Report on the Methodology for developing projections of GHG emissions and removals for energy sector of the Kyrgyz Republic

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Deliverable 6: Report on the Methodology for developing projections of GHG emissions and removals for energy sector

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1. Report on the Methodology for developing projections of GHG emissions and removals for energy sector of Kyrgyzstan

Introduction

The Greenhouse Gas Abatement Cost Model (GACMO) is a greenhouse gas (GHG) emissions modelling tool developed by UNEP-Copenhagen Climate Centre (UNEP-CCC). The tool is used to calculate the GHG emission reductions resulting from the implementation of specific mitigation measures and to generate a mitigation scenario compared to a business-as-usual (BAU) scenario. GACMO is an Excel-based bottom-up GHG emissions modelling approach using core IPCC and CDM methodologies.

The GACMO tool thus assists technical experts and decision makers in assessing and understanding the impacts of mitigation measures on climate change and GHG emissions.

1.1. Identification of policies and measures in the Energy sector for the development of a GHG emission projections

Climate policies

he conducted analysis of the current national strategic regulations adopted by the Government of Kyrgyzstan shows that the republic is an active participant in international efforts to combat climate change and is involved in the global climate agenda. The Kyrgyz Republic is committed to the implementation of the UN Agenda for Sustainable Development until 2030.[1] The Sustainable Development Goals (SDGs) are included in state policy and reflected in the National Development Strategy of the Kyrgyz Republic for 2018–2040[2].

To achieve the SDGs by 2030, the Kyrgyz Republic has identified policies focused on and directed at human development as a key priority, which also includes the implementation of national plans to mitigate the effects of climate change. Since the beginning of the implementation of the SDGs, the Kyrgyz Republic has ratified a number of important international agreements, including the Paris Agreement on Climate Change.

At the country level, in 2021, an updated Nationally Determined Contribution - an action plan to reduce emissions and adapt to climate change (NDC) was adopted. The updated NDC of the Kyrgyz Republic has been prepared in compliance with the following decisions of the Conference of Parties of the United Nations Framework Convention on Climate Change and the Paris Agreement.

[1]https://mineconom.gov.kg/ru/direct/9/300

[2]https://mineconom.gov.kg/froala/uploads/file/7ec5fa875f2dcee2aa785af041a6976f096c0295.pdf

The NDC is drafted with consideration given to a comprehensive state approach and is approved by a decree of the Coordination Council on Issues of Climate Change, Environment and Green Economy headed by the Prime Minister of the Kyrgyz Republic. Under the overall coordination of the State Committee for Ecology and Climate of the Kyrgyz Republic and with the participation of an inter-agency working group, as well as with the involvement of experts and representatives of the scientific community, civil society, private sector and the youth, an open process of the discussion of these national commitments was ensured.

The drafting of the updated NDC was supported by the UNDP in the Kyrgyz Republic as part of the UNDP's global initiative Climate Promise and the NDC Partnership.

The achievement of the NDC is underlain by mitigation actions and policies covering five sectors. However, the primary mitigation capacity is concentrated in the Energy, Agriculture, Forestry and Other Land Uses sectors.

“Being a relatively low emitter of greenhouse gases, Kyrgyzstan nevertheless declares its intention to increase its climate commitments and by 2025 will reduce its GHG emissions by 16.63% under the “Business as Usual” scenario, and with international support by 36.61%. By 2030, Kyrgyzstan can reduce GHG emissions by 15.97% of the GHG emission levels under the “Business as Usual” scenario, and by 43.62% with international support.”[3] - This is the General Goal of Climate Change Mitigation in the Kyrgyz Republic as a contribution to achieving the goal of the Paris Agreement.

The mitigation potential in the Energy sector will be used through the implementation of the following policies aimed at reducing GHG emissions:

1. Increasing the energy efficiency of buildings and households.
2. Reducing coal consumption through gasification of households and boiler houses
3. Development of renewable energy sources (solar, wind, heat pumps, biogas, etc.)
4. Development of hydropower
5. Reducing electricity losses during transmission
6. Reducing electricity losses during distribution
7. Improving heat supply systems

Mitigation measures in Energy

The General goal will be achieved through mitigation measures covering key sectors of the Kyrgyz economy, including Energy. All measures are distributed across two scenarios: (a) With measures (WM), which are supported by financial resources and (b) With additional measures (WAM), for the financing of which it is necessary to mobilize international support.

Planned and possible measures are presented in the table 1 below.[4]

[3] https://mnr.gov.kg/assets/files/froala/d5698a92ae2de9d80843b1d338a98f28f535f5d8.pdf, Updated Nationally Determined Contribution 2021

[4] https://mnr.gov.kg/assets/files/froala/d5698a92ae2de9d80843b1d338a98f28f535f5d8.pdf, Updated Nationally Determined Contribution 2021

Sector	Energy		
Goals	Measures[16]	Target indicators, 1000 tons of CO_2 eq.	
		2025	2030
1. Reduction of GHG emissions	1.1. Reducing coal consumption through gasification of households in the country (WM)[19]	809,979	971,247
	1.2. Replacement of light vehicles with internal combustion engines for electric vehicles (WAM)	444,990[17]	423,181[18]
	1.3. Improving Traffic Management and Cycling Infrastructure Development (WM)	253,037	747,963
	1.4. Reduction of electricity losses during transmission (WM)	13,668	13,668
	1.5. Reduction of electricity losses during distribution (WM)[19]	10,888	30,275
	1.6. Replacement of buses with diesel/gasoline fuel engines by buses with gas-powered engines in Bishkek (WM)	7,967	14,734
	1.7. Reconstruction and improvement of the heat supply system of the city of Bishkek (WM)	3,357	3,357
	1.8. Replacement of diesel/ gasoline fuel engines buses with buses with gas-powered engines in Osh city (WAM)	2,749	4,416

Table 1. Mitigation measures in Energy

Sector	Energy		
Goals	Measures[16]	Target indicators, 1000 tons of CO_2 eq.	
		2025	2030
	1.9. Expansion of the trolleybus fleet by replacing buses with internal combustion engines in Bishkek (WAM)	0,882	0,882
	1.10 Replacement of buses with diesel/gasoline fuel engines by buses with gas-powered engines on suburban routes in Bishkek (WAM)	Not estimated (NE)	2,501
2. Improvement of energy efficiency	2.1. Scaling up the installation of energy efficient stoves in households (WAM)	772,449	886,314
	2.2. Improving energy efficiency of small boiler houses by replacing coal-fired boilers with gas-fired ones (WAM)	402,203	1 223,697
	2.3. Construction of new buildings according to energy efficient CSR (WM)	14,552	16,866
	2.4. Energy efficiency improvement of existing Buildings (WAM)	NE	10,868
3. Development of RES	3.1. Expanding the use of biogas plants (BGP)[20] (WAM)	187,666	1 311,980
	3.2. Increasing the capacity of existing HPSs (WM)	98,935	98,935
	3.3. Electricity generation at existing private small hydropower plants (WM)	2,737	2,737
	3.4. Expansion of the application of solar heat collectors (WAM)	NE	78,400
	3.5. Construction of new hydropower plants (WAM)	NE	64,606
	3.6. Construction and launch of new small hydropower plants (WAM)	NE	49,796
	3.7. Development of geothermal energy (heat pumps) (WAM)	-	38,590

Table 1. Mitigation measures in Energy (continue)

Sector	Energy		
Goals	Measures[16]	Target indicators, 1000 tons of CO_2 eq.	
		2025	2030
	3.8. Solar power development (WAM)	NE	13,000
	3.9. Wind energy development (WAM)	NE	3,594

Table 1. Mitigation measures in Energy (continue1)

1.2. Basic scenarios for developing and determining greenhouse gas emission projections.

"Business as Usual" Scenario

Scenarios are the basis for developing and determining greenhouse gas emission projections. According to the IPCC methodology: "A scenario is a coherent, internally consistent, and plausible description of a possible future state of the world. It is not a forecast; rather, each scenario is one alternative way of thinking about how the future might unfold."

"Business-as-usual" (BAU) in the context of climate refers to a scenario in which greenhouse gas emissions continue to increase without efforts to reduce them. It assumes that current trends in energy consumption, production, and other emission-generating activities do not change. Under such a scenario, global temperatures are expected to rise further and the likelihood of catastrophic climate impacts increases.

The approach to estimating total greenhouse gas emissions in this scenario is considered as the sum of GHG emissions from fuel combustion in the Energy sector, fugitive and other emissions from fossil fuel extraction, and GHG emissions from non-energy sectors. Specifically for the Energy sector, GHG emissions from non-energy sectors are not taken into account.

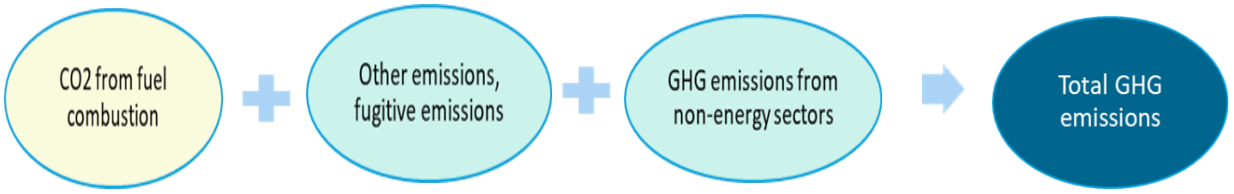

Figure. 1.1 Emissions GHG under BAU scenario

Greenhouse gas emissions in the starting year 2023 and further are calculated based on the data of the National GHG Inventory, data on used (burned) fuel based on the fuel and energy balance from the NSC KR database[5]and IPCC fuel-specific emission factors[6]. When calculating emissions in subsequent years, % CAGR is used - the average annual growth rate for each GHG source category according to the IPCC[7], which was determined during the National GHG Inventory in Kyrgyzstan

[5]https://stat.gov.kg/en/

[6]https://www.ipcc-nggip.iges.or.jp/public/2006gl/russian/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

[7]https://www.ipcc-nggip.iges.or.jp/public/2006gl/russian/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

Growth from the start year - Kyrgyzstan						
Growth and multiplication factors	Annual % increase in the period			% increase from start year values		
	2023 to 2025	2025 to 2030	2030 to 2035	2025	2030	2035
Population growth	1,44%	1,38%	1,21%	3%	10%	17%
GDP growth	2,55%	2,96%	2,69%	5%	22%	39%
1. Energy						
1.A. Fuel combustion						
1.A.2. Manufacturing industries and construction						
Industry - fuel in steel	2,5%	2,5%	2,5%	5%	19%	34%
Industry - fuel in chemical	0,6%	0,6%	0,6%	1%	4%	7%
Industry - fuel in non metallic mineral	2,0%	2,0%	2,0%	4%	15%	27%
Industry - fuel in food and beverage	6,0%	6,0%	6,0%	12%	50%	101%
Industry - fuel in construction	10,3%	10,5%	10,5%	22%	100%	230%
Industry - fuel in mining	4,9%	4,9%	4,9%	10%	40%	78%
Industry - fuel in machinery	2,9%	2,9%	2,9%	6%	22%	41%
Industry - fuel in paper and pulp	0,7%	0,7%	0,7%	1%	5%	9%
Industry - fuel in transport equipment	0,1%	0,1%	0,1%	0%	1%	1%
Industry - fuel in textile and leather	6,8%	6,8%	6,8%	14%	58%	120%
Industry - fuel in miscellaneous	4,7%	4,5%	4,5%	10%	37%	70%
Industry - electricity consumption	1,5%	1,5%	1,5%	3%	11%	19%
1.A.3. Transport						
Transport - fuel in road	2,0%	2,0%	2,2%	4%	15%	28%
Transport - fuel in rail	2,0%	2,0%	2,0%	4%	15%	27%
Transport - fuel in air	2,0%	2,0%	2,0%	4%	15%	27%
Transport - electricity consumption	2,0%	3,0%	4,0%	4%	21%	47%
1.A.4. Other sectors						
1.A.4.b. Residential						
Households - LPG	0,9%	0,9%	0,9%	2%	6%	11%
Households - electricity consumption	2,8%	2,8%	2,8%	6%	22%	40%
1.A.4.a. Commercial/institutional						
Services - fuel	2,5%	2,5%	2,5%	5%	19%	35%
Services - electricity consumption	3,3%	3,3%	3,3%	7%	26%	48%
1.A.4.c. Agriculture/forestry/fishing						
Agriculture - fuel	2,8%	3,4%	3,4%	6%	25%	48%
Agriculture - electricity consumption	4,4%	4,4%	4,4%	9%	35%	68%

Table 2. Values of CAGR in Energy

The CAGR for the energy sector for the period 2017-2023 was estimated using greenhouse gas inventory data. Initial indicators were also used from NSC data[8]and the Ministry of Economy and

[8]https://stat.gov.kg/en/

Commerce of the Kyrgyz Republic[9] for 2023

$$\mathrm{CAGR} = \left(\frac{V_{\mathrm{final}}}{V_{\mathrm{begin}}}\right)^{1/t} - 1$$

CAGR = compound annual growth rate
V_{begin} = beginning value
V_{final} = final value
t = time in years

Figure.1.2. Formula of CAGR under BAU scenario

The calculation of GHG emissions from fuel combustion in the Energy sector is calculated as the product of the volume of fuel consumed and the GHG emission factor for each individual type of fuel consumed, in each source according to the IPCC, which are summed up to show the volume of emissions from a specific source category in Energy.

Figure.1.3. Formula of CO2 emissions from Fuel combustion under BAU scenario

In this case, fuel consumption in subsequent years is calculated based on the previously calculated CAGR growth rate.

Figure. 1.4 . Formula of Energy consumption with Growth rates under BAU scenario

Mitigation scenario WM "with measures" and WAM "with additional measures"

Climate change mitigation scenarios involve various strategies and measures aimed at reducing greenhouse gas emissions and preventing further global warming. Key areas include switching to

[9]https://mineconom.gov.kg/ru

renewable energy sources, increasing energy efficiency, changing agricultural practices, restoring and protecting forests, capturing and storing carbon, developing greener transport, changing consumer habits, and raising awareness.

In accordance with the Paris Agreement, Kyrgyzstan committed to preparing a Nationally Determined Contribution (NDC), a country plan to reduce national greenhouse gas (GHG) emissions and adapt to the impacts of climate change, and investment prospects. NDCs include: - plans (targets) to reduce greenhouse gas emissions; - adaptation plans; - plans to provide financial and technological assistance. The Kyrgyz Republic submitted its initial NDC in 2015 when signing the Paris Agreement. In accordance with the prospective NDC, the Kyrgyz Republic declared its intentions to reduce greenhouse gas emissions by 11.49-13.75% compared to the "BAU" scenario and conditionally by 30.89% in the presence of additional international support by 2030 from the 2010 baseline.

Kyrgyzstan plans to implement scenarios for the introduction of mitigation measures reflected in the NDC at the expense of its own funding - this is the mitigation of the WM "with measures", and in the case of the implementation of more ambitious measures upon receipt of international financial support - this is the mitigation of the WAM "with additional measures".

The GACMO tool contains 119 predefined mitigation options. The user selects the mitigation options (from the 119 available mitigation options) that are applicable to the country and applicable to the mitigation scenario.

For each mitigation option (measure) selected, the user will be required to specify (in Column I) the number of units expected to be implemented by 2025, 2030, 2035 or 2050. The unit of the corresponding mitigation option is specified in Column E.

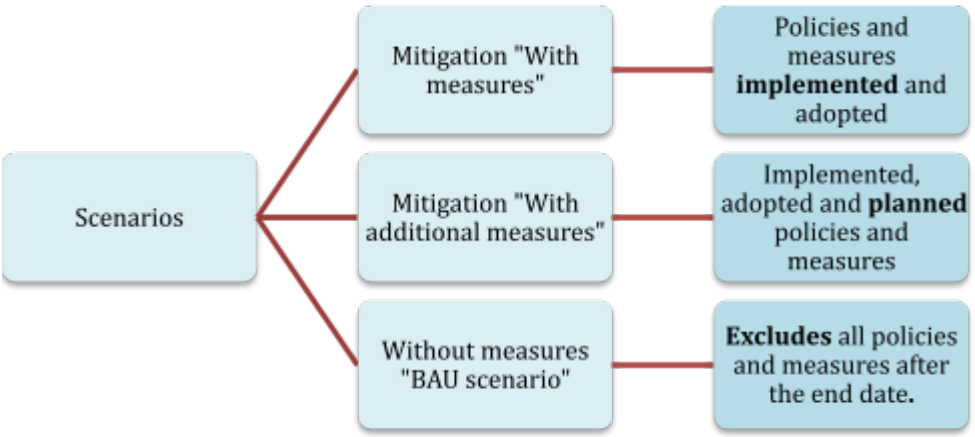

Figure. 1.5. Scenarios in Mitigation WM (with measures) and WAM (with additional measures)

To make a choice among all the options, the user can refer to national reports such as sectoral policy planning documents, national development strategies, etc. This choice can also be made based on expert judgment. For Kyrgyzstan, mitigation measures for the energy sector are defined within the framework of the adopted NDC.

The main objectives reflected in Kyrgyzstan's NDC are aimed at: 1. Reduction of GHG emissions; 2. Improvement of energy efficiency; 3. Development of RES; 4. Strengthening the national MRV system and introducing new technologies. (A detailed NDC plan with specific measures is in Appendix 1 to the report).

Emissions for mitigation scenarios are calculated as the difference between the scenario (BAU) and

the Total Emission Reductions from individual mitigation options.

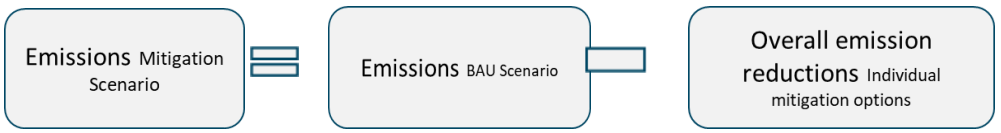

Figure. 1.6. Formula of Emissions from Mitigation Scenario

In this case, the Total Emission Reductions from Individual Mitigation Options are the combined reductions from individual mitigation measures.

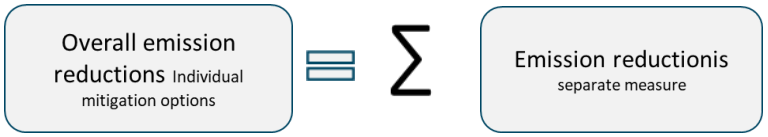

Figure. 1.7. Formula of Overall Emissions from individual Mitigation options

According to the CDM methodology[10], an approach to calculating emission reductions resulting from the adoption of mitigation measures, defines the value of emission reductions from a single implemented measure as the difference between emissions without measures and emissions after the implementation of the given measure.

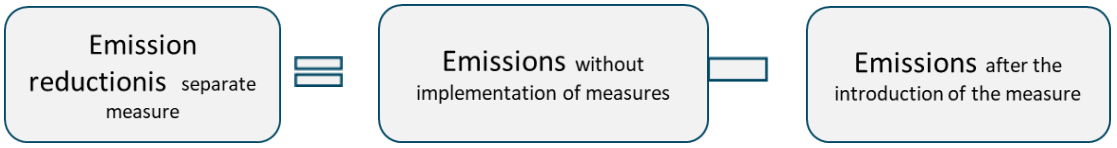

Figure.1. 8. Formula of Emission reductions from separate measures

The GACMO tool is built on the basis of Excel software and all the above-mentioned methodological calculation formulas are built into its base and make it possible to quickly make calculations and build emission forecasts for the period 2025, 2030, 2035 or 2050, in which mitigation measures in the energy sector are expected to be implemented.

Below, Table 3 and Table 4 provide a list of mitigation options included in the With Measures (WM) and With Additional Measures (WAM) scenarios, along with specific policies.

[10]nfccc.int/process-and-meetings/the-kyoto-protocol/mechanisms-under-the-kyoto-protocol/the-clean-development-mechanism

No. Measures	Policies and measures	Indicators	Target indicators	Implementation period, years	Expected reductions, kt CO2e	Progress Assessment (2023)	
						Performance indicators	Mitigation indicators, kt CO2e
Policy 1. Reducing GHG emissions in the Energy sector							
With measures (WM)							
Task 1.1 Improve the energy efficiency of new buildings and households, taking into account the needs of vulnerable groups, including women							
1.1.1.	Construction of apartment buildings according to energy-efficient building codes	sq. meters/annually of housing	1,165,055 thousand square meters	2021-2030	In 2025 – 38,025 In 2030 – 44,976	415,714	12.58
Task 1.2. Reducing coal consumption through gasification of households and boiler houses							
1.2.1.	Implementation of Gazprom Kyrgyzstan projects for gasification of households	*% of gasification of households in the country*	2020 – 33% 2025 – 44% 2030 – 60%	2021-2030	In 2025 – 810,847 In 2030 – 1135.186	38%	341.41
Task 1.3. Development of hydropower plants							
1.3.1.	Increasing the capacity of existing hydroelectric power plants	Capacity of existing hydroelectric power plants	360 MW.	2021-2030	In 2025 – 108,719 In 2030 -108,719	4 MW	1.09
1.3.2.	Electricity generation at existing private small hydroelectric power plants	Total capacity of existing private small hydroelectric power plants	84.46 MW.	2021-2030	In 2025 - 22,956 In 2030 – 22,956	8.7 MW	5.02
1.3.3.	Construction and launch of new small HP plants	Capacity of built and launched small HP plants	100 MW	2021-2030	In 2025 – 0 In 2030 – 29,167	Not installed	Not rated
1.3.4.	Reduction of losses of National Grid (transmission)	Total electricity transmission losses per year	4.7%	2021-2030	In 2025 9,280 In 2030 - 9,280	5.35%	5.33
Task 1.4. Reducing electricity losses during distribution							
1.4.1.	Reduction of electricity losses at National Grid (distribution)	Electricity losses during distribution per year	9-10%	2021-2030	In 2025 10,763 In 2030 - 30,275	10.29%	10.45
Task 1.5. Improving the heating systems of Bishkek							
1.5.1.	Modernization of heating systems to improve energy efficiency	Reduction of electricity consumption in heating supply in Bishkek per year	24-25%	2021-2030	In 2025 – 3,754 In 2030 – 3,754	25.7%	3.09
1.5.2.	Modernization of heating networks to improve energy efficiency. SM	Reducing electricity consumption by heating network pumps	33%	2021-2030	In 2025 – 0.571 In 2030 – 0.571	33%	0.57

Table 3. Mitigation measures under the "With Measures" (WM) scenario in Energy

No. Measures	Policies and measures	Indicators	Target indicators	Implementation period, years	Expected reductions, kt CO2e	Progress Assessment (2023)	
						Performance indicators	Mitigation indicators, kt CO2e
Policy 1. Reducing GHG emissions in the Energy sector							
With additional measures (WAM)							
Task 1.6 Improving the energy efficiency of existing buildings and households, taking into account the needs of vulnerable groups							
1.6.1.	Scaling up the installation of energy-efficient coal stoves in households	Number of energy-efficient stove installations in households	127 thousand units annually	2021-2030	In 2025 – 177,914 In 2030 – 1067,484	89 pcs.	0.12
1.6.2.	Improving energy efficiency and replacing small coal-fired boilers with gas-fired boilers	Number of small boiler houses converted to gas	48 boiler houses in Bishkek, 136 public, private boiler houses, pcs.	2021-2030	In 2025 – 198,167 In 2030 – 236,464	19 boiler houses and 36 private boiler	59.23
1.6.3.	Improving the energy efficiency of existing buildings	square meters of public buildings	1000,161 thousand	2021-2030	In 2025 – 0 In 2030 – 10,868	Not installed	Not rated
Task 1.7. Development of renewable energy sources							
1.7.1	Installation and use of biogas plants (BGP) in Kyrgyzstan	Total volume of BGU reactors in country	15 thousand m^3	2021-2030	In 2025 – 3785.217 In 2030 – 4346,861	Not installed	Not rated
1.7.5.	Expansion of the use of solar thermal collectors for hot water supply.	Capacity of installations	50 MW.	2021-2030	In 2025 – 0 In 2030 – 78,400	Not installed	Not rated
		Number of flat-plate collectors	Install 35,715 flat-plate collectors			Not installed	Not rated
1.7.6.	Development of solar power.	Solar power plants with total installed capacity	300 MW.	2021-2030	In 2025 – 0 In 2030 – 13,000	Not installed	Not rated
1.7.7	Expansion of the use of geothermal energy (installation of heat pumps).	Total capacity of heat pump installations. Number of heat pumps	50.00 MW. 2 thousand heat pumps of 25 kW each.	2021-2030	In 2025 – 0 In 2030 – 38,590	Not installed	Not rated
1.7.8	Implementation of the wind farm project of Kyrgyz Wind Systems OJSC (wind energy).	Total capacity of installations	600 MW.	2021-2030	In 2025 – 0 In 2030 – 3,594	Not installed	Not rated
Task 1.8. Development of large-scale hydropower							
1.8.1.	Construction of new hydroelectric power plants / Upper Naryn Cascade.	Capacity of hydroelectric power plants built since 2021	237.7 MW.	2021-2030	In 2025 – 0 In 2030 – 64,606	Not installed	Not rated

Table 4. Mitigation measures under the "With additional measures" (WAM) scenario in Energy

1.3. Documentation of the methodology for developing the GHG emission projections.

Documentation principles

Documentation of GHG emissions, in accordance with IPCC methodologies, is of great importance for:

- Ensuring transparency and comparability of data:
- This allows governments, organizations and individuals to track progress in reducing emissions and compare results.
- Support for decision-making in the field of climate policy:
- Clear and reliable information on emissions is the basis for developing effective measures to mitigate climate change.
- Meeting international commitments: Many countries have committed to reducing emissions under the Paris Agreement and other international treaties, and documenting emissions is an important step in meeting these commitments.

Documenting the greenhouse gas (GHG) emissions methodology is an important process of systematically recording and describing all aspects related to the determination, measurement and calculation of GHG emissions. This includes a clear definition of organizational boundaries, the selection of emission sources, calculation methods and data used, as well as a description of the assumptions and uncertainties applied. A well-documented methodology ensures transparency, comparability and reliability of GHG emissions data. It is GACMO that meets these requirements and creates an electronic document step by step.

The transition to electronic documentation, the creation of an electronic database based on Excel tables with explanations, significantly simplifies the documentation process. At the same time, GACMO meets the following main aspects of IPCC documentation:

1. Defining organizational boundaries:

2. Identification of emission sources:

3. Selection of calculation methods:

4. Collection and use of data:

5. Calculation and analysis:

6. Documenting assumptions and uncertainties:

7. Ensuring transparency and comparability:

8. Principles of GHG emissions accounting (basic principles: relevance, completeness, consistency, transparency and accuracy).

Also important is that GACM0 allows to utilize GACMO results for the Biennial Transparency Report (BTR).

The Common Tabular Formats (CTFs) are integral to the BTRs under the Paris Agreement. The tables correspond to the CTF Table 9 “Information on projections of greenhouse gas emissions and removals under a 'without measures' scenario” and CTF Table 7 “Information on projections of greenhouse gas emissions and removals under a 'with measures' scenario”. Therefore, you can directly incorporate the data from these tables into CTF Tables 7 and 9.

Additionally, CTF Table 8, “Information on projections of greenhouse gas emissions and removals under a 'with additional measures' scenario” is provided below. (The GACMO tool can generate one

Business-As-Usual scenario and one mitigation scenario within a single GACMO file. If needed, a second mitigation scenario can be added by creating an additional GACMO file. The tables are presented in the Annex 1 below.

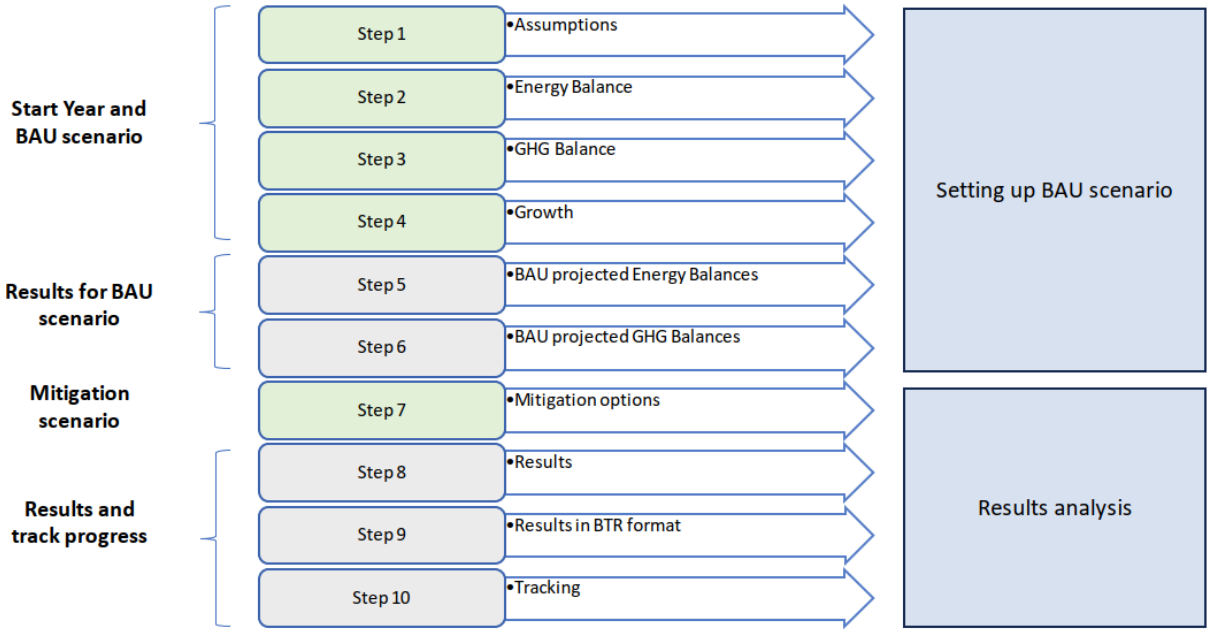

Figure. 1.9. GASMO steps with electronic tables of data and calculations

Electronic documentation GACMO (tables)

GACMO is used in a step-by-step format, with each step using tables containing data and formulas for the necessary calculations in accordance with the methodology used.

Start-up Year and BAU Scenario Stage: at Step 1 - Tables with assumptions; at Step 2 - Tables with energy balance data for GHG emission source categories; at Step 3 - Tables of GHG emission balance for source categories and amount of fuel used; at Step 4 - Tables with data on growth rates in categories.

Results stage according to BAU scenario: at Step 5 - Tables with projections of the energy balance for 2025, 2030, 2035, 2040, 2045, 2050; at Step 6 - Tables with projections of the balance of GHG emissions for source categories and the amount of fuel used for 2025, 2030, 2035, 2040, 2045, 2050.

Mitigation scenario stage: at Step 7 - Tables with 119 mitigation measures for all major sectors of the economy, including energy for 2025, 2030, 2035, 2040, 2045, 2050.

Mitigation scenario results and progress monitoring stage: at Step 8 - Tables with the results of calculations for BAU and the mitigation scenario, as well as graphs and Instagrams for 2025, 2030, 2035, 2040, 2045, 2050; at Step 9 - Tables in BTR format with the results of calculations for BAU and the mitigation scenario, as well as graphs and Instagrams for 2025, 2030, 2035, 2040, 2045, 2050; at Step 10 - Tables for tracking the results of progress from the implementation of mitigation measures for 2025, 2030, 2035, 2040, 2045, 2050.

Column D:	**The emission reduction cost of a mitigation option,** i.e. the cost of reducing 1 tonne of CO2e emissions for a mitigation option.
Column F:	**The emission reduction potential per unit** (defined in column E) of the mitigation option, expressed in tonnes CO2e per unit.
Column G:	**Investment cost** (in millions of US dollars) for the mitigation option compared to the reference option. This value is calculated based on the parameters in the Technology Sheet and the data entered in Column I.
Column H:	**The annual cost** (annual cost is $ million per year) for the mitigation option compared to the reference option. This value is calculated based on the parameters in the Technology Sheet and the data entered in Column I.
ColumnJ:	**The emission reduction potential per year** considered in the table for the mitigation option compared to the reference option in thousands of tonnes CO2e. This value is calculated based on the parameters in the Technology Sheet and the data entered in Column I.
Column K:	**The total emission reduction potential** in a given year is achieved through mitigation options (listed above).
Column L	**The cumulative percentage of emission reductions** achieved through mitigation options (listed above).

Table 1.2. Example - Data tables for each of the 119 mitigation measures in Step 7

GACMO's potential for Kyrgyzstan

The use of the GACMO tool in the energy sector is a first for Kyrgyzstan, and adapting it to the national context will require expertise and time. Below is information on the input data used and their sources for Kyrgyzstan at each GACMO step.

Step 1 - Tables with assumptions

- The exchange rate of the national currency, the som, against the US dollar – data from the National Bank of Kyrgyzstan[11]
- The cost of various types of fuel is based on the expert's personal data and available sources, converted into US dollars.[12]
- The cost of electricity is according to the Ministry of Energy and the Department for Regulation of the Fuel and Energy Complex of Kyrgyzstan.[13]
- Electricity losses in the republic's networks - data from the Kyrgyz Energy Settlement Center [14]

[11]https://www.nbkr.kg/index1.jsp?item=1562&lang=RUS
[12]https://ru.globalpetrolprices.com/Kyrgyzstan/gasoline_prices/
[13]https://regultek.gov.kg/ru
[14]https://esep.energo.kg/

- Greenhouse gas emissions by energy sector categories and fuel used – data from the Ministry of Natural Resources, Ecology and Technical Supervision of Kyrgyzstan on the GHG inventory for 2023[15.]
- Population of Kyrgyzstan - data from the National Statistical Committee of Kyrgyzstan.[16]
- Gross Domestic Product Growth – World Bank data for Kyrgyzstan[17]

Step 2 - Tables with energy balance data for GHG emission source categories;

- Energy balance – data from the Ministry of Natural Resources, Ecology, and Technical Supervision of Kyrgyzstan on the GHG inventory for 2023 in accordance with the IPCC 2006 methodology. The IPCC 2006 category structure was used.[18]As well as data from the National Statistical Committee on the fuel and energy balance[19]

Step 3 - Tables of GHG emission balance for source categories and amount of fuel used

- The sector's emissions balance is based on data from the Ministry of Natural Resources, Ecology, and Technical Supervision of Kyrgyzstan on the GHG inventory for 2023 in accordance with the IPCC 2006 methodology. The IPCC 2006 category structure was used.[20]

Step 4 - Tables with data on growth rates in categories.

- Growth rates for various sectors in accordance with the IPCC 2006 framework (with individual data from the Ministry of Economy of Kyrgyzstan)[21], as well as expert assessment using available data.

Step 5 - Tables with projections of the energy balance for 2025, 2030, 2035, 2040, 2045, 2050;

- There was no need to enter data, since the GACMO tool constructed projections automatically.

Step 6 - Tables with projections of the balance of GHG emissions for source categories and the amount of fuel used for 2025, 2030, 2035, 2040, 2045, 2050.

- There was no need to enter data, since the GACMO tool constructed projections automatically.

Step 7 - Tables with 119 mitigation measures

- At this stage, mitigation measures were selected that most closely matched those adopted in Kyrgyzstan's NDC. Some measures were reflected in the register of measures, but when disclosed in the technological description, they did not correspond to Kyrgyzstan's conditions. These measures include: expanding the use of energy-efficient coal stoves; gasification of private households with a transition to natural gas. Other measures could not be included. These include: implementation of energy-efficient building codes in new construction; reduction of losses in heat distribution; and use of heat pumps for households. The list of mitigation measures included in GACMO added in Annex.
- The technical and economic parameters of the mitigation measures used were updated. The CO2-eq emission factor was revised to 0.172 tCO2/MWh. The number of solar insolation hours was also adjusted taking into account local conditions of Kyrgyzstan and amounted to

[15]https://mnr.gov.kg/ru/
[16]https://stat.gov.kg/ru/statistics/naselenie/
[17]https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=KG
[18]https://mnr.gov.kg/ru/
[19]https://stat.gov.kg/ru/publications/toplivno-energeticheskij-balans/
[20]https://mnr.gov.kg/ru/
[21]https://mineconom.gov.kg/ru

8 hours a day or 2920 hours a year. The data on the necessary investments for implementing the measures, developed by an economics and finance expert, was also updated.

In the future, when GACMO is adapted to national conditions in more detail, it is planned to develop a MAR curve to compare emission reductions and emission reduction revenues (US$/t) resulting from the application of different mitigation measures.

1.4. Conclusions

Advantages of the tool GACMO:

1. GACMO truly simplifies and automates the process of calculating future projections, reducing the human factor and improving calculation quality. Until now, calculations for each measure were performed individually by experts in Excel.
2. The GACMO tool is a convenient and accessible way to calculate future GHG emission projections in the energy sector. Currently, Kyrgyzstan uses a correlation-regression linear projection in key sectors such as energy, industrial processes, agriculture, and waste, which requires specialist expertise. The projection of future GHG emissions in the Kyrgyz Republic was based on the determination of correlations between GHG emissions and the main factors that determine them, i.e., GDP growth, which determines the growth of production in the country's economy, and population growth, which determines the growth of household consumption.
3. GACMO allows you to calculate emission projections not only in the main categories, but also in the subcategories in Energy.
4. GACMO calculates projections of future GHG emissions for BAUs under one scenario: the baseline (average) for all sectors, including Energy.
5. GACMO truly simplifies and automates the process of calculating future projections, reducing the human factor and improving calculation quality. Until now, calculations for each measure were performed individually by experts in Excel.
6. The GACMO tool requires minimal time for training and its subsequent use in any sector of the Economy.
7. The GACMO showed which mitigation measures are the most optimal in terms of their economic efficiency and the lowest costs for their implementation, as well as the amount of emission reduction and the period of operation of the measure in the Kyrgyz Republic.
8. The GACMO makes it possible to track the results of the implementation of mitigation measures.

Limitations on the use of the toolGACMO:

9. For more accurate forecasting, it is necessary to utilize the potential of the Ministry of Economy of the Kyrgyz Republic to forecast GDP growth for individual economic activities.
10. It should be noted that the GACMO tool needs to be adapted to Kyrgyzstan's national conditions. This primarily applies to the register of mitigation measures. It needs to be expanded, and adjustments need to be made to the technological calculation tables for each measure.
11. Some gaps in data by activity require the involvement of the National Statistical Committee of the Kyrgyz Republic to obtain the necessary data.

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Annex 1

List of mitigation measures included in GACMO

Total GHG mitigation in Kyrgyzstan

Type	Reduction option	US$/tCO2e	Sub-type unit	Emission reduction tCO2e/unit	Investment Million US$	Annual costs MUS$/year	Units penetrating in 2025	Emission reduction in 2025		
								Per option	Added	
								CO2e/year	CO2e/year	Frac of total
EE households	Efficient charcoal stoves	218,92	1000 stoves	293	239	40,72	635	186,00	186	1,8%
	LPG stoves replacing wood stoves	74,36	1000 stoves	2 055	9	47,22	309	634,98	821	8,0%
# GHG reduction options:	2			Totals:	249	88				

Type	Reduction option	US$/tCO2e	Sub-type unit	Emission reduction tCO2e/unit	Investment Million US$	Annual costs MUS$/year	Units penetrating in 2030	Emission reduction in 2030		
								Per option	Added	
								CO2e/year	CO2e/year	Frac of total
EE households	Efficient charcoal stoves	218,92	1000 stoves	293	431	73,30	1 143	334,80	335	2,9%
	LPG stoves replacing wood stoves	74,36	1000 stoves	2 055	9	47,22	309,00	634,98	970	8,5%
Hydro	Hydro power connected to main grid	5,46	1 MW	499	680	1,63	597,70	298,30	1 268	11,2%
	Mini hydro power connected to main grid	784,64	1 MW	504	830	72,95	184,46	92,97	1 361	12,0%
Solar	Solar PVs, large grid	-65,11	1 MW	276	120	- 5,39	300	82,78	1 444	12,7%
Transport	Electric cars	1 810,99	1000 cars	1 351	1 231	128,70	52,60	71,07	1 515	13,3%
	New bicycle lanes	-273,26	1 km bicycle l	687	13	- 46,90	250	171,65	1 687	14,8%
Wind	Wind turbines, on-shore	354,98	1 MW	315	900	67,09	600	189,00	1 876	16,5%
# GHG reduction options:	8			Totals:	4 214	339				

Type	Reduction option	US$/tCO2e	Sub-type unit	Emission reduction tCO2e/unit	Investment Million US$	Annual costs MUS$/year	Units penetrating in 2035	Emission reduction in 2035		
								Per option	Added	
								CO2e/year	CO2e/year	Frac of total
Hydro	Hydro power connected to main grid	5,46	1 MW	499	1 024	2,45	900,00	449,18	449	3,5%
	Mini hydro power connected to main grid	784,64	1 MW	504	1 350	118,64	300,00	151,20	600	4,7%
Solar	Solar PVs, large grid	-65,11	1 MW	276	240	- 10,78	600	165,56	766	6,0%
Transport	Electric cars	1 810,99	1000 cars	1 351	2 462	257,40	105,20	142,13	908	7,1%
	New bicycle lanes	-273,26	1 km bicycle l	687	25	- 93,81	500	343,29	1 251	9,8%
Wind	Wind turbines, on-shore	354,98	1 MW	315	1 200	89,46	800	252,00	1 503	11,8%
# GHG reduction options:	6			Totals:	6 301	363				

BTR Table 8,

Step 9 - Results in BTR format

Use this sheet if you plan to utilize GACMO results for the Biennial Transparency Report (BTR).

The Common Tabular Formats (CTFs) are integral to the BTRs under the Paris Agreement. The tables below correspond to the **CTF Table 9 "Information on projections of greenhouse gas emissions and removals under a 'without measures' scenario"** and **CTF Table 7 "Information on projections of greenhouse gas emissions and removals under a 'with measures' scenario"**. Therefore, you can directly incorporate the data from these tables into CTF Tables 7 and 9.

Additionally, **CTF Table 8, "Information on projections of greenhouse gas emissions and removals under a 'with additional measures' scenario"** is provided below. (The GACMO tool can generate one Business-As-Usual scenario and one mitigation scenario within a single GACMO file. If needed, a second mitigation scenario can be added by creating an additional GACMO file. Copy the results for the third "with additional measures" scenario into the third table below.)

Please note that **scenario definitiion** for the purposes of the BTR should be the following:
A 'with measures' scenario encompasses currently implemented and adopted policies and measures.
If provided, **a 'with additional measures' scenario** encompasses implemented, adopted and planned policies and measures.
If provided, **a 'without measures' projection** excludes all policies and measures implemented, adopted and planned after the year chosen as the starting points for the projection.

Information on projections of greenhouse gas emissions and removals under without measures scenario

	Most recent year in the Party's national inventory report (kt CO2 eq)	*Projections of GHG emissions and removals, (kt CO2 eq)*					
	2023	*2025*	*2030*	*2035*	*2040*	*2045*	*2050*
Sector							
Energy*	6338	6599	7339	8241	9353	10761	12586
Transport	3507	3649	4029	4491	5006	5561	6222
Industrial processes and product use	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0
LULUCF	0	0	0	0	0	0	0
Waste	0	0	0	0	0	0	0
Other (specify)							
Gas							
CO2 emissions including net CO2 from LULUCF	9165	9539	10579	11844	13351	15187	17467
CO2 emissions excluding net CO2 from LULUCF	9165	9539	10579	11844	13351	15187	17467
CH4 emissions including CH4 from LULUCF	562	607	677	763	868	997	1158
CH4 emissions excluding CH4 from LULUCF	562	607	677	763	868	997	1158
N2O emissions including N2O from LULUCF	99	102	112	125	140	159	183
N2O emissions excluding N2O from LULUCF	99	102	112	125	140	159	183
HFCs							
PFCs							
SF6							
NF3							
Other (specify)							
Total with LULUCF	9845	10248	11368	12732	14359	16342	18808
Total without LULUCF	9845	10248	11368	12732	14359	16342	18808

*Energy excluding transport

Information on projections of greenhouse gas emissions and removals under a 'with measures' scenario

	Most recent year in the Party's national inventory report (kt CO2 eq)	*Projections of GHG emissions and removals, (kt CO2 eq)*					
	2023	*2025*	*2030*	*2035*	*2040*	*2045*	*2050*
Sector							
Energy*	6338	5778	5707	7223	8146	9394	11056
Transport	3507	3649	2655	4006	4398	4770	5208
Industrial processes and product use	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0
LULUCF	0	0	0	0	0	0	0
Waste	0	0	0	0	0	0	0
Other (specify)							
Gas							
CO2 emissions including net CO2 from LULUCF	9165	8719	7772	10340	11536	13008	14924
CO2 emissions excluding net CO2 from LULUCF	9165	8719	7772	10340	11536	13008	14924
CH4 emissions including CH4 from LULUCF	562	607	677	763	868	997	1158
CH4 emissions excluding CH4 from LULUCF	562	607	677	763	868	997	1158
N2O emissions including N2O from LULUCF	99	102	112	125	140	159	183
N2O emissions excluding N2O from LULUCF	99	102	112	125	140	159	183
HFCs							
PFCs							
SF6							
NF3							
Other (specify)							
Total with LULUCF	9845	9427	8562	11228	12544	14164	16264
Total without LULUCF	9845	9427	8562	11228	12544	14164	16264

*Energy excluding transport