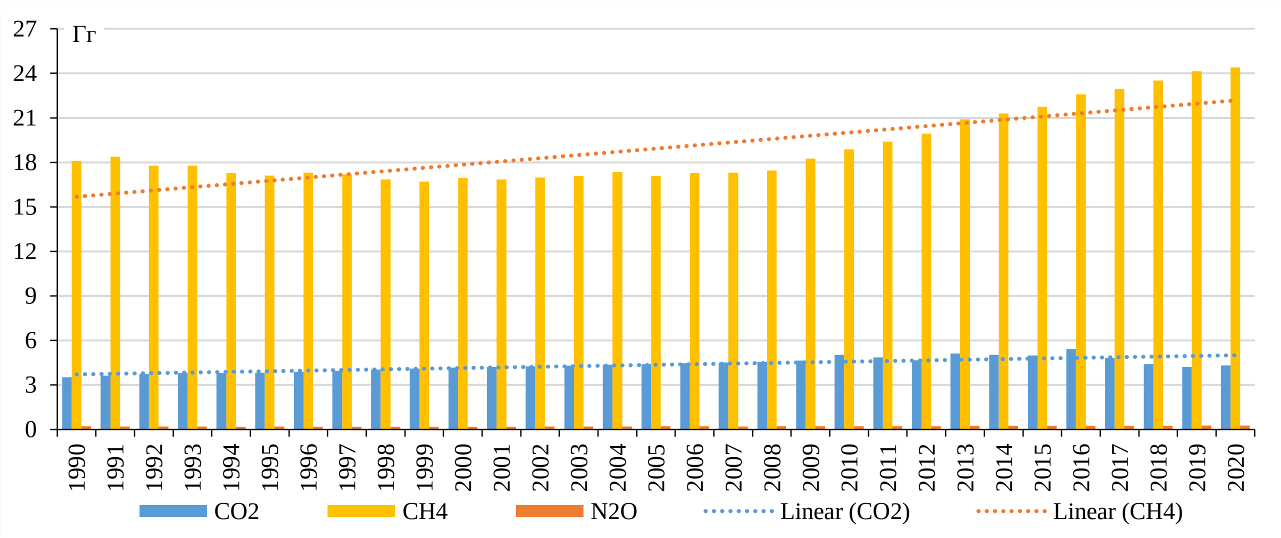
Table 4.2. GHG Emissions of the Waste Sector for 1990-2020 (Gg).[113]

Gases	1990	1991	1992	1993	1994	1995	1996	1997
CO_2	3.533	3.63	3.735	3.793	3.803	3.828	3.897	3.961
CH_4	18.109	18.38	17.781	17.783	17.283	17.112	17.292	17.186
N_2O	0.219	0.2	0.201	0.2	0.18	0.194	0.19	0.178
Gases	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CO_2	4.031	4.102	4.165	4.21	4.255	4.299	4.355	4.414
CH_4	16.857	16.688	16.946	16.844	16.971	17.089	17.337	17.092
N_2O	0.186	0.191	0.185	0.188	0.199	0.204	0.207	0.215
Gases	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
CO_2	4.464	4.52	4.562	4.646	5.034	4.864	4.671	5.122
CH_4	17.291	17.295	17.456	18.248	18.879	19.397	19.933	20.904
N_2O	0.216	0.212	0.221	0.23	0.23	0.231	0.229	0.237
Gases	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	
CO_2	5.034	4.995	5.428	4.813	4.398	4.209	4.328	
CH_4	21.288	21.736	22.591	22.962	23.506	24.142	24.392	
N_2O	0.244	0.241	0.255	0.245	0.252	0.261	0.272	

The trends of GHG emissions by individual gases for the period 1990-2020 showed an increase. Thus, during this period carbon dioxide (CO_2) emissions increased by 22.52%, methane (CH_4) emissions increased by 34.70% and nitrous oxide (N_2O) emissions increased by 24.32%. The dynamics of emissions by gas is presented in fig. 4.5.

Figure 4.5. Dynamics of the GHG emissions in the Waste Sector during 1990-2020 by gas.

[113] Ibid.



The results of recalculation of GHG emissions of the Waste Sector in CO_2 equivalent by emission source categories for the period 1990-2020 are presented in Table 4.3.

Table 4.3. GHG emissions in the Waste Sector in the period 1990-2020 by source category in Gg CO_2 equivalent.

Categories	1990	1991	1992	1993	1994	1995	1996
4 - Waste	**451.68**	**451.69**	**439.38**	**439.1**	**422.42**	**423.19**	**425.86**
4.A - Solid Waste Disposal	218.45	229.61	239.17	244.74	243.39	243.47	241.52
4.B - Biological Treatment of Solid Waste	4.091	4.122	4.166	4.166	4.19	4.308	4.451
4.C - Incineration and Open Burning of Waste	17.061	17.529	18.035	18.316	18.366	18.486	18.819
4.D - Wastewater Treatment and Discharge	212.09	200.43	178.01	171.88	156.47	156.93	161.07
Categories	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
4 - Waste	**419.99**	**415.54**	**413.69**	**417.48**	**416.26**	**422.33**	**426.33**
4.A - Solid Waste Disposal	241.14	238.66	237.22	235.83	235.11	233.65	231.91
4.B - Biological Treatment of Solid Waste	4.483	4.518	4.558	4.803	4.942	4.966	4.99
4.C - Incineration and Open Burning of Waste	19.131	19.464	19.808	20.111	20.331	20.549	20.76
4.D - Wastewater Treatment and Discharge	155.24	152.89	152.11	156.74	155.88	163.17	168.67
Categories	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
4 - Waste	**432.71**	**429.96**	**434.55**	**433.42**	**439.5**	**459.15**	**472.89**
4.A - Solid Waste Disposal	232.61	231.65	231.59	231.97	237.49	253.22	264.62
4.B - Biological Treatment of Solid Waste	5.025	5.291	5.52	5.599	5.797	5.948	5.1
4.C - Incineration and Open Burning of Waste	21.033	21.314	21.558	21.828	22.031	22.438	24.31
4.D - Wastewater Treatment and Discharge	174.05	171.71	175.88	174.03	174.17	177.54	178.86
Categories	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
4 - Waste	**483.72**	**494.22**	**517.63**	**527.74**	**536.21**	**559.01**	**562.81**
4.A - Solid Waste Disposal	276.63	283.99	294.96	301.5	309.97	315.42	320.09
4.B - Biological Treatment of Solid Waste	6.36	7.088	5.671	5.374	4.712	4.427	3.671
4.C - Incineration and Open Burning of Waste	23.488	22.558	24.735	24.312	24.12	26.214	23.242

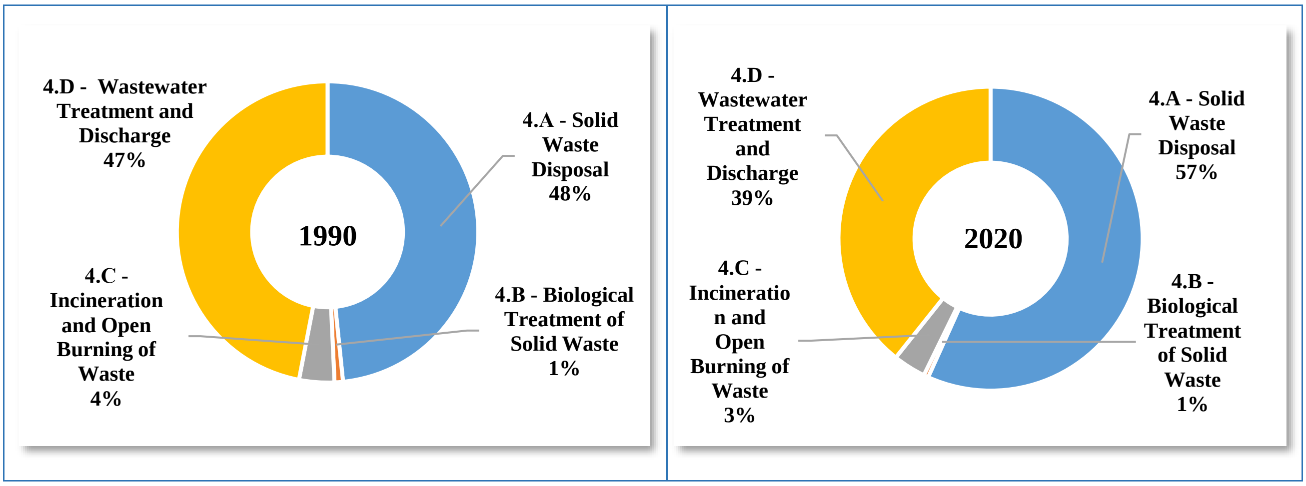
4.D - Wastewater Treatment and Discharge	177.24	180.58	192.27	196.55	197,4	212,95	215,81

Categories	2018	2019	2020
4 - Waste	**576.04**	**592.087**	**600.936**
4.A - Solid Waste Disposal	325.96	333.759	340.938
4.B - Biological Treatment of Solid Waste	3.445	3.120	2.978
4.C - Incineration and Open Burning of Waste	21.238	20.327	20.902
4.D - Wastewater Treatment and Discharge	225.4	234.881	236.118

The results of the 4th National GHG Inventory show that, unlike other sectors, there was no sharp decline in GHG emission trends of the Waste Sector at the beginning of the 1990s. Emissions of the sector have grown steadily, and in comparison with 1990 have increased in 2020 by 33.04% in total volume of CO_2 equivalent. At the same time, the increase of GHG emissions in category 4.A - Waste Disposal was 56.07%, in category 4.C - Incineration and Open Burning - 22.52%, in source category 4.D - Waste Water Treatment and Discharge - 11.33%. In contrast, the emissions of source category 4.B - Biological treatment of solid waste decreased by 11.33%.

Accordingly, the structural distribution of shares of GHG emissions by sources also changed, with the increase in the share of emissions from solid waste disposal to 57 percent due to reduction of the share of emissions from treatment and disposal of sewage water to 39 percent and emissions from open combustion by 1 percent (see fig. 4.6).

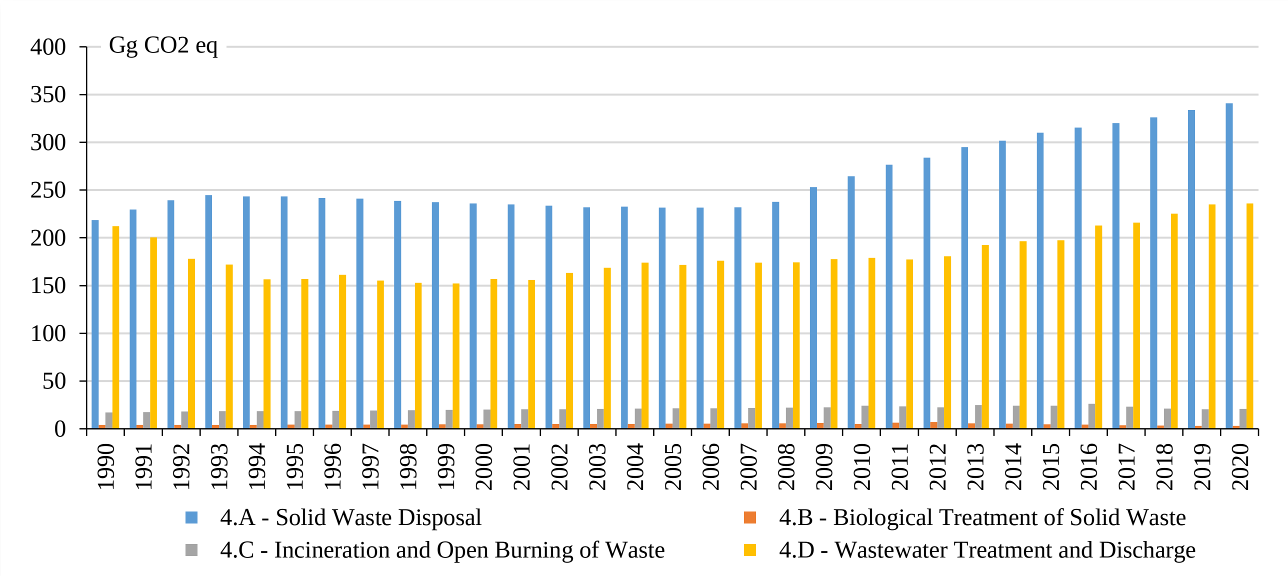
Figure 4.6. GHG emissions of the Waste Sector by source in 1990 and 2020.



The dynamics of GHG emissions of the sector by major emission sources from 1990 to 2020 is presented in figure 4.7.

Figure 4.7. GHG emissions by emission sources in the sector for 1990-2020.[114]

[114] MNRETS. GEF UNEP. 2022. IPCC Inventory Software V2.54 Data Base.



Future GHG emissions for the Waste Sector were projected in the same way as for the other sectors under the three business-as-usual scenarios up to 2050. The values of modelled CO_2 equivalent emissions for the Waste Sector up to 2050 by three scenarios are presented in table 4.4.

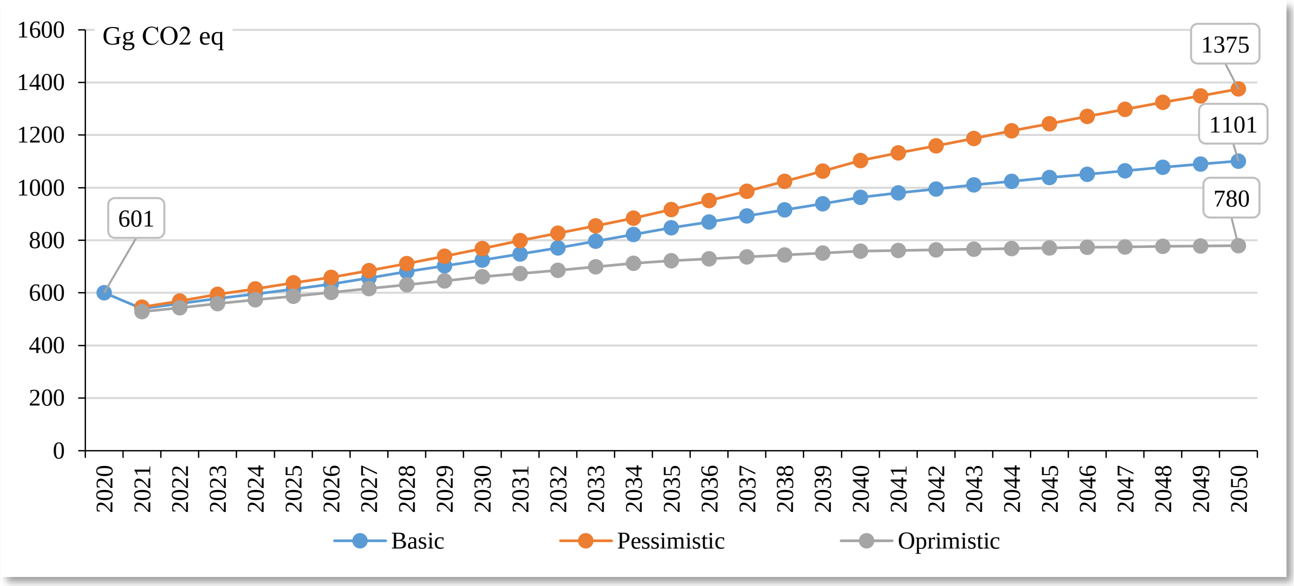
Table 4.4. Projected results for future GHG emissions (Gg CO_2 eq) up to 2050 in the Waste Sector for three scenarios.[115]

Year	Scenario			Year	Scenario		
	Basic	Pessimistic	Optimistic		Basic	Pessimistic	Optimistic
2020	600.936			**2036**	869.956	951.115	729.579
2021	540.069	546.093	528.354	**2037**	892.419	986.843	736.691
2022	558.946	569.429	543.870	**2038**	915.530	1024.093	743.846
2023	578.473	593.940	559.718	**2039**	939.293	1062.926	751.015
2024	596.051	615.562	573.383	**2040**	963.708	1103.406	758.171
2025	614.179	638.081	587.276	**2041**	979.984	1131.909	761.045
2026	632.877	658.528	601.421	**2042**	994.961	1159.086	763.958
2027	656.521	684.176	615.840	**2043**	1010.270	1187.060	766.292
2028	681.180	711.024	630.548	**2044**	1024.194	1215.863	768.670
2029	702.544	739.144	645.560	**2045**	1038.427	1243.124	771.099
2030	724.676	768.611	660.886	**2046**	1051.189	1271.150	772.947
2031	747.611	799.502	673.384	**2047**	1064.226	1297.437	774.845
2032	771.383	826.567	686.070	**2048**	1077.548	1324.419	776.793
2033	796.034	854.716	698.971	**2049**	1089.295	1349.474	778.155
2034	821.604	883.978	712.126	**2050**	1101.294	1375.155	779.567
2035	848.134	916.847	722.531				

The dynamics of future emissions of the Waste Sector up to 2050 under the three scenarios are shown in fig. 4.8.

Figure 4.8. Evolution of Waste Sector Emissions up to 2050 under the three scenarios.[116]

[115] MNRETS. GEF UNEP. 2022. IPCC Inventory Software V2.54 Data Base.
[116] Developed by authors based on MNRETS. GEF UNEP. 2022. IPCC Inventory Software V2.54 Data Base.



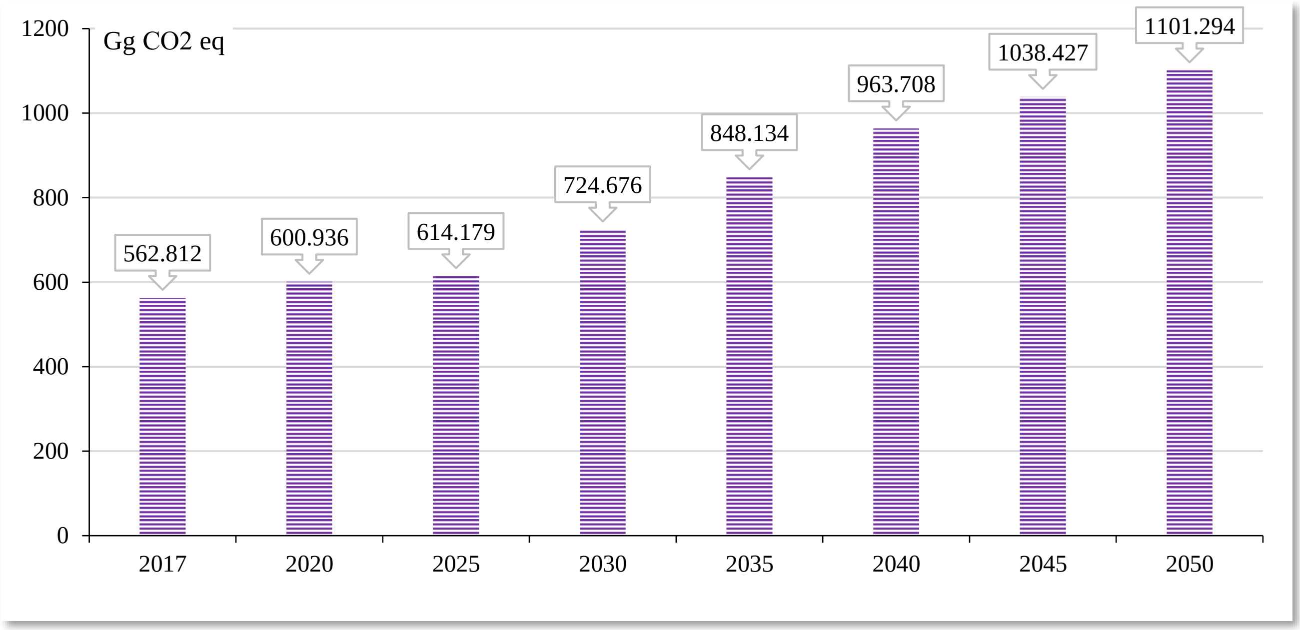
In the Waste Sector, all mitigation measures identified during the stakeholder consultations in the NDC update process were regulatory by character and do not lead directly to GHG emission reductions, and accordingly were not assessed. The development of biogas plants in landfills and wastewater treatment plants in Bishkek and Osh are not supported, in the short term, by investment projects and therefore belong to the WAM scenario and their respective mitigation potential is assessed, starting from 2025, in the Energy sector.

At the same time, the use of seized food waste from landfills and sediments from the municipal wastewater treatment plants of Bishkek and Osh to generate energy in the biogas plants would reduce the methane emissions of the Waste Sector being used for bioenergy generation.

The projection of GHG emissions of the Waste Sector under the BAU scenario for 2017-2050 is shown in the diagram (see fig. 4.9).

Figure 4.9. Projection of future Waste Sector GHG emissions under the BAU scenario up to 2050.[117]

[117] Ibid.



Landfill gas, consisting of 50-60% methane plus carbon dioxide and small amounts of other gases, can be captured and combusted on site. The carbon dioxide produced when the methane is burned is less harmful to the climate than the methane. This option was debated during SWG sessions and seems to be included in the Bishkek city municipal landfill managing enterprise for further elaboration.

4.2 Decision context

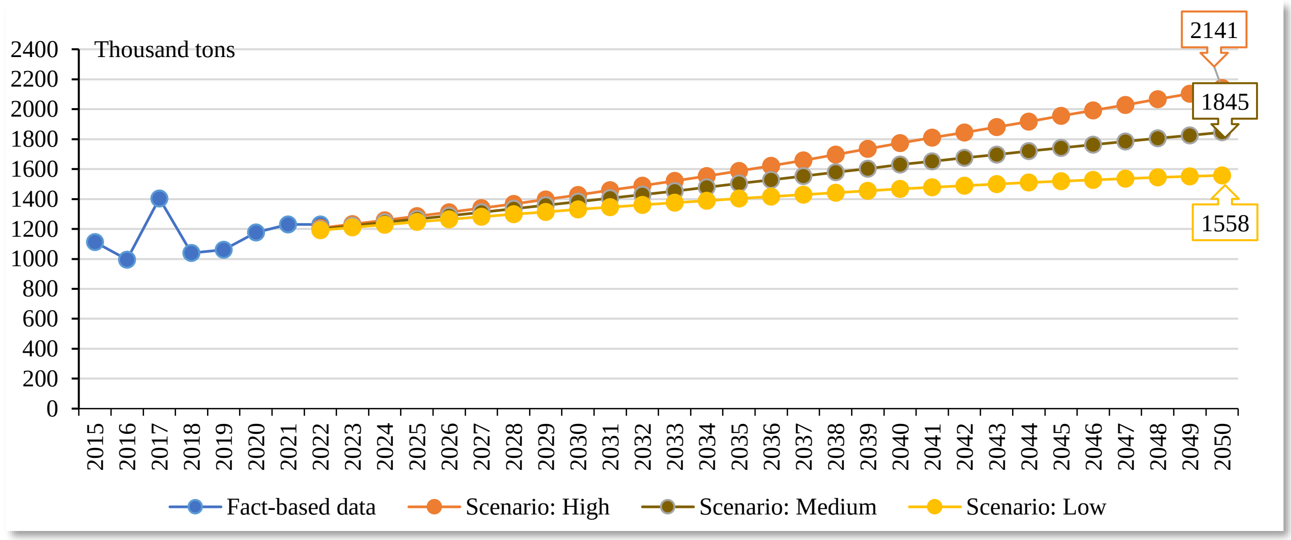
From the point of view of climate change mitigation measures, the Waste sector is of significant interest. The point is not only that the contribution of this source to the global anthropogenic methane (CH_4) emission is estimated at 5 to 20% of the total methane emission, but also that the use of waste as secondary material resources for recycling and reuse is a very promising area, that is practically not used currently in Kyrgyzstan. Also, one of the important reasons is that, in addition to the actual CH_4 emissions from waste disposal, this sector has a significant impact on the state of the environment. For instance in Bishkek the air pollution with P 2.5 particles during winter times is one of the highest in the world, burning of landfills causes by the methane emissions also contributing for that.

Given the fact that CH_4 is emitted into the atmosphere during the anaerobic decomposition of organic waste located in municipal solid waste landfills and the disposal of organic waste generated after wastewater treatment (activated sludge and primary sludge), organic waste decomposes at a gradually slowing pace and requires some years.

According to forecast data, the amount of disposed municipal solid waste in 2030, according to the Medium scenario, will reach 1,381.5 thousand tons[118] (fig. 4.10), which will require both additional space (land resources) and additional financial costs for personnel and machinery.

Figure 4.10. Forecast of the amount of waste disposed to the landfills of the Kyrgyz Republic[119]

[118]Forecast of the amount of waste placed within the NDC KR, 2021
[119] Developed by authors.



It should be noted that there is wide spread opinion that the existing waste management system is inefficient, most of the existing localities for the placement of solid waste disposal sites do not meet the requirements of environmental and sanitary safety, they have exceeded the design life by several times or placed violating the requirements of environmental and sanitary safety.

In accordance with the requirements of the Procedure for handling production and consumption waste in the Kyrgyz Republic, approved by the Decree of the Government of the Kyrgyz Republic dated August 5, 2015 No. 559, it is prohibited to accept waste that can be used as secondary resources, whole used tires for disposal at waste disposal sites, with the exception of their use as a stabilizing material during reclamation and oil products to be processed and (or) disposed of.

Also, the collection of production and consumption waste belonging to the category of secondary material resources should be carried out at waste generation facilities separately in accordance with the directions on their use and processing. Despite these requirements, in fact, more than 70% of the waste placed in landfills is the type of waste suitable for processing and recycling.

Taking into account all of the above factors, this paper considered mitigation measures for the management of waste placed at landfills, which would lead to a reduction in the amount of waste, involvement in the reuse / recycling of waste materials, the use of waste for the production of organic fertilizers, thereby to reduce GHG emissions.

Additionally, UNDP Climate promise II and NDC Partnership project is providing support currently to develop enhanced NDC Implementation Plan and Long-Term Strategy for Carbon Neutrality (LTS) until 2050. The first consultation with the experts engaged into that process showed high interest and willingness to be involved into TNA process, too. Thus, it was decided to coordinate TNA project also with NDC Implementation Plan and in terms of the Waste Sector mitigation measures with LTS 2050 development.

The process of technology selection with TNA project in Kyrgyzstan was divided into the following stages:

1. Analysis of the sector's current GHG emission and future projections, as well as mitigation capacity and measures conducted so far.
2. Analysis of the enabling frameworks, specific characteristics of the waste sector's operations, also mapping stakeholders to determine the demand on technology.
3. Identification of priority subsectors having mitigation capacity to deploy climate mitigation technologies there.
4. Overview of past experience in technologies implementation within the Waste Sector.

5. Study of existing technologies in the waste sector and possible options based on international and relevant national experience.
6. Selection and creation of the extended list of technologies by the national consultants, also gathering proposals from the sectors' stakeholders and compiling long list of mitigation technologies from open sources.
7. Detailed discussion of each technology with a team of national experts and on the sessions of Sectoral Working Groups.
8. Formation of the short lists of technologies recommended for MCA exercise and preparation of Technology Fact Sheets.
9. Prioritisation of short-listed technologies using MCA Matrixes Tool.
10. Discussion of the MCA result and corresponding recommendations on SWG and preparation of the TNA Reports.
11. Presentation of the selected technologies to the TNA Project National Steering Committee.

All above listed factors were duly taken into account by the members of SWG during decision making process on waste mitigation technologies prioritisation.

It should be noted that one of the major factors in decision making about the technologies assessment was determined by NATCOM 3 and 4 and NDC, which defined some climate change mitigation measure for the Waste Sector.

4.3 Overview of Existing Technologies in the Waste Sector

According to the results of the inventory of the waste disposal sites conducted by the State Agency for Environment Protection and Forestry in 2018, there are 406 landfills in the Kyrgyz Republic, where over 16 million tons of solid waste have been accumulated. There are no specialized dumps and landfills for separate disposal of industrial waste (except for tailings, sludge reservoirs, etc.) in the republic, and a significant part of industrial waste is disposed on the territories of enterprises. On average, about one percent of the waste generated per year is transferred to other enterprises, mainly for recycling or disposal. All the waste is transferred or disposed mainly to municipal landfills. There is no separate accounting for medical waste, medical waste is disposed to landfills together with municipal solid waste, some of it being open-burned.

The existing wastewater disposal system provides gravity drainage of wastewater through the main collectors to the city treatment plants. Wastewater from the outskirts below the treatment plant is pumped by a sewage pumping station. Wastewater from residential areas, administrative and public buildings and industrial enterprises is discharged into the city sewer system. From undeveloped areas wastewater is taken to a drainage station. Part of the housing in urban areas has filtered pit latrines, which also serve as additional factors for contamination of soil and groundwater with pathogenic microbes and products of organic decomposition.

In the Kyrgyz Republic, both municipal and industrial wastewater is discharged into the centralized sewerage system. As a rule, industrial wastewater is treated together with municipal wastewater of settlements. Heavily polluted wastewater from individual industrial plants is pre-treated at the plants' wastewater treatment plants before being discharged into municipal systems.

Currently, the solid waste disposal sites are sources of secondary pollution of atmospheric air, soil, underground aquifers, including sources of drinking water supply. Also, the volume of toxic waste at enterprises is increasing every year. Over a long period of economic activity, about 100 million tons of production and consumption waste have been accumulated on the territory of the Kyrgyz Republic.

Issues of environmentally safe management of production and consumption waste are quite actual practically everywhere in the republic[120].

4.4 Mitigation Technologies Options for the Waste Sector

The process of selecting, analysing and evaluating technologies for climate change mitigation is a process that spans different scales, sectors and levels of intervention. In this work, mitigation measures for handling collected waste were considered divided into groups depending on the result and final product:

- reuse/recycling of waste into raw materials;
- use of waste for the production of organic fertilizers by fermentation(composting);
- use of waste for production of heat and electricity: anaerobic digestion to produce biogas;
- direct combustion to produce heat or electricity, including in cogeneration plants; and
- disposal of solid waste.

Based on the proposed TNA methodology, the National TNA Consultant prepared a list of possible technologies in the field of waste management based on the national waste management policy, the NDC Plan, the TFSs from CTCN and UNEP-CCC data base and international experience. That list of possible technologies is presented in table 4.5.

Table 4.5. Possible mitigation technologies for the Waste Sector

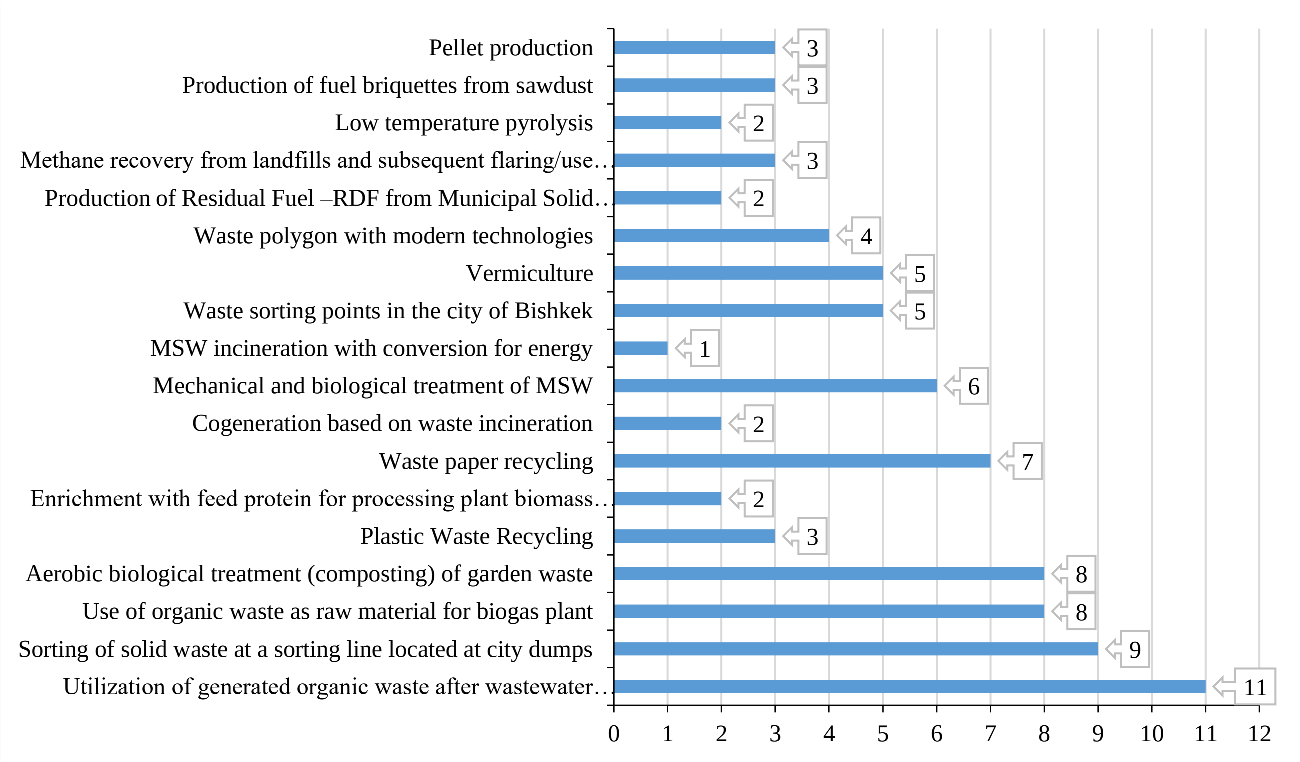
#	Technologies
1.	Utilization of generated organic waste after wastewater treatment for biogas plants
2.	Sorting of solid waste at a sorting line located at city dumps
3.	Use of organic waste as raw material for biogas plant
4.	Aerobic biological treatment (composting) of garden waste
5.	Plastic waste recycling
6.	Enrichment with feed protein for processing plant biomass and various organic wastes, mainly carbohydrate- and cellulose-containing
7.	Waste paper recycling
8.	Cogeneration based on waste incineration
9.	Mechanical and biological treatment of MSW
10.	MSW incineration with conversion for energy
11.	Waste sorting points in the city of Bishkek
12.	Vermiculture
13.	Waste landfill with modern technologies
14.	Production of Residual Fuel – RDF from Municipal Solid Waste
15.	Methane recovery from landfills and subsequent flaring/use for power generation
16.	Low temperature pyrolysis
17.	Production of fuel briquettes from sawdust
18.	Pellet production

This list and the matrix for identifying priority technologies for the Waste sector were sent to the 20 members of the working group. The matrix was a preliminary list of technologies consisting of 18 technologies, in tabular form with a description of the technologies and expected results.

[120]Comprehensive Analysis of the Current Situation of the Municipal Solid Waste (MSW) Management System http://eco-expertise.org/wp-content/uploads/2009/06/201805251452046.pdf

After exchanging information on technologies with members of the sectoral working groups, the responses received were processed and summarized in a single table for prioritization of technologies after the survey. The results of the stakeholder SWG voting to compile a long list of mitigation technology options are shown in fig. 4.11.

Figure 4.11.The results of SWG voting.



In result of SWG debate, consultations and additions from SWG the long list of mitigation technologies options has been prepared for MCA exercise (see table 4.6).

Table 4.6. The long list of mitigation technology options for MCA.

#	Technology
1	Mechanical and biological treatment of MSW (TFS 6)
2	Use of organic waste as raw material for biogas plants (TFS 1)
3	Waste sorting points in the Bishkek city streets (TFS 7)
4	Utilization of generated organic waste after wastewater treatment for biogas plants (TFS 4)
5	Waste landfill with modern technologies (TFS 9)
6	Aerobic biological treatment (composting) of garden waste (TFS 2)
7	Sorting of solid waste at a sorting line located at city dumps (TFS 8)
8	Vermiculture (TFS 3)
9	Waste paper recycling (TFS 5)

After the first SWG meeting, the national consultant proceeded to complete the TFSs for all above technologies. Available sources of information were used to compile TFSs from internet resources as well as from different sector stakeholders, including business plans, commercial offers, investment plans, scientific articles, technological regulations, manuals and other sources. Given limited resources, the estimations used to prioritize technologies were agreed as indicative. The completed TFSs for the selected technologies were sent by e-mail to the members of the SWG, with a proposal to make the necessary adjustments and additions. Thus, all the TFSs were analysed by the members of the SWG, and there were no objections to filling in, except for clarifications on the text, which were taken into account.

4.5 Criteria and process of technology prioritisation

Multi-Criteria analysis (MCA) provides a structured framework for comparing a number of mitigation technologies across a number of criteria. A major benefit of using MCA for prioritizing mitigation technologies is the ability to include the preferences of stakeholders involved in the process, emphasizing the importance of having appropriate representation of stakeholders during the prioritization process.

In order to compare different technology options and to identify what makes one technology better or more appropriate than another and more worthy of implementation, the criteria used in evaluating each technology option were defined. The final selection of criteria depends on the national climate change mitigation context and priorities.

Following the selection of preferred technologies for the Solid Waste Disposal and Wastewater Treatment and Discharge subsectors, TFSs were compiled in which relevant information was collected on each technology. The technical descriptions of technologies includes the following information: short descriptions, information on productivity, capital costs, number of jobs, resource efficiency, market potential, advantages and disadvantages of technology, barriers, and various benefits. All those benefits were divided into six categories: cost, economic, social, environmental, climate, institutional to be used in MCA exercise.

The nominated technologies for the Waste sector were evaluated based on their economic, social, environmental and climate benefits. The national consultant, together with the members of the working group, identified 15 criteria covering 6 categories.

1. **Cost category criteria include the following two:**
   - Capital investments - expenses of the organization for the acquisition, creation, improvement of fixed assets / technology;
   - Operating and maintenance costs include the costs of scheduled and unscheduled maintenance.
2. **The group of economic criteria includes:**
   - Equipment service life: the period from the beginning of the operation of the equipment to its complete physical and obsolescence;
   - Resource efficiency is the efficient, rational use of available resources at minimal cost or obtaining the maximum possible volume of production using these resources;
   - Market potential reflects the expected level of possible, under certain assumptions, application of technology within the country.
3. **The group of social criteria includes the following three criteria:**
   - The criterion is the number of beneficiaries, in a broad sense, the beneficiary is the ultimate recipient of any profit. It can be either an individual or a legal entity;
   - The criterion of jobs reflects the number of jobs created after the possible spread of technology in the country;
   - The criterion of gender equality and social inclusion reflects the contribution of technology to any improvement in the status of women and vulnerable groups.
4. **The environmental group of criteria includes two criteria:**
   - The reduction in landfilled organic waste reflects the expected contribution of the technology to the reduction of landfilled organic waste;
   - The positive impact on biodiversity shows the impact of technology on local biodiversity, including flora and fauna species, as well as local ecosystems.

5. **Climatic criteria include three the most important criteria for mitigation:**
    - Reduction of GHG emissions Gg CO_2 eq. /ton - contribution of technology to the reduction of GHG emissions per 1 ton of disposed waste, in case of its distribution;
    - Reduction of GHG emissions Gg CO_2 eq. /year - - contribution of the technology to the reduction of emissions, if it is disseminated;
    - Specific cost of CO_2 reduction thousand $/Gg - the average price of a commodity unit or a unit of use value.
6. **Institutional criteria category includes the following:**
    - Easy to implement - an estimate of how much efforts and resources will be required to implement the technology;
    - Compliance with national development priorities - compliance with national strategies, programmes and development directions laid down in them.

All proposed categories and criteria following the general guidelines for TNA, measure units including both "qualitative" with proposed scoring set and "quantitative" values, as well as weights were duly debated on SWG meetings and agreed upon unanimously. The criteria used in the MCA evaluation process are presented in table 4.7.

Table 4.7. Criteria for MCA analysis.

Category	#	Criterion	Index	Weight
Cost	1	Capital investments	million US$ / unit of equipment	5
	2	Operating and maintenance costs	$ \ ton	5
Economic	3	Lifetime	Years	5
	4	Resource efficiency	efficiency factor %	10
	5	Market potential	thousand $/processed ton	5
Social	6	Number of beneficiaries	thousand people	5
	7	Jobs	number	10
	8	Gender equality	from very low to very high (with scoring from 20 to 100)	5
Environmental	9	Reducing the amount of organic waste placed	thousand tons/year	10
	10	Positive impact on biodiversity	from very low to very high (with scoring from 20 to 100)	5
Climatic	11	Reduction of GHG emissions	Gg CO_2 eq. /ton	5
	12	Reduction of GHG emissions	Gg CO_2 eq. /year	10
	13	Specific cost of reducing emissions	CO_2, thousand $/Gg	5
Institutional	14	Easy to implement	from very low to very high (with scoring from 20 to 100)	5
	15	Compliance with national development priorities	from very low to very high (with scoring from 20 to 100)	10

Those criteria were duly used for the MCA matrixes, all of which are presented further in tables 4.8, 4.9, and 4.10.

Table 4.8. MCA Performance Matrix

Performance Rating Matrix																
#	Technologies / Criteria	Costs		Benefits												
				Economic			Social			Environmental		Climate			Institutional	
		Capital expenditures $ mln. /unit equipment	Operating and maintenance costs . cf. $ \ton	Service life / year	Resource efficiency, efficiency %	Market potential, $thousand/tonne processed	Number of beneficiaries, thousand people	Jobs qty	Gender equality	Reduction the volume of disposed waste with organic matter, thousand tons / year	Positive impact on biodiversity	Reduction of GHG emissions Gg CO_2 eq. /ton	Reduction of GHG emissions Gg CO_2 eq. /year	Specific cost of CO_2 reduction, thousand $/Gg	Easy to implement	Compliance with national development priorities
1	***Use of organic waste as raw material for biogas plant***	0,75	0,33	25	40	9,6	1074,07	15	average	27,9	high	0,0031	43,2	0,05	average	very high
2	***Aerobic biological treatment (composting) of garden waste***	0,16	0,57	15	40	0,0015	26,9	20	high	77	high	0,0002	15,2	0,01	high	high
3	***Vermiculture***	0,015	1,1	16	60	0,9	5,6	10	high	0,0116	high	0,0000020	0,0014	0,01	high	average
4	***Use of organic waste after wastewater treatment for biogas plants***	0,44	0,2	25	40	6,44	1074,07	15	average	7,6	high	0,0038	29	0,02	average	high
5	***Waste paper recycling***	0,20	6,79	15	70	0,8	0,56	15	average	1,6	average	0,00007	0,11	0,0018	average	average
6	***Mechanical and biological treatment of MSW***	5,3	0,34	50	90	6,5	1074,07	65	high	213,5	high	0,00031	49,7	0,24	average	very high
7	***Waste sorting point in Bishkek city***	2,3	0,025	15	51	1,05	1074,07	230	average	4,1	high	0,00007	0,27	8,70	average	very high
8	***Sorting of solid waste at a sorting line located at city dumps***	0,39	5,9	25	50	2,1	100	50	average	14	low	0,00008	1,1	0,35	average	very high
9	***Waste polygon with modern technologies***	7,38	14	19	90	2,7	55,6	60	low	111,25	average	0,00030	21,1	0,35	low	high

Table 4.9 MCA Scoring Matrix

Score Matrix (for each criterion, scores should range from 0 to 100)																
#	Technologies / Criteria $Yi = \frac{Xi - Xmin}{X max - Xmin} * 100$ $Yi = \frac{Xmax - Xi}{X max - Xmin} * 100$	Costs		Benefits												
				Economic			Social			Environmental		Climate			Institutional	
		Capital expenditures $ mln. /unit equipment	Operating and maintenance costs . cf. $ \ton	Service life / year	Resource efficiency, efficiency %	Market potential, $thousand/tonne processed	Number of beneficiaries, thousand people	Jobs qty	Gender equality	Reduction the volume of disposed waste with organic matter, thousand tons / year	Positive impact on biodiversity	Reduction of GHG emissions Gg CO_2 eq. /ton	Reduction of GHG emissions Gg CO_2 eq. /year	Specific cost of CO_2 reduction, thousand $/Gg	Easy to implement	Compliance with national development priorities
1	***Use of organic waste as raw material for biogas plant***	90,02	97,82	28,57	0,00	100,00	100,00	2,27	60,00	13,06	80,00	81,99	86,90	99,41	60,00	100,00
2	***Aerobic biological treatment (composting) of garden waste***	98,07	96,10	0,00	0,00	0,00	2,45	4,55	80,00	36,06	80,00	5,19	30,57	99,91	80,00	80,00
3	***Vermiculture***	100,00	92,31	2,86	40,00	9,36	0,47	0,00	80,00	0,00	80,00	0,00	0,00	99,91	80,00	60,00
4	***Use of organic waste after wastewater treatment for biogas plants***	94,23	98,75	28,57	0,00	67,08	100,00	2,27	60,00	3,55	80,00	100,00	58,33	99,84	60,00	80,00
5	***Waste paper recycling***	97,53	51,56	0,00	60,00	8,32	0,00	2,27	60,00	0,74	60,00	1,72	0,21	100,00	60,00	60,00
6	***Mechanical and biological treatment of MSW***	28,24	97,75	100,00	100,00	67,70	100,00	25,00	80,00	100,00	80,00	8,21	100,00	97,26	60,00	100,00
7	***Waste sorting point in Bishkek city***	68,97	100,00	0,00	22,00	10,92	100,00	100,00	60,00	1,92	80,00	1,72	0,54	0,00	60,00	100,00
8	***Sorting of solid waste at a sorting line located at city dumps***	94,85	57,96	28,57	20,00	21,86	9,26	18,18	60,00	6,55	40,00	2,04	2,23	96,00	60,00	100,00
9	***Waste polygon with modern technologies***	0,00	0,00	11,43	100,00	28,11	5,13	22,73	40,00	52,11	60,00	7,94	42,41	96,00	40,00	80,00
Criteria weights		**5**	**5**	**5**	**10**	**5**	**5**	**10**	**5**	**10**	**5**	**5**	**10**	**5**	**5**	**10**

Table 4.10 MCA Decision Matrix

Decision Matrix: Weighted Scores

#	Technologies / Criteria	Costs		Benefits													Total	Priority rank
				Economic			Social			Environmental		Climate			Institutional			
		Capital expenditures $ mln. /unit equipment	Operating and maintenance costs . cf. $ \ton	Service life / year	Resource efficiency, efficiency %	Market potential, $thousand/tonne processed	Number of beneficiaries, thousand people	Jobs qty	Gender equality	Reduction the volume of disposed waste with organic matter, thousand tons / year	Positive impact on biodiversity	Reduction of GHG emissions Gg CO2 eq. /ton	Reduction of GHG emissions Gg CO2 eq. /year	Specific cost of CO2 reduction, thousand $/Gg	Easy to implement	Compliance with national development priorities		
1	***Use of organic waste as raw material for biogas plant***	450,10	489,09	142,86	0,00	500,00	500,00	22,73	300,00	130,63	400,00	409,95	869,00	497,05	300,00	1000,00	6011,41	**2**
2	***Aerobic biological treatment (composting) of garden waste***	490,33	480,50	0,00	0,00	0,00	12,27	45,45	400,00	360,62	400,00	25,94	305,74	499,53	400,00	800,00	4220,39	**6**
3	***Vermiculture***	500,00	461,54	14,29	400,00	46,80	2,35	0,00	400,00	0,00	400,00	0,00	0,00	499,53	400,00	600,00	3724,51	**8**
4	***Use of organic waste after wastewater treatment for biogas plants***	471,15	493,74	142,86	0,00	335,39	500,00	22,73	300,00	35,54	400,00	500,00	583,35	499,22	300,00	800,00	5383,97	**3**
5	***Waste paper recycling***	487,67	257,79	0,00	600,00	41,60	0,00	22,73	300,00	7,44	300,00	8,59	2,12	500,00	300,00	600,00	3427,93	**9**
6	***Mechanical and biological treatment of MSW***	141,21	488,73	500,00	1000,00	338,52	500,00	250,00	400,00	1000,00	400,00	41,05	1000,00	486,31	300,00	1000,00	7845,82	**1**
7	***Waste sorting point in Bishkek city***	344,87	500,00	0,00	220,00	54,62	500,00	1000,00	300,00	19,15	400,00	8,59	5,40	0,00	300,00	1000,00	4652,63	**4**
8	***Sorting of solid waste at a sorting line located at city dumps***	474,24	289,80	142,86	200,00	109,31	46,32	181,82	300,00	65,52	200,00	10,22	22,28	479,99	300,00	1000,00	3822,35	**7**
9	***Waste polygon with modern technologies***	0,00	0,00	57,14	1000,00	140,57	25,64	227,27	200,00	521,05	300,00	39,68	424,06	479,99	200,00	800,00	4415,40	**5**
Criteria weights		**5**	**5**	**5**	**10**	**5**	**5**	**10**	**5**	**10**	**5**	**5**	**10**	**5**	**5**	**10**		

4.6 Results of technology prioritisation

Based on the TNA methodology and the application of the MCA tool conducted in accordance with the guidelines, nine technologies were evaluated. The final results of the assessment of the mitigation technology options are presented in table 4.11.

Table 4.11. Results of the MCA assessment of technology options

#	Technology	Score	Ranking
1	**Mechanical and biological treatment of Municipal Solid Waste**	**7846**	**1**
2	**Use of organic waste as raw material for biogas plants**	**6011**	**2**
3	**Use of organic waste after the wastewater treatment for biogas plants**	**5384**	**3**
4	Waste sorting point in the city of Bishkek	4653	4
5	Modern technologies landfill site	4415	5
6	Aerobic biological treatment (composting) of garden waste	4220	6
7	Sorting of solid waste at a sorting line located at city dumps	3822	7
8	Vermiculture	3725	8
9	Waste paper recycling	3428	9

The final short list of the prioritised mitigation technology options for the Waste Sector of the Kyrgyz Republic included the following three:

1. **Mechanical and biological treatment of MSW.**
2. **Use of organic waste as raw material for biogas plants.**
3. **Use of organic waste after the wastewater treatment for biogas plants.**

However, after the debate of the results of the mitigation technologies prioritization by the members of SWG, it was also proposed to include another four technologies in the sectoral pipeline for the future resource mobilization initiatives (see table 4.12).

Table 4.12 Mitigation technologies for the Waste Sector pipeline.

#	Technology
1.	Waste sorting point in the city of Bishkek
2.	Waste landfill with modern technologies
3.	Aerobic biological treatment (composting) of garden waste
4.	Sorting of solid waste at a sorting line located at city dumps

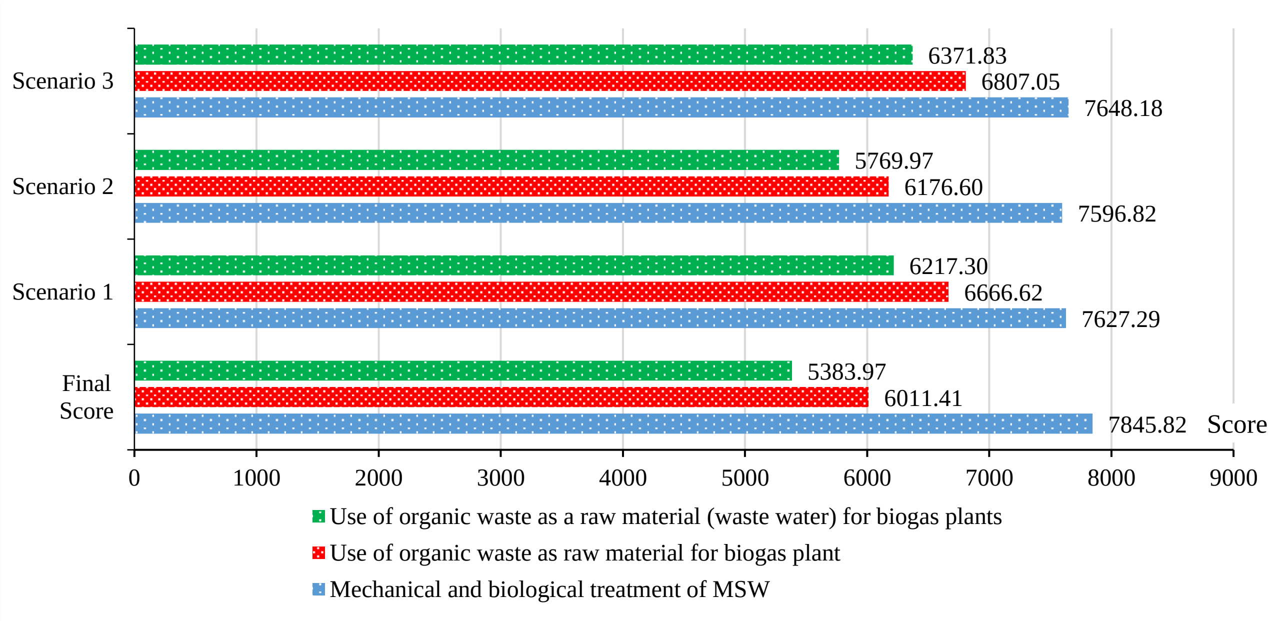
4.7 Sensitivity analysis

As in the Energy Sector, the sensitivity analysis for the obtained results was conducted to test the results of technology prioritization depending on the chosen weights of different criteria using the following three alternative scenarios:

1) Equal weights for all fifteen criteria;
2) Relatively higher weight of economic and social criteria (70%) and lower weight of environmental and climate-related criteria and institutional criteria;
3) Relatively lower weight of economic and social criteria (30%) and higher weight of environmental and climate-related criteria and institutional criteria;

In all tested scenarios the three selected technologies received the highest scores. The general conclusion is that changing the criteria weight has virtually no effect on the choice of the priority technology. (See fig. 4.12).

Figure 4.12. The final score of three selected technologies and the values of the sensitivity analysis under three scenarios.



Chapter 5 Summary and Conclusions

Concluding the first ever process of TNA in Kyrgyzstan to prioritise mitigation technologies in the Energy and Waste sectors, it should be noted that the priorities established by MCA fully correspond to the national development priorities under both sectors.

The Energy Sector is the leading sector in terms of GHG emissions in Kyrgyzstan, which to a great extent uses outdated technologies and traditional sources of energy. These factors justify the Energy Sector being selected for the TNA. Three leading energy subsectors include the following:

- Energy production/ generation including traditional and renewable energy sources;
- Transport; and
- Energy consumption by residential and office buildings/

Three technologies recommended for further elaboration within TNA project for TAP development including:

1. Natural gas for household heating instead of coal
2. Insulation of existing buildings
3. Energy efficient stoves for residential sector

The other sector which considered in the TNA for mitigation was the Waste Sector, which regardless of the low contribution to the total GHG emission is considered the most important to be modernised in terms of environmentally sound and green technologies. Two subsectors were analysed for adequate mitigation technologies prioritization:

- Solid water disposal; and
- Wastewater treatment and discharge

Three technologies were prioritized for further action plan development are:

1. Mechanical and biological treatment of MSW.
2. Use of organic waste as raw material for biogas plants.
3. Use of organic waste after the wastewater treatment for biogas plants.

The final list of prioritised technology options for the sectors of Energy and Water is presented in table 5.1.

All these technologies in both sectors are related to a wide spectrum of economic social and political factors. It is understood that barrier analysis and development of Technology Action Plans for these selected technologies will reflect the need for technology actions for all other technologies debated in the chosen subsectors.

Table 5.1. Prioritized Mitigation Technologies for the Energy and Waster Sectors

Energy Sector			**Waste Sector**	
Energy Consumption Subsector			Solid Waste Disposal Subsector	Waste water Treatment and Discharge Subsector
Natural gas for households' heating instead of coal	Insulation of existing buildings	Energy efficient stoves for residential sector	Mechanical and biological treatment of MSW.	Use of organic waste after the wastewater treatment for biogas plants.
			Use of organic waste as raw material for biogas plants.	

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Annex I: Technology Fact Sheets (TFS) for selected technologies

TFS for the Energy Sector

Technology Fact Sheet # 1

Sector	**Energy**
Subsector	**Energy production**
Name Technology	**Hydropower plants**
Introduction (Short description)	Kyrgyzstan is a mountainous country and the hydropower potential technically possible for development is 142.5 TWh. The level of development of the potential is only 6%. The total capacity of the existing large HPPs is 3030 MW, or 76% of the total installed capacity, which generates about 90% of the total electricity. To ensure the economic development of the country, it is necessary to provide for a growth rate of the gross product of at least 5% per year. This requires the rapid development of electricity generation. It is planned to build new HPPs with a capacity of 4399.7 MW and cover by 2040 part of the electricity demand for the country, with a total demand of 24.642 TWh. A list of potential HPPs is attached.

ADB data. Master Plan for Complex Development of the Energy Sector of the Kyrgyz Republic 2022.

HPP plant name	Capacity MW	long term production GWh/year	CAPEX million US$	total O&M $/MWh	COD year	live storage Mm^3
Akbulun	87.4	346	207	9	2029	8
Naryn HPP-1	47.7	188	171	9.1	2026	0
Naryn HPP-2	47.6	189	144	11.4	2026	0
Naryn HPP-3	55	221	206	9.3	2027	0
Cascade	**237.7**	**942**	**728**	-	-	**8**
Alabuga	600	2358	1745	11.1	2035	2219
Karabulun HPP-1	149	536	530	9.9	2035	0
Toguztorou	248	915	720	11.8	2035	0
Cascade	**997**	**3809**	**2995**	-	-	**2219**
Karakol	33	95	258	27.2	2029	380
Kokomerenskaya HPP -1	360	848	1608	19	2035	523
Kokomeren HPP-2	912	2374	1478	9.3	2039	80
Cascade	**1305**	**3317**	**3344**	-	-	**983**
Kambarata HPP-1	**1860**	5640	**2916**	7.8	2032	2870

* CAPEX – Capital expenditures; O&M – operations and maintenance; COD – Commercial Operations Date

Climate benefits	
Mitigation	Reducing GHG emissions by 2030. by 64,606 thousand tons of CO_2 eq.
Specifications	
Productivity: / comparative for modernization /	Generation of 11,415 TWh by 2040 annually
Resource efficiency: / for each type of energy source, consider /	Average operating time per year 3504 hours (40% of annual) at 90% efficiency of installation
Life time:	30 years
National context	
Market potential: /sales of products, replication of technology in the field /	High demand for electricity 24,642 TWh. (of which 90% of hydroelectric power plants produce) by forecast for 2040. The average sales tariff of 6 soms and the exchange rate of $107 soms = $0.056/kWh will amount to $1.38 billion

Advantages: /arguments in comparison with others/	A large storage reservoir coupled with a large generation capacity providing a valuable source of winter generation, large expected annual energy generation and a low levelized cost of electricity compared to other types of HPPs. Ensure the energy security of the country. Irrigation is possible. Local business development
Flaws:	High cost, construction period of about 10 years, land flooding.
Necessary institutional requirements: / state structures, service, training, etc. /	Available. It is necessary to create a Directorate for the construction development.
Compliance with national priorities	National Development Strategy of the Kyrgyz Republic until 2040, Programme of Green Economy of the Kyrgyz Republic.
Expert Opinion/Special Expert Opinion/	Kambarata-1 HPP will facilitate construction and operation downstream of the planned HPPs
Costs	
Capital Expenditure:	Preliminary $6.639 billion
O&M	Preliminary average $11.34/MWh
Other	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Previously up to 2 thousand working places for the construction of the Upper Naryn cascade. For Kambaritskaya HPP-1, preliminary 5-8 thousand working places.
Economic growth:/ impact on GDP, sector growth/	The contribution of the generation of the entire energy sector to GDP is approximately 4%. According to the data of the National Statistical Committee in 2021 - 2.13% for the month of April.
Number of beneficiaries:	All population and sectors of the economy using electricity in the country. Expected 20% growth.
Health: /morbidity rates, impact/	No negative impact on health
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Available in Kyrgyz State Technical University, Kyrgyz-Russian Slavonic University, Osh State University and other specialized specialties and training is being conducted
Gender equality and social inclusion	Mandatory in accordance with the specifics of the project. Technology does not limit women's participation.
Environmental benefits	No polluting emissions. Production of Green Energy. The reservoir will contribute to the development of biodiversity. Local business development.
Implementation opportunities: /laws, institutions, strategies, policies/	There is a support policy, strategies for the NDS 2040, and the Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040. National Development Programme of the Kyrgyz Republic until 2026. Draft National Energy Programme.
Barriers to implementation: / lack of preferences, equipment, financial support, etc. /	Lack of funds from the government for projects. Lack of economic tariffs for electricity, clear guarantees to investors and, as a result, unattractiveness of projects for investors.

Technology Fact Sheet # 2

Sector	**Energy**
Subsector	**Energy production**
Name Technology	**Small hydropower**
Introduction (Short description)	An assessment of the gross potential of small rivers in the Kyrgyz Republic revealed the possibility of constructing an SHPP with a total capacity of 333 MW with a generation of 1.7 TWh for the period up to 2030. It is technically possible to build 42 small HPPs with an installed capacity of 157 MW with a gradual increase in generation to 774 million kWh per year. A list of the most promising SHPPs is attached.

ADB data. Master Plan for Complex Development of the Energy Sector of the Kyrgyz Republic. 2022.

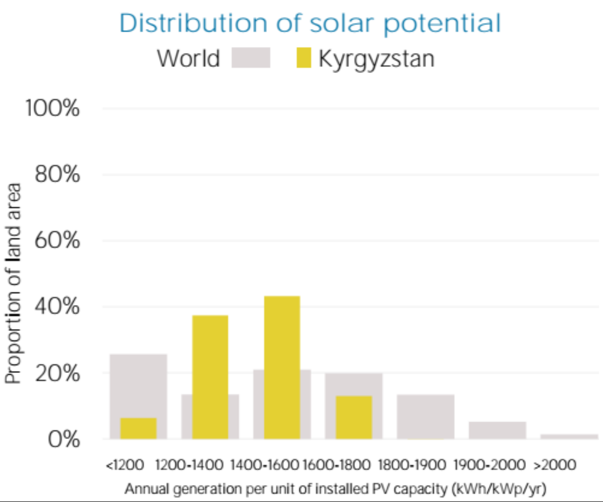
SHPP plant name	Capacity MW	long term production GWh/year	CAPEX million US$	COD
Orto-Tokoi	21	80.9	31.4	2025
Kirov	25	83.1	22.9	2022
Papan	20	83	33.2	2030
Karakul	18	110	26.7	2023
Tortkul	3	11.9	4.2	2030
Sokuluk 5	1.5	9.1	4.2	2036
Oy-Alma 2	7.7	54.5	23.2	2036
Total	96.2	432.5	145.6	-

* CAPEX – Capital expenditures; O&M – operations and maintenance; COD – Commercial Operations Date

Climate benefits	
Mitigation	Expected by 2030 Emission reduction 49,796 thousand tons CO_2 eq
Specifications	
Productivity: / comparative for modernization /	Generation of 432.5 million kWh by 2040 with an installed capacity of 96.2 MW
Resource efficiency: / for each type of energy source, consider /	Average operating time per year 3504 hours (40-60% of the annual) with an efficiency of 90% of the installation
Life time:	30 years
National context	
Market potential: /sales of products, replication of technology in the field /	High demand for electricity. Possibility of construction of SHPPs in the regions on more than 40 river alignments.
Advantages: /arguments in comparison with others/	Basically, SHPPs are of a diversion type, combined with generating capacity, providing a source of generation all year round, a guaranteed volume of energy generation and an average low levelized cost of electricity - $47 / MWh. Compared to other types of hydroelectric power plants, it does not require a large reservoir and land flooding. They provide energy coverage for the internal needs of the country. The construction period is about 2-3 years. Low cost compared to large hydroelectric power plants. Work in automatic mode.
Flaws:	Decreased electricity generation in winter.
Necessary institutional requirements: / state structures, service, training, etc. /	Does not require the creation of additional organizations
Compliance with national priorities	National Development Strategy of the Kyrgyz Republic until 2040. Programme of Green Economics of the Kyrgyz Republic. National Development Programme of the Kyrgyz Republic until 2026.
Expert Opinion/Special Expert Opinion/	
Costs	
Capital Expenditure:	Preliminary $145.6 million for initial projects
O&M	Preliminary average 47 US$/MWh
Other	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Preliminarily up to 50 working places for the construction of one SHPP. Operation in automatic mode with a minimum number of employees
Economic growth:/ impact on GDP, sector growth/	Contribution of SHPPs to the total generation is currently about 1% of the total. Development of the energy sector in the regions.
Number of beneficiaries:	Regional population and all sectors of the economy using electricity in the republic
Health: /morbidity rates, impact/	No negative health impact

Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Available in Kyrgyz State Technical University, Kyrgyz-Russian Slavonic University, Osh State University and other specialized specialties and training is being conducted
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	No polluting emissions. Production of Green Energy
Implementation opportunities: /laws, institutions, strategies, policies/	There is a support policy, strategies for the NDS 2040, and the Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040.
Barriers to implementation: / lack of preferences, equipment, financial support, etc. /	Lack of funds from the government for projects. Lack of regulatory support for land allocation for the construction of SHPPs, economic tariffs for electricity, clear guarantees for investors and, as a result, delays in the implementation of projects.

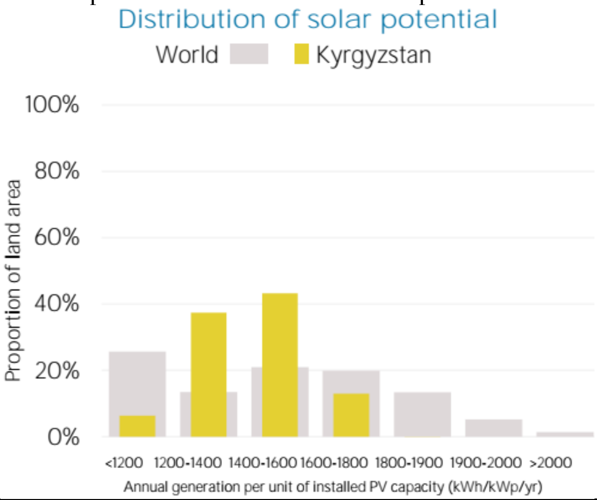
Technology Fact Sheet # 3

Sector	**Energy**
Subsector	**Energy production**
Name Technology	**Solar energy (for hot water)**
Introduction (Short description)	The geographical and climatic conditions of Kyrgyzstan are favourable for the use of solar energy. The annual inflow of solar radiation in Kyrgyzstan is on average about 2000 kWh/(m^2 year). Solar thermal installations include all water heating and heating collectors, furnaces, dryers, greenhouses, desalination plants and other installations. Solar collectors have a direct impact on the roof, either on the frame, or on the flat roof, or on the ground. Based on research in the Kyrgyz Republic, solar systems can annually save traditional fuel: - up to 75% - for hot water supply (DHW) with year-round use; - up to 95% - for hot water supply with seasonal use; - up to 50% - for heating; - up to 80% - for the purposes of standby heating. The total solar energy potential of the Kyrgyz Republic is estimated at an average of 490 million kWh/year. According to IRENA potential in the Kyrgyz Republic shown below (Annual generation per unit of installed photovoltaic capacity (kWh/kW/year). 
Climate benefits	
Mitigation	Emission reduction expected by 2030 78.4 thousand tons of CO_2 eq.
Specifications	
Productivity: / comparative for modernization /	Generation of 490 million kWh by 2040 using the full potential
Resource efficiency: / for each type of energy source, consider /	Thermal solar systems show an efficiency of more than 55% depending on the type of collector. (42% in winter) with 247 sunny days a year.
Life time:	15 years

National context	
Market potential: /sales of products, replication of technology in the field /	Demand for hot water and heating. Possibility of installation on any building. 8.61 million peoples are expected by 2040.
Advantages: /arguments in comparison with others/	The most efficient installations for temperate and cold climates, withstands temperatures down to -50°C and low solar radiation intensity; • have a large number of connection schemes; • are easily integrated into existing hot water and heating systems; • tank location does not require strict placement, so systems are easier to modify than passive ones; • high performance due to active circulation of the liquid. Simplicity of design, easy assembly and installation; • Permanent work and convenience;
Flaws:	Depends on the availability of sunlight (weather). Difficult to use for heating in KR efficiently. Relatively expensive cost for citizens with average incomes.
Necessary institutional requirements: / state structures, service, training, etc. /	Does not require the creation of additional organizations
Compliance with national priorities	National Development Strategy of the Kyrgyz Republic until 2040. Programme of Green Economy of the Kyrgyz Republic. National Development Programme of the Kyrgyz Republic until 2026.
Expert Opinion/Special Expert Opinion/	In the Kyrgyz Republic, it is effective for hot water supply (without heating)
Costs	
Capital Expenditure:	From $3500 for a set of 300 liters. Preliminary $9.95 million.
O&M	Preliminary average of $40 per system per year
Other	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Operation in automatic mode. 2 workers to install the kit. (200 on average in the Kyrgyz Republic)
Economic growth:/ impact on GDP, sector growth/	Contribution to fuel economy.
Number of beneficiaries:	Total population and all economic sectors using hot water supply (kWh/capita)
Health: /morbidity rates, impact/	No negative impact on health, maintaining health through compliance with sanitary and hot water standards.
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Available in Kyrgyz State Technical University, Kyrgyz-Russian Slavonic University, Osh State University and other specialized specialties and training is being conducted
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	No polluting emissions. Reduce emissions by saving fossil fuels
Implementation opportunities: /laws, institutions, strategies, policies/	There is a support policy, strategies for the NDS 2040, and the Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040.
Barriers to implementation: / lack of preferences, equipment, financial support, etc. /	Lack of government funding to support the use of technology. Lack of economic tariffs for heat and electricity, which would stimulate the use of technology.

Technology Fact Sheet # 4

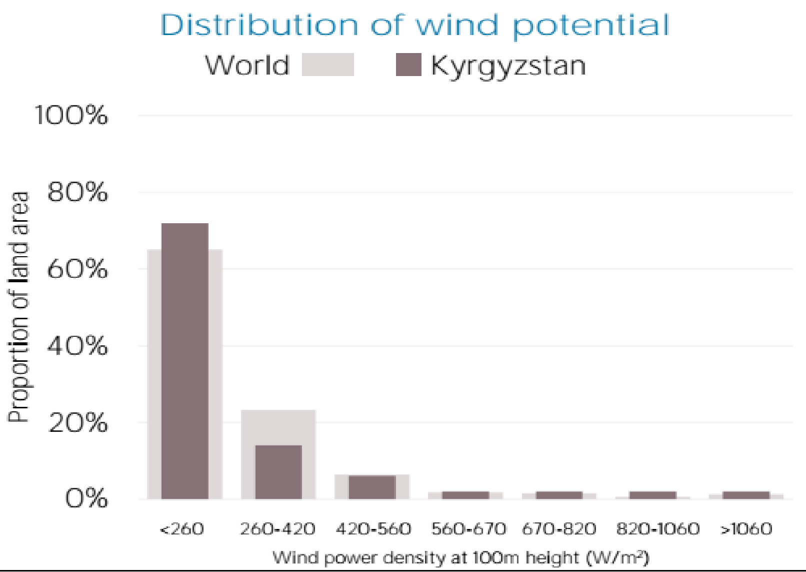
Sector	Energy
Subsector	**Energy production**
Name Technology	**Solar photovoltaic (electricity)**
Introduction (Short description)	The geographical position and climatic conditions of Kyrgyzstan are favorable for the use of solar energy. The annual solar radiation in Kyrgyzstan averages about 2000 kWh/(m2 year). According to the type of solar energy conversion, these types of solar installations are referred to as photovoltaic converters. A set of an autonomous Photovoltaic station (PVS) with a capacity of 3 kW is designed to supply power to remote objects with the main electricity consumption in the summer up to

	16 kWh per day, or to work in hybrid systems with round-the-clock electricity consumption. Solar radiation of 1 kW / m2 on a solar panel with an area of 0.4 m2, generates about 40-50 W of peak power. The total solar energy potential of the Kyrgyz Republic is estimated at an average of 490 million kW. hours / year According to IRENA, there is a potential in the Kyrgyz Republic shown below (Annual generation per unit of installed photovoltaic capacity. (kWh/kW/year). 
Climate benefits	
Mitigation	Emission reduction expected by 2030 13 thousand tons of CO_2 eq.
Specifications	
Productivity: / comparative for modernization /	Generation of 490 million kWh by 2040 using the full potential
Resource efficiency: / for each type of energy source, consider /	PVS show an efficiency of about 18% of the illumination level
Life time:	25 years
National context	
Market potential: /sales of products, replication of technology in the field /	Demand for electricity, especially in places where there is no centralized power supply. Possibility of installation on any building or land.
Advantages: /arguments in comparison with others/	Work at -40C - +85C. Small dimensions and weight. Simplicity of design, easy assembly and installation; • Permanent work, simplicity and ease of use;
Flaws:	Depends on the availability of sunlight (weather). Relatively expensive cost for citizens with average incomes.
Necessary institutional requirements: / state structures, service, training, etc. /	Does not require the creation of additional organizations
Compliance with national priorities	National Development Strategy of the Kyrgyz Republic until 2040 Programme Green Economy of the Kyrgyz Republic. National Development Programme of the Kyrgyz Republic until 2026
Expert Opinion/Special Expert Opinion/	In the Kyrgyz Republic, it is effective for independent power supply
Costs	
Capital Expenditure:	From $5500 for a 3kW kit. Provisionally $298.5 million.
O&M	Preliminary average of $50 per system per year
Other	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Operation in automatic mode. 3 workers per set installation.
Economic growth:/ impact on GDP, sector growth/	Contribution to fuel economy.
Number of beneficiaries:	The entire population and all sectors of the economy using electricity
Health: /morbidity rates, impact/	No negative health impact

Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Available in Kyrgyz State Technical University, Kyrgyz-Russian Slavonic University, Osh State University and other specialized specialties and training is being conducted
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	No polluting emissions. Reduce emissions by saving fossil fuels used to generate electricity.
Implementation opportunities: /laws, institutions, strategies, policies/	There is a support policy, strategies for the NDS 2040, and the Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040.
Barriers to implementation: / lack of preferences, equipment, financial support, etc. /	Lack of government funding to support the use of technology. Lack of economic tariffs for heat and electricity, which would stimulate the use of technology.

Technology Fact Sheet # 5

Sector	**Energy**
Subsector	**Energy production**
Name Technology	**Wind power plants**
Introduction (Short description)	This equipment functions as follows: the wind has kinetic energy that can be converted into mechanical energy of the rotor. The device then converts mechanical energy into electrical energy. Europe currently has about 197 GW of installed wind capacity, of which 174 GW is for onshore wind and 23 GW for offshore projects. In the Kyrgyz Republic, the potential for wind farms has not been explored. According to IRENA, Kyrgyzstan has a wind potential at 100m heights shown below (W/m.2)



Climate benefits	
Mitigation	By 2030 Emission reduction expected 3,594 thousand tons of CO_2 eq.
Specifications	
Productivity: / comparative for modernization /	Not determined definitively for Kyrgyzstan. Preliminary design up to 600 MW, no more than 120 days a year
Resource efficiency: / for each type of energy source, consider /	The efficiency installed capacity utilization factor reaches up to 30%.
Life time:	25 years
National context	
Market potential: /sales of products, replication of technology in the field /	Demand for electricity. Possibility of installation in places with wind potential.

Advantages: /arguments in comparison with others/	Work at -40C - +40C. Low capital costs for construction compared to hydroelectric power plants, nuclear power plants, thermal power plants, geothermal power plants. The cost of electricity in both onshore and offshore global wind energy at $0.033/kWh and $0.114/kWh. Doesn't take up much space. The operating process of wind farms is quite simple, the assembly time is very short, and the operation and maintenance costs are also quite low. The power plant produces 85 times more energy than it consumes. It also has relatively small losses during energy transportation.
Disadvantages:	Impermanence. Depends on the presence of wind. Interference. Some wind farms with large blade diameters and some with high rotation speeds can cause radar and TV interference. Relatively expensive cost for citizens with average incomes. Possible danger during periods of bird migration. Wind farms produce electricity about 30% of the time and must be supported by power plants operating on a different type of energy source.
Necessary institutional requirements: / state structures, service, training, etc. /	Does not require the creation of additional organizations
Compliance with national priorities	National Development Strategy of the Kyrgyz Republic until 2040 Programme Green Economy of the Kyrgyz Republic. National Development Programme of the Kyrgyz Republic until 2026
Expert Opinion/Special Expert Opinion/	
Costs	
Capital Expenditure:	From $1325/kW of the constructed wind farm. Preliminary 900 million US dollars.
O&M	From 33-65 $/kW of installed capacity per year
Other	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Operation in automatic mode. Up to 20 workers per kit installation.
Economic growth:/ impact on GDP, sector growth/	Contribution to saving fossil fuels. green energy
Number of beneficiaries:	The entire population and all sectors of the economy using electricity
Health: /morbidity rates, impact/	Generally absent. However, wind farms have a negative impact on the health of people living near them. Due to their influence, a person may experience the so-called wind turbine syndrome (problems with sleep, concentration, headaches and dizziness), therefore it is recommended to place wind farms at a distance of at least 2.5 - 3 km from residential buildings;
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Available in Kyrgyz State Technical University, Kyrgyz-Russian Slavonic University, Osh State University and other specialized specialties and training is being conducted,but special training in WES is required.
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	No polluting emissions. Reduce emissions by saving fossil fuels used to generate electricity.
Implementation opportunities: /laws, institutions, strategies, policies/	There is a support policy, strategies for the NDS 2040, and the Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040.
Barriers to implementation: / lack of preferences, equipment, financial support, etc. /	Lack of government funding to support the use of technology. Lack of economic electricity tariffs to encourage the use of the technology.

Technology Fact Sheet # 6

Sector	**Energy**
Subsector	**Energy production**
Name Technology	**Biogas for heating and electricity**

Introduction (Short description)	The annual amount of livestock waste in the Kyrgyz Republic is on average more than 20 million tons, of which about 7 million tons are accumulated in farms. According to forecasts in 2030, the volume of food waste delivered to landfills in Bishkek and Osh will amount to 123.6 thousand tons / year. On average, the volume of wastewater in Bishkek is 116,736.9 thousand cubic meters per year. Amount of waste from the food industry of the Kyrgyz Republic in 2030 will reach 84 thousand tons/year. This is organic waste that can be processed anaerobically in biogas plants and produce biogas. Biogas contains on average 65% methane, 30% carbon dioxide, 1% hydrogen sulfide, and trace amounts of nitrogen, oxygen, hydrogen and carbon monoxide. The calorific value of biogas is 20-25 MJ/m3, which is equivalent to the combustion of 0.6 liters of gasoline; 0.85 liters of alcohol or 1.7 kg of firewood. Methane contained in biogas, as well as collected methane from landfills and wastewater, is burned to generate heat and electricity. The volume of biogas plant reactors required for the processing of animal waste collected only in Kyrgyzstan is 230,000 m3. Estimated potential is 1.3 TWh. After fermentation valuable organic fertilizer is obtained which may increases the yield by 2-3 times and reduces the cost of purchasing imported mineral fertilizers.
Climate benefits	
Adaptation	Bio fertilizers as by-products pf BGP can be used to increase climate change resilience of crop farming, which will contribute to food security and nutrition.
Mitigation	By 2030 Emission reduction expected 1,311.980 thousand tons of CO_2 eq. (contribution to reduction: agricultural waste 83.4%, food industry 9.1%, landfills 6.3%, runoff 1.15%)
Specifications	
Productivity: / comparative for modernization /	Potential 1.3 TWh Example: 800 m3 digester produces: 1 million cubic meters of biogas/year; electricity 2.6 million kWh/year, heat 3.12 million kWh/year. Total generation energy is 5.72 million kWh/year.
Resource efficiency: / for each type of energy source, consider /	The efficiency of biomass processing into biogas is 40-60% of organic waste used. Efficiency of electric plant on biogas 40%, for thermal plant on biogas efficiency from zero to 50%
Life time:	25 years
National context	
Market potential: /sales of products, replication of technology in the field /	Demand for electricity, heat, biogas and fertilizers. Possibility of installation of small biogas plants in the field and industrial bioenergy complexes in the presence of the necessary organic waste.
Advantages: /arguments in comparison with others/	Relatively free raw materials. Work with constant load. Recycling. Generation of heat and electricity. Cost of Electricity - The weighted average in Europe was $0.088/kWh and the rest of the world was $0.070/kWh[121]. Increasing soil fertility.
Flaws:	Requires constant availability of organic raw materials. Compliance with fermenting technology and correct handling of equipment under pressure. Increased flammability. Relatively expensive cost for citizens with average incomes (small biogas plants up to 50 cubic meters). The problem with the collection of livestock waste from small farmers.
Necessary institutional requirements: / state structures, service, training, etc. /	Does not require the creation of additional organizations
Compliance with national priorities	National Development Strategy of the Kyrgyz Republic until 2040 Programme Green Economy of the Kyrgyz Republic. National Development Programme of the Kyrgyz Republic until 2026
Expert Opinion/Special Expert Opinion/	
Costs	
Capital Expenditure:	In 2021, the global cost weighted average installed capacity of bioenergy plant with generation of $2353 /kW USD of the bioenergy plant under construction. Preliminarily $56 million.

[121] IRENA Report. Power generation cost. 2021

O&M	From 2% to 6% of the total installed costs per year. Oriented 27$/MWh (https://www.iea.org/data-and-statistics/data-tools/levelised-cost-of-electricity-calculator)
Other	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Up to 3 workers per kit installation (small biogas plants). More jobs are possible in industrial plants. Depends on the volume of the biogas plant and equipment for energy generation.
Economic growth:/ impact on GDP, sector growth/	Contribution to the development of agriculture, saving fossil fuels. Green energy.
Number of beneficiaries:	The entire population and all sectors of the economy that use electricity and heat. Suppliers of raw materials/waste (farmers, enterprises) for disposal.
Health: /morbidity rates, impact/	Reduces the level of disease arising from the inability to dispose of waste.
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Available in Kyrgyz State Technical University, Kyrgyz-Russian Slavonic University, Osh State University and other specialized specialties and training is being conducted , but special training in BSU is required.
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	Improves sanitation in the regions. Reduces polluting emissions. Reduce emissions by saving fossil fuels used to generate electricity.
Implementation opportunities: /laws, institutions, strategies, policies/	There is a support policy, strategies for the NDS 2040, and the Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040.
Barriers to implementation: / lack of preferences, equipment, financial support, etc. /	Lack of government funding to support the use of technology. The absence of economic tariffs for electricity, heat, which would stimulate the use of technology.

Technology Fact Sheet # 7

Sector	**Energy**
Subsector	**Energy production**
Name Technology	**Natural Gas Combustion**
Introduction (Short description)	Gazprom Kyrgyzstan is carrying out large-scale gas supply of the country in more than 60 settlements with 90,000 households. Planned by 2030 to bring the level of gas supply of the Kyrgyz Republic to 60% and gas consumption of 1.14 billion cubic meters / year. (https://kyrgyzstan.gazprom.ru/about/project/genshema/) On average, households use for heating from 3 till 5 tons of coal per season. GHG CO_2 emissions from burning 1 ton of coal are on average 3.7 kg, and when burning 1 kg of gas - 2.75 kg. On average, the population of the Kyrgyz Republic burns, according to the NSC, 929 thousand tons of coal of different quality annually. Natural gas is a more environmentally friendly fuel than coal.
Climate benefits	
Mitigation	by 2030 Emission reduction expected 971.247 thousand tons CO_2 eq.
Specifications	
Productivity: / comparative for modernization /	The calorific value of natural gas is 10.2 kW/m^3, compared to coal 7.5 kW/kg. To obtain the same amount of heat, less gas must be burned (factor 0.7). The average efficiency of coal-fired stoves in the population is 30-60%.
Resource efficiency: / for each type of energy source, consider /	The efficiency of gas furnaces is not less than 85-90%.
Life time:	30 years
National context	
Market potential: /sales of products, replication of technology in the field /	Demand for gas heating. The possibility of installing automated gas boilers in homes where there is a centralized supply of natural gas.
Advantages: /arguments in comparison with others/	Easy to operate gas boilers and stoves. Comfort and lack of problems with fuel. Work continuously and constantly. Compared to stoves and coal-fired boilers.

Flaws:	It is necessary to strictly observe the rules for the use of gas. Relatively expensive cost of equipment and connection to gas networks for citizens with average incomes. RK has no own resources of natural gas
Necessary institutional requirements: / state structures, service, training, etc. /	Does not require the creation of additional organizations
Compliance with national priorities	National Development Strategy of the Kyrgyz Republic until 2040 Programme Green Economy of the Kyrgyz Republic. National Development Programme of the Kyrgyz Republic until 2026. Gas supply programme of the Kyrgyz Republic Gazprom Kyrgyzstan.
Expert Opinion/Special Expert Opinion/	
Costs	
Capital Expenditure:	USD 758 million by 2030 at the expense of the company.
O&M	3.6 soms in the tariff of 18.6 soms Gazprom Kyrgyzstan 1 m3 (rate 84) will be $4.05/MWh.
Other	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Up to 100 workers for laying and maintaining networks. In the Kyrgyz Republic up to 1000 places.
Economic growth:/ impact on GDP, sector growth/	Contribution to the development of the Kyrgyz Republic.
Number of beneficiaries:	90 thousand households using gas for heating and hot water supply.
Health: /morbidity rates, impact/	Reduces the level of disease arising from the inability to heat or heating with coal.
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Available in Kyrgyz State Technical University, Kyrgyz-Russian Slavonic University, Osh State University and other specialized specialties and training is being conducted .
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	Improves sanitation in the regions. Reduces polluting emissions. Reduced emissions by using cleaner fuels used for heat generation.
Implementation opportunities: /laws, institutions, strategies, policies/	There is a support policy, strategies for the NDS 2040, and the Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040.
Barriers to implementation: / lack of preferences, equipment, financial support, etc. /	Lack of government funding to support the use of technology. Acquisition of equipment and connection to networks.

Technology Fact Sheet # 8

Sector	**Energy**
Subsector	**Transport**
Name Technology	**CNG Public Buses**
Introduction (Short description)	The transport sector is responsible for 44.1% of greenhouse gas (GHG) emissions in Kyrgyzstan, and in cities like Bishkek for 75% of air pollutants. In the transport sector, road transport is responsible for almost all GHG and air pollutant emissions - 99% and 100% respectively. *Compressed natural gas (CNG)* can be used as an alternative to conventional gasoline and diesel. Vehicles powered by CNG are considered safer than vehicles with gasoline engines. CNG vehicles are less polluting and more efficient. There are 18 million CNG vehicles in operation worldwide, representing 1.2% of the global vehicle fleet. The use of CNG in heavy-duty vehicles is expected to increase to 12,000 units by 2025, primarily in Poland and Hungary.* In line with the national plans presented to the European Commission, which also provides for a total of 431 filling stations and other infrastructure development in the EU - as part of the Trans-European Transport Network (TEN-T) - totaling up to 257 million euros by 2025*.

	Planned in Bishkek: replacement of 78 old trolleybuses with a similar number of modern trolleybuses; acquisition of 20 more trolleybuses to expand the existing fleet (some trolleybuses can be equipped with batteries); replacement of 78 old diesel buses with the same number of CNG buses; replacement of 200 old diesel minibuses with 40 CNG buses. In Osh: 17 new trolleybuses, continuing the ongoing EBRD programme which has already replaced 23 trolleybuses; 50 CNG buses to replace existing old diesel buses; 120 CNG buses to replace the current 600 older diesel minibuses. Possibly 1,158 CNG buses for the entire project. * https://www.oecd-ilibrary.org/sites/553b26c9-ru/index.html?itemId=/content/component/553b26c9-ru
Climate benefits	
Mitigation	By 2030 Emission reduction expected 19.5 thousand tons of CO_2 eq. for pilot projects in Bishkek and Osh.
Specifications	
Productivity: / comparative for modernization /	A petrol engine emits 22 kg CO_2 per 100 km, while a CNG engine emits 16.3 kg CO_2 per 100 km. 25.9% less emissions. Coefficient of car emissions. diesel - 1.2974 CO_2 eq kg/km
Resource efficiency: / for each type of energy source, consider /	The efficiency of petrol/diesel and CNG engines is the same. But on gas, CO_2 emissions from the engine are 30% lower.
Life time:	20 years
National context	
Market potential: /sales of products, replication of technology in the field /	Demand for gas buses in all regions. Possibility of installation of a car of the gas equipment on any type of the car across all republic.
Advantages: /arguments in comparison with others/	Combustion of CNG releases fewer unwanted gases than other fuels and is safer in the event of a spill because natural gas is lighter than air and therefore dissipates quickly if it leaks. Natural gas vehicles emit on average 80% less ozone-forming emissions, ie carbon dioxide (CO_2) and nitrogen oxide (NO_x), than gasoline vehicles.
Flaws:	The fuel tanks of CNG vehicles must be larger than those of vehicles with a gasoline engine. Since it is a compressed gas and not a liquid like gasoline, CNG takes up more space. Rapid refuelling technology also requires expensive investments in infrastructure and can lead to gas leaks.
Necessary institutional requirements: / state structures, service, training, etc. /	Does not require the creation of additional organizations
Compliance with national priorities	National Development Strategy of the Kyrgyz Republic until 2040 Programme Green Economy of the Kyrgyz Republic. National Development Programme of the Kyrgyz Republic until 2026.
Expert Opinion/Special Expert Opinion/	
Costs	
Capital Expenditure:	USD 75 million by 2030 preliminary to Bishkek and Osh.
O&M	The operating and maintenance costs of CNG vehicles are lower compared to hydrocarbon fuel vehicles.
Other	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Around 500 jobs on new CNG buses by 2030
Economic growth:/ impact on GDP, sector growth/	Contribution to the development of environmentally friendly transport in the Kyrgyz Republic.
Number of beneficiaries:	Residents of Bishkek, Osh and adjacent areas
Health: /morbidity rates, impact/	Reduces the level of disease arising from emissions from engine operation on gasoline / diesel fuel
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Available in Kyrgyz State Technical University, Kyrgyz-Russian Slavonic University, Osh State University and other specialized specialties and training is being conducted .

Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	CNG vehicles are less polluting and more efficient.
Implementation opportunities: /laws, institutions, strategies, policies/	There is a support policy, strategies for the NDS 2040, and the Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040.
Barriers to implementation: / lack of preferences, equipment, financial support, etc. /	Lack of government funding to support the use of technology. Acquisition of equipment to create a network of gas stations.

Technology Fact Sheet # 9

Sector	**Energy**
Subsector	**Transport**
Name Technology	**Electric vehicles**
Introduction (Short description)	In the Kyrgyz Republic, the number and quality of cars are the main driving forces behind increasing emissions today. Vehicles in the Kyrgyz Republic emit more than 107.88 million tons of carbon dioxide into the atmosphere on average per year. A viable solution to reduce emissions is the introduction of electric vehicles. In particular, passenger electric vehicles. More than 700677 passenger cars with internal combustion engines are registered in the republic. In order to obtain GHG emission reductions, it is necessary by 2030 every year replace 3% of cars with internal combustion by passenger cars with electric engines. Decrease in emissions per year 1121.4 if annually decrease of 1% for cars with internal combustion engines with a volume of up to 2 cubic meters with a run of 9880 km per year.
Climate benefits	
Mitigation	Emission reduction expected by 2030 423.181 thousand tons CO_2 eq. Average reduction per 1 passenger car- 640.86 tons of CO_2
Specifications	
Productivity: / comparative for modernization /	The mileage of electric vehicles on average before charging is 250-300 km. Electricity consumption: 3.7 miles per kWh or 16.7kWh per 100km[122].
Resource efficiency: / for each type of energy source, consider /	The overall efficiency of an electric vehicle is 40-50%. This is the highest of all types of cars.
Life time:	15 years
National context	
Market potential: /sales of products, replication of technology in the field /	Demand for electric vehicles exists but is limited due to the high cost of electric vehicles.
Advantages: /arguments in comparison with others/	Complete absence of emissions when using energy from Hydroelectric Power Plants. Reduce road noise from traffic.
Flaws:	The high cost of a car compared to conventional cars with ICE (internal combustion engine), lack of charging infrastructure, obtaining technical conditions for connecting charging stations, general lack of awareness among the population, as well as the lack of support for this sector from the state. Relatively low mileage without recharging (250 km on average). In the future, there will be a problem with the disposal of batteries from electric vehicles.
Necessary institutional requirements: / state structures, service, training, etc. /	Does not require the creation of additional organizations
Compliance with national priorities	National Development Strategy of the Kyrgyz Republic until 2040 Programme Green Economy of the Kyrgyz Republic. National Development Programme of the Kyrgyz Republic until 2026.
Expert Opinion/Special Expert Opinion/	National Development Strategy of the Kyrgyz Republic until 2040 Programme Green Economy of the Kyrgyz Republic. National Development Programme of the Kyrgyz Republic until 2026.

122 https://www.which.co.uk/reviews/new-and-used-cars/article/electric-car-charging-guide/how-much-does-it-cost-to-charge-an-electric-car-a8f4g1o7JzXj

Costs	
Capital Expenditure:	USD 266 million by 2030 previously
O&M	Vehicle operation and maintenance costs are lower compared to hydrocarbon fuel vehicles.
Other	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Approximately 500
Economic growth:/ impact on GDP, sector growth/	Contribution to the development of environmentally friendly transport in the Kyrgyz Republic.
Number of beneficiaries:	The entire population of the republic
Health: /morbidity rates, impact/	Does not affect health
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Available in Kyrgyz State Technical University, Kyrgyz-Russian Slavonic University, Osh State University and other specialized specialties and training is being conducted
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	Electric vehicles are environmentally friendly.
Implementation opportunities: /laws, institutions, strategies, policies/	There is a support policy, strategies for the NDS 2040, and the Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040.
Barriers to implementation: / lack of preferences, equipment, financial support, etc. /	Lack of charging infrastructure, obtaining technical conditions for connecting charging stations, general lack of awareness among the population, as well as the lack of state support for this sector.

Technology Fact Sheet # 10

Sector	Energy
Subsector	**Transport**
Name Technology	**Electric public transport**
Introduction (Short description)	The use of electric public transport gives: reduction of air pollution from exhaust gases from public transport; refusal to use old buses for the transport of passengers; stimulating the population to use public transport and refusing to use personal transport. Reducing carbon dioxide emissions into the atmosphere and improving the conditions for passenger transportation in cities and intercity routes. This requires the purchase of 300 electric buses with a capacity of 40-50 passengers, as well as the creation of an electric charging infrastructure for these buses (about 20 charging stations).
Climate benefits	
Mitigation	by 2030 Emission reduction expected 7.05 thousand tons of CO_2 eq. according to NDC
Specifications	
Productivity: / comparative for modernization /	88 million passengers in 10 years
Resource efficiency: / for each type of energy source, consider /	Efficiency of about 85-90% for electricity conversion
Life time:	15 years
National context	
Market potential: /sales of products, replication of technology in the field /	Demand for services of 88 million passengers in 10 years Bishkek and Osh
Advantages: /arguments in comparison with others/	Organization of transportation of passengers by electric buses and creation of a charging station
Flaws:	infrastructure will reduce carbon dioxide emissions into the atmosphere, improve the ecology of cities, increase the comfort of passenger transportation
Necessary institutional requirements: / state structures, service, training, etc. /	Does not require the creation of additional organizations

Compliance with national priorities	National Development Strategy of the Kyrgyz Republic until 2040 Programme Green Economy of the Kyrgyz Republic. National Development Programme of the Kyrgyz Republic until 2026.
Expert Opinion/Special Expert Opinion/	
Costs	
Capital Expenditure:	Estimated tentatively at $37 million US dollars
O&M	Vehicle operation and maintenance costs are lower compared to hydrocarbon fuel vehicles.
Other	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	During the implementation of the project, the following jobs are expected to be created: additional drivers 600 people; service personnel (engineers, foremen) 50 people, personnel for the operation and maintenance of the electric charging infrastructure 40 people;
Economic growth:/ impact on GDP, sector growth/	- Contribution to the development of the economy and transport in the Kyrgyz Republic.
Number of beneficiaries:	30 % of cities' population
Health: /morbidity rates, impact/	Less morbidity and mortality from air pollution in cities
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Available in Kyrgyz State Technical University, Kyrgyz-Russian Slavonic University, Osh State University and other specialized specialties and training is being conducted.
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	In this regard, the mass of emissions into the atmosphere of harmful substances containing: carbon monoxide, nitrogen oxides, sulfur dioxide, soot and other harmful substances will be reduced by 100%.
Implementation opportunities: /laws, institutions, strategies, policies/	There is a support policy, strategies for the NDS 2040, and the Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040. The main directions for the development of railway transport in the Kyrgyz Republic for 2022-2026.
Barriers to implementation: / lack of preferences, equipment, financial support, etc. /	Lack of funds for project implementation, as well as lack of state support for this sector.

Technology Fact Sheet # 11

Sector	**Energy**
Subsector	**Transport**
Name Technology	**Electric railway transport**
Introduction (Short description)	The Kyrgyz Railway serves 424.6 km of main tracks, 220 km of station tracks, and 66.4 km of sidings. The Kyrgyz railway transports over 7 million tons of cargo per year. On average, consuming diesel no more than 7 thousand tons / year, while emitting GHG 22.3041 Gg. CO_2 eq. Among the priority projects of the Main directions of development of the railway. the project - the investment project "Electrification of the railway section Turksib - Balykchy" - the implementation of which financing provides for initiatives within the framework of public-private partnership. The railway section "Turksib - Balykchy" is the main transport artery connecting Kyrgyzstan with Kazakhstan and other countries. The section is single-track, the operational length is 321.5 km, of which 60.3 km - on the territory of Kazakhstan and 261.2 km - on the territory of Kyrgyzstan. As well as electrification of the section 63 km Balykchy-Kara-keche. A viable solution to reduce emissions is the introduction of electric rail vehicles.
Climate benefits	
Mitigation	By 2030 expected reduction in emissions 22.3041 thousand tons of CO_2 eq.
Specifications	

Productivity: / comparative for modernization /	over 7 million tons of cargo per year
Resource efficiency: / for each type of energy source, consider /	The efficiency of electric locomotives, considering the generation of electricity, will be 20-30%, which is comparable to the efficiency of a diesel locomotive of 15-25%.
Life time:	20 years
National context	
Market potential: /sales of products, replication of technology in the field /	Demand for railway services. Transportation is limited due to the dead-end scheme of the railway tracks of the Kyrgyz Republic.
Advantages: /arguments in comparison with others/	Water consumption by train locomotives will be reduced by 4400 m^3/year and water disposal by 1900 m^3/year. The oil content in the upper part of the railway tracks and right-of-way reduced.
Flaws:	The dependence of work on the availability of electricity in the networks.
Necessary institutional requirements: / state structures, service, training, etc. /	Does not require the creation of additional organizations
Compliance with national priorities	National Development Strategy of the Kyrgyz Republic until 2040 Programme Green Economy of the Kyrgyz Republic. National Development Programme of the Kyrgyz Republic until 2026. The main directions for the development of railway transport in the Kyrgyz Republic for 2022-2026
Expert Opinion/Special Expert Opinion/	
Costs	
Capital Expenditure:	200 million US dollars in advance
O&M	Vehicle operation and maintenance costs are lower compared to hydrocarbon fuel vehicles.
Other	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Approximately 200 jobs
Economic growth:/ impact on GDP, sector growth/	Contribution to the development of the economy and transport in the Kyrgyz Republic.
Number of beneficiaries:	Railway KR and the entire population of the republic
Health: /morbidity rates, impact/	Noise is a significant harmful factor in the impact of diesel locomotives on human health. With the transfer to electric traction, the noise level will decrease.
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Available in Kyrgyz State Technical University, Kyrgyz-Russian Slavonic University, Osh State University and other specialized specialties and training is being conducted.
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	In this regard, the mass of emissions into the atmosphere of harmful substances containing: carbon monoxide, nitrogen oxides, sulfur dioxide, soot and other harmful substances will be reduced by 100%. Noise is a significant harmful factor in the impact of diesel locomotives on the human environment. With the transfer to electric traction, the noise level will decrease.
Implementation opportunities: /laws, institutions, strategies, policies/	There is a support policy, strategies for the NDS 2040, and the Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040. The main directions for the development of railway transport in the Kyrgyz Republic for 2022-2026.
Barriers to implementation: / lack of preferences, equipment, financial support, etc. /	Lack of funds for project implementation, as well as lack of state support for this sector.

Technology Fact Sheet # 12

Sector	**Energy**
Subsector	**Other Sectors (Commercial/Institutional)**

Name Technology	Insulation in buildings
Introduction (Short description)	Public buildings in the Kyrgyz Republic consume about 850 GWh of energy per year, which is 10% of the country's primary energy consumption (10% of national energy consumption and 11% of total coal consumption) and the public buildings sector is one of the largest end-users of energy. Currently, specific energy consumption averages 162 kWh per square meter, while demand averages 250 kWh per square meter. Approximately 70-88% of energy consumption in public buildings is used for space heating, with electricity used for space heating in 60% of all public buildings. subject to the implementation of the selected energy efficiency measures, the total theoretical energy saving potential will be 50–60% of the total energy consumption or 500 GWh per year. The upgrade will require an investment of US$1.085 billion for 5,000 buildings covering 5.3 million square meters. and then, the entire stock of public buildings will be brought into line with the energy efficiency requirements of class "B". According to the legislation of the Kyrgyz Republic in the field of energy efficiency of buildings, class "B" is the minimum energy efficiency class.
Climate benefits	
Mitigation	By 2030, the expected reduction in emissions by 2030 10.868 thousand tons CO_2 eq.
Specifications	
Productivity: / comparative for modernization /	1.635 million m^2 of residential buildings until 2030 or 146 GWh, year. Total 5.3 million m^2 with energy saving potential of about 500 GWh/year, with a total consumption of 850 GWh/year
Resource efficiency: / for each type of energy source, consider /	Building efficiency class "B". Energy saving efficiency 55-75% possible.
Life time:	30 years
National context	
Market potential: /sales of products, replication of technology in the field /	The demand for services is in demand throughout the country. Potential for scalability at the country and sector level
Advantages: /arguments in comparison with others/	Provide additional energy savings and economic viability; The potential level of functionality, safety and value of the building will increase. The level of energy consumption will actually decrease, and comfort will increase significantly.
Flaws:	
Necessary institutional requirements: / state structures, service, training, etc. /	Does not require the creation of additional organizations
Compliance with national priorities	National Development Strategy of the Kyrgyz Republic until 2040 Programme Green Economy of the Kyrgyz Republic. National Development Programme of the Kyrgyz Republic until 2026. Programme of the Government of the Kyrgyz Republic on energy saving and energy efficiency policy planning.
Expert Opinion/Special Expert Opinion/	
Costs	
Capital Expenditure:	According to WB calculations, 310 million US dollars preliminary by 2030. For all existing buildings $1.085 billion. An average investment of 140-190$/$m^2$ is required.
O&M	According to the NSC, approximately 0.172% of the budget for the maintenance of buildings or 0.000086 S/kWh. At , the ratio of capital expenditures invested in energy efficient renovation to projected energy savings over the lifetime is $0.05 per kilowatt-hour (3.6 som/kWh), i.e. For every kilowatt-hour saved, an investment of $0.05 is required, which is a good ratio.
Other	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Approximately 500 people
Economic growth:/ impact on GDP, sector growth/	Contribution to the development of the social sector in the Kyrgyz Republic.
Number of beneficiaries:	The entire population of the republic

Health: /morbidity rates, impact/	A significant reduction in diseases due to comfortable indoor conditions in accordance with sanitary standards.
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Available in Kyrgyz State Technical University, Kyrgyz-Russian Slavonic University, Osh State University and other specialized specialties and training is being conducted.
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	Reducing emissions through efficient use of energy and reduced energy consumption.
Implementation opportunities: /laws, institutions, strategies, policies/	There is a support policy, strategies for the NDS 2040, and the Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040. Programme of the Government of the Kyrgyz Republic on energy saving and energy efficiency policy planning
Barriers to implementation: / lack of preferences, equipment, financial support, etc. /	Lack of funds for project implementation, as well as lack of state support for this sector. Lack of staff (and rotation) and institutional memory. Lack of understanding of the benefits of energy efficiency measures. Lack of political will to implement the recommended mechanisms.

Technology Fact Sheet # 13

Sector	**Energy**
Subsector	**Other Sectors (Commercial/Institutional)**
Name Technology	**Building energy management systems**
Introduction (Short description)	Modern houses are literally "stuffed" with electronics and household appliances. The average area of residential premises is also increasing. All this leads to an increase in energy bills in the structure of the family budget. You can save on payments through the use of new energy-efficient technological solutions and modern "smart" nanotechnologies. So the energy of solar panels and wind turbines depends on weather conditions, which can lead to interruptions in the supply of electricity during the day. This problem can be solved by storage devices that store energy - lithium batteries. "Smart" thermostats are connected to the Internet, so users can control the climate in the house even remotely. "Smart" lighting systems will regulate the biorhythms of the body, improve the mood and performance of a person, and the level of illumination. Smart home 100 m^2 with 2.7 m high ceilings in central Russia - saves approximately: 27 kWh / month on lighting, electric heating in winter 1400 kWh / month.
Climate benefits	
Mitigation	Emission reduction expected by 2030 up to 30%
Specifications	
Productivity: / comparative for modernization /	Reduced energy bills (users estimate up to 30%)
Resource efficiency: / for each type of energy source, consider /	Reduced utility bills by improving the efficiency of home heating and air conditioning systems (up to 30% estimated by users)
Life time:	20 years
National context	
Market potential: /sales of products, replication of technology in the field /	Demand for services may be in demand throughout the country. Potential scalability at the country and sector level but only for the affluent population 16.8% (NSC 2021). With an average family of 4 people, this will amount to 281 thousand households. Maybe 10% use technology.
Advantages: /arguments in comparison with others/	Creation of a backup power system in case of emergency shutdown of the centralized power supply. Maximizing household use of clean renewable energy. Ability to remotely control the state of heating and air conditioning systems, lighting, alarms, etc. at home
Flaws:	High cost of equipment. Accessible to the wealthy population. Control unit - from \$500, battery - from \$1500, Thermostats - from - \$300, RES sources - from \$1000, etc.

Necessary institutional requirements: / state structures, service, training, etc. /	Does not require the creation of additional organizations
Compliance with national priorities	National Development Strategy of the Kyrgyz Republic until 2040 Programme Green Economy of the Kyrgyz Republic. National Development Programme of the Kyrgyz Republic until 2026. Programme of the Government of the Kyrgyz Republic on energy saving and energy efficiency policy planning.
Expert Opinion/Special Expert Opinion/	
Costs	
Capital Expenditure:	From $5,000 for a home kit, including repairs and installation.
O&M	not required
Other	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Perhaps up to 100 places in the Kyrgyz Republic
Economic growth:/ impact on GDP, sector growth/	Contribution to the development of nanotechnology and energy saving in the Kyrgyz Republic.
Number of beneficiaries:	The entire population of the republic with prosperity
Health: /morbidity rates, impact/	A significant reduction in diseases due to comfortable indoor conditions in accordance with sanitary standards.
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Available in Kyrgyz State Technical University, Kyrgyz-Russian Slavonic University, Osh State University and other specialized specialties and training is being conducted.
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	Reducing emissions through efficient use of energy and reduced consumption of its volumes.
Implementation opportunities: /laws, institutions, strategies, policies/	There is a support policy, strategies for the NDS 2040, and the Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040. Programme of the Government of the Kyrgyz Republic on energy saving and energy efficiency policy planning
Barriers to implementation: / lack of preferences, equipment, financial support, etc. /	Lack of funds for project implementation, as well as lack of state support for this sector. Lack of understanding of the benefits of energy efficiency measures. Lack of political will to implement the recommended mechanisms.

Technology Fact Sheet # 14

Sector	**Energy**
Subsector	**Other Sectors (Commercial/Institutional, Residential))**
Name Technology	**Energy Efficient construction**
Introduction (Short description)	The Kyrgyz Republic has adopted an update of national building codes and regulations (SNiP). The innovations will contribute to the achievement of the country's goal of reducing energy consumption by 30-50% by improving the energy efficiency of buildings through the revision of building codes. Starting from 2013, new buildings must be built exclusively on the basis of energy efficient and energy saving technologies.
Climate benefits	
Mitigation	Introduction of elements of ecosystem mitigation
Mitigation	By 2030 expected Reduction of emissions 16.866 thousand tons of CO_2 eq. thirty%
Specifications	
Productivity: / comparative for modernization /	1597 thousand m2 housing commissioning annually. Consumption 159700 kw/year. Will be According to the NDC, the real consumption will be up to 500 kWh/m^2/year.
Resource efficiency: / for each type of energy source, consider /	Reducing energy consumption by 30-50% by improving the energy efficiency of buildings. The consumption rate in the new SNIP of energy consumption is 100 kWh/m^2/year.

Life time:	30 years
National context	
Market potential: /sales of products, replication of technology in the field /	The demand for services is in demand throughout the country. Potential for scalability at the country and sector level
Advantages: /arguments in comparison with others/	Saving energy and consequently reducing GHG emissions.
Flaws:	Increasing costs for the use of modern energy-efficient technologies in construction.
Necessary institutional requirements: / state structures, service, training, etc. /	Does not require the creation of additional organizations
Compliance with national priorities	National Development Strategy of the Kyrgyz Republic until 2040 Programme Green Economy of the Kyrgyz Republic. National Development Programme of the Kyrgyz Republic until 2026. Gas supply programme of the Kyrgyz Republic Gazprom Kyrgyzstan. Programme of the Government of the Kyrgyz Republic on energy saving and energy efficiency policy planning.
Expert Opinion/Special Expert Opinion/	
Costs	
Capital Expenditure:	From 140-190 US dollars per 1 m^2 additional costs for energy efficiency. Preliminary USD 175.6 million.
O&M	According to the NSC, approximately 0.172% of the budget for the maintenance of buildings or 0.000086 S/kWh. At the ratio of invested energy efficiency capital expenditures to projected life-cycle energy savings is $0.05 per kilowatt-hour (3.6 som/kWh), i.e. For every kilowatt-hour saved, an investment of $0.05 is required. (WB)
Other	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Preliminary 1000 work places
Economic growth:/ impact on GDP, sector growth/	Contribution to the development of the use of modern materials obtained by nanotechnology in construction and energy savings in the Kyrgyz Republic.
Number of beneficiaries:	The entire population of the republic in new built houses
Health: /morbidity rates, impact/	A significant reduction in diseases due to comfortable indoor conditions in accordance with sanitary standards.
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Available in Kyrgyz State Technical University, Kyrgyz-Russian Slavonic University, Osh State University and other specialized specialties and training is being conducted.
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	Reducing emissions through efficient use of energy and reduced consumption of its volumes.
Implementation opportunities: /laws, institutions, strategies, policies/	There is a support policy, strategies for the NDS 2040, and the Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040. Programme of the Government of the Kyrgyz Republic on energy saving and energy efficiency policy planning
Barriers to implementation: / lack of preferences, equipment, financial support, etc. /	Lack of funds for project implementation, as well as lack of state support for this sector.

Technology Fact Sheet # 15

Sector	**Energy**
Subsector	**Other Sectors (Commercial/Institutional, Residential)**
Name Technology	**Energy efficiency stoves for Residential houses**
Introduction (Short description)	In the Kyrgyz Republic, only 15% of the housing stock is heated centrally. 40% of urban households use inefficient coal stoves/heating boilers. 57% of individual

	houses in Bishkek, and 66% of Tokmok city use solid fuel. The low efficiency of such heaters entails a 20-30% increase in coal consumption compared to more efficient models. Inefficient technologies exacerbate the negative health and environmental impacts of coal use. On average, the population of the Kyrgyz Republic burns, according to the NSC KR 929 thousand tons of coal of various quality annually. The use of energy-efficient stoves with an efficiency of 70% for private households will reduce coal consumption by an average of 35%.
Climate benefits	
Mitigation	By 2030 emission reduction expected 886.314 thousand tons of CO_2 eq.
Specifications	
Productivity: / comparative for modernization /	14 thousand ovens initially by 2030
Resource efficiency: / for each type of energy source, consider /	Reduction of coal energy consumption by 35% on average
Life time:	20 years
National context	
Market potential: /sales of products, replication of technology in the field /	The demand for services is in demand throughout the country. Potential for scalability at the country and sector level
Advantages: /arguments in comparison with others/	Saving fossil fuels and consequently reducing GHG emissions.
Flaws:	
Necessary institutional requirements: / state structures, service, training, etc. /	Does not require the creation of additional organizations
Compliance with national priorities	National Development Strategy of the Kyrgyz Republic until 2040 Programme Green Economy of the Kyrgyz Republic. National Development Programme of the Kyrgyz Republic until 2026. Programme of the Government of the Kyrgyz Republic on energy saving and energy efficiency policy planning.
Expert Opinion/Special Expert Opinion/	
Costs	
Capital Expenditure:	Preliminary 10 million US dollars.
O&M	Not required
Other	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Approximately 100 jobs
Economic growth:/ impact on GDP, sector growth/	Contribution to saving fossil fuels in the Kyrgyz Republic.
Number of beneficiaries:	The entire population of the republic living in private houses without central heating.
Health: /morbidity rates, impact/	A significant reduction in diseases due to comfortable indoor conditions in accordance with sanitary standards.
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Available in Kyrgyz State Technical University, Kyrgyz-Russian Slavonic University, Osh State University and other specialized specialties and training is being conducted.
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	Reducing emissions through efficient use of energy and reduced consumption of its volumes.
Implementation opportunities: /laws, institutions, strategies, policies/	There is a support policy, strategies for the NDS 2040, and the Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040. Programme of the Government of the Kyrgyz Republic on energy saving and energy efficiency policy planning

Barriers to implementation: / lack of preferences, equipment, financial support, etc. /	Lack of funds for project implementation, as well as lack of state support for this sector.

TFS for the Waste Sector

Technology Fact Sheet # 1

Sector	**Waste**
Subsector	**4.A. Waste disposal.**
Technology name	**Use of organic waste as raw material for biogas plants**
Introduction (Short description)	Biogas contains on average 65% methane, 30% carbon dioxide, 1% hydrogen sulphide, and trace amounts of nitrogen, oxygen, hydrogen and carbon monoxide. The calorific value of biogas is 20-25 MJ/m^3, which is equivalent to the combustion of 0.6 litres of gasoline; 0.85 litres of alcohol or 1.7 kg of firewood. At Biogas Plants, after fermentation, a valuable ecological fertilizer is obtained - a fluid that increases harvest yield by 2-3 times and reduces the cost of purchasing imported mineral fertilizers. The biogas production process is divided into four stages: - preparation of source material; - waste processing (fermentation), consisting of hydrolysis, acetogenesis, acidogenesis and methanogenesis; - conversion of biogas into renewable electricity and useful heat using gas engines; - digestate post-processing.
Climate benefits	
Adaptation	When processing organic waste, effective biofertilizers are obtained. Active biological plant growth stimulators of the auxin class, which increase yield. Humic-like compounds for structuring the fertile soil layer.
Mitigation	Reducing CH4 emissions by 2025 – 43.2 Gg (CO_2-eq.) for Bishkek, 49.8 2 Gg (CO_2-eq.) for Osh city[123] Assumption: - by 2025, the volume of separately collected food waste will amount to 20% of the generated waste.
Specifications	
Performance: / comparative for modernization /	Biocomplex BSU-60 Productivity for raw materials, up to 60 tons per day Total volume of reactors, m^3 - 840 Fermentation time, days - 12 Productivity on raw materials, t/day - 60 Biogas output, m^3/day - 1200 Biogas output, m^3/h - 62.5 Quantity of biofertilizer, tons/day - 60 Power of the cogeneration plant, kW- 250 Cost, Rubles - 40 000 000 https://agrotrest.com/catalog/utilizatory_otkhodov/biogazovye_ustanovki/2468/ +7 473 205-20-97 zakaz@agrotrest.com
Resource efficiency: / for each type of energy source, consider /	Efficiency 40%
Life time:	25 years
National context	
Market potential: /sales of products, replication of technology in the field /	Demand for electricity, heat, biogas and fertilizers. Possibility of installation of small biogas plants in the field and industrial bioenergy complexes in the presence of the necessary organic waste.
Advantages:	Relatively free raw materials. Work continuously (24/7) with constant load 1 month for a complete revision of the reactor and the entire installation)

[123] NDC Reduction Estimated 2020

	Recycling. Generation of heat and electricity. Cost of Electricity - The weighted average in Europe was $0.088/kWh and the rest of the world was $0.070/kWh. Increasing soil fertility[124].
Disadvantages:	Requires constant availability of organic raw materials. Compliance with fermenting technology and correct handling of equipment under high pressure. Increased flammability. Relatively expensive cost for citizens with average incomes (small BSUs). Problem with separate collection of organic waste
Necessary institutional requirements: / state structures, service, training, etc. /	Available.
Alignment with national priorities	- National Development Strategy of the Kyrgyz Republic for 2018 - 2040; - National Development Programme of the Kyrgyz Republic until 2026; - The concept of green economy in the Kyrgyz Republic "Kyrgyzstan is a country of green economy"; - Decree of the President of the Kyrgyz Republic "On measures to ensure environmental safety and climate sustainability of the Kyrgyz Republic" dated March 19, 2021 No. 77.
Expert Opinion/Special Expert Opinion/	CH_4 emissions from waste disposal at landfills in the Kyrgyz Republic in 2020 amounted to 340.938 Gg CO_2-eq[125]. According to forecasts in 2030 the volume of food waste at landfills in Bishkek and Osh will amount to 123.6 thousand tons / year. The volume of waste from the food industry of the Kyrgyz Republic in 2030 will amount to 84 thousand tons / year[126]. There is no separate collection in the Kyrgyz Republic, MSW is collected in garbage containers at waste collection sites and goes to the landfill as a complex heterogeneous mixture. In order to use food waste as a raw material for biogas plants, it is necessary to introduce separate waste collection
Price	
Capital expenditures:	Approximate cost; 40 000 000 rubles/1 installation 750,000 USD Equipment – 597,000[127], including VAT The cost of launch work is $153,000
Operation and maintenance:	2% to 6% of total installed costs per year
Other:	Payback from 3 to 5 years
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Approximate to 15 workers The exact number of workers is established during the development of the feasibility study
Economic growth: / impact on GDP, sector development /	Contribution to the development of agriculture, saving fossil fuels. Green energy.
Number of beneficiaries:	The entire population and all sectors of the economy that use electricity and heat. Suppliers of raw materials/waste (population, enterprises) for disposal.
Health: /morbidity rates, impact/	Reduces the level of disease arising from the inability to dispose of waste.
Education: Availability of specialized training of specialists, Universities, Technical College according to the beneficiaries/	There are specialized specialties in KTU, KRSU, Osh State University, but special training in BSU is required.
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	Reducing the amount of waste placed in landfills.
Implementation opportunities: /laws, institutions, strategies, policies/	There is a support policy, strategies for the NDS 2040, and the Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040.

[124]TDT Biogas plants, Energy sector
[125]Fourth National Communication of the Kyrgyz Republic. National Greenhouse Gas Inventory. 2020
[126]NDC Reduction Estimated 2020
[127] the average exchange rate of the ruble against the dollar in 2021 amounted to 67 rubles/$

Barriers to implementation: /lack of preferences, equipment, financial support, etc./	Lack of government funding to support the use of technology. The absence of economic tariffs for electricity, heat, which would stimulate the use of technology.

Technology Fact Sheet # 2

Sector	**Waste**
Subsector	**4.A. Waste disposal**
Technology name	**Aerobic biological treatment (composting) of garden waste**
Introduction (Short description)	Composting is a biochemical process designed to convert organic solid waste into a stable, humus-like product that is primarily used to improve soil composition. There are two composting systems: a) open (burt) composting; b) closed composting. ***Open collar composting (OBC)*** represents the laying of waste in heaps, the average duration of the process of decay of organic waste is about 10-60 weeks. ***closed composting.*** In closed systems, composting takes place in sealed, i.e. better managed and optimized conditions, thus reducing the duration rotting and improve the quality of the final product. The following design options are possible: 1. Workshop composting (in flat piles) 2. Tunnel composting. 3. Horizontal rotating drums (bio drums) 4. Boxes / containers[128] Composting plants can essentially be used anywhere, but it is advantageous to build them closer to where the relevant waste is generated and where there is access to a road and transport network, which creates good opportunities for selling compost products. As with any biowaste treatment facility, a minimum distance to the nearest residential area must be maintained to prevent any potential nuisance due to odors, rodents or other unwanted predators.[129].
Climate benefits	
Adaptation	Compost is a source of organic matter that soils need to retain air, moisture, and nutrients.
Mitigation	Utilization and recycling of organic waste from various industries while freeing the territories from the disposal of organic waste, respectively, reducing CH4 emissions. Composting—the conversion of such waste into a useful soil amendment—reduces those emissions by more than 50 percent.[130]
Specifications	
Performance:	The throughput of tunnel installations is usually higher compared to container systems. Tunnel systems operate cost-effectively when processing from 3,000 tons of waste per year.[131].
Resource efficiency:	40%[132]
Life time:	15 years
National context	
Market potential:	Use as a substrate for greenhouses, artificial soil, recultivation of disturbed lands, as an insulating layer in a landfill, organic fertilizer for urban landscaping
Advantages:	- fertilizer production;

[128]Recommendations for organizing plant waste composting in the Minsk regionhttps://www.ecopartnerstvo.by/sites/default/files/publications/kompost2019_0.pdf
[129]WASTE. LOW-WASTE AND WASTE-FREE TECHNOLOGIES.
BEST PRACTICE FOR MUNICIPAL WASTE MANAGEMENT. UDC 502.174. 2018
[130]Composting. https://drawdown.org/solutions/composting
[131]Recommendations for organizing plant waste composting in the Minsk regionhttps://www.ecopartnerstvo.by/sites/default/files/publications/kompost2019_0.pdf
[132] PROBLEMS OF ENVIRONMENT AND NATURAL RESOURCES Review information, No 6 http://lamb.viniti.ru/sid2/sid2free?sid2=J17776241

	- the possibility of recycling a significant proportion of waste, which leads to a reduction in the amount of waste placed, respectively, the harmful environmental impact and the amount of costs; - relative ease of handling; - relatively low volume of investment funds.
Disadvantages:	- the need for separate collection of organic waste; - the need for space, a long process; - Unpleasant odours near the work site. - Lack of awareness in the area of dissemination of composting technology.
Necessary institutional requirements: / state structures, service, training, etc. /	Available. Organization in the Kyrgyz Republic of training centers, carrying out work to promote the development of composting in the republic.
Alignment with national priorities	- National Development Strategy of the Kyrgyz Republic for 2018 - 2040; - National Development Programme of the Kyrgyz Republic until 2026; - The concept of green economy in the Kyrgyz Republic "Kyrgyzstan is a country of green economy"; - Decree of the President of the Kyrgyz Republic "On measures to ensure environmental safety and climate sustainability of the Kyrgyz Republic" dated March 19, 2021 No. 77.
Expert Opinion/Special Expert Opinion/	In the Kyrgyz Republic, composting of garden and park waste and the organic part of MSW is carried out at the local level, at the household level. The National Statistical Committee does not keep a record of the proportion of the population that composts waste, but does keep records of households that dispose of waste by landfill. According to the National Statistical Committee, in 2020, 8.3% of the population of the Kyrgyz Republic dispose of MSW (vegetable residues) by instillation. There is no separate collection in the Kyrgyz Republic, it is collected in garbage containers at waste collection sites and goes to the landfill as a complex heterogeneous mixture. In the event that landscape gardening waste enters the total mass taken to the landfill, the extraction of this fraction “in its pure form” during sorting on the spot is practically impossible. This type of waste must be classified as separately collected waste, i.e. in containers or bags, and then export to the landfill. Despite the ban on waste incineration, leaves and plant residues are systematically burned in residential areas, which leads to air pollution. According to the results of the assessment of GHG emissions in the CNS, GHG emissions from the composting category amounted to 2.978 CO_2-eq.[133].
Price	
Capital expenditures:	Approximate cost: $157,380 (without the cost of the membrane)[134]. The cost of covering technology will increase by the cost of covering membrane and site preparation with automatic compost aeration.
Operation and maintenance:	0.40 to 0.80 Euro per ton of organic product that is composted[135]
Other:	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Composting opens up wide employment opportunities for both unskilled and skilled personnel. Preliminary 12-14 people in 1 shift (sorting), 6 - processing
Economic growth: / impact on GDP, sector development /	Contribution to the development of the "green economy".
Number of beneficiaries:	All population and housing and utilities sectors
Health: /morbidity rates, impact/	Safety Compliance
Education:	Requires organization of training. Informing the population on an ongoing basis, to encourage people to compost in household plots.

[133]Fourth National Communication of the Kyrgyz Republic. National Greenhouse Gas Inventory. 2020
[134]Eurasian Association "Ecology of Society" https://ecosotsiuma.ru/kompleksnye-resheniya-po-tko
Business plan http://sovmopk.ru/doc/mater_09042021_5.pdf
[135]Composting equipment https://finpro.group/scolari/kompost-mashiny

Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	Reducing the amount of waste taken to the landfill. The product obtained during the composting process can be used as a material for filling the MSW landfill, as soil for landscaping.
Implementation options:	Availability of raw materials and broad prospects for the use of final products.
Barriers to implementation:	- the absence in the legislation of a unified approach to the technological operations of the composting process and, as a result, uncertainty in the qualification of composting as a type of activity in the field of MSW management; - poorly developed initiative of the population to implement separate collection of solid waste; - lack of incentives for the introduction of separate collection of solid waste; - lack of rules for implementation by consumers; separate accumulation of MSW and organized sites with containers for separate collection.

Technology Fact Sheet # 3

Sector	**Waste**
Subsector	**4. A. Landfill waste**
Technology name	**Vermiculture**
Introduction (Short description)	Vermitechnology refers to biological methods of organic waste processing (bioconversion). The attractiveness of this method lies in its biological basis, which excludes the danger of environmental pollution. Vermiculture is the cultivation of worms in an organic substrate in order to obtain a high quality organic fertilizer (vermicompost). Usually earthworms are used. Especially high processing activity is characterized by the "California hybrid of the red worm" (hereinafter referred to as CRW). When feeding organic waste (primarily manure) with CRW, the so-called biohumus (manure processed by worms) is obtained with a higher (6-10 times) content of nutrients than in manure, and CRW biomass, which is used for fattening poultry and breeding fish. The biomass of CRW contains 55-70% protein and more than 10% fat[136]. The process of processing the substrate is possible both year-round in heated rooms with maintaining the optimum temperature of the substrate at about 20 ° C, and in the open air, when the ambient temperature allows the worms to be active. In the small-scale production of vermicompost, the most common container technology for placing worms is relatively labor-intensive. For larger production, however, it has proved to be optimal to place the substrate in piles, when the worm population is populated at one end of the pile and, as it consumes nutrients in the substrate, migrates to the other, leaving behind the produced biohumus, which significantly reduces the cost of manual labor, allowing you to effectively serve 300 –500 m^2 of usable substrate area by one handyman[137]. **Suggested technology:** **- Trench technology for the use of CRW at the landfill / landfill**. Trench technology, includes the formation of a trench in the upper layer of the landfill / landfill, its filling with food and organic waste, covering with a film and introducing an adapted CRW culture into the substrate[138]. The order of work is as follows:

[136]Vermiculture and vermicomposthttp://www.cnshb.ru/news/vex_vermi.shtm

[137]VERMICULTURE AS A BASIS FOR THE DEVELOPMENT OF THE GREEN ECONOMY OF RURAL TERRITORIES https://fundamental-research.ru/ru/article/view?id=42561

[138]The implementation of this project by ILIN LLP has shown its viability in Kazakhstan, the possibility of processing organic waste at the lowest economic cost, reducing the burden on the environment, extending the life of solid waste landfills, and accelerating the process of returning fertile lands to circulation.https://csd-center.kz/baza-znaniy/opyt-pererabotki-organicheskih-othodov-v-respublike-kazahstan-s-pomosc.html?lang=kk

	• An excavator prepares a trench 2 metres deep, 2 metres wide and 2 metres long, for equipping a CRW breeding incubator. • The bottom of the incubator is lined with straw and foliage to a depth of 0.5 metres. • On the resulting litter, the CRW breeding stock is deposited and the rest is filled with organic waste. • Within a month, according to the schedule, the waste is moistened, pierced, loosened in the incubator with the addition of a new layer of waste. • After a month, a batch of CRW is deposited directly into the working trench, where the waste to be processed is located. To do this, the waste received at the landfill, after sorting, is unloaded to the working site in front of the trench and crushed. • Then part of the waste collides to the bottom of the trench and is leveled. • CRW withdrawn from the hatchery is moved to the working trench and covered with insulating soil. • The trench remains operational until May next year. Next year, a larger trench is being developed, as the population of California worm individuals will increase by an order of magnitude. The substrate is prepared and the new trench is filled with the previously mentioned method. The transition from one trench to another by the California worm will occur on its own. - Container technology for placing worms (for part-time farms) • Preparation of boxes and soil. Agrofibre is laid out at the bottom with the breathing side out, for air to enter. Humus is poured inside, filling the box by 1/2 part. • Move. Worms are placed on the surface of the finished soil in boxes, after which they are sprinkled with a small layer of loose earth or the same humus. • Breeding of worms. The optimum temperature is from +20 °C to +25 °C. Soil moisture should be 70-80%. Soil acidity at 6.9 pH. The soil must be constantly moistened with water and the soil must be pierced with a fork with rounded ends for oxygen to enter. • Transfer. Every 2-3 months, part of the worms are transplanted into empty boxes, adding a new layer of humus and food to each box. If vermicompost is produced, the worms are removed 3-4 months after their full reproduction and processing of humus into vermicompost.
Climate benefits	
Adaptation	The production of high-humus organic fertilizers and humic preparations and their use in agriculture will help to switch to organic farming.
Mitigation	Utilization and recycling of organic waste from various industries (see Note) while freeing the territories from the disposal of organic waste, respectively, reducing CH4 emissions. Mitigating GHGs emissions during vermicomposting - 16,5 % decrease in CO_2 emission[139].
Specifications	
Performance:	A working population with a total weight of 100-150 kg is able to dispose of 2-3 tons of waste in an extremely short time. The process of processing 1 ton of substrate with a yield of up to 600 kg of biohumus and exponential reproduction of the population takes, depending on the strength of a number of factors favourable for the life of worms, an average of 30 to 60 days[140].
Resource efficiency:	60% (https://ecoportal.su/public/other/view/1007.html)

[139] Review Impact of Vermicomposting on Greenhouse Gas Emission: A Short Review
[140]Vermiculture as a basis for the development of the Green Economy in rural areas. Basic research. ISSN 1812-7339 https://fundamental-research.ru/ru/article/view?id=42561

Life time:	Under optimal conditions, one individual can produce an average of 1,500 individuals per year.[141]. The service life depends on the conditions of detention.
National context	
Market potential	With 2-3 tons of waste, it allows to obtain 1.5-2 tons of high-quality biohumus, the cost of which varies from 1 to 2 dollars per kilogram and 40-50 kg of worm biomass.
Advantages	Relatively free raw materials. Work continuously and constantly. Processing of organic waste in vermiburts: low capital costs, simple operation. Recycling of organic waste in containers: Relatively small spaces are required.
Disadvantages:	Processing of organic waste in vermiburt: intensive manual labor, large areas required, slow waste processing. Processing of organic waste in containers: significant costs for containers and handling equipment, difficulty in maintaining moisture by spraying, intensive manual labor. A constant supply of raw materials (organic waste) is required.
Necessary institutional requirements	Organization of training centers in the Kyrgyz Republic, carrying out work to promote the development of vermiculture, supply of technological earthworms to create a breeding stock in the republic.
Alignment with national priorities	- The concept of green economy in the Kyrgyz Republic "Kyrgyzstan is a country of green economy".
Expert opinion	CH_4 emissions from waste disposal at landfills in the Kyrgyz Republic in 2020 amounted to 340.938 Gg CO^2-eq. There is no separate collection in the Kyrgyz Republic and is carried out within the framework of individual projects at the level of districts or residential complexes. MSW is collected in garbage containers, at waste collection sites and delivered to the landfill as a complex heterogeneous mixture. One of the effective ways to dispose of the organic waste that prevails in MSW is the use of vermiculture, which means breeding earthworms on special farms. Note: The red California worm is able to process all types of organics. Organic waste suitable for processing by vermiculture: farm, cattle manure, pig manure, horse manure, bird droppings, rabbit, goat and sheep droppings, vegetable waste, industrial and municipal waste, brewer's grains, vegetable and fruit waste, food waste, sewage sludge , leaves and grass, paper and cardboard, organic part of MSW.
Price	
Capital expenditures:	For a subsidiary farm, approximately: Room area 120 m2 launch14776.12$[142]. For a landfill/landfill, indicative: Cost of a tractor for digging a trench in the top layer of a landfill (landfill equipment) Acquisition of breeding stock, approximate cost 430$6
Operation and maintenance:	Pre-average maintenance 30%, cf. $/ton
Other:	Efficiency 60%[143]
Contribution to development, additional benefits	
Payback	3 years
Workplaces	10 people
The economic growth	Contribution to the development of the "green economy".
Number of beneficiaries:	Solid waste landfills, subsidiary farms.
Health:	Compliance with labour safety measures
Education:	Requires organization of training.

[142]Prices for 2020https://zarabatyvayemsami.ru/razvedeniye-chervey-biznes/#punkt9
[143]https://csd-center.kz/baza-znaniy/opyt-pererabotki-organicheskih-othodov-v-respublike-kazahstan-s-pomosc.html?lang=kk

Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	In the subsidiary farm: utilization and recycling of organic waste from various industries, respectively, reducing the amount of exported waste. At the landfill for solid domestic waste: reduction of the volume of municipal solid waste received, as well as the restoration of contaminated land and their return to circulation.
Implementation options	Low capital intensity of vermicompost production, availability of raw materials and broad prospects for marketing the production of final products.
Barriers to implementation	Lack of finance from the government to support the use of technology, the allocation of territory.

Technology Fact Sheet # 4

Sector	**Waste**
Subsector	**4. D. Waste water**
Technology name	**Use of organic waste as waste water for biogas plants**
Introduction (Short description)	The biogas complex produces biogas from primary sludge and excess activated sludge generated during the treatment of wastewater from urban wastewater treatment plants, as well as from imported organic material using anaerobic, mesophilic digestion technology. Biogas contains on average 65% methane, 30% carbon dioxide, 1% hydrogen sulphide, and trace amounts of nitrogen, oxygen, hydrogen and carbon monoxide. The calorific value of biogas is 20-25 MJ/m^3, which is equivalent to the combustion of 0.6 litres of gasoline; 0.85 litres of alcohol or 1.7 kg of firewood. At the BSU, after fermentation, a valuable ecological fertilizer is obtained - a fluid that increases the yield by 2-3 times and reduces the cost of purchasing imported mineral fertilizers. The biogas production process is divided into four stages: - preparation of source material; - waste processing (fermentation), consisting of hydrolysis, acetogenesis, acidogenesis and methanogenesis; - conversion of biogas into renewable electricity and useful heat using gas engines; - digestate post-processing.
Climate benefits	
Adaptation	When processing organic waste, effective biofertilizers are obtained. Active biological plant growth stimulators of the auxin class, which increase yield. Humic compounds for structuring the fertile soil layer.
Mitigation	The estimate of GHG emission reduction was made for Bishkek and Osh by 2025 - 42.397 Gg (CO_2-eq.) 29.0 Gg (CO_2-eq.) - Bishkek, 13.4 Gg (CO_2-eq.) - Osh city[144]
Specifications	
Performance	Biocomplex BGU-30 Productivity for raw materials, up to 30 tons per day Total volume of reactors, m^3 - 420 Fermentation time, days - 12 Productivity on raw materials, t./days. T- 30hirty Biogas output, m^3/day - 600 Biogas output, m^3/hour - 25 Quantity of biofertilizer, tons/day - 30 Power of the cogeneration plant, kWh - 10030,000,000 rubles / piece https://agrotrest.com/catalog/utilizatory_otkhodov/biogazovye_ustanovki/2468/ +7 473 205-20-97 zakaz@agrotrest.com
resource efficiency	Electrical efficiency 40%
Life time:	25 years

[144]NDC Reduction Estimated 2020

National context	
Market potential	Demand for electricity, heat, biogas and fertilizers. The heat generated by Biocomplex BGU-30 can be used directly inside the technological process to maintain optimal parameters of its flow, as well as heating technological premises and nearby buildings and structures of the enterprise.
Advantages	Relatively free raw materials. Work continuously and constantly. Recycling. Generation of heat and electricity. Cost of Electricity - The weighted average in Europe was $0.088/kWh and the rest of the world was $0.070/kWh. Increasing soil fertility[145].
Disadvantages:	Requires constant availability of organic raw materials. Compliance with fermenting technology and correct handling of equipment under ~~high~~ pressure. Increased flammability.
Necessary institutional requirements: / state structures, service, training, etc. /	Available.
Alignment with national priorities	- National Development Strategy of the Kyrgyz Republic for 2018 - 2040; - National Development Programme of the Kyrgyz Republic until 2026; - The concept of green economy in the Kyrgyz Republic "Kyrgyzstan is a country of green economy"; - Decree of the President of the Kyrgyz Republic "On measures to ensure environmental safety and climate sustainability of the Kyrgyz Republic" dated March 19, 2021 No. 77.
Expert Opinion/Special Expert Opinion/	CH4 emissions from wastewater in the Kyrgyz Republic in 2020 amounted to 236.118 Gg CO_2-eq[146] Currently, the Kyrgyz Republic does not use primary sludge and excess sludge as a raw material for biogas plants.
Cost	
Capital expenditures:	Approximate cost: Equipment –448149.0$
Operation and maintenance:	From 2% to 6% of the total installed costs per year. (Adopted according to TFS#6 sector Energy)
Other:	Payback from 3 to 5 years
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Preliminary 15 people
Economic growth: / impact on GDP, sector development /	Contribution to the development of agriculture, saving fossil fuels. Green energy.
Number of beneficiaries:	The entire population and all sectors of the economy that use electricity and heat. Suppliers of raw materials/waste (population, enterprises) for disposal.
Health: /morbidity rates, impact/	Reduces the level of disease arising from the inability to dispose of waste.
Education:/ Availability of training of specialized specialists, universities, technical lyceums according to the beneficiaries/	There are specialized specialties in KTU, KRSU, Osh State University, but special training in BSU is required.
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	Reducing the amount of waste placed in landfills. Reducing air emissions by saving fossil fuels used to generate electricity.
Implementation options	Has a support policy NDS 2040 strategy, Law on Investments. Strategy for the development of the fuel and energy complex until 2025. Draft Concept for the development of the fuel and energy complex until 2030 and until 2040.

[145]TOT Biogas plants, Energy sector
[146]Fourth National Communication of the Kyrgyz Republic. National Greenhouse Gas Inventory. 2020

Barriers to implementation	Lack of government funding to support the use of technology. The absence of economic tariffs for electricity, heat, which would stimulate the use of technology.

Technology Fact Sheet # 5

Sector	**Waste**
Subsector	**4.A. Waste disposal**
Technology name	**Waste paper recycling**
Introduction (Short description)	Waste paper recycling is the extraction of waste paper products and processing them into new products. The paper recycling process includes collecting waste paper, sorting it into categories, shredding waste paper, which is returned to the paper making process. The point of paper recycling is to extract valuable raw materials and recycle them to create new paper. **Suggested technology:** waste paper recycling by using a cardboard machine. Cardboard machines are designed for the production of the following products from waste paper: 1. Cardboard with a density of 90 to 160 g/m^2 Most often, this type of cardboard is used for the production of corrugated cardboard (material for the manufacture of cardboard boxes), paper bags, bags, etc.; 2. Wrapping, packaging paper of all types, including food, with a density of 90 to 160 g/m^2; 3. Can be used for other purposes as paper stock with a density of 90 to 160 g/m2. Raw materials: waste paper grades MS - 6 (old corrugated cardboard or scraps) and MS-7 (mixed cardboard). Other waste paper is also allowed in the composition. Cardboard machine for the production of cardboard from waste paper is a set of technological equipment: 1. Equipment for the preparation of paper pulp; 2. Paper machine[147].
Climate benefits	
Adaptation	
Mitigation	- reduction of waste placed in landfills.
Specifications	
Performance:	From 2 to 10 tons/day, depending on the amount of processed raw materials. For the assessment, the brand of equipment KDM-1400 / 7BAR up to 6 tons / day was accepted[148]
resource efficiency	Efficiency 70%
Life time:	15 years
National context	
Market potential: /sales of products, replication of technology in the field /	Production products: polymers of all kinds, polymer-sand products, PET bottles, containers, packaging, pressed textiles, compost.
Advantages:	- reducing the amount of waste
Disadvantages:	- Mandatory presence of sewer communications (industrial sewerage, a reservoir for discharge industrial wastewater, septic tank - optional)
Necessary institutional requirements: / state structures, service, training, etc. /	Available.
Alignment with national priorities	- National Development Strategy of the Kyrgyz Republic for 2018 - 2040; - National Development Programme of the Kyrgyz Republic until 2026;

[147] Equipment for the production of toilet paper, paper towels and napkins from the finished base and waste paper, as well as equipment for the production of cardboard from waste paper http://www.bumzav.ru/catalog/carton

[148] Equipment for the production of toilet paper, paper towels and napkins from the finished base and waste paper, as well as equipment for the production of cardboard from waste paper http://www.bumzav.ru/catalog/carton

	- The concept of green economy in the Kyrgyz Republic "Kyrgyzstan is a country of green economy"; - Decree of the President of the Kyrgyz Republic "On measures to ensure environmental safety and climate sustainability of the Kyrgyz Republic" dated March 19, 2021 No. 77.
Expert Opinion/Special Expert Opinion/	CH4 emissions from waste disposal at landfills in the Kyrgyz Republic in 2020 amounted to 340.938 Gg CO_2-eq[149]. According to the forecast, the amount of paper placed at the landfill in Bishkek will be 39.12 thousand tons by 2025 (with Paper -11.3% in the morphological composition of MSW[150])
Price	
Capital expenditures:	Approximate cost of equipment $ 196,613
Operation and maintenance:	Operating and maintenance costs. 6.79$ \ton
Other:	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Preliminary 10 people
Economic growth: / impact on GDP, sector development /	Contribution to the development of the "green economy". Profit from the sale of secondary raw materials.
Number of beneficiaries:	Population
Health:	Compliance with safety measures and MSW technology
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Requires awareness rising campaigns of a wider public, including educational institutions.
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	Reducing the amount of waste taken to the landfill.
Implementation opportunities: /laws, institutions, strategies, policies/	Availability of raw materials and broad prospects for the use of final products.
Barriers to implementation: /lack of preferences, equipment, financial support, etc./	- high investment costs; - lack of sufficient financial support from the government; - lack of separate collection of MSW, in connection with which MSW waste is delivered to the landfill in the form of a complex heterogeneous mixture, which greatly complicates the process of sorting and extracting the useful fraction.

Technology Fact Sheet # 6

Sector	**Waste**
Subsector	**4.A. Waste disposal**
Technology name	**Mechanical and biological treatment of MSW**
Introduction (Short description)	A mechanical biological treatment (MBT) system is a waste treatment plant that combines a waste sorting plant with biological treatment methods such as anaerobic digestion and/or composting. MBT plants are designed for the processing of mixed municipal waste, as well as commercial and industrial waste. Thus, MBT is not a single technology, since it combines a wide range of processing methods and operations (mechanical and biological), dictated by the market needs for final products. The products of mechanical-biological treatment technology are: • Recyclable materials such as metals, paper, plastics, glass, etc. • Unusable materials (inert materials) are safely disposed of in a sanitary landfill • Compost MBT systems can become an integral part of the waste management infrastructure in the region.

[149]Fourth National Communication of the Kyrgyz Republic. National Greenhouse Gas Inventory. 2020
[150]IPCC Guidelines, 2006. Chapter 2, Table 2.3., p. 2.13

	Proposed Technology: Waste Recycling Plant, which includes both mechanical and biological (aerobic) processing: - receiving and sorting complex; - VMP deep processing complex; - composting complex[151].
Climate benefits	
Adaptation	The resulting compost is a source of organic matter that soils need to retain air, moisture and nutrients.
Mitigation	Reducing the amount of waste placed in landfills, respectively, GHG emissions. This technology will reduce up to 49.71 Gg CO_2/year
Specifications	
Performance: / comparative for modernization /	▪ Sorting plant with three sorting lines of 330 tons/day each; ▪ Work in two shifts per day (40-50 people); ▪ Receipt of recyclables - 280 tons / day; ▪ Output up to 140 tons/day; ▪ Composting of organic waste (500 tons/day). In general, thanks to the composting process, the amount of waste can be reduced by 40%.
Resource efficiency: / for each type of energy source, consider /	Annual income (with 50% of extracted SMR from 100% of all VMR)[152]
Life time:	Average service life 50 years
National context	
Market potential: /sales of products, replication of technology in the field /	Production products: polymers of all kinds, polymer-sand products, PET bottles, containers, packaging, pressed textiles, compost
Advantages:	- reducing the volume and reactivity of waste that must be sent to landfills, and thus waste space, gas emissions, leachate discharge and unpleasant odors at the landfill - combining special types of processing and disposal of materials and obtaining different fractions of materials for further use.
Disadvantages:	- need for space, preliminary 1/1-1.5/ /2-2.5/ Ha
Necessary institutional requirements: / state structures, service, training, etc. /	Available
Alignment with national priorities	- National Development Strategy of the Kyrgyz Republic for 2018 - 2040; - National Development Programme of the Kyrgyz Republic until 2026; - The concept of green economy in the Kyrgyz Republic "Kyrgyzstan is a country of green economy"; - Decree of the President of the Kyrgyz Republic "On measures to ensure environmental safety and climate sustainability of the Kyrgyz Republic" dated March 19, 2021 No. 77.
Expert Opinion/Special Expert Opinion/	CH4 emissions from waste disposal at landfills in the Kyrgyz Republic in 2020 amounted to 340.938 Gg CO_2-eq[153].
Costs	
Capital expenditures:	According to EBRD consultants, the estimated cost of the plant is $11.9 million. Of these, US$6.6 million can be financed through EBRD grant funds. An additional USD 5.3 million is required for the successful implementation of the project.
Operation and maintenance:	30% of the cost
Other:	

[151]Eurasian Association "Ecology of Society" https://ecosotsiuma.ru/kompleksnye-resheniya-po-tko
Business plan http://sovmopk.ru/doc/mater_09042021_5.pdf

[152]Eurasian Association "Ecology of Society" https://ecosotsiuma.ru/kompleksnye-resheniya-po-tko
Business plan http://sovmopk.ru/doc/mater_09042021_5.pdf

[153]Fourth National Communication of the Kyrgyz Republic. National Greenhouse Gas Inventory. 2020

Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Preliminary: 65 people (two shifts per day)
Economic growth: / impact on GDP, sector development /	Contribution to the development of the "green economy". Uninterrupted supply of processing enterprises with raw materials; Profit from the sale of secondary raw materials.
Number of beneficiaries:	1,074,070 people (residents of Bishkek city)
Health:	In the processing chain, an increased risk of air pollution by microorganisms and spores should be expected, especially when the process is carried out without sealing. Technical protective measures and personal protection measures (use of face masks) at exposed locations are strongly recommended to prevent potential health risks.
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Requires organization of training.
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	Reducing the amount of waste taken to the landfill.
Implementation opportunities: /laws, institutions, strategies, policies/	Availability of raw materials and broad prospects for the use of final products.
Barriers to implementation: /lack of preferences, equipment, financial support, etc./	- high investment costs; - lack of sufficient financial support from the government; - lack of separate collection of MSW, in connection with which MSW waste is delivered to the landfill in the form of a complex heterogeneous mixture, which greatly complicates the process of sorting and extracting the useful fraction.

Technology Fact Sheet # 7

Sector	**Waste**
Subsector	**Solid waste disposal**
Technology name	**Waste sorting point in the city of Bishkek**
Introduction (Short description)	One of the most important stages in the reduction of solid household waste is the organization of separate collection of household waste and recycling. Organization process is implemented by concluding agreements with processors or buyers of separated waste for recycling. Also, the process of transportation and acceptance of solid waste is carried out by the buyer of the separated waste. Currently, 80 enterprises are engaged in waste processing in Bishkek (wastnet.kg). Waste is sorted into different tanks, depending on what type of raw material is indicated on it. 
Climate benefits	
Mitigation	Reduction of GHG emissions
Specifications	

<table>
<tr><td>Performance:</td><td>Number of sorting points in Bishkek: 200 points
Number of garbage containers: 1600 pcs.
Number of employees (sorter): 230 people

<table>
<tr><td>Total MSW</td><td>342 000</td><td>tons/year</td></tr>
<tr><td>Paper, cardboard (11%)</td><td></td><td>37 620</td></tr>
<tr><td>Plastic (bottles, bags, films, etc.) 8%</td><td></td><td>27 360</td></tr>
<tr><td>Metal waste (1%)</td><td></td><td>3420</td></tr>
<tr><td>Glass (8%)</td><td></td><td>27 360</td></tr>
<tr><td>Total: 28%</td><td></td><td>95 760</td></tr>
</table>

By recycling MSW, the annual amount of MSW entering the Bishkek sanitary landfill can be reduced by 28%.</td></tr>
<tr><td>Resource efficiency:</td><td>51%</td></tr>
<tr><td>Life time:</td><td>Building: 10-25 years;
Stainless steel container from 10 to 25 years, average 15.</td></tr>
<tr><td colspan="2">National context</td></tr>
<tr><td>Market potential:</td><td>1.05 thousand $ / sorted tons</td></tr>
<tr><td>Advantages:</td><td>The organization of separate collection of solid waste leads to:
- organization of new enterprises;
- the emergence of new jobs;
- reducing the area of landfills;
- improvement of the ecological situation;
- low cost
- natural resources are preserved.</td></tr>
<tr><td>Disadvantages:</td><td>-One of the disadvantages is the need to allocate more land for container sites than today. Taking into account the need to build a room for a sorter and a sector for collection and sorting, i.e. the need for more territory for each container site.</td></tr>
<tr><td>Necessary institutional requirements</td><td>In the process of organizing waste recycling, one of the important tasks is the formation of an appropriate culture. Without a conscious culture of sorting household waste among the population, it will be difficult to achieve the intended goal simply by installing containers for separate waste collection.</td></tr>
<tr><td>Alignment with national priorities</td><td>Currently, waste recycling is widely practiced in a number of countries around the world. Our country also pursues a consistent policy in the field of environmental protection, rational use of natural resources, as well as improving the sanitary and ecological condition of the regions.</td></tr>
<tr><td>Expert opinion</td><td>Area of the Bishkek sanitary landfill: 44.6 ha. as of 2012:
Total population: 1,027,000 people
Total daily amount of waste dumped in landfill: 936 tons
Annual volume of incoming waste in the service and collection area (retrospective):
• MSW volume per year: 729,600 m³
• Quantity of MSW per year: 342,000 tons
• Morphological composition of incoming waste
<table>
<tr><th>Component name</th><th>% content</th></tr>
<tr><td>Food and organic waste</td><td>49%</td></tr>
<tr><td>Garden and park waste1</td><td>-</td></tr>
<tr><td>Paper, cardboard</td><td>11%</td></tr>
<tr><td>Wood1</td><td>-</td></tr>
<tr><td>Textiles (rags)</td><td>1%</td></tr>
<tr><td>Rubber and leather1</td><td>-</td></tr>
<tr><td>Plastic (bottles, bags, films, etc.)</td><td>8%</td></tr>
<tr><td>Metal waste</td><td>1%</td></tr>
<tr><td>Glass</td><td>8%</td></tr>
<tr><td>Other types of waste (including landscaping waste, wood, rubber and leather)</td><td>22%</td></tr>
<tr><td>Total</td><td>100</td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td>The estimated (design) capacity of the new sanitary landfill under construction is 3,200,000 tons with the estimated generation of MSW in the amount of 330,000 tons / year.
The total amount of accumulated waste is approximately 27 million cubic meters. m.</td></tr>
<tr><td colspan="2">Costs</td></tr>
<tr><td>Capital expenditures:</td><td>On average, one waste sorting station requires 8 containers
<table>
<tr><td>Name</td><td>Cost per pip in US dollars</td><td>Cost per 200 pips in US dollars</td><td>Manufacturer</td></tr>
<tr><td>building construction</td><td>9 655</td><td>1,931,000</td><td>Kyrgyzstan</td></tr>
<tr><td>Container
770 lit.</td><td>2192
(1 cont = 274)</td><td>438 400</td><td>Turkey</td></tr>
<tr><td>Total</td><td>11 846</td><td>2,369,400</td><td></td></tr>
</table>



</td></tr>
<tr><td>Operation and maintenance:</td><td>~~Included in the price~~ av. 0,025 $ \ton</td></tr>
<tr><td>Other:</td><td></td></tr>
<tr><td colspan="2">Contribution to development, additional benefits</td></tr>
<tr><td>Increase in income</td><td>According to unofficial data, the profit from sorted waste is 27,000 soms per month.
Approximate cost of selling types of MSW KGS/year:
<table>
<tr><td>Paper, cardboard (1kg=12.4 soms)</td><td>466 488</td></tr>
<tr><td>Plastic (bottles, bags, films, etc.) (1kg=28.4 soms)</td><td>782 496</td></tr>
<tr><td>Metal waste (1kg=24 soms)</td><td>82 080</td></tr>
</table></td></tr>
<tr><td>Workplaces</td><td>Previously 230</td></tr>
<tr><td>The economic growth</td><td>A well-designed procedure for recycling materials helps to significantly reduce the cost of producing new products. This saves time, labor and raw materials.</td></tr>
<tr><td>Number of beneficiaries:</td><td>All population, Bishkek city administration, Tazalyk municipality, Waste processing plants</td></tr>
<tr><td>Health</td><td>Safety Compliance</td></tr>
</table>

Education	It is necessary to increase the literacy of the population, the level of self-awareness of citizens and inform the population about the benefits of separate waste collection.
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	Reducing the amount of waste taken to the landfill.
Implementation options	Availability of raw materials and broad prospects for the use of final products.
Barriers to implementation	- high investment costs; - lack of sufficient financial support from the government; - low awareness of the population about the types of waste and, as a result, the inability to properly sort waste;

Technology Fact Sheet # 8

Sector	**Waste**
Subsector	**4.A. Waste disposal**
Technology name	**Sorting of solid waste at a sorting line located at city dumps**
Introduction (Short description)	The volume of waste placed at landfills in large cities in 2020 amounted to 326.14 thousand tons in Bishkek and 415.09 thousand tons in Osh. Regular observations of the morphological composition in the republic are not conducted. There is no laboratory service at MSW landfills, as a result of which the control of the fractional, morphological and chemical composition of waste entering the landfill is not carried out. According to the morphological composition, the largest volume of MSW is food waste 40.96%, followed by paper - 11.48%, wood - 8.03%, plastic - 6.4%, glass - 3.56%, ferrous metal - 3.86 %, leather / rubber - 0.81 and others -22.26%[154]. There is no separate collection in the Kyrgyz Republic and is carried out within the framework of individual projects at the level of districts or residential complexes. MSW is collected in waste containers at waste collection sites and delivered to the landfill as a complex heterogeneous mixture. Integrated solution for small towns waste sorting complex for a city, region with a population of 50,000 people with an annual processing capacity of 10,000 tons of municipal solid waste per year with one-shift work (8 hours). Purpose of the complex 1. Mixed, separate collection and transportation of municipal solid waste (MSW). 2. Conveyor-controlled sorting of waste and recycling of secondary resources (secondary polymers, PET, waste paper, textiles, scrap metal, glass). 3. Production based on SMR (secondary material resources) of building materials, products from secondary polymers, structural products, industrial and technical products for housing and communal services, road and capital construction[155].
Climate benefits	
Mitigation	- reduction in the placement of organic waste (paper, wood, textiles, food waste
Specifications	
Performance: / comparative for modernization /	Sorting, industrial processing and disposal of waste - 20,000 tons when working 8 hours a day, for a city with a population of 100,000
Resource efficiency: / for each type of energy source, consider /	Efficiency 90 50% of which are sorted and processed useful fractions taking into account deep processing and 40% of organic waste sent for composting
Life time:	25
National context	
Market potential: /sales of products, replication of technology in the field /	Production products: polymers of all kinds, polymer-sand products, PET bottles, containers, packaging, pressed textiles2.
Advantages:	Integrated solution for solid waste management;

[154] INDC project, 2021
[155]Eurasian Association "Ecology of Society" https://ecosotsiuma.ru/
MPZ business planhttp://sovmopk.ru/doc/mater_09042021_5.pdf

	- reducing the amount of waste placed
Disadvantages:	- the need for space, previously 1 ha;
Necessary institutional requirements: / state structures, service, training, etc. /	Available.
Alignment with national priorities	- National Development Strategy of the Kyrgyz Republic for 2018 - 2040; - National Development Programme of the Kyrgyz Republic until 2026; - The concept of green economy in the Kyrgyz Republic "Kyrgyzstan is a country of green economy"; - Decree of the President of the Kyrgyz Republic "On measures to ensure environmental safety and climate sustainability of the Kyrgyz Republic" dated March 19, 2021 No. 77.
Expert Opinion/Special Expert Opinion/	CH4 emissions from waste disposal at landfills in the Kyrgyz Republic in 2020 amounted to 340.938 Gg CO_2-eq[156].
Costs	
Capital expenditures:	The approximate cost of the complex is 394480 $
Operation and maintenance:	cf.5,9 $ \ton
Other:	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Preliminary 50 people in 2 shifts
Economic growth: / impact on GDP, sector development /	Contribution to the development of the "green economy". Uninterrupted supply of processing enterprises with raw materials; Profit from the sale of secondary raw materials.
Number of beneficiaries:	Population, housing and communal services sectors,-the village council
Health:	Compliance with measures and safety precautions
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Requires organization of training.
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	Reducing the amount of waste taken to the landfill.
Implementation opportunities: /laws, institutions, strategies, policies/	Availability of raw materials and broad prospects for the use of final products.
Barriers to implementation: /lack of preferences, equipment, financial support, etc./	- high investment costs; - lack of sufficient financial support from the government; - lack of separate collection of MSW, in connection with which MSW waste is delivered to the landfill in the form of a complex heterogeneous mixture, which greatly complicates the process of sorting and extracting the useful fraction.

Technology Fact Sheet # 9

Sector	**Waste**
Subsector	**4.A. Waste disposal**
Technology name	Modern technologies landfill site
Introduction (Short description)	Construction of a modern, high-tech waste sorting complex, a landfill with a composting site At the landfill, it is planned to accept solid municipal and similar waste for disposal after the separation of useful components from them and transfer for disposal. The production area of the Facility is divided into:

[156]Fourth National Communication of the Kyrgyz Republic. National Greenhouse Gas Inventory. 2020

− waste sorting complex building

Fig.1. General view of manual sorting

− site for crushing bulky waste (LWB);

Fig.2. crushing plant

After acceptance, weighing and control, waste suitable for sorting enters the site in front of the building of the waste sorting complex, where it is distributed into streams at the unloading site:

− up to 10% of large-sized organic waste (LGO) is sent to the crushing site, and then to the landfill for biocomposting;

− up to 90% of the waste goes to the production building for the reception and sorting of municipal solid waste of the waste sorting complex.

When sorting MSW at MSC, the following fractions are subject to selection:

one) For reuse (secondary material resources):

− scrap of ferrous metals;
− cardboard, paper;
− plastic, polymer film;
− PET bottles (separated by color);
− aluminum cans;
− glass;
− other useful fractions.

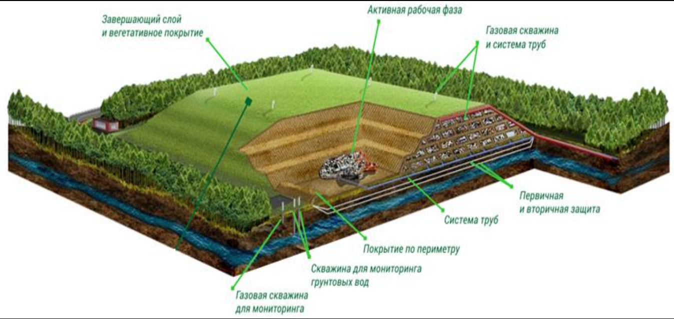
2) On the biocomposting for soil preparation:

− organic waste, incl. woody (KGO);

After extracting up to 7% of inorganic secondary resources, “tails” are formed at the MSC site - sorting residues, which are mainly organic waste with an admixture of inorganic inclusions. Up to 45% of the selected organic waste suitable for biocomposting is moved by on-site transport to the site for preparing soil for biocomposting.

Thus, after the extraction of useful fractions (inorganic secondary resources) and organic waste suitable for biocomposting, inorganic municipal solid waste is delivered to the landfill.

Pic. 1. Waste disposal area

	
Climate benefits	
Adaptation	The resulting compost is a source of organic matter that soils need to retain air, moisture and nutrients.
Mitigation	Reducing the amount of waste placed in landfills, respectively, GHG emissions.
Specifications	
Performance: / comparative for modernization /	The design capacity of the waste sorting facility under construction, technologically linked to the waste disposal site, is at least 158.9 thousand tons / year.
Resource efficiency: / for each type of energy source, consider /	efficiency 90%
Life time:	Estimated service life is 18 years.
National context	
Market potential: /sales of products, replication of technology in the field /	Production products: polymers of all kinds, polymer-sand products, PET bottles, containers, packaging, pressed textiles, compost2.
Advantages:	- reducing the volume of waste disposal, subject to possible reuse by increasing the share of selection of useful fractions and sending them for recycling; - ensuring sustainable development of waste management infrastructure; - introduction of modern efficient technologies in the field of processing and disposal of municipal solid waste; - creation of new jobs; - emergence of new sources of replenishment of budgets of all levels.
Disadvantages:	- need for space
Necessary institutional requirements: / state structures, service, training, etc. /	Available.
Alignment with national priorities	- National Development Strategy of the Kyrgyz Republic for 2018 - 2040; - National Development Programme of the Kyrgyz Republic until 2026; - The concept of green economy in the Kyrgyz Republic "Kyrgyzstan is a country of green economy"; - Decree of the President of the Kyrgyz Republic "On measures to ensure environmental safety and climate sustainability of the Kyrgyz Republic" dated March 19, 2021 No. 77.
Expert Opinion/Special Expert Opinion/	CH_4 emissions from waste disposal at landfills in the Kyrgyz Republic in 2020 amounted to 340.938 Gg CO_2-eq[157].
Price	
Capital expenditures:	$7.38 million
Operation and maintenance:	Operating and maintenance costs avg.14 $ \ton
Other:	
Contribution to development, additional benefits	
Workplaces: / per installation at all stages of implementation /	Preliminary: 60 people
Economic growth: / impact on GDP, sector development /	Contribution to the development of the "green economy". Uninterrupted supply of processing enterprises with raw materials; Profit from the sale of secondary raw materials.
Number of beneficiaries:	The population, processing companies.

[157]Fourth National Communication of the Kyrgyz Republic. National Greenhouse Gas Inventory. 2020

Health:	Technical protection measures and personal protection measures (use of face masks) at exposed locations are strongly recommended to prevent potential health risks. Compliance with safety regulations.
Education: / Availability of specialized training of specialists, universities, technical lyceums according to the beneficiaries /	Requires organization of training.
Gender equality and social inclusion	In accordance with the specifics of the project, it is mandatory for use. Technology does not limit women's participation.
Environmental benefits	Reducing the amount of waste taken to the landfill.
Implementation opportunities: /laws, institutions, strategies, policies/	Availability of raw materials and broad prospects for the use of final products.
Barriers to implementation: /lack of preferences, equipment, financial support, etc./	- high investment costs; - lack of sufficient financial support from the government.

Annex II: List of Stakeholders involved and their contacts

List of stakeholders involved in technologies prioritisation for the Energy Sector

#	Full name	Organization, position	Contacts
1.	Esengeldiev Ermek	Center for Climate Finance, Expert, MPRETN	0556 08 40 00 ermek.esengeldiev@gmail.com
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6.	Samarets Svetlana	OJSC Electric Stations. Deputy Head of PTO of Bishkek CHPP	0555 771 607 es@infotel.kg
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13.	Artur Madumarov	LLC NEW-TEK Kyrgyz-Germany, Deputy Directors	0770 050 551 a.madumarov@newtek-schmid.com
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25.	Bidinov Urmatbek	ARIS, coordinator of the heat supply improvement project	0558 883 886 ubidinov@aris.kg
26.	Nurzat Adyrasulova	OF "Unison" Chairman	(0755) 741718 office@unisongroup.org
27.	Iskembaev Azamat Zhakypovich	Bishkek Solar LLC. General director	(0501) 138 393 bishkeksolarre@gmail.com
28.	Ms. Zamira Naimanbaeva	Gender equality and inclusion. CFC Gender Specialist	T. 770 058 505 E-почта: zamiranaiman-work@gmail.com
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List of stakeholders involved in technologies prioritisation for the Waste Sector

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17.	Esengeldiev Ermek	Center for Climate Finance, Expert, MPRETN	0556 08 40 00 ermek.esengeldiev@gmail.com
18.	Dastan Akbaraliev	Agencies for development and investment. Specialist. City Hall of Bishkek	0708 312996 d.akbaraliev@meria.kg
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30.	Obozov Alaibek Zhumabekovich	NAS KR, Laboratory of RES, Doctor of Technical Sciences, Professor	0559 190 606 obozov-a@mail.ru
31.	Abduvaliev Maksat.	IVPGGE NAS KR, Head. Hydropower Laboratory	0550 056 442 abduldaev59@mail.ru
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