First Biennial Update Report of the Kyrgyz Republic under the United Nations Framework Convention on Climate Change

Mountain landscapes of Kyrgyzstan.

Bishkek 2022

The first Biennial Update Report of the Kyrgyz Republic under the United Nations Framework Convention on Climate Change (UNFCCC) was prepared within the framework of the project "Support to the Kyrgyz Republic in the preparation of the first Biennial Update Report (BUR1) and the fourth National Communication (NC4) on the UNFCCC" implemented by the Ministry of Natural Resources, Environment and Technical Supervision of the Kyrgyz Republic and the UN Environment Program with the financial support of the Global Environment Facility.

Document references

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Representatives of the following organizations were involved in the preparation of the First Biennial Update Report of the Kyrgyz Republic under the UN Framework Convention on Climate Change:

- Government Bodies:
    - Ministry of Economy and Commerce,
    - Ministry of Finance,
    - Ministry of Foreign Affairs, Foreign Trade and Investment,
    - Ministry of Agriculture,
    - Ministry of Emergency Situations,
    - Ministry of Health,
    - Ministry of Education and Science,
    - Ministry of Energy,
    - Ministry of Transport and Roads,
    - Ministry of Natural Resources, Environment and Technical Supervision,
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    - Land Service under the Ministry of Agriculture of the Kyrgyz Republic,
    - Forestry Service under the Ministry of Agriculture of the Kyrgyz Republic,
    - Water Service under the Ministry of Agriculture of the Kyrgyz Republic,
    - State Agency for Architecture, Construction and Housing and Communal Services under the Cabinet of Ministers of Kyrgyz Republic,
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    - Kyrgyz-Russian Slavic University named after B.N. Yeltsin,
    - Kyrgyz National Agrarian Academy,
    - American University of Central Asia, Tien Shan Center,
    - Naryn State University,
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    - Research Institute of Energy and Economics of the Kyrgyz Republic,
    - Kyrgyz Research Institute of Livestock and Pastures KNAU named after K. I. Skryabin,
    - Research and Production Center on Forest of the Institute of Biology under the National Academy of Science,
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    - Institute of Water Problems and Hydropower of the National Academy of Science of the Kyrgyz Republic,
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    - JSC "Electric Stations,"
    - OJSC "Kyrgyzenergoholding,"
    - OJSC "Kyrgyzneftegaz,"
    - OJSC "Kant Cement Plant,"
    - TPP "Bishkek TPP,"
    - LLC "Frunze metal rolling plant",

    - CJSC “South Kyrgyz Cement,”
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    - Association of Renewable Energy Sources of Krygyzstan,
    - Society of Soil Scientists of Kyrgyzstan,
    - Association of Forest and Land Users of Kyrgyzstan,
    - National Association of Pasture Users of Kyrgyzstan,
    - Environmental movement “BIOM.”
- Municipal organizations and enterprises:
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    - Municipal Enterprise “Bishkek AsphaltService,”
    - Municipal Enterprise “Bishkekvodokanal,”
    - Association of legal entities “First Bishkek Recycling Association,”
    - Municipal Enterprise “Tazalyk, ”
    - Center for State Sanitary and Epidemiological Surveillance of the city of Bishkek.

List of abbreviations and acronyms

AD	Activity data
AFOLU	Agriculture, Forestry and Other Land Use Sector
BOD	Biochemical Oxygen Demand
BUR	Biennial update report to the United Nations Framework Convention on Climate Change
CCGEDCC	Coordinating Council on Green Economy Development and Climate Change
CFC	Climate Finance Center
COD	Chemical Oxygen Demand
COP	Conference of Parties
DOC	Degradable organic carbon
EAF	Electric Arc Furnaces
EF	Emission Factor
EEA	European Environment Agency
EFDB	Emission Factor Database
EMEP	European Monitoring and Evaluation Program for the long-range transmission of air pollutants
ES	Executive summary
FEB	Fuel and energy balance
FER	Fuel and energy resources
FOD	First Order Decay
FOLU	Forestry and Other Land Use
GCF	Green Climate Fund
GDP	Gross domestic product
GEF	Global Environmental Facility
GHG	Greenhouse gases
HCS	Housing and Communal Service
HPP	Hydroelectric power plant
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use Sector
ISTC	International Standard Trade Classification
KR	Kyrgyz Republic
MAFILR	Ministry of Agriculture, Food Industry and Land Reclamation
ME	Municipal Enterprise
MES	Ministry of Emergency Situations
MNRETS	Ministry of Natural Resources, Environment and Technical Supervision
MRV	Measurement, reporting and verification system
NAS KR	National Academy of Science of Kyrgyz Republic
NC	National Communication of the Kyrgyz Republic to the UN Framework Convention on Climate Change
NDC	Nationally Determined Contributions
NGHGI	National Greenhouse Gas Inventory
NIR	National Inventory Report
NIIP	National Inventory Improvement Plan
NSC	National Statistical Committee
OJSC	Open Joint Stock Company
PIU	Project Implementation Office
QA/QC	Quality assurance and quality control
RES	Renewable energy sources
SAEPF	State Agency on Environmental Protection and Forestry under the Government of Kyrgyz Republic

SAWRH	State Agency of Water Resources and Hydropower
SE	State Enterprise
SI	State Institution
SRCEPES	State Regulation Center on Environment Protection and Ecological Safety
TEG	Technical expert group
TNC	Third National Communication
UNDP	UN Development Program
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organization

Chemical formulas and units used

CO_2	Carbon dioxide
CH_4	Methane
N_2O	Nitrous oxide
HFC	Hydrofluorocarbons
PFC	Perfluorocarbons
CO	Carbon monoxide
SF_6	Sulfur hexafluoride
NMVOC	Non-Methane Volatile Organic Compounds
NO_x	Nitrogen oxides
SO_2	Sulphur dioxide
Gg	Gigagram = 1,000 tons, 1 kiloton
TOFE	Tons of fuel 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

Foreword

Dear readers,

We would like to present you the first Biennial Update Report (BUR1), which continues the list of the regular country reporting documents submitted by the Kyrgyz Republic in fulfillment of its obligations under the UN Framework Convention on Climate Change.

Kyrgyzstan, as a mountainous country, is already experiencing the negative impacts of climate change and is actively promoting an adaptation agenda to increase the country's climate-sustainable development, its economic stability and the preservation of ecosystem services, with a focus primarily on the safety, health and well-being of our citizens. For this purpose, Kyrgyzstan, with the support of the Green Climate Fund, will develop a National Adaptation Plan for all vulnerable sectors, as well as being conducted assessment of the needs for climate technologies.

Climate change mitigation, with the political support, received from the state, has significant transformational potential for the transition to a "green" low-carbon development paradigm, to form a "green" economy, to reduce pressure on ecosystems, and preserve the nature of Kyrgyzstan for future generations.

It is clear that the efforts of one state will not be enough to implement the full mitigation potential and reduce GHG emissions to the level of carbon neutrality. This requires the efforts of all stakeholders' in all sectors of the economy, all forms of ownership, as well as households. At the same time, at the level of households that determine consumption and markets that there is a significant reserve to reduce GHG emissions due to changes in the structure of personal consumption.

Despite the minimal contribution of Kyrgyzstan to the anthropogenic impact on the Earth's climate system, our country supports the global efforts of all countries to reduce greenhouse gas emissions, as evidenced by our recently updated and presented in Glasgow, our second Nationally Determined Contribution to the Paris Agreement. By taking on more ambitious commitments than the previous NDC, Kyrgyzstan has clearly demonstrated its mitigation intentions. It should be noted that the basis for the development of NDC mitigation measures was the developments received by the Ministry in the framework of the preparation of BUR 1. This primarily relates to the inventory of greenhouse gas emissions and removals, as well as to the projection of future emissions under the "business as usual" scenario.

We would like to emphasize that due to the difficulties of national development, Kyrgyzstan for the first time took advantage of the opportunity to prepare BUR under the financial mechanism of the UNFCCC. Therefore, the ministry intends to further fully use the remarkable opportunity that the Global Environment Facility (GEF) provides to Kyrgyzstan. The support provided by the GEF for us to prepare climate-reporting documents contributes to the development of national institutional, human, scientific, educational, and expert capacities, as well as contributes to raising awareness of the public on the climate agenda.

I also would like to note the support of the United Nations Environment Programme (UNEP), which provided technical support in all aspects of BUR preparation.

Finally, it is important to note that since BUR 1 is a follow-up to the previous reporting, it covers the time from 2011 to 2018 and, accordingly, represents the country context for that period.

Dinara Kutmanova

UNFCCC Focal Point in the Kyrgyz Republic
Minister of Natural Resources, Environment
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Contents

List of tables

List of illustrations

Executive Summary (ES)

ES 1. Introduction

The Kyrgyz Republic, as a signatory of the UN Framework Convention on Climate Change, directs all its climate actions to achieve the ultimate goal of the Convention, aimed at stabilizing the concentration of greenhouse gases in the atmosphere at a level that would prevent dangerous anthropogenic impact on the climate system.

Under Article 4 paragraph 1 point a) on the Obligations of the Parties and Article 12 paragraph 1 (a) on the provision of information related to the implementation of the Convention, each Party to the Convention is expected to regularly submit country reporting to the Conference of the Parties (COP).

The main mechanism for providing information on the country's activities under the UNFCCC is the National Communications (NC). The guidelines for the preparation of national communications for non-Annex I countries were adopted at the Conference of the Parties in 1996 in Geneva (Decision 10/CP2). The 8th Conference of the Parties (New Delhi, 2002) adopted a new Guide to National Communications for countries, which are not parties to Annex I of the Convention (Decision 17/CP8).

Following the Guidelines of the UNFCCC and within the framework of the UN Development Program (UNDP) project "Assistance to Kyrgyzstan in the preparation of the First National Communication in response to the obligations under the UN Framework Convention on Climate Change" with financial support from the Global Environment Facility (GEF), the Kyrgyz Republic developed in 2003 it's First National Communication, including a national inventory of greenhouse gas emissions for the period 1990 – 2000. This document was approved by the Decree of the Government of the Kyrgyz Republic on April 10, 2003 No. 200.

The second national communication of the Kyrgyz Republic to the UNFCCC was also developed within the framework of a UNDP project with financial support from the GEF in 2009 and approved by the Resolution of the Government of the Kyrgyz Republic dated by May 6, 2009 No. 274.

Kyrgyzstan prepared the Third National Communication with the support of the GEF project and the United Nations Environment Programme (UNEP) in 2016. This document was also approved by the Resolution of the Government of the Kyrgyz Republic dated October 13, 2016 No. 546.

This document is the First Biennial Update Report (BUR 1) of the Kyrgyz Republic, prepared according to the "UNFCCC biennial update reporting guidelines for Parties not included in Annex I to the Convention" (Annex III to Decision 2/COP17), approved at the 17th Conference of the Parties of the UNFCCC (Durban, 2011).

BUR 1 supplements the information contained in the Third National Communication of the Kyrgyz Republic, submitted under the Articles 4 and 12 of the UNFCCC, in terms of not only updating the information on the national greenhouse gas inventory for 2011-2018, but also presents the results of the recalculation of the estimated GHG emissions of the Kyrgyz Republic. Republic for the period 1990-2018, due to the transition to a new assessment methodology in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Consequently, all data presented in this document correspond to the reporting period from 2011 to 2018.

ES 2. National Circumstances

General information

Country development during the period 2011-2018 took place against the backdrop of the global financial crisis, growing uncertainty in world markets, which created risks for all market participants, including the main trading partners of Kyrgyzstan - Russia, Kazakhstan and China.

The internal political events of 2010 marked a new milestone in the development of the Kyrgyz Republic, which will go down in the history of the country as a test of the strength of the Kyrgyz statehood and the entire system of public administration, including socio-political, economic, environmental, financial and other spheres of development management.

The most important outcome of this period, as a whole for Kyrgyzstan, was the transition of the Kyrgyz Republic to a parliamentary form of government and overcoming the unpredictable economic decline on the background against the consequences of the global financial crisis in 2008-2009, the change of the ruling regime, the interethnic conflict in April and June 2010, as well as technogenic accident at the largest gold mining enterprise "Kumtor" in 2012.

The deep socio-political and economic upheavals resulted in a noticeable decline in the standard of living of the population. Thus, in 2012, about 2.1 million people or 38% of the total population lived below the poverty line, among them almost 66% were residents of rural settlements.[1]

In this situation, the question arose about the mobilization and rational use of all reserves and resources of the country to enter a sustainable course of development, including economic, human, natural, financial and other aspects. The new political leadership of the country has officially declared a course towards sustainable development. For Kyrgyzstan, as a country with limited natural and financial resources, the transition to sustainable development seems to be a logical and politically justified choice.

The idea of sustainable development became consonant with the traditions, spirit, and mentality of the peoples of Kyrgyzstan, since, the peoples of Kyrgyzstan regardless of ethnic and party affiliation were and remain unanimous in their desire to overcome difficulties and live in a country that has a "future" and stable positions in development.

The political course of the Kyrgyz Republic towards sustainable development was confirmed by the establishment of the National Council for Sustainable Development under the President of the Kyrgyz Republic on November 24, 2012, which started its work uniting the efforts of all branches of government, the private sector and civil society on future development issues. The National Strategy for Sustainable Development of the Kyrgyz Republic for the period 2013-2017 was approved by the Decree of the President of the Kyrgyz Republic on January 21, 2013, based on the Council's second meeting results.[2]

This document outlined the strategic guidelines for the new sustainable development model, the main priorities and 78 largest investment projects for this period. Taking into account that the implementation of the National Sustainable Development Strategy of the Kyrgyz Republic for the period 2013-2017 required a real management tool for the next five years, the Government of the Kyrgyz Republic adopted the Program on the transition of the Kyrgyz Republic to sustainable development for 2013-2017.[3] These two strategic documents determined the development of the country during the period under review.

In 2018, the National Development Strategy of the Kyrgyz Republic for 2018-2040 has been endorsed by the Decree of the President. However, its provisions relevant for the climate change action at that time were on the initial stage evolving gradually. Thus, those will be duly presented in NC 4.

Geography and climate

[1] The Program on the Transition of the Kyrgyz Republic to sustainable development for the period 2013-2017.

[2] Approved by the Decree of the President of the Kyrgyz Republic dated January 21, 2013 No.11.

[3] Approved by the Resolution of the Government of Kyrgyz Republic dated April 30, 2013 No. 218.

The Kyrgyz Republic (KR) is located in the center of the Eurasian continent, the northeast of Central Asia. The area of the territory is 199.95 thousand km^2. 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 - up to 1,200 m, mid-mountain - from 1,200 to 2,200 m, high-mountain - from 2,200 to 3,500 m, and nival - 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 center 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 t 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 Kyrgyz Republic (Kyrgyzstan) – sovereign, democratic, legal, secular, unitary, and social state.

The state power in the Kyrgyz Republic is based on principles of the power division to 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 Government include 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.

In 2018, the Kyrgyz Republic had 2 cities of republican significance (Bishkek and Osh), 7 regions, 40 districts, 31 cities, 12 villages, and 453 rural districts. There are 531 administrative-territorial units in total.

Demography

The population in the Kyrgyz Republic amounted to 6,256.73 thousand people (50.4% women) as of January 1, 2018. The share of the population under the working-age (0-15 years) was 33.9%, the portion of the working-age population (men aged 16-62 and women aged 16-57) was 58.6%, 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 7.5%. 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 2018 was 1.9%.

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 31 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 2018 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 % of land for industry, transport, etc. - 1.2% and reserve land - 41.2%. In 2018, the area of arable land was 1,287.8 thousand hectares, with 79.9% of them being irrigated.

Kyrgyzstan is the only country in Central Asia, whose water resources are mostly formed on its territory, and this 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 km2 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 km2. Significant water reserves are concentrated in the glaciers of Kyrgyzstan, the volume of which is about 760 billion cubic meters. The area of glaciation has decreased by 16% as a result of climatic influences over the past 70 years.[4]

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. Among them, 1,731 km^3 (or 99.2% of the volume of all lakes) concentrated in the Issyk-Kul Lake, the water of which is salty and unsuitable for water supply. There are more than 3,500 large 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. In addition, there are 44 deposits of underground fresh and mineral waters. The potential reserves of fresh groundwater in the Kyrgyz Republic estimated at 13 km^3.

In 2018, the volume of water consumption amounted up to 5.1 billion m^3 of water, an increase compared to 2014 by 6.7%. The total water intake from water sources per one inhabitant of the republic in 2018 amounted to 1,239.9 m^3.

According to the National Forest Inventory (2008-2010), 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 bushes.

The Kyrgyz Republic possesses sufficient reserves of fuel and , of minerals of the Kyrgyz Republic includes 44 deposits with reserves of 1.411 billion tons, including brown coal - 1.083 billion tons, bituminous coal - 327.8 million tons, coking coal - 120.896 million tons. In 2018, the coal production amounted to 2,156.8 thousand tons. Industrial reserves of oil and gas are insignificant. Hence, oil is estimated at 88.506 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 2018, oil production amounted to 200 thousand tons, and gas production - 27.3 million m^3.[5]

[4] Water Resources under the Government of Kyrgyz Republic (SAWR). Site: https://www.water.gov.kg/index.php?option=com_content&view=article&id=228&Itemid=1274&lang=ru

[5] NSC, Fuel and Energy Balance of 2018. http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/

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 2018 accounted: coal – 2,638.7 thousand tons; oil - 137.4 thousand tons; gas - 305.2 million m^3; fuel oil - 171.6 thousand tons; electricity – 12,159.3 million kWh; thermal energy – 2,924.9 thousand gigacalories.

The main type of renewable energy sources in Kyrgyzstan are hydropower resources, which, according to the Institute of Water Problems and Hydropower of the National Academy of Sciences of Kyrgyz Republic, amounting to 245.2 billion kWh, where technically feasible potential for development is 142.5 billion kWh, and the economic (production)) capacity - 60 billion kWh. 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

The state of the economy in the period 1990-2018 illustrates the dynamics of the consumer price index and real GDP in constant 2010 US dollars. Thus, in 2018, nominal GDP amounted to 6,87 billion constant 2010 US dollars, and the consumer price index was 101.1% of the prices of the previous year. At the same time, the share of industry in total GDP was 14.3%, agriculture - 11.7%, construction - 9%, trade and catering - 19.2%, transport – 3.8, information and communication – 2.6%, and all others - 39.5%. In 2018, GDP per capita was 93.8 thousand soms, and the exchange rate of the som against the US dollar at the end of the year was 69.85 soms.

Imports of Kyrgyzstan in 2018 amounted to 5,291.9 million USD and exports 1,836.8 million USD.

The number of employed people in 2018 was 2,382.5 thousand people, and the unemployment rate was 6.2%.

The actual final consumption of households per capita in 2018 amounted to 85.6 thousand soms, and the monetary income of the population per capita was 5,337.3 soms per month. The average subsistence level per capita in 2018 was 4,792.54 soms per month, and the cost of the food basket of the minimum consumer budget was 3,115.15 soms per month.

Institutional framework for the preparation of BUR1 and NC4 under the UNFCCC

The institutional framework that determines the preparation of Kyrgyzstan's country reporting under the UNFCCC since joining it in 2000 has changed along with the institutional development of the public administration system in the Kyrgyz Republic.

In 2020, there have been changes in the institutional organization of climate actions. The government decree designated the Ministry of Foreign Affairs as the responsible state body for the UNFCCC instead of the State Agency on Environmental Protection and Forestry under the Government of the Kyrgyz Republic (SAEPF), and instead of the Coordination Committee on Climate Change, chaired by the Vice Prime Minister, there was established the Coordination Council for the Development of a Green Economy and climate change, chaired by the Prime Minister.

Since the preparation of the current country reports under the Convention (BUR 1 and NC 4) is being carried out by the SAEPF already for the third year, during the government consultations it was decided that the SAEPF will continue and complete the preparation of these documents.

A Process Coordinator was appointed in the SAEPF to carry out the work on both documents, and a Project Implementation Office established with a minimum staff on the base of the State Regulation Center on Environment Protection and Ecological Safety.

After the reorganization of the Government of the Kyrgyz Republic in 2021, the overall management of the fourth national GHG inventory and preparation of country reporting documents for the UNFCCC was transferred to the Ministry of Natural Resources, Environment and Technical Supervision (MNRETS).

MNRETS is preparing BUR 1 and NC 4 in partnership with the United Nations Environment Program (UNEP) with financial support from the Global Environment Facility. MNRETS organized a National Project Advisory Committee including representatives of all stakeholders to ensure monitoring of the process and appropriate progress oversight of the preparation of the documents.

MNRETS also established an Interdepartmental Working Group to monitor the process, collect data, control the quality and inform about the process, which included representatives of all stakeholders involved in the process: ministries and departments, science, civil society organizations, and the private sector.

It should be noted that to ensure the quality of the developed documents, each stage of the individual products of the TEG drafting was accompanied by the arrangement of relevant national consultations through seminars, sectoral round tables, and coordination meetings of technical expert groups to include them into country reporting.

ES 3. National GHG Inventory

ES 3.1. Process

The institutional arrangement of the Fourth National GHG Inventory (NGHGI 4) in Kyrgyzstan, which ensures comprehensive coverage and involvement of stakeholders to obtain a qualitative estimate of emissions by sources and removals by sinks, was determined by the national context and included the following stakeholders:

- Responsible for the UNFCCC government agency
- Project Implementation Unit responsible for the process (PIU)
- Technical Expert Group on GHG Inventory
- Providers of information
- Technical experts for quality assurance and control
- Industry stakeholders for quality assurance.

The corresponding description and diagram are presented in the corresponding section on the text.

NGHGI 4 was conducted according to a new Kyrgyzstan methodology presented in the 2006 IPCC Guidelines for National GHG Inventories, as well as using IPCC GHG Inventory Software 2.54. The transition to the new methodology and the application of the new software was accompanied by a number of NGHGI experts' capacity-building activities arranged in 2018 by the SAEPF with the support of the World Bank. An attracted British consulting company "RICARDO Energy Environment" conducted two rounds of advanced training courses on NGHGI for national experts and issued the corresponding certificates.

The process organized for conducting NGHGI 4 included a series of sequential steps, presented in the relevant chapter below.

ES 3.2. Scope and limitations of NGHGI 4

Continuing the country reporting on GHG emissions and removals, this document presents GHG emissions and removals by time series of 2011-2018. According to the IPCC Guidelines 2006, the report provides an estimate of GHG emissions and removals for the following sectors:

- Energy,
- Industrial Processes and Product Use (IPPU)
- Agriculture, forestry and other of land use (AFOLU)
- Waste.

At the same time, the inventory of GHG emissions and removals in the AFOLU sector was carried out in parallel by two groups - separately, for GHG emissions of the "Agriculture" category and, separately, for GHG removals of the "Forestry and other of land use" category. As studies on soil carbon sequestration and loss in the country are still ongoing and a consistently long time series of land-use change has not yet been completed at this stage, the preparation of a land-use change matrix for the NGI under the "Land" category is carried over to the next round of the NGI.

The NGI 4 process estimated emissions for the following direct greenhouse gases:

- Carbon dioxide (CO_2),
- Methane (CH_4),
- Nitrous oxide (N_2O),
- Hydrofluorocarbons (HFCs) or F-gases

Emissions for other greenhouse gases, including perfluorocarbons (PFCs) and sulfur hexafluoride (SF6), have not been estimated due to the lack of available data on emissions.

In addition to direct greenhouse gas emissions, NGI 4 also estimated emissions of indirect greenhouse gases or precursor gases: carbon monoxide (CO), nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC), and sulfur dioxide (SO2).

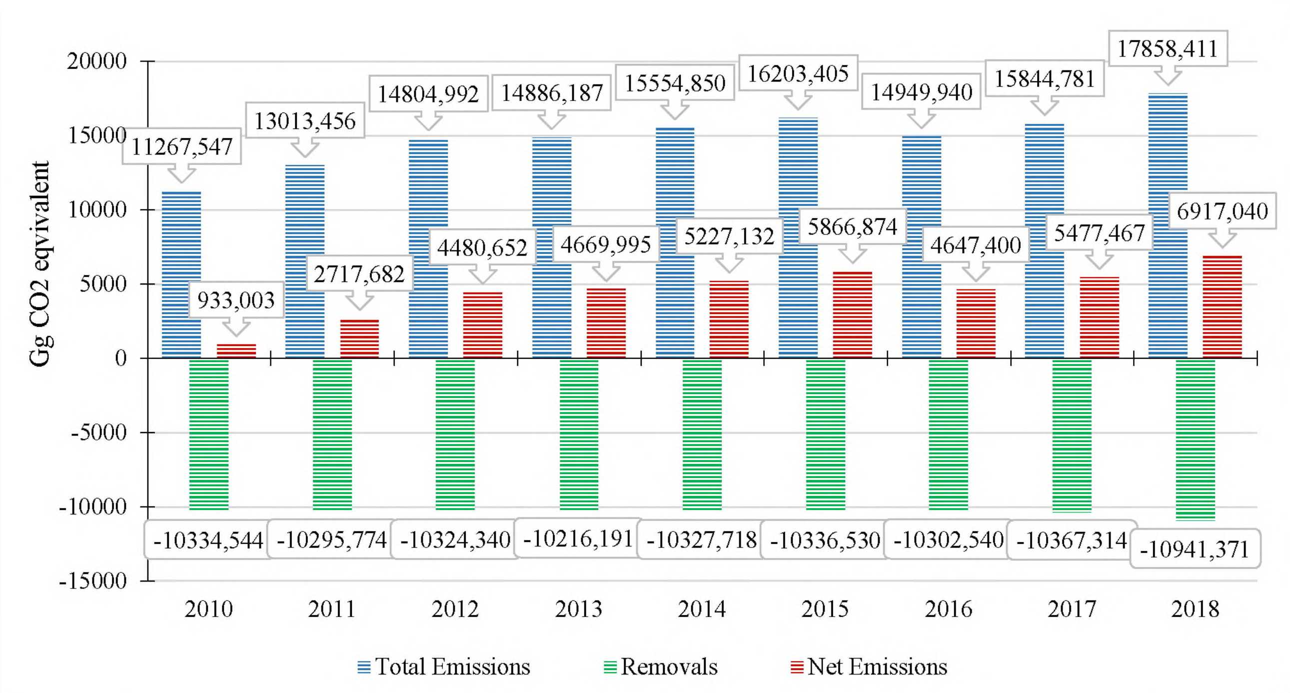
Estimated emissions of CH_4, N_2O, and HFCs were converted to CO_2 equivalent (CO_2 eq.) according to the values of the Global Warming Potential (GWP) for GHG effects in the 100-year time horizon presented in the IPCC Second Assessment Report 1995.[6]

ES 3.3. Results of NGHGI 4

The total GHG emissions of Kyrgyzstan in 2018 amounted to 17,858.411 Gg CO_2 eq. absorption - 10,941.371 Gg CO_2, and, accordingly, net emissions – 6,917.040 Gg CO_2 eq. Compared to 2010, total emissions increased by 58.15%. This is mainly due to an increase in emissions by categories as road transport, fuel combustion in the residential sector, emissions of F-gases from refrigeration and air conditioning units, as well as an increase in livestock and the use of nitrogen fertilizers on croplands. Dynamics of emissions and removals during 2010-2018 shown in Figure 0.1.

Figure 0.1. Dynamics of GHG emissions and removals in 2010-2018.

[6] IPCC. 1995 Second Assessment Report, IPCC GWP Values.



In 2018, total GHG emissions per unit of GDP amounted to 0.03 kg CO_2 eq. , thus, reduced by 38,66 as compared to 2010 (0.05 kg CO_2 eq.). However, total emissions per capita increased by 32,6% and amounted to 2.38 t CO_2 eq. in 2018 against 2.08 t CO_2 eq. in 2010.

The assessment of total emissions and removals in 2018 for the main categories of sources presented in table 0.1.

Table 0.1. GHG emissions and removals by main source categories (Gg CO2 eq.) [7]

Energy	IPPU	Agriculture	FOLU	Wastes
10923,480	1162,553	5196,342	-10941,371	576,037

The assessment of emissions in 2018 by types of greenhouse gases presented in table 0.2.

Table 0.2. Greenhouse gas emissions by type [8]

Emissions (Gg)			In CO2 eq. (Gg)	Emission (Gg)			
Net CO2	**CH4**	**N2O**	**HFCs**	**NOx**	**CO**	**NMVOCs**	**SO2**
474,484	174,361	8,346	193,688	35,924	266,697	40,232	42,656

ES 3.4. Projection of future GHG emissions

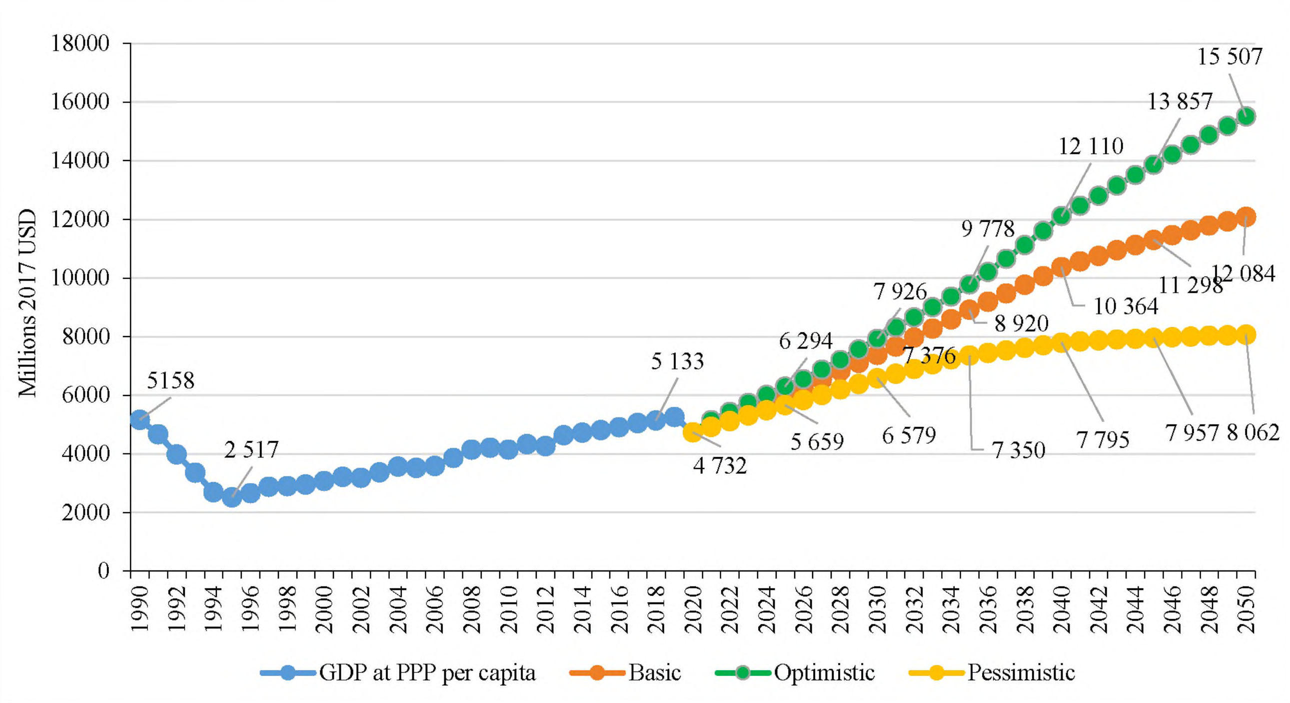
The projection of future GHG emissions in the Kyrgyz Republic was built based on determining the correlations of GHG emissions with the main factors causing them, i.e. GDP growth, which determines the growth of production of the country's economy and population growth, determining the growth of household consumption.

Both of these factors are combined in terms of GDP at PPP per capita. The values of this factor modeled up to 2050 were used to determine the correlation and the equation of the linear historical trend for the period 2000-2018. At the same time, calculations of values and modeling of changes in GDP

[7] MNRETS. 2021 Assessment Inventory of GHG Emissions and Removals in the Kyrgyz Republic for 1990-2010.
[8] Ibid

at PPP were carried out according to three scenarios: baseline, optimistic and pessimistic (see Figure 0.2).

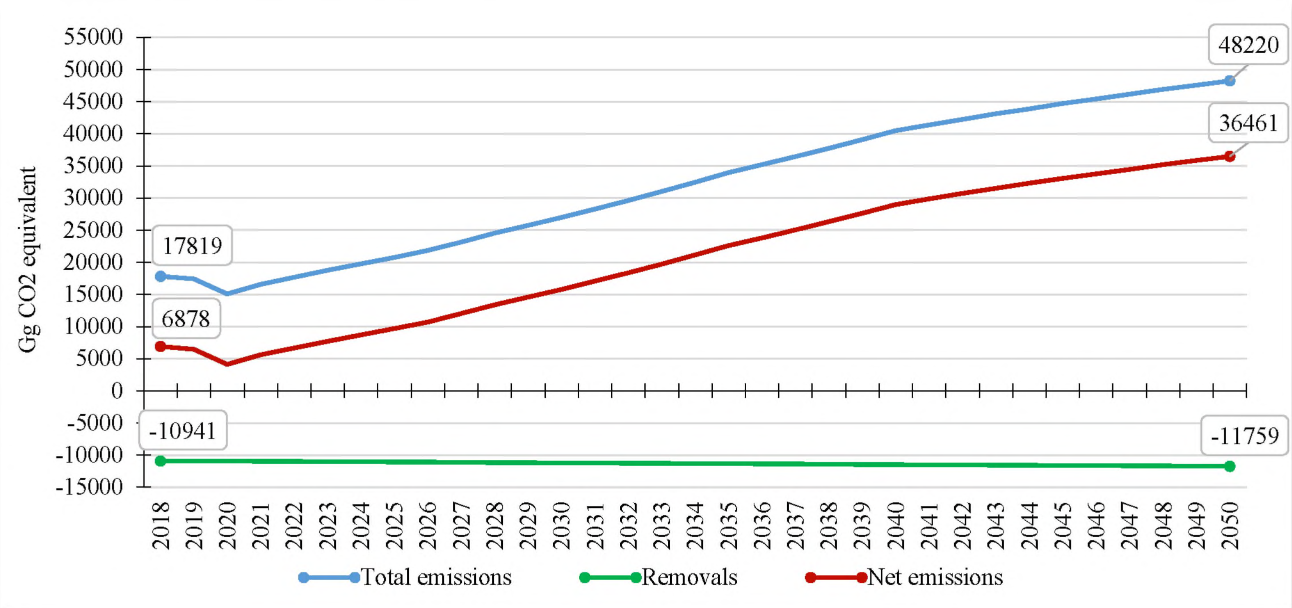
Figure 0.2. Dynamics of GDP at PPP per capita in 1990-2018 and its projection until 2050 according to three scenarios.[9]



Since the annual contribution of different sectors to total national emissions varied over the entire time of series from 1990 to 2018, future emissions were projected for each sector separately and then aggregated into total and net national emissions. Projection of future GHG emissions and removals according to the scenario "business as usual", i.e. without taking measures to mitigate or mitigate climate change presented in Figure 0.3.

Figure 0.3. Projection of total and net GHG emissions and removals up to 2050

[9] UNDP. 2021 A. Kadyrov. Technical report.



ES 4. Climate Change Mitigation: Actions, Projection and Impact Assessment

The development of mitigation measures in the Kyrgyz Republic was carried out within the project of the UNDP and Global Partnership for NDCs aimed to update the Nationally Determined Contributions (NDCs) of Kyrgyzstan to the Paris Agreement under the UNFCCC. A broad process of participation of all stakeholders in updating the NDC was conducted under the leadership of the Ministry of Economy and Finance by a special interdepartmental working group, which included representatives of relevant ministries and departments, science, civil society, and the expert community.

The mitigation measures presented in the NDC 2 of Kyrgyzstan cover all sectors of GHG emissions and removals: energy, IPPU, agriculture, AFLOU, and waste. All measures were divided into those that Kyrgyzstan implements on its own and measures that require international support. At the same time, the calculated values of the reduced emissions were carried out relative to the values of the net emissions of Kyrgyzstan.

However, since 2017 is defined as the base year for mitigation actions of the Kyrgyz Republic in NDC 2, and since the time of this document covers 2011-2018, information on the previous NDC 1 with a full list of measures and calculated GHG emission reductions are presented here. At the same time, GHG emission reductions presented both in quantitative terms in Gigagrams CO_2 eq. and as a percentage of the level of future projected emissions under the “business as usual” scenario, i.e. without taking action. A summary of the main categories of NDC 1 measures is presented in Table 0.3.

Table 0.3. NDC 1 mitigation actions’ targets for Kyrgyzstan by sector in 2025

#	Measure	Gg CO_2 eq.	Status
1	Reduction of heat energy losses	80,54	Is being implemented
2	Implementation of the Building Code on energy efficiency of buildings	74,16	Is being implemented
3	Improving the energy efficiency of the existing building stock	123,57	Resource mobilization is underway
4	Reduction of energy losses	109,91	Is being implemented
5	Reduction of gas losses	860,06	Is being implemented

6	Transport	1395,80	Resource mobilization is underway
7	Biomass	347,00	Resource mobilization
8	Solar energy - electricity	12,95	Resource mobilization
9	Solar energy - heat	78,44	Resource mobilization
10	Geothermal energy	137,22	Resource mobilization
11	Hydropower	49,0	Resource mobilization is underway
Total estimated reductions		**3269,73**	
% of reductions from BAU emissions		**23,24**	

ES 5. Information about received support and needs

Support received

During the period under review, Kyrgyzstan has received and is receiving significant support in climate finance and capacity building. However, until now, the technology transfer mechanism has practically not been used.

Technology transfer is defined as a broad set of processes encompassing the “know-how” flows, experiences, and equipment for mitigating and adapting to climate change among the various stakeholders. It covers the transfer of technology between developed countries, developing countries, and countries with economies in transition. It includes the process of learning to understand, use and replicate the technology, including the ability to select and adapt it to local conditions, as well as incorporate it into local technologies.[10]

At the same time, today, in order to achieve the ultimate goal of the UNFCCC, as formulated in Article 2, KR will require technological innovation, rapid and widespread transfer and implementation of technologies, including the “know-how” of reducing the effects of greenhouse gas emissions. Technology transfer for adaptation to climate change is also an important element in reducing vulnerability to climate change. Technologies for mitigating and adapting to climate change, defined as environmentally sound technologies (EST), support the overall sustainable development of the Kyrgyz Republic.

A special Technology Mechanism of the Convention has been established to facilitate obligations the provision of the convention on the development and technology transfer. Provision of Article 10 of the Paris Agreement serves as the legally binding basis for the functioning of this mechanism. Structurally, the mechanism consists of two bodies working together, the Technology Executive Committee (TEC) and the Climate Technology Center and Network (CTCN). The Executive Committee, as well as the Center and the Network, operates under the authority of the Conference of the Parties, providing communications and advice through the Subsidiary Body for Implementation. Although this Mechanism is represented by two bodies, they are initially aimed at synergy in the process of providing targeted technical support and responding to the needs of countries.

During the reporting period, the Kyrgyz Republic received significant support from international donors in the area of climate change. (See Chapter 4).

Since 2018, the country has been implementing the project “Support to Kyrgyzstan in the preparation of the First Biennial Update Report and the Fourth National Communication of the Kyrgyz Republic under the UNFCCC” with financial support from the GEF. The aim of the project is to assist the country in preparing NC 4 and BUR 1 for the Conference of the Parties as fulfilling obligations under the

[10] IPCC. Special report. Methodological and Technological Issues in Technology Transfer. 2000 - p. 3.

Convention, the Decision 1/CP.16 (paragraph 60), Decision 2 / CP.17 (paragraph 41) and its Annex III. The project is being implemented by UNEP.

Support Needs

The need for support for climate action is determined by the national socio-economic context and the inadequate institutional organization of climate action in Kyrgyzstan.

According to the subject of BUR 1, the problems presented below are supposed to be solved with the international support and expertise.

Thus, in the field of inventory of greenhouse gases, as well as mitigation of climate change, there are the following main problems: (a) Lack of institutional mechanisms for regular inventory and maintenance of GHG inventories; (b) Lack of an accepted format of official statistical accounting for keeping records and inventory of GHGs; (c) Gaps in the time series of data, lack or absence of data for individual sectors of the economy; (d) Insufficient capacity for forecasting the development and emissions by sector; (e) Lack of strategic documents on reducing GHG emissions by sources and expanding absorption by sinks; (f) Lack of a national system for Measuring, Reporting and Verification / Enhanced Transparency Framework for mitigation measures, actions and projects; (g) Insufficient legal and financial incentives for the introduction of environmentally friendly technologies; (h) Insufficient capacity of mathematical modeling of development and use of dynamic models of emissions and priority mitigation actions; (i) Insufficient capacity to transfer environmentally sound technologies.

ES 6. Domestic (National) System of Measurement, Reporting and Verification (MRV)

Prerequisites for the MRV system establishment

The Measurement, Reporting and Verification System (MRV) is an essential tool for tracking the progress made by a country in the implementation of actions to achieve Nationally Determined Contributions (NDCs) to global emission reductions, but also in achieving the Sustainable Development Goals (SDG 13, etc.). The MRV system is structured in three key areas: MRV of GHG emissions, MRV of mitigation and adaptation actions, and MRV assistance (financial, technological and capacity building).

The Paris Agreement adopted in 2015 calls promotes Enhanced Transparency Framework of GHGI action and support, noting that all Parties to the agreement need to work towards establishing common rules, procedures and guidelines based on the experience of UNFCCC transparency reporting. It is expected that these countries will receive support to build a strengthened transparency framework.

According to Law of the Kyrgyz Republic “On the State Regulation and Policy in the Field of Emissions and Absorption of GHG”, the monitoring of emissions and absorption of greenhouse gases are conducted to provide state bodies that regulate and control climate change, as well as individuals and legal entities with timely and reliable information on the emissions level and absorption of greenhouse gases. At the same time, state monitoring of greenhouse gas emissions and absorption is an integral part of environmental monitoring, and the results of monitoring greenhouse gas emissions are subject to registration in the State cadaster of greenhouse gas emissions and removals after verification carried out in accordance with the established procedure by a specially authorized state body.[11]

[11] Law of the Kyrgyz Republic “On State Regulation and Policy in the field of Emission and Absorption of Greenhouse Gases” dated May 25, 2007 No. 71. Article 10, paragraph 1.

Unfortunately, these provisions of the Law did not work due to the lack of necessary subordinate regulations: developed methods, instructions, and procedures, as well as the lack of the necessary human resources.

Currently, the Kyrgyz Republic uses the global MRV mechanism, and the key elements of the domestic (national) MRV system manifested in the periodic reporting mechanisms to the UNFCCC, established for country reporting on current and projected emissions, as well as on mitigation and adaptation projects implemented in the country. KR reports on national emissions and their trends in regular national communications developed based on research, analysis, reports of leading national experts, publications of leading international organizations, and consultants.

Individual documents that can be used for the home MRV system in Kyrgyzstan have been developed in the frame of various projects implemented by international development partners. Thus, in 2013, within the "Poverty and Environment Initiative" of UNDP and UNEP, involving the OECD, there was developed the Guidance on national Green Growth indicators of Monitoring and Evaluation in the Kyrgyz Republic. In 2018, within the GEF-UNDP project "Strengthening the institutional and legal capacity to ensure improvement of the national environmental information management and monitoring system," were analyzed and conducted a methodological comparison of 39 main indicators developed by the UNECE working group on a set of key statistics related to the climate change. This set of 39 indicators can become the basis not only for improving national statistics on climate change but also for launching a home (national) MRV system in Kyrgyzstan.

Recommendations to organize the national MRV system

The creation of a domestic MRV system in Kyrgyzstan will be carried out in full compliance with the UNFCCC guidelines on greenhouse gases, mitigation and adaptation actions and will also include an MRV for climate finance. This system will reflect the vision of the Government of Kyrgyzstan of the MRV system designed, among other things, to track its progress towards achieving targets of the Paris Agreement and the implementation of the UNFCCC requirements on the Enhanced Transparency Framework.

The Kyrgyz Republic's MRV system will follow the principles of cost efficiency and maximum use of existing infrastructure and processes for data collection, reporting and verification, including quality control and quality assurance procedures. Establishing the MRV system is a complex process that requires adequate time and resources. Except establishing of working organizational structures, it is necessary to legalize the system by means of the relevant government decrees on MRV.

The existing legislative framework provides an initial legal basis for the implementation of the MRV system. However, the implementation of MRV in Kyrgyzstan should be preceded by the development of detailed MRV standards and rules, including the creation of appropriate templates and forms for measurements and reporting, determination of the baseline or starting point, as well as modeling of an institution and a system of accreditation of validators to check the reliability of the submitted reports, which also requires the development of appropriate tools. All these instruments will be approved by the relevant decisions of the Government of Kyrgyz Republic. At the same time, the process of developing these tools will be accompanied by measures to build the necessary human resources in the relevant organizations and institutions.

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Introduction

Climate Action Goals of the Kyrgyz Republic

As a signatory to the UNFCCC, the Kyrgyz Republic directs all its climate action to reach the ultimate goal of the Convention, which is aimed to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic impact on the climate system. This level must be achieved in a time frame sufficient for the natural adaptation of ecosystems to climate change, avoiding jeopardizing food production and ensuring further economic development on a sustainable basis.[12]

Today 196 countries are parties to the Convention. The Kyrgyz Republic joined the UNFCCC on January 14, 2000.[13]

According to Article 4 paragraph 1 point a) on the Obligations of the Parties and Article 12 paragraph 1 on Submission of Information Related to the Implementation of the Convention, each Party to the Convention is expected to submit to the Conference of the Parties (COP):

a) A national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, to the possible extent, using comparable methodologies to be proposed and agreed upon by the Conference of the Parties; A national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be promoted and agreed upon by the Conference of the Parties;
b) A general description of steps taken or envisaged by the Party to implement the Convention; and
c) Any other information that the Party considers relevant to the achievement of the objective of the Convention and suitable for inclusion in its communication, including, if feasible, material relevant for calculations of global emission trends.[14]

Reporting under the Convention

The National Communications are the main mechanism to provide information on the country's activities under the UNFCCC. Guiding Principles (Guidelines) for the preparation of national communications for non-Annex I countries were adopted at the Conference of the Parties in 1996 in Geneva (Decision 10/CP2). COP-8 (Delhi, 2002) adopted new Guidelines on National Communications for countries not parties to Annex I of the Convention (Decision 17/CP 8).

In compliance with these Guidelines, the Kyrgyz Republic developed in 2003 its First National Communication, including a national inventory of greenhouse gas emissions for the period 1990 – 2000, under the UNDP project "Assistance to Kyrgyzstan in preparation of the First National Communication in response to obligations under the UNFCCC" with financial support from the GEF. The Government of Kyrgyz Republic approved this document by the Decree No. 200 dated April 10, 2003.

The second national communication of the Kyrgyz Republic to the UNFCCC was also developed within the framework of the UNDP project with financial support of the GEF in 2009 and approved

[12] Article 2 of the UNFCCC dated May 9, 1992, UN website: https://www.un.org/ru/documents/decl_conv/conventions/climate_framework_conv.shtml
[13] Law of the Kyrgyz Republic "On the accession of the Kyrgyz Republic to the UN Framework Convention on Climate Change and the UNECE Convention on Long-Range Transboundary Air Pollution" dated January 14, 2000. No. 11.
[14] Article 12 of the UNFCCC, UN website: https://www.un.org/ru/documents/decl_conv/conventions/climate_framework_conv.shtml

by the Government of the Kyrgyz Republic on May 6, 2009 No. 274. Kyrgyzstan prepared the third National Communication with the support of the GEF and the UN Environmental Program (UNEP) project in 2016. The Government of the Kyrgyz Republic approved this document by the Resolution No. 546 on October 13, 2016.

COP 3 (Kyoto, 1997) adopted the Kyoto Protocol, representing a tool to set binding targets for Parties to the Convention through the commitments of industrialized countries and countries with economies in transition included in Annex I of the Convention to reduce total direct greenhouse gas (GHG) emissions at least by 5% against the 1990 level over the five years 2008-2012. The Kyrgyz Republic ratified the Kyoto Protocol on January 15, 2003.[15] As a non-Annex I party to the Convention, Kyrgyzstan had no GHG reduction commitments in the first commitment period of the Kyoto Protocol.

The 18th Conference of the Parties (Doha, 2012) adopted the Doha Amendment to the Kyoto Protocol, establishing a second commitment period (2013-2020), which assumed that during this period the developed countries from Annex I would reduce their GHG emissions by 18% relative to 1990. According to Conference Decision 1/CMP.8 and the provisions of the Kyoto Protocol (Article 21, paragraph 7 and Article 20, paragraph 4), this amendment will enter into force upon receipt by the Depositary of the Protocol "Instruments of Acceptance" by three-quarters of the parties to the Kyoto Protocol. This means that the Doha Amendment requires signed acceptance instruments from 144 countries to enter into force. As of February 18, 2020, 137 parties have placed their acceptance instruments to the depositary, most of which are non-Annex I countries of the UNFCCC.

In April 2013, in the response letter to the Notification to the Parties of the Copenhagen Agreement, received from the Secretariat of the Convention on January 18, 2010, Kyrgyzstan associated with the Copenhagen Agreement and following paragraph 5 of the Agreement provided an information on the quantitative target indicator of the Kyrgyz Republic by 2020 in the format of Annex II of this Agreement "Nationally Acceptable Mitigation Action in Developing Countries." The target indicator for Kyrgyzstan under this Agreement was to reduce GHG emissions by 20% via 2020 concerning the base year (1990) with the availability of adequate support.[16] This goal is presented without defining specific nationally acceptable actions, clearly described and quantified, and without explanation of the necessary support to achieve it. At the same time, it was clear that to accomplish the goal it is needed significant financial, technological support, as well as capacity development support obtained through the financial mechanism of the UNFCCC.

At the 19th Conference of the Parties (Warsaw, 2013), the parties agreed to submit their Intended Nationally Determined Contributions under Decision 1/CP.19 to include in a new climate agreement planned for adoption at COP 21 in Paris. For the new climate agreement, a new commitment period was established to reduce GHG emissions from 2021 to 2030 inclusive. In addition, COP 19 also adopted General Guidelines (Guidelines) for Home (National) Measurement, Reporting, and Verification Systems for Nationally Acceptable Mitigation Actions undertaken by Developing Countries at the National Level (Decision 21/CP.19).

Numerous developing countries in Warsaw have endeavored to establish loss and damage as an independent issue under the Convention, noting that loss and damage occur when mitigation and adaptation are not sufficient to prevent the negative impacts of climate change on food security and sustainable development. By a decision of the conference (2/CP.19), the Warsaw International Mechanism was established to promote appropriate approaches to address loss and damage — especially when loss and damage are pushing societies to revise existing ways of thinking and managing climate risks.

[15] Law of the Kyrgyz Republic "On Ratification of the Kyoto Protocol to the UN Framework Convention on Climate Change" dated January 15, 2003.
[16] Letter of the national responsible official body (State Agency on Environmental Protection and Forestry under the Government of Kyrgyz Republic) No. 07-01-28/1233 dated April 26, 2013, to the Secretariat of the Convention.

At COP 20 (Lima, 2014), the parties agreed to the Lima Call for Action on Climate Change, urging each party of the Convention (Decision 1/CP.20) to submit to the Secretariat their Intended Nationally Determined Contribution (INDC for achieving the objective of the Convention). To promote clarity, transparency, and understanding, INDCs may include: (i) quantitative information about the starting point; (ii) time frame and/or implementation period; (iii) scope and coverage; (iv) planning processes; (v) methodological approaches and assumptions, including those used to estimate and account for anthropogenic GHG emissions and removals; (vi) how a party takes into account its national circumstances and how it contributes to the achievement of the Convention's objective as set out in its Article 2.

According to the Lima Call to Action on Climate Change, countries were asked to submit their INDCs by March 31, 2015, and September 31, 2015, was set as the deadline. The Secretariat of the Convention was required to present a consolidated report on the aggregate effect of all INDCs submitted by the parties by November 1, 2015.

Kyrgyzstan was fully involved in the negotiation process under the UNFCCC on the adoption of the Paris Agreement at the 21st Conference of the Parties – a document that has legal force under the Convention for all parties to keep global warming below 2^0C by 2100 compared to the pre-industrial period.

The Minister of Foreign Affairs on behalf of the Kyrgyz Republic signed the Paris Agreement at the 71st session of the UN General Assembly in New York on September 24, 2016, and ratified on November 12, 2019. [17]

On September 29, 2015, Kyrgyzstan submitted its INDCs with an appropriate note verbale from the Ministry of Foreign Affairs of the Kyrgyz Republic to promote clarity, transparency, and understanding, referring to decisions 1/CP.19 and 1/CP/20.

In terms of mitigating climate change, according to its INDCs[18], the Kyrgyz Republic intends to achieve, at its own expense, the (unconditional) national goal of reducing greenhouse gas emissions by 11.49-13.75% relative to the "business as usual" scenario in 2030 and by 12.67-15.69% in 2050. Additionally, with international support, Kyrgyzstan can implement measures to achieve the (conditional) national goal of reducing GHG emissions by 29.00-30.89% relative to the "business as usual" scenario in 2030 and by 35.06-36.75% in 2050.

On November 7-18, 2016, the 22nd Conference of the Parties to the UNFCCC, the 12th Conference of the Parties to the Kyoto Protocol, as well as the first Conference of the Parties to the Paris Agreement (PC) took place in Marrakesh (Morocco). The main topics of the 22nd COP (November 14-15) were water resources management and the decarbonization of energy supply. In addition, the conference discussed the development of sustainable public transport in the direction of "zero emissions," the integration of low-emission technologies, and the promotion of innovative financing for existing infrastructure for the transition to green energy, the development of business models with a minimum carbon footprint.

The COP 23 of the Convention was held on November 6-17, 2017, in Bonn, Germany, under the chairmanship of the Prime Minister of Fiji. The 13th Kyoto Protocol Conference and the 2nd session of the 1st COP of PA were also held here. The conference continued to discuss the rules, detailed guidelines for the implementation of the Paris Agreement and made a decision called "Fijian Impulse for Implementation," which noted the need for urgent action and increased ambition to achieve the goals of the COP. The conference also made the historic decision to conduct work on agriculture by the forces of the convention to develop new strategies for adaptation and mitigation in agriculture. A

[17] Law of the Kyrgyz Republic "On the ratification of the Paris Agreement on the UN Framework Convention on Climate Change, signed on December 12, 2015 in Paris" dated November 12, 2019.

[18] After ratification, they become National Designated Contributions (NDC).

group of 30 countries announced the creation of the Past Coal Energy Alliance to move coal out of the power generation sector by 2030, today with 180 members.

The COP-24 of the convention took place in Katowice (Poland) on December 2-15, 2018. It also hosted the 14th Conference of the Parties to the Kyoto Protocol and the 3rd session of the 1st Conference of the Parties to the PA. The conference continued to develop and improve the PA Implementation Rules Book on how governments will measure and report on their efforts to reduce GHG emissions. At the PA COP adopted a package of climate documents, which outlined 8 principles (Annex to Decision 18/CMA.1) of the Enhanced Transparency Framework (WF) of the Paris Agreement to build confidence and certainty that all countries contribute to global efforts. In addition, the climate package adopted at the conference concretized this framework, applicable to all countries, by adopting a detailed set of Modalities, Procedures, and Guidelines (MPGs). The conference participants welcomed the timely submission by the IPCC of the Special Report on Global Warming by 1.5°C. The Informal Group of the High Ambition Coalition, including the countries of the European Union, Argentina Mexico, and Canada, announced their readiness to make higher commitments to reduce GHG emissions.

The 25th COP of the UNFCCC was held on December 2-13, 2019 in Madrid (Spain). It also hosted the 15th meeting of the parties to the Kyoto Protocol and the second meeting of the parties to the Paris Agreement. By general estimates, the results of the conference were insignificant and the contradictions insurmountable. Several operational decisions were adopted on the activities of the Warsaw Mechanism for Loss and Damage, the national adaptation plan, the financial mechanism of the convention, enhancing the development and transfer of climate technologies through the Technology Mechanism, and reviewing the implementation of the capacity-building framework in developing countries.

Representatives of the relevant state bodies of the Kyrgyz Republic took part in the above-mentioned Conferences of the Parties to the UNFCCC on an ongoing basis.

The 26th Conference of the Parties to the UNFCCC will take place from 1-12 November 2021 in Glasgow (UK), chaired by the UK in partnership with Italy, and will host a number of preliminary events.

In preparation for the 26th COP, Kyrgyzstan updated the second NDC to the Paris Agreement of the UNFCCC and submitted it to the Convention Secretariat.

The First Biennial Update Report (BUR 1) of the Kyrgyz Republic was prepared according to the "UNFCCC biennial update reporting guidelines for Parties not included in Annex I of the Convention" (Annex III to Decision 2/COP17), approved by the 17th Conference Parties to the UNFCCC.

BUR 1 supplements the information of the Third National Communication of the Kyrgyz Republic, submitted under Articles 4 and 12 of the UNFCCC, not only in terms of updating the information on the national greenhouse gas inventory for 2011-2018 but also presents the results of recalculating the estimate of GHG emissions in the Kyrgyz Republic for the period 1990-2018 using the 2006 IPCC Guidelines for National Greenhouse Gas Inventories methodology.

1. National Circumstances

1.1. General Description

Country development in the period 2010 to 2018 took place against the backdrop of the global financial crisis, growing uncertainty in world markets, which created risks for all market participants, including for the main trading partners of Kyrgyzstan - Russia, Kazakhstan, and China.

The internal political events of 2010 marked a new milestone in the development of the Kyrgyz Republic that will go down in the history of the country as a strength test of the Kyrgyz statehood and the entire system of public administration, including socio-political, economic, environmental, financial and other spheres of development management.

The most important result of this period as a whole for Kyrgyzstan was the transition of the Kyrgyz Republic to a parliamentary form of government and overcoming the unpredictable economic decline against the background of the consequences of the global financial crisis of 2008-2009, the change of the ruling regime and the interethnic conflict in April and June 2010 and technical accident at the largest gold mining enterprise “Kumtor” in 2012.

The result of deep socio-political and economic changes was a noticeable decline in the standard of living of the population. Thus, in 2012, about 2.1 million people or 38% of the total population lived below the poverty line, amongst them almost 66% were residents of rural settlements.[19]

The beginning of Kyrgyzstan's development stabilization period after the change of the ruling regime was characterized by the absence of long-term political strategies, and to determine the target socio-economic benchmarks to solve the problems of socio-economic development of the country at that time, the Government used the tool for the medium-term forecast of the socio-economic development of the Kyrgyz Republic. Consequently, another such document was adopted in early 2011.[20]

At that moment, there was an acute issue of mobilization and rational use of all reserves and resources to enter a sustainable path of development, including economic, human, natural, financial, and other aspects. The new political leadership of the country has officially declared a course towards sustainable development. For Kyrgyzstan, as a country with limited natural and financial resources, the transition to sustainable development seems to be a logical and politically justified choice.

The idea of sustainable development turned out to be consonant with the traditions, spirit, and mentality of the peoples of Kyrgyzstan, since, regardless of ethnicity and party affiliation, the peoples of Kyrgyzstan today are unanimous in their desire to overcome difficulties and live in a country that has a “future” and stable positions in development.

Confirmation of the political course of the Kyrgyz Republic towards sustainable development was the establishment of the National Council for Sustainable Development under the President of the Kyrgyz Republic on November 24, 2012, which commenced its work combining the efforts of all government branches, the private sector and civil society on future development issues. Based on the results of the second meeting of the Council, the President of Kyrgyz Republic approved the National Sustainable Development Strategy of Kyrgyz Republic for the period 2013-2017 on January 21, 2013.[21]

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[19] The Programme of the Kyrgyz Republic Transition to Sustainable Development for 2013-2017.

[20] Mid-Term Forecast of socio-economic development of the Kyrgyz Republic for 2011-2013 adopted by the Governmental Resolution as of 26th January 2011 # 25.

[21] Adopted by the Presidential Decree as of 21st January 2013 # 11.

This document outlined the strategic guidelines for the new sustainable development model, the main priorities, and the 78 largest investment projects for this period. Taking into account that the implementation of the National Strategy for Sustainable Development of the Kyrgyz Republic 2013-2017 requires a real management tool for the next five years, the Government of Kyrgyz Republic adopted the Program for the Transition of the Kyrgyz Republic to Sustainable Development for 2013-2017. These two strategic documents determined the development of the country during the period considered in this document.[22]

1.1.1. Geography and Climate

The Kyrgyz Republic (hereinafter - KR) is located in the center of the Eurasian continent, in the northeast of Central Asia (Figure 1.1). 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 on four states: the Republic of Kazakhstan, the People's Republic of China, the Republic of Tajikistan, and the Republic of Uzbekistan.

Figure 1.1Map of Kyrgyzstan [23]

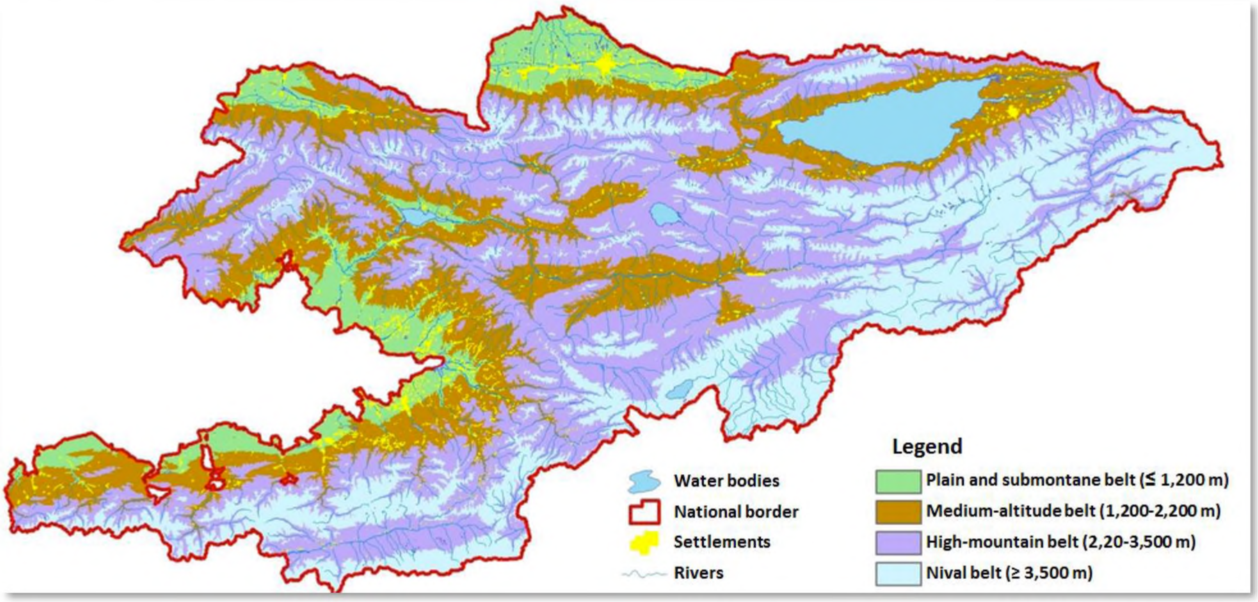
KR is located within the Tien Shan and Pamir-Alai mountain ranges. The lowest point (488 m above sea level) is the point where the Naryn River crosses the border with the Republic of Uzbekistan, and the highest is Pobeda Peak (7439 m). The average height of the territory above sea level is 2630 m.

[22] Approved by the Resolution of the Government of Kyrgyz Republic dated April 30, 2013 No. 218.

[23] Source: https://www.nationsonline.org/oneworld/map/kyrgyzstan-political-map.htm

All the variety of landscapes and natural and climatic conditions of the Kyrgyz Republic are combined into four natural and climatic zones: valley-foothill - up to 1200 m, mid-mountain - from 1200 to 2200 m, high-mountain - from 2200 to 3500 m, and nival - above 3500 m (Figure 1.2, Figure 1.3).

Figure 1.2 Natural and climatic zoning in altitude above sea level

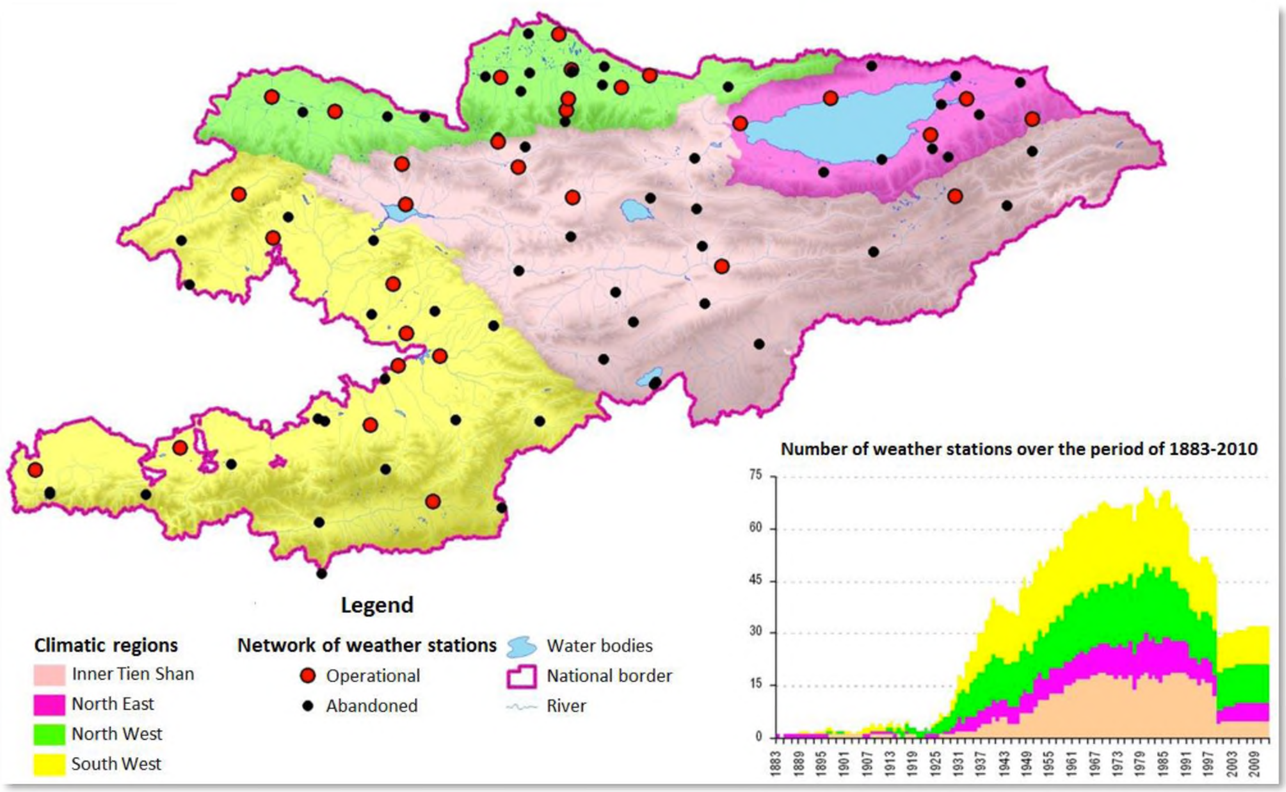


Less than 20% of the territory of the Kyrgyz Republic belongs to areas with comfortable living conditions. Large systems of mountain ranges, oriented in different directions, led to the creation of several regions, where the climate is considerably homogeneous and noticeably different from each other.

There are four climatic regions on the territory of the Kyrgyz Republic: Inner Tien Shan, North-East, North-West, South-West (Figure 1.3).

Figure 1.3 Climate zoning and observation network of the Kyrgyz Republic[24]

[24] Source: KRSU



1.1.1.1. Climate

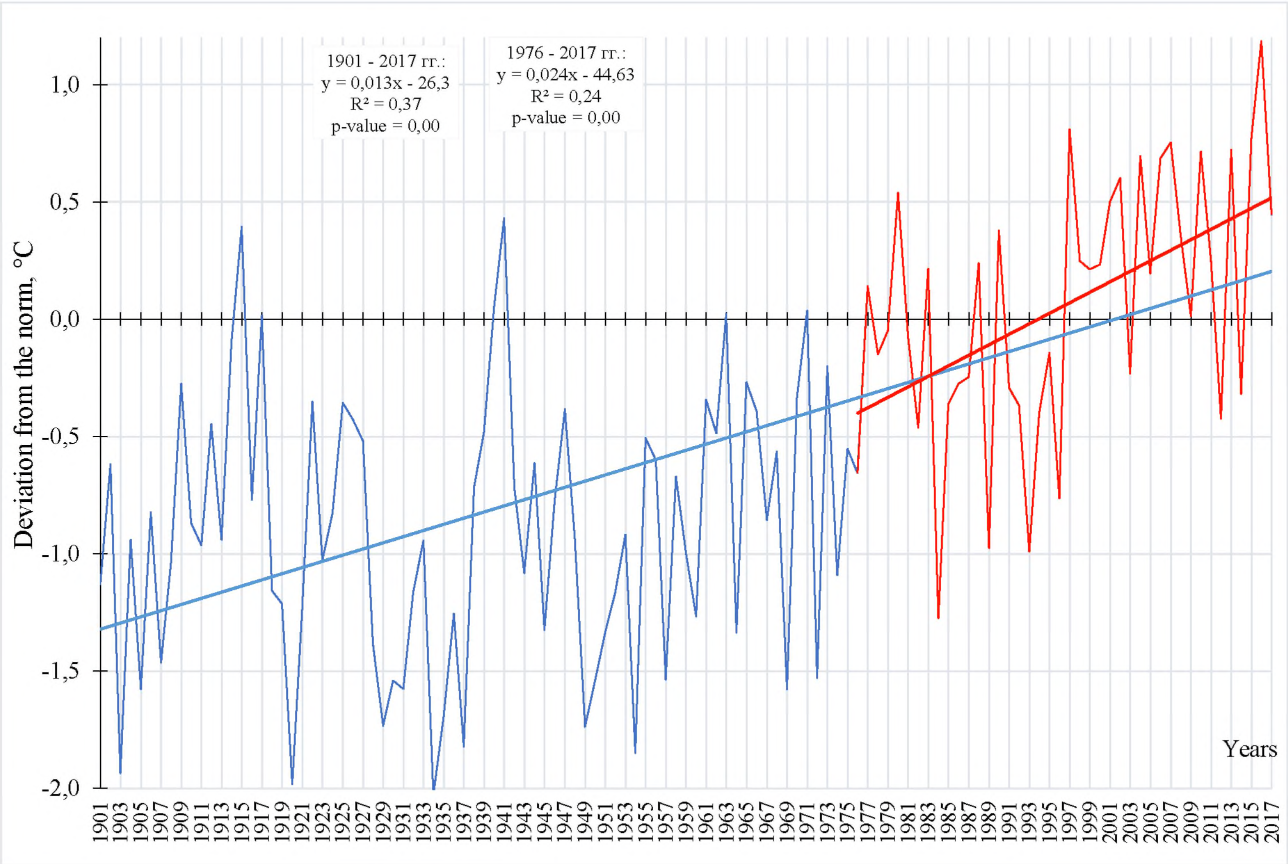
The climate of the Kyrgyz Republic is sharply continental, mostly arid, moderately smoothed by an increase in cloudiness and precipitation due to the high-mountainous relief. The peculiarities of the climate determined by the location of the republic in the Northern Hemisphere in the center of Eurasia, as well as the distance from significant water bodies and the proximity of deserts. Temperature ranges vary greatly, on average from - 28°C in the mountain valleys in January to + 27°C in the Fergana Valley in July. The registered absolute maximum temperature was + 43.6°C in the north of the republic; the absolute minimum was - 53.6°C in the Ak-Sai valley. The features of the relief shape the vertical zonation in the distribution of precipitation. In general, the annual rainfall in many areas is significant, however, during the summer vegetation season, it is limited. A characteristic feature of the territorial distribution of precipitation is its extreme unevenness. The largest amount of annual precipitation (about 1000 mm) was noted in the mid-mountain zone of the southwestern slopes of the Fergana ridge, the high-mountain and nival belt of the northern slopes of the Kyrgyz ridge, on the Chatkal ridge, and in the Eastern Issyk-Kul region (700-900 mm per year). The smallest annual precipitation (about 150 mm) was observed in the Western Issyk-Kul region, in some areas of the Fergana region, and some high-mountainous areas of the Osh region.

The first meteorological station on the territory of the Kyrgyz Republic was opened in 1856 (Ak-Suu, Issyk-Kul region). The largest number of observational hydrometeorological points recorded in the 70s - early 80s of the last century (more than 80 meteorological stations). A two-stage reduction in the number of meteorological stations, especially high-altitude ones in the early and late 90s of the last century, associated with a decrease in funding allocated for the maintenance of the observational network (Figure 1.3). With the support of international donors, mainly the World Bank, after 2015 there were marked openings of new weather stations with automatic observations. At present, the Kyrgyzhydromet system has more than 50 automatic meteorological stations, including 34 meteorological stations with parallel manual types of observations.

The uniform data from 32 meteorological stations of Kyrgyzhydromet were used to process the results of changes in the observed climate. Homogeneous meteorological series have been available since the mid-1970s of the last century, and therefore, to restore the historical series from 1901 to 1975, the method of inverse linear regression was used applying datasets gridded to CRU with the resolution of 0.5 degrees.

The analysis conducted with the support of the IFAD in 2017 indicates a significant increase in air temperature on the territory of the Kyrgyz Republic. Therefore, the average annual temperature during the period from 1901 to 2017 has increased significantly in the Kyrgyz Republic (see Figure 1.4.). If the average annual temperature in the republic from the beginning of the last century was 0.013 °C/year (or 0.1 °C every 10 years), then during the period from 1976 to 2017 the growth rate almost doubled and amounted to 0.024 °C/year (or 0.2 °C every 10 years). Both trends are statistically significant with a 95% confidence level.

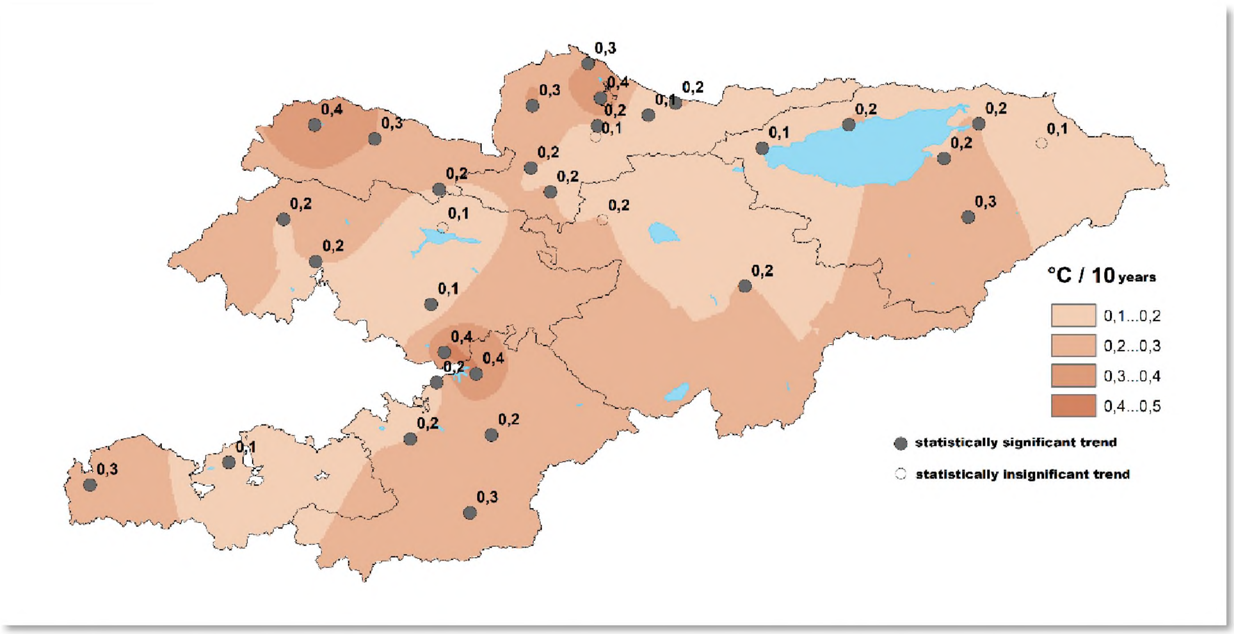
Figure 1.4 Anomalies of the average annual air temperature (in ° C) over the territory of the Kyrgyz Republic



Anomalies are calculated relative to the baseline period 1981-2010. Blue line - a linear trend for 1901-2017, red line - a linear trend for 1976-2017.

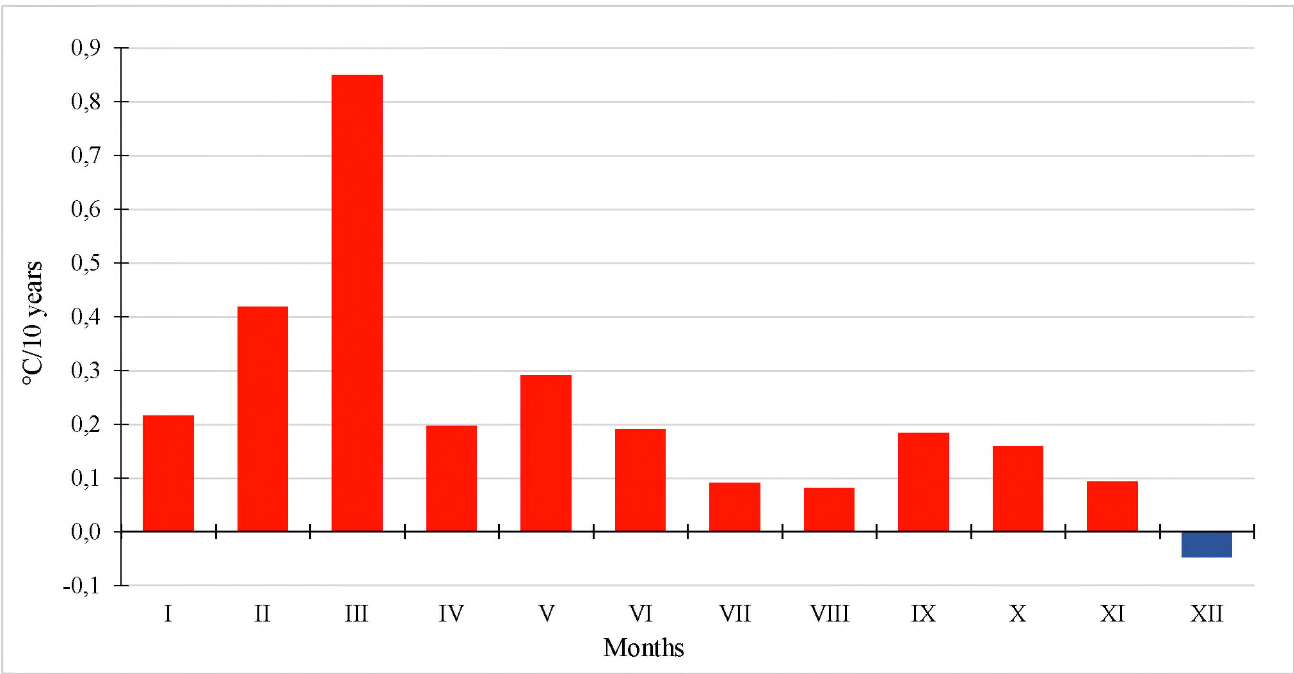
The highest growth rates of the average annual temperature (an increase of 0.4 °C every 10 years) are observed in large cities of Kyrgyzstan - Bishkek, Jalal-Abad, Kara-Suu (Osh), as well as Kyzyl-Adyr - in the area of the Kirov reservoir (figure 1.5).

Figure 1.5 The change rate in air temperature (in °C for every ten years) in Kyrgyzstan at the locations of meteorological stations during 1976-2017 (linear trend coefficient)



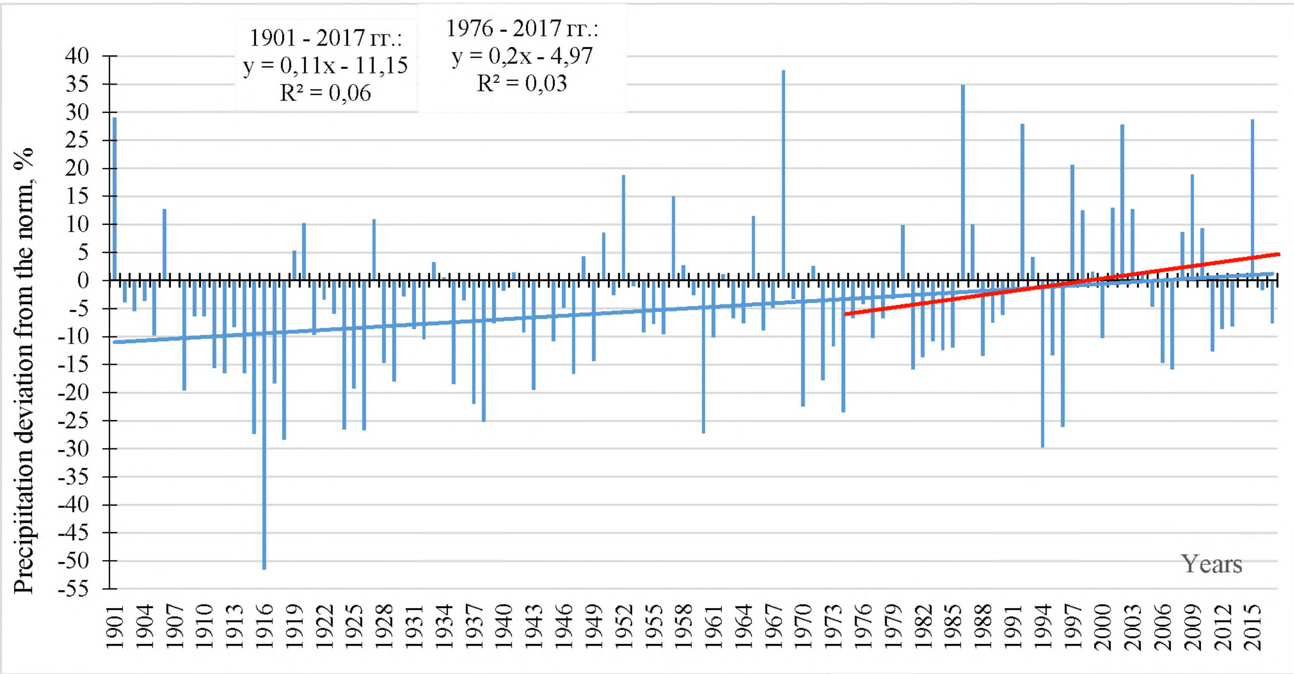
Considering the nature of the air temperature changes seasonally, the highest growth rates (statistically significant) for the entire republic are observed in the spring period - by 0.45 °C every 10 years; in winter, summer, and autumn periods, the temperature change is statistically insignificant and is 0.22 °C, 0.12 °C, and 0.14 °C every 10 years, respectively. Every month, the largest increase in temperature for the republic as a whole is observed in March and estimated 0.85 °C every 10 years and in February - by 0.42 °C every 10 years (Figure 1.6). In the warm period of the year (from May to September), there is a tendency to increase in the number of cases and duration of heatwaves, mainly in the valley zones of the country and in the southeast of the Issyk-Kul region.

Figure 1.6The rate of change in monthly temperature on average in Kyrgyzstan (linear trend coefficient) for the period 1976 - 2017



The precipitation regime in the Kyrgyz Republic, apart from significant territorial and seasonal variability, is also characterized by inter annual variability and cyclicality. Overall, in the republic, since the beginning of the last century, there has been an insignificant tendency towards an increase in the annual amount of precipitation - by 0.11%/year (or by 1% every 10 years). Since the mid-70s of the last century, the rate of annual increase has been increasing and amounts to 0.2%/year (or 2% every 10 years). Both trends are statistically insignificant. The largest tendencies for an increase in precipitation are observed in the summer and winter periods (the trends are statistically irrelevant). However, local changes in monthly precipitation have an individual character of change: from significant reductions to significant increases. During the research, precipitation anomalies for deviations from the norm were calculated relative to the base period 1981-2010. (See Figure 1.7. Blue line - a linear trend for 1901-2017, red line - a linear trend 1976-2017)

Figure 1.7Annual precipitation anomalies (%) over the territory of the Kyrgyz Republic



1.1.2. State Governance

The Kyrgyz Republic (Kyrgyzstan) is a sovereign, democratic, law-based, secular, unitary, and social State.

State power in the Kyrgyz Republic is based on the principles of the division of State power into the legislative, executive, and judicial branches furthermore their coordinated functioning and interaction.

The President of the Kyrgyz Republic is the head of State and embodies the unity of the people and State power. The President is elected for a term of six years.

The Zhogorku Kenesh is the Parliament of Kyrgyz Republic, the highest representative body exercising legislative power and supervisory functions within the limits of its powers.

Executive power in the Kyrgyz Republic is exercised by the Government, its subordinate ministries, State committees, administrative departments, and local State administrations.

Judicial power is executed through constitutional, civil, criminal, administrative, and other forms of judicial proceedings. The judicial system of the Kyrgyz Republic consists of the Supreme Court and local courts. The Constitutional Chamber is part of the Supreme Court.

The first Constitution was adopted on 5 May 1993 at the twelfth session of the Supreme Soviet of the Republic of Kyrgyzstan. Based on the results of the referendum on May 05, 2021, a new version of the Constitution of the Kyrgyz Republic was ratified.

State organization has three levels of administrative and territorial division. As of 1st January 2018, the system of administrative-territorial organization of the Kyrgyz Republic includes 7 oblasts (regions), the cities of Bishkek and Osh, which have the status of republican subordinate cities, 40 districts (without urban districts), 31 cities, 9 urban-type settlements, 3 settlements, 453 aiyl aimaks. The Kyrgyz Republic has the status of a republican subordinate city. [25]

1.1.3. Demography

As of 1 January 2018, the resident population of the Kyrgyz Republic amounted to 6,257 thousand people (50.4% are women). Because of the mountainous terrain, the population of Kyrgyzstan distributed extremely uneven throughout the territory of the Republic.

The number of inhabitants per km^2 was 31 people. The majority of the population lives and carries out most of the economic activity within the low mountains, the intermountain basin, and the mountain valleys, and the greatest activity of the population is concentrated within these settlements and a small buffer zone of 5 km around the settlements. The share of the urban population is 33.9%, 66.8% of which are of working age (men from 16 to 62, women 16 to 57 years). The rural population accounts for 66.1%, 58.2% of whom are of working age. [26]

In 2018, the average life expectancy at birth was 71.3 years (67.4 for men and 75.6 for women).[27]

For the period 2011-2018 the average annual growth rate of the population in the republic varied from 1.9% to 2.1%.[28] The general demographic situation in the Kyrgyz Republic at the beginning of 2018 is shown in Table 1.1.

Table 1.1 Demographic indicators by administrative entities in 2018 (thousand people) [29]

Regions and cities of republican subordination	Entire population			Urban population			Rural population		
	All	Male	Female	All	M	F	All	M	F
Kyrgyz Republic	6,256.7	3,101.8	3,154.9	2,121.0	1,007.6	1,113.4	4,135.7	2,094.2	2,041.5
Batken region	513.6	261.4	252.2	121.1	60.3	60.8	392.5	201.1	191.4
Jalal-Abad region	1,190.6	598.8	591.8	259.2	124.8	134.4	931.4	474.0	457.4
Issyk-Kul region	483.0	240.4	242.6	139.0	65.9	73.1	344.0	174.5	169.5
Naryn region	283.8	144.4	139.4	39.3	19.4	19.9	244.5	125.0	119.5
Osh region	1,314.1	663.7	650.4	100.9	50.2	50.7	1,213.2	613.5	599.7
Talas region	259.0	130.9	128.1	37.7	17.9	19.8	221.3	113.0	108.3
Chui region	921.7	453.7	468.0	166.1	77.6	88.5	755.6	376.1	379.5
Bishkek city	1,002.1	468.8	533.3	997.7	466.6	531.1	4.4	2.2	2.2
Osh city	288.8	139.7	149.1	260.0	124.9	135.1	28.8	14.8	14.0

[25] National Statistical Committee (NSC). Kyrgyzstan in numbers. –B., 2021
[26] NSC. Demographic Yearbook 2016-2020 –B., 2021
[27] NSC. Kyrgyzstan in numbers. –B., 2021
[28] Ibid.
[29] NSC. Demographic Yearbook 2014-2018 –B. 2018.

1.2. Natural Resources

1.2.1. Land Resources

The territory of Kyrgyzstan can be divided into four main geomorphological categories: mountains, foothills, foothill valleys, and foothill plains. Mountains (over 1,500 meters) cover over 90% of the country's territory, where about 14% of the population lives. 86% of the population and all arable land is concentrated on 7% of the territory occupied by valleys and plains. The soil cover in Kyrgyzstan is represented by a wide variety of soil areas, which include zone of desert soils, zone of the desert steppe, zone of the dry steppe, zone of mountain meadow-steppe soils, zone of mountain meadow soils, zone of meadow steppe (subalpine and alpine), zone of high mountain steppe and zone of high-mountainous desert soils.[30] The general land distribution is shown in table 1.2.

Table 1.2 Dynamic of the various categories of land resources of the Kyrgyz Republic (thousands of hectares) [31]

Categories*	2011	2012	2013	2014	2015	2016	2017	2018
Total	**19,994.9**	**19,994.9**	**19,994.9**	**19,994.9**	**19,994.9**	**19,994.9**	**19,994.9**	**19,994.9**
including:								
agricultural lands	5,679.7	5,674.8	6,502.3	6,544.1	6,542.6	6,753.9	6,753.4	6,754.8
lands of settlements	266.4	272.9	273.9	275.3	276.2	276.7	277.9	278.4
lands for industry, transport, defense, communications and other purposes	222.7	224.3	227.1	228.2	228.9	230.9	230.8	231.5
lands of specially protected natural areas	707.4	707.3	715.3	742.4	823.8	854.4	1,187.3	1,187.3
forest lands	2,617.2	2,617.8	2,609.7	2,600.0	2,600.0	2,596.8	2,530.4	2,530.4
water fund lands	767.3	767.3	767.3	767.3	767.3	767.3	767.3	767.3
reserve lands	9,734.2	9,730.5	8,899.3	8,837.6	8,756.0	8,514.9	8,247.8	8,247.2
As a percentage of total								
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
including:								
agricultural lands	28.4	28.4	31.3	32.8	32.8	33.8	33.8	33.8
lands of settlements	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
lands for industry, transport, defense, communications and other purposes	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2
lands of specially protected natural areas	3.5	3.5	3.6	3.7	4.1	4.3	5.9	5.9
forest lands	13.1	13.1	13.1	13.0	13.0	13.0	12.7	12.7
water fund lands	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
reserve lands	48.7	48.7	45.7	44.2	43.8	42.5	41.2	41.2

* In accordance with the Land Code of the Kyrgyz Republic.

The area of irrigated land in 2018 amounted to 79.9% of the total arable land. There has been a steady downward trend in arable areas throughout the entire period. At the same time, the proportion of irrigated land and its total area have increased. The area of fallow lands and hayfields has increased. The area of perennial plantations changed insignificantly (see table 1.3).

[30] United Nations Economic Commission for Europe. Committee on Environmental Policy. Environmental Performance Reviews. Kyrgyzstan. Geneva. 2009 r.

[31] NSC. Environment in the Kyrgyz Republic. Statistical collection 2011-2015. Bishkek. 2016; Environment of the Kyrgyz Republic 2014-2018. Bishkek. 2019; Environment of the Kyrgyz Republic 2016-2020. Bishkek. 2021.

Table 1.3 Agricultural land area, (at the beginning of the year, thousand hectares) [32]

Land type	2011	2012	2013	2014	2015	2016	2017	2018
Total	10,650.8	10,647.20	10,629.70	10,626.40	10,625.20	10,624.7	10,608.1	10,607.2
including:								
Arable land	1,276.2	1,275.90	1,276.60	1,278.70	1,280.60	1,280.6	1,287.8	1,287.8
Perennials	74.2	74.7	74.8	75.4	75.2	75.2	75.8	75.9
Deposits	38.9	38.7	38.4	37.8	36.0	35.9	34.8	34.8
Hayfields	197.5	199.5	199.7	201.4	201.7	202.1	202.2	202.2
Pasture	9,064.0	9,058.40	9,040.20	9,033.10	9,031.7	9,030.9	9,007.5	9,006.5

1.2.2. Water Resources

Kyrgyzstan is the only country in Central Asia, whose water resources are almost entirely formed on its territory, and this is its hydrological feature and advantages. Water resources are used for energy production, irrigation, industrial, and domestic water supply. The republic's water resources are concentrated in glaciers, lakes, rivers, and groundwater.

In total, according to the "Landsat-8" data remote sensing as of 2013-2016, there are 9,959 glaciers on the territory of the Kyrgyz Republic with a total area of 6,683.9 km^2, including 6,227 glaciers larger than 0.1 km^2, with a total area of 6,494.0 km^2 and 3,732 glaciers less than 0.1 km^2 in size, with a total area of 189.9 km^2.

According to the Catalogue of Glaciers of the USSR (40-70s of the XX century), there were 8,164 glaciers on the territory of Kyrgyz Republic with a total area of 7,944.2 km^2, including 6,719 glaciers with a size larger than 0.1 km^2, with a total area of 7,866.6 km^2 and 1,445 glaciers less than 0.1 km^2 in size, with a total area of 77.6 km^2.[33]

Thus, over approximately seventy years, there have been significant changes in the overall glaciation of the Kyrgyz Republic. The area of glaciers in Kyrgyzstan has decreased by 16%, the area of bige glaciers has decreased by 17%, while the area of small glaciers has increased by two and a half times (by 245%). This is related to the general acceleration of glacier melting, in which the degradation of large glaciers not only reduces their area but also degrades them into separate parts, that function as independent small glaciers. Besides, in some parts of the Catalogue of Glaciers of the USSR, glaciers less than 0.1 km^2 in size are not included at all, and in the present catalogue all glaciers larger than 0.01 km^2 each are counted. The total number of glaciers has increased by 22%. This is due to an increase in the number of small glaciers (smaller than 0.1 km2) by two and a half times (by 258%), while the number of large glaciers (larger than 0.1 km2) has decreased by 7.5%.[34]

Kyrgyzstan's glaciers contain significant water resources amounting to about 760 cubic km. [35]

Lakes, reservoirs, and ponds are of great importance in the development and functioning of the national economy, the development of water and energy resources, the protection of the environment, and the establishment of an efficient water balance.

Kyrgyzstan has 1,923 lakes with a total surface area of 6,836 km^2, the largest of which are Issyk-Kul (6,236 km^2), Son-Kul (275 km^2), and Chatyr-Kul (175 km^2). The lakes are located mainly in the high mountain zone - 3-4 thousand m above sea level. [36] The water reserves in the lakes of the republic are

[32] NSC. Environment of the Kyrgyz Republic 2014-2018. - B., 2019
[33] Central Asian Institute for Applied Geosciences. Catalogue of glaciers of Kyrgyzstan. - B., 2018.
[34] Central Asian Institute for Applied Geosciences. Catalogue of glaciers of Kyrgyzstan. - B., 2018.
[35] State Agency for Water Resources under the Government of the Kyrgyz Republic (GAVR). website: https://www.water.gov.kg/index.php?option=com_content&view=article&id=228&Itemid=1274&lang=ru
[36] Ibid.

estimated at 1,745 km^3. Among them, 1,731 km^3 (or 99.2% of the volume of all lakes) is concentrated in Lake Issyk Kul, which is saline and unsuitable for water supply.

There are more than 3,500 large and small rivers in the Kyrgyz Republic. Around 2,000 rivers are longer than 10 km and their total length is almost 35,000 km. The longest rivers are the Naryn (535 km), the Chatkal (205 km), and the Chu (221 km). Moreover, there are 44 deposits of freshwater and mineral groundwater.[37]

The hydropower potential of the rivers is about 174 bln. kW hour and the capacity is 19.8 mln kW. [38]

According to the data of the National Statistic Committee, in 2018, water intake made up 7,758 million m^3, which is 4,65% more than in 2011. 96,8% of this intake were from surface water objects and 3,2 % from underground waters.[39]

The structure of water use in the Republic is represented by the needs of irrigated agriculture, industry, and water supply of the population. Forestry, fisheries, energy and services sphere together use up to 1% of total domestic water use.

In 2018, water consumption accounted for 5,088.7 million cubic meters. Of the total water consumption, a significant proportion (94.7%) is used for irrigation and agricultural water supply, 3.2% for domestic drinking water, and 1.6% for production. [40] About 27% of the water is lost during transportation due to poor irrigation systems.

The largest consumers of water for irrigation and agricultural water supply in 2018 are Chui (24.4%) and Osh (17.4%) and Jalal-Abad (14.2%) regions. Concerning the use of water for domestic use, the largest share accounted for the city of Bishkek (34.7 %), Osh region (over 26 %) and Chui region(13.4%).[41]

The last and the most extensive reassessment was carried out by the Institute of Water Issues and Hydro Energy of the National Academy of Sciences of Kyrgyz Republic on the basis of researches on river flow dynamics over the last 40 years, against the background of climate change. The average annual flow of the main river basins of the Kyrgyz Republic is 47.2 km^3. [42]

Potential freshwater resources of the Kyrgyz Republic are estimated at 13 km^3. They are mainly concentrated in the intermountain trenches, the territories of which are the most economically developed. Operating groundwater reserves in industrial categories are more than 16 million cubic meters/day or more than 5 cubic kilometers per year.[43]

The total water consumption per capita in 2018 amounted to 813.4 m^3. [44]

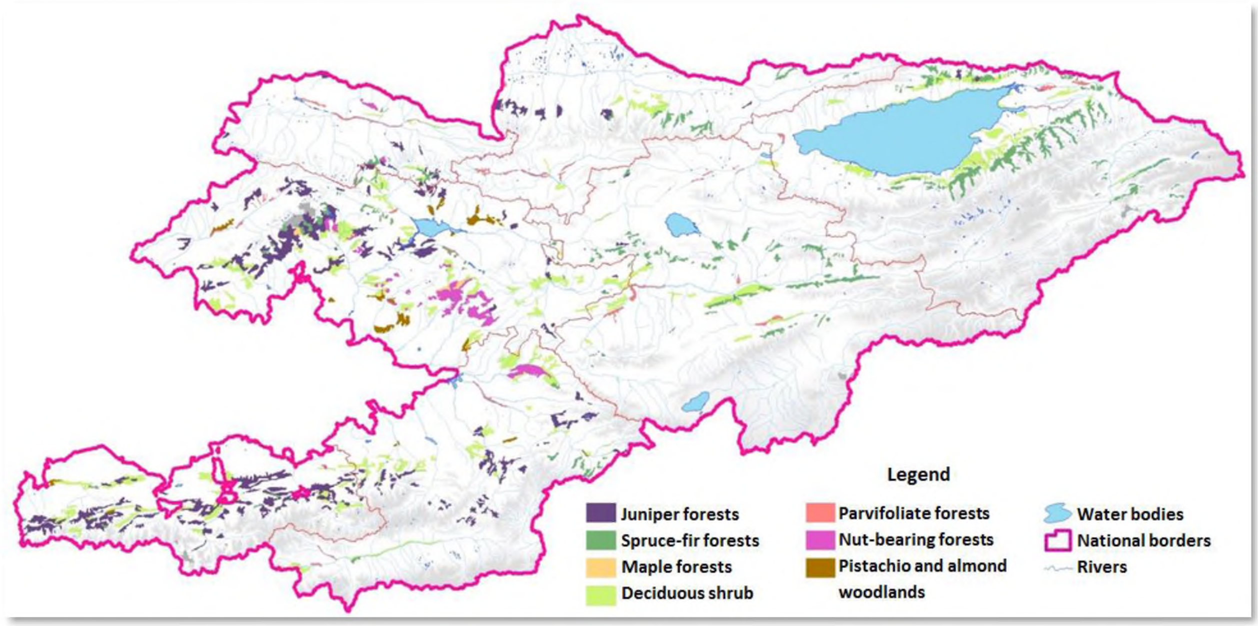
1.2.3. Forest Resources

In the Kyrgyz Republic, 30 species of woody vegetation of all groups of tree species, typical for mid-latitudes, are found under natural conditions: coniferous, hardwood, soft nut fertilizer, fruit, seed, fruit, and more than 17 species of shrubs. The combination of different species determines a wide variety of

[37] NSC. Environment 2014-2018. Statistical compilation. Bishkek. 2019.
[38] Website State Agency of Water Resources - https://www.water.gov.kg/index.php?option=com_content&view=article&id=228&Itemid=1274&lang=ru
[39] NSC. Environment 2016-2020. Statistical collection. Bishkek. 2021.
[40] Ibid.
[41] NSC. Environment 2016-2020. Statistical collection. Bishkek. 2021.
[42] National report on the state of the environment of the Kyrgyz Republic for 2011-2014, approved by the Decree of the Government of Kyrgyz Republic dated December 19, 2016 No.549-r
[43] TNC, approved by the Resolution of the Government of the Kyrgyz Republic of October 13, 2016 No. 546.
[44] NSC. Environment 2016-2020. Statistical collection. Bishkek. 2021.

forest ecosystems, ranging from archipelagic (juniper) and spruce in the highlands, nuts in the midlands to thick (floodplains) in the low mountains (Figure 1.8).

Figure 1.8 Forests of Kyrgyzstan[45]



The most widespread are arch (juniper) and spruce forests (about half of the forested area). Walnut trees occupy about 10% of the area covered by forests.

The vertical zonation and the diversity of climatic zones, on the one hand, have led to a wide variety of forest-forming species in forest reservoirs and, on the other hand, to a low forest cover of the country's territory.

According to the 2013 State Forest Fund (SFF) Register, the total area of state forest fund, protected natural areas of the Kyrgyz Republic, and forests that are not included in these two categories is 3,766,058.3 hectares, including 3,474,073.8 hectares in the operational administration of the State Agency on Environmental Protection and Forestry under the Government of Kyrgyz Republic, among them: State Forest Fund - 2,619,675.5 hectares, and Protected Areas - 870,882.8 hectares.[46]

According to the National Forest Inventory (2008 - 2010), the forest area of the Kyrgyz Republic is 1,116.56 thousand hectares or 5.6% of the total area of the country (Tab. 1.4).

Table 1.4 Forest areas by territory. [47]

№	Regions	Total forest covered area		including:			
		Thousand ha	%	Forested area of the SFF and PA		Forest area not included in SFF and PA	
				Thou. ha	%	Thou. ha	%
1	Batken	166.5	0.83	138.77	0.69	27.73	0.14
2	Osh	186.31	0.93	110.55	0.55	75.76	0.38
3	Jalal-Abad	380.25	1.9	324.8	1.62	55.45	0.28
4	Talas	61.01	0.33	28.06	0.16	32.95	0.16
5	Chui	44.53	0.22	30.96	0.15	13.57	0.07

[45] Source: SAEPF, Department of Forest Ecosystems.
[46] The Kyrgyz Republic's Concept for the Forestry Sector Development up to 2040. Approved by the Resolution of the Government of the Kyrgyz Republic of May 27, 2019, No. 231
[47] Resolution of the Government of the Kyrgyz Republic of July 26, 2011 No. 407.

№	Regions	Total forest covered area		including:			
		Thousand ha	%	Forested area of the SFF and PA		Forest area not included in SFF and PA	
				Thou. ha	%	Thou. ha	%
6	Issyk-Kul	142.36	0.71	102.8	0.51	39.56	0.2
7	Naryn	135.6	0.68	103.62	0.52	31.98	0.16
Total:		**1,116.56**	**5.6**	**839.56**	**4.2**	**277**	**1.39**

The data in Table 1.4 served as the basis for the assessment of greenhouse gas removals by forest lands, since the process of the national forest inventory is carried out according to the national methodology every ten years.

1.2.4. Fuel and Energy Resources

The Kyrgyz Republic has sufficient reserves of fuel and energy resources, including significant reserves of coal and about 30% of the hydropower resources of the Central Asian region. However, the capacity for the fuel and energy system development is not sufficiently implemented. Thus, in the structure of the fuel and energy balance, 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.

To date, the State Balance of Mineral Deposits has accounted for 44 deposits with reserves in the amount of 1.411 billion tons, of which: brown coals – 1.083 billion tons, hard coals – 327.8 million tons, coking coals – 120.896 million tons.

Deposits and coal occurrences are grouped into four coal-bearing basins - South Fergana, Uzgen, North Fergana, Kavak, and three coal-bearing regions - Alay, Alabuka-Chatyrkul, South Issyk-Kul.

During the reported period of 2011-2018, the production of coal has increased 2.9 times and amounted to 2,392.5 thousand tons in 2018.[48] The level of development of industrial coal reserves equals 0.15%. Coal is mined by 116 companies, of which 60 are underground and 56 are open-pit mining companies. The state enterprise "Kyrgyzkomur" was established with a branch in the Kara-Keche opencast mine with reserves of over 435 million tons.[49]

Industrial reserves of oil and gas are insignificant. Thus, oil amounts to 88.506 million tons, recoverable - 11.16 million tons. Natural gas amounting 5578.9 million m^3 is concentrated in the south of the country in seven deposits, five of which are located in the Jalal-Abad region and two - in Batken. The level of development of reserves is extremely low (for oil 0.07%, for gas 0.6%), due to the lack of funds for operational drilling. Thus, oil production in 2011-2018 increased by 2.6 times and amounted to 200.0 thousand tons in 2018, and gas production in the same period increased by 1.03 times and amounted to 27.3 million m^3 in 2018.[50] In the coming years, maintaining the existing volumes of oil and gas production is possible only through rehabilitation work and the annual commissioning of 20-25 new wells. After the exploration work phase is completed, the expected increase in gas reserves will be 1.3 billion m^3, oil - 300 thousand tons.[51]

General data on the fuel and energy balance of the Kyrgyz Republic for the reporting period 2011-2018 in tons of reference fuel are listed in the table 1.5.

[48] NSC. The Fuel and Energy Balance of 2018. http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/
[49] State Committee for Industry, Energy and Subsoil Use. Draft Concept for the Development of the Fuel and Energy Complex of the Kyrgyz Republic until 2040 http://www.gkpen.kg/index.php/home1212/372-2040
[50] NSC. The Fuel and Energy Balance of 2018. http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/
[51] State Committee for Industry, Energy and Subsoil Use. Draft Concept for the Development of the Fuel and Energy Complex of the Kyrgyz Republic until 2040 http://www.gkpen.kg/index.php/home1212/372-2040

Table 1.5. The 2011-2018 fuel and energy balance, taking into account the products of own processing and transformation (thousands) [52]

Fuel and Energy Resources	2011	2012	2013	2014	2015	2016	2017	2018
Total resources:	**15,090.0**	**16,376.0**	**15,794.0**	**15,563.0**	**15,359.0**	**14,758.0**	**16,570.9**	**17,844.4**
Extraction (production)	11,397.0	11,517.0	10,836.0	11,419.0	10,425.0	10,642.0	12,542.3	13,148.3
Import	2,921.0	4,208.0	4,069.0	3,332.0	4,067.0	2,744.0	2,905.5	3,413.4
Other income	99.0	98.0	68.0	-	-	-	-	-
Balances at the beginning of the year	673.0	553.0	821.0	812.0	867.0	1,372.0	1,123.0	1,282.7
Total distribution	**15,090.0**	**16,376.0**	**15,794.0**	**15,563.0**	**15,359.0**	**14,758.0**	**16,571.0**	**17,844.4**
Consumed within the republic	12,008,0	13,165.0	13,256.0	12,508.0	12,488.0	12,268.0	13,408.1	14,540.0
including:								
for conversion into other types of energy[1]	5,724.0	5,733.0	5,251.0	5,770.0	5,273.0	4,781.3	5,548.0	5,664.1
for production, technological and other needs[2]	6,284.0	7,432.0	8 005.0	6,738.0	7,215.0	7,487.0	7,860.1	8,875.9
Export	1,187.0	872.0	419.0	349.0	503.0	410.0	845.0	1,031.0
Losses	1,338.0	1,531.0	1,240.0	1,378.0	996.0	957.0	1,035.0	1,046.9
Balances at the end of the year	557.0	808.0	879.0	1,328.0	1,372.0	1,123.0	1,283.0	1,226.6

[1] here electricity and heat
[2] including supply to the people

The consumption of fuel and energy resources by type of economic activity in 2018 and is presented in Table 1.6. below.

Table 1.6 The 2018 consumption of fuel and energy resources by economic activity in 2018. [53]

Economic activities	Coal, thousand t	Oil, thousand t	Natural gas, Mln. м^3	Fuel Oil, thousand t	Diesel fuel thousand t	Gasoline, thousand t	Electricity, mln kWh	Heat energy, thousand. GCal
Consumed by the whole republic*	**2 638,7**	**137,4**	**305,3**	**172,6**	**750,0**	**791,8**	**12 159,3**	**2 924,9**
Agriculture, forestry and fishing	3,1	-	0,1	-	3,7	2,2	223,9	0,1
Mining	1 040,1	20,4	57,2	8,1	28,1	35,3	147,9	0,5
Manufacturing industries	394,2	117,0	79,5	122,8	240,3	179,3	1 579,4	259,2
Provision (supply) of electricity, gases, steam and conditioned air	922,6	-	162,4	38,9	2,6	4,6	8 590,9	2 310,7
Water supply, purification, waste treatment and recovery of secondary raw materials	0,1	-	0,0	-	5,5	6,1	214,1	0,7
Construction	3,4	-	0,1	0,7	38,1	4,4	191,9	5,4
Wholesale and retail trade; car and motorcycle repair	112,1	-	0,1	0,0	407,6	537,0	105,8	6,2
Transport activities and storage of goods	11,4	-	0,1	0,5	12,9	4,1	79,2	18,5

[52] NSC. The Fuel and Energy Balance of 2018. http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/
[53] Ibid.

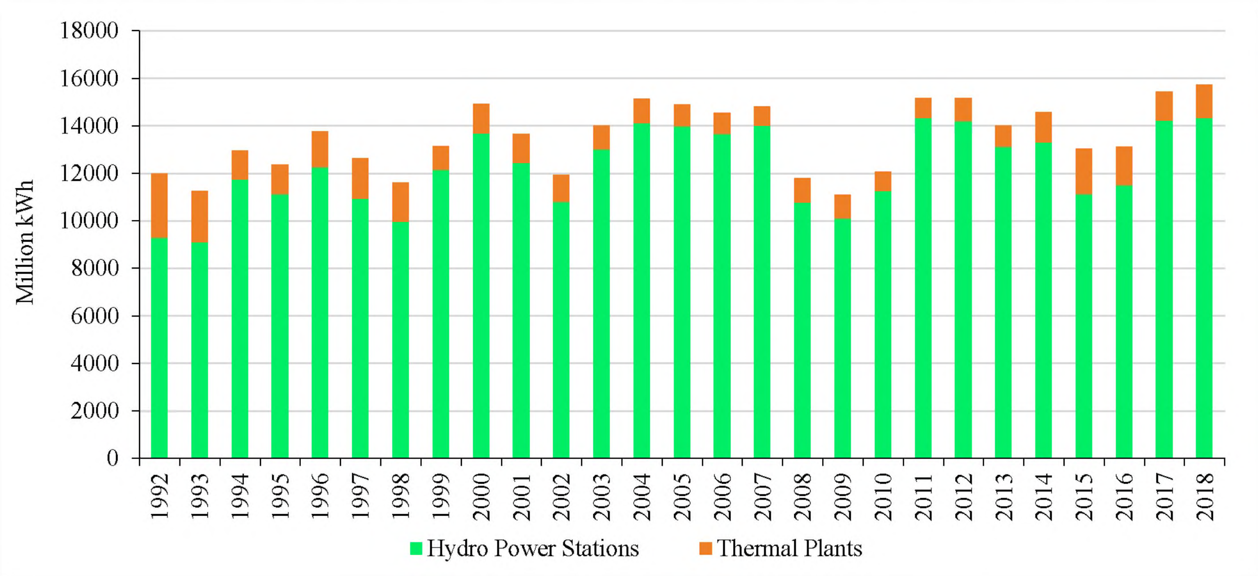
Economic activities	Coal, thou-sand t	Oil, thou-sand t	Natural gas, Mln. м³	Fuel Oil, thou-sand t	Diesel fuel thou-sand t	Gaso-line, thou-sand t	Electric-ity, mln kWh	Heat en-ergy, thou-sand. GCal
Hotel and restaurant activities	-	-	0,0	-	0,2	0,2	37,6	9,6
Information and com-munication	0,1	-	0,0	-	0,5	2,6	159,4	5,7
Financial intermedia-tion and insurance	0,4	-	0,0	-	0,2	0,9	11,9	4,0
Real estate operations	3,8	-	-	0,0	0,3	0,4	45,9	1,5
Professional, scientific and technical activities	1,3	-	0,0	1,2	4,1	1,6	63,8	11,2
Administrative and support activities	0,3	-	0,0	-	0,3	0,5	5,3	0,2
Public administration and defense; compul-sory social security	117,0	-	3,8	0,3	5,0	9,0	408,9	115,5
Education	10,1	-	0,2	0,0	0,3	1,3	109,9	102,2
Public health and so-cial services	18,5	-	1,8	-	0,3	2,0	165,3	64,6
Arts, entertainment and recreation	0,2	-	0,1	-	0,0	0,2	14,8	8,9
Other service activities	0,1	-	0,0	-	0,0	0,2	3,5	0,3

* including supply to the population

The analysis of the consumption structure of fuel and energy resources in 2018 shows that the largest shares fall on housing and communal services for energy supply - 60.5%, industry - 14.9%, mining – 6.7%, trade and transport – 6.5%, and public administration, defense and social security - 3.3%.[54]

From 1990 to 2018, the share of electricity generated by thermal power plants has been steadily decreasing (Figure 1.9). Whereas in 1992, the thermal power plants produced 2.69 billion kWh (or 22.5%), by 2000 - 1.25 billion kWh (or 8.4%), in 2011 - 0.849 billion kWh (5.6% of total production), and in 2018 - 1.41 billion kWh (8.9%).

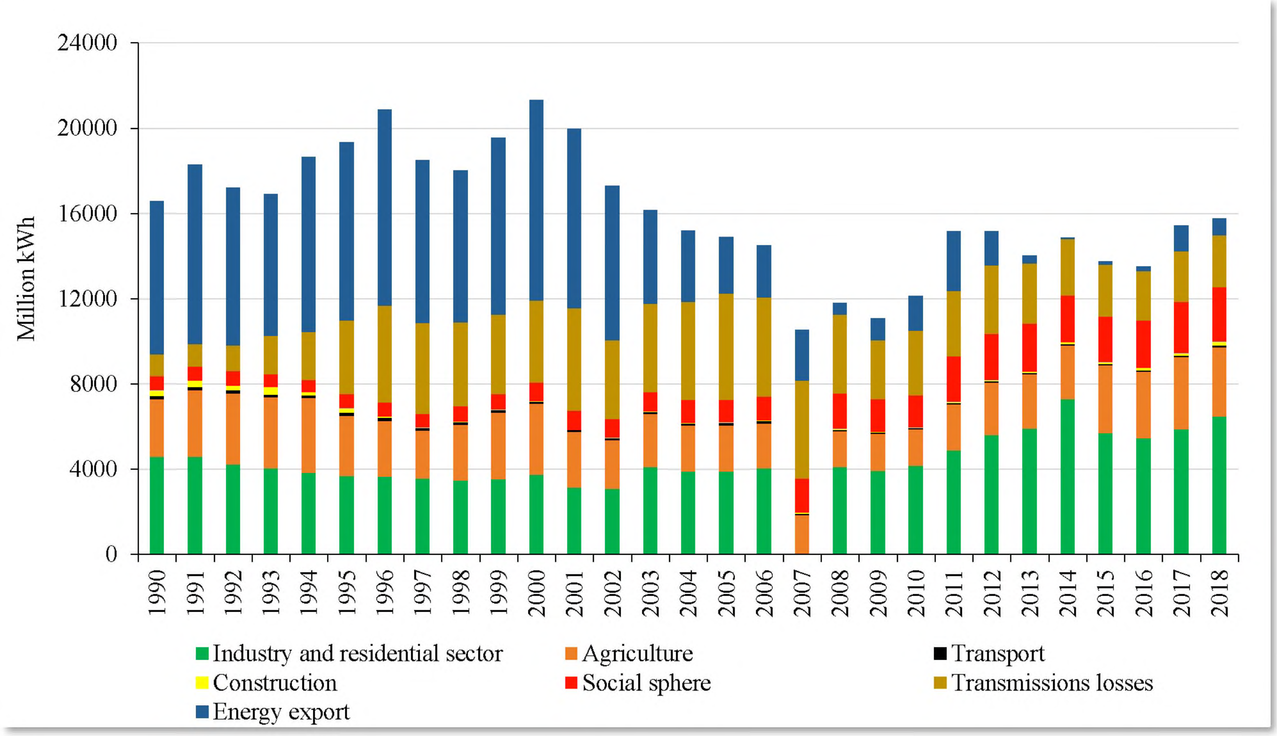
Figure 1.9 Shares of electricity generation by type of electric station from 1990 to 2018 [55]



[54] NSC. The Fuel and Energy Balance of 2018. http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/
[55] NSC. Electricity generation by power plants. Data from 1992. http://www.stat.kg/ru/statistics/promyshlennost/

The portion of generated electricity losses is high in the structure of electricity consumption. Thus, if in 1990-1992, the level of losses did not exceed 13%, then in 1995-2008, losses were more than 30%, reaching 41.5% in 2001, 40.7% in 2005. Since 2011(25%), there has been a decrease in losses although the total volume of such losses exceeds the consumption of electricity in the social sphere or the total consumption of such sectors of the economy as agriculture, transport, construction. In 2018, losses in power grids amounted to 17.9% of total production[56] (Figure 1.10).

Figure 1.10 Electric balance of consumption by main economic sectors for 1990-2018.[57]



1.2.5. Renewable Energy Sources

As noted above, the main type of renewable energy sources in Kyrgyzstan are hydropower resources, which, according to the Institute of Water Problems and Hydropower of the National Academy of Sciences of the Kyrgyz Republic, amounting to 245.2 billion kWh, where the technically feasible capacity for development - 142.5 billion kWh, and the economic (production) capability - 60 billion kWh. The level of utilization of the gross potential is 6%, technical - 10%, economic (production) - 24%.

A possible decrease in hydropower capacity associated with the expected climate change under a favorable scenario is up to 51 billion kWh, and for the worst-case scenario - up to 36 billion kWh according to the data provided in the Third National Communication of the Kyrgyz Republic on the UN Framework Convention on Climate Change.[58]

Hydropower capability concentrated in the river basins: Naryn (36%), Fergana Valley (Chatkal and others - 27%), Sarydzhaz (10.7%), Chu (9%), and of these, the most promising is the river basin Naryn

[56] NSC. The Fuel and Energy Balance of 2018. http://www.stat.kg/ru/publications/toplivno-energeticheskij-balans/

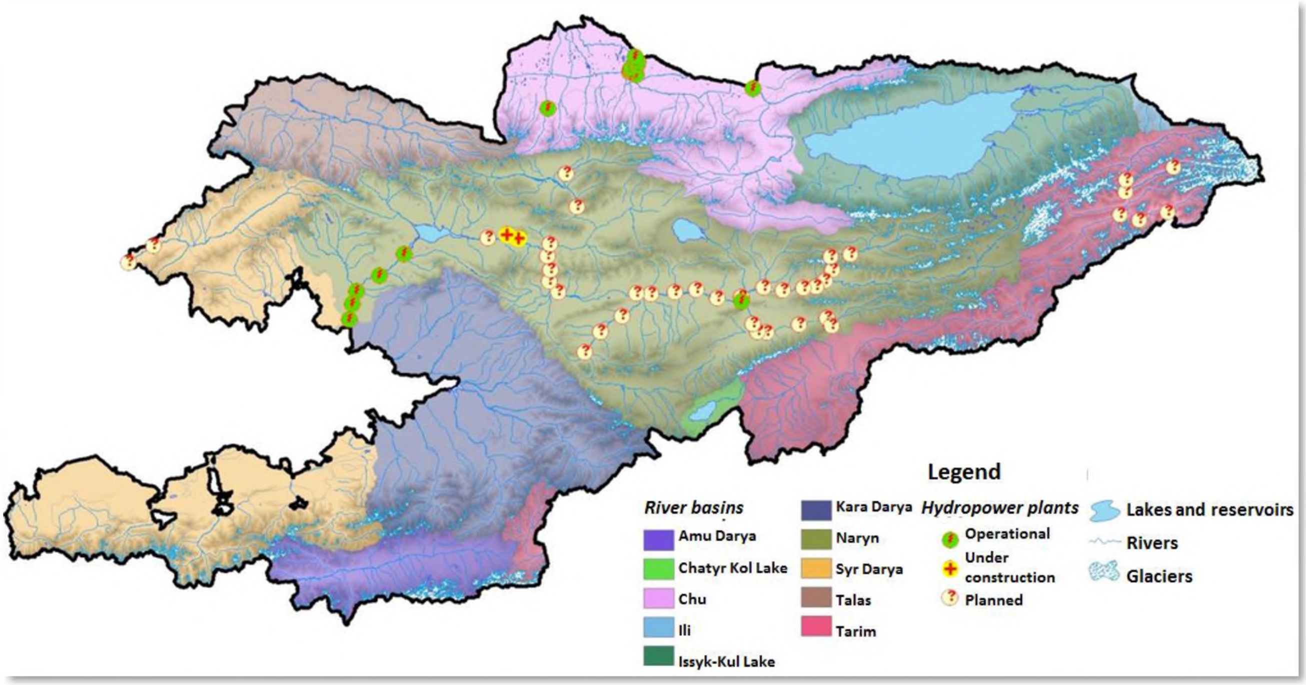
[57] NSC. Electricity Balance of the Economy Sectors. 1990-2018. http://www.stat.kg/ru/statistics/promyshlennost/

[58] State Committee on Industry, Energy and Subsoil Management. Draft Concept of Development of Fuel and Energy Complex of the Kyrgyz Republic up to 2040. http://www.gkpen.kg/index.php/home1212/372-2040

with a possible capacity of 6970 MW. The river basin Sary-Jaz is also promising with a potential capacity of 993 MW.

The most developed is the lower course of the Naryn river basin, where the Lower Naryn Hydroelectric Station Cascade operates with reservoirs of the perennial term (Toktogul) and seasonal regulation (Kurpsai, Tashkumyr, Shamaldysai, and Uchkurgan). Electricity production depends on natural and climatic conditions and water content in the Naryn river basin and its tributaries. In this case, the cycles of low water and high water alternate every 3-4 years. Accordingly, electricity production fluctuates between 12-15 billion kWh. The main generating capacities - the Lower Naryn Cascade HPP and the Kambarata HPP - 2 with a total installed capacity of 2,980 MW, located in the Jalal-Abad region, Atbashinskaya HPP with a capacity of 40 MW in the Naryn region are part of Electric Stations OJSC (see Figure 1.11). The dependence of electricity generation on climatic conditions leads to the winter shortage of electricity and imports from neighboring countries.

Figure 1.11 Hydropower resources of Kyrgyzstan by main river basins [59]



The total gross **hydropower potential** of **small rivers and watercourses** surveyed on the territory of the republic exceeds 80 billion kWh per year, of which the technically feasible for development is 6 billion kWh per year on average. The level of their development is 0.000003%.[60]

The installed capacity of small hydroelectric power plants located in the Chui and Osh regions is 45.2 MW with an electricity generation of up to 250 million kWh per year. JSC “Chakan HPP” is the largest producer of electricity among small HPPs in the Kyrgyz Republic. It accumulated vast experience in the operation of small hydroelectric power plants. The share of the generation of JSC “Chakan HPP” in the total energy balance is more than 1%. At the same time, since the establishment of the company, the annual output has doubled; the company's revenues have increased 10 times during this period. The main problem in the operation of the power plants of JSC “Chakan HPP” is a high level of wear, which at the moment is more than 80.8%.[61]

[59] State Committee on Industry, Energy and Subsoil Management. Draft Concept of Development of Fuel and Energy Complex of the Kyrgyz Republic up to 2040. http://www.gkpen.kg/index.php/home1212/372-2040.
[60] Ibid.
[61] Ibid.

To make rational use of the high capacity of solar energy, as well as wind energy, it is necessary to reassess their potential across the territory of the regions applying modern methods, including the results of space surveys.

The potential of geothermal springs is mainly used for recreational purposes in the sanatorium-resort zones of the country's regions.

In general, at the moment, the potential for using renewable energy sources in Kyrgyzstan remains at a low level despite the availability of reserves, while the country is experiencing a shortage of energy resources due to insignificant supplies and production volumes of hydrocarbon fuel, which is confirmed by the analysis of the fuel and energy balance of the country and regions.

1.3. Economic Development of the Kyrgyz Republic in 1990-2018

1.3.1. General Trends

From 1990 to 2018, several stages can be distinguished in the socio-economic development of the Kyrgyz Republic. At the first stage (1991-1995), amid a significant decline in economic activity, especially in industry, by 1995 there was a sharp decline in GDP - to 50.7% compared to 1990 (in constant 2010 US dollars), including the gross industrial product - up to 33%; agriculture - up to 61.3%; construction - up to 45%; transport - up to 88.6%, services - up to 61.7%. The second stage (from 1996 to the present) is characterized by the growth of GDP in real terms. During these years, the economic situation has stabilized.[62]

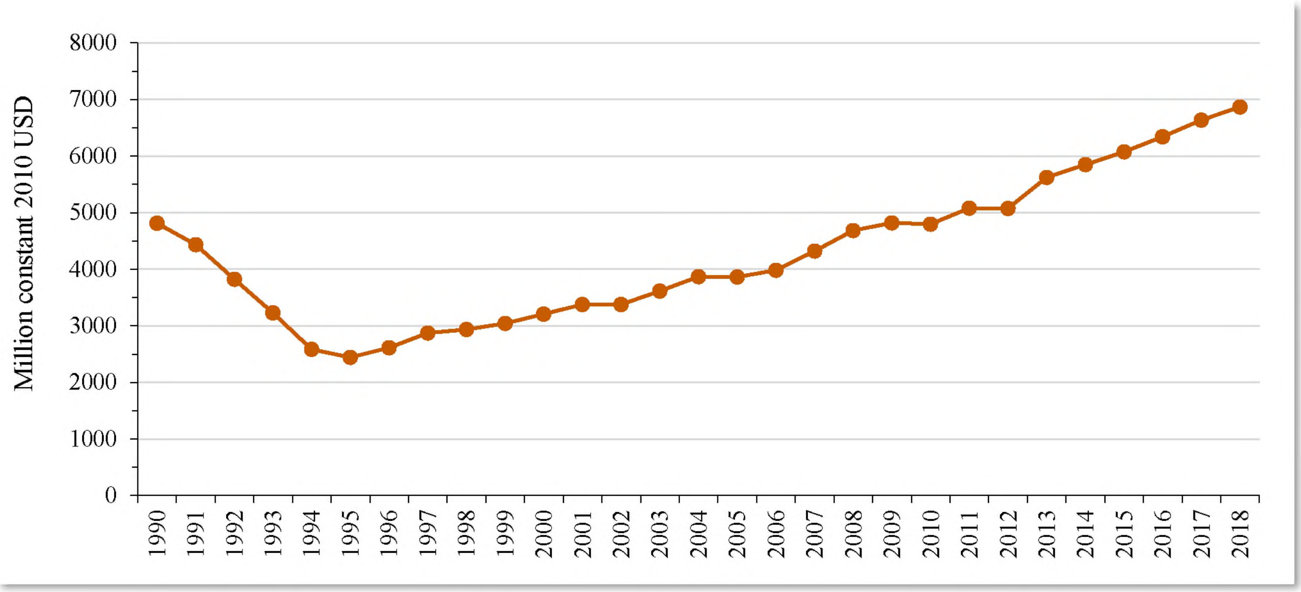
The state of the economy from 1993 to 2018 illustrates the dynamics of the consumer price index (table 1.7) and the real GDP in constant US dollars in 2010 (Figure 1.12).

Table 1.7 Consumer Price Index, 1993-2018 (in percent to the previous year) [63]

Year	Consumer price index	Year	Consumer price index	Year	Consumer price index
1993	1186, 2	2002	102,1	2011	116,6
1994	280,7	2003	103,1	2012	102,8
1995	143,5	2004	104,1	2013	106,6
1996	132,0	2005	104,3	2014	107,5
1997	123,4	2006	105,6	2015	106,5
1998	110,5	2007	110,2	2016	100,4
1999	135,9	2008	124,5	2017	103,2
2000	118,7	2009	106,8	2018	101,5
2001	106,9	2010	108,0		

Figure 1.12 Dynamic of the Kyrgyzstan real GDP from 1990 to 2018 (in constant 2010 US dollars) [64]

[62] NSC. http://www/stat.kg/ru/statistics/nacionalnye-scheta/
[63] NSC. http://www/stat.kg/ru/statistics/ceny-i-tarify/
[64] World Bank https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=KG&view=chart



Kyrgyzstan has been always defined as agrarian country. However, the survey of the contributions of various sectors of national economy to the republic's GDP shows that in recent years the share of agriculture in the structure of the republic's GDP has been steadily decreasing. At the same time, the portion of the service sector has grown significantly. Those data and the main indicators of the standard of living of the population in 2018, as compared to 2005 and 2011, are shown in Table 1.8 below.

Table 1.8 Indicators of the economy and living standards of the population of Kyrgyzstan in 2005 - 2011 – 2018.

Indicator	Unit of measurement	2005	2011	2018
General Economic [65]				
GDP nominal*, including:	mln $2010	3,859.4	5,079.9	6,866.6
Industry	% to GDP	17.3	22.2	18.1
Agriculture	% to GDP	28.5	16.6	11.7
Construction	% to GDP	2.7	4.9	9.0
Trade and catering	% to GDP	19.2	16.6	19.6
Transport and communications	% to GDP	6.6	8.5	7.5
Other sectors and taxes	% to GDP	25.8	31.2	34.1
GDP per capita	thous. som	20.2	54.4	93.8
KR Som to USD exchange rate	som/US$	41.3011	46.4847	69.8500
Import (SITC)	thous. US$	1,188,704.9	4,261,226.4	5,291,945.8
Export (SITC)	thous. US$	674,042.0	2,242,166.4	1,836,838.7
Employment [66]				
Employed population	thous. people	2,077.1	2,277.7	2,382.5
Employment of population ratio	%	59.5	59.3	55.2
Unemployment rate	%	8.1	8.5	6.2
Standards of living [67]				
Actual final household consumption per capita	thous. som	18.3	50.9	85.6

[65] NSC. http://www.stat.kg/ru/statistics/vneshneekonomicheskaya-deyatelnost/
[66] NSC. Employment and unemployment. - B., 2019.
[67] NSC. http://www.stat.kg/ru/statistics/uroven-zhizni-naseleniya/

Indicator	Unit of measure-ment	2005	2011	2018
Cash income of the population per capita	thous. com per month	955.9	2,936.4	5,337.3
Average monthly accrued wages of one employee	som	2,612	9,304	16,427
The average monthly amount of the assigned pension of one pensioner with compensation payments	som	775	3,853	5,761
Average subsistence level per capita, including:	som per month	1,836.6	4,390	4,792.5
Population of working age	som per month	2,127.8	4,920.7	5,357.9
Population over working age	som per month	1,492.9	3,858.3	4,286.7
The cost of the food basket of the minimum consumer budget	som per month	1,336.9	2,853.5	3,115.2
Gini coefficient (based on income)[68]		0.433	0.382	0.378

* - data of the World Bank

1.3.2. Agriculture

In 2018, the gross agriculture, forestry and fishery products output made up 204,969.9 million soms. The agricultural production was 199,534.1 mln. soms, including 100, 514.8 mln. soms of crop production and 99, 019.3 mln. soms of livestock breeding. Agriculture services were provided for 4,926.7 mln. soms, the forestry sector outputs made up 329.0 mln., hunting products output was 19.1 mln. soms and fishery output made up 161.0 mln.soms.[69]

Between 1990 and 2018, the share of agriculture in the country's GDP has been changing and since 1996, it has had a constant downward trend from 46.2% (1996) to 11.7% (2018) due to the progressive growth of the services sector. The main increase is made by crop and livestock products. The contribution of agricultural services to GDP, along with the contribution of forestry and hunting services, is insignificant. Gross agricultural production in the reporting period 2011-2018 changed slightly (see figure 1.13).

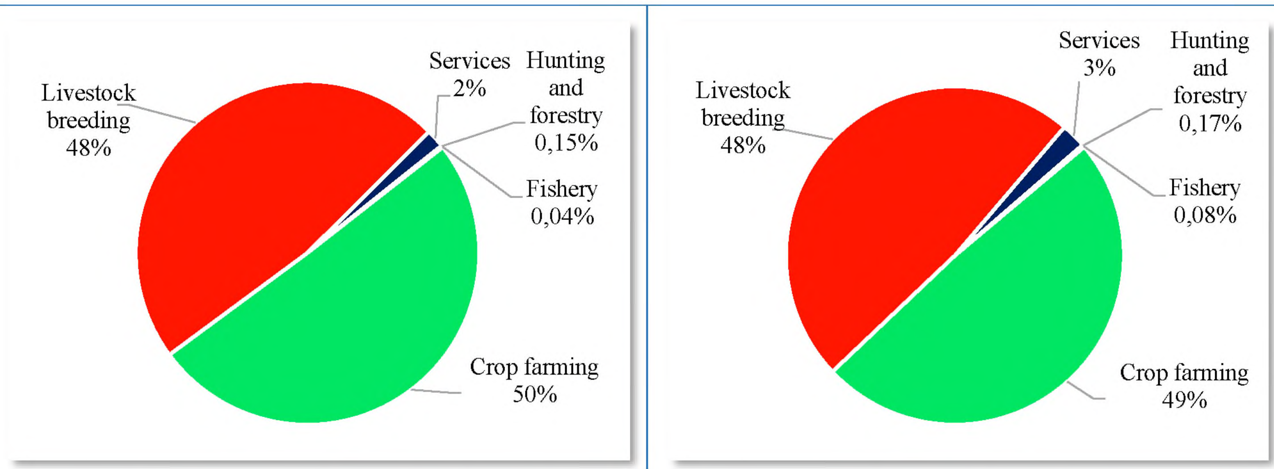
Figure 1.13 Contribution of industries to the gross output of agriculture in 2011 and 2018.[70]

2011	2018

[68] A quantitative indicator showing the degree of inequality of different income distribution options, developed by the Italian economist, statistician and demographer Corrado Gini

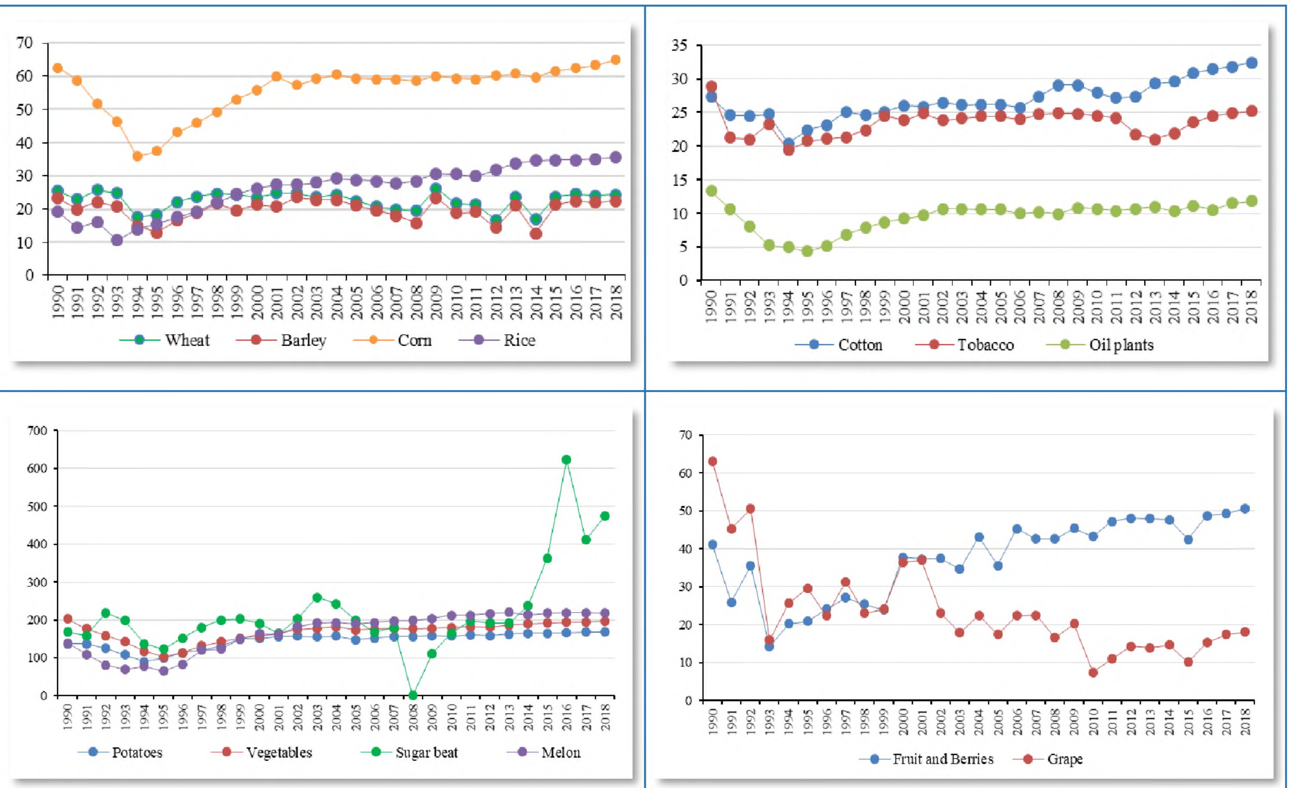
[69] NSC. Kyrgyzstan in numbers. Bishkek. 2021.

[70] NSC data. http://www.stat.kg/ru/statistics/selskoe-hozyajstvo/



Agriculture is the most climate-dependent industry, and its productivity, especially in crop production, is directly dependent on changes in climatic indicators of the year - the sum of annual precipitation, its seasonal distribution, and vegetation humidity. Frosts, droughts, hailstorms, tornadoes, and other weather events have a significant impact on agricultural performance. Trends in the yield of the main crops are shown in Figure 1.14.

Figure 1.14 Dynamics of the yield of the main agricultural crops for 1991-2018 (centners per hectare) [71]



At the same time, the dynamics of the main types of agriculture products displays a steady upward growth except for wheat, tobacco, oilseeds, and raw cotton. (See tab. 1.9).

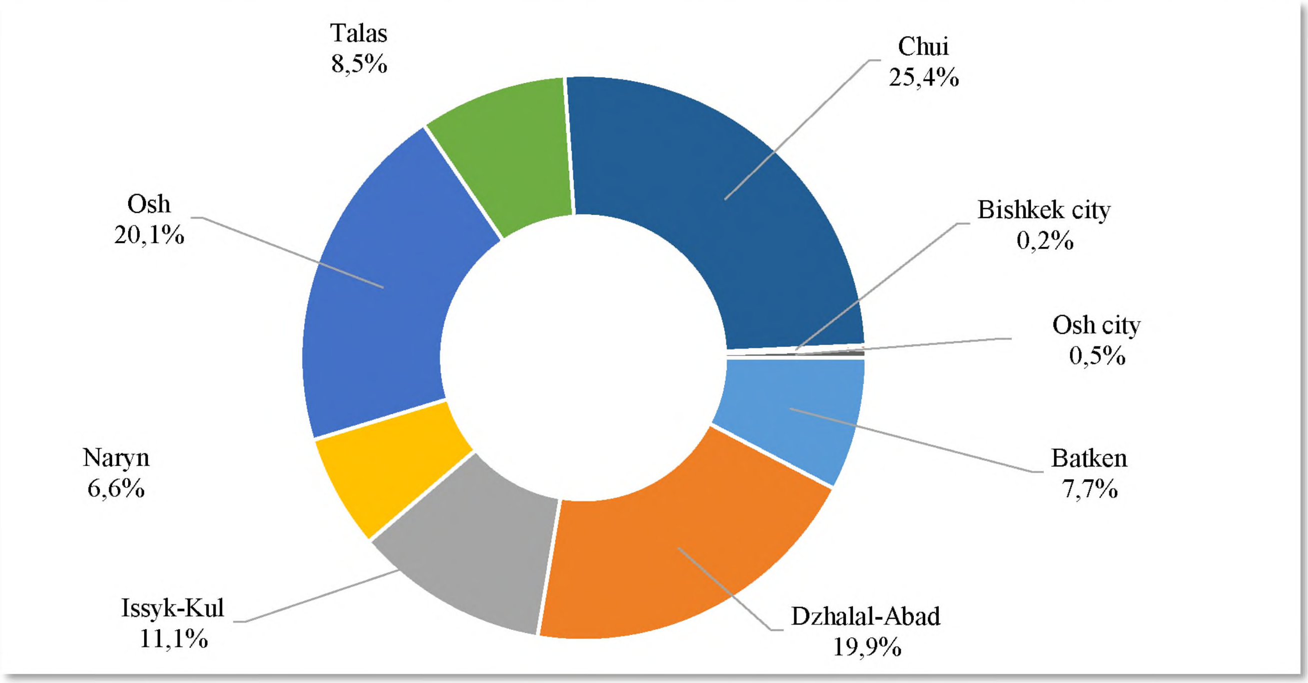
Table 1.9 Production of main types of agricultural commodities in 2011-2018 (thousand tons) [72]

[71] NSC. http://www.stat.kg/ru/statistics/selskoe-hozyajstvo/
[72] NSC. http://www.stat.kg/ru/statistics/selskoe-hozyajstvo/

Indicators	2011	2012	2013	2014	2015	2016	2017	2018
Grain (in weight after processing)	1,485.0	1,333.8	1,700.9	1,327.5	1,723.1	1,728.1	1,681.8	1,741.5
Wheat (in weight after processing)	799.8	540.5	819.4	572.7	704.6	661.5	601.0	615.9
Barley (weight after processing)	233.8	212.7	309.9	197.1	370.1	415.3	424.4	429.3
Corn for grain	446.4	578.3	568.2	556.1	641.9	648.7	653.3	692.9
Rice (in weight after processing)	19.4	23.1	27.2	28.2	30.2	34.8	38.2	40.8
Pulses (in weight after processing)	76.1	81.3	84.9	90.1	96.71	97.7	102.6	106.6
Sugar beetroot (factory)	158.8	102.0	195.4	173.6	183.2	705.2	712.3	773.0
Raw cotton (in test weight)	101.3	84.7	68.6	69.0	44.1	52.1	65.3	74.7
Tobacco (weighing in)	9.9	7.4	6.5	4.4	1.3	0.5	1.5	1.8
Oilseeds	56.6	58.6	55.7	45.7	49.1	41.3	39.7	35.4
Potatoes	1,379.2	1,312.7	1,332.0	1,320.7	1,416.4	1,388.4	1,416.0	1,446.6
Vegetables	820.9	865.9	881.5	919.7	1,052.1	1,069.3	1,086.7	1,094.9
Melons food	151.6	193.3	195.8	200.2	248.5	237.3	259.0	249.1
Fruits and berries	215.1	222.7	233.6	237.0	209.1	239.3	240.6	251.4
Grape	6.7	7.9	8.1	8.5	5.7	8.6	8.6	8.8
Meat	190.4	192.3	193.2	202.8	208.3	212.4	216.6	221.3
Milk	1,358.1	1,382.4	1,408.2	1,445.5	1,481.0	1,524.6	1,556.2	1,589.7
Wool (in physical weight)	11.1	11.3	11.6	11.8	12.1	12.4	12.6	12.8
Eggs, mln.	392.8	418.0	422.3	445.8	432.9	469.7	510.7	533.2

The regional distribution of the agricultural production as per territories of the Kyrgyz Republic is shown on figure 1.15 below.

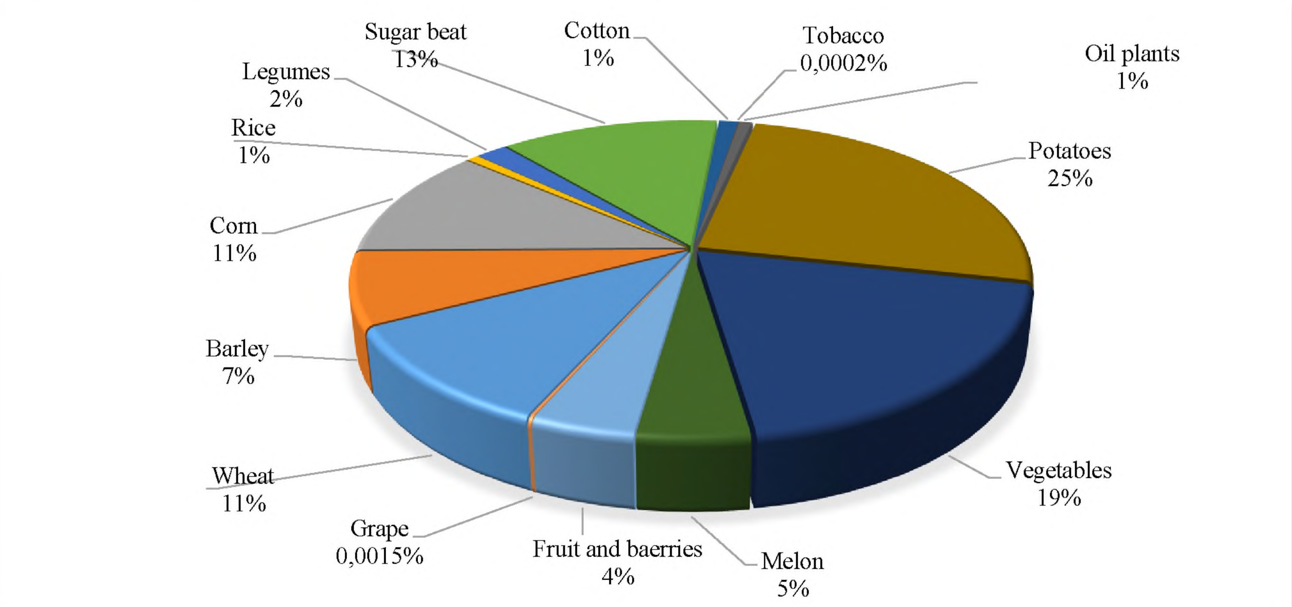
Figure 1.15. Contributions of the regions to the total agricultural production of Kyrgyzstan in 2018.[73]



[73] NSC. http://www.stat.kg/ru/statistics/selskoe-hozyajstvo/

The total gross output of crop production in 2018 was about 100,514.8 million soms[74] in current prices. Statistical data on production of the main types of crop production in 2018 provide a complete picture of the structure of agricultural production in the republic. (Figure 1.15.)

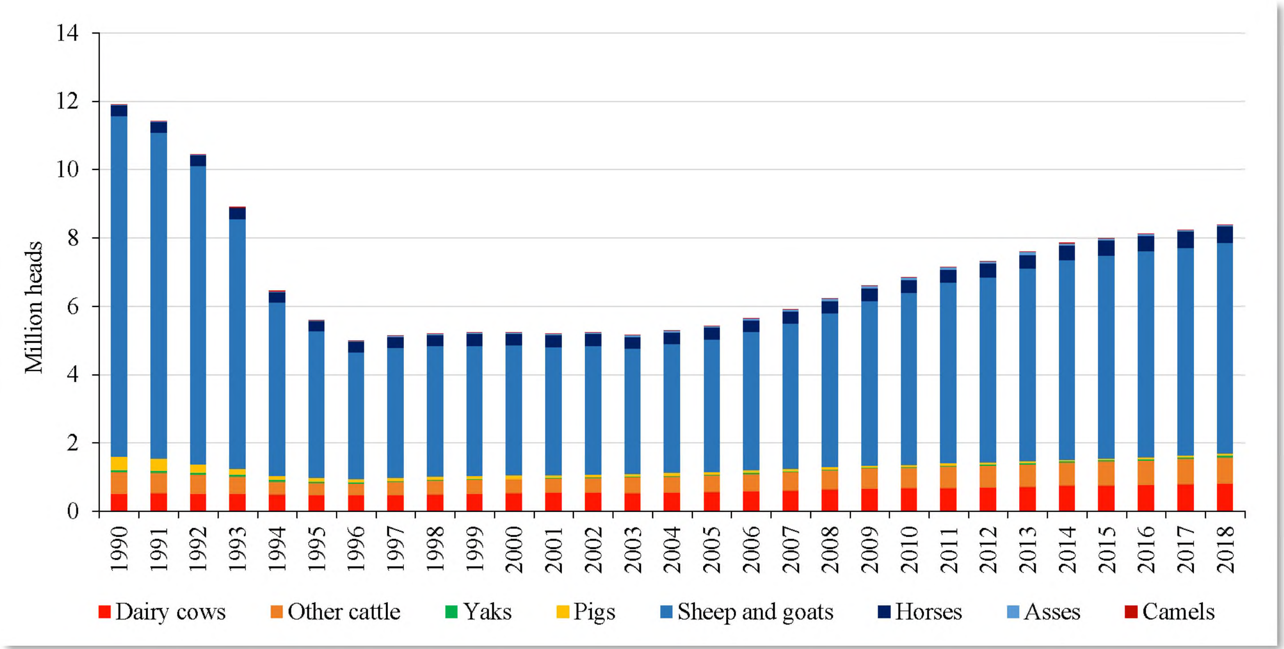
Figure 1.16 Production of major crop products in 2018 [75]



Livestock raising is a traditional occupation of the Kyrgyz, consequently, the majority of the rural population and part of the urban population engaged in livestock management. Domestic animals are not only an important source of household income but also a reliable tool for capitalizing farmers' incomes with a high degree of liquidity. Since 1996, the country's public herd has had a stable growth trend in all populations of domestic animals, except for pigs after a sharp decline in the number of domestic animals following the collapse of the system of collective and state farms of the Soviet Union in the early 1990s. (See figure 1.16.)

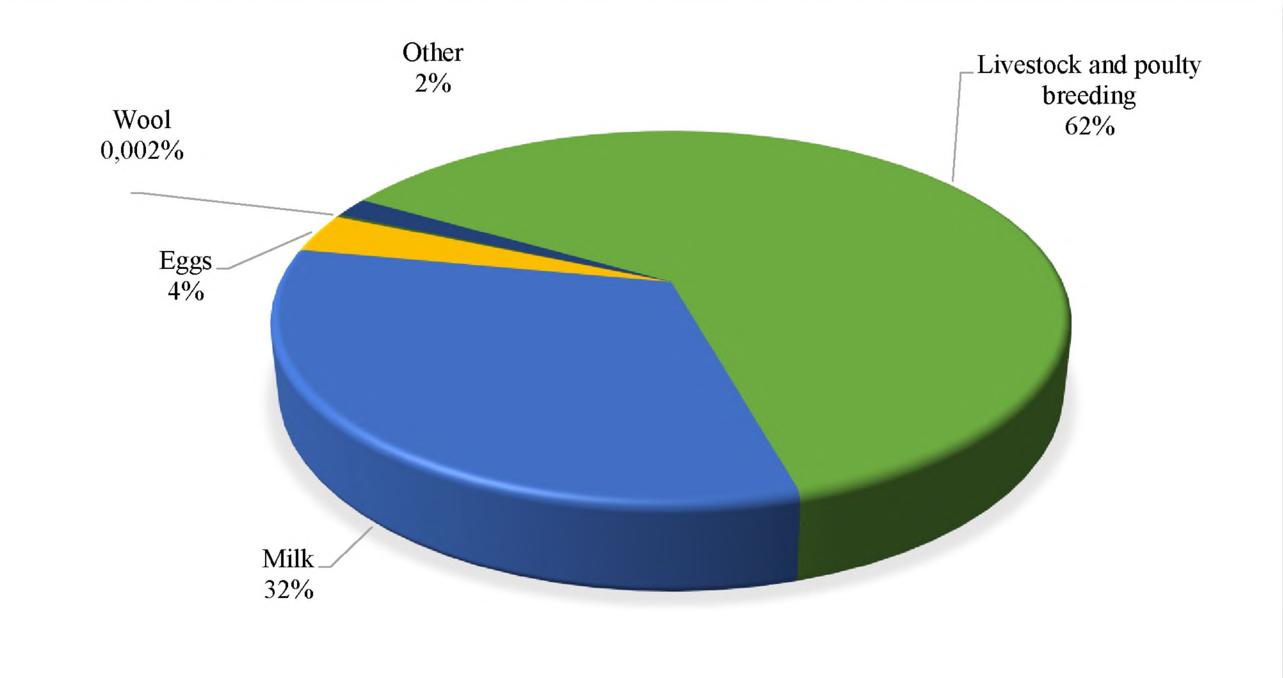
Figure 1.17 Dynamic in the number of domestic animals between 1990 and 2018 [76]

[74] NSC. Kyrgyzstan in numbers. Bishkek. 2021.
[75] NSC. http://www.stat.kg/ru/statistics/selskoe-hozyajstvo/
[76] NSC. http://www.stat.kg/ru/statistics/selskoe-hozyajstvo/



The gross output of livestock production in 2018 was 99,019.3 million som in current prices. The structure of livestock production sector by main products in 2018 is presented in figure 1.17 below.

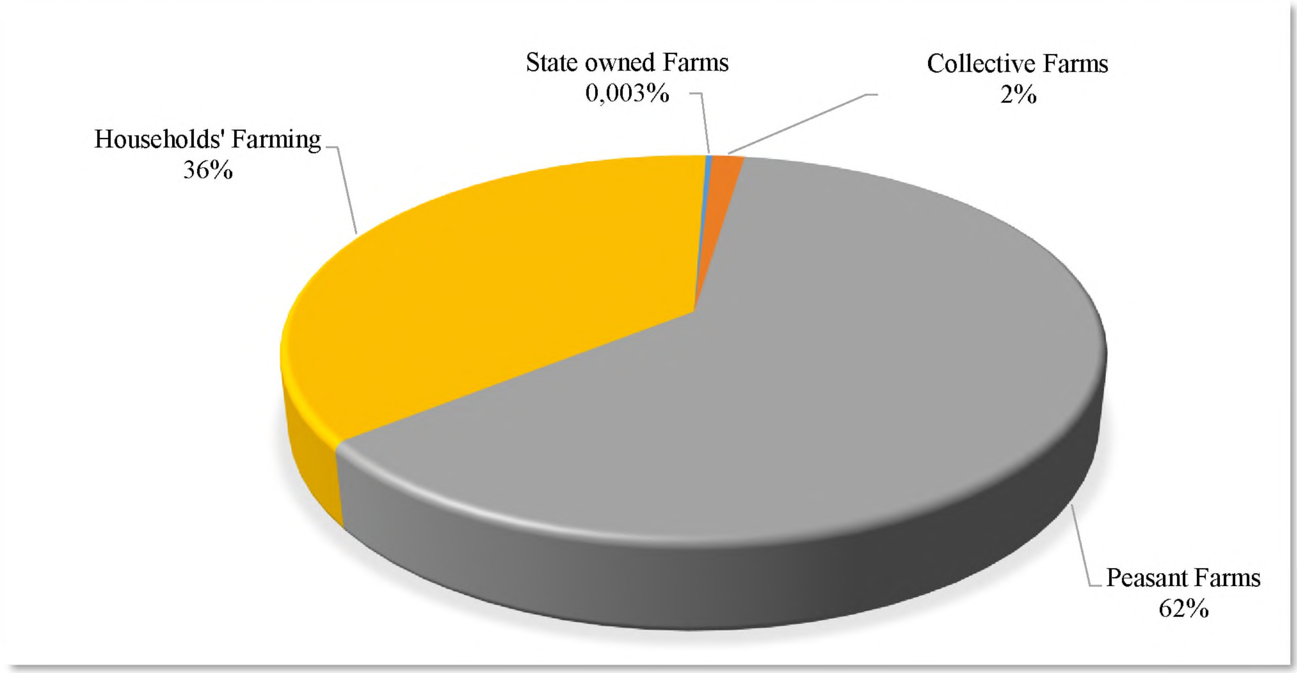
Figure 1.18 Structure of production of main livestock products in 2018 [77]



The situation with the main agricultural producers in the country market did not change during the reporting period. Thus, in the structure of the total volume of agricultural production, the dominant contribution is made by the small holding peasant farms - 61.5% and personal household farms of the population - 36%. At the same time, both in crop production and in animal husbandry in recent years, the contribution of farmer households has prevailed (Figure 1.18).

[77] Ibid.

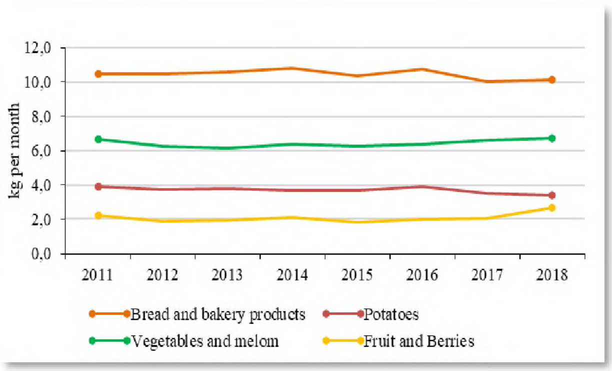
Figure 1.19 Contribution of various farm categories to agricultural production in 2018 [78]

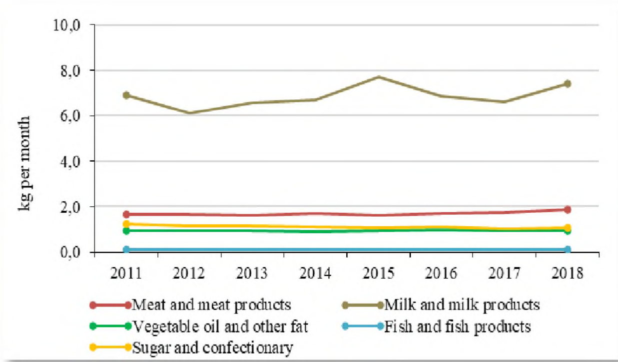


1.3.3. Food Security

During the reporting period from 2011 to 2018, the consumption of the main food groups stabilized. Average food consumption per person in the Kyrgyz Republic for 2011-2018 is shown in Figure 1.19.

Figure 1.20 Adequacy of per capita consumption of major food groups for 2011 - 2018 (kg per month per capita) [79]





The average daily food consumption of the population in the republic in terms of energy value amounted to 2,238.5 kcal per day in 2018 and only slightly exceeded the WHO norm for the minimum daily requirement (2100 kcal per day). However, in Batken region (2,089.5 kcal per day) and Osh city (1,871.1 kcal per day), the actual daily consumption was lower than the officially adopted WHO base-line norm. (See Figure 1.20).

Figure 1.21 Trends of the energy value of the population's nutrition in 1990-2018 [80]

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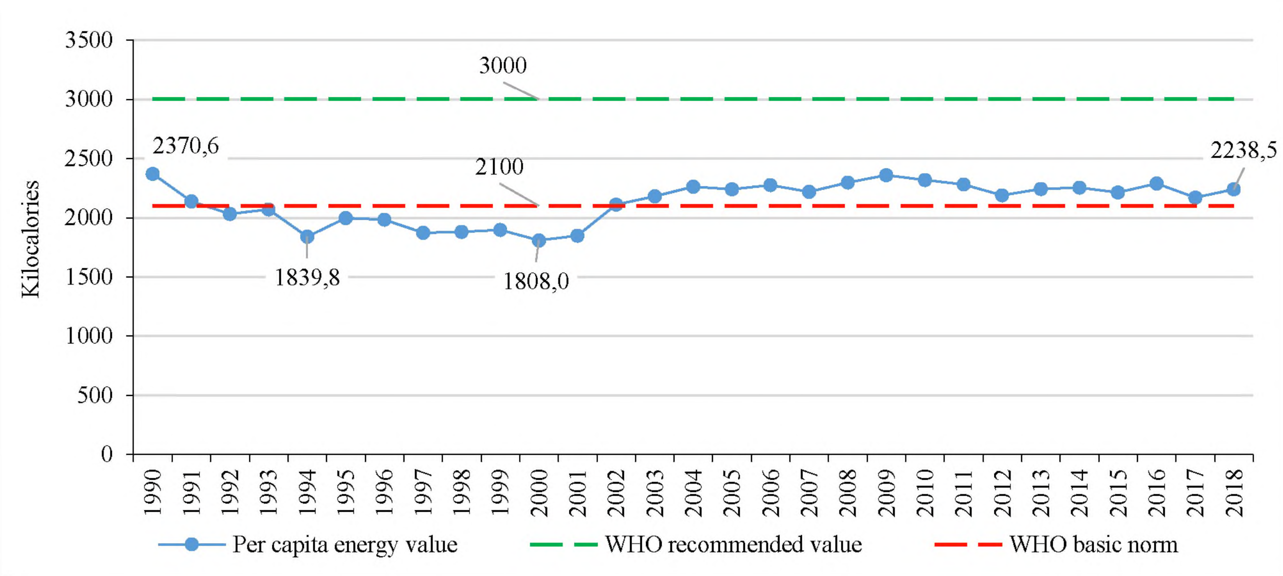
[78] NSC. http://www.stat.kg/ru/statistics/selskoe-hozyajstvo/
[79] NSC. Information bulletin of the Kyrgyz Republic on food security and poverty. Bishkek. 2019.
[80] NSC. http://www.stat.kg/ru/statistics/uroven-zhizni-naseleniya/

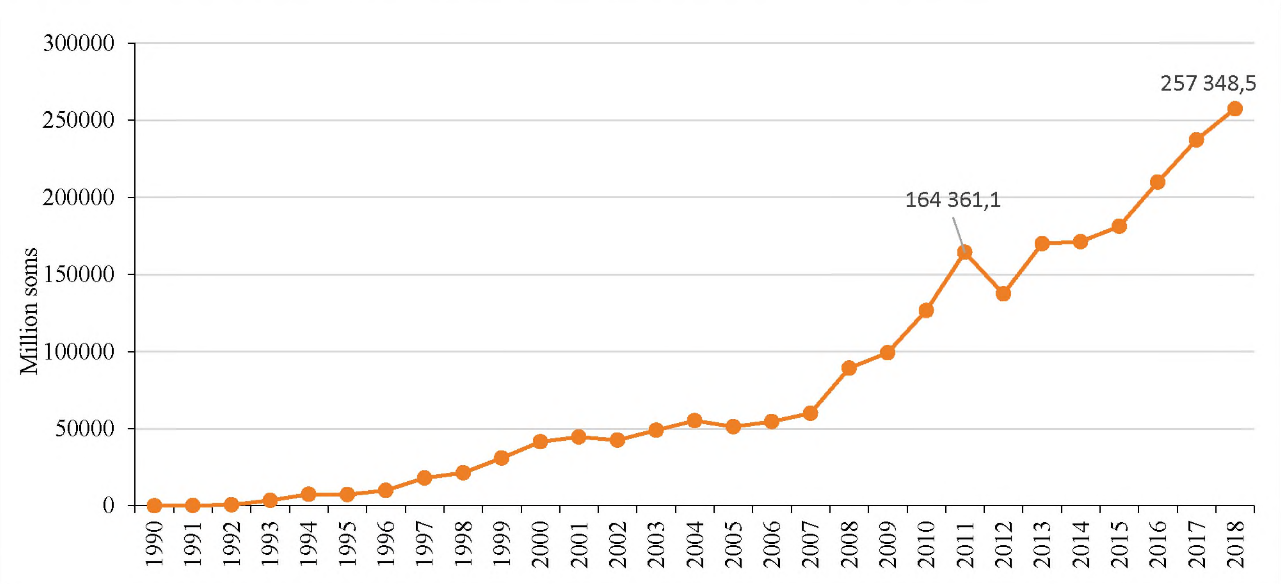


In general, the country's food supply is estimated to be reasonably adequate. The shortage of own grain resources can be compensated by increasing yields (data on crop yields achieved in collective farms in the recent past, as well as in developed countries, show the reality of this path) and by a correction of crop and consumption structure. The daily energy requirement adopted in the republic is 75% of the WHO recommended standard (3000 kcal per day).

1.3.4. Industry

Since 2011, the total volume of industrial production has increased from 164,361.1 million som to 257,348.5 million in 2018 (Figure 1.21). At the same time, the total share of industry in the country's total GDP fell from 22.5% to 18.1%.

Figure 1.22 Dynamics of industrial production in 1990-2018 (million som)[81]



[81] NSC. http://www.stat.kg/ru/statistics/promyshlennost/

During the reporting period of 2011-2018, there has been some redistribution of output between individual sectors (Figure 1.22).

Table 1.10 Industrial output by type of economic activity for 2011-2018. (million som) [82]

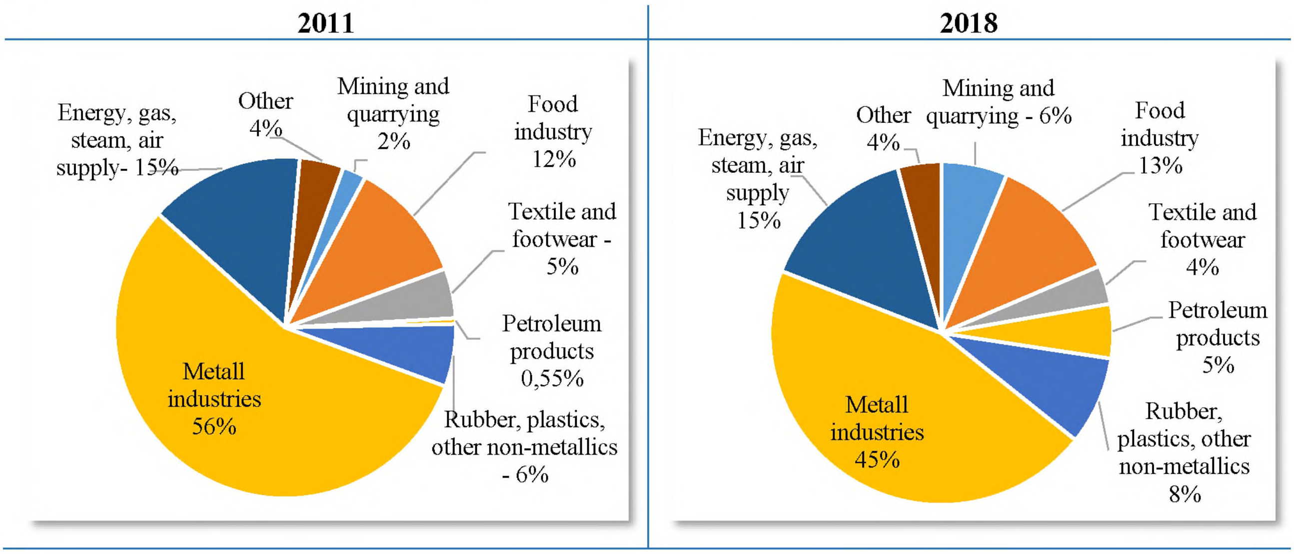
Items	2011	2012	2013	2014	2015	2016	2017	2018
Total	**164,361.1**	**137,229,2**	**169,829.4**	**171,108.9**	**181,026.7**	**209,812.0**	**237,225.3**	**257,348.5**
Mining and quarrying	3,682.3	6,061.3	5,064.9	5,596.5	7,913.8	12,741.7	17,906.6	16,047.0
Production of food products and tobacco	19,035.2	21,104.9	22,332.9	24,835.2	23,129.3	25,909.4	31,752.1	31,826.4
Textile production; production of footwear, leather goods	7,780.1	9,592.3	8,546.0	6,144.7	5,405.2	6,608.7	6,758.8	9,404.4
Manufacture of wood and paper products; printing	1,597.3	2,020.6	1,910.7	2,041.4	2,066.1	2,043.8	1,946.2	2,176.8
Production of coke and refined petroleum.	901.2	936.1	865.2	3,198.2	6,528.2	7,990.5	11,197.4	13,169.9
Production of chemicals	1,018.7	1,319.3	1,168.1	1,216.9	779.2	697.1	605.7	917.9
Production of pharmaceutical products	111.4	142.9	155.3	173.9	228.1	241.3	426.1	274.9
Production of rubber and plastics items, other non-metallic products	9,767.5	12,710.6	17,253.4	17,304.7	16,324.0	14,397.6	17,819.4	21,469.0
Production of basic metals, finished metal articles	92,100.9	54,550.7	84,847.1	80,938.3	82,212.5	101,327.0	106,740.0	116,271.3
Manufacture of computers, electronic and optical equipment	64.7	83.6	67.0	72.5	67.3	99.9	64.3	33.1
Production of electrical equipment	1,297.7	1,382.7	1,537.9	1,867.7	1,782.6	1,550.3	1,368.5	1,501.5

[82] NSC. http://www.stat.kg/ru/statistics/promyshlennost/

Items	2011	2012	2013	2014	2015	2016	2017	2018
Production of machinery and equipment	265.4	305.6	342.1	408.0	280.4	224.8	372.6	249.4
Production of vehicles	598.0	793.9	1,018.2	746.8	607.6	906.0	1,189.9	956.6
Other production, repair and installation of machinery and equipment	1,051.1	1,162.5	1,305.9	1,318.6	1,193.7	1,302.0	1,333.4	1,646.9
Energy, gas, steam and air conditioning supply	24,219.6	23,899.8	22,070.9	23,691.4	30,856,4	31,900.2	35,685.3	38,539.7
Water supply, waste treatment and processing, recycling	870.0	1,162.4	1,343.8	1,554.1	1,652,3	1,871.8	2,059.0	2,863.8

The share of metal industries remains the most significant in the total volume of industrial production, but during the reporting period, it decreased from 56% in 2011 to 45.2% in 2018. Textiles, clothing, and footwear production declined by 60%. The shares of the energy sector remained unchanged, while the percentage of the food industry increased slightly. The share of petrochemical production increased 5 to 8 times and the share of the mining industry in the total industrial output of the country has more than quadrupled. In addition, the contribution of pharmaceutical production has grown more than 2.5 times. The share of high-tech industries: machinery, electrical, electronic and optical, and other equipment continued to fall to 1.2% of the gross industrial output in 2018. The industrial production structure in 2011 and 2018 is shown in Figure 1.23.

Figure 1.23 Industrial production structure in 2011 and 2018 [83]



[83] НСК. http://www.stat.kg/ru/statistics/promyshlennost/

1.3.5. Transport

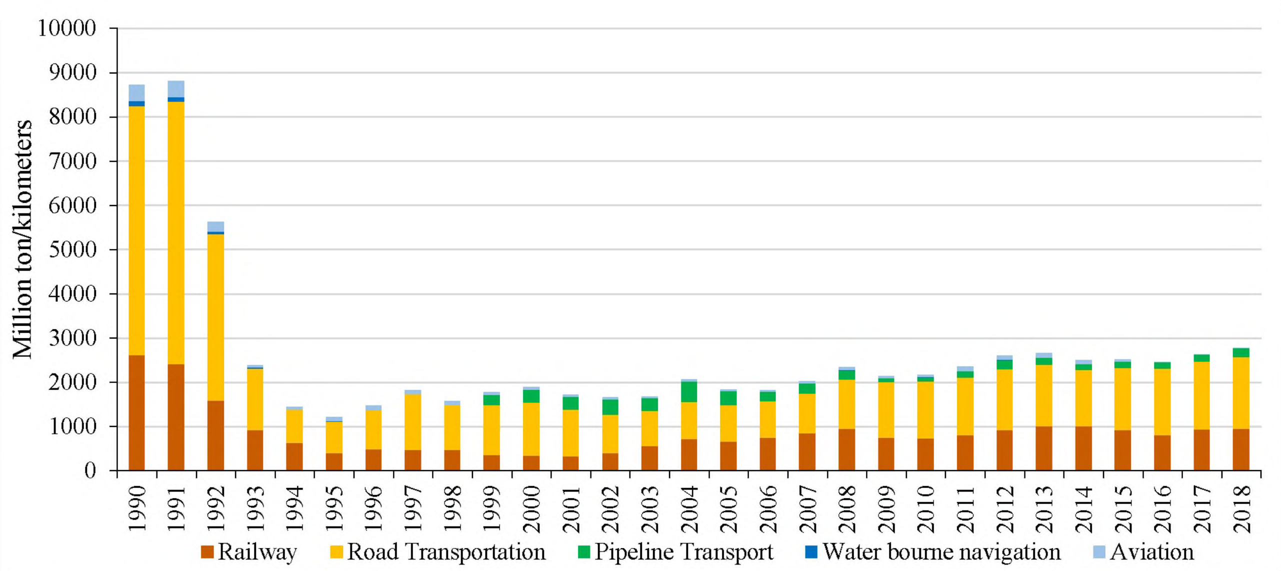
Physical and geographical (mountainous terrain, absence of navigable rivers) and economic (underdevelopment and relatively high cost of air transportation) conditions of the Kyrgyz Republic determine the dominant role of road transport in domestic transportation. The volume of traffic by water on Lake Issyk-Kul is insignificant. Since 2005, the situation has not changed in the external transport structure: the main traffic volume in the northern direction (Eurasian Economic Union, Europe) is carried out by rail, in the southeast (China) by road. Air transport plays a significant role only in the transportation of passengers.

The length of the national railway network is only 423.9 km. Most of them pass through the Chui region and connect with Kazakhstan. Separate short lines pass through the territory of Osh, Jalal-Abad, and Batken regions.

The pipeline transport consists of the main gas pipelines Bukhara - Tashkent - Bishkek - Almaty, and Mailuu-Suu - Jalal-Abad - Kara-Suu – Osh, as well as the local gas distribution network.

Freight and passenger turnover dynamics are shown in Figure 1.24 and Fig 1.25. Personal road transport, for which statistics are not available, is not included.

Figure 1.24 Dynamics of freight turnover by type of transport in the Kyrgyz Republic for 1990-2018 [84]

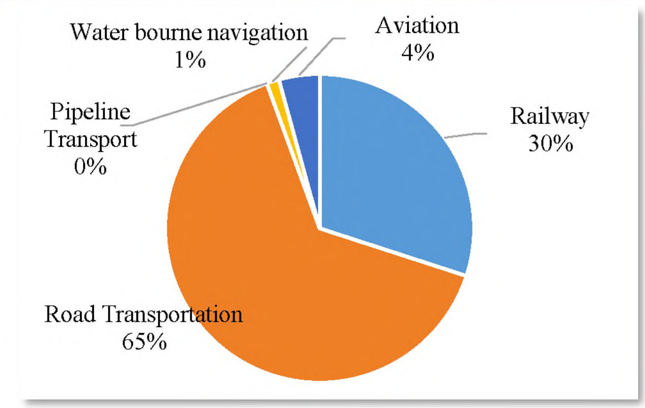


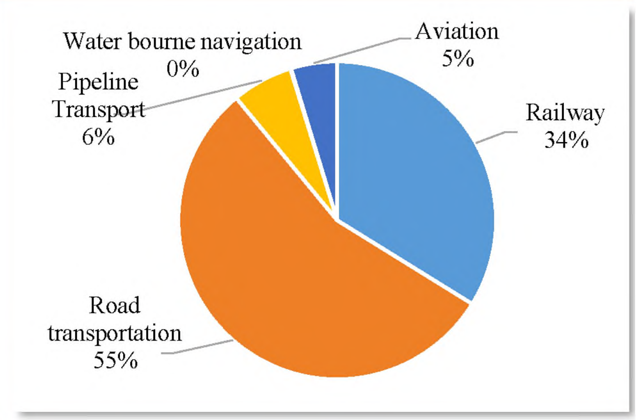
The mountainous terrain of the country and the development of road infrastructure determines the predominant use of road transport for freight transportation. Figure 1.24 shows the distribution of freight traffic in Kyrgyzstan by mode of transport in 1990 and 2018.

Figure 1.25 Freight transportation structure in 1990 and 2018

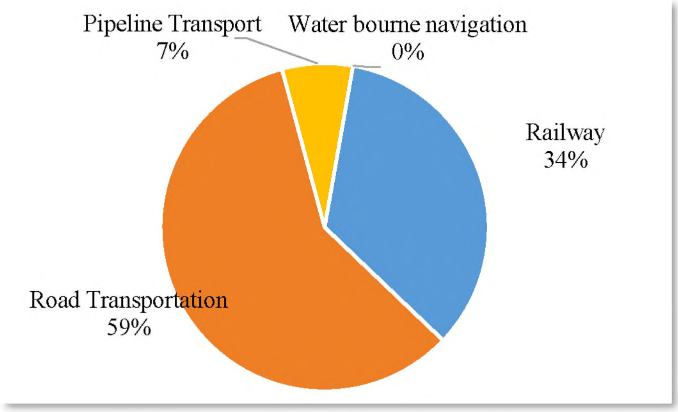
1990	2011

[84] НСК. http://www.stat.kg/ru/statistics/transport-i-svyaz/



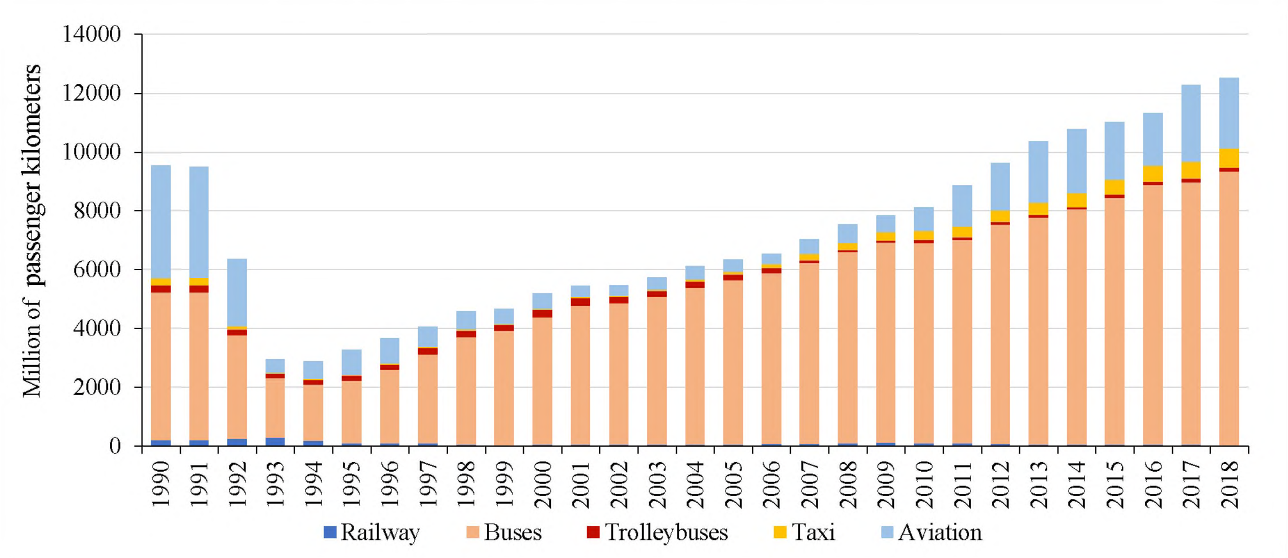


2018



The mobility of the country's population is also provided mainly by various road vehicles. Figure 1.25 shows the dynamics of passenger turnover between 1990 and 2018.

Figure 1.26 Passenger turnover dynamics between 1990 and 2018. [85]

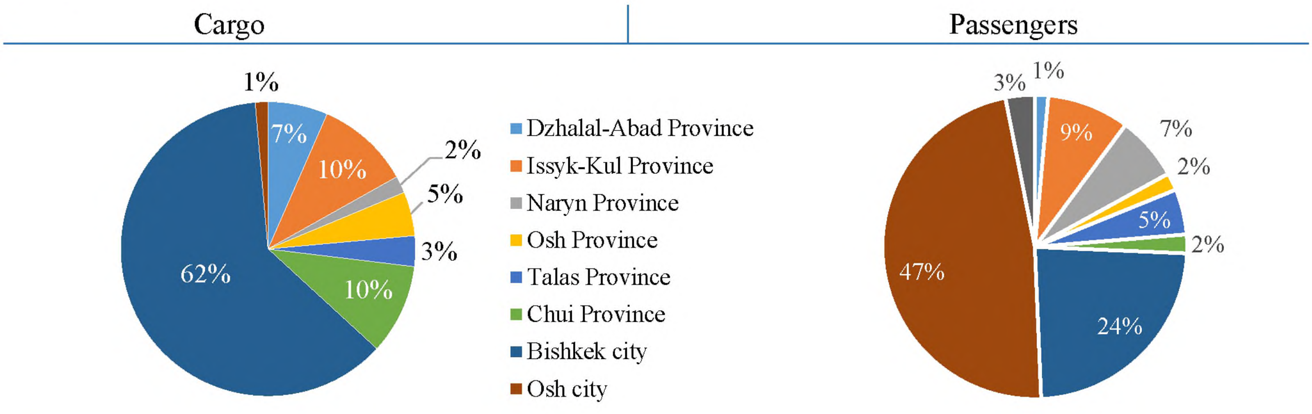


The geographical distribution of cargo freight and passenger traffic by regions of Kyrgyzstan during the reporting period of 2011-2018 maintained its structure. Hence, most of the transportation of goods

[85] НСК. http://www.stat.kg/ru/statistics/transport-i-svyaz/

in 2018 took place in Bishkek and the Issyk-Kul region, and most of the passenger movement took place in Bishkek and Chui region (Figure 1.26).

Figure 1.27 Distribution of domestic cargo and passenger transport by administrative territory in 2018[86]



1.4. Institutional Framework for the Preparation of the First Biennial Update Report and the Fourth National Communication

1.4.1. Governmental Institutions

The Kyrgyz Republic proclaimed its independence with the Declaration of Independence, adopted by the Supreme Council of the Kyrgyz Republic on August 31, 1991, during the collapse of the Soviet Union. The first Constitution of the independent Kyrgyz Republic was adopted at the XII session of the Supreme Council of the Kyrgyz Republic on May 5, 1993. It was amended in 1994 and 1996, and in 2007, a new Constitution of the Kyrgyz Republic was adopted, which lasted until 2010.

According to the current Constitution, adopted by a popular referendum on June 27, 2010, and updated by a referendum on December 11, 2016, the Kyrgyz Republic (Kyrgyzstan) is defined as a sovereign, democratic, law-based, secular, unitary, and social state. The people of Kyrgyzstan are the bearers of sovereignty and the only source of state power in the Kyrgyz Republic.[87]

The election of deputies to the Zhogorku Kenesh (Parliament), the President, and deputies of local self-government is conducted on the basis of universal, equal and direct suffrage by secret ballot. Citizens of the Kyrgyz Republic who have reached the age of 18 have the right to vote.

State power in the Kyrgyz Republic is based on the principles of the supremacy of the power of the people, represented and guaranteed by the popularly elected Zhogorku Kenesh and the President; the separation of state power, openness and responsibility of state and local governmental bodies to the people and the exercise of their powers in the interests of the people.[88]

The State is headed by a President elected every six years, who represents the unity of the people and the authority of the State.

[86] Там же.
[87] The Constitution of the Kyrgyz Republic approved by the Law of the Kyrgyz Republic as on 27th June 2010. And Law "On the amendments of the Constitution of the Kyrgyz Republic" as of 28th December 2016, # 218, endorsed by the referendum on 11th December 2016. Article 1 and 2.
[88] Ibid. Article 3.

The Zhogorku Kenesh is the highest representative body exercising legislative power and controlling functions, within the limits of its powers and consists of 120 deputies elected for a five-year term under a proportional system.

Executive power in the Kyrgyz Republic is exercised by the Government, its subordinate ministries, state committees, administrative departments, and local state administrations. The Government is the highest executive body of the Kyrgyz Republic. The Government of Kyrgyzstan consists of the Prime Minister, Deputy Prime Ministers, Ministers, and Chairmen of State Committees.[89] In 2018, the Government included:

1. Ministry of Foreign Affairs,
2. Ministry of the Interior,
3. Ministry of Justice,
4. Ministry of Finance,
5. Ministry of Economy,
6. Ministry of Agriculture, Food Industry and Land Reclamation,
7. Ministry of Transport and Roads,
8. Ministry of Emergency Situations,
9. Ministry of Education and Science,
10. Ministry of Health,
11. Ministry of Culture, Information and Tourism,
12. Ministry of Labor and Social Development,
13. State Committee for National Security,
14. State Committee for Defense Affairs,
15. State Committee for Industry, Energy and Subsoil Use,
16. State Committee for Information Technologies and Communications.

Judicial power in Kyrgyzstan is exercised only by the courts, under the Constitution of Kyrgyzstan. The judicial system of the Kyrgyz Republic is established by the Constitution and laws and consists of the Supreme Court and local courts. The Supreme Court has a Constitutional Chamber. Specialized courts may be established by law. Judges are independent and subject only to the Constitution and the laws.[90]

The judge has the right to immunity and may not be detained or arrested, searched or individually examined unless he was caught at the scene of a crime. No one has the right to request a judge to report on a particular case. Any interference in the administration of justice is prohibited. Those responsible for influencing a judge are liable to the penalties prescribed by law.[91]

1.4.2. Institutional Set Up for the Preparation of the First Biennial Update Report and the Fourth National Communication

The institutional framework, determining the preparation of country reporting under the UNFCCC since Kyrgyzstan's accession in 2000, has changed along with the institutional development of the public administration system in the Kyrgyz Republic. For example, in 2003, the first national communication (NC 1) was prepared on behalf of the Government by the Ministry of Ecology and Emergencies, which was responsible for the development and implementation of the country's climate policy within the framework of the United Nations Development Programme (UNDP) project with financial support from the Global Environment Facility (GEF).

[89] Law of the Kyrgyz Republic "On the Government of the Kyrgyz republic" as of 18th June 2012 # 85.
[90] The Constitution of the Kyrgyz Republic approved by the law as of 27th June 2010 г. Article 93.
[91] Ibid, article 94.

NC 1 was prepared by the UNDP project team, involving national and international experts from all stakeholders of the Kyrgyz Republic.

In 2009, the Second National Communication was prepared by the State Agency on Environmental Protection and Forestry under the Government of Kyrgyz Republic (SAEPF), which at that moment was responsible for the development and implementation of climate policy and the UNFCCC,[92] within the UNDP project with financial support from the GEF. The project was prepared with the participation of UNDP but based on the Climate Change Centre (CCC), specifically established under the initiative of SAEPF, which has formed a multidisciplinary expert team. Experts from all stakeholders: ministries and departments, as well as civil society, participated in the preparation of NC 2 in close cooperation with the CCC, which has become an independent legal entity.

The Third National Communication (NC 3) was prepared in 2016 by the State Agency on Environmental Protection and Forestry under the Government of the Kyrgyz Republic, as the state body[93] responsible for the development and implementation of climate policy and the UNFCCC, within the framework of the UN Environment Program (UNEP) project with financial support from the GEF. Since the SAEPF demonstrated the availability of sufficient expert capacity in the country, UNEP provided the SAEPF and the CCC with greater independence in the preparation of NC 3, providing remote expert consultations. This made it possible to attract even more participants and national expertise to the development of the TNC.

All three previous reporting documents have undergone a quality assurance process through public discussion and inter-ministerial coordination by the Government's special coordinating bodies on climate change - the Coordinating Committee (Council) on Climate Change Problems (CCCC), which included all interested ministries and departments, academic science and civil society, chaired by the first Vice-Premier. Moreover, all three national communications were approved by decrees of the Government of the Kyrgyz Republic.[94]

The development of this document - the First Biennial Update Report (BURs 1) and the Fourth National Communication (NC4) under the UNFCCC - was initiated by the SAEPF as the responsible authority for the UNFCCC in 2018 under the UNEP project with financial support from the GEF. At the same time, SAEPF established a Project Implementation Unit (PIU) established under its structural subdivision, the State Regulation Center on Environment Protection and Ecological Safety.

In 2020, the Government adopted several decisions, specifying the Ministry of Foreign Affairs[95] as the responsible state body for the country's cooperation under the UNFCCC. By the same document, the Ministry of Economy was designated as the national authorized body for the Green Climate Fund (GCF), and the Climate Finance Center (CFC) as the national authorized institution in the UNFCCC Climate Technology Center and Network. In addition, the recognition of the importance of climate change issues was reflected in the establishment of a new coordinating mechanism for green development and climate action, chaired by the Prime Minister of Kyrgyzstan - the Coordination Council for the Green Economy Development and Climate Change, which included representatives of interested ministries and departments, administrative state bodies, representatives of science, the private sector and civil society, and the CFC is defined as its secretariat.[96]

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[92] Order of the Government of Kyrgyz Republic (GKR) of January 16, 2006, No.13–r; Resolution of the GKR of December 2, 2012 "On increasing the efficiency of cooperation between the Kyrgyz Republic and international organizations."

[93] Resolution of the Government of the Kyrgyz Republic of December 2, 2015, No.817 "On increasing the efficiency of cooperation of the Kyrgyz Republic with international organizations, integration associations and international treaty bodies."

[94] NC 1 was approved by Governmental Resolution as of 10th April 2003 # 200; NC 2 - by Governmental Resolution as of 6th May 2009 # 274; and NC 3 – by Governmental Resolution as of 13th October 2016 # 546.

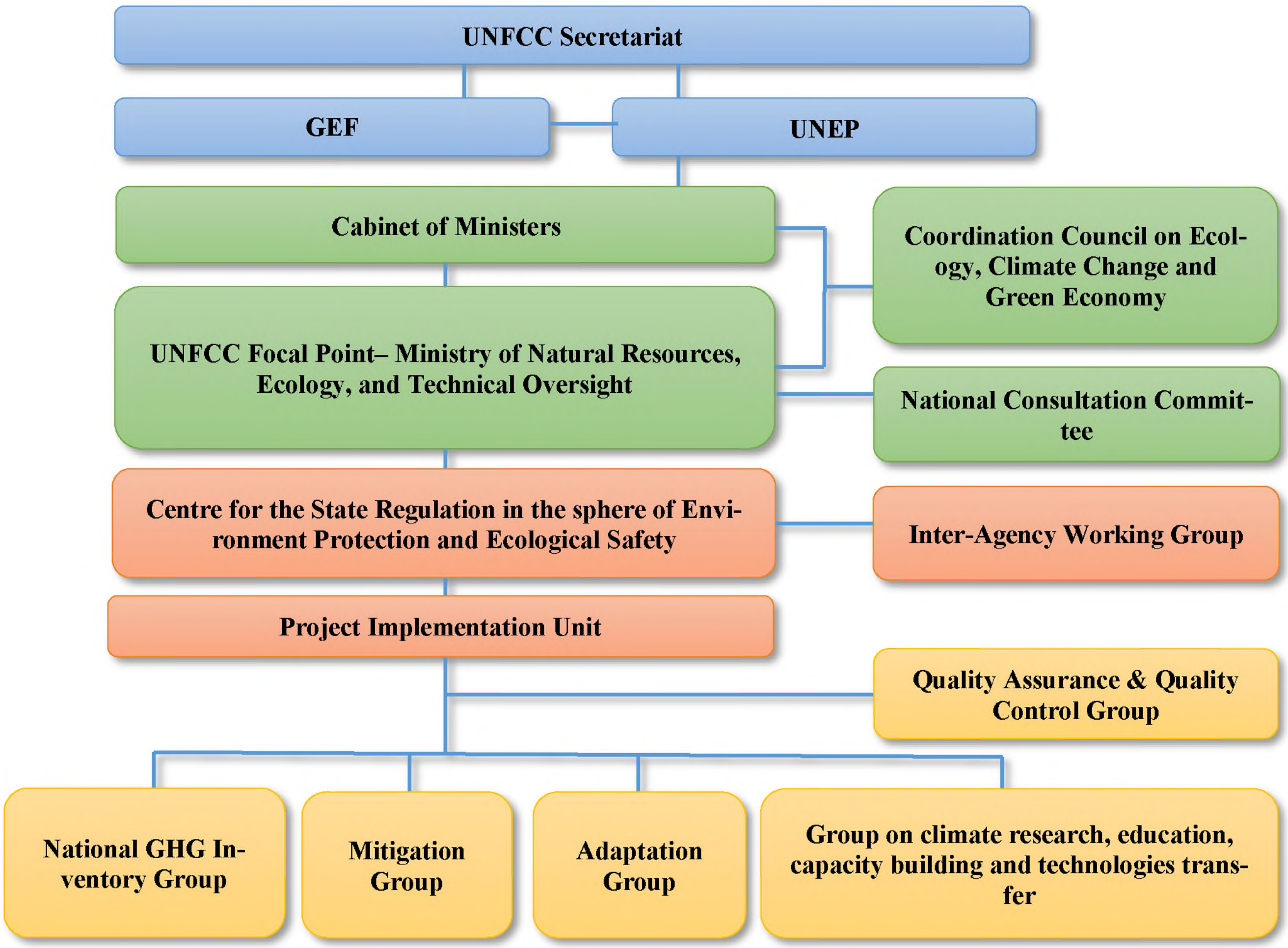
[95] Resolution of the Government of Kyrgyz Republic dated January 20, 2020, # 15.

[96] Resolution of the Government of Kyrgyz Republic dated January 30, 2020, # 46.

In 2021, the Ministry of Natural Resources, Ecology, and Technical Supervision (MNRETS) was established by a Government Decision with the transfer of responsibility for the UNFCCC and the financial mechanism of the convention.

During the interdepartmental consultations with all stakeholders, it was agreed that in the new institutional context the MNRETS will be preparing BUR 1 and NC 4 in close coordination with all participants and stakeholders of climate action in Kyrgyzstan according to the scheme shown in Figure 1.27.

Figure 1.28 Institutional organization of preparation of BUR 1 and NC 4



It should be noted that institutional organization was particularly important, especially in the process of the fourth national greenhouse gas inventory, which involves the collection of national and administrative statistics. The following section of the document, therefore, addresses this issue.

2. National Greenhouse Gases Inventory

2.1. Background

The previous three national inventories of greenhouse gas emissions and removals of the Kyrgyz Republic were conducted according to the methodology developed by the Intergovernmental Panel on Climate Change (IPCC), which includes the following main documents:

- Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 1996 Guidelines). [97]
- Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.[98]
- Good Practice Guidance for Land Use, Land-Use Change and Forestry. [99]

Compiled together, they represent an internationally agreed methodology used by countries and currently used in the assessment of greenhouse gas inventories for country reporting under the United Nations Framework Convention on Climate Change (UNFCCC).

The 1996 IPCC Guidelines, outlined in three volumes, defined the coverage of the national inventory in terms of gases and categories of emissions by sources and removals by sinks, and all other guidelines provided additional direction on the choice of estimation methodology and improvement of methods, as well as recommendations on complex issues, including uncertainty assessment, time-series consistency, quality assurance, and quality control.

The first National Greenhouse Gas Inventory (NGHGI) was conducted in 1999-2003, the second NGGI in 2004-2009, and the third NGHGI in 2009-2014 carried using the above 1996 Guidelines.

The Fourth National Greenhouse Gas Inventory of Kyrgyzstan was developed using the IPCC 2006 Guidelines for National Greenhouse Gas Inventories.[100] These guidelines include new sources and gases, as well as updates of previously published methods, where scientific and technical knowledge has improved since the previous guidelines were issued. The content of the five volumes constituting the IPCC 2006 Guidelines has significantly expanded the coverage of anthropogenic emissions impacting climate change.

Greenhouse gas inventories are based on several key concepts with a common understanding. This helps to ensure that inventories are comparable between countries, that there is no double-counting or missing, and that actual changes in emissions are reflected in the time series.

"Anthropogenic emissions and removals" mean that greenhouse gas emissions and removals included in national inventories are the results of human activities. The distinction between natural and anthropogenic emissions and removals follows directly from the data used to quantify such activities.

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[97] Intergovernmental Panel on Climate Change (IPCC) (1997). Houghton J.T., Meira Filho L.G., Lim B., Tréanton K., Mamaty I., Bonduki Y., Griggs D.J. and Callander B.A. (Eds). Revised 1996 IPCC Guidelines for National Greenhouse Inventories. IPCC/OECD/IEA, Paris, France.

[98] Intergovernmental Panel on Climate Change (IPCC) (2000). Penman J., Kruger D., Galbally I., Hiraishi T., Nyenzi B., Emmanuel S., Buendia L., Hoppaus R., Martinsen T., Meijer J., Miwa K., and Tanabe K. (Eds). Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. IPCC/OECD/IEA/IGES, Hayama, Japan.

[99] Intergovernmental Panel on Climate Change (IPCC) (2003), Penman J., Gytarsky M., Hiraishi T., Krug, T., Kruger D., Pipatti R., Buendia L., Miwa K., Ngara T., Tanabe K., Wagner F., Good Practice Guidance for Land Use, land-Use Change and Forestry IPCC/IGES, Hayama, Japan

[100] Prepared by the IPCC National Greenhouse Gas Inventories Programme, Eggleston H.S., Miwa K., Srivastava N. and Tanabe K. (eds), Institute for Global Environmental Strategies 2108-11, Kamiyamaguchi Hayama, Kanagawa, Japan, 240-0115

National inventories contain estimates for the calendar year when air emissions (or removals) have occurred. Where suitable data are not available to comply with this principle, emissions/removals can be estimated using data from other years using appropriate methods such as averaging, interpolation, and extrapolation. The sequence of estimates of annual greenhouse gas inventories (e.g., for each year from 1990 to 2018) is called a time series. Due to the importance of tracking emission trends over time, countries should ensure that the time series of estimates are as consistent as possible.

The Greenhouse Gas Inventory Report (National Inventory Report) includes a set of standard reporting tables covering all relevant gases, categories and years, and a written report that documents methodologies and data used to prepare the evaluations. The 2006 Guidelines provide standardized reporting tables, but the actual nature and content of the tables, as well as the written report, are subject to change.

The fourth national inventory of anthropogenic greenhouse gas emissions by sources and removals by sinks in Kyrgyzstan was accompanied by several methodologically important innovations:

- Transition to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. (hereinafter Guidelines 2006);[101] and
- Application of IPCC Inventory Software Ver. 2.54» released in June 2017.[102]
- Using the EMEP/EEA Air Pollutant Emission Inventory Guidebook. Technical guidance for preparing national emission inventories. European Environment Agency. Report 21/2016. [103]

Kyrgyzstan presents the results of the fourth national inventory of anthropogenic greenhouse gas emissions by sources and removals by sinks in the First Biennial Update on the UNFCCC for the period 2011-2018. The inventory was carried out in accordance with the provisions of the IPCC 2006 Guidelines for National Greenhouse Gas Inventories (hereinafter the Guidelines 2006) and includes emissions and removals of six direct greenhouse gases:

1. CO_2 (carbon dioxide),
2. CH_4 (methane),
3. N_2O (nitrous oxide),
4. HFC (hydrofluorocarbons - HFCs),
5. PFC (PFC perfluorocarbons), and
6. SF_6 (Sulphur hexafluoride)

and four precursor gases:

7. CO (carbon monoxide),
8. NOx (nitrogen oxides),
9. NMVOC (non-methane volatile organic compounds of NMVOCs) and
10. SO_2 (sulphur dioxide).

The 4th national GHG Inventory of the Kyrgyz Republic covered the first four categories of greenhouse gases, because studies of the initial data, as well as in the 3rd NGHGI, showed that emissions for the fifth (PFC) and sixth (SF6) GHG categories in Kyrgyzstan are practically absent[104] as emissions for the rest of the GHGs from the list of the IPCC 2006 Guidelines.

[101] UNFCCC. https://www.ipcc-nggip.iges.or.jp/public/2006gl/russian/pdf/
[102] IPCC website. https://www.ipcc-nggip.iges.or.jp/software/index
[103] EEA website: https://www.eea.europa.eu/www/ru/publications/rukovodstvo-emep-eaos-po-inventarizaciivybrosov-2016
[104] SAEPF, GEF, UNEP, CCC. Third National Communication of Kyrgyz Republic. –B., 2016, p. 60.

2.2. Institutional Organization for the Fourth National GHG Inventory

The legal framework for the inventory of anthropogenic emissions from sources and removals by sinks of greenhouse gases (hereinafter - inventory) is determined by the Law of the Kyrgyz Republic "On state regulation and policy in the field of emission and absorption of greenhouse gases" [105] and the Resolution of the Government of the Kyrgyz Republic dated July 23, 2001, No.369 "On measures to implement the United Nations Framework Convention on Climate Change."

Pursuant to article 13 of the abovementioned law, the country maintains state records of indicators on the emission and absorption of greenhouse gases, which includes the collection and synthesis of inventory and monitoring results in order to obtain reliable information. Article 14 indicates that the state inventory of greenhouse gas emissions and removals is a single and comprehensive register of greenhouse gas emissions and removals in the territory of the Kyrgyz Republic, and the procedure for its operation is approved by the Government of the Kyrgyz Republic.

The Ministry of Foreign Affairs was designated as the responsible body for the UNFCCC instead of the State Agency on Environmental Protection and Forestry under the Government of the Kyrgyz Republic following the Resolution of the Government of the Kyrgyz Republic No. 15 "On Amendments to the Resolution of the Government of the Kyrgyz Republic "On increasing the efficiency of cooperation of the Kyrgyz Republic with international organizations, integration associations, and international treaty bodies dated December 2, 2015 No. 817" dated January 20, 2020. Thus, the UNFCCC was assigned to the Ministry of Foreign Affairs, which is now responsible for the preparation and coordination, including domestic, of draft documents on various issues of international cooperation, including National Communications, Biennial Reports, Greenhouse Gas Inventory, National Greenhouse Gas Inventory Reports.

As noted above, since the preparation of the First Biennial Update Report and the Fourth National Communication under the UNFCCC was started in 2018, prior the above-mentioned resolution, it was decided that the State Agency on Environmental Protection and Forestry under the Government of the Kyrgyz Republic (SAEPF) and the State Regulation Center on Environmental Protection and Ecological Safety (SRCEPES) under SAEPF will continue the work and finilize the development of both documents, including the conduct of a national inventory of greenhouse gases and an update of the GHG inventory.

According to the Resolution of the Government of Kyrgyz Republic "On the Coordination Council for the Green Economy Development and Climate Change" dated January 30, 2020, No. 46, the Coordination Council for the Green Economy Development and Climate Change will be the main body to manage the drafting process, periodic updates and submission of the necessary reporting on the implementation of the international obligations of the Kyrgyz Republic on climate change, including the inventory of greenhouse gases.

The overall management of the fourth national GHG inventory was managed by MNRETS and the Project Implementation Unit (PIU) of GEF-UNEP at SRCEPES. A cross-sectoral GHG Inventory Team, comprising several Technical Expert Groups (TEG), was established to provide technical support to the national GHG inventory and developing the register related GHG inventory. Each TEG included experts on the inventory of GHG sectors (two experts: the TEG Head and Leading Specialist), industry statisticians and representatives of relevant organizations and departments. Therefore, the direct administrator of the national GHG inventory is the Project Implementation Unit under the SRCEPES and its GHG Inventory Group, which consisted of the following TEGs:

- Energy (combustion of all types of fossil fuels in all industries, including transport and all other sectors, as well as fugitive emissions (vaporization) of various types of fuels).
- Industrial processes and product use.
- Agriculture (livestock, rice, soil).
- Forestry and other types of land use (for 6 types of land use).

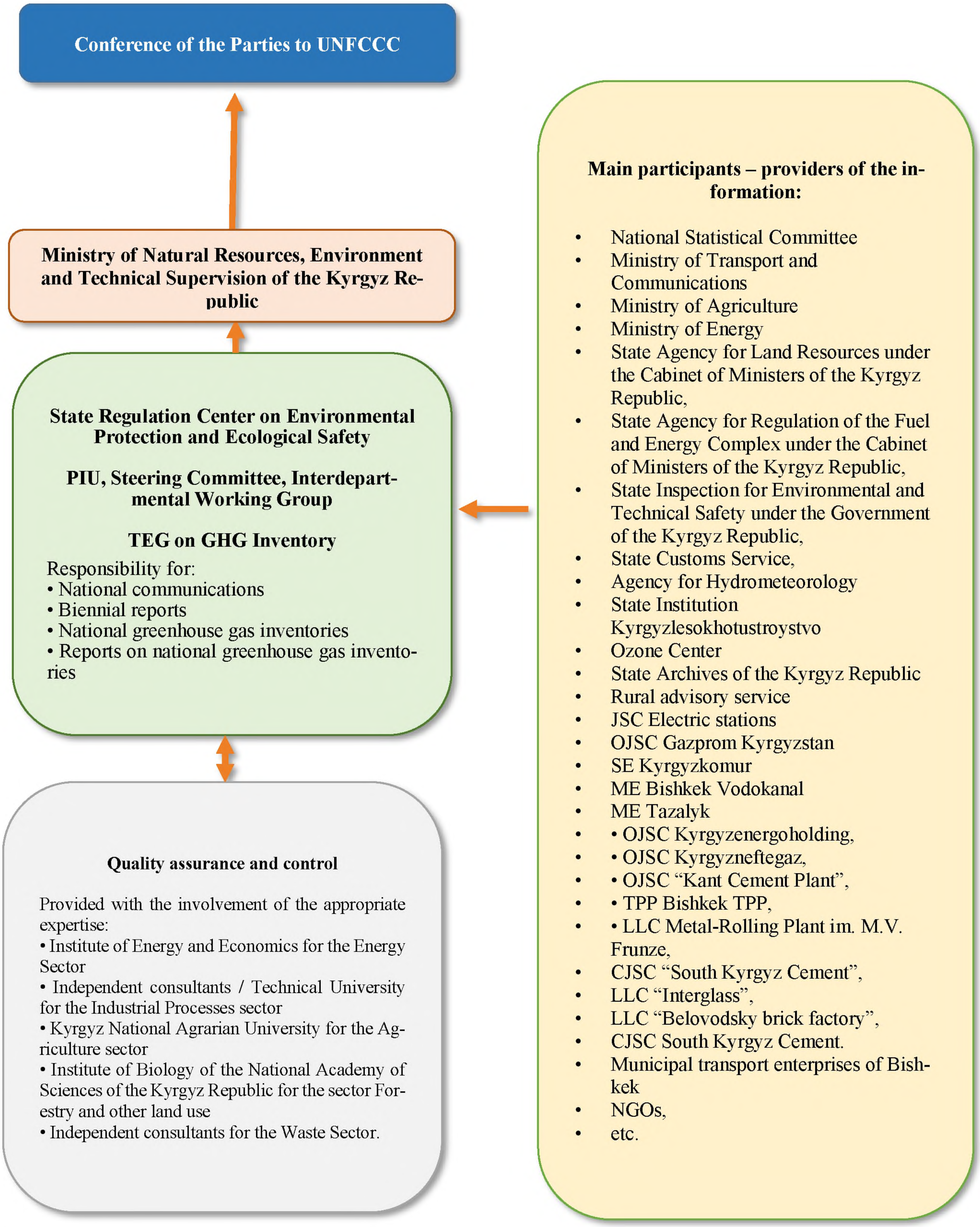
[105] Law of the Kyrgyz Republic No.71 of May 25, 2007.

- Waste (solid waste and waste water).

The provision of technical planning, coordination and quality control of the work of the group under the overall supervision of the project manager and coordinator was carried out by the Head of the Technical Expert Groups, which provided ongoing inventory control and technical advisory support.

The information and data required for the National GHG Inventory was provided by several organizations. At the same time, priority was given to the use of official statistics of the Kyrgyz Republic, which was delivered by ministries and departments, administrative bodies, the state archive, government agencies and enterprises, and private business structures. The general scheme for conducting a national GHG inventory is presented in Figure 2.1. below.

Figure 2.1 Institutional organization of the national GHG inventory in the Kyrgyz Republic



The Minister of Natural Resources, Environment and Technical Supervision was in charge of the overall management of the greenhouse gas inventory preparation process and ensured the essential interaction with all stakeholders in the process. The project coordinator at SRCEPES provided the day-to-day management of the GHG inventory process by ensuring that the PIU communicated with the required information providers.

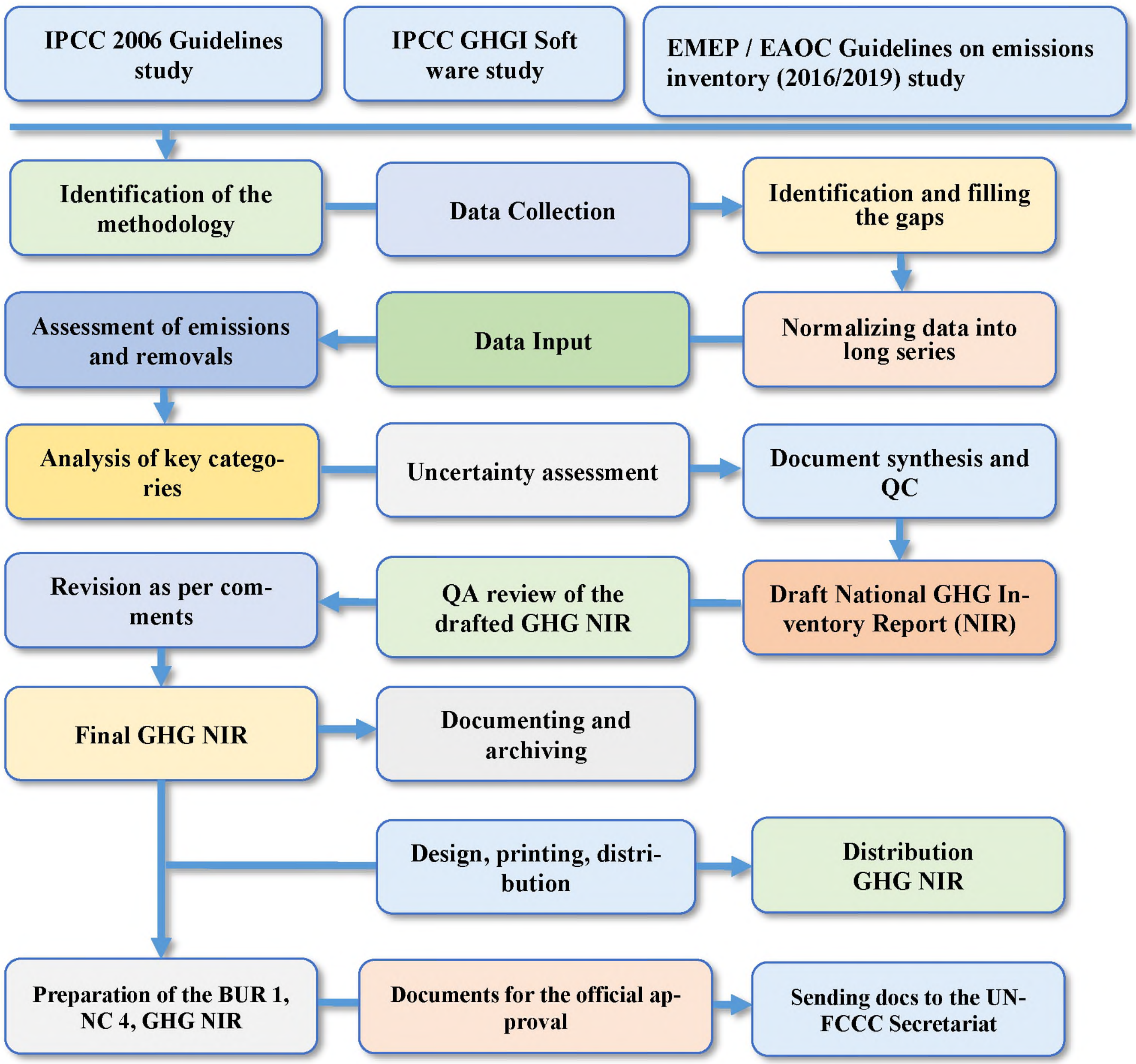
The project manager ensured routine management of the PIU, the deadlines of each stage of the process, preparation and distribution of requests for information on sources, and ensuring timely responses to requests, as well as the organization and implementation of all project activities.

2.3. Fourth National GHG Inventory Process

The process of the Fourth National Greenhouse Gas Inventory was conducted according to the recommendations of the UNFCCC and IPCC Guidelines within the national legal framework and institutional organization of the process presented above. Besides, the timing of the inventory was determined by the project document and the UNEP-GEF Project Implementation Plan, in close coordination with the UNEP office in Nairobi.

The primary performer of the GHG inventory was the PIU, including the GHG Inventory Group team, and the head of the technical expert groups. The main stages of the process are shown in Figure 2.2 below.

Figure 2.2 Diagram of the national GHG inventory process in the Kyrgyz Republic



The leader of the sectoral TEG inventory, together with the Project Manager, was responsible for organizing and conducting regular coordination meetings of all sectoral TEGs, as well as for collecting and compiling the results of the conducted emission inventory assessment into the National GHG Inventory, ensuring the integrity and quality of the inventory, presenting it in Chapter 2 "National GHG Inventory" in the BUR 1 and the NC 4.

Emissions by individual sources and removals by separate sinks are the responsibility of national inventory experts who together with the TEG leader, decide on the use of the most appropriate methodology, collect activity data necessary for estimating emissions. Since the new IPCC 2006 Guidelines were used to conduct the current emissions assessment and the new software had to re-generate long time series of activity data and recalculate emissions for all categories.

Decisions on the choice of parameters for emissions assessment, collecting the most necessary information and data, choosing the most adequate level and emission factors, calculating emissions, assessing uncertainty, checking the results for quality assurance and quality control by independent scientific institutes and experts, ministries and departments, private structures were made jointly by the project manager, TEG leader, and national inventory experts. National experts also prepared explanatory text on ongoing emissions assessment studies, as well as all used bibliography.

In addition, national experts prepared summary tables of emissions by sector, category and subcategory, conducted uncertainty analysis and carried out quality assurance and control (QAC) activities in close cooperation with the TEG Leader - compiler of the National GHG Inventory in accordance with the QAC Plan developed by the PIU.

During the review of the draft National GHG Inventory, the document was sent to a group of independent experts who did not participate in the preparation of the inventory. The purpose of the inventory review is to receive comments from experts in the relevant fields on the quality of the work performed, in particular on the relevance of the methodological approaches used, emission coefficient, and activity data. The received comments were checked and corrected accordingly.

After completing the final editing of the National GHG Inventory, based on the comments received during the peer review, the PIU prepared the final version electronic version for approval by the MNRETS. This version was then used for publication.

The inventory of GHG emissions and removals after the publication, its data were included in BUR 1 and NC 4, after approval at the appropriate level of government of the country, were submitted to the UNFCCC secretariat.

2.4. Methodology

GHG emissions by sector were estimated in accordance with the IPCC 2006 Guidelines for National Greenhouse Gas Inventories developed by the United Nations Framework Convention and related good practice guidelines that provide internationally agreed methodologies for countries to use inventories assessment of greenhouse gases for reporting to the UNFCCC.

According to the IPCC 2006 Guidelines, estimation of greenhouse gas emissions and removals are divided into main sectors, combining relevant processes, sources and sinks.

- Energy
- Industrial Processes and Product Use (IPPU)
- Agriculture, forestry and other types of land use (AFOLU)
- Waste.

Energy

In the modern economy, energy systems are largely driven by the burning of fossil fuels. Carbon and hydrogen from fossil fuels are mainly converted to carbon dioxide (CO_2) and water (H_2O), releasing the chemical energy of the fuel and converting it into heat. This heat is usually used either directly or (with some conversion loss) to generate mechanical energy, most often to generate electricity or to transport.

The energy sector is usually the most important in the greenhouse gas inventory, accounting for over 90 percent of CO2 emissions and 75 percent of total greenhouse gas emissions in developed countries. About half of these emissions are associated with combustion in the energy industries, mainly in power plants and refineries. Mobile combustion (cars and other vehicles) also accounts for a significant portion of the energy sector's emissions.

The energy sector consists mainly of:

- Exploration and Production of Primary Energy Sources,
- Converting primary energy sources into more usable forms of energy in refineries and electric and thermal plants,
- Fuel transfer and distribution,
- Stationary and mobile use (combustion) of fuel.

Emissions resulting from activities of solid, liquid, and gaseous fuels combustion, as well as volatile emissions, are subject to national inventories of greenhouse gas emissions from the energy sector.

Industrial Processes and Product Use (IPPU)

Many types of industrial production are associated with greenhouse gas emissions. The main sources of emissions are those coming from industrial processes of chemical or physical processing of materials (for example, blast furnaces in the steel industry; ammonia and other chemical products from fossil fuels used as chemical raw materials, cement production are the most important examples of industrial processes associated with the release of significant quantities of CO_2). These processes produce a variety of greenhouse gases, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

In addition, greenhouse gases are often can be found in products such as refrigerators, foams, and aerosol cylinders. For example, HFCs are used in various types of products instead of ozone-depleting substances (ODS). Sulfur hexafluoride (SF6) and N2O are also used in several industrial products (for example, SF6 in electrical equipment, N2O as a propellant in aerosol products, mainly in the food industry), as well as in final consumer products (for example, SF6 is used in sneakers, N2O for anesthesia). A distinctive feature of this use of products is that in almost all cases a rather long time elapses between the production of the product and the release of the greenhouse gas. This delay time can range from a few weeks (for example, for aerosol cans) to several decades (for rigid foams). In some applications (such as refrigeration), the fraction of greenhouse gases contained in a product can be recovered at the end of the product's useful life and then reused or destroyed.

Product applications are integrated in the IPCC guidance with industrial processes, because production, import, and export data are often needed to estimate emissions of products; and since - in addition to application in non-industrial sectors (retail, services, household) - the use of products can be part of industrial production. [106] Consequently, this sector is called Industrial Processes and Product Use (IPPU).

Agriculture, forestry and other types of land use (AFOLU)

The Agriculture, Forestry and Other Land Use (AFOLU) sector is the only sector that not only emits greenhouse gas emissions, but also absorbs them. It has a number of features with regard to the development of inventory techniques. It contains many processes leading to emissions and removals of

[106] IPCC. Guidelines for National Greenhouse Gas Inventories. Vol. 3. 2006 https://www.ipcc-nggip.iges.or.jp/public/2006gl/russian/pdf/3_Volume3/V3_1_Ch1_Introduction.pdf

greenhouse gases, which can be widely distributed in space and highly variable over time. The factors controlling emissions and removals can be both natural and anthropogenic (direct or indirect), and it can be difficult to distinguish clearly between causal factors.

For the AFOLU sector, anthropogenic emissions and removals of greenhouse gases are defined as all emissions and removals occurring in agricultural production on "managed land". Managed land is land where human intervention and activities take place to implement production, environmental and social functions. All definitions and classifications of land should be established at the national level, described in a clear way and applied consistently over time. For unmanaged land, information on emissions / removals should not be provided. However, it is good practice for countries to quantify and track the area of unmanaged land over time to ensure consistency in accounting for area under land-use change.

The main sources of emissions from the sector are:

- CO_2 emissions and removals due to carbon stock changes in biomass
- emissions of CO_2 and non- CO_2 gases from fires on all managed lands;
- CH_4 emissions from domestic animals (enteric fermentation);
- CH_4 and N_2O emissions from systems for cleaning, storing, and using manure
- N_2O emissions from all cultivated soils;
- CH_4 emissions from rice cultivation.

Due to the complex nature and specificity of each component, during the 4th NIPG, the AFOLU sector was divided into two subsectors - Agriculture and Forestry and other types of land use and examined separately. The results of these two analyzes were compiled into a sectoral single report.

Waste

The Waste section in the consolidated and annual inventory tables contains the results of the estimation of emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) in the following categories:

Disposal of solid waste;

Biological treatment of solid waste;

Incineration and open burning of waste;

Wastewater treatment and discharge (chapter 6).

Each sector consists of separate categories and subcategories. Ultimately, all countries start building the inventory at the subcategory level, as this is the way the IPCC methodology is presented, and the total amount of emissions is calculated by subsequent summation. The national total is calculated by summing emissions and removals for each gas. The exception is emissions from fuel used on ships and aircrafts engaged in international transport, which are not included in the national total but reported separately.

A method has to be chosen to calculate the national total. To this end, countries can choose any of the approaches reflected in the Guiding Principles. The reporting procedures are generally structured and organized according to the sector where actual emissions or removals are generated.

In the 2006 Guidelines and the 2000 IPCC Good Practice Guidelines, the most common simple methodological approach for conducting national GHG inventories is to combine information on the volume and extent of human activity (called "activity data" or AD) with coefficients, which determine the volume of emissions or removals per unit of activity. Such values are called emission factors (EFs). Thus, the basic equation is:

$$\text{Emissions} = EF \times AP$$

Under certain conditions, the basic equation may be modified to include parameters other than the emission factors. The 2006 Guidelines also provide more complex modeling approaches, especially at higher levels. While this simple equation is widespread, the 2006 Guidelines also contain mass balance-based methods, such as the stock change method used in the AFOLU sector, which estimates CO2 emissions from the change in carbon in living biomass and reservoirs of dead organic matter over time.

The IPCC methods use the concept of "good practice," including the definition of "inventories consistent with good practice as those which contain neither over- nor underestimates so far as can be judged, and in which uncertainties are reduced as far as is practicable."

The 2006 guidelines provide three levels of methodology for conducting national GHG inventories. The level represents the degree of methodological complexity. Tier 1 is the basic method, level 2 is intermediate, and level 3 is the most difficult in terms of difficulty and data requirements. Levels 2 and 3 are sometimes referred to as higher-level methods and are generally considered more accurate.

The Tier 1 methods provided for all categories are designed to use publicly available national or international statistics in combination with established default emission factors and additional parameters provided, and therefore should be applicable to all countries.

The Key Category concept is used to identify categories that have a significant impact on a country's overall greenhouse gas inventory in terms of absolute emissions and removals, trends in emissions and removals, or uncertainty in emissions and removals. Key categories should be prioritized by countries when allocating inventory resources for data collection, compilation, quality assurance/quality control, and reporting.

The IPCC guidance documents also provide so-called decision trees for each category. They help inventory compilers navigate the guidelines and select the appropriate tiered methodology suitable for their conditions, based on an assessment of key categories.

2.4.1. Methodology, Emission Factors and Data Time Series

The adoption of the new methodology (2006) and the use of new software specified to choose a simpler Tier 1 methodology for almost all categories of emissions and removals.

The use of the IPCC software package for data entry also determined the use of default emission factors.

Unfortunately, the lack of an archive of the previous - third national inventory forced the inventory team to collect data again and form long time series of data. At the same time, in many cases, experts had to contend with the availability of periodic data, data gaps, or the presence of multiple data options.

In cases where national information was unavailable or inaccessible, international databases were used (UN Food and Agriculture Organization, World Bank, etc.). The definition and use of the methodology and parameters, prerequisites, sources of information, and the results of the inventory were discussed at regular meetings with representatives of relevant ministries and departments, educational and scientific institutions, non-governmental organizations, and the business sector. The interpolation was used in the case of irrecoverable omissions of the original data. Interpolation algorithms are described in the relevant sectoral sections on the GHG inventory.

The information used consists of three main groups:

- activity data, mainly fuel consumption and output;
- emissions and sink coefficients for GHG and precursor gases;
- indicators and parameters specific to each source or sink, such as the morphological composition of waste, etc.

Activity data are based on governmental and/or departmental statistics and business reports. The indicators of this group are available in officially published sources or collected at the request of ministries, departments, and organizations.

The following used as emission factors:

- Values given in the IPCC Guidelines and its online Emission Factor Database;
- Values given in other international guidelines, e.g., EMEP / EEA Air Pollutant Emission Inventory Guidebook of the European Environment Agency 2016-2019;
- Values used in the national system of inventory and regulation of emissions of pollutants into the environment or derived from previous studies (in the Industrial Processes and Land Use, Land-Use Change, and Forestry sectors).

Specific indicators and parameters have been adopted according to the IPCC Guidelines based on available national data or determined by calculation through indirect indicators using the results of scientific research. In the absence of other possibilities, the indicators were determined by the method of expert assessments.

2.4.2. Key Categories

Chapter 4 Volume 1 of the 2006 IPCC Guidelines defines a key category as a category "that is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of greenhouse gases in terms of the absolute level, the trend, or the uncertainty in emissions and removals. Whenever the term key category is used, it includes both source and sink categories." [107]

This section presents an analysis of key sources/sinks of GHG emissions and removals in the Kyrgyz Republic for the period 1990-2018 by the absolute values of emissions/absorption (analysis of levels and by trends).

The share of individual categories (convertible to CO2 equivalent) in the total emissions/removals is calculated in accordance with the total level of emissions/removals (level estimate) to determine the key categories of sources/sinks. After calculation of the percentage contribution of each source/sink category, they are summed up in descending order to the level of 95% of the sum of all key categories.

According to the trend assessment method, a source/sink category is considered a key category if it makes a significant contribution to the overall trend of national emissions and removals. For this assessment, the trend of the source category is calculated for each emission/removal category as the difference between the emissions/removals obtained from this source/sink category between the current and base years of the inventory, divided by the current year's emissions/removals. In addition, the trend of the total inventory value is calculated by dividing the difference between the total emissions of the current and base year by the total emissions of the present year.

To assess the actual significance of the difference between the source category and the general trends in the general inventory results, these differences are weighted according to the estimated share of the absolute value of emissions in the source category, i.e. the level is estimated. Particularly, the overall emission trend is subtracted from the estimated trend of the source category and multiplied by the level value (share) obtained for that source category by the "level estimation" calculated for the base year. The values obtained for all source categories are added together, and the proportion of each category is calculated as part of this total. Thus, the key source category will include a source category where the difference between the overall inventory trend and the trend of the source categories according to the "level" of the source category in the base year is significant.

[107] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol.1, chapter 4, p. 4-5.

The 2006 IPCC Good Practice Guidelines (Volume 1, Chapter 4) presents techniques called “approaches” that are used to identify key categories. These methods define key categories by means of one-year inventory analysis of emission levels of individual categories (level assessment) and analyzing the time series of the inventory data (trend assessment), as well as through detailed analysis of inventory data with the estimation of errors (Level 2 assessment and trends accounting uncertainties).

During the fourth NGHGI, the analysis of key categories was carried out under the Approach 1 procedure for estimating GHG emissions in the Kyrgyz Republic for 2018 as the last reporting year. Consisting with IPCC documents, this analysis included both emissions by sources and removals by sinks.

Since the first round of the fourth national GHG inventory covers the period 1990-2018, 1990 is considered the base year for trends assessment. The results were presented in descending order and the overall values were calculated. Sources for which totals were equal to or above 95% of all CO_2 equivalent emissions were identified as key source categories in terms of trends.

By the tools of IPCC Software v.2.54, used in the 4th NGHGI, it is possible to analyze the key categories of GHG emissions and sinks by level and trends. The results of the analysis of key categories by level are presented in tables 2.1. and 2.2 below.

Table 2.1 Key categories of GHG emissions and removals sources by level [108]

A	B	C	D	E	F	G
IPCC Category code	**IPCC Category**	**Greenhouse gas**	**2018 Ex,t (Gg CO2 Eq)**	**|Ex,t| (Gg CO2 Eq)**	**Lx,t**	**Cumulative Total of Column F**
3.B.1.a	**Forest land Remaining Forest land**	**CO2**	**-7471,735**	**7471,735**	**0,259**	**0,259**
1.A.3.b	**Road Transportation**	**CO2**	**4354,582**	**4354,582**	**0,151**	**0,411**
3.B.2.a	**Cropland Remaining Cropland**	**CO2**	**-3469,096**	**3469,096**	**0,120**	**0,531**
3.A.1	**Enteric Fermentation**	**CH4**	**2684,639**	**2684,639**	**0,093**	**0,624**
1.A.4	**Other Sectors - Solid Fuels**	**CO2**	**1926,916**	**1926,916**	**0,067**	**0,691**
3.C.4	**Direct N2O Emissions from managed soils**	**N2O**	**1539,647**	**1539,647**	**0,053**	**0,745**
1.A.1	**Energy Industries - Solid Fuels**	**CO2**	**1060,279**	**1060,279**	**0,037**	**0,781**
1.A.4	**Other Sectors - Liquid Fuels**	**CO2**	**1033,901**	**1033,901**	**0,036**	**0,817**
2.A.1	**Cement production**	**CO2**	**915,983**	**915,983**	**0,032**	**0,849**
1.A.2	**Manufacturing Industries and Construction - Solid Fuels**	**CO2**	**628,881**	**628,881**	**0,022**	**0,871**
3.C.5	**Indirect N2O Emissions from managed soils**	**N2O**	**590,657**	**590,657**	**0,021**	**0,892**
1.A.3.e	**Other Transportation**	**CO2**	**455,396**	**455,396**	**0,016**	**0,907**
4.A	**Solid Waste Disposal**	**CH4**	**325,958**	**325,958**	**0,011**	**0,919**
1.A.4	**Other Sectors - Gaseous Fuels**	**CO2**	**314,345**	**314,345**	**0,011**	**0,930**
1.A.1	**Energy Industries - Liquid Fuels**	**CO2**	**221,342**	**221,342**	**0,008**	**1,000**
1.A.1	Energy Industries - Gaseous Fuels	CO2	177,041	177,041	0,006	0,936
3.A.2	Manure Management	N2O	163,387	163,387	0,006	0,941
4.D	Wastewater Treatment and Discharge	CH4	152,543	152,543	0,005	0,947
1.B.2.a	Oil	CH4	146,681	146,681	0,005	0,952
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO2	142,926	142,926	0,005	0,957

[108] IPCC Inventory Software V2.54 Data Base.

As shown in table 2.1., in 2018, the key category analysis of the contribution level to the total GHG emissions and removals volume included 15 categories, where emissions and removals module amounted to 93.85% of total emissions in 2018. Table 2.2 below presents 18 key categories of GHG emissions and removals based on the assessment of trends in 2018 compared to the GHG emissions of the base year 1990.

Table 2.2 Key categories of sources of the Kyrgyz Republic's GHG inventory by trends. [109]

A	B	C	D	E	F	G	H
IPCC Category code	**IPCC Category**	**Greenhouse gas**	**1990 Year Estimate Ex0 (Gg CO2 Eq)**	**2018 Year Estimate Ext (Gg CO2 Eq)**	**Trend Assessment (Txt)**	**% Contribution to Trend**	**Cumulative Total of Column G**
3.B.1.a	**Forest land Remaining Forest land**	**CO2**	**-6850,850**	**-7471,735**	**0,093**	**0,213**	**0,213**
1.A.3.b	**Road Transportation**	**CO2**	**2824,570**	**4354,582**	**0,085**	**0,193**	**0,406**
3.B.2.a	**Cropland Remaining Cropland**	**CO2**	**-3415,270**	**-3469,096**	**0,053**	**0,121**	**0,527**
3.A.1	**Enteric Fermentation**	**CH4**	**2510,217**	**2684,639**	**0,045**	**0,102**	**0,629**
1.A.4	**Other Sectors - Liquid Fuels**	**CO2**	**459,663**	**1033,901**	**0,022**	**0,051**	**0,679**
1.A.1	**Energy Industries - Gaseous Fuels**	**CO2**	**2648,369**	**177,041**	**0,022**	**0,050**	**0,729**
1.A.1	**Energy Industries - Liquid Fuels**	**CO2**	**2575,481**	**221,342**	**0,020**	**0,045**	**0,774**
2.A.1	**Cement production**	**CO2**	**591,522**	**915,983**	**0,018**	**0,041**	**0,815**
3.C.4	**Direct N2O Emissions from managed soils**	**N2O**	**2633,558**	**1539,647**	**0,014**	**0,031**	**0,846**
1.A.2	**Manufacturing Industries and Construction - Solid Fuels**	**CO2**	**262,017**	**628,881**	**0,014**	**0,031**	**0,877**
4.A	**Solid Waste Disposal**	**CH4**	**218,446**	**325,958**	**0,006**	**0,014**	**0,892**
3.C.5	**Indirect N2O Emissions from managed soils**	**N2O**	**909,996**	**590,657**	**0,006**	**0,014**	**0,906**
1.A.2	**Manufacturing Industries and Construction - Gaseous Fuels**	**CO2**	**795,453**	**82,009**	**0,006**	**0,013**	**0,919**
1.A.4	**Other Sectors - Gaseous Fuels**	**CO2**	**390,187**	**314,345**	**0,004**	**0,010**	**0,929**
2.F.1	**Refrigeration and Air Conditioning**	**HFCs**	**0,000**	**117,459**	**0,003**	**0,007**	**0,936**
1.B.2.a	**Oil**	**CH4**	**113,678**	**146,681**	**0,003**	**0,006**	**0,942**
4.D	**Wastewater Treatment and Discharge**	**CH4**	**148,981**	**152,543**	**0,002**	**0,006**	**0,948**
3.A.2	**Manure Management**	**N2O**	**200,620**	**163,387**	**0,002**	**0,005**	**0,953**
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO2	209,506	142,926	0,002	0,004	0,956
1.B.1	Solid Fuels	CH4	253,383	38,998	0,002	0,003	0,960

[109] MNRETS, GEF-UNEP. Database of IPCC Inventory Software V2.54. – B., 2020

2.4.3. Quality Control and Quality Assurance

Quality control and quality assurance were carried out on the basis of a predetermined institutional organization of the fourth national GHG inventory, specified by the national context and in full accordance with the recommendations of the 2006 IPCC Guidelines. According to these Guidelines, national inventories should be transparent, well-documented, consistent, comparable, assessed for uncertainty, passed verification and quality assurance and control (QA/QC) process. In doing so, the 2006 IPCC Guidelines define QA / QC as follows:

- Quality control (QC) is a system of routine technical activities for measuring and controlling the quality of an inventory during its development. The basic quality control system should provide routine and consistent checks to ensure the integrity, correctness and completeness of the data; identify and correct errors and omissions; document and archive inventory materials and record all QC activities.
- Quality assurance (QA) includes a planned system of verification procedures carried out by specialists not directly involved in the cadaster compilation and conducting the inventory.[110]

Data quality assurance and quality control of calculations were performed in all three inventories according to the 2006 IPCC Guidelines and the 2000 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.

The Quality Assurance and Quality Control Work Plan and tabular forms were developed to be filled during the quality control process of the inventory by sector to ensure the quality of the PIU of the project.

It should be noted that the QA / QC process has been improved based on the results of the self-assessment of previous National Communications conducted in 2018. Thus, to ensure quality and compliance with the requirements of the Enhanced Transparency Framework, all products developed and adopted at internal coordination meetings of sectoral TEGs were discussed during sectoral consultations in the form of round tables with all stakeholders, where all decisions made were documented in protocols and accepted for implementation.

The QA / QC process of the fourth national inventory of emissions by sources and removals by GHG sinks was organized in several stages:

- The first step was to determine the methodology and the parameters proposed by the 2006 IPCC Guidelines. For this, each sectoral TEG prepared proposals justifying the choice of the level, parameters, required activity data set, and other essential parameters needed for conducting a national GHG inventory. Then these proposals were discussed and agreed upon at coordination meetings of all sectoral TEGs on inventory in the PIU and were finalized and submitted for discussion at sectoral round tables, where consultations were held with representatives of all stakeholders, based on consultations there were made agreed decisions on the chosen methodology for the National GHG Inventory.
- At this stage, the completeness, comparability, and consistency of the time series of the initial data coming from various sources were checked. All sources of background information - data providers were ranked according to the degree of confidence in the following order of priority:
    - Official publications and online resources of the National Statistical Committee;
    - Official publications and online resources of ministries and agencies;
    - Data of the State Archive of the Kyrgyz Republic;

[110] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 1, chapter 6, p. 6.5.

- Information from international sources;
- Information from national experts;
- Information received by calculation;
- Information from various Internet resources.

In case of data discrepancy between different sources, information from a higher priority was used. Additional queries and/or additional meetings with different data providers were undertaken to address issues of concern, and decisions were documented in a protocol.

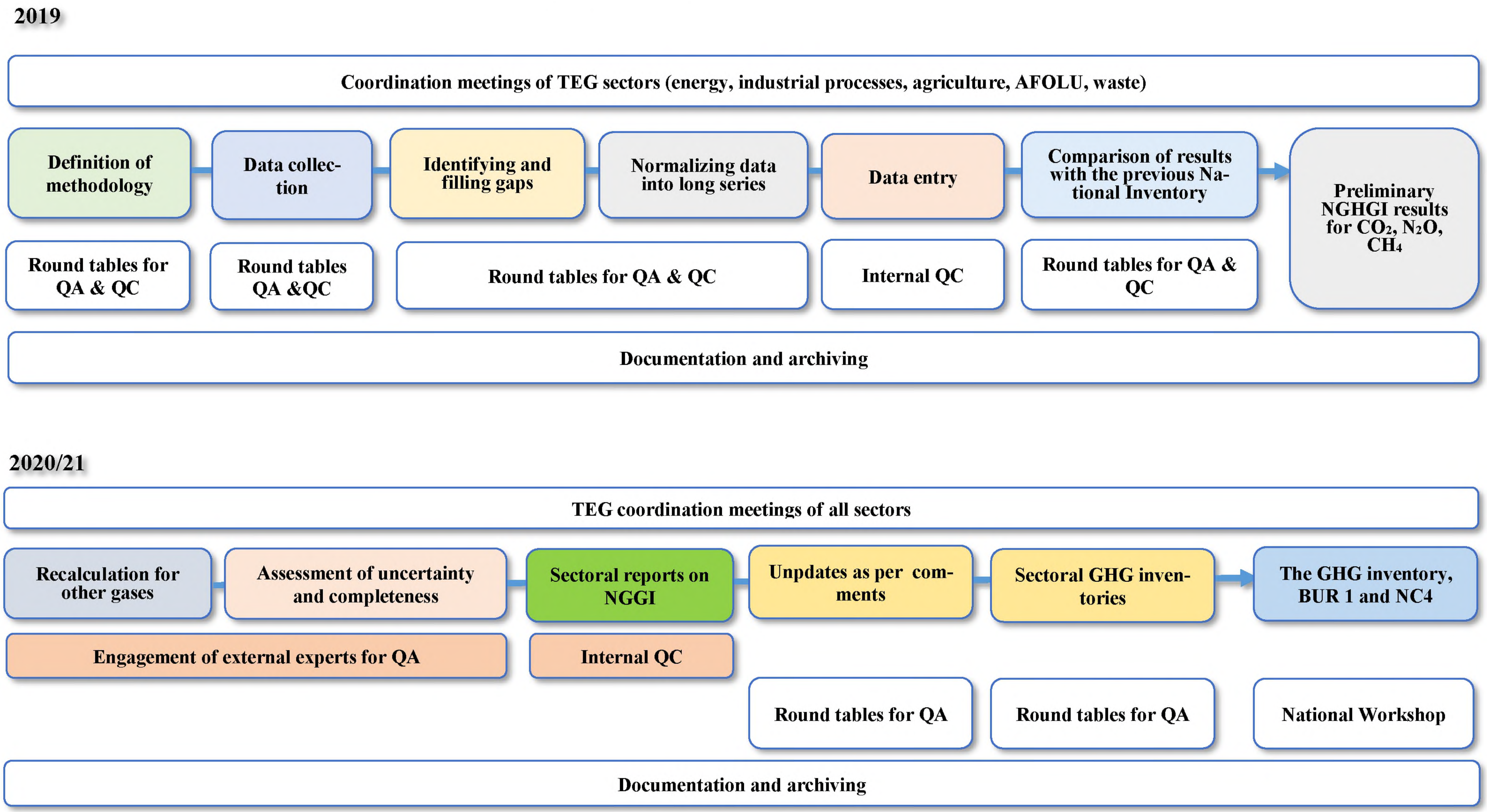
- At the third stage, long time series were formed and gaps in the data were identified and necessary calculations were made. The data were entered in series and normalized in the uniform required format of units of measure. Methods of calculations and data normalization were checked and agreed upon at coordination meetings between TEG and PIU. The resulting time series of activity data from 1990 to 2018 to estimate GHG emissions and sinks were then also submitted to the sectoral round tables, where agreed by all stakeholders. The decisions taken on data harmonization were consolidated in the respective protocols.
- The fourth step was to verify and agree on the preliminary results of the sectoral assessment of emissions by category and subcategory and by all gases. As a result of the transition to the new methodology, sectoral groups have recalculated emissions since 1990. For quality assurance, a comparison was made with the results of the third national inventory of GHG emissions and removals for the period 1990-2010 within PIU at coordination meetings of sectoral TEG. The results of the comparative analysis were then presented at the sectoral roundtables to all stakeholders.
- At the fifth stage, uncertainty in level and trends was assessed. Since the inventory was carried out for Tier 1, the uncertainty for the three main GHGs, CO_2, N_2O, and CH_4, as well as the completeness of the coverage for other gases, was estimated for all sectors, the calculation was made using CORINAIR emission factors of the European Environment Agency. The results of the uncertainty assessment and completeness for gases were presented at coordination meetings of all sectoral TEGs in the PIU for quality control.
- At the sixth stage, all data were consolidated in the tables of the UNFCCC common reporting format and the obtained results of various types of GHG emissions were brought into CO_2 equivalent format using the Global Warming Potential (GWP) factors.[111] At the sixth stage, all data were consolidated in the tables of the UNFCCC common reporting format and the obtained results of various types of GHG emissions were brought into CO2 equivalent format using the Global Warming Potential (GWP) factors. GWP presents factors that determine the extent to which different greenhouse gases contribute to global warming. Carbon dioxide shall be taken as a starting point, with a GWP of 1. The effect of GWP is calculated over a certain time horizon, usually 20, 100, or 500 years. The generally accepted GWP values are provided by the IPCC, which updates them in its assessment reports. Since the previous third national GHG inventory of the Kyrgyz Republic used the GWP values of the Second Assessment Report (SAR) of the IPCC to ensure comparability and analysis of the final data on GHG emissions and sinks, the data from the results of the Fourth National GHG Inventory were also recalculated using the IPCC SAR values. The results of this work were presented at online round tables to all interested parties due to the introduced restrictions on holding mass events in the country in connection with the COVID 19 pandemic.
- Then all the tables with the results of the 4th NGHGI were compiled into a separate document. In addition, the data from the results of the fourth NGHGI were compared with the

[111] GWP was introduced in 1997 in the Kyoto Protocol.

results of international organizations (for example, the International Energy Agency, official World Bank data, etc.) and the results of inventories in other countries, especially countries with similar climatic and socio-economic conditions (Central Asian region). The comparative calculations were also presented to all interested parties in the online discussion of the sectors.

- On the final step, a group of independent experts and specialists from research and educational institutions has been engaged to implement the QA/QC Work Plan and conducted full verification and assurance of the documentation and results-based databases of the fourth national GHG inventory and the Inventory of GHG emissions and removals in the Kyrgyz Republic for the period 1990-2018. After an external evaluation, all comments received were integrated into the National Inventory Report as appropriate. Then, the final NIR was presented at the national workshop to all stakeholders as an Annex to BUR 1.

Figure 2.3 Quality assurance and quality control process of the fourth national GHG inventory



2.4.4. Assessment of uncertainty and scope

Uncertainty estimates are an essential element of a complete inventory of greenhouse gas emissions and removals. They should be obtained for both the national level and for the trend assessment, as well as for their constituent parts such as emission factors, activity data, and other assessment parameters for each category.[112]

In the absence of developed national emission factors derived from published studies that are appropriate to the circumstances of this country, the default factors given in the sectoral volumes of the 2006 IPCC Guidelines were used in NGHGI 4, which are the most typical. However, there are uncertainties associated with the use of the factors in circumstances not related to the original measurements. There can be significant variability in how well the default totals reflect the conditions of the actual population of activities in a given country.

The default methods for using the factors represent a trade-off between the level of detail that would be required to generate accurate estimates for each country and the input data that are likely or readily available in most countries. It is clear that default methods are often simplistic and can introduce more uncertainty into a national estimate.

Activity data are more closely related to economic activity than emission factors. However, unlike emission factor data, there are usually no readily available statistical samples of alternative estimates of activity data that can match distributions and estimate uncertainty. However, activity data generally have lower uncertainty and lower correlation between years than emission factor data. Activity data are often collected and regularly published by national statistical offices, which also assess the uncertainty associated with their data as part of their data collection procedures and publish the data themselves.[113]

The NSC of the country has a significant information resource since it maintains and publishes various statistical data that can be used in the GHG inventory. For example, there are long series of data on macroeconomics, energy production, livestock, waste volumes, forest, and agricultural land. However, the long time series that is important for the GHG inventory on the number of different types of vehicles and their fuel consumption, the volume of industrial production, the morphological composition of waste, etc. are not available.

Uncertainty information is not intended to question the validity of the GHG inventory estimates, but to help improve the accuracy of future inventories and the validity of future methodological decisions. Despite the desire of the Kyrgyz national inventory team to estimate emissions with the highest accuracy, there were different uncertainties at all sectors, but with different percentages. The lack or unavailability of data, the use of a default emission factor, or an incomplete understanding of how emissions are generated by sources are the main factors contributing to the uncertainty surrounding the reported emission estimates.

It should be noted that the IPCC software for national GHG inventory, among other tools, also provides an opportunity to analyze uncertainty both for individual sectors and all data from GHG inventory as a whole. The largest percentage of uncertainty is associated with used IPCC default emission factors, the percentage of the uncertainty of which is automatically set in the range from several units to several hundred percent for each specific source of emissions and removals.

[112] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006 vol. 1, chapter 3.

[113] Ibid

According to the IPCC software data used for all values entered during the fourth NGHGI, the uncertainty of the activity data ranged from 5 to 75%. And the uncertainty of the applied IPCC default emission factors are presented in the range from 3.1 to 999%.[114]

In general, the uncertainty in total inventory obtained in the result of the 4th NGHGI GHG Inventory for the period 1990-2018, according to the IPCC software package, is determined at 61.255%, and the trend uncertainty at 22.882%. (See Annex 1 to NIR).

A complete table of uncertainty analysis of the GHG inventory is presented in the NIR annexed to BUR 1. Uncertainties of sectoral inventories are presented further in the relevant sections.

The completeness of scope of the fourth national GHG sector inventory was consistent with the IPCC methodology and the corresponding calculations were made for the following greenhouse gas emissions: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O) and hydrofluorocarbons (HFCs), as well as for precursor gases (HP): carbon monoxide (CO); nitrogen oxides (NOx); non-methane volatile organic compounds (NMVOC); and sulfur dioxide (SO2).

The analysis of the background information, as in the 3rd NGHGI, [115] found that there is no emission of perfluorocarbons and sulfur hexafluoride in the republic and these gases are not considered further.

Emissions of methane, nitrous oxide, and HFCs were converted to CO2 equivalents (CO2 eq.) using the values of the Global Warming Potential to estimate the total emissions of the country and sectors. The Global Warming Potential (GWP) has been developed to make it possible to compare the effects of different gases on global warming. It assigns a certain value to the amount of heat captured by a given mass of gas compared to the portion of heat captured by a similar mass of carbon dioxide in a given unit of time. The reference gas is carbon dioxide (CO2), whose GWP is 1. The effect of emissions is estimated over a certain period of time - a time horizon of 100 years. The values given in the 1995 IPCC Second Assessment Report on Climate Change were used for comparison with previous inventories (see table 2.3).[116] In addition, these recalculation equivalents are set by default in the IPCC software package.

Table 2.3. GWP values accepted for calculation in this document [117]

Gases	Chemical Formula	Global Warming Potential with a Time Horizon of 100 Years
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
Hydrofluorocarbon (HFC) - 23	CHF_3	11,700
HFC -32	CH_2F_2	650
HFC -125	CHF_2CF_3	2,800
HFC -134a	CH_2FCF_3	1,300
HFC -143a	CH_3CF_3	3,800
HFC -227 ea	CF_3CHFCF_3	2,900

[114] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006 vol. 1-5.

[115] SAEPF. GEF_UNEP. Third National Communication of the Kyrgyz Republic on UNFCCC. Bishkek. 2016, p. 60.

[116] https://archive.ipcc.ch/publications_and_data/publications_and_data_reports.shtml

[117] IPCC. Second Assessment Report. 1995.

2.4.5. Recalculation and Improvements

The transition to the new IPCC methodology and the application of the new IPCC software product in NGHGI 4 necessitated the recalculation of the entire time series of estimates of the 3rd NGHGI presented in the Third National Communication. Therefore, the inventory team recalculated the entire time series from 1990 to 2018 for all direct greenhouse gases and indirect GHG precursor gases. In addition, a new round of activity data collection was carried out and the archive of the long data series was updated, which significantly expanded the primary database. Undoubtedly, this increased the quality, accuracy, coverage, and reliability of the obtained estimates of emissions by sources and removals by sinks in the process of the next NGHGI.

The results of recalculation of emissions of greenhouse gases and precursor gases by type in the Kyrgyz Republic for the period 1990-2018 in Gg are presented in Table 2.4.

Table 2.4 Results of direct and indirect greenhouse gases recalculations by gases for the period 1990-2018 (Gg) [118]

Year	Net CO_2	CH_4	N_2O	HFC-CO_2 eq	NO_x	CO	NMVOC	SO_2
1990	10031,278	183,188	13,351	0,000	50,255	371,469	60,966	101,326
1991	7631,225	176,404	14,053	0,000	42,884	310,618	53,265	86,024
1992	4005,783	159,665	12,519	0,000	33,312	261,844	40,465	71,628
1993	230,076	141,486	6,210	0,000	23,599	183,287	30,711	56,662
1994	-3032,120	114,784	4,770	0,000	16,565	120,212	21,772	46,888
1995	-4990,691	103,647	4,169	3,637	12,185	64,104	14,317	24,833
1996	-4895,548	99,976	4,114	4,094	13,040	71,148	15,247	22,582
1997	-4796,877	102,633	5,218	4,718	13,689	84,283	15,091	19,972
1998	-5380,236	104,081	4,995	5,510	12,052	91,966	15,033	20,585
1999	-5567,967	105,204	5,110	6,469	14,512	92,000	13,962	23,631
2000	-5855,474	106,913	5,082	7,597	10,966	87,200	13,341	24,111
2001	-5380,959	107,877	5,171	8,893	13,275	97,746	14,217	24,887
2002	-5709,159	109,852	5,140	10,357	10,329	90,986	14,841	23,805
2003	-5119,062	108,794	5,110	11,990	10,679	92,060	16,122	22,413
2004	-5219,664	110,945	5,188	13,661	11,356	100,404	17,589	21,679
2005	-4719,488	113,182	5,361	15,759	13,688	124,867	16,655	31,490
2006	-4620,528	116,538	5,568	17,896	13,795	127,924	16,326	31,427
2007	-3806,999	120,728	5,730	16,660	18,557	145,702	18,744	32,500
2008	-2952,789	126,850	6,214	22,139	20,388	183,194	20,997	42,561
2009	-3427,456	131,879	6,454	24,606	22,540	191,786	21,882	40,931
2010	-3966,646	136,033	6,429	49,983	21,776	198,820	24,027	34,933
2011	-2382,824	140,261	6,745	64,092	27,291	216,122	25,794	38,540
2012	-850,206	144,668	6,997	123,821	31,859	251,804	31,231	41,676
2013	-793,734	147,567	7,096	165,184	33,986	271,921	32,649	38,759
2014	-622,020	154,857	7,682	215,743	31,218	229,551	30,890	53,243
2015	-61,516	158,220	7,696	219,883	32,980	237,888	31,632	61,052
2016	-1462,075	161,831	7,758	305,900	28,891	224,296	33,410	40,522
2017	-918,246	167,874	8,157	341,548	32,334	237,129	35,389	38,570

118 MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic in the period 1990-2018.. Bishkek. 2022.

Year	Net CO_2	CH_4	N_2O	HFC-CO_2 eq	NO_x	CO	NMVOC	SO_2
2018	474,484	174,361	8,346	193,688	35,924	266,697	40,232	42,656

The results of the recalculation of the GHG emissions by sources and removals by sinks (minus values) with global warming potentials in Gg CO_2 eq. are presented in Table 2.5.

Table 2.5 Recalculation of GHG emissions by sources and removals by sinks for the period 1990 – 2018.[119]

Year	Energy	IPPU	Agriculture	FOLU	Waste	Net CO2 eq.
1990	20529,719	871,638	6437,637	-10273,525	451,682	18017,151
1991	18063,523	829,765	6641,579	-10294,483	451,686	15692,070
1992	14382,567	636,145	6071,064	-10289,530	439,378	11239,623
1993	10629,428	393,427	3957,862	-10293,574	439,104	5126,247
1994	7379,889	210,270	3154,111	-10309,734	422,415	856,952
1995	5398,675	169,149	2814,657	-10323,647	423,188	-1517,978
1996	5084,389	271,207	2734,142	-10032,159	425,864	-1516,555
1997	5387,290	331,971	3144,841	-10303,286	419,987	-1019,196
1998	4813,977	346,578	3114,813	-10331,511	415,535	-1640,609
1999	4800,656	202,095	3154,514	-10339,095	413,694	-1768,135
2000	4421,042	227,930	3210,044	-10303,877	417,481	-2027,380
2001	4837,803	236,972	3226,578	-10221,398	416,263	-1503,781
2002	4478,844	269,261	3270,211	-10239,260	422,325	-1798,619
2003	4625,340	370,012	3254,211	-9914,316	426,328	-1238,425
2004	4859,120	435,130	3308,048	-10302,866	432,714	-1267,855
2005	5213,316	482,930	3414,776	-10205,986	429,963	-665,001
2006	5239,271	556,227	3549,578	-10208,929	434,549	-429,305
2007	6160,400	585,435	3651,920	-10309,902	433,423	521,277
2008	7070,779	507,011	3893,094	-10250,705	439,495	1659,674
2009	6911,588	266,180	4033,822	-10303,402	459,145	1367,333
2010	6273,356	431,877	4089,427	-10334,544	472,887	933,003
2011	7658,652	569,079	4302,008	-10295,774	483,717	2717,682
2012	9205,812	735,169	4369,795	-10324,340	494,216	4480,652
2013	8958,767	950,554	4459,238	-10216,191	517,627	4669,995
2014	9221,209	1073,505	4732,395	-10327,718	527,741	5227,132
2015	9920,106	944,071	4803,018	-10336,530	536,210	5866,874
2016	8546,374	953,259	4891,298	-10302,540	559,009	4647,400
2017	9129,504	1078,098	5074,368	-10367,314	562,812	5477,467
2018	10923,480	1162,553	5196,342	-10941,371	576,037	6917,040

As shown in table 2.5, in the period of 1995-2006, Kyrgyzstan was a country with a negative carbon balance due to the post-soviet economy collapse and consumption decline.

The use of the new IPCC methodology during NGHGI 4 has resulted in some differences in the GHG emissions assessment with the previous GHG inventory. This is primarily related to the expansion of the scope and a more thorough assessment not only of emissions by source but also removals by sinks. The rejection of the old biomass growth factors of the Forestry Institute of the National Academy of Sciences of the Kyrgyz Republic, developed in the late 90s of the last century, and use of the default emission factors values from the 2006 IPCC Guidelines for recalculating carbon sinks, led to more

[119] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic in the period 1990-2018.. Bishkek. 2022.

than a 10-fold increase in the values of carbon absorption by forests and perennial crops, and, consequently, to a decrease in the values of the total GHG emissions of Kyrgyzstan. The difference between the assessments of the total emissions of NGHGI 4 in comparison with NGHGI 3 (in Gg of CO_2 eq. and %) is presented in table 2.6. below.

Table 2.6 The difference between NGHGI 4 and NGHGI 3 on total GHG emissions estimate for the period of 1990-2010. [120]

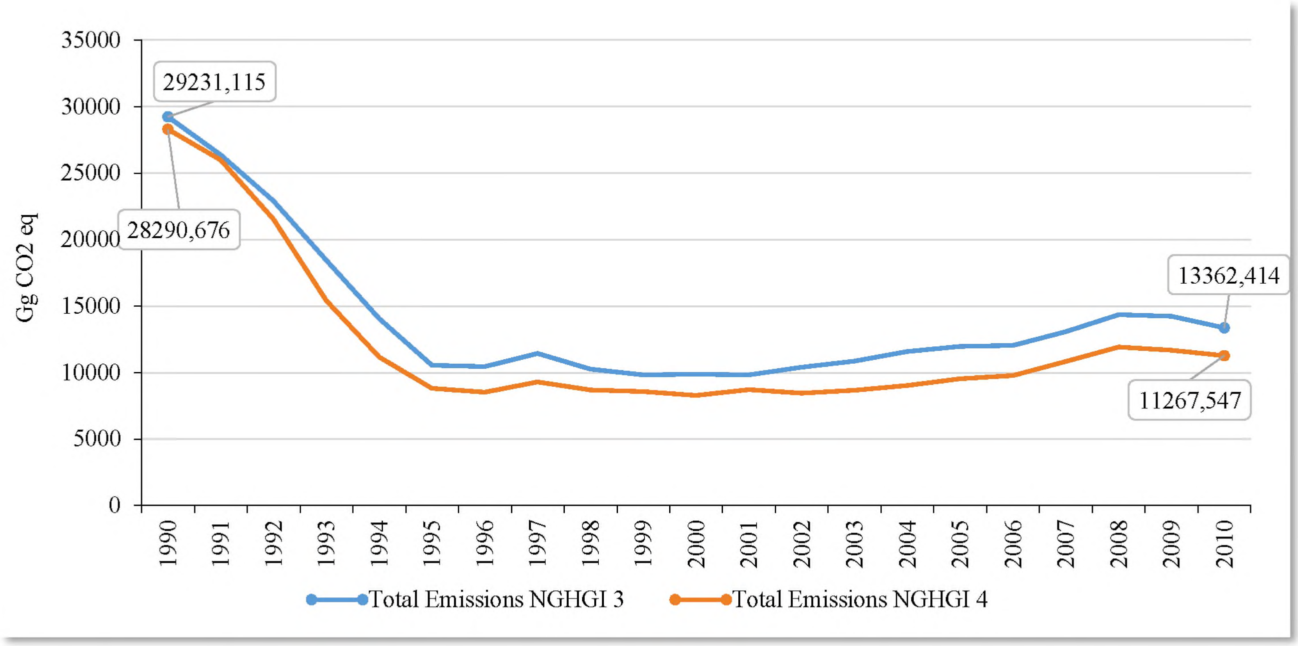
Indicators	1990	1991	1992	1993	1994	1995	1996
NGHGI 4	28290,676	25986,553	21529,154	15419,821	11166,686	8805,669	8515,603
NGHGI 3	29231,115	26382,498	22907,183	18439,035	14060,027	10538,306	10453,192
Difference (Gg)	-940,439	-395,945	-1378,029	-3019,214	-2893,341	-1732,637	-1937,589
Difference in %	-3,22	-1,50	-6,02	-16,37	-20,58	-16,44	-18,54
Indicators	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
NGHGI 4	9284,089	8690,903	8570,960	8276,497	8717,616	8440,641	8675,891
NGHGI 3	11426,954	10256,726	9821,162	9866,469	9821,705	10407,446	10848,899
Difference (Gg)	-2142,865	-1565,823	-1250,202	-1589,972	-1104,089	-1966,805	-2173,008
Difference in %	-18,75	-15,27	-12,73	-16,11	-11,24	-18,90	-20,03
Indicators	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
NGHGI 4	9035,011	9540,985	9779,624	10831,179	11910,379	11670,735	11267,547
NGHGI 3	11572,979	11957,163	12028,185	13074,542	14343,157	14230,964	13362,414
Difference (Gg)	-2537,968	-2416,178	-2248,561	-2243,363	-2432,778	-2560,229	-2094,867
Difference in %	-21,93	-20,21	-18,69	-17,16	-16,96	-17,99	-15,68

As can be seen from the table, there is difference in the estimate of total GHG emissions between 1990 and 2010. The difference between the results of NGHGI 3 and NGHGI 4 is observed for each year from a maximum of -21.93% in the total 2004 emissions to a minimum of -1.5% in the total 1990 emissions assessment (see Figure 2.4).

Figure 2.4 The difference in the assessments of the 3rd and 4th NGHGIs of the total GHG emissions of Kyrgyzstan in the period 1990-2010 [121]

[120] Ibid.

[121] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic in the period 1990-2018.. Bishkek. 2022.



The transition to the new methodology of the 2006 IPCC Guidelines using appropriate biomass growth factors led to changes in the assessment of carbon sequestration in the Forestry and Other Land Use (FOLU) sector's sink to the biomass of forests and croplands perennials. The difference in the assessments of the volume of annual FOLU sector GHG removals in the period 1990-2010 based on the results of the 3rd and 4th NGHGIs data is presented in table 2.7.

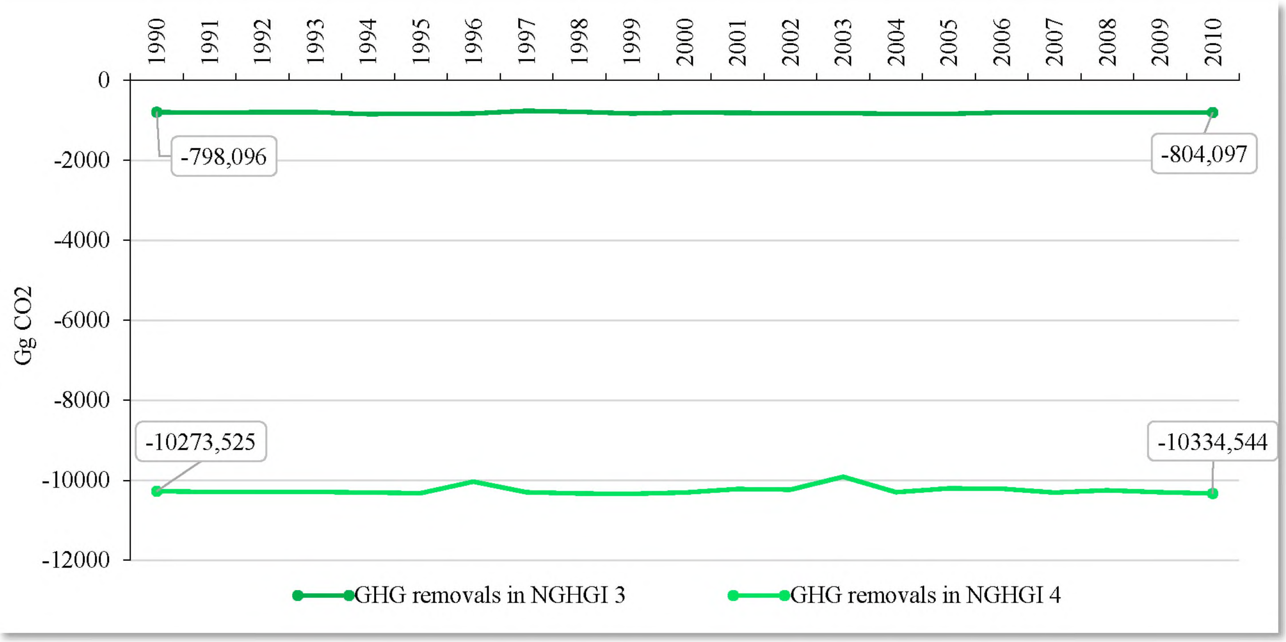
Table 2.7 Difference in the estimates of the third and fourth NGHGIs of CO_2 sequestration (in Gg) in the FOLU sector between 1990 and 2010 [122]

	1990	1991	1992	1993	1994	1995	1996
NGHGI 4	-10273,525	-10294,483	-10289,530	-10293,574	-10309,734	-10323,647	-10032,159
NGHGI 3	-798,096	-803,823	-798,788	-797,073	-845,476	-841,7	-828,167
Difference, Gg	-9475,429	-9490,660	-9490,742	-9496,501	-9464,258	-9481,947	-9203,992
Difference, %	1187,25	1180,69	1188,14	1191,42	1119,40	1126,52	1111,37
	1997	1998	1999	2000	2001	2002	2003
NGHGI 4	-10303,286	-10331,511	-10339,095	-10303,877	-10221,398	-10239,260	-9914,316
NGHGI 3	-764,051	-793,783	-827,822	-808,808	-813,996	-822,758	-821,911
Difference, Gg	-9539,235	-9537,728	-9511,273	-9495,069	-9407,402	-9416,502	-9092,405
Difference, %	1248,51	1201,55	1148,95	1173,96	1155,71	1144,50	1106,25
	2004	2005	2006	2007	2008	2009	2010
NGHGI 4	-10302,866	-10205,986	-10208,929	-10309,902	-10250,705	-10303,402	-10334,544
NGHGI 3	-838,879	-840,367	-804,864	-804,167	-804,08	-803,662	-804,097
Difference, Gg	-9463,987	-9365,619	-9404,065	-9505,735	-9446,625	-9499,740	-9530,447
Difference, %	1128,17	1114,47	1168,40	1182,06	1174,84	1182,06	1185,24

As can be seen, the difference in the estimates of carbon sinks in forests in the 3rd and 4th NGHGIs is significant, due to the use of new forest area data and new biomass growth factors from the 2006 IPCC Guidelines. Dynamics of CO2 absorptions in FOLU between 1990 and 2010 in the 3rd and 4th NGHGI estimates are presented in figure 2.5.

[122] SAEPF, GEF-UNEP. Third National Communication. - B., 2016; MNRETS, GEF-UNEP. Inventory of Emissions and Removals of Greenhouse Gases in the Kyrgyz Republic in the period 1990-2018.Bishkek. 2022.

Figure 2.5 Absorption of CO_2 in the FOLU sector in the period 1990 - 2010 [123]



2.5 GHG emissions and removals report

The timeframe of NGHGI 4 results presented in this document cover the period 2011–2018. Wherein, the estimates of GHG emissions by sources and removals by sinks were also recalculated for the entire period 1990-2018. These results, in accordance with the accepted coverage of the main greenhouse gases and precursor gases are presented in tabular form in the commonly accepted for GHG emissions metric units - Gigagrams (Gg) in NIR 1.

The assessment of emissions of different types of GHGs by major emitters and sinks for 2018 is presented in table 2.8.

Table 2.8 Greenhouse gas emissions and removals by main categories of sources and sinks in 2018 (Gg) [124]

Sources \ Gases	Net CO_2	CH_4	N_2O	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-227ea
Total national emissions and removals	**474,484**	**174,361**	**8,346**	**0,007**	**0,018**	**0,048**	**0,012**	**0,010**
1 – Energy	10442,593	16,377	0,442					
2 – IPPU	968,864			0,007	0,018	0,048	0,012	0,010
3 – AFOLU	-10941,371	134,478	7,653					
4 - Waste	4,398	23,506	0,252					
International Aviation Bunker	**340,613**	**0,002**	**0,010**					

The results of the 2018 inventory for the precursor gases emissions data are presented in table 2.9.

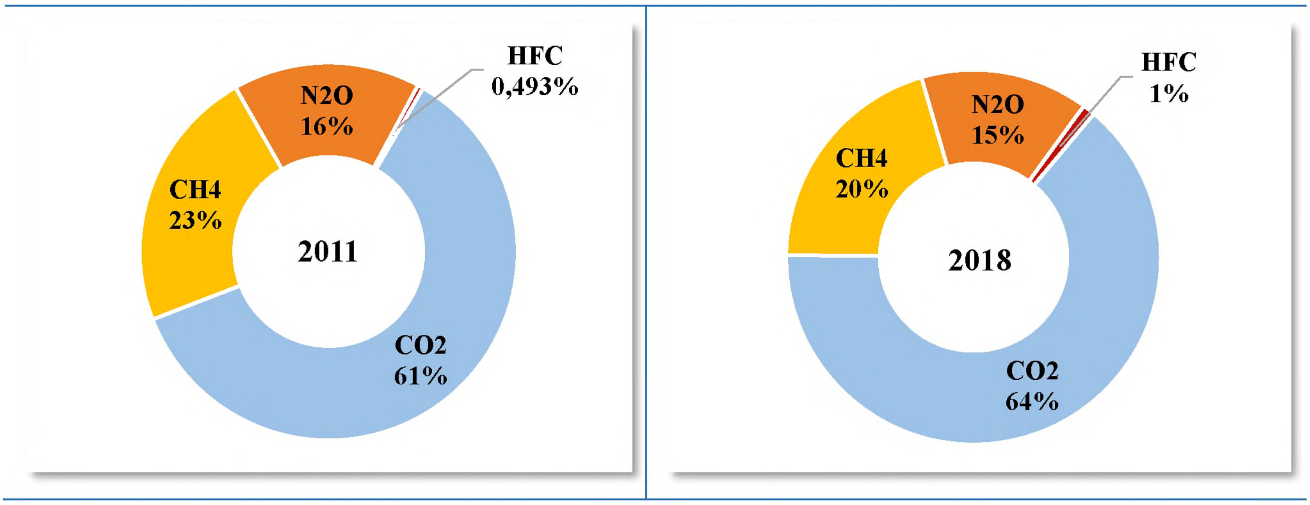
[123] Ibid.
[124] Ibid

Table 2.9 Emissions of precursor gases by major sources in 2018 (Gg). [125]

Sources \ Gases	NOx	CO	NMVOC	SO_2
Total national emissions	**35,924**	**266,697**	**40,232**	**42,656**
1 – Energy	31,152	244,524	36,893	42,638
2 – IPPU	0,009	0,049	3,219	0,006
3 – AFOLU	0,453	16,681	-	-
4 - Waste	0,310	5,444	0,120	0,011
International Aviation Bunker	**0,000**	**0,000**	**0,000**	**0,000**

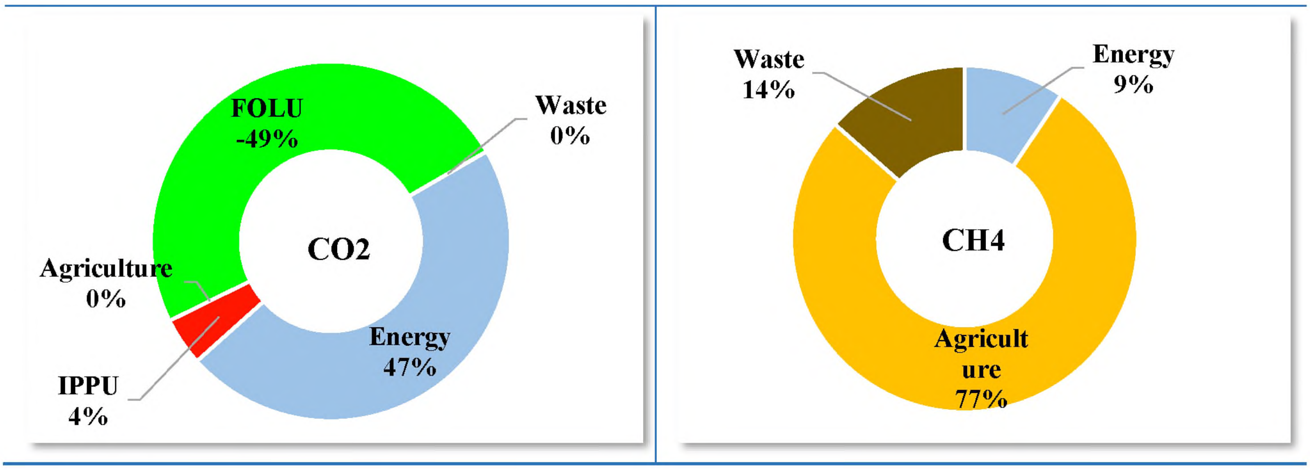
According to the data of 2018 GHG emissions recalculated in CO_2 equivalent, most of the emissions were produced in carbon dioxide (64%), the share of methane in the total GHG emissions was 20%, nitrous oxide - 15% and the share of HFCs - 1%. There were no emissions of PFCs and SF_6 in 2018. The structure of emissions by forks of gases is shown in Figure 2.6.

Figure 2.6 The structure of greenhouse gases emissions in 2011 and 2018 in CO_2 eq.[126]

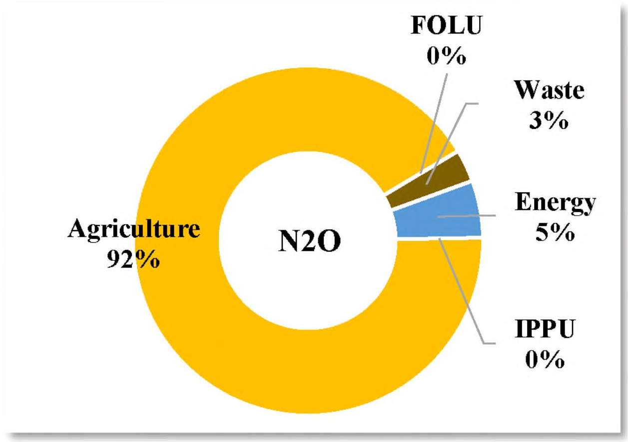


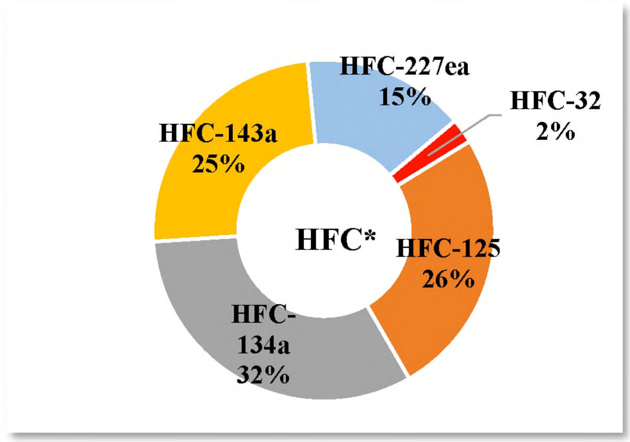
Inventory results as per main GHG emission source categories in 2018 are shown in Figure 2.7.

Figure 2.7 Distribution of greenhouse gas emissions for 2018 in CO_2 equivalent by major emitting sectors [127]



[125] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018. Bishkek. 2022.
[126] Ibid.
[127] Ibid.

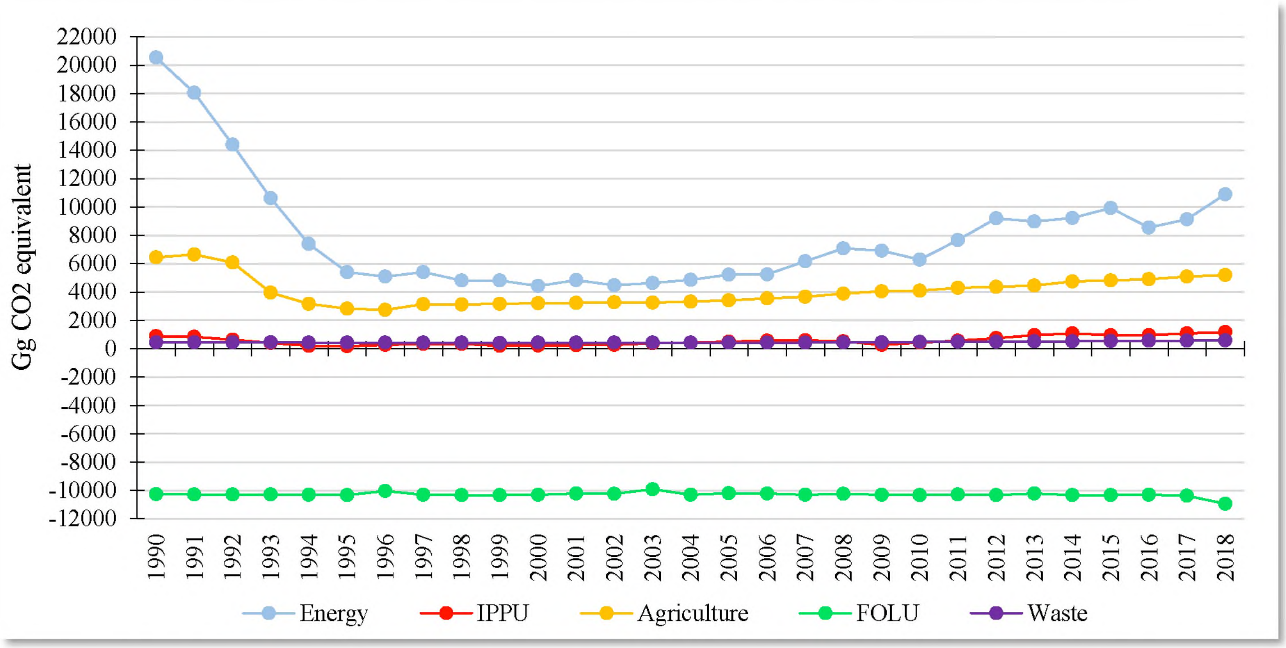




* Emissions of all types of HFCs are related to the IPPU sector

The general dynamics of GHG emissions and removals in CO_2 equivalent by major sectors-emitters for the period 1990-2018 is shown in Figure 2.8.

Figure 2.8 Emissions and removals of GHGs in CO_2 equivalent by sources for the period 1990-2018.[128]



In terms of contributions to the total annual GHG emissions of the sectors between 1990 and 2018, the largest share has been from the Energy sector. Thus, emissions from the energy sector varied from the maximum value of 20529,719 Gg CO_2 eq. in 1990 to a minimum value of 4421,042 Gg CO_2 eq. in 2000.

The second contributor to GHG emissions in the period under review has been the Agricultural sector, whose emissions reached a maximum in 1991 and amounted to 6641,579 Gg CO_2 eq. and decreased to their minimum of 2734,142 Gg CO_2 eq. in 1996.

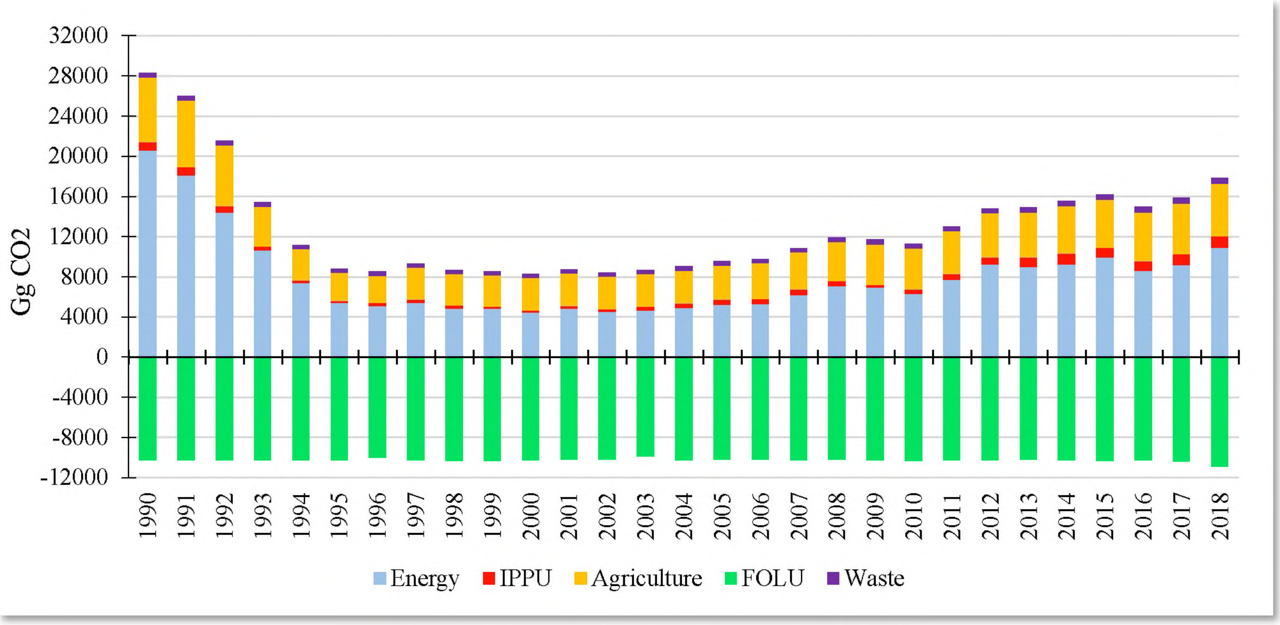
A completely different situation with emissions in the sector Industrial Processes and Product Use, where the maximum emissions were in 2018 amounting 1884,481 Gg CO_2 eq. and a minimum in 1995 accounted 169,149 Gg CO_2 eq.

[128] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018.. – Bishkek. 2022.

The "Waste" sector maintained a relatively stable and steady growth of emissions in the period under review and, therefore, it had a maximum value of emissions amounting 576,037 Gg CO_2 eq. in 2018, and the minimum in the amount of 413,694 Gg CO_2 eq. in 1999.

Carbon dioxide was sequestered by the Forestry and Other Land Use Sector. The amount of carbon dioxide sink to forests and perennials of cropland has remained stable throughout the period under review at the amount of 10000 Gg CO_2 annually. (Figure 2.9).

Figure 2.9 Emissions and removals of GHGs between 1990 and 2018 by major sector [129]



2.5.1. GHG Emissions by Trends

In the period of 1990-2018, the GHG emissions in the Kyrgyz Republic, has showed generally a downward trend. The total volume of all GHG emissions decreased by 36,88% from 28290,676 Gg CO_2 eq. in 1990 up to 17858,411 Gg CO_2 eq. in 2018. The volume of removals has increased by 6,5% from 10273,525 Gg CO_2 in 1990 to 10941,371 Gg CO_2 in 2018. The volume of net emissions in 2018 amounted to 6878,042 Gg CO_2 eq. compared to 18017,151 Gg CO_2 eq. in 1990, thus, demonstrating reduction by 61,61%.

The volumes of GHG emissions in the Energy Sector decreased by 46,79% from 20529,719 Gg CO_2 eq. in 1990 up to 10923,480 Gg CO_2 eq. in 2018, GHG emissions of the second largest emitting sector - Agriculture, decreased by 19,28% from 6437,637 Gg CO_2 eq. to 5196,342 Gg CO_2 eq. in 2018.

At the same time, emissions from the Industrial Processes and Product Use sector increased by 33,38% from 871,638 Gg CO_2 eq. in 1990 up to 1162,553 Gg CO_2 eq. in 2018, as well as GHG emissions from the Waste sector increased by 27,53% from 451,682 Gg CO_2 eq. in 1990 up to 576,037 Gg CO_2 eq. in 2018.

Dynamics of the total and net GHG emissions and absorptions during 1990-2018 and the corresponding linear trends shown in Figure 2.10.

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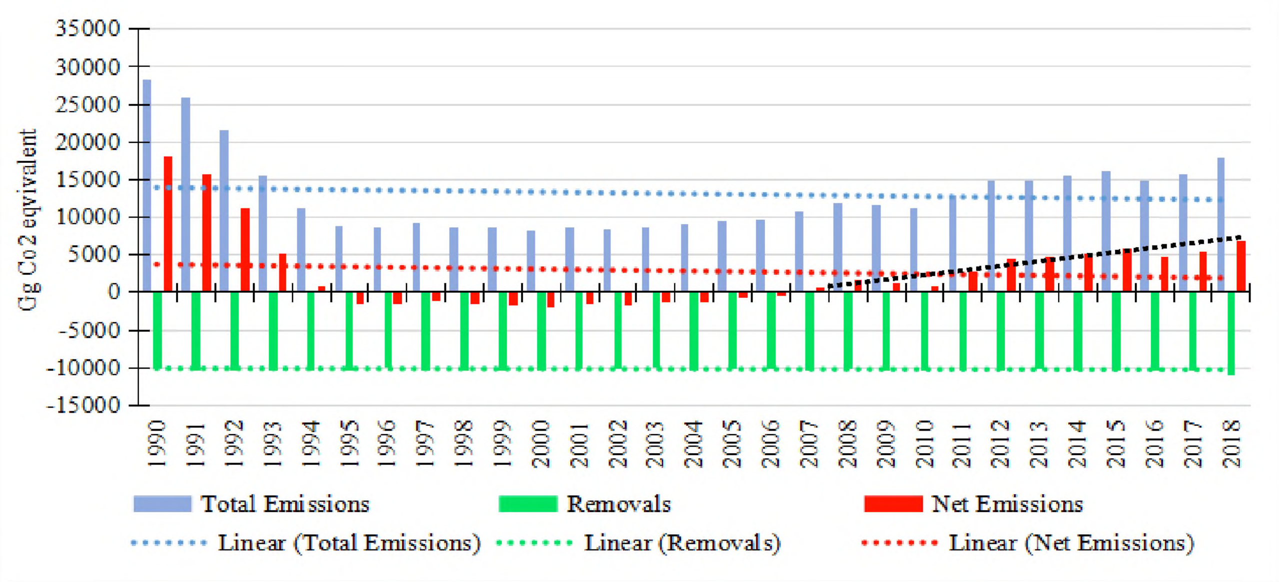
[129] Ibid.

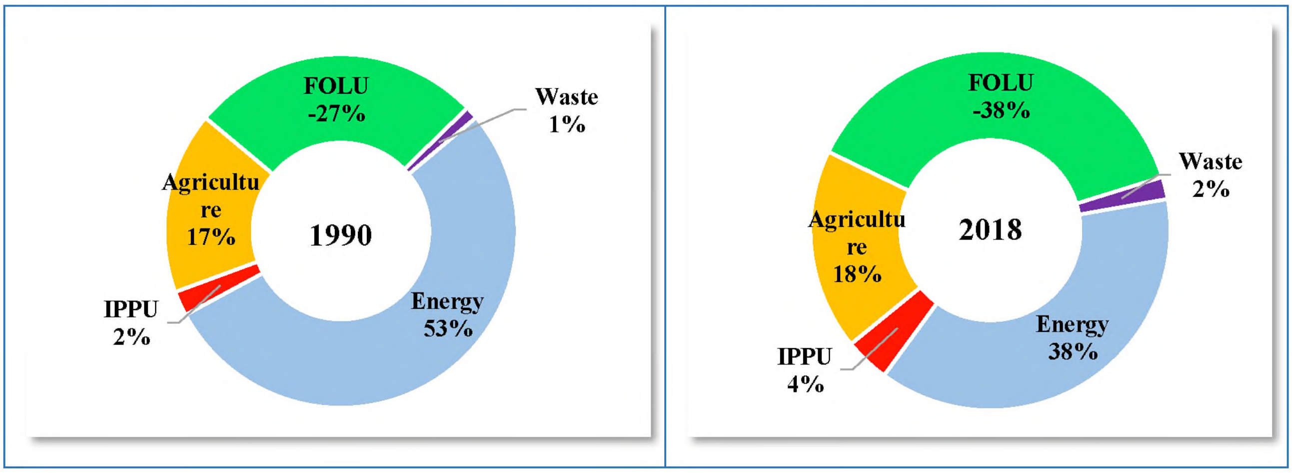
Figure 2.10 Dynamics and trends of the total and net GHG emissions and removals in the period 1990-2018 [130]



As shown in figure 2.10, despite the general downward trends in both total and net emissions between 1990 and 2018, the trend of the last 10 years turned towards an increase in emissions. The growth in net GHG emissions in 2018 increased by 1219,46% compared to 2007 (see the trend in black), which determines the need to develop strategies to reduce emissions for all categories of emission sources in the emitting sectors and to the increase absorption of carbon dioxide by sinks.

The distribution of GHG emissions by major source category and the volume of emissions also changed in the period 1990-2018. Figure 2.11 shows the distribution of GHG emissions in CO_2 eq. by main sources, comparing the situations in 1990 and in 2018.

Figure 2.11 Distribution of GHG emissions by main sources in 1990 and in 2018 [131]



[130] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018.. Bishkek. 2022.

[131] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018.. Bishkek. 2022.

The figure shows that by 2018 the share of emissions from the Energy sector decreased due to increases in emissions from all other sectors. The decrease in the total emissions of the emitting sectors also increased the absorption share of the FOLU sector.

According to the results of the analysis of GHG emissions key categories of for the period 1990-2018 carried out during the 4th NGHGI, the level of various GHG emissions has significantly decreased in the following categories of emission sources:[132:]

- CO_2 emissions in category 1.A.1 “Energy industries” - gaseous fuels by 93,32%, and in the same category for liquid fuel - by 91,41%;
- CO_2 emissions in category 1.A.2 “Manufacturing industries and construction”- gaseous fuels - by 89,69%;
- N_2O emissions in category 3.C.4 “Direct N2O emissions from managed soils” - by 41.54%;
- N_2O emissions in category 3.C.5 “Indirect N2O emissions from managed soils” - by 35,09%;
- CO_2 emissions in category 1.A.4 “Other sectors”- gaseous fuels” - by 19,44%; and
- N_2O emissions in category 3.A.2 “Manure management” - by 18,56%.

Despite the general downward trend in GHG emissions, a comparative analysis of emissions in 1990 and 2018 by key categories showed an increase in emissions from the following sources[133]:

- HFC emissions in category 2.F.1 "Refrigeration and air conditioning" increased by more than 10 thousand % which is primarily due to the lack of activity data on the beginning of the 90s of the last century;
- CO_2 emissions in category 1.A.2 “Manufacturing industries and construction”- solid fuels - by 140,02%;
- CO_2 emissions in category 1.A.4 “Other sectors”- liquid fuels” - by 124,93%;
- CO_2 emissions in category 2.A.1 "Cement production" - by 54,85%;
- CO_2 emissions in category 1.A.3.b "Road transport" - by 54,17%;
- CH_4 emissions in category 4.A "Solid waste disposal" - by 49,22%;
- CH_4 emissions in category 1.B.2.a "Oil" - by 29,03%;
- CH_4 emissions in category 3.A.1 "Enteric fermentation" - by 6,95%; and
- CH_4 emissions in category 4.D "Wastewater Treatment and Discharge" – by2,39%.

In the period 1990-2018, the level of CO_2 sequestration increased:

- in category 3.B.1.a "Forest lands remaining forest land" by 9.06%; and
- in category 3.B.2.a. Cropland remaining cropland by 1.58%. [134]

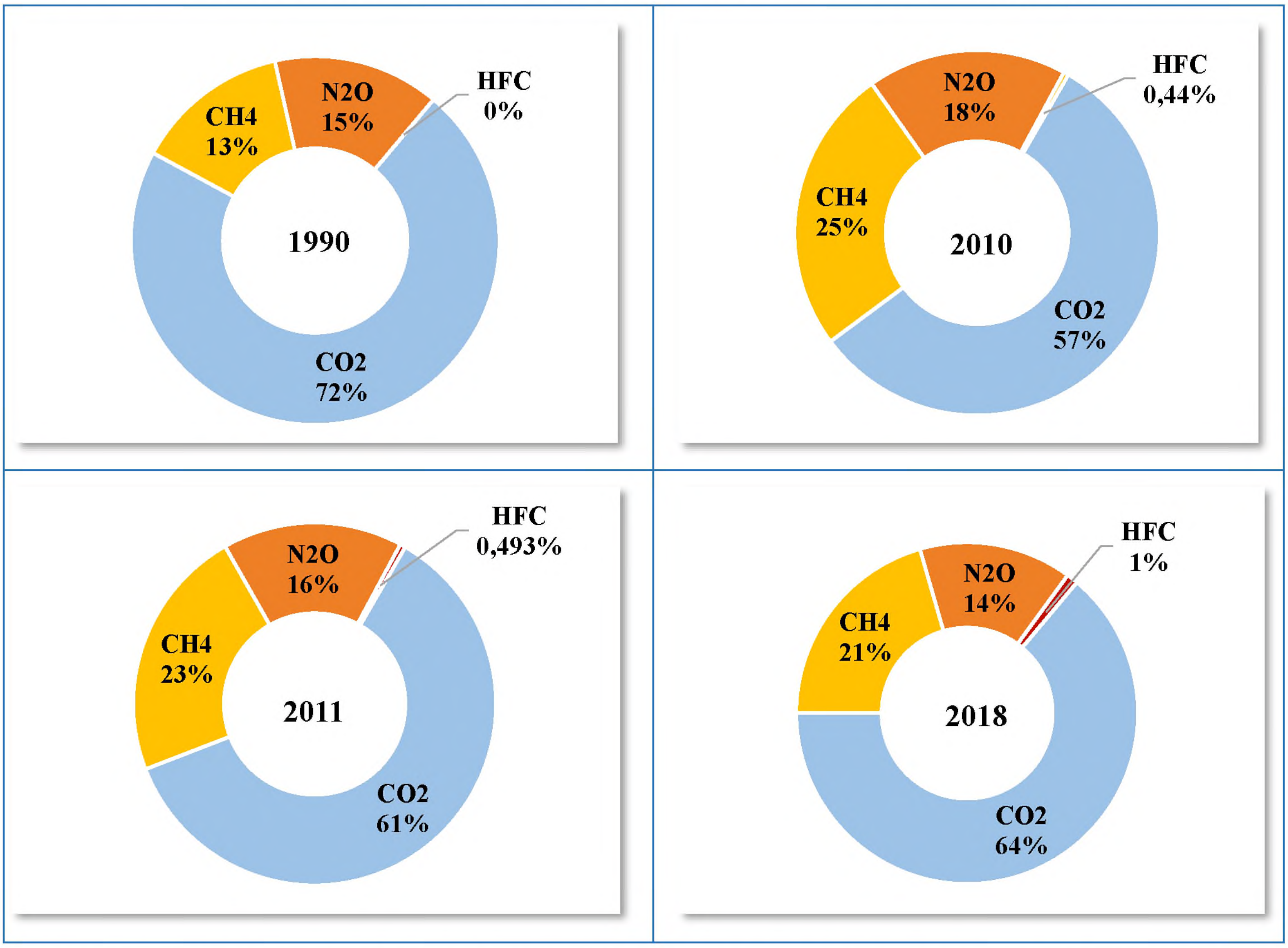
2.5.2. GHG Emissions and Removals by Gases

Emissions of major GHGs continued to increase during the reporting period 2011 - 2018. Thus, carbon dioxide emissions in 2018 increased by 44,27% compared to 2011, methane emissions by 24,31%, and nitrous oxide emissions by 23,74%. At the same time, the emissions of the same gases in 2018 compared with the 1990 level decreased: CO_2 by 43,78%, CH_4 by 4,84%, and N_2O by 37,49%.

The composition of GHG emissions for the same period 2011-2018 changed insignificantly, but the ratio of the main greenhouse gases has changed compared to 1990 by reducing the share of carbon dioxide emissions by 12%, and nitrous oxide by 1%, while increasing methane emissions by 8%. (Figure 2.12).

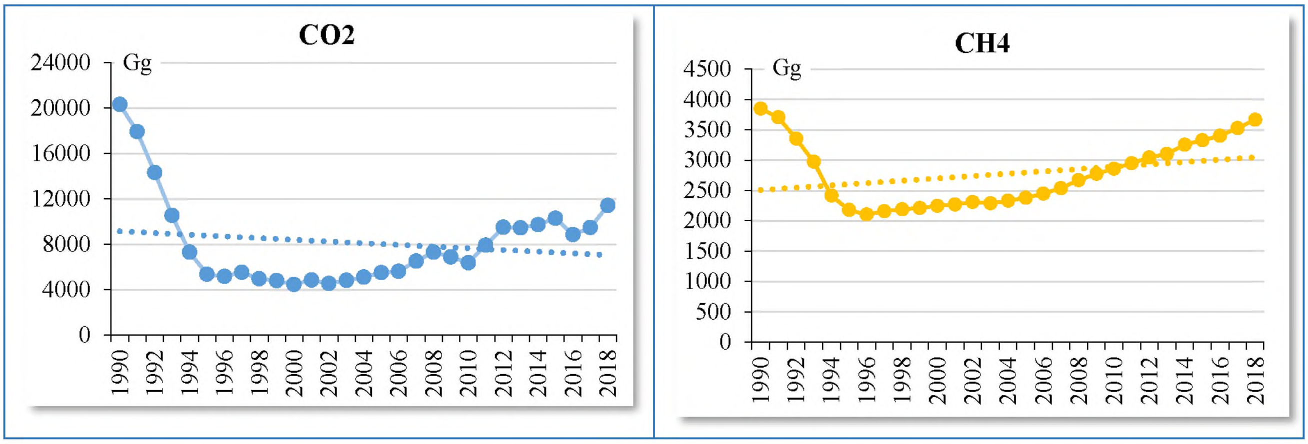
[132] MNRETS, GEF-UNEP. IPCC Inventory Software Database 2.54.
[133] MNRETS, GEF-UNEP. IPCC Inventory Software Database 2.54.
[134] Ibid.

Figure 2.12 Structural composition of direct greenhouse gas emissions (in CO_2 equivalent) [135]



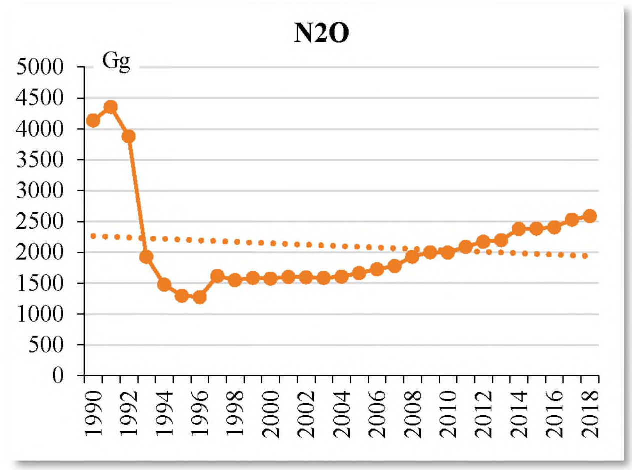
Dynamics and linear trends of major GHG emissions in the Kyrgyz Republic in the period 1990-2018 are presented in Figure 2.13.

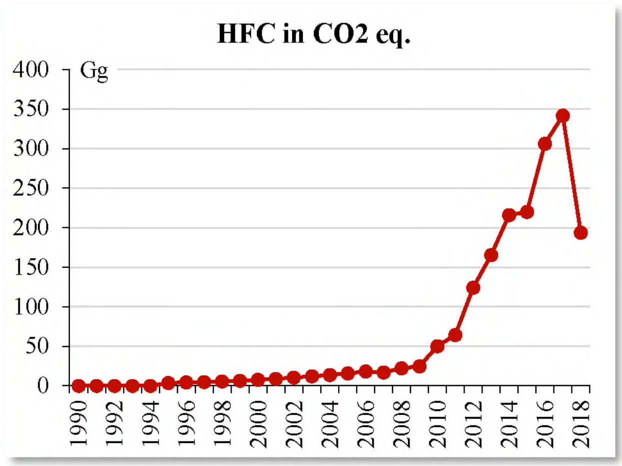
Figure 2.13 Dynamics and linear trends of emissions of the main greenhouse gases in the period 1990-2018 (Gg). [136]



[135] MNRETS, GEF-UNEP. Inventory of Emissions and Removals of Greenhouse Gases in the Kyrgyz Republic in 1990-2018. Bishkek. 2022.

[136] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018.. Bishkek. 2022.





Results of recalculation of the 4th NGHGI consolidated in a long time series of data on direct greenhouse gas emissions for the period 1990-2018 are presented in table 2.10.

Table 2.10. Direct greenhouse gas emissions in the Kyrgyz Republic in 1990-2018 (Gg) [137]

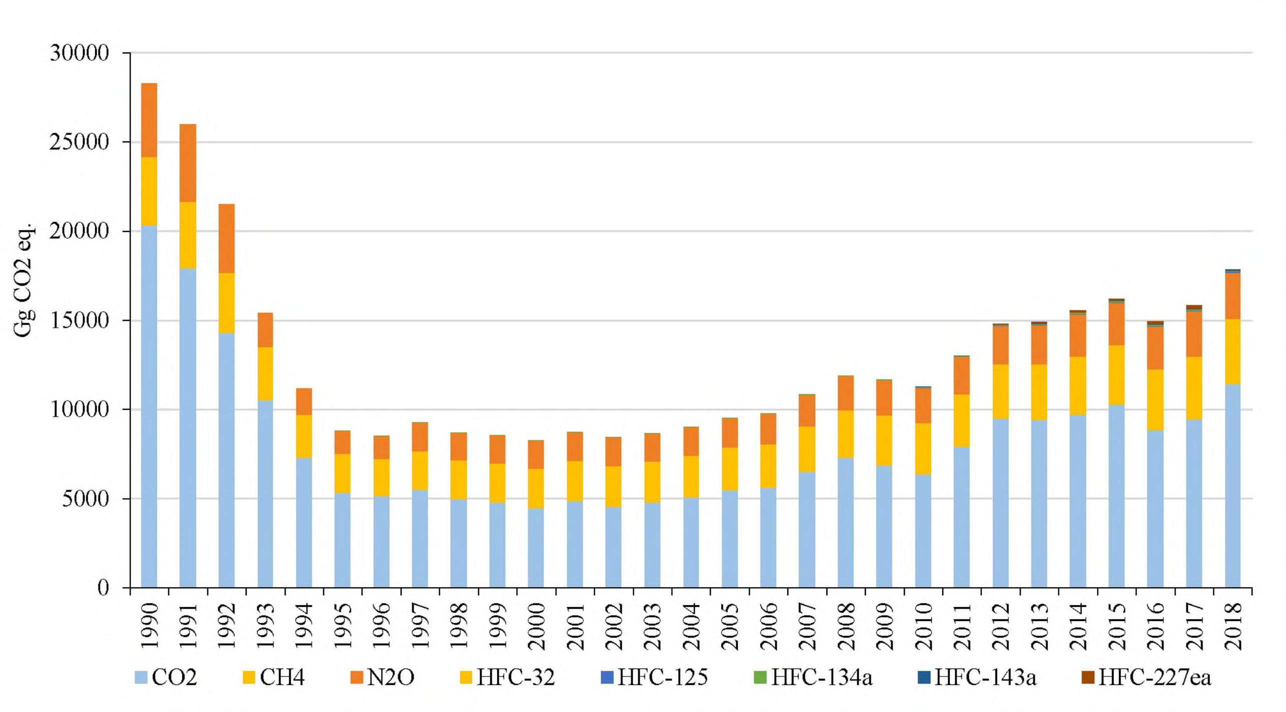
Gas / Year	1990	1991	1992	1993	1994	1995	1996	1997
CO_2	20304,803	17925,708	14295,314	10523,65	7277,614	5332,956	5136,61	5506,409
CH_4	183,188	176,404	159,665	141,486	114,784	103,647	99,976	102,633
N_2O	13,351	14,053	12,519	6,210	4,770	4,169	4,114	5,218
HFC-32	-	-	-	-	-	-	-	-
HFC-125	-	-	-	-	-	-	-	-
HFC-134a	-	-	-	-	-	0,003	0,003	0,004
HFC-143a	-	-	-	-	-	-	-	-
HFC-227ea	-	-	-	-	-	-	-	-
Gas / Year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CO_2	4951,275	4771,128	4448,403	4840,439	4530,101	4795,254	5083,202	5486,498
CH_4	104,081	105,204	106,913	107,877	109,852	108,794	110,945	113,182
N_2O	4,995	5,110	5,082	5,171	5,140	5,110	5,188	5,361
HFC-32	-	-	-	-	-	-	-	-
HFC-125	-	-	-	-	-	-	-	-
HFC-134a	0,004	0,005	0,006	0,007	0,008	0,009	0,011	0,012
HFC-143a	-	-	-	-	-	-	-	-
HFC-227ea	-	-	-	-	-	-	-	-
Gas / Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
CO_2	5588,4	6502,903	7297,916	6875,947	6367,899	7912,95	9474,134	9422,457
CH_4	116,538	120,728	126,850	131,879	136,033	140,261	144,668	147,567
N_2O	5,568	5,730	6,214	6,454	6,429	6,745	6,997	7,096
HFC-32	-	-	-	-	0,001	0,004	0,005	0,005
HFC-125	-	-	-	-	0,001	0,007	0,008	0,01
HFC-134a	0,014	0,013	0,017	0,019	0,033	0,025	0,028	0,027
HFC-143a	-	-	-	-	0,001	0,003	0,004	0,006
HFC-227ea	-	-	-	-	-	-	0,015	0,027
Gas / Year	**2014**	**2015**	**2016**	**2017**	**2018**			
CO_2	9705,698	10275,014	8840,465	9449,068	11415,855			
CH_4	154,857	158,220	161,831	167,874	174,361			
N_2O	7,682	7,696	7,758	8,157	8,346			
HFC-32	0,006	0,006	0,007	0,007	0,007			
HFC-125	0,012	0,013	0,015	0,017	0,018			

137 Ibid.

HFC-134a	0,033	0,035	0,041	0,044	0,048
HFC-143a	0,007	0,009	0,01	0,011	0,012
HFC-227ea	0,038	0,034	0,058	0,066	0,010

Dynamics of emissions of the main greenhouse gases in CO_2 equivalent for the period 1990-2018 is presented in Figure 2.14.

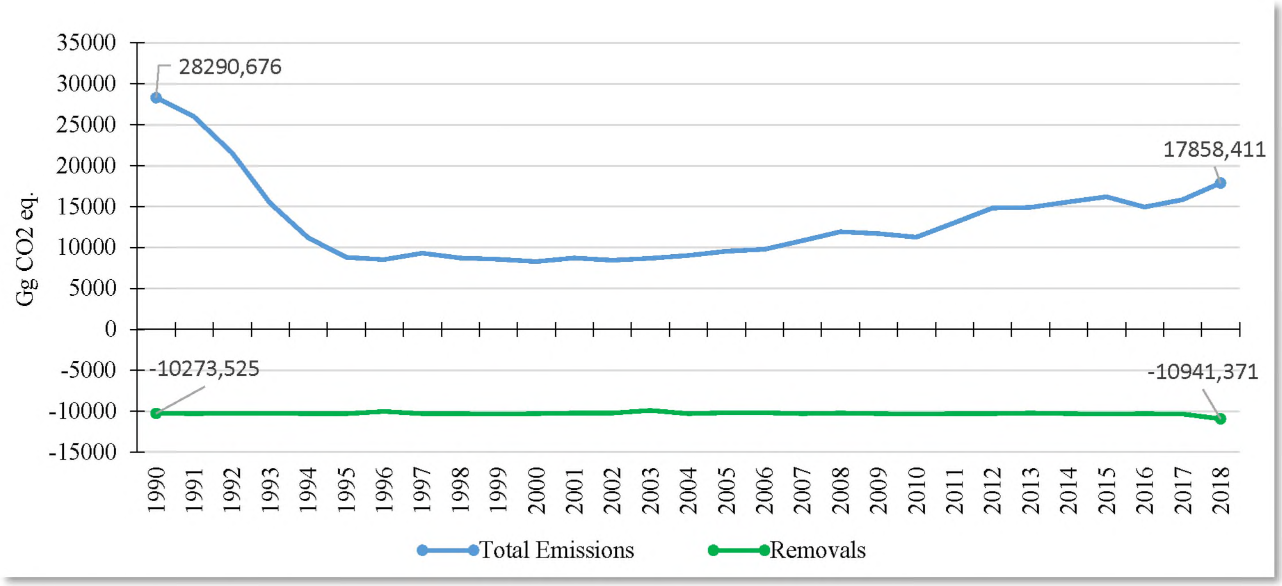
Figure 2.14 Greenhouse gas emissions in the period of 1990-2018 in CO_2 equivalent. [138]



Along with the change in GHG emissions in the period 1990-2018, a stable level of GHG absorption is maintained in Kyrgyzstan due to the sink of CO_2 into the forest and perennial plantations biomass. Conserving total forest area is a critical stabilizing factor for carbon balance and a low-carbon green economy. (Figure 2.15).

Figure 2.15 Dynamics of GHG emissions and removals in the period 1990-2018 (CO_2 eq.) [139]

[138] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018.. Bishkek. 2022.
[139] Ibid.



Recalculation of GHG removals according to the new IPCC methodology using biomass growth factors increased the CO_2 absorption values for the IPCC 3.B "Land" absorption source category. A time series of CO_2 uptake data for this category is presented below in Table 2.11.

Table 2.11 Dynamics of CO_2 absorption by category 3.B Land. (Gg) [140]

1990	1991	1992	1993	1994	1995	1996	1997
-10273,525	-10294,483	-10289,530	-10293,574	-10309,734	-10323,647	-10032,159	-10303,286
1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
-10331,511	-10339,095	-10303,877	-10221,398	-10239,260	-9914,316	-10302,866	-10205,986
2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
-10208,929	-10309,902	-10250,705	-10303,402	-10334,544	-10295,774	-10324,340	-10216,191
2014	**2015**	**2016**	**2017**	**2018**			
-10327,718	-10336,530	-10302,540	-10367,314	-10941,371			

The results of the **assessment of precursor gases' emissions** for the reporting period 2011-2018 show an increase in all gases. Thus, emissions of nitrogen oxides (NO_x) increased in 2018 compared to 2011 by 31,64%, carbon monoxide (CO) by 23,40%, non-methane volatile organic compounds (NMVOC) by 55,98%, and sulfur dioxide (SO_2) by 10,68%.

The updated long series of precursor gas emissions in the country for the period 1990-2018 are presented in table 2.12 below.

Table 2.12 GHG precursor gases' emissions in the Kyrgyz Republic in the period 1990-2018(Gg) [141]

Gas	1990	1991	1992	1993	1994	1995	1996	1997
NO_x	50,255	42,884	33,312	23,599	16,565	12,185	13,040	13,689
CO	371,469	310,618	261,844	183,287	120,212	64,104	71,148	84,283
NMVOC	60,966	53,265	40,465	30,711	21,772	14,317	15,247	15,091
SO_2	101,326	86,024	71,628	56,662	46,888	24,833	22,582	19,972
Gas	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**

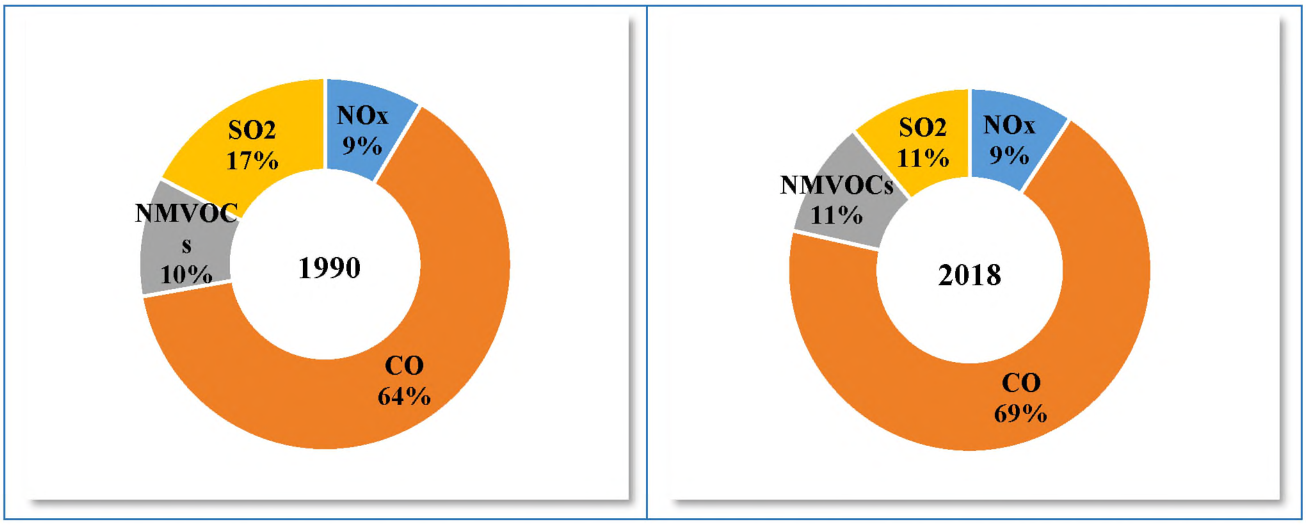
[140] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018.. Bishkek. 2022.
[141] Ibid.

NO_x	12,052	14,512	10,966	13,275	10,329	10,679	11,356	13,688
CO	91,966	92,000	87,200	97,746	90,986	92,060	100,404	124,867
NMVOC	15,033	13,962	13,341	14,217	14,841	16,122	17,589	16,655
SO2	20,585	23,631	24,111	24,887	23,805	22,413	21,679	31,490
Gas	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
NOx	13,795	18,557	20,388	22,540	21,776	27,291	31,859	33,986
CO	127,924	145,702	183,194	191,786	198,820	216,122	251,804	271,921
NMVOC	16,326	18,744	20,997	21,882	24,027	25,794	31,231	32,649
SO2	31,427	32,500	42,561	40,931	34,933	38,540	41,676	38,759
Gas	**2014**	**2015**	**2016**	**2017**	**2018**			
NOx	31,218	32,980	29,768	32,334	35,924			
CO	229,551	237,888	234,538	237,129	266,697			
NMVOC	30,890	31,632	33,735	35,788	40,232			
SO2	53,243	61,052	40,525	38,570	42,656			

Compared with 1990 precursor gases emissions, their emission in 2018 has reduced: emissions of NOx – by 28,52%; emissions of CO – by 28,20%; NMVOC emissions – by 34,01% and emissions of SO2 – by 57,90%.

The compound structure of annual emissions of precursor gases in the Kyrgyz Republic did not change significantly and was always dominated by carbon monoxide or carbon monoxide, which is a combustion product. (Figure 2.16).

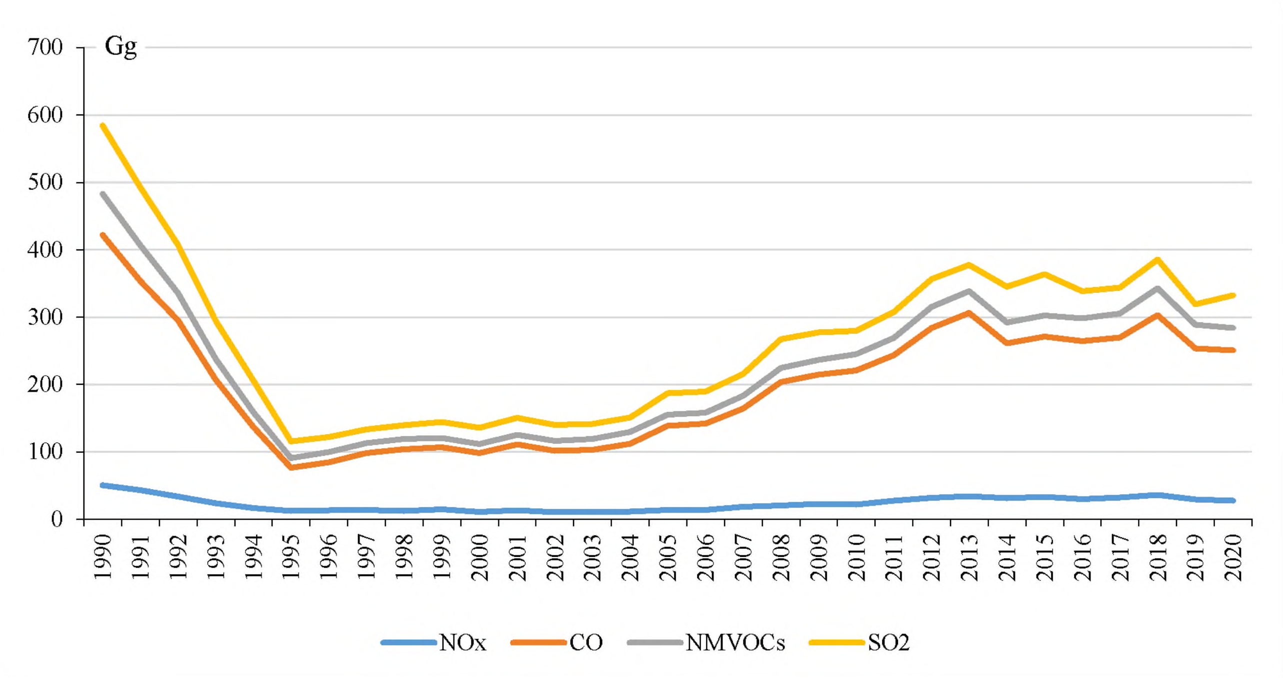
Figure 2.16 Comparison of the structure of emissions of precursor gases in 1990 and 2018. [142]



Dynamics of emissions of various types of precursor gases between 1990 and 2018 is shown in Figure 2.17.

Figure 2.17 Dynamics of emissions of precursor gases in the Kyrgyz Republic in 1990 and 2018. [143]

[142] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018. Bishkek. 2022.
[143] Ibid.



2.5.3. GHG Emissions by Sectors

2.5.3.1. Energy

In the modern economy, energy systems are largely determined by the burning of fossil fuels. Carbon and hydrogen from fossil fuels are mainly converted to carbon dioxide (CO2) and water (H2O), releasing the chemical energy of the fuel and converting it into heat. This heat is usually used either directly or (with some conversion loss) to generate mechanical energy, most often to generate electricity or to transport.

The energy sector is usually the most important in the greenhouse gas inventory, accounting for over 90 percent of CO2 emissions and 75 percent of total greenhouse gas emissions in developed countries. About half of these emissions are associated with combustion in the energy industries, mainly in power plants and refineries. Mobile combustion (cars and other vehicles) accounts for about a quarter of the energy sector's emissions.

The energy sector mainly includes the following:

- exploration and production of primary energy sources,
- conversion of primary energy sources into more usable forms of energy in refineries, power, and thermal plants.
- fuel transfer and distribution.
- stationary and mobile use (combustion) of fuel.

Emissions resulting from the combustion of solid, liquid, and gaseous fuels, as well as volatile emissions, are the subject of national inventories of greenhouse gas emissions from the energy sector.

For inventory purposes, fuel combustion can be defined as the deliberate oxidation of materials in devices designed for the production of heat or mechanical work, or use outside of these devices. This definition aims to separate the combustion of fuel for independent and industrial energy consumption from emissions released by the use of hydrocarbons in chemical reactions in industrial processes, or from the use of hydrocarbons as industrial products. The latter relate to emissions of another GHG source category - Industrial Processes and Product Use (IPPU).

2.5.3.1.1. Assessment methodology, level and emissions factors

The Fourth National Inventory of Greenhouse Gas Emissions from Various Emission Source Categories of the Energy Sector was prepared according to the methodology of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories,[144] which define mandatory accounting for emissions of direct greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) from fuel combustion. In addition, EMEP/CORINAIR[145] Emission Inventory Guidebook was used in the calculation of the resulting data to select methods for estimating emissions of indirect greenhouse gases and other air pollutants.

IPCC 2006 Inventory Software V2.54[146] was used for data processing. The Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC 2004) [147] and the Updated 1996 IPCC Guidelines for National Greenhouse Gas Inventories[148]. were also used.

Following the methodology of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, the Fourth NGHGI of Kyrgyz Republic was conducted according to the following principles:

- Following the logic and structure of the 2006 IPCC Guidelines;
- Prioritization of the use of national data and indicators;
- Using as many sources of information as possible.
- Implementation of quality assurance and quality control procedures.

The greenhouse gas inventory focused on the estimation of emissions of direct greenhouse gases - carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) in key sectoral activity categories.

The GHG emissions estimates for the Energy Sector were based on a Tier 1 method with the estimation parameters of emission factors for the combustion of various fuels adopted by default in the 2006 IPCC Guidelines and based on collected sector activity data.

The Tier 1 method is based entirely on fuel indicators, so emissions from all combustion sources can be calculated based on the amount of fuel burned and average emission factors. Emission factors for the Tier 1 approach are available for all relevant direct greenhouse gas emissions. The quality of these emission factors differs from gas to gas. For CO_2, emission factors are highly dependent on the carbon content of the fuel. The burning conditions are of comparatively minor importance.

To convert different types of fuel units into consumed energy units – tera (10^{12}) joule (Tj), the default net calorific value (NCV) by IPCC was used as a conversion factor.

Therefore, CO2 emissions can be estimated fairly accurately based on the total fuel burned and the average carbon content of the fuel. However, the emission factors for methane and nitrous oxide depend on the combustion technology and operating conditions and vary significantly, both as per combustion plants and time. Because of this variability, the use of average emission factors for these gases, which is necessary to account for the high variability in process conditions, generates associated uncertainty.

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[144] IPCC. Guidelines for National Greenhouse Gas Inventories. Volume 2. 2006. https://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html.

[145] https://www.eea.europa.eu/publications/emep-eea-guidebook-2019

[146] https://www.ipcc-nggip.iges.or.jp/software/index.html

[147] https://www.ipcc-nggip.iges.or.jp/public/gp/english/index.html

[148] https://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html

According to the structure and types of activities, in the “Energy” sector, the national inventory is carried out according to the following categories in the IPCC code:

- 1.A. Fuel combustion activities
    - 1.A.1. Energy Industry
        - 1.A.1.a Electricity and heat production
        - 1.A.1.b Refinery
        - 1.A.1.c Solid fuel production and other industries
    - 1.A.2. Industry and construction
        - 1.A.2.a Cast iron and steel
        - 1.A.2.b. Non-ferrous metals
        - 1.A.2.c. Chemicals
        - 1.A.2.d. Pulp, paper and printing 1A2e
        - 1.A.2.e. Food processing, beverages and tobacco
        - 1.A.2.f. Non-metallic minerals
        - 1.A.2.g. Transport equipment
        - 1.A.2.h. Machines and mechanisms
        - 1.A.2.i. Mining. (except fuel) industry
        - 1.A.2.j. Timber and timber
        - 1.A.2.k. Building
        - 1.A.2.l. Textiles and leather
        - 1.A.2.m. Unspecified industries
- 1.A.3. Transport
        - 1.A.3.a. civil Aviation
        - 1.A.3.b Road transport
        - 1.A.3.c Railways
        - 1.A.3.d. Water transport
        - 1.A.3. Other modes of transport
    - 1.A.4. Other sectors
        - 1.A.4.a Commercial and institutional sector
        - 1.A.4.b Residential
        - 1.A.4.c Agriculture, forestry, fisheries
    - 1.A.5. Undefined sectors
        - 1.A.5.a Stationary sources
        - 1.A.5.b Mobile sources
        - 1.A.5.c Multilateral operations
- 1.B Fugitive emissions from fuel
    - 1.B.1 Solid fuel
        - 1.B.1.a Coal mining and processing
        - 1.B.1.b Uncontrolled combustion and burning of coal dumps
    - 1.B.2. Oil and natural gas
        - 1.B.2.a Oil
        - 1.B.2.ai Gas evacuation
        - 1.B.2.aii Torch burning
        - 1.B.2.aiii Anything else
        - 1.B.2.b Natural gas
    - 1.B.3 Other emissions from energy
- 1.C CO_2 transportation and storage
    - 1.C.1. Transportation
    - 1.C.2. Injection and storage

- 1.C.3. Other. [149]

The 4th NGHGI of Kyrgyzstan on the “Energy” sector was carried out only for available sources of GHG emissions within categories 1.A. and 1.B. Activity in category 1.C. is not carried out in Kyrgyzstan.

2.5.3.1.2. Activity data

Activity data in the Energy sector usually represent the amount of fuel burned. This data is sufficient to perform a Tier 1 analysis. Higher-level approaches require additional data on fuel characteristics and combustion technologies.

A list of fuels based mainly on International Energy Agency (IEA) definitions is used to describe emissions from fuel combustion which are also used in the 2006 IPCC Guidelines. These five categories are liquid, solid, gaseous, biomass, and other fuels.

Energy statistics and other energy data collection systems for the production and consumption of solid, liquid, and gaseous fuels use physical units such as tons or cubic meters. Thermal coefficients must be applied to convert this data to common units such as joules. The 2005 IPCC Guidelines use net calorific value (NCV) values expressed in SI[150] units or in SI units (e.g. TJ / Mg).

Statistical data on fuel compiled by officially recognized national agencies are generally the most appropriate and available activity data. There are currently two main sources of international energy statistics: the International Energy Agency (IEA) and the United Nations (UN). Both of these international organizations collect energy data from the data of the national administrations of the member countries using questionnaire systems. The data collected in this way is considered “official”.

The main sources (providers) of data used for the fourth national inventory of GHG emissions of Kyrgyzstan in the “Energy” sector were:

- National Statistical Committee (NSC),
- Ministry of Transport and Roads,
- State Committee for Industry, Energy and Subsoil Use,
- Agency for Fuel and Energy Complex under the Government of the Kyrgyz Republic,
- State Registration Service under the Government of the Kyrgyz Republic,
- State Civil Aviation Agency of the Kyrgyz Republic,
- Manufacturing companies in the energy sector and transport,
- International sources: UN, EuroStat, EEA, IEA, WB, IMF, etc.,
- Data obtained by national experts calculations,
- Data obtained by the calculations of Technical Expert Group of the PIU.

The computational method of obtaining data was used only to fill the gaps in the initial activity data in the long time series and was used when certain trends of energy consumption were significantly evident. At the same time, the use of different approaches and calculations to fill gaps was subject to a quality assurance and control procedure.

All sources of information were ranked according to their reliability. Official publications of NSCs, ministries, departments, public and private organizations, and companies had the highest rank of in-

[149] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 2, ch. 1.

[150] The international system of units (fr. Le Système International d'Unités, SI) is a system of units of physical quantities, a modern version of the metric system.

formation reliability followed by the information of national experts, along with data obtained by calculation and, lastly, the mass media data, which were then clarified in the corresponding profile organizations.

NGHGI 4 in the "Energy" sector is produced on the basis of the national Fuel and Energy Balance data (FEB), which is compiled by the NSC of KR according to the nationally approved methods of statistical observations. Further subcategorization of emission sources in the NGHGI takes taking into account the standardized structure of data presentation and FEB clauses.

The NSC has long time series of energy statistics that have been used to construct long time series of activity data needed to estimate greenhouse gas emissions in the energy sector.

Normalization or unification and bringing time series into the required format and obtained data was brought in accordance with the 2006 IPCC Guidelines into uniform units of measurement of burned fuel volumes, taking into account the carbon content in the corresponding fuel.

In accordance with the 2006 IPCC Guidelines, the Quality Control and Quality Assurance system (QA/QC) was used in NGHGI 4 as a set of regular checks to ensure the integrity, correctness, and completeness of data and calculations, actions to identify and eliminate errors, as well as it is designed to preserve all cadastral information with the involvement of external expertise and all stakeholders in the sector.

At the first stage of the QA/QC activity, the completeness, comparability, and consistency of the time series of data coming from the NSC, other ministries, and organizations providing baseline information were checked. The QA / QC procedures were carried out by experts from the greenhouse gas inventory group of the PIU under MNRETS. Besides verification of the activity data, the correctness of the application of the emission factors and the selected methodologies of emissions calculations have been monitored.

The second phase involved the verification of the calculations and results and the preparation of the inventory. Quality control of calculations and inventory is also carried out by the NGHGI experts group of the PIU under MNRETS. Further, independent experts checked the correctness of the use of the initial statistical information, emission factors, selected calculation methodologies, the quality of the description of trends in GHG emissions and removals.

The collected primary data on used fuels were formed into long data series by activity category from 1990 to 2018 in Excel format and entered into the software to obtain the calculation of GHG emissions.

In accordance with the 2006 IPCC Guidelines, the gaps in the primary data were filled by computation, linear interpolation, and extrapolation in cases where trends in consumption were reasonably clear.

The informational basis of NGHGI 4 in the "Energy" sector, including the categories of the "Transport" sector, and the estimation of emissions of the "Fugitive emissions from fuel" category, was mainly the official statistical information on the consumption of fuel and energy resources. Namely, published FEB KR 1985-1999, FEB KR 1999-2005, in which for 1990, 1995, 1997, 1999, 2001, and 2005 and after 2005, every year, sufficiently detailed information is provided on the production of energy of different types and on the consumption of fuel and energy resources and different types of energy in various sectors of the economy and/or individual modes of transport.

It should be noted that in the course of the work on long time series and data entry in the software application, several errors in the data obtained from the NSC were identified, which were then discussed and corrected together with the NSC specialists.

In fact, lack of all needed disaggregated data prevent inventory team to estimate and report CO_2 fuel combustion emissions using both the sectoral and the reference approaches, and to see differences between the two approaches.[151] This will be considered in the next round of NGHGI.

2.5.3.1.3. Assessment of GHG emissions from 2011 to 2018

In 2018, the total GHG emissions of the Energy Sector amounted to 10923,480 Gg CO_2 eq. At the same time, emissions of CO_2 eq in the main category "Fuel combustion activities" amounted to 10706,682 Gg, including emissions from Energy Industries equaled to 1464,729 Gg, emissions from Manufacturing Industries and Construction – 858,718 Gg, Transport emissions – 4990,4015 Gg, emissions from Other Sectors including residential – 3392,834 Gg, and emissions in the category "Fugitive emissions from fuels" amounted to 216,798 Gg CO_2 eq.[152]

The estimate of the sector's emissions for various types of greenhouse gases and precursor gases and the major emission source categories are presented in table 2.13.

Table 2.13 GHGs' and precursor gases' emissions from the Energy sector in 2018 as per sources categories. (Gg) [153]

Categories	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
1 - Energy	10442,593	16,377	0,442	35,152	244,524	36,893	42,638
1.A - Fuel Combustion Activities	10434,200	6,452	0,442	35,152	244,524	24,816	42,638
1.A.1 - Energy Industries	1458,662	0,022	0,018	2,802	0,619	0,166	19,069
1.A.1.a - Main Activity Electricity and Heat Production	1458,662	0,022	0,018	2,802	0,619	0,166	19,069
1.A.1.a.ii - Combined Heat and Power Generation	1275,963	0,018	0,017	2,698	0,522	0,145	18,751
1.A.1.a.iii - Heat Plants	182,699	0,004	0,001	0,105	0,097	0,020	0,318
1.A.2 - Manufacturing Industries and Construction	853,816	0,072	0,011	2,007	6,362	2,101	6,005
1.A.2.a - Iron and Steel	0,198	0,000	0,000	0,000	0,002	0,000	0,002
1.A.2.c - Chemicals	0,239	0,000	0,000	0,002	0,000	0,000	0,000
1.A.2.d - Pulp, Paper and Print	7,801	0,000	0,000	0,034	0,108	0,014	0,022
1.A.2.e - Food Processing, Beverages and Tobacco	82,046	0,004	0,001	0,201	0,277	0,043	0,247
1.A.2.f - Non-Metallic Minerals	183,540	0,018	0,003	0,331	1,651	1,595	1,594
1.A.2.g - Transport Equipment	1,633	0,000	0,000	0,003	0,016	0,002	0,015
1.A.2.h - Machinery	17,059	0,000	0,000	0,023	0,009	0,007	0,000
1.A.2.i - Mining (excluding fuels) and Quarrying	2,309	0,000	0,000	0,009	0,013	0,001	0,012
1.A.2.k - Construction	60,965	0,002	0,000	0,380	0,056	0,019	0,041
1.A.2.l - Textile and Leather	3,368	0,000	0,000	0,001	0,001	0,000	0,000
1.A.2.m - Non-specified Industry	494,659	0,046	0,007	1,022	4,229	0,419	4,071
1.A.3 - Transport	4846,560	1,317	0,375	27,645	97,954	12,740	0,034
1.A.3.a - Civil Aviation	32,440	0,000	0,001	0,147	0,097	0,019	0,009
1.A.3.a.ii - Domestic Aviation	32,440	0,000	0,001	0,147	0,097	0,019	0,009
1.A.3.b - Road Transportation	4354,582	1,238	0,214	22,919	84,211	11,964	0,012
1.A.3.b.i - Cars				22,919	84,211	11,964	0,012

[151] UNFCC. FCCC/CP/2002/7/Add.2. 28 March 2003. Decision 17/CP.8. Guidelines on preparation of national communications from parties not included in Annex I to the Convention. P.6.
[152] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018.. Bishkek. 2022.
[153] Ibid.

Categories	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
1.A.3.c - Railways	4,142	0,000	0,002	0,066	0,010	0,006	0,000
1.A.3.d - Water-borne Navigation	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1.A.3.d.ii - Domestic Water-borne Navigation	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1.A.3.e - Other Transportation	455,396	0,079	0,158	4,513	13,636	0,751	0,014
1.A.3.e.i - Pipeline Transport				0,000	0,000	0,000	0,000
1.A.3.e.ii - Off-road	455,396	0,079	0,158	4,513	13,636	0,751	0,014
1.A.4 - Other Sectors	3275,162	5,041	0,038	2,698	139,589	9,809	17,531
1.A.4.a - Commercial/Institutional	640,605	0,079	0,007	0,608	63,067	1,613	3,160
1.A.4.b - Residential	2628,004	4,941	0,031	2,082	76,127	8,151	14,311
1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	6,553	0,021	0,000	0,008	0,395	0,045	0,061
1.A.4.c.i - Stationary	6,553	0,021	0,000	0,008	0,395	0,045	0,061
1.B - Fugitive emissions from fuels	8,393	9,924	0,000	0,000	0,000	12,078	0,000
1.B.1 - Solid Fuels	5,435	1,857		0,000	0,000	1,916	0,000
1.B.1.a - Coal mining and handling	5,435	1,857		0,000	0,000	1,916	0,000
1.B.1.a.i - Underground mines	3,822	1,399		0,000	0,000	0,153	0,000
1.B.1.a.i.1 - Mining	3,507	1,284		0,000	0,000	0,000	0,000
1.B.1.a.i.2 - Post-mining seam gas emissions	0,316	0,116		0,000	0,000	0,153	0,000
1.B.1.a.ii - Surface mines	1,613	0,458		0,000	0,000	1,763	0,000
1.B.1.a.ii.1 - Mining	1,210	0,443		0,000	0,000	0,000	0,000
1.B.1.a.ii.2 - Post-mining seam gas emissions	0,403	0,015		0,000	0,000	1,763	0,000
1.B.2 - Oil and Natural Gas	2,957	8,067	0,000	0,000	0,000	10,161	0,000
1.B.2.a - Oil	1,082	6,985	0,000	0,000	0,000	10,147	0,000
1.B.2.a.i - Venting	0,501	2,414		0,000	0,000	0,460	0,000
1.B.2.a.iii - All Other	0,581	4,570	0,000	0,000	0,000	9,687	0,000
1.B.2.a.iii.2 - Production and Upgrading	0,580	4,569	0,000	0,000	0,000	9,674	0,000
1.B.2.a.iii.3 - Transport	0,000	0,001	0,000	0,000	0,000	0,013	0,000
1.B.2.b - Natural Gas	1,876	1,082	0,000	0,000	0,000	0,014	0,000
1.B.2.b.i - Venting	1,843	0,000		0,000	0,000	0,000	0,000
1.B.2.b.iii - All Other	0,033	1,082	0,000	0,000	0,000	0,014	0,000
1.B.2.b.iii.2 - Production	0,003	0,333		0,000	0,000	0,009	0,000
1.B.2.b.iii.3 - Processing	0,001	0,007		0,000	0,000	0,003	0,000
1.B.2.b.iii.4 - Transmission and Storage	0,000	0,193		0,000	0,000	0,000	0,000
1.B.2.b.iii.5 - Distribution	0,029	0,549		0,000	0,000	0,002	0,000
1.C - Carbon dioxide Transport and Storage	0,000			0,000	0,000	0,000	0,000
Memo Items (3)							
International Bunkers	340,613	0,002	0,010	0,000	0,000	0,000	0,000
1.A.3.a.i - International Aviation (International Bunkers) (1)	340,613	0,002	0,010	0,000	0,000	0,000	0,000
Information Items							
CO2 from Biomass Combustion for Energy Production	10,069						

Compared to 2011, emissions of all major GHGs increased in 2018. Thus, emissions of carbon dioxide (CO_2) increased by 41,06%, methane emissions (CH_4) by 77,84% and nitrous oxide (N_2O) by

120,44%. Dynamics in changes of emissions volume by the types of greenhouse gases in the "Energy" sector for the reporting period 2011-2018 are presented in Figure 2.17 below.

Figure 2.18 Dynamics of changes in the main GHGs by the sector in the period 2011-2018.[154]

The primary sources of GHG emissions from the Energy sector in the IPCC categorization are several sectors summarized in Category 1. A - Fuel Combustion Activities. In decreasing order of importance, the contribution to total GHG emissions in CO_2 equivalent for this category in 2018 will be:

- 1.A.3.b - Road transportation – 4446,864 Gg;
- 1.A.4.b - Residential – 2741,362 Gg;
- 1.A.1.a - Main Activity Electricity and Heat Production – 1464,729 Gg;
- 1.A.4.a - Commercial/Institutional - 644,452 Gg.
- 1.A.3.e - Other Transportation - 506,169 Gg;
- 1.A.2.m - Non-specified Industry – 497,791 Gg.

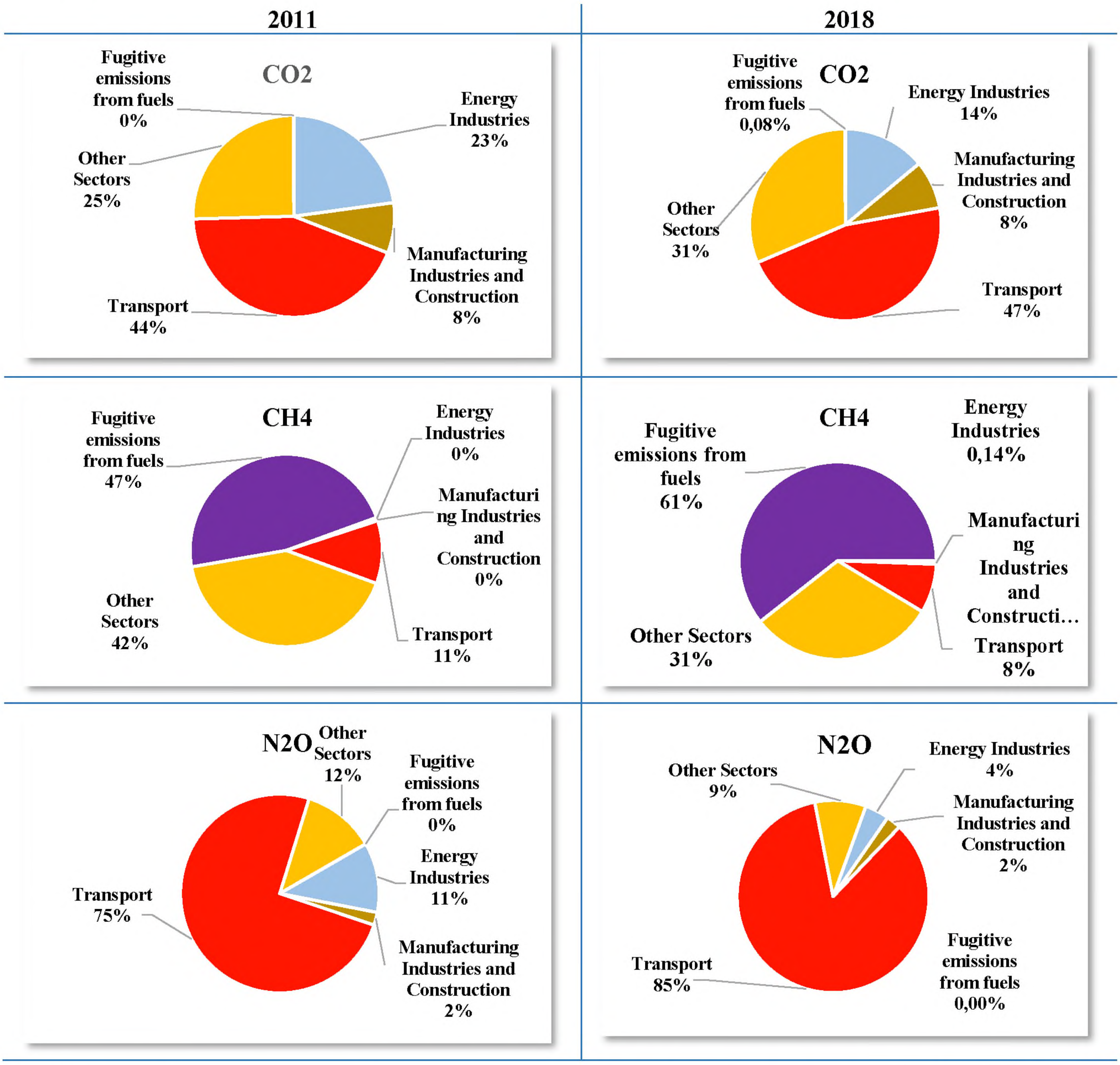
The rest of the sector's emission sources are grouped under category 1.B. - Fugitive Emissions from Fuels, the total emissions of which are relatively insignificant (216,798 Gg CO2 eq).[155]

Distribution of direct greenhouse gas emissions by main categories of the emission sources for 2011 and 2018 for the "Energy" sector are presented in Figure 2.18.

[154] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018.. Bishkek. 2022.

[155] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018.. Bishkek. 2022.

Figure 2.19 Distribution of emissions of the main GHGs in the sector by main source categories in 2011 and 2018. [156]

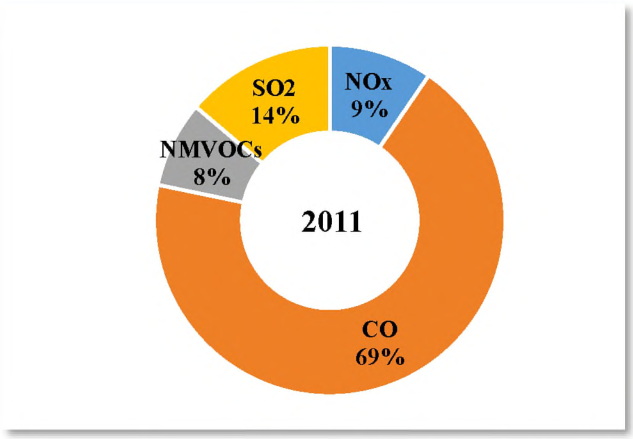


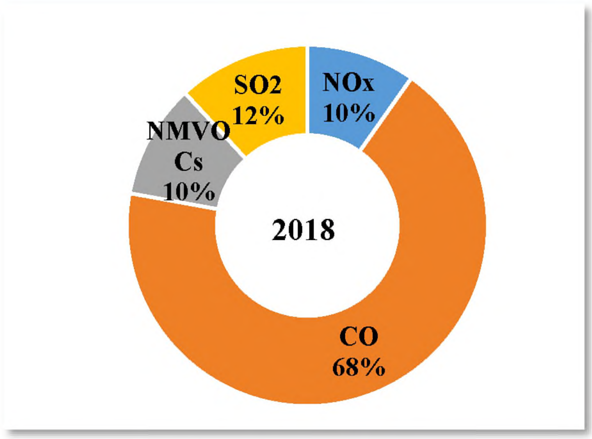
Small changes in the structure of precursor gas emissions for the Energy sector during the reporting period are presented in figure 2.19.

Figure 2.20 Structure of precursor gas emissions in 2011 and 2018[157]

[156] Ibid.

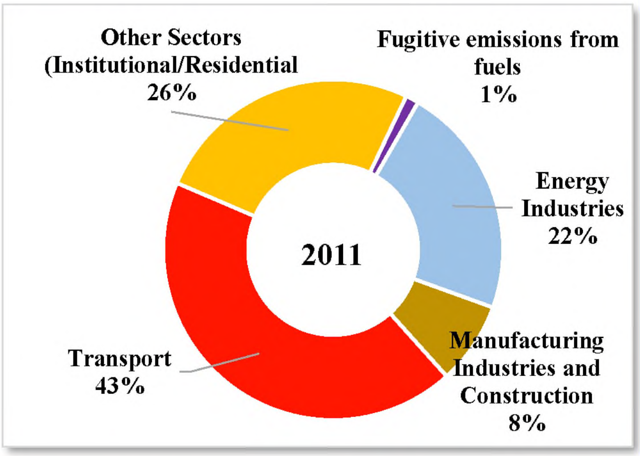
[157] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018.. Bishkek. 2022.

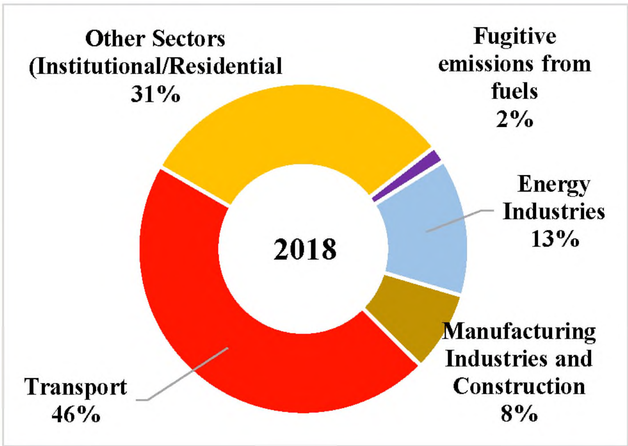




In the reporting period 2011-2018, the distribution structure of GHG emissions in CO_2 equivalent by the major sources also changed. Thus, the share of emissions from transport, other sectors and volatile fuel emissions in total GHG emissions has increased and the share of GHG emissions from energy production, industry and construction has decreased. (See Figure 2.21).

Figure 2.21 GHG emissions in the Energy sector in 2011 and 2018 by categories of sources [158]



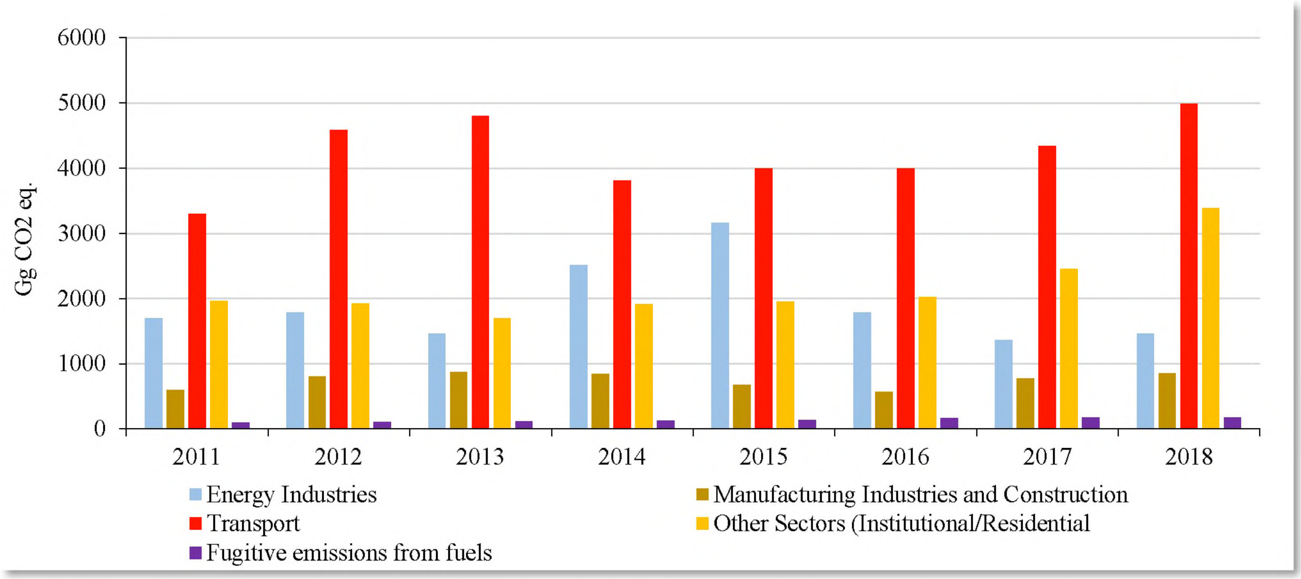


The dynamics of quantitative indicators of GHG emissions in CO2 equivalent of the "Energy" sector for the main emission source categories in the reporting period are presented in figure 2.22 below.

Figure 2.22 Dynamics of GHG emissions from the "Energy" sector by sources in the period 2011-2018. [159]

[158] Ibid.

[159] Ibid.



This graph vividly demonstrates an increase in emissions from Transport and certain stability of emissions in the Energy sector, as well as in Manufacturing and Construction. In 2011, emissions from the "Transport" category amounted to 3298,806 Gg CO2 eq., and in 2018 – 4990,401 Gg CO2 eq., i.e. there was an increase of almost 51,28%.[160]

2.5.3.1.4. Recalculation and improvement of emission estimates in the Energy sector

Application of the new IPCC methodology in NGHGI 4 led to the recalculation of the previous sectoral GHG inventory for the period 1990 - 2018. Table 2.14 provides the data of recalculation of GHG emissions for the period 1990 - 2010 in comparison with the results of the previous, NGHGI 3 conducted in the period 2010 - 2014 and covering the period from 1990 to 2010

Table 2.14 Comparison of GHG emission results for 1990-2010 in CO_2 equivalent after changing to the new methodology [161]

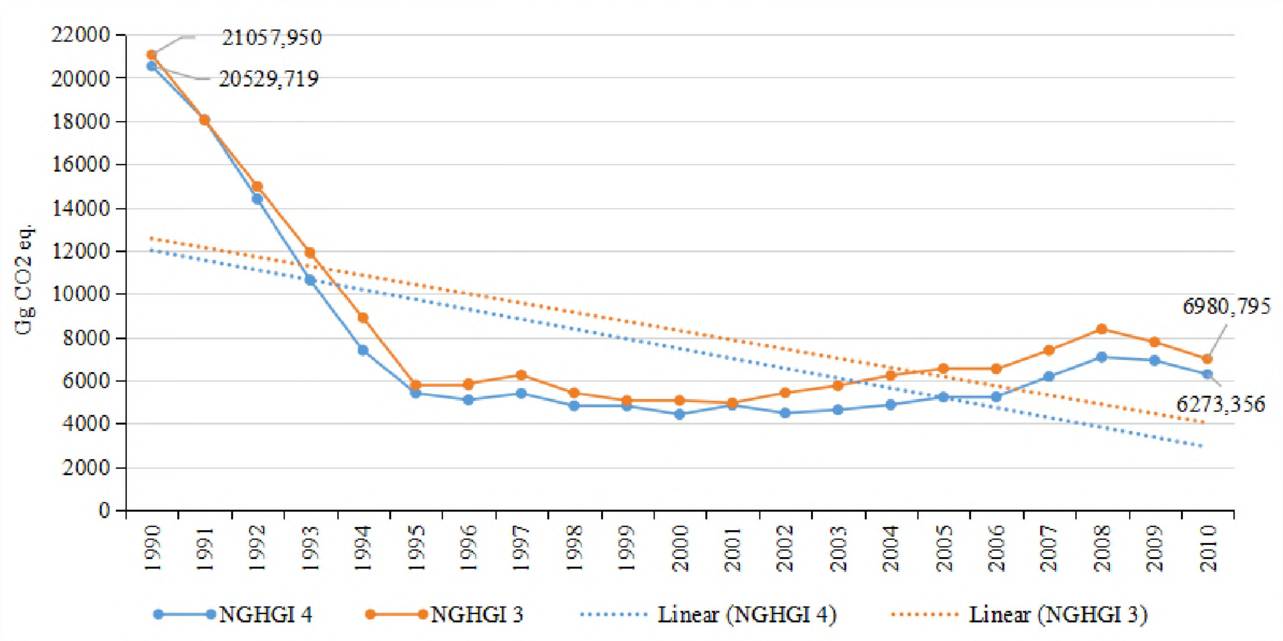
Years	NGHGI 3				NGHGI 4				Difference %
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	
1990	19825,36	1170,529	62,058	21057,95	19429,632	868,721	231,366	20529,719	-2,51
1991	16930,48	1054,54	52,856	18037,87	17092,313	775,826	195,384	18063,523	0,14
1992	14035,34	889,71	43,759	14968,81	13655,435	597,318	129,814	14382,567	-3,92
1993	11093,04	763,816	34,544	11891,4	10126,431	424,922	78,076	10629,428	-10,61
1994	8254,185	611,796	26,051	8892,032	7063,540	276,930	39,419	7379,889	-17,01
1995	5239,945	515,329	16,872	5772,146	5163,616	175,925	59,135	5398,675	-6,47
1996	5417,723	410,223	16,828	5844,773	4865,600	171,055	47,735	5084,389	-13,01
1997	5901,914	313,758	17,776	6233,449	5175,195	167,694	44,402	5387,290	-13,57
1998	5144,456	249,142	16,587	5410,184	4606,177	169,452	38,349	4813,977	-11,02
1999	4837,568	194,862	17,197	5049,627	4571,401	160,265	68,991	4800,656	-4,93
2000	4710,341	328,555	16,9	5055,796	4223,906	168,172	28,964	4421,042	-12,55
2001	4471,014	455,898	16,135	4943,048	4608,150	172,495	57,158	4837,803	-2,13
2002	4642,274	756,098	17,329	5415,701	4266,942	179,324	32,579	4478,844	-17,30

[160] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018.. Bishkek. 2022.
[161] Ibid.

Years	NGHGI 3				NGHGI 4				Difference %
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	
2003	4670,135	1058,724	17,539	5746,398	4432,933	163,062	29,345	4625,340	-19,51
2004	4826,88	1371,023	18,581	6216,485	4657,377	168,212	33,530	4859,120	-21,83
2005	4851,768	1666,995	18,755	6537,518	5014,913	151,879	46,523	5213,316	-20,26
2006	4961,463	1526,598	21,102	6509,163	5045,606	147,189	46,476	5239,271	-19,51
2007	5840,425	1513,999	23,024	7377,447	5929,608	152,411	78,382	6160,400	-16,50
2008	6675,641	1662,09	24,429	8362,16	6808,575	180,996	81,208	7070,779	-15,44
2009	6612,306	1125,037	23,638	7760,981	6630,005	167,141	114,442	6911,588	-10,94
2010	5980,268	977,986	22,541	6980,795	5980,971	192,516	99,869	6273,356	-10,13

The analysis of data from the 3rd NGHGI carried out as part of the preparation of the NC 3, and the results of NGHGI 4, conducted as part of the preparation of BUR 1 and NC 4, showed that there are certain differences in the values of the GHG emissions reduction ranging from 21,83% for 2004 to 0,14% for 1991. These differences are primarily caused by the use of updated activity data, as well as the use of IPCC software, which gives the more accurate calculation of the average default emission factors. In general, the overall dynamics of GHG emissions in the Energy sector remained unchanged, as well as the trends in emissions reduction, with a change in the proportion of emissions of different types of greenhouse gases. (See Figure 2.23).

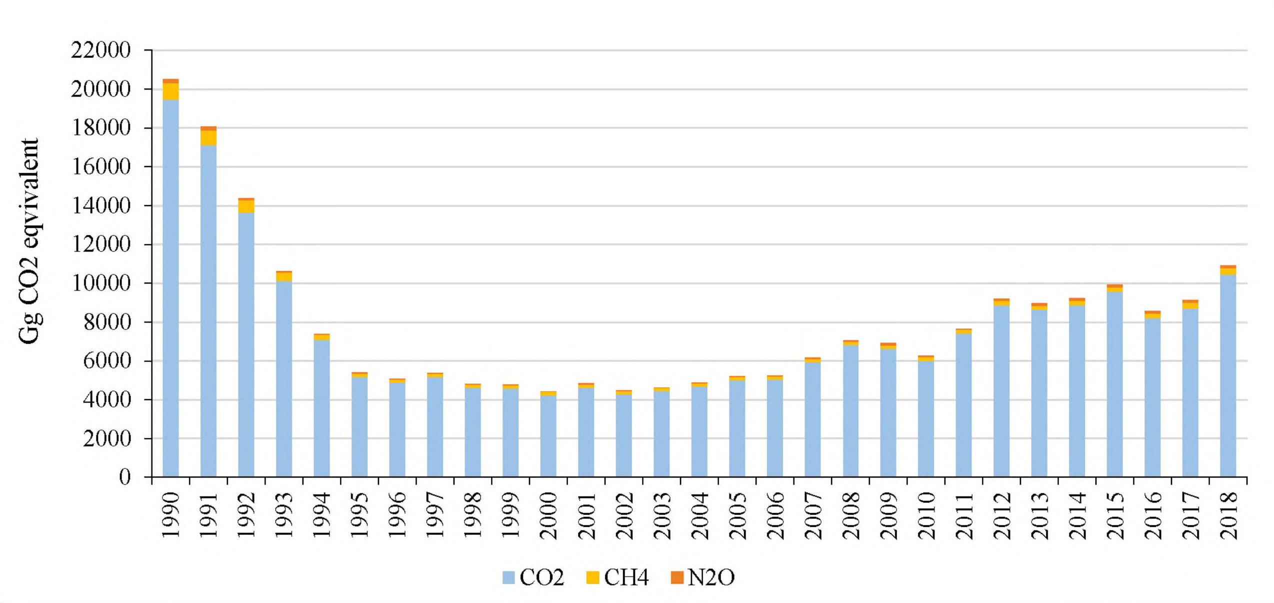
Figure 2.23 Comparison of the overall dynamics of GHG emissions in the Energy sector based on the results of the 3rd and 4th NGHGIs for the period 1990-2010.[162]



The volumes of nitrous oxide and methane emissions in the Energy sector, converted with GWP factors for the analysis of GHG emissions in CO_2 equivalent, were insignificant compared to the emissions of carbon dioxide, which prevailed throughout the entire estimated period 1990-2018. Therefore, in Figure 2.24 below, presenting the total emissions for various types of greenhouse gases within the period 1990-2018, they are almost invisible.

[162] According to data of the SAEPF, GEF-UNEP. Third National Communication. Bishkek. 2016 and MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018.. Bishkek. 2022.

Figure 2.24 Emissions of different types of greenhouse gases in CO_2 eq. from 1990 to 2018.[163]



The recalculation results and the corresponding data time series on annual GHG emissions in the period 1990-2018 for the Energy sector by main categories of emission sources in CO_2 equivalent are presented in Table 2.15.

Table 2.15 Total emissions of the Energy sector by sources for the period 1990-2018.[164]

Categories	1990	1991	1992	1993	1994	1995
1 - Energy	**20529,719**	**18063,523**	**14382,567**	**10629,428**	**7379,889**	**5398,675**
1.A - Fuel Combustion Activities	**19989,871**	**17552,627**	**13994,435**	**10348,122**	**7186,284**	**5248,243**
Energy Industries	8138,325	7723,440	5989,827	4924,074	3868,153	2821,850
Manufacturing Industries and Construction	1270,286	914,997	894,636	700,484	506,332	215,146
Transport	4314,441	3723,818	2970,903	1635,778	774,151	1220,913
Other Sectors (Institutional/Residential	6266,820	5190,373	4139,070	3087,786	2037,648	990,334
Fugitive emissions from fuels	**539,848**	**510,895**	**388,132**	**281,306**	**193,605**	**150,432**
1.B.1 - Solid Fuels	286,693	266,686	185,902	132,573	71,254	26,918
1.B.2 - Oil and Natural Gas	253,155	244,209	202,231	148,733	122,351	123,514
Categories	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
1 - Energy	**5084,389**	**5387,290**	**4813,977**	**4800,656**	**4421,042**	**4837,803**
1.A - Fuel Combustion Activities	**4936,115**	**5244,453**	**4680,466**	**4685,011**	**4298,812**	**4716,510**
Energy Industries	2787,044	2769,414	2218,840	1990,124	2110,342	2266,445
Manufacturing Industries and Construction	251,277	282,778	267,067	251,356	260,461	276,456
Transport	1023,695	1434,083	1307,479	1427,234	901,438	1163,416
Other Sectors (Institutional/Residential	874,099	758,177	887,080	1016,297	1026,570	1010,194
Fugitive emissions from fuels	**148,274**	**142,838**	**133,511**	**115,645**	**122,230**	**121,292**
1.B.1 - Solid Fuels	23,783	21,596	20,536	20,039	19,659	20,442
1.B.2 - Oil and Natural Gas	124,491	121,241	112,975	95,606	102,571	100,850
Categories	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
1 - Energy	**4478,844**	**4625,340**	**4859,120**	**5213,316**	**5239,271**	**6160,400**

[163] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018.. Bishkek. 2022.
[164] Ibid.

1.A - Fuel Combustion Activities	**4349,597**	**4514,456**	**4745,401**	**5104,509**	**5137,427**	**6062,241**
Energy Industries	2027,284	1788,442	1549,600	2055,381	1947,447	1921,477
Manufacturing Industries and Construction	251,633	236,816	221,360	788,770	866,030	894,002
Transport	832,591	1023,558	1279,047	1302,477	1355,376	2161,757
Other Sectors (Institutional/Residential	1238,089	1465,640	1695,394	957,880	968,574	1085,004
Fugitive emissions from fuels	**129,247**	**110,884**	**113,718**	**108,807**	**101,844**	**98,159**
1.B.1 - Solid Fuels	20,505	16,586	13,114	10,918	9,290	8,273
1.B.2 - Oil and Natural Gas	108,742	94,299	100,604	97,889	92,553	89,887

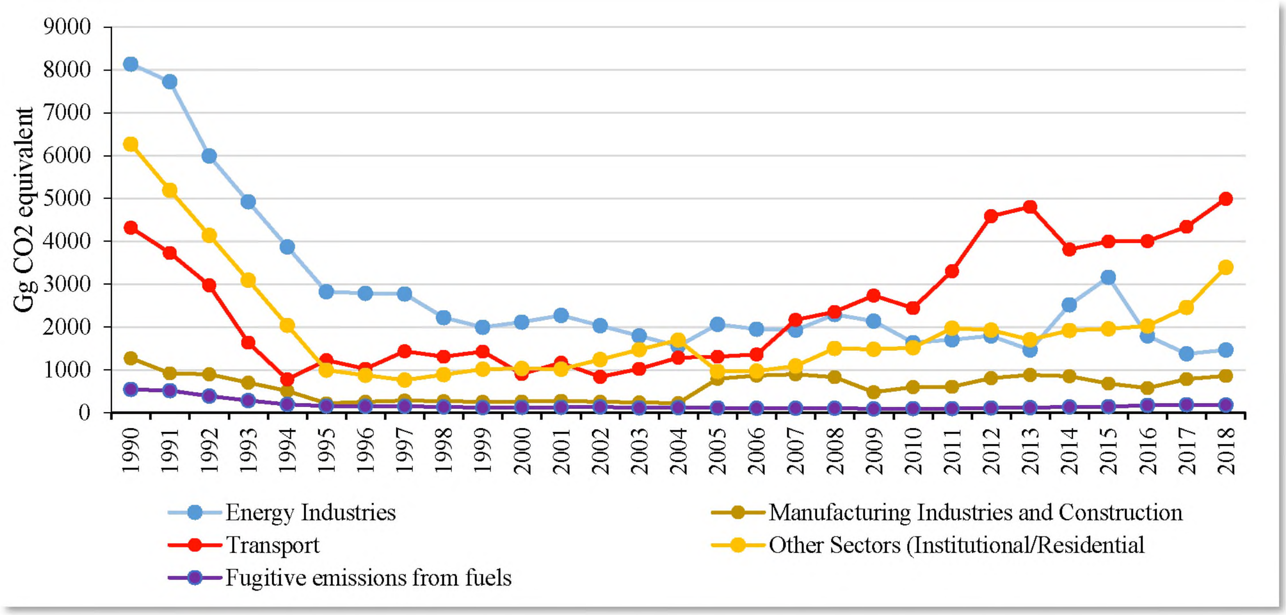
Categories	2008	2009	2010	2011	2012	2013
1 - Energy	**7070,779**	**6911,588**	**6273,356**	**7658,652**	**9205,812**	**8958,767**
1.A - Fuel Combustion Activities	**6967,973**	**6823,079**	**6180,267**	**7563,343**	**9097,645**	**8839,414**
Energy Industries	2291,303	2137,379	1634,739	1698,223	1786,964	1462,698
Manufacturing Industries and Construction	826,903	477,508	590,883	600,143	802,910	874,935
Transport	2348,118	2734,624	2438,424	3298,806	4583,654	4798,463
Other Sectors (Institutional/Residential	1501,649	1473,568	1516,221	1966,170	1924,116	1703,317
Fugitive emissions from fuels	**102,806**	**88,509**	**93,089**	**95,310**	**108,168**	**119,353**
1.B.1 - Solid Fuels	11,791	13,302	11,962	14,728	23,019	33,144
1.B.2 - Oil and Natural Gas	91,016	75,207	81,127	80,582	85,148	86,209

Categories	2014	2015	2016	2017	2018
1 - Energy	**9221,209**	**9920,106**	**8546,374**	**9129,504**	**10923,480**
1.A - Fuel Combustion Activities	**9088,762**	**9780,106**	**8380,327**	**8946,805**	**10706,682**
Energy Industries	2514,043	3154,001	1787,096	1370,359	1464,729
Manufacturing Industries and Construction	847,480	675,407	572,335	779,952	858,718
Transport	3810,490	3992,686	4000,791	4338,885	4990,401
Other Sectors (Institutional/Residential	1916,748	1958,011	2020,105	2457,609	3392,834
Fugitive emissions from fuels	**132,447**	**140,000**	**166,047**	**182,698**	**216,798**
1.B.1 - Solid Fuels	48,171	37,277	34,780	31,463	44,433
1.B.2 - Oil and Natural Gas	84,276	102,723	131,267	151,235	172,364

Overall dynamics of the Energy sector GHG emissions in CO_2 eq. for the period 1990-2018 by main sources is presented in Figure 2.25.

Figure 2.25 Total GHG emissions of the Energy sector by major emission sources in the period 1990-2018.[165]

[165] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018.. Bishkek. 2022.



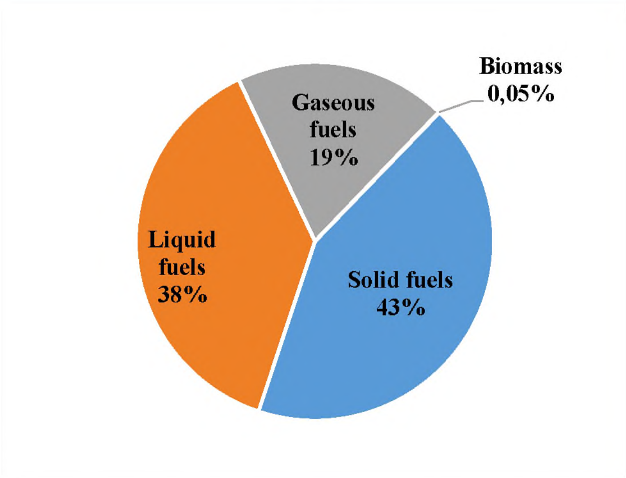
The results of the 4th NGHGI showed that between 1990 and 2018 there have been changes in GHG emissions from the use of different types of fuel burned (see figure 2.25 below).

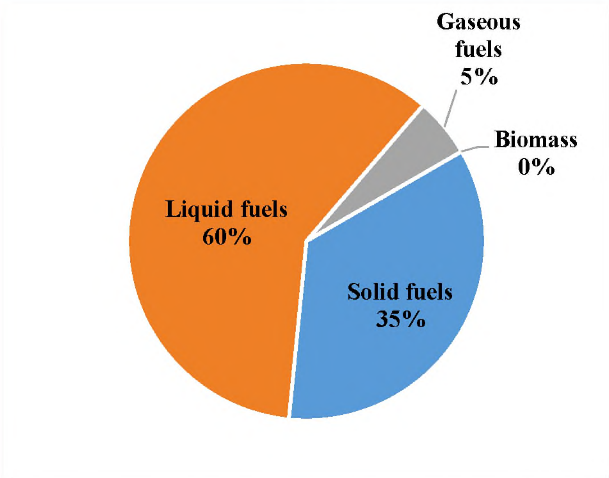
Thus, in 1990, GHG emissions from combustion of liquid fuel amounted to 8572,317 Gg CO2 eq., emissions from combustion of solid fuels amounted to 7570,409 Gg CO2 eq., emissions from the combustion of gaseous fuels amounted to 3838,147 Gg CO2 eq. and emissions from biomass combustion – 8,998 Gg CO2 eq.

In 2018, the Energy sector was also dominated by emissions from the combustion of liquid fuels amounted to 6395,151 Gg CO2 eq., emissions from the solid fuel made up 3736,475 Gg CO2 eq. and emissions from gaseous fuels – 574,397 Gg CO2 eq. and 0,548 Gg CO2 eq. from burning biomass.

Figure 2.26 Distribution of emissions from fuel combustion in 1990 and 2018.[166]

1990	2018





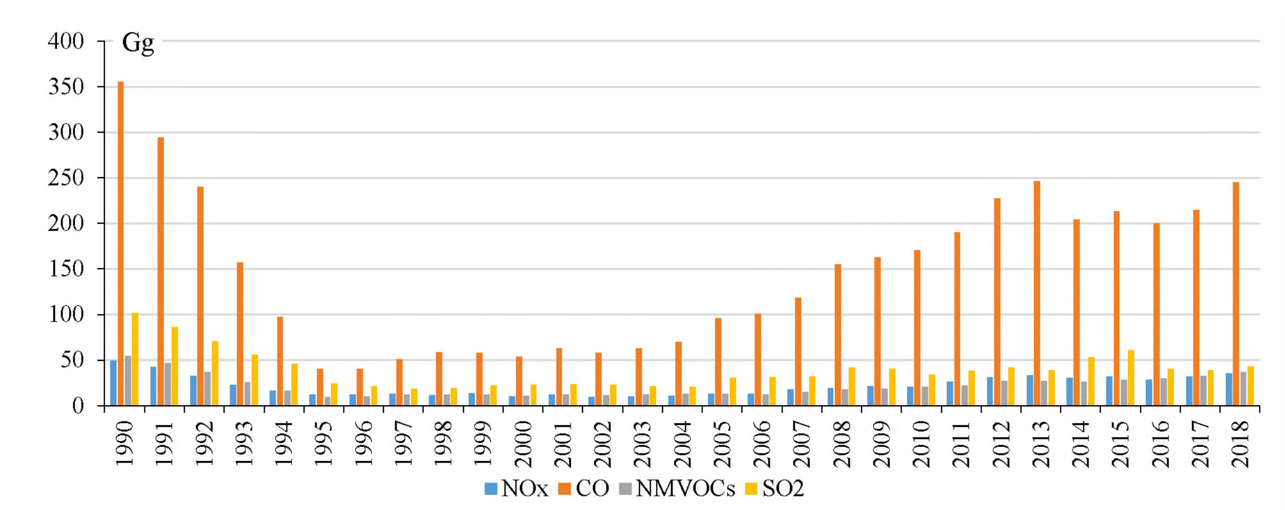
As can be seen in the figure above, the pattern of emissions from the combustion of different fuels has undergone significant changes between 1990 and 2018 that directly reflect the pattern of consumption of different fuels, both in the economy and at the household level. Emissions from flared gas have

166 MNRETS, GEF-UNEP. IPCC Inventory Software Database 2.54. Bishkek. 2022.

significantly decreased, while GHG emissions from flared liquid fuels of various types have increased and accounted for more than half of GHG emissions from the combustion of all fuels. At the same time, the share of emissions from solid fuel combustion also decreased.

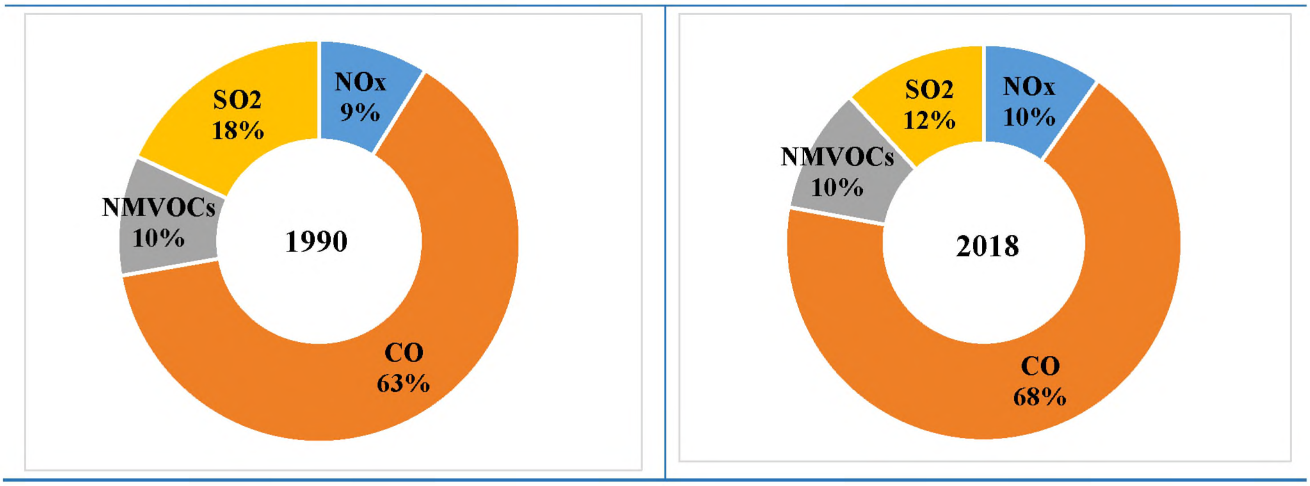
Emissions of precursor gases in the Energy Sector varied throughout the reporting period 1990-2018. The dynamics of emissions of gases of precursors in the Energy sector are shown in Figure 2.27 below.

Figure 2.27 Trends of precursor gas emissions between 1990 and 2018.[167]



The results of the precursor gas inventory show a general decrease in precursor emissions between 1990 and 2018 and very small changes in the ratio of individual gas deposits to total precursor gas emissions. A comparison of the proportions of precursor gases emissions in 1990 and 2018 is presented in Figure 2.28.

Figure 2.28 Composition of precursor gases emissions in 1990 and 2018.[168]



[167] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018.. Bishkek. 2022.
[168] Ibid.

2.5.3.1.5. Assessment of uncertainty of the NGHGI 4 in the Energy Sector

Uncertainty assessments are an important element of a complete inventory of greenhouse gas emissions and removals. Activity data are the main source of uncertainty in GHG emissions calculations. For the Energy Sector, most of the activity data is fuel combustion data.

The uncertainty analysis of the national GHG inventory in the Energy sector was carried out in accordance with the 2006 IPCC Guidelines based on Approach 1 and covered all emission source categories and all direct greenhouse gases. The year 2018 was taken as the uncertainty estimate of the last year (t), and 1990 was the base year. Uncertainty assessments for activity data and emission factors were based on typical values proposed by the 2006 IPCC Guidelines.

The results of the fourth GHG inventory analysis in the Energy sector showed that the uncertainty of the emission estimation (percentage uncertainty in the total volume) in terms of the level is within 7,66%, and the uncertainty in trends within 2,42%.[169] Herewith, uncontrolled GHG emissions from solid fuels, oil and gas production have the highest estimates of uncertainty. Uncertainty is also relatively high for nitrous oxide emissions from commercial/institutional (departmental) fossil fuel combustion sources. The differences in the magnitude of the uncertainty across the different source categories are negligible.

2.5.3.2. Industrial Processes and Product Use

Many types of industrial production are associated with greenhouse gas emissions. The major emissions from the sector are generated from industrial processes of chemical or physical processing of materials (for example, blast furnaces in the steel industry; ammonia and other chemical products from fossil fuels used as chemical raw materials, cement production are the most important examples of industrial processes associated with the release of the significant amount of CO_2). These processes produce a variety of greenhouse gases, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and hydrofluorocarbons (HFCs).

In addition, greenhouse gases are often found in common products such as refrigerators, foam, and aerosol cans. For example, HFCs are used in various types of products instead of ozone-depleting substances (ODS). N_2O is also used in several industrial products (for example, N_2O - as a propellant in aerosol products, mainly in the food industry), as well as in end-use products (for example, N_2O for anesthesia in medicine). The distinctive feature of this use of products is that in almost all cases it takes a long time between the production of a product and the release of greenhouse gas. This delay time can vary from a few weeks (for example, for aerosol cans) to several decades (for hard foams). In some applications (such as refrigeration), the greenhouse gas fraction of the product may be extracted at the end of the product's life and then reused or destroyed.

Use of products is integrated into the 2006 IPCC Guidelines with industrial processes, as production, import and export data are often needed to estimate emissions of products; and since – besides the use in non-industrial sectors (retail, services, and household) - the use of products can be part of industrial production. [170] Accordingly, this sector is called Industrial Processes and Product Use (IPPU).

2.5.3.2.1. Assessment methodology, level and coefficients

The methodology for estimating carbon dioxide emissions from the IPPU sector actually includes several sections. For example, the use of carbonate raw materials in production and use of various mineral

169 Expert report of TEG "Energy". PIU Archive.

170 IPCC. Guidelines for National Greenhouse Gas Inventories. Volume 3. 2006 https://www.ipcc-nggip.iges.or.jp/public/2006gl/russian/pdf/3_Volume3/V3_1_Ch1_Introduction.pdf

materials is based on two methods of releasing CO_2 from carbonates: calcination and the release of CO_2 in reaction with an acid.

The main process leading to the release of CO_2 is the calcination of carbonates, which, when heated, forms a metal oxide.

$$CaCO_3 + heat \longrightarrow CaO + CO$$ [171]

Although emissions from calcination are similar for all categories of mineral production, three categories of this common source can be distinguished based on their relatively large contribution to global emissions. These source categories are cement production, lime production, and glass production. Apart from these three source categories, this chapter examines emissions from the use of carbonates in other industries, including the production of ceramics and bricks. Limestone and other carbonate materials are also consumed by other industries. Examples include the use of carbonates as fluxes and slag formers, in the smelting and refining of metals (for example, in the production of iron and steel and base metals such as copper), and as raw materials for the chemical industry (for example, for the production of fertilizers).

The methods for emissions assessment from carbonate use discussed here are applicable to these other industries as well. According to the rules of good practice for GHG inventory, emissions from the use of limestone, dolomite and other carbonates are classified in the category of industrial sources where they occur (for example, in the steel industry). The methodologies for estimating emissions for the IPPU sector, described in Volume 3 of the 2006 IPCC Guidelines, note that this sector considers only emissions associated with processes, and not with the consumption and use of energy in production.

Cement production

In cement production, CO_2 is generated during the production of clinker, a granular intermediate product, which is then finely ground together with a small proportion of calcium sulfate [gypsum ($CaSO_4 \cdot 2H_2O$) or anhydrite ($CaSO_4$)] to produce hydraulic cement (usually Portland). During the clinker production process, limestone, which is predominantly carbonate ($CaCO_3$), is heated (or calcined) to produce lime (CaO) and a by-product of CO_2. CaO then reacts with silica (SiO_2), alumina (Al_2O_3), and iron oxide (Fe_2O_3) raw materials to form clinker minerals (mainly calcium silicates). Cement can be made (ground) entirely from imported clinker, in this case, it can be assumed that the cement plant produces zero CO_2 emissions associated with the process.

The IPCC Guidelines, noting good practice for choosing the best method, taking into account national conditions, suggests 3 levels. During preliminary discussions with all stakeholders, the Tier 1 method was chosen for the 4th NGHGI sector, where the emission estimate is based on an assessment of the volume of clinker production, which is derived from the volume of cement production, adjusted for import and export of clinker. In estimating GHG emissions from cement production, CO2 emissions are calculated from the equation:

$$CO_2\ emissions = \left[\sum_i (M_{ci} \times C_{cli}) - Im + Ex\right] \times EF_{clc}$$

Where:
CO_2 emissions = CO_2 emissions from cement production, tons
M_{ci} = weight (mass) of type i cement produced, tons
C_{cli} = fraction of clinker in cement type i, shot
Im = import of clinker for consumption, tons
Ex = export of clinker, tons

[171] Ibid.

EF_{clc} = Emission Factor for Clinker in a Specific Cement, tons CO_2 / clinker ton Default Emission Factor for clinker (EF_{clc}), corrected.

Lime production.

Lime production consists of several stages, including extraction of raw materials, crushing and sorting by size, calcining the raw materials to produce lime, and (if necessary) hydrating the lime to acquire calcium hydroxide. In some cases, the consumption of lime as a product does not result in CO_2 emissions. Using slaked lime to soften water, for example, causes CO_2 to react with lime and re-form calcium carbonate, which does not emit CO_2 into the atmosphere. Similarly, precipitated calcium carbonate, which is used in paper and other industries, is a product made in a high calcium CO_2 gassed lime reaction. All recarbonization in these industries can be calculated and recorded only when proven and validated methods are used to calculate CO_2 that reacts with lime to form calcium carbonate.

As for cement production, the Tier 1 method based on the volume of production using default emission factor values was chosen to estimate GHG emissions from lime production. Tier 1 is an output-based method where the emission factor is multiplied by the total amount of lime produced. The emission factor is based on stoichiometric ratios that vary with the type of lime produced. The IPCC guidelines propose the following formula for calculating the emission factor:

$$\begin{aligned} EF_{lime} &= 0{,}85 * EF_{lime\ with\ high\ calcium\ content} + 0{,}15 * EF_{dolomite\ lime} \\ &= 0{,}85 * 0{,}075 + 0{,}15 * 0{,}77^{a} \\ &= 0{,}6375 + 0{,}1155 \\ &= 0{,}75\ CO_2 \text{ tons / ton of lime produced.} \end{aligned}$$ [172]

Glass production.

Many types of glass products and compositions are used on an industrial scale, wherein the glass industry is divided into four main categories - container glass, sheet (window) glass, fiberglass, and special-purpose glass. The Kyrgyz Republic has the first two types of production. These two categories use almost exclusively sodium-calcium glass, which consists of silicon oxide (SiO_2), soda (Na_2O), and lime (CaO) with small amounts of aluminum oxide (Al_2O_3) and oxides of other alkaline and alkaline soil elements, as well as other ingredients in smaller quantities.

Limestone ($CaCO_3$), dolomite Ca, Mg (CO_3) and soda ash (Na_2CO_3) constitute the largest part of the glass raw material that releases CO_2 during the smelting process.

The behavior of these carbonates during glass melting is a complex high-temperature reaction that cannot be directly compared with the reaction of calcining carbonates with the formation of quicklime or with the burning of dolomite lime. However, this melting (around 1500°C) has the same net effect in terms of CO_2 emissions.

The IPCC Tier 1 method was used in NGHGI 4 because there were insufficient data on glass production by different technologies or on carbonates used in glass production. In Tier 1, the default emission factor and the proportion of cullet were applied according to national glass production statistics. The calculation of emissions from glass production according to the IPCC Guidelines was made as the following formula:

$$CO_2 \text{ emissions} = Mg \cdot EF \cdot (1 - CR)$$

Where:
CO_2 emissions = CO_2 emissions from glass production, tons
Mg = mass of glass produced, tons
EF = emission factor for glass production, CO_2 tons/ton glass

[172] IPCC. Guidelines for National Greenhouse Gas Inventories. Volume 3. 2006, ch. 2, p - 2.29.

CR = fraction of cullet used in the process (national average or default), fraction. [173]

At Tier 1, the default emission factor, which is based on the «type» feed material mixture, is applied to the data for national glass production. A typical soda-lime charge consists of sand (56.2wt%), spar (5.3wt%), dolomite (9.8wt%), limestone (8.6wt%), and soda ash (20.0wt%). Based on this composition, about 0.84 tons of glass are produced per ton of raw materials, with about 16.7% of the weight lost as volatiles (in this case, volatiles are almost entirely CO_2). Hence the calculation of the emission factor for glass production:

$$EF = 0,167 / 0,84 = 0,20 \ CO_2 \text{ tons / ton glass}$$ [174]

Ceramics

The Ceramics category in the IPPU sector includes the production of bricks and roofing tiles, glazed ceramic pipes, fire-resistant and ceramic products, floor and wall tiles, tableware and decorative items (household ceramics), ceramic sanitary ware, technical ceramics, and inorganic abrasives with a binder. Emissions from the ceramic manufacturing process result from the calcination of clay carbonates as well as from additives. Similar to cement and lime production processes, carbonates are heated to high temperatures in a kiln, producing oxides and CO_2. Most ceramic products are made from one or more types of clay (for example, shale, refractory clay, and lumpy clay). The raw materials are combined and finely ground in successive milling operations. The milled particles are then burned in an oven to produce a powder (which can be liquefied). Additives are then added, molded or poured into the ceramic, and machined to smooth the sharp edges and obtain the desired ceramic properties. In traditional ceramics, items are then dried and glazed before being fired in a kiln.

CO_2 emissions come from the calcination of raw materials (especially clay, shale, limestone, dolomite, and vitrite) and the use of limestone as a flux.

The method for estimating emissions from the production of Tier 1 ceramics assumes that only limestone and dolomite are used as carbonate feedstock in industry and adjusts the use of limestone and the default dolomite share. Tier 1 emissions are calculated based on the mass of consumed carbonates

$$CO_2 \text{ emissions} = Mc \times (0,85 \ EFls + 0,15 \ EFd)$$

Where:
CO_2 emissions = CO_2 emissions from other processes using carbonates, tons
Mc = mass of consumed carbonates, tons
EFls or EFd = emission factor from calcination of limestone or dolomite, tons
CO_2 / ton of carbonate. [175]

Metal Industry, iron and steel production.

The main processes of iron and steel production include blast coke, agglomerate, pellets, iron ore processing, cast iron, steel, casting steel, and, often, blast gas and gas burning from chamber ovens to support other processes.

Steel production can be carried out in integrated iron ore plants or in secondary plants where steel is produced primarily from secondary steel scrap. Integrated plants include coke production, blast furnaces, and oxygen converters or, in some cases, open hearth furnaces (OHFs). Raw steel is produced in oxygen converters from pig iron, smelted in a blast furnace, and then processed into final products.

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[173] Ibid, p. 2.31
[174] IPCC. Guidelines for National Greenhouse Gas Inventories. Volume 3, 2006, ch.2, p. 2.33.
[175] Ibid, p. 2.38

Blast furnace cast iron can also be processed directly into iron products. Electric Arc Furnaces (EAFs) are most commonly used for secondary steelmaking.

Cast-iron production can be carried out at an integrated steel-making plant or a separate plant including blast furnaces and oxygen converters. In addition to being manufactured in a blast furnace, cast iron can be directly recovered. Direct reduction is the reduction of iron ore at temperatures below 1,000 ° C to solid metallic iron.

The largest CO2 emissions in the metal industry are produced by the production of cast iron, or rather, the use of coal to convert iron ore into iron. The carbon is supplied to the blast furnace mainly in the form of coke derived from coking coal. Carbon has two functions in the metallurgical process - primarily a reduction in the reaction of iron oxide reduction to iron; it is also a source of energy because the carbon and oxygen reactions are accompanied by the release of heat.

Steel production in an oxygen converter begins with the loading of molten cast iron (70-90%) and steel scrap (10-30%). The high-purity oxygen then reacts with the carbon in the cast iron to generate heat, which melts the charge while simultaneously reducing the carbon content. Cast iron from blast furnaces usually contains 3-4% carbon, which should be reduced to 1%; the iron is refined and alloyed with additives to form the desired steel grade.

Steel production in EAF typically involves a 100% charge of secondary steel scrap, which melts with the consumption of electricity supplied to the charge through carbon electrodes; the melt is then purified and alloyed with additives to obtain the desired steel grade. Since there is one EAF process - scrap smelting, without reducing oxides, carbon is not as important as in the furnace/converter process. In most EAFs fueled by scrap, CO_2 emissions are mainly associated with the consumption of carbon electrodes.

The IPCC Guidelines provide three tiers of CO_2 emissions calculation and two tiers of CH_4 emissions calculation from iron and steel production. The choice of method in good practice, which depends on national conditions, was determined for Kyrgyzstan by a Tier 1 method that uses national production data and default emission factors, which are given in the agglomerate production document, cast iron, direct reduction iron, pellets, as well as for each method of smelting steel. The main sources of emissions are cast iron production and steel smelting.

Emissions from cast iron and steel production using the Tier 1 method are determined by multiplying default emission factors by national production data. Since emissions per unit of steel production can vary widely depending on the steel production method, then it is good practice to determine the share of steel production by various methods, calculate the emissions for each method of production, and then sums them up. The equation for calculating emissions from iron and steel production at Tier 1 is as follows:

$$E_{CO2,\ non\text{-}energy} = BOF * EF_{BOF} + EAF * EF_{EAF} + OHF * EF_{OHF}$$

Where:
$E_{CO2,\ non\text{-}energy}$ = CO_2 emissions to be accounted for in the IPPU sector, tons
BOF = the amount of crude steel smelted in the oxygen converters, tons
EAF = amount of crude steel smelted in EAF, tons
OHF = amount of crude steel smelted in OHF, tons. [176]

Non-energy use of products from fuels and solvent use

The IPPU sector also estimates emissions from the first use of fossil fuels as primary products such as lubricants, waxes, bitumen/asphalt, and solvents. Emissions from further use or disposal of products

[176] IPCC. Guidelines for National Greenhouse Gas Inventories. Volume 3, 2006, ch. 4, p. 4.22.

after use (e.g., incineration of used oils and lubricants) are accounted for in the Waste sector if incinerated and in the Energy Sector if energy is extracted. In general, the methods for calculating carbon dioxide (CO_2) emissions from the use of non-energy products obey the basic formula, where emission factor consists of a carbon ratio and a ratio that reflects the share of fossil carbon that oxidizes during use (ODU), i.e. the proportion of lubricants that burns in the engine combustion chamber. The basic formula for calculating CO_2 emissions from non-energy use of products is as follows:

$$CO_2 \text{ emissions} = \sum_i (NEUi * CC_i * ODUi) * 44/12$$

Where:
CO_2 emissions = CO_2 emissions from non-energy product uses, ton CO_2
NEUi = non-energy use of fuel i, TJ
CCi = specific carbon content of fuel i, ton C/TJ (=kg C/GJ)
ODUi = ODU factor for fuel i, fraction
44/12 = mass ratio of CO_2 /C[177]

Lubricants are mainly used in industry and transport. The use of lubricants in engines is primarily due to their lubricating properties; emissions from this use are considered non-combustion emissions and attributed to the IPPU sector.

The Tier 1 method used in NGHGI 4 applies an analytical approach where emission factors are multiplied by the data on the amount of lubricants consumed in the country (in energy units, for example, in TJ). The emission factor is the product of the specific carbon content (tons C / TJ) by the ODU coefficient. Further multiplication by 44/12 (CO_2/C mass ratio) gives the emission factor expressed in tons of CO2 / TJ.

Besides lubricants, this category includes products such as liquid paraffin, paraffin wax, and other waxes that are solid at ambient temperatures. Paraffin is isolated from crude oil during the production of light lubricating oils (distillation). Paraffin wax is used to make candles, corrugated boxes, paper coverings, glued boards, food products, mastics, detergents, and more. Emissions from wax use occur mainly when waxes or wax derivatives are burned during use (e.g., candles) when they are incinerated with and without heat recovery. The formula for calculating CO2 emissions from the use of paraffin:

$$CO_2 \text{ Emissions} = PW \bullet CC_{Wax} \bullet ODU_{Wax} \bullet 44/12$$

Where:
CO_2 Emissions = CO_2 emissions from waxes, ton CO_2
PW = total wax consumption, TJ
CC_{Wax} = carbon content of paraffin wax (default), ton C/TJ (= kg C/GJ)
ODU_{Wax} = ODU factor for paraffin wax, fraction
44/12 = mass ratio of CO_2 /C[178]

Emissions of fluorinated substitutes for ozone-depleting substances

Hydrofluorocarbons (HFCs) and, to a very limited extent, perfluorocarbons (PFCs) are used as alternatives to ozone-depleting substances (ODS), which are being phased out under the Montreal Protocol. Current and projected uses of HFCs and PFCs include the following:

- air conditioning and cooling;

[177] IPCC. Guidelines for National Greenhouse Gas Inventories. Volume 3, 2006, ch. 5, p. 5.5
[178] IPCC. Guidelines for National Greenhouse Gas Inventories. Volume 3, 2006, ch. 5, p. 5.12

- fire fighting and explosion protection;
- aerosols;
- cleaning with solvents;
- foaming; and
- other areas of application. [179]

HFCs are substances containing only hydrogen, carbon and fluorine. Prior to the adoption of the Montreal Protocol and the ODS phase-out, of all HFCs, only HFC-152a (part of the R-500 refrigerant blend) and HFC-23 (low-temperature refrigerant, a by-product of HCFC-222 production) were produced. HFC-134a started to be produced in 1991, and since then many HFCs have been introduced and are currently used, including as substitutes for ODS.

The Tier 1 method is both less information-demanding and less complex because emission estimates are usually made at the application level, rather than at the level of product or equipment types. However, these approaches vary greatly depending on the characteristics of a particular application. The IPCC Guidelines can apply Tier 1 approaches using a default emission factor that goes up to 100% for instantaneous emission applications. For simpler Tier 1 approaches, sales data for chemicals at the application level are generally sufficient. However, accounting for the individual components of mixtures still presents a significant difficulty. Regardless of the Tier 1 methodology chosen, countries are required to report HFCs separately. Therefore, information is required on the practical use of commercial types of HFC refrigerants, blowing agents, solvents, etc. Many of these products are mixtures of two or more HFCs, and the composition of the fluids used for these purposes may vary according to the product formulated by the company.[180]

It should be noted that not all production types described in the 2006 IPCC Guidelines were reflected in the IPPU section of the Inventory of GHG emissions and removals of Kyrgyzstan for the period 1990-2018, this is due not only to a lack of activity data, as well as the characteristics of the national economy and industrial production, the technological context, the lack of production processes related to GHG emissions and precursor gases.

According to the structure and types of activities in the IPPU sector, the national GHG inventory is carried out according to the following categories in the IPCC code:

- 2.A Mineral Industry
  - 2.A.1 Cement Production
  - 2.A.2 Lime Production
  - 2.A.3. Glass Production
  - 2.A.4 Other Processes Uses of Carbonates
  - 2.A.5. Other
- 2.B Chemical Industry
  - 2.B.1. Ammonia Production
  - 2.B.2. Nitric Acid Production
  - 2.B.3. Adipic Acid Production
  - 2.B.4. Caprolactam, Glyoxal and Glyoxylic Acid Production
  - 2.B.5. Carbide Production
  - 2.B.6. Titanium Dioxide Production
  - 2.B.7. Soda Ash Production
  - 2.B.8. Petrochemical and Carbon Black Production
  - 2.B.9. Fluorochemical Production
  - 2.B.10. Other

[179] IPCC. Guidelines for National Greenhouse Gas Inventories. Volume 3, 2006, ch. 7.
[180] Ibid. p. 7.15

- 2.C Metal industry
  - 2.C.1 Iron and Steel Production
  - 2.C.2 Ferroalloy Production
  - 2.C.3 Aluminum Production
  - 2.C.4 Magnesium Production
  - 2.C.5 Lead Production
  - 2.C.6 Zinc Production
  - 2.C.7 Other
- 2.D Non-Energy Products from Fuels and Solvent Use
  - 2.D.1 Lubricant Use
  - 2.D.2 Paraffin Wax Use
  - 2.D.3 Solvent Use
  - 2.D.4 Other
- 2.E. Electronics Industry
  - 2.E.1 Integrated Circuit or Semiconductor
  - 2.E.2 TFT Flat Panel Display
  - 2.E.3 Photovoltaics
  - 2.E.4 Heat Transfer Fluid
  - 2.E.5 Other
- 2.F Product Uses as Substitutes for Ozone Depleting Substances
  - 2.F.1 Refrigeration and Air Conditioning
  - 2.F.2 Foam Blowing Agents
  - 2.F.3 Fire Protection
  - 2.F.4 Aerosols
  - 2.F.5 Solvents
  - 2.F.6 Other Applications
- 2.G Other Product Manufacture and Use
  - 2.G.1 Electrical Equipment
  - 2.G.2 SF_6 and PFCs from Other Product Uses
  - 2.G.3 N_2O from Product Uses
  - 2.G.4 Other
- 2.H Other.
  - 2.H.1 Pulp and Paper Industry
  - 2.H.2 Food and Beverage Industry
  - 2.H.3 Other[181]

The use of the IPCC category during the inventory of NGHGI 4 of KR was determined by the presence of similar industries in the country and the availability and accessibility of data on their activities.

2.5.3.2.2. Activity Data

It is necessary to collect and form long time series of data to estimate GHG emissions from mineral production. The availability of these data largely determines the choice of the methodology and the appropriate level of assessment and calculation of GHG emissions. For example, to estimate GHG emissions from cement production in Tier 1, data should be collected on the types of cement produced and the proportion of clinker in the cement composition in order to estimate clinker production at the country level (or, where possible, at the plant level). If the production of cement cannot be disaggregated by type of cement and if there is reason to believe that significant quantities of mixed and/or

[181] IPCC. Guidelines for National Greenhouse Gas Inventories. Volume 3, 2006, ch. 1.

buried cement are produced in addition to Portland cement, then it can be assumed that the total clinker fraction is 75%. If almost all of the cement produced is known to be Portland cement, in good practice it is assumed that clinker is 95% by default.

To apply the Tier 1 GHG emission estimation methodology for lime production, the following default values were used: (1) types of lime produced and/or (2) proportion of hydrated lime produced.

Activity data for Tier 1 glass production include national glass production statistics by weight, as well as a correction for the amount of cullet used in glass production. However, Tier 1 assumes that the default cullet proportion is 50%; therefore, to estimate national emissions, the country-level glass production data is multiplied by 0.20 • (1 - 0.50) = 0.10 CO_2tons/ton of glass.

During using the Tier 1 method in ceramics production, activity data should be collected for all carbonate consumption that is accompanied by emissions. In the absence of better data, good practice assumes that limestone accounts for 85% of carbonate consumption and dolomite 15%. For the use of soda ash, inventory compilers should collect data on the total amount of soda ash used at the country or plant level. For clays used in the ceramics industry, it is necessary to collect national data on the production of bricks for roofing tiles, glazed ceramic pipes, and refractory products and calculate the amount of clay consumed by multiplying the amount of production by the default loss factor.

In metal industry, to assess emissions in iron and steel production under Tier 1 method, it is necessary to know only the total amount of steel produced in the country as per each method, the total amount of iron production that will not be processed into steel, and the total amount of coke, direct reduced iron, pellets and agglomerate; in this case, it is assumed that the entire amount of coke was produced at the combined coke plants.

An activity data in units of energy (TJ) were required to estimate emissions from non-energy use of lubricants. Calorific value factors, proposed by the IPCC Guidelines as default, are needed to convert consumption data in units of mass (e.g., in tonnes) into generally accepted energy units (e.g., in TJ, based on the lowest calorific value). Basic data on non-energy products used in the country were obtained from production, import and export data, and the ratio of energy/non-energy use in national statistics. Besides, the collected activity data for this sector included information on the production indicators of the main industries, where emissions of various GHGs and gases of precursors occur during the technological process. [182]

An activity data for ODS substitutes represent the net amount of each chemical consumed per year in the country for a specific annex, sub-annex, or, at a more detailed level, for a type of equipment/product. Using the Tier 2a method, it is often necessary to collect activity data for many items of a particular type of equipment or product in order to estimate the quantities of chemicals consumed or in banks. If the chemicals are in cans, then the historical structure of net consumption needs to be ascertained, either from the year the chemicals were first used or over the average life of the products or equipment in use. This allows the accumulated bank to be calculated when emission factors need to be applied. It should be noted that such data on the global or regional net consumption can be obtained from regional and world databases.

The collection of national activity data consists of gathering information on the net consumption of HFCs for each substance and, where emissions are delayed after consumption, on the stock of substances in banks. There is a need to analyze and understand all data collected and to identify possible data gaps.[183]

It is clear that the collection of data on this sector always presents a certain challenge due to the variety of fields of activity, forms of ownership, differences in forms, units of measurement, and irregular

[182] IPCC. Guidelines for National Greenhouse Gas Inventories. Volume 3, 2006, ch. 2,3,4,5
[183] Ibid. ch.7, p. 7.21.

reporting. In such conditions, the formation of long time series of data was rather difficult and required additional efforts and approvals.

Among the data collected for the fourth GHG inventory sector were:

- In the category "Production of mineral materials:"
    - Cement production is tons of clinker used
    - Lime production - tons of lime;
    - Glass production - tons of glass produced;
    - Ceramic (brick) production - tons of carbon used.
- In the category "Metal industry:"
    - Iron and steel casting - tons of metal produced.
    - Antimony and mercury production - tons of metals produced
- By category "Use of solvents and non-energy products from fuels:"
    - Use of lubricants - tons.
    - Use of hard paraffin - tons.
- By category 2.F "Use of substitutes for ozone depleting substances:"
    - Use of hydrofluorocarbons - tons.

2.5.3.2.3. Estimation of GHG emissions in the period 2011-2018

According to the results of NGHGI 4 in 2018, the total GHG emissions in the IPPU sector amounted to 1162,553 Gg CO_2 eq. At the same time, CO_2 emissions from the production of mineral substances amounted to 957,684 Gg, emissions from the metal industry – 0,049 Gg CO_2 eq., and emissions from Non-Energy Products from Fuels and Solvent Use – 9.672 Gg CO_2 eq., total HFC emissions under category Product Uses as Substitutes for Ozone Depleting Substances amounted to 193,688 Gg CO_2 eq.[184]

Emissions of the IPPU sector in 2018 by types of greenhouse gases are presented in Table 2.16.

Table 2.16 Greenhouse gas emissions in 2018. (Gg) [185]

Categories	CO2	CH4	N2O	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-227ea
2 - Industrial Processes and Product Use	**968,864**	**0,000**	**0,000**	**0,007**	**0,018**	**0,048**	**0,012**	**0,01**
2.A - Mineral Industry	**957,684**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**
2.A.1 - Cement production	915,983			0,000	0,000	0,000	0,000	0,000
2.A.2 - Lime production	6,515			0,000	0,000	0,000	0,000	0,000
2.A.3 - Glass Production	22,257			0,000	0,000	0,000	0,000	0,000
2.A.4 - Other Process Uses of Carbonates	12,929	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2.A.4.a - Ceramics	12,929			0,000	0,000	0,000	0,000	0,000
2.B - Chemical Industry	**0**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**
2.C - Metal Industry	**0,049**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**
2.C.1 - Iron and Steel Production	0,049	0,000		0,000	0,000	0,000	0,000	0,000
2.C.7 - Other (please specify)				0,000	0,000	0,000	0,000	0,000
2.D - Non-Energy Products from Fuels and Solvent Use	**11,131**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**
2.D.1 - Lubricant Use	11,095			0,000	0,000	0,000	0,000	0,000
2.D.2 - Paraffin Wax Use	0,036			0,000	0,000	0,000	0,000	0,000

[184] MNRETS, GEF-UNEP. National Inventory Report on GHG Emissions and Removals in the Kyrgyz Republic for 1990-2018.. Bishkek. 2022.

[185] Ibid.

Categories	CO2	CH4	N2O	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-227ea
2.D.3 - Solvent Use				0,000	0,000	0,000	0,000	0,000
2.D.4 - Other (please specify)				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	**0,0000**	**0,0000**	**0,0000**	**0,0070**	**0,0176**	**0,0481**	**0,0125**	**0,0103**
2.F.1 - Refrigeration and Air Conditioning	0,0000	0,0000	0,0000	0,0027	0,0098	0,0435	0,0083	0,0000
2.F.1.a - Refrigeration and Stationary Air Conditioning				0,0027	0,0095	0,0249	0,0080	0,0000
2.F.1.b - Mobile Air Conditioning				0,0000	0,0003	0,0185	0,0003	0,0000
2.F.2 - Foam Blowing Agents					0,0000	0,0000		0,0103
2.F.3 - Fire Protection					0,0000	0,0000		0,0000
2.F.6 - Other Applications (please specify)				0,0043	0,0078	0,0046	0,0041	0,0000
2.G - Other Product Manufacture and Use	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**
2.G.3 - N2O from Product Uses	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2.G.4 - Other (Please specify)					0,000	0,000	0,000	0,000
2.H - Other	**0,000**	**0,000**	**0,000**	**0,000**				
2.H.1 - Pulp and Paper Industry								
2.H.2 - Food and Beverages Industry								

Emissions of the precursor gases from the IPPU sector in 2018 are presented in Table 2.17.

Table 2.17 Emissions of precursor gases from the IPPU sector in 2018. (Gg)

Categories	NOx	CO	NMVOCs	SO2
2 - Industrial Processes and Product Use	**0,009**	**0,049**	**3,219**	**0,006**
2.A - Mineral Industry	**0,000**	**0,000**	**0,000**	**0,000**
2.A.1 - Cement production	0,000	0,000	0,000	0,000
2.A.2 - Lime production	0,000	0,000	0,000	0,000
2.A.3 - Glass Production	0,000	0,000	0,000	0,000
2.A.4 - Other Process Uses of Carbonates	0,000	0,000	0,000	0,000
2.A.4.a - Ceramics	0,000	0,000	0,000	0,000
2.B - Chemical Industry	**0,000**	**0,000**	**0,000**	**0,000**
2.C - Metal Industry	**0,006**	**0,031**	**0,000**	**0,000**
2.C.1 - Iron and Steel Production	0,006	0,031	0,000	0,000
2.C.7 - Other (please specify)	0,000	0,000	0,000	0,000
2.D - Non-Energy Products from Fuels and Solvent Use	**0,000**	**0,000**	**0,002**	**0,000**
2.D.1 - Lubricant Use	0,000	0,000	0,000	0,000
2.D.2 - Paraffin Wax Use	0,000	0,000	0,000	0,000
2.D.3 - Solvent Use	0,000	0,000	0,000	0,000
2.D.4 - Other (please specify)	0,000	0,000	0,002	0,000
2.E - Electronics Industry	**0,000**	**0,000**	**0,000**	**0,000**
2.F - Product Uses as Substitutes for Ozone Depleting Substances	**0,000**	**0,000**	**0,000**	**0,000**
2.F.1 - Refrigeration and Air Conditioning	0,000	0,000	0,000	0,000
2.F.1.a - Refrigeration and Stationary Air Conditioning	0,000	0,000	0,000	0,000
2.F.1.b - Mobile Air Conditioning	0,000	0,000	0,000	0,000

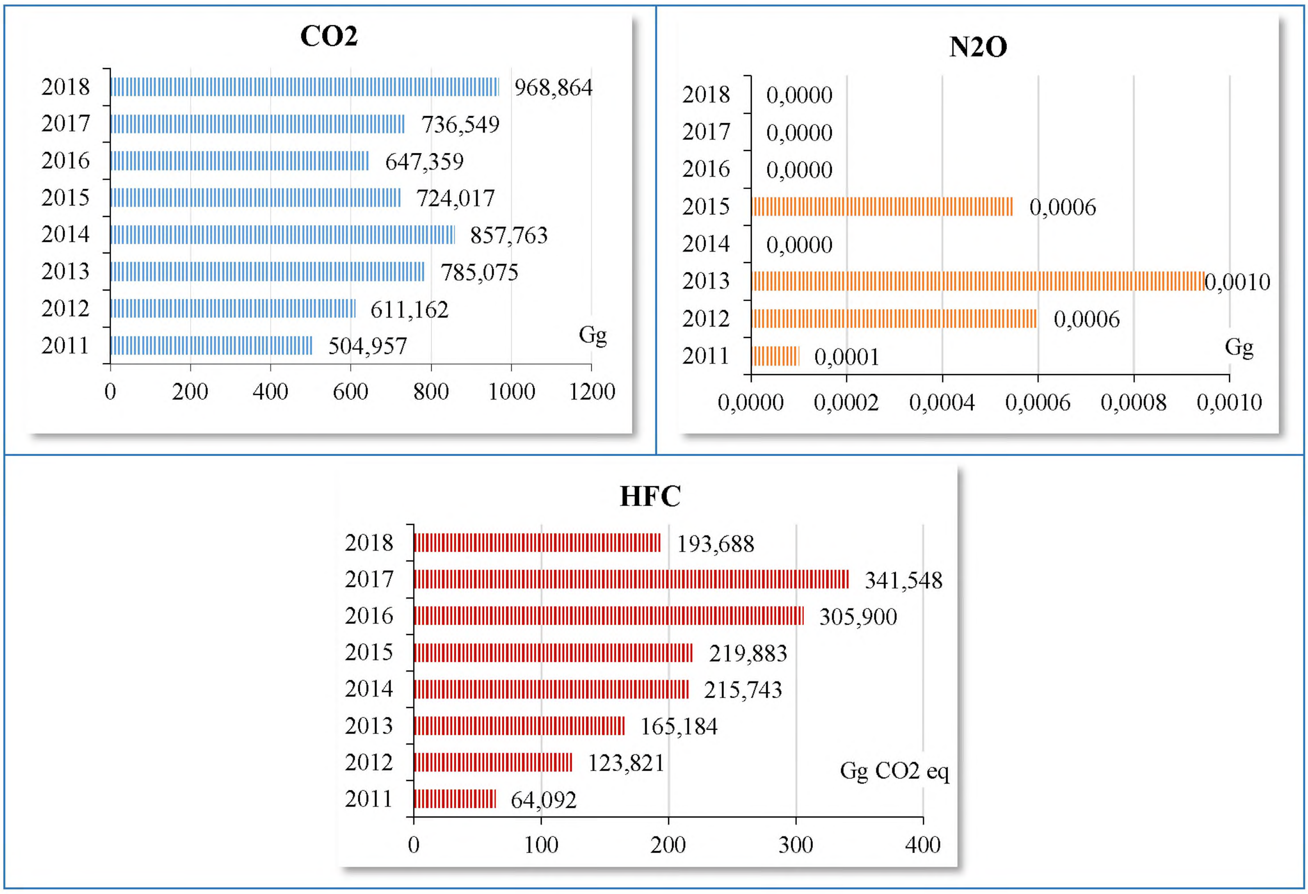
Categories	NOx	CO	NMVOCs	SO2
2.F.2 - Foam Blowing Agents	0,000	0,000	0,000	0,000
2.F.3 - Fire Protection	0,000	0,000	0,000	0,000
2.F.6 - Other Applications (please specify)	0,000	0,000	0,000	0,000
2.G - Other Product Manufacture and Use	0,000	0,000	0,000	0,000
2.G.3 - N2O from Product Uses	0,000	0,000	0,000	0,000
2.G.4 - Other (Please specify)	0,000	0,000	0,000	0,000
2.H - Other	**0,003**	**0,018**	**3,217**	**0,006**
2.H.1 - Pulp and Paper Industry	0,003	0,018	0,006	0,006
2.H.2 - Food and Beverages Industry	0,000	0,000	3,210	0,000

During the GHG inventory in the IPPU sector, emissions were estimated for the following gases:

- carbon dioxide (CO2),
- nitrous oxide (N2O) and
- five types of hydrofluorocarbons (HFCs)
    - HFC – 32
    - HFC – 125
    - HFC – 134a
    - HFC – 143a
    - HFC 227ea.

GHG emissions by types in the period 2011-2018 are shown in Figure 2.29.

Figure 2.29 IPPU sector GHG emissions by main gases in 2011 and 2018 [186]

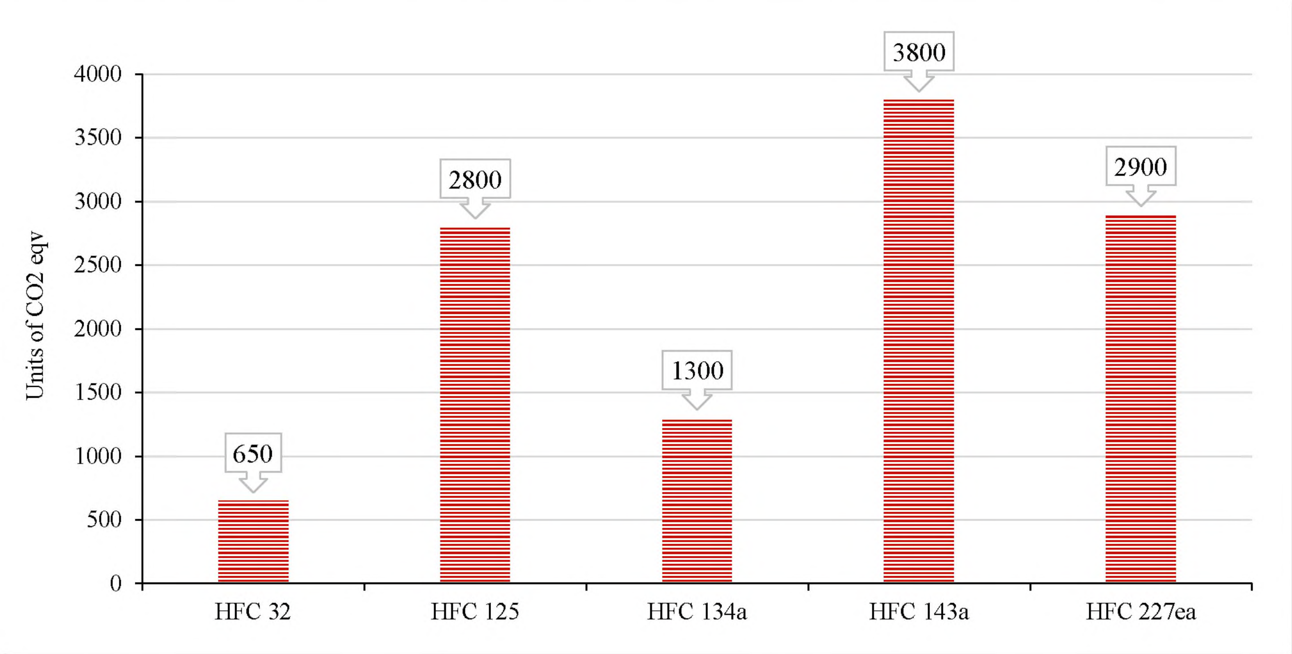


[186] MNRETS, GEF-UNEP. IPCC Inventory Software Database V2.54. Bishkek. 2022.

The use of HFCs has been developed and taken into account in cooling equipment only since the mid-90s when the sector had used primarily ozone-depleting substances whose emissions are accounted for under the Montreal Protocol on Ozone Depleting Substances, Today, various types of HFCs are widely used in refrigeration equipment, stationary and automotive air conditioning, as well as in construction as foaming agents.

Each gas has a different Global Warming Potential conversion factor to convert to CO2 equivalent, which is many times greater than carbon dioxide. (See Figure 2.30 below).

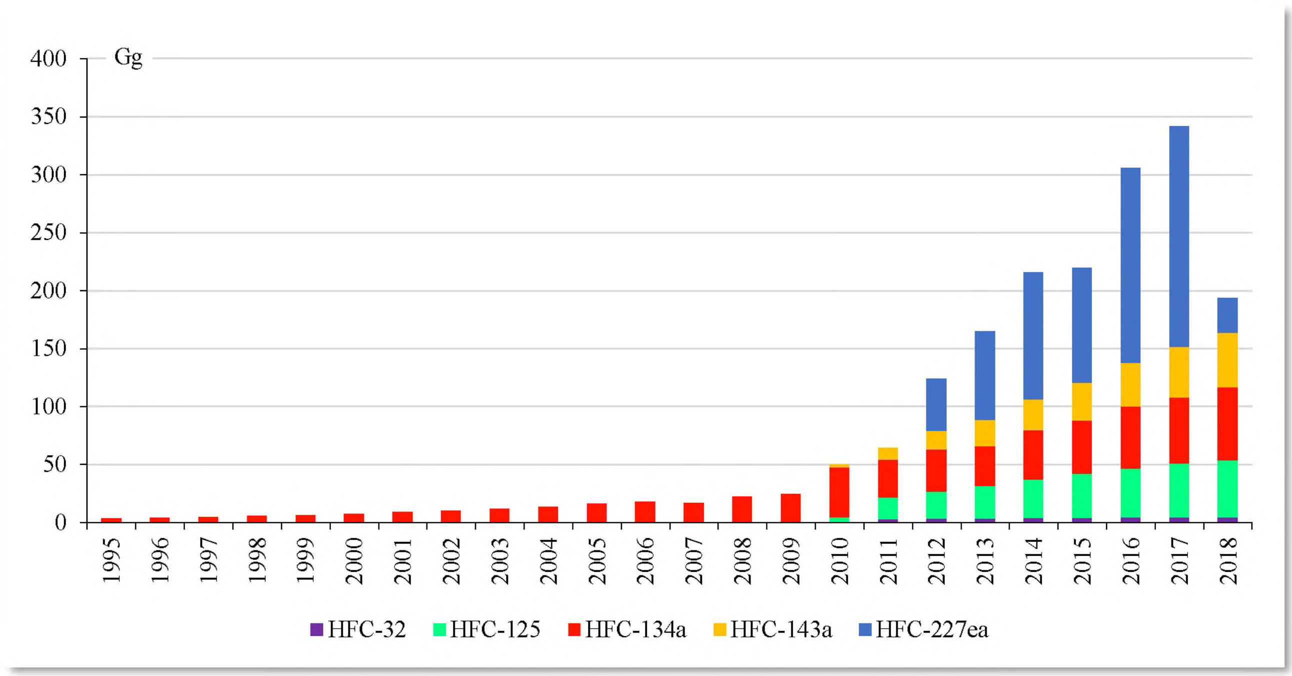
Figure 2.30 HFC gas conversion factors used to estimate their emissions from the IPPU sector[187]



Trend assessment of HFC emissions in the IPPU sector of Kyrgyzstan for the period 1995 - 2018 presented in Figure 2.31.

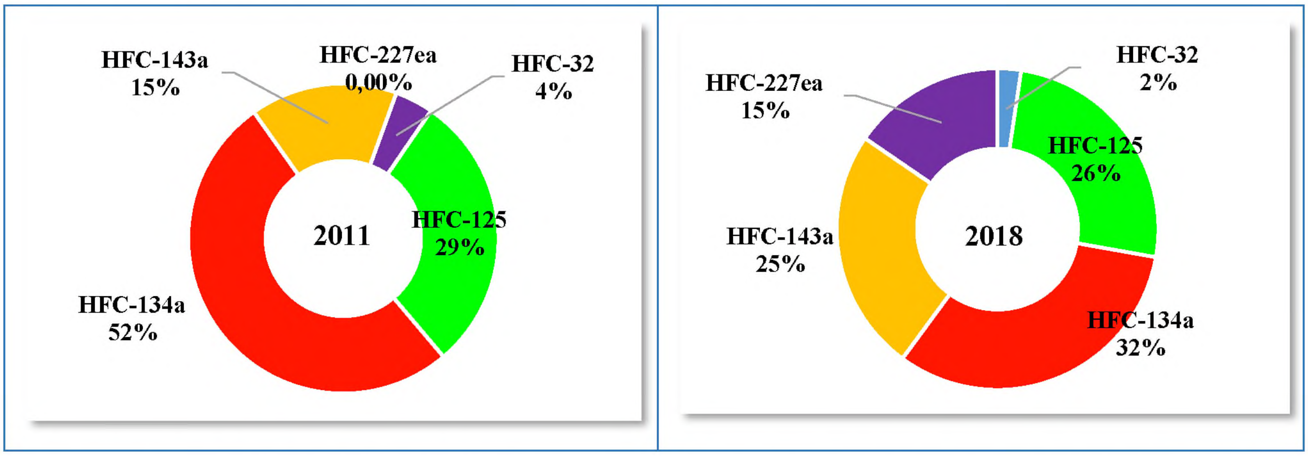
Figure 2.31 Dynamics of HFC emissions from the IPPU sector in the period 1995-2018.[188]

[187] MNRETS, GEF-UNEP. IPCC Inventory Software Database V2.54. Bishkek. 2022.
[188] Ibid



The comparison of HFC emissions in 2011 and 2018 shown in Figure 2.33 further.

Figure 2.32 HFC emissions in 2011 and 2018 by types of gases [189]

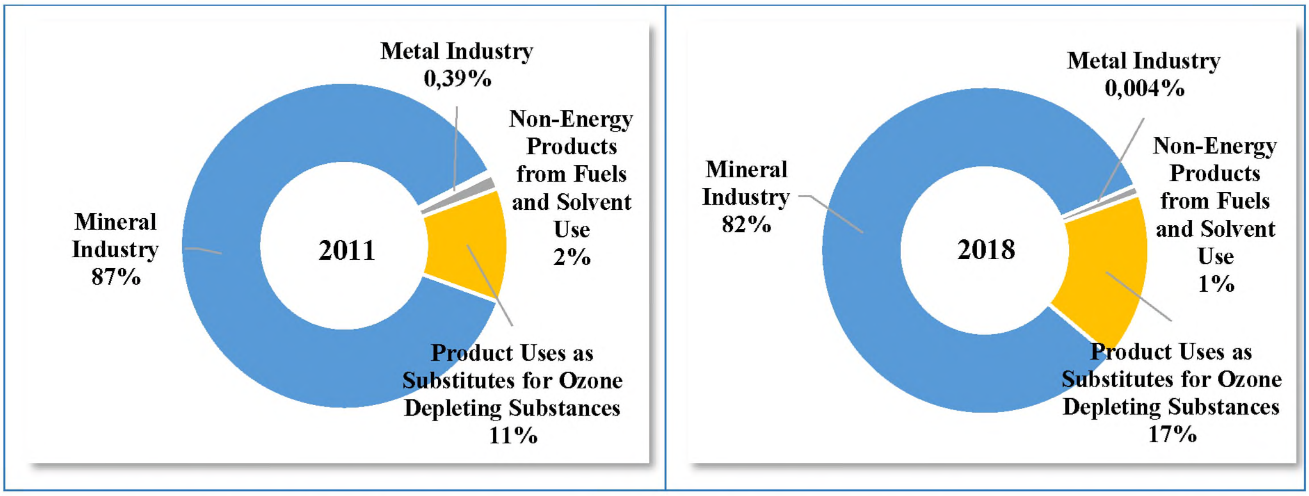


The comparison of emissions of all GHG in the sector in 2011 and 2018 for the main categories of sources is shown in Figure 2.33.

Figure 2.33 The structure of GHG emissions in 2011 and 2018 by sources[190]

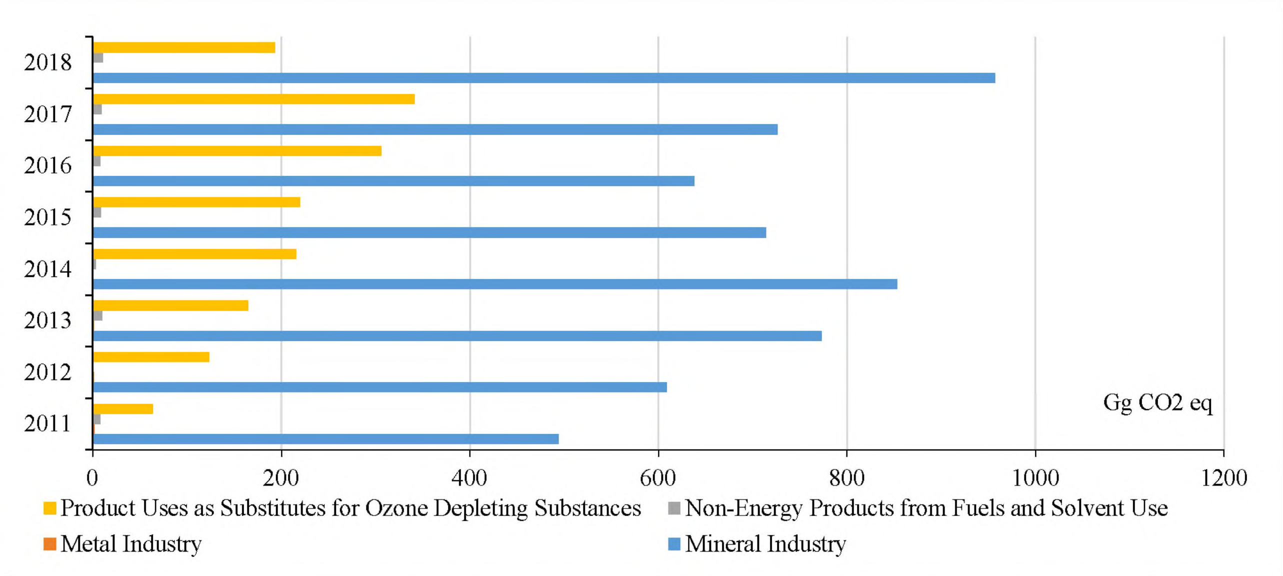
[189] Ibid

[190] Ibid.



The analysis of the results of the inventory of GHG emissions in the reporting period 2011-2018 shows that the main contribution to the total emissions of the sector is made by the category of Mineral Industry by production of cement, lime, glass, and brick. Figure 2.34. shows this overwhelming predominance.

Figure 2.34 CO2 emissions from the IPPU sector by emission source category [191]



The recalculation results of the different GHGs' types emissions in the IPPU sector using the new IPCC methodology and the available activity data for the entire period from 1990 to 2018 is presented in Table 2.18.

Table 2.18 IPPU sector's GHG emissions by gas type in the period 1990-2018 (Gg) [192]

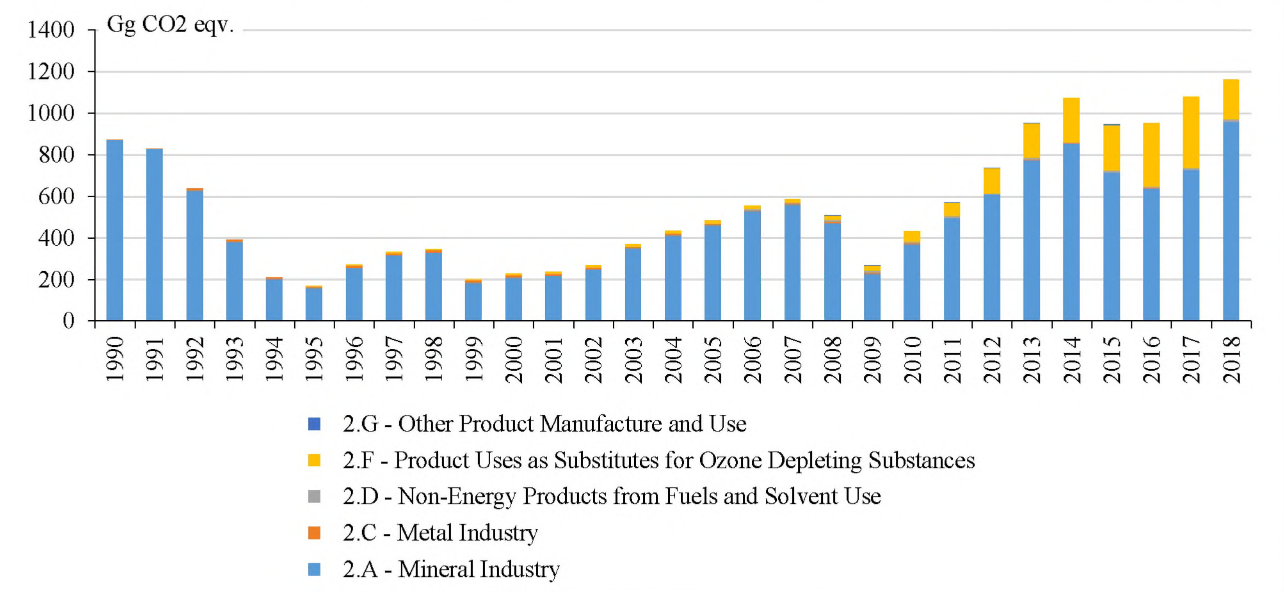
Year	CO2	CH4	N2O	HFC 32	HFC 125	HFC 134a	HFC 143a	HFC 227ea
1990	871,638	0,000	0,0000					
1991	829,765	0,000	0,0000					
1992	636,145	0,000	0,0000					
1993	393,427	0,000	0,0000					
1994	210,270	0,000	0,0000					
1995	165,512	0,000	0,0000			0,003		

[191] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.
[192] Ibid.

Year	CO2	CH4	N2O	HFC 32	HFC 125	HFC 134a	HFC 143a	HFC 227ea
1996	267,114	0,000	0,0000			0,003		
1997	327,253	0,000	0,0000			0,004		
1998	341,068	0,000	0,0000			0,004		
1999	195,626	0,000	0,0000			0,005		
2000	220,333	0,000	0,0000			0,006		
2001	228,079	0,000	0,0000			0,007		
2002	258,904	0,000	0,0000			0,008		
2003	358,022	0,000	0,0000			0,009		
2004	421,470	0,000	0,0000			0,011		
2005	467,171	0,000	0,0000			0,012		
2006	538,331	0,000	0,0000			0,014		
2007	568,775	0,000	0,0000			0,013		
2008	484,779	0,000	0,0003			0,017		
2009	241,296	0,000	0,0009			0,019		
2010	381,894	0,000	0,0000	0,001	0,001	0,033	0,001	0,000
2011	504,957	0,000	0,0001	0,004	0,007	0,025	0,003	0,000
2012	611,162	0,000	0,0006	0,005	0,008	0,028	0,004	0,015
2013	785,075	0,000	0,0010	0,005	0,010	0,027	0,006	0,027
2014	857,763	0,000	0,0000	0,006	0,012	0,033	0,007	0,038
2015	724,017	0,000	0,0006	0,006	0,013	0,035	0,009	0,034
2016	647,359	0,000	0,0000	0,007	0,015	0,041	0,010	0,058
2017	736,549	0,000	0,0000	0,007	0,017	0,044	0,011	0,066
2018	968,864	0,000	0,0000	0,007	0,018	0,048	0,012	0,010

The assessment of the GHG emissions dynamics in CO_2 equivalent in the IPPU sector for the main categories of sources in 1990-2018 is shown in Figure 2.35.

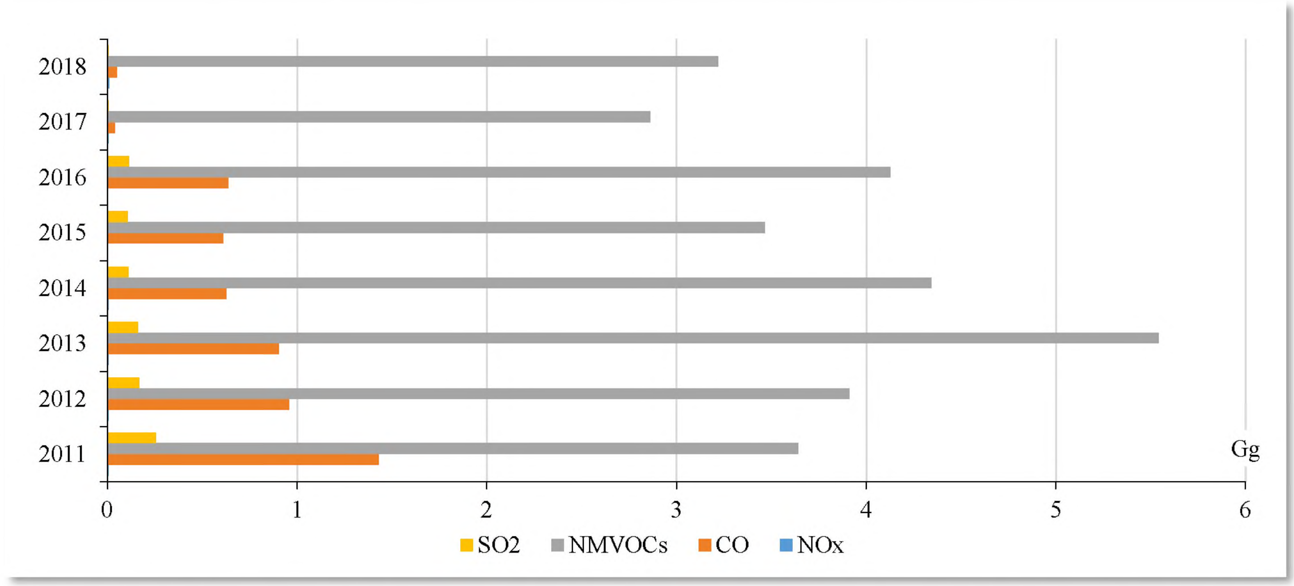
Figure 2.35 The dynamic of GHG emissions of the sector by source in the period of 1990-2018. [193]



The results of precursor gases emissions inventory in the IPPU sector in the reporting period 2011-2018 showed a decrease in total emissions in 2018 compared to 2011. (See Figure 2.36.)

[193] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022..

Figure 2.36 Trends of precursor gas emissions between 2011 and 2018. (Gg) [194]

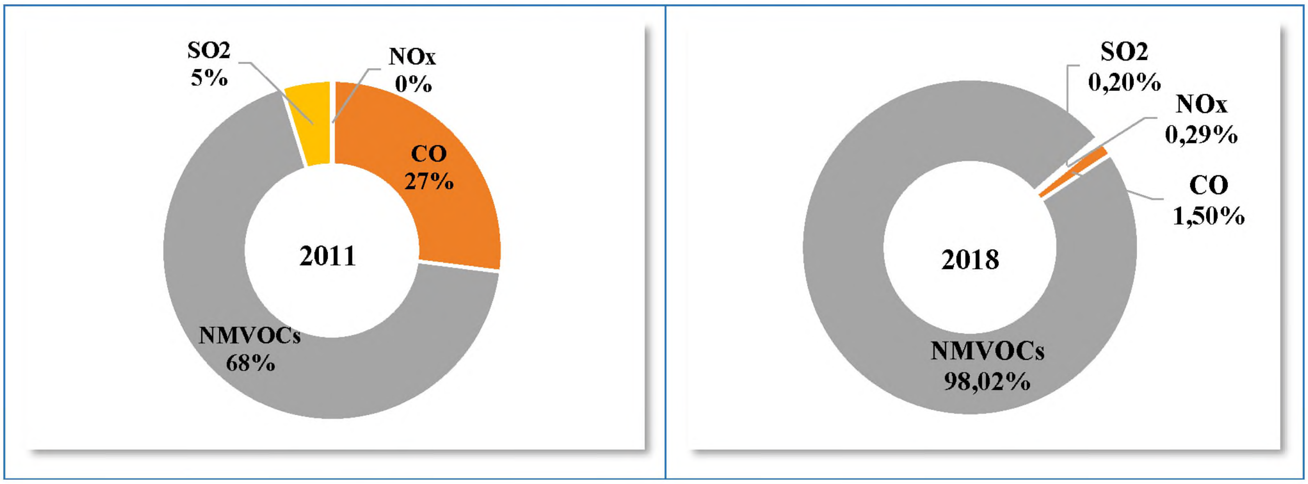


Thus, emissions of carbon monoxide (CO) increased by 13,52%, emissions of nitrogen oxides (NOx) decreased by 96,57%, emissions of non-methane volatile organic compounds (NMVOC) decreased by 11,60%, and emissions of sulfur dioxide decreased by 97,46%. Such assessment values are associated primarily with data on the corresponding activity on the production of precursor gases by sources of emissions.

The sources of NOx emissions are category 2.C.1 "Iron and steel production (casting)" and category 2.H.1 "Pulp and paper industry". The sources of CO emissions are categories 2.C.1 "Iron and steel production (casting)", 2.C.7 "Other (mercury and antimony)" and 2.H.1. "Pulp and paper industry". The sources of NMVOC emissions are category 2.D.3 "Use of solvents", 2.H.1. "Pulp and paper industry", 2.H.2 "Food and Beverages Industry" and 2.D.4 "Other (production of asphalt)". And the sources of SO_2 emissions are categories 2.C.7 "Other (mercury and antimony production)" and 2.H.1 "Pulp and paper industry" and 2.H.2 "Food and Beverages Industry"

A comparison of the structure of emissions of precursor gases in 2011 and 2018 is shown in Figure 2.37.

Figure 2.37 The composition of precursor gas emissions in 2011 and 2018. [195]



194 Ibid.

195 MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.

As can be seen from figure 2.37, the share of NMVOC emissions in total precursor gas emissions increased due to the reduction of CO, NOx and SO_2 emissions.

2.5.3.2.4. Recalculation and Improvement of Emissions Estimates in the IPPU Sector

The application of the new methodology during NGHGI 4 necessitated the recalculation of the results of the previous IPPU sector inventory for the entire time series of sector activity data. The results of recalculation of the sector's GHG emissions estimate in CO_2 equivalent are presented in Table 2.19.

Table 2.19. Estimated GHG emissions in the IPPU sector for the period 1990-2018 (Gg) [196]

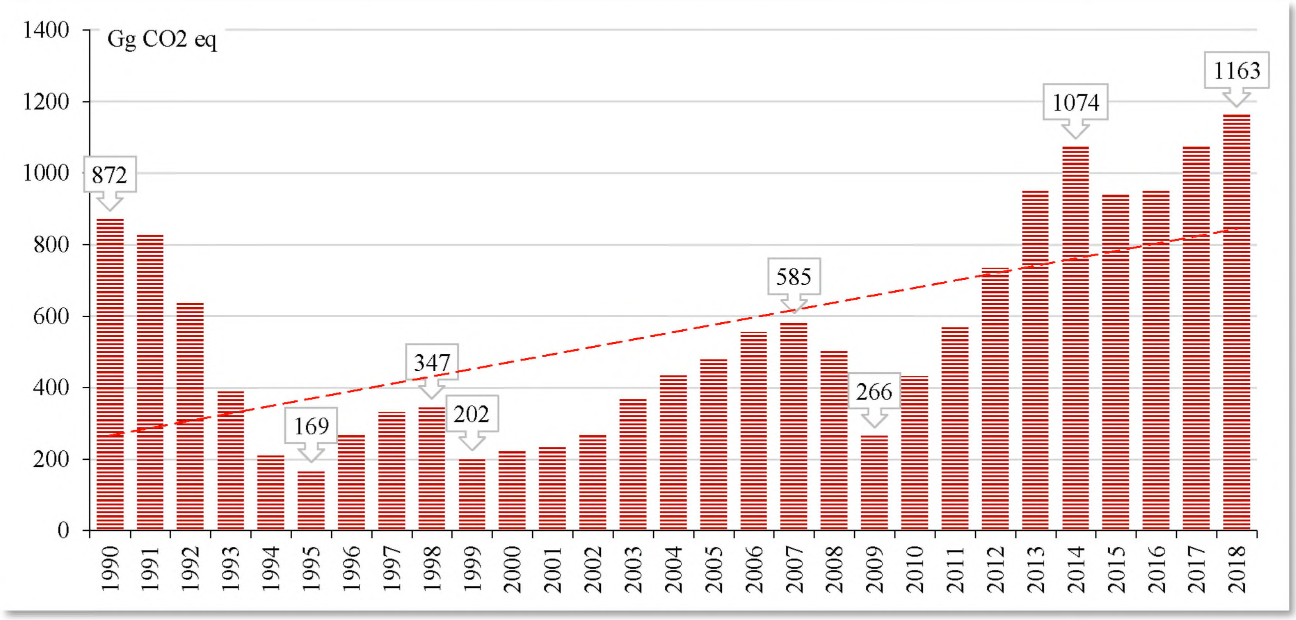
Categories	1990	1991	1992	1993	1994	1995	1996	1997
2 - Industrial Processes and Product Use	**871,638**	**829,765**	**636,145**	**393,427**	**210,270**	**169,149**	**271,207**	**331,971**
2.A - Mineral Industry	871,042	829,169	628,067	382,112	202,902	158,523	255,789	315,406
2.C - Metal Industry	0,596	0,595	8,078	11,315	7,368	6,990	11,324	11,847
2.D - Non-Energy Products from Fuels and Solvent Use	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	0,000	0,000	0,000	0,000	0,000	3,637	4,094	4,718
2.G - Other Product Manufacture and Use	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Categories	1998	1999	2000	2001	2002	2003	2004	2005
2 - Industrial Processes and Product Use	**346,578**	**202,095**	**227,930**	**236,972**	**269,261**	**370,012**	**435,130**	**482,930**
2.A - Mineral Industry	328,565	183,121	209,612	216,620	248,186	350,848	412,001	461,269
2.C - Metal Industry	12,503	12,505	10,720	11,459	10,718	7,174	9,469	5,902
2.D - Non-Energy Products from Fuels and Solvent Use	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	5,510	6,469	7,597	8,893	10,357	11,990	13,661	15,759
2.G - Other Product Manufacture and Use	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Categories	2006	2007	2008	2009	2010	2011	2012	2013
2 - Industrial Processes and Product Use	**556,227**	**585,435**	**506,918**	**265,902**	**431,877**	**569,049**	**734,984**	**950,261**
2.A - Mineral Industry	529,281	560,478	471,827	226,682	368,722	494,315	609,270	773,342
2.C - Metal Industry	3,301	6,463	5,636	6,282	6,483	2,230	1,485	1,398
2.D - Non-Energy Products from Fuels and Solvent Use	5,749	1,834	7,316	8,332	6,688	8,412	0,407	10,336
2.F - Product Uses as Substitutes for Ozone Depleting Substances	17,896	16,660	22,139	24,606	49,983	64,092	123,821	165,184
2.G - Other Product Manufacture and Use	0,000	0,000	0,093	0,279	0,000	0,031	0,186	0,295
Categories	2014	2015	2016	2017	2018			
2 - Industrial Processes and Product Use	1073,505	943,901	953,259	1078,098	1162,553			
2.A - Mineral Industry	853,588	714,074	638,107	726,843	957,684			
2.C - Metal Industry	0,962	0,888	0,982	0,035	0,049			

[196] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.

2.D - Non-Energy Products from Fuels and Solvent Use	3,213	9,055	8,270	9,672	11,131
2.F - Product Uses as Substitutes for Ozone Depleting Substances	215,743	219,883	305,900	341,548	193,688
2.G - Other Product Manufacture and Use	0	0,171	0	0	0,000

The results of the NGHGI in the IPPU sector show that the sector's GHG emissions, after a significant decrease in the early 1990s, have an upward trend and have already exceeded the values of the base year 1990 (see Figure 2.38).

Figure 2.38 Dynamics of GHG emissions of the IPPU sector in the period 1990-2018 [197]



The recalculations of precursor emissions of the IPPU sector for the period 1990-2018 are presented in table 2.20.

Table 2.20 Estimated emissions of precursor gases in the IPPU sector within the period 1990-2018 (Gg) [198]

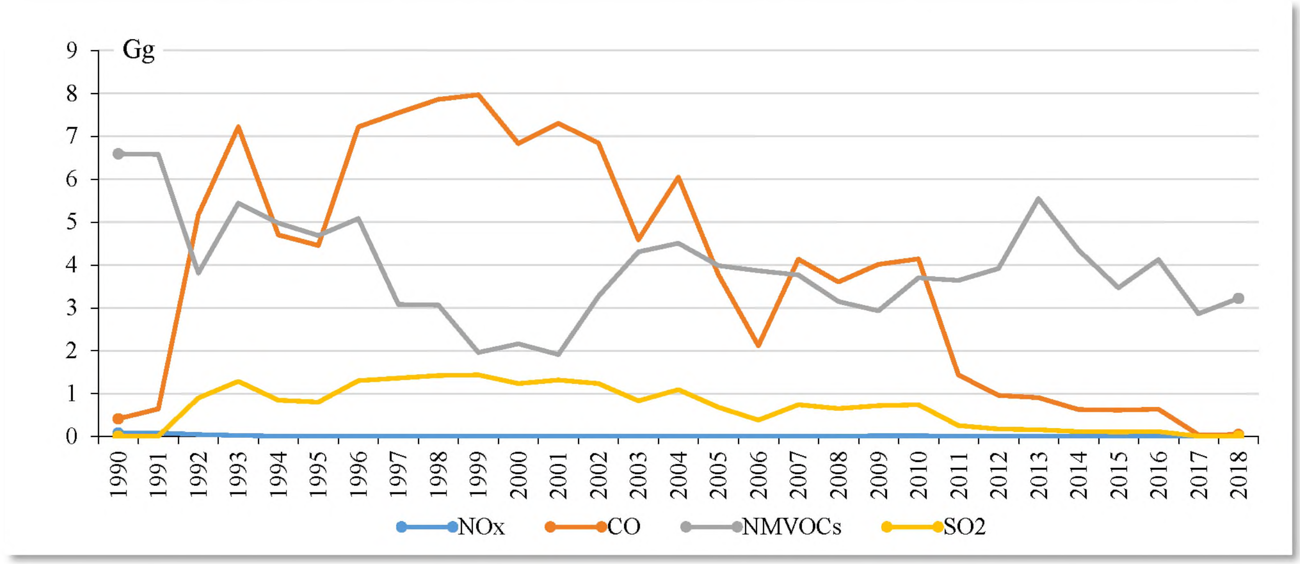
Gases	1990	1991	1992	1993	1994	1995	1996	1997
NOx	0,081	0,080	0,048	0,022	0,006	0,005	0,005	0,006
CO	0,409	0,641	5,167	7,217	4,697	4,454	7,216	7,548
NMVOCs	6,590	6,577	3,808	5,442	4,977	4,683	5,083	3,080
SO2	0,011	0,010	0,897	1,286	0,844	0,801	1,299	1,358
Gases	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
NOx	0,002	0,002	0,002	0,004	0,006	0,006	0,007	0,006
CO	7,862	7,965	6,828	7,298	6,841	4,585	6,045	3,771
NMVOCs	3,064	1,960	2,159	1,910	3,265	4,303	4,504	3,985
SO2	1,417	1,435	1,230	1,313	1,234	0,827	1,090	0,678
Gases	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
NOx	0,007	0,010	0,006	0,014	0,015	0,008	0,007	0,006
CO	2,119	4,131	3,600	4,011	4,142	1,433	0,958	0,903

[197] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.
[198] Ibid.

NMVOCs	3,862	3,769	3,145	2,932	3,701	3,641	3,914	5,543
SO2	0,381	0,742	0,648	0,715	0,738	0,255	0,170	0,162
Gases	**2014**	**2015**	**2016**	**2017**	**2018**			
NOx	0,007	0,004	0,005	0,007	0,009			
CO	0,628	0,611	0,639	0,039	0,049			
NMVOCs	4,346	3,466	4,128	2,862	3,219			
SO2	0,112	0,107	0,116	0,006	0,006			

The results of the 4th NGHGI show that the trends of precursor gases' emissions of the IPPU sector are characterized by great variability and dynamics in the period 1990-2018. (See Figure 2.39).

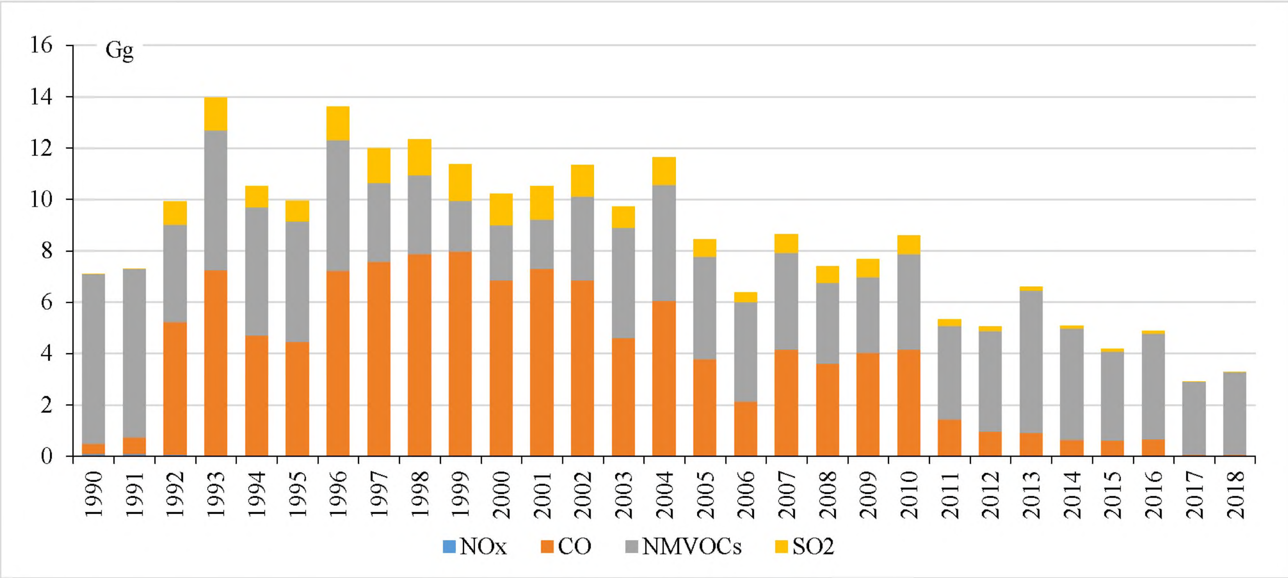
Figure 2.39 The dynamics of the precursor gases from the IPPU sector between 1990 and 2018. [199]



The NMVOCs emissions have dominated in recent years in terms of the greatest contribution to the total gas emissions of precursors gases from the IPPU sector, although they have been in the period 1992-2010. Carbon monoxide (CO) accounted for the largest share of emissions of precursor gases. (See Figure 2.40.)

Figure 2.40 Emissions of major precursor gases from the IPPU sector between 1990 and 2018. [200]

[199] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.
[200] Ibid.



2.5.3.2.5. Uncertainty assessment of the results of NGHGI 4

Uncertainty assessment of the results of the NGHGI in the IPPU sector was also carried out following the provisions of the IPCC methodology and using the relevant working forms. According to the results obtained, the level of uncertainty in the total inventory of the IPPU sector was 6.85%, and the uncertainty by trend was 8.36%.

Uncertainty for the overall GHG inventory obtained as a result of the 4th NGHGI, including the IPPU sector, is presented in Annex 3.

2.5.3.3. Agriculture, Forestry and Other Land Use

The Agriculture, Forestry and Other Land Use (AFOLU) sector is the only sector that not only emits greenhouse gas emissions but also absorbs them. It has a number of features in relation to the development of inventory techniques. It contains many processes leading to emissions and removals of greenhouse gases, which can be widely distributed in space and highly variable over time. The factors controlling emissions and removals can be both natural and anthropogenic (direct or indirect), and it can be challenging to distinguish clearly between causal factors.

For the AFOLU sector, anthropogenic greenhouse gas emissions and removals are defined as all emissions and removals occurring on “managed land”. Managed land is a land where human intervention and activities take place to perform productive, environmental, and social functions. All definitions and classifications of land should be established at the national level, described clearly, and applied consistently over time. For unmanaged land, information on emissions/removals may not be provided. However, it is good practice for countries to quantify and track the area of unmanaged land over time to ensure consistency in accounting for the area under land-use change.[201]

Greenhouse gas fluxes in the AFOLU sector can be estimated in two ways: 1) as net changes in carbon stocks over time (used for most CO_2 fluxes), and 2) directly as the intensity of gas fluxes to and from the atmosphere (used to estimate non-CO_2 emissions, gases and, some CO_2 emissions and removals).

[201] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 1, p. 1.5.

The use of carbon stock changes to estimate CO_2 emissions and removals is based on the fact that changes in carbon stocks in ecosystems occur predominantly (but not exclusively) through the exchange of CO_2 between the earth's surface and the atmosphere (i.e. other carbon transfer processes, such as leaching, considered insignificant). Accordingly, increases in total carbon stocks over time equated to net CO_2 removals from the atmosphere, while decreases in total carbon stocks (minus transfers to other reservoirs such as harvested wood products) equate to net CO_2 emissions

Emissions of non-CO_2 gases are mainly products of microbiological processes (occurring in soil, the digestive tract of animals, and manure) and the burning of organic materials. The processes of emissions and removals in the AFOLU sector for stocks and processes of large ecosystems are described below, sorted by ecosystem component, i.e. 1) biomass, 2) dead organic matter, 3) soils and 4) domestic animals.[202]

The IPCC guidelines and methods for estimating greenhouse gas emissions and removals for the AFOLU sector cover the following:

- CO_2 emissions and removals from carbon stock changes in biomass, dead organic matter and mineral soils for all managed lands,
- emissions of CO_2 and non-CO_2 gases from fires on all managed lands,
- emissions of N_2O from all cultivated soils,
- emissions of CO_2 associated with the application of lime and urea to cultivated soils,
- emissions of CH_4 from rice cultivation,
- emissions of CO_2 and N_2O from cultivated organic soils,
- emissions of CO_2 and N_2O from managed wetlands (with a basis for methodological development for CH_4 emissions from flooded lands),
- emissions of CH_4 from domestic animals (enteric fermentation),
- emissions of CH_4 and N_2O from systems for cleaning, storing and using manure, and
- Carbon stock changes associated with harvested wood products. [203]

The main areas of interest for greenhouse gas inventories in this sector are CO_2, N_2O, and CH_4. CO_2 fluxes between the atmosphere and ecosystems are mainly regulated through absorption through photosynthesis of plants and release during respiration, decomposition, and combustion of organic matter. N_2O is mainly emitted from ecosystems as a by-product during nitrification and denitrification, while CH_4 is released during methanogenesis under anaerobic conditions in soils and manure storage facilities, during enteric fermentation and incomplete combustion of organic matter. Other gases of interest (from combustion and soil) include NO_X, NH_3, NMVOC and CO, as they are precursors for the formation of greenhouse gases in the atmosphere. The formation of greenhouse gases from precursor gases is considered an indirect emission. Indirect emissions are also associated with the leaching and sink of nitrogen compounds, in particular with the loss of NO_3 from soils; some of these compounds may subsequently be converted to N_2O via denitrification.[204]

As noted in the section on institutional organization of the 4th NGHGI, the emissions assessment of the AFOLU sector was split into two parts and carried out by two technical expert groups. One part included GHG emissions from the Agriculture subsector, and the second part included the Forestry and other land use subsector.

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[202] Ibid. p.1.7

[203] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 1, p. 1.5.

[204] Ibid. p.1.7.

2.5.3.3.1. Estimation of emissions from the Agriculture subsector

Livestock is one of the leading sectors of agriculture in Kyrgyzstan. In terms of estimating GHG emissions to the atmosphere, livestock is a source of methane (CH_4) emissions from enteric fermentation, as well as CH_4 and nitrous oxide (N_2O) emissions from livestock manure management systems.

In Kyrgyzstan, cattle are an important source of CH_4 due to their large and growing numbers. Methane emissions from manure management systems are less significant than enteral emissions; the most significant emissions are associated with animal housing, where manure is treated in liquid systems. Nitrous oxide emissions from manure management vary significantly across different types of management systems and can also lead to indirect emissions associated with other forms of nitrogen losses from the system. Calculating nitrogen losses from manure cleaning, storage and use systems is also an important step in determining the amount of nitrogen that will ultimately be contained in manure applied to cultivated soils or used as feed, fuel or construction. Methods for estimating CH_4 and N_2O emissions from livestock require the definition of livestock subcategories, annual livestock, and for higher tier methods, feed consumption and more detailed livestock characteristics. [205]

The development of crop production and the expansion of arable land requires the increase of use of various fertilizers that provide the soil with the main macronutrients, including nitrogen. Nitrous oxide (N_2O) is a greenhouse gas with a significantly higher Global Warming Potential than CO_2. It is produced naturally in soils through the processes of nitrification and denitrification. Nitrous oxide is a gaseous intermediate in the sequence of denitrification reactions and a by-product of nitrification that is released by microbial cells into the soil and ultimately enters the atmosphere. One of the main regulating factors in this reaction is the presence of inorganic nitrogen in the soil.

The IPCC NGHGI methodology estimates N_2O emissions using data from anthropogenic resulting nitrogen additions to soils (for example, artificial or organic fertilizers, animal manure, plant residues, sewage sludge) or nitrogen mineralization in soil organic matter by drying/treating organic soils, or cultivation/land-use change on mineral soils (for example, forest/pasture/settlements converted to cropland).

Emissions of N_2O as a result of anthropogenic nitrogen inputs or nitrogen mineralization occur both directly (i.e. directly from soils, where nitrogen is added/transferred) and through two indirect pathways: i) following the volatilization of NH_3 and NOx from cultivated soils, and from the combustion of fossil fuels and biomass; and (ii) after nitrogen leaching and runoff, mainly in the form of NO_3, from treated soils. Direct N_2O emissions from treated soils are estimated separately from indirect emissions, despite using a common activity dataset. [206] The Tier 1 methodology used in the 4th NGHGI of Kyrgyzstan does not take into account different land covers, soil types, climatic conditions and management practices (in addition to the above) due to the lack of long time series of such data.

There has been an increase in the area of rice cultivation in the country's agriculture in recent years. Nevertheless, the anaerobic decomposition of organic material in flooded rice paddy fields results in the release of methane (CH_4), which enters the atmosphere mainly by transport through rice plants. The annual amount of CH_4 emissions from a given rice field area depends on the number of crops and length of crop cultivation, water regimes before and during the cultivation period, and the use of organic and inorganic fertilizers. Soil type, temperature, and rice variety also affect CH_4 emissions.[207]

Thus, according to the 2006 IPCC Guidelines, the list of greenhouse gas emissions for the Agriculture subsector where inventory includes the following gases and emission source categories.

- Methane (CH_4) emissions from enteric (internal) fermentation of livestock,

[205] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 10, p. 10.7.
[206] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 11, p.11.6
[207] Ibid., vol. 4, ch. 5, p. 5.54

- Methane (CH_4) emissions from manure management,
- Methane (CH_4) emissions from rice cultivation,
- Nitrous oxide (N_2O) emissions from manure management - direct and indirect.
- Emissions of nitrous oxide (N_2O), associated gases of ammonia and nitrogen oxides (NOx and NH_3) from the treated soils:
    - direct N_2O emissions from arable land,
    - indirect emissions of N_2O and associated gases NOx and NH_3 from the use of nitrogen in agriculture.[208]

The structure of reporting on the GHG inventory of the Agriculture subsector includes the following categories:

- 3.A Livestock
    - 3.A.1 Enteric Fermentation
        - 3.A.1.a Cattle
            - 3A1ai Dairy Cow
            - 3A1aii. Other Cattle
        - 3.A.1.b Buffalo
        - 3.A.1.c Sheep
        - 3.A.1.d Goats
        - 3.A.1.e Camels
        - 3.A.1.f Horses
        - 3.A.1.g Mules and Asses
        - 3.A.1.h Swine
        - 3.A.1.j Other
    - 3.A.2 Manure Management
        - 3.A.2.a Cattle
            - 3A1ai Dairy Cows
            - 3A1aii. Other Cattle
        - 3.A.2.b Buffalo
        - 3.A.2.c Sheep
        - 3.A.2.d Goats
        - 3.A.2.e Camels
        - 3.A.2.f Horses
        - 3.A.2.g Mules and Asses
        - 3.A.2.h Swine
        - 3.A2.i Poultry
        - 3.A.2.j Other
- 3.C Aggregate Sources and Non-CO_2 Emissions Sources on Land
    - 3.C.1 Emissions from Biomass Burning
        - 3.C.1.b Biomass Burning in Croplands
        - 3.C.1.c Biomass Burning in Grasslands
        - 3.C.1.d Biomass Burning in All Other Land
    - 3.C.2 Liming
    - 3.C.3 Urea Application
    - 3.C.4 Direct N_2O Emissions from Managed Soils
    - 3.C.5 Indirect N_2O Emissions from Managed Soils
    - 3.C.6 Indirect N_2O Emissions from Manure Management

[208] Ibid., vol. 4, ch. 1, 5, 10, 11.

- 3.C.7 Rice Cultivations
- 3.C.8 Other [209]

2.5.3.3.1.1. Assessment methodology, tier and emission factors

Methane emissions from enteric fermentation

Methane is produced by the fermentation of fodder in the digestive system of animals. In the general case, the higher the feed consumption, the higher the methane emissions. However, the amount of methane produced can also depend on the composition of the diet. Feed intake is directly proportional to animal size, growth rate and productivity (for example, milk yield, hair growth, pregnancy). To represent the variability in emission rates among different animal species, the livestock population should be divided into subgroups and the emission rate per animal for each subgroup should be estimated. The amount of methane emitted by a subgroup is calculated by multiplying the emission rate for one animal by the number of animals in the subgroup.[210]

National Statistical Committee's statistics and a livestock accounting system determined the choice of methodology for estimating emissions from domestic fermentation of animals at IPCC Tier 1 and default IPCC emission factors. Therefore, the basic characteristic of livestock with an average annual population was adopted for the following types: dairy cattle, non-dairy cattle, yaks, sheep and goats, swine, horses, camels, mules, and poultry.

Emission factors (EFs) for all animal species except cattle are taken from Table 10.10 of the IPCC Guidelines with a default value. For cattle, the coefficients for the Asian region were taken as the closest to our livestock conditions and characteristics (live weight, average milk supply), table 10.11. IPCC guidelines.

One of the approaches for developing nationally approximated emission factors is to use a Tier 1 emission factor for animals with a similar digestive system and proportionally recalculate the emission factor using the animal weight ratio raised to the power of 0.75. For example, an approximate emission factor for yaks was calculated, which is not specified in the IPCC Guidelines:

$$NE = (\text{yak mass}) / (\text{non-dairy cattle mass})^{0,75} * (\text{NE for cattle non-dairy IPCC}) = (210 / 233)^{0,75} \times 47 = 43.$$

The rest NEs used for the NGHGI were taken from the 2006 IPCC Guidelines.
According to the IPCC Guidelines for total emissions estimation, the established emission factors are multiplied by the corresponding values of the animal population (see the equation below), and then all the results are summed together.

$$CH_4 \text{ Emissions} = EF_{(T)} * N_{(T)} / 10^6$$

Where:
$CH_{4\ Manure}$ = CH_4 emissions from manure management, for a defined population, Gg CH_4 yr^{-1}
$EF_{(T)}$ = emission factor for the defined livestock population, kg CH4 $head^{-1}$ yr^{-1}
$N_{(T)}$ = the number of head of livestock species/category *T* in the country
T = species/category of livestock[211]

Methane emissions from storage, handling and use of manure

[209] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 1, p. 1.5.
[210] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 10, p. 10.22
[211] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch .10, p. 10.31

To estimate these emissions, a Tier 1 method was used, where livestock population requires data by animal species/categories, climatic regions or temperature conditions in combination with IPCC default emission factors to estimate emissions.

- In terms of regional characteristics, Kyrgyzstan is classified as a cold-chain region of the Middle East.
- According to manure storage systems, more than two thirds of manure is left on grasslands and pastures (60%), and about one third of manure is processed in dry form (40%).

Therefore, emission factors for all animals except cattle are also taken from table 10.15 for the cold region of developing countries, and for cattle and swine are taken from table 10.14. 2006 IPCC Guidelines.

Data from the Climate Profile of the Kyrgyz Republic[212] and the Bulletin on the Current State and Climate Change in the Kyrgyz Republic[213]were used during determining the average annual temperature. Therefore, the temperature regime was adopted for use in a cold climate within ≤10°C, according to the conditions of manure management of the Middle East.[214]

Nitrous oxide (N_2O) emissions from manure management, storage and use

As noted above, the emissions category is divided into direct and indirect. For direct emissions, the Tier 1 method involves multiplying the total nitrogen emitted (by all species/categories of animals) in each type of manure collection, storage, and use system by the emission factor for that type of manure management system. The emissions are then added together for all the systems mentioned. The Tier 1 method is applied using default N2O emission factors provided by the IPCC, default nitrogen release (excretion) data, and default data for a manure collection, storage and use system. The rates of nitrogen excretion are taken for the Asian region as the closest in terms of the animal mass.

Two manure storage systems, broken down by proportion, were adopted at a round table with the participation of the relevant authorities: pasture/grazing/enclosure (60%) and dry storage (40%). The accepted manure management systems were divided into proportions - for cattle, sheep and goats, horses, mules, camels:

a) In solid form, in enclosures and at farms (40%);
b) Pastures and fenced pastures (60%)

For swine and poultry - in solid form, enclosures and farms (100%).

Indirect emissions were also calculated using the Tier 1 methodology, where calculation of nitrogen volatility in the form of NH_3 and NOx from manure management, storage and use systems is based on multiplying the amount of nitrogen released (by all species/categories of animals) and treated in each of the manure management systems to the proportion of volatilized nitrogen. Then the nitrogen losses are summed up for all the systems mentioned.

The Tier 1 method is applied using IPCC default data for nitrogen, manure handling, storage and use system and default nitrogen losses from manure handling, storage and use systems due to volatilization.[215]

Methane emissions (CH_4) from rice cultivation

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[212] Ilyasov Sh., Zabenko O., Gaidamak N., Kirilenko A., Myrsaliev N., Shevchenko V., Penkina L. Climatic profile of the Kyrgyz Republic. - B., 2013, p. 99.
[213] Agency for Hydrometeorology "Kyrgyzhydromet" under the Ministry of Emergency Situations of the Kyrgyz Republic. Bulletin. Current State and Climate Change in the Kyrgyz Republic. –B., 2015
[214] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 10, p. 10.40
[215] Ibid., vol. 4, ch. 10, p. 10.59

CH_4 emissions are estimated by multiplying the daily emission factors by the rice-growing period and the annual harvest area. In its simplest form, this equation is applied using national activity data (i.e., national average rice growing period and area harvested) and a single emission factor. However, environmental conditions and agricultural management of rice production can vary greatly within a country. A good practice is to account for this variability by dividing the total harvest area into subunits (for example, harvested areas with different water regimes). The harvest area for each subunit is multiplied by the relevant growing period and emission factor that represents the subunit conditions. With this disaggregated approach, the total annual emissions are equal to the sum of emissions from each subunit of the harvest area.

The Tier 1 method is used by countries where CH_4 emissions from rice cultivation are not a key category and country-specific emission factors are unavailable. It is recommended to include the maximum possible number of conditions (i, j, k, etc.) that affect CH_4 emissions in the calculations. Emissions for each subunit are adjusted by multiplying the default baseline emission factor (for non-flooded fields less than 180 days prior to rice cultivation and continuously flooded fields without organic fertilizer, EFs) by various scaling factors.[216]

Emissions of nitrous oxide from agricultural soils

Direct N_2O emissions from agricultural soils are estimated separately from indirect emissions, despite using a common activity dataset. The Tier 1 methodology does not take into account different land covers, soil types, climatic conditions, and management practices (other than the above). The methodology also does not account for any delay in direct nitrogen emissions from plant residues and attributes those emissions to the year when the residues were returned to the soil. Such factors are not considered for direct (or indirect, depending on the case) emissions due to the limited availability of data to derive appropriate emission factors.

The methodology for estimating direct N_2O emissions from managed soils includes the following nitrogen sources:

1. Synthetic nitrogen fertilizers (F_{SN});
2. Organic nitrogen applied as fertilizer (e.g. manure, compost, sewage sludge, rendering waste) (F_{ON});
3. Nitrogen from urine and dung from grazing animals (F_{PRP});
4. Nitrogen in crop residues (above-ground and below-ground), including from N-fixing crops 2 and from forages during pasture renewal (F_{CR});
5. Nitrogen mineralization associated with loss of soil organic matter resulting from the change of land use or management of mineral soils (F_{CR}).

Aside from direct N_2O emissions from managed soils, which occur directly (i.e. directly from soils that receive nitrogen), N_2O emissions also occur via two indirect pathways. The first of these is the volatilization of nitrogen in the form of NH_3 and nitrogen oxides NO_X and the deposition of these gases and their products NH_4 and NO_3 on the soils and lake surfaces and other water bodies. The second path is the leaching and runoff of nitrogen from the soil, which is part of artificial and organic fertilizers and plant residues, mineralization of nitrogen associated with loss of soil carbon in mineral and drained/cultivated organic soils as a result of land-use changes or management practices and the abandonment of urine and dung from grazing animals.[217]

The approach to the methodology used in the 4th NGHGI considered the following nitrogen sources for indirect N2O emissions from managed soils resulting from agricultural nitrogen inputs through:

1. Synthetic nitrogen fertilizers (**F_{SN}**);

[216] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 5, p. 5.52.
[217] Ibid., vol. 4, ch. 11, p. 11.5-11.8.

2. Organic nitrogen applied as fertilizer (for example, manure, compost, sewage sludge, rendering waste and other organic fertilizers) (**F_{ON}**);
3. Urine and dung nitrogen deposited on pasture, , range and paddock by grazing animals (**F_{PRP}**);
4. Nitrogen in crop residues (above-ground and below-ground), including from nitrogen-fixing crops and from forages during pasture renewal (**F_{CR}**).

2.5.3.3.1.2. Activity Data

Official information on livestock numbers is required to estimate methane emissions from enteric fermentation of livestock. The baseline characteristic at Tier 1 is sufficient for most animal species. The National Statistical Committee provided the livestock data.

Estimation of methane emissions from manure management depends on the amount of manure produced and the proportion of manure that undergoes anaerobic decomposition. The first of these factors depends on the rate of manure production per animal and the number of animals, and the second depends on how the manure is collected, stored, and used. Estimates using the simplified Tier 1 method require livestock population data by animal species/category, climatic region, or temperature conditions, combined with IPCC default emission factors. Since some emissions from manure management systems are highly temperature-dependent, it is good practice to estimate the average annual temperature in areas where manure is collected, stored and used. Manure management systems, as well as their shares, were agreed upon by experts at a round table with representatives from all interested departments. The average annual temperature in the republic was determined from the Climate Profile and Bulletin on the Current State and Climate Change in the Kyrgyz Republic.

In order to estimate the methane emissions from rice cultivation, data were obtained from the National Statistical Committee on harvested areas, period, water regime, and agricultural practice of rice cultivation in the republic. All these parameters were agreed upon at a round table with representatives from all the relevant departments.

In assessing nitrous oxide emissions from manure management, direct and indirect data were used on the number of livestock and manure management and storage systems, as well as data on the live weight of livestock. All this information was provided by the National Statistical Committee.

Activity data from the following sources were used to estimate nitrogen oxide emissions and associated ammonia and nitrogen oxides (NO_X and NH_3) from managed soils (direct and indirect):

- The amounts of nitrogen and organic fertilizers used were provided by the Department of Chemicalization and Plant Protection of the Ministry of Agriculture and Food Industry (MAFI),
- the area of crops is represented by the State Registration Service and the MAFI;
- livestock of farm animals, gross production of major crops by the National Statistical Committee.

2.5.3.3.1.3. Estimated GHG emissions in Agriculture for the period 2011 - 2018

The total GHG emissions of the Agriculture subsector continued to grow during the reporting period 2011-2018. In 2018, the total GHG emissions of the sector amounted to 5196,342 Gg CO_2 equivalent, which is 20,79% more than in 2011.[218]

The estimated emissions of the Agriculture sector in 2018 by types of greenhouse gases and categories are presented in Table 2.21.

[218] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.

Table 2.21. GHG emissions of the Agriculture sector in 2018 (Gg) [219]

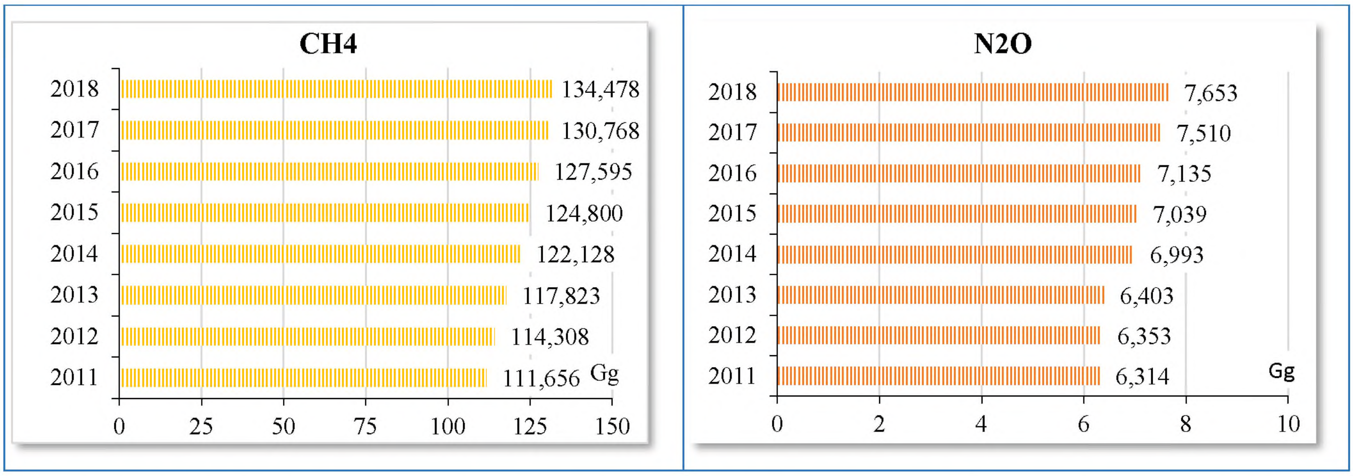
Categories	CO2	CH4	N2O	NOx	CO	NMVOCs
3 - Agriculture, Forestry, and Other Land Use	FOLU data	134,478	7,653	0,453	16,681	0,000
3.A - Livestock	0,000	131,560	0,527	0,000	0,000	0,000
3.A.1 - Enteric Fermentation	0,000	127,840	0,000	0,000	0,000	0,000
3.A.1.a - Cattle	0,000	87,672	0,000	0,000	0,000	0,000
3.A.1.a.i - Dairy Cows		49,568		0,000	0,000	0,000
3.A.1.a.ii - Other Cattle		38,104		0,000	0,000	0,000
3.A.1.c - Sheep and Goats		30,840		0,000	0,000	0,000
3.A.1.e - Camels		0,011		0,000	0,000	0,000
3.A.1.f - Horses		8,976		0,000	0,000	0,000
3.A.1.g - Mules and Asses		0,289		0,000	0,000	0,000
3.A.1.h - Swine		0,051		0,000	0,000	0,000
3.A.2 - Manure Management	0,000	3,720	0,527	0,000	0,000	0,000
3.A.2.a - Cattle	0,000	2,431	0,189	0,000	0,000	0,000
3.A.2.a.i - Dairy cows		1,625	0,119	0,000	0,000	0,000
3.A.2.a.ii - Other cattle		0,805	0,069	0,000	0,000	0,000
3.A.2.c - Sheep and Goats		0,617	0,265	0,000	0,000	0,000
3.A.2.e - Camels		0,000	0,000	0,000	0,000	0,000
3.A.2.f - Horses		0,544	0,062	0,000	0,000	0,000
3.A.2.g - Mules and Asses		0,017	0,002	0,000	0,000	0,000
3.A.2.h - Swine		0,051	0,005	0,000	0,000	0,000
3.A.2.i - Poultry		0,060	0,004	0,000	0,000	0,000
3.C - Aggregate sources and non-CO2 emissions sources on land	0,000	2,918	7,126	0,453	16,681	0,000
3.C.1 - Emissions from biomass burning	0,000	0,491	0,013	0,453	16,681	0,000
3.C.1.a - Biomass burning in forest lands		0,004	0,000	0,002	0,082	0,000
3.C.1.b - Biomass burning in croplands		0,487	0,013	0,451	16,599	0,000
3.C.4 - Direct N2O Emissions from managed soils			4,967	0,000	0,000	0,000
3.C.5 - Indirect N2O Emissions from managed soils			1,905	0,000	0,000	0,000
3.C.6 - Indirect N2O Emissions from manure management			0,241	0,000	0,000	0,000
3.C.7 - Rice cultivations		2,427		0,000	0,000	0,000

GHG emissions in the subsector increased during the reporting period. Therefore, methane (CH_4) emissions increased between 2011 and 2018 by 20.44%, and nitrous oxide (N_2O) emissions by 21,21%. The dynamic in methane (CH_4) and nitrous oxide (N_2O) emissions between 2011 and 2018 in the Agriculture subsector are shown in Figure 2.41.

Figure 2.41 The dynamic in the emissions of the main greenhouse gases between 2011 and 2018 [220]

[219] Ibid.

[220] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.



The Agriculture subsector is the second largest source of GHG emissions after the Energy sector. The results of the recalculation of methane and nitrous oxide emissions into CO_2 equivalent in 2018 for the main source categories are presented in Table 2.22.

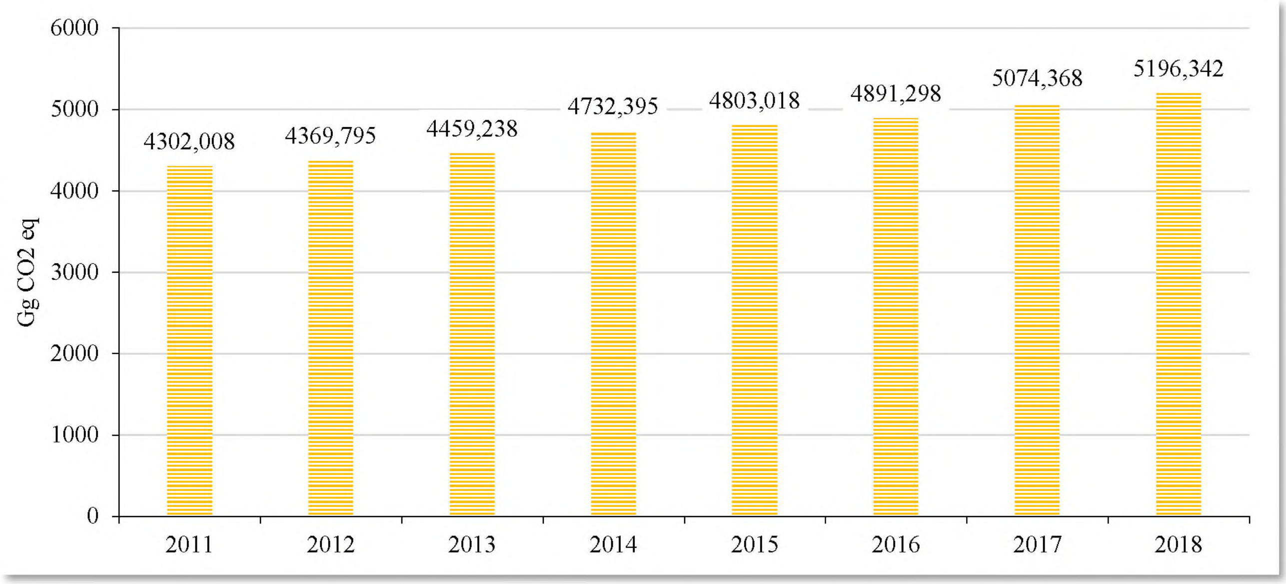
Table 2.22. GHG emissions from the Agriculture sector in 2018 (Gg CO_2 eq)[221]

Categories	CH_4	N_2O	CO_2 eq
3 - Agriculture, Forestry, and Other Land Use	2824,034	2372,307	5196,342
3.A - Livestock	2762,758	163,387	2926,145
3.A.1 - Enteric Fermentation	2684,639	0,000	2684,639
3.A.1.a - Cattle	1841,110	0,000	1841,110
3.A.1.a.i - Dairy Cows	1040,935		1040,935
3.A.1.a.ii - Other Cattle	800,175		800,175
3.A.1.c - Sheep and Goats	647,635		647,635
3.A.1.e - Camels	0,238		0,238
3.A.1.f - Horses	188,503		188,503
3.A.1.g - Mules and Asses	6,078		6,078
3.A.1.h - Swine	1,077		1,077
3.A.2 - Manure Management	78,118	163,387	241,505
3.A.2.a - Cattle	51,041	58,481	109,522
3.A.2.a.i - Dairy cows	34,129	36,942	71,071
3.A.2.a.ii - Other cattle	16,912	21,539	38,451
3.A.2.c - Sheep and Goats	12,953	82,121	95,074
3.A.2.e - Camels	0,007	0,009	0,015
3.A.2.f - Horses	11,415	19,334	30,748
3.A.2.g - Mules and Asses	0,365	0,615	0,980
3.A.2.h - Swine	1,077	1,512	2,589
3.A.2.i - Poultry	1,262	1,314	2,576
3.C - Aggregate sources and non-CO2 emissions sources on land	61,276	2208,920	2270,197
3.C.1 - Emissions from biomass burning	10,305	3,977	14,282
3.C.1.a - Biomass burning in forest lands	0,075	0,061	0,137
3.C.1.b - Biomass burning in croplands	10,230	3,915	14,145
3.C.4 - Direct N2O Emissions from managed soils		1539,647	1539,647
3.C.5 - Indirect N2O Emissions from managed soils		590,657	590,657
3.C.6 - Indirect N2O Emissions from manure management		74,639	74,639
3.C.7 - Rice cultivations	50,971		50,971

The dynamic of GHG emissions assessment in CO_2 eq. for the subsector during the reporting period is presented in Figure 2.42.

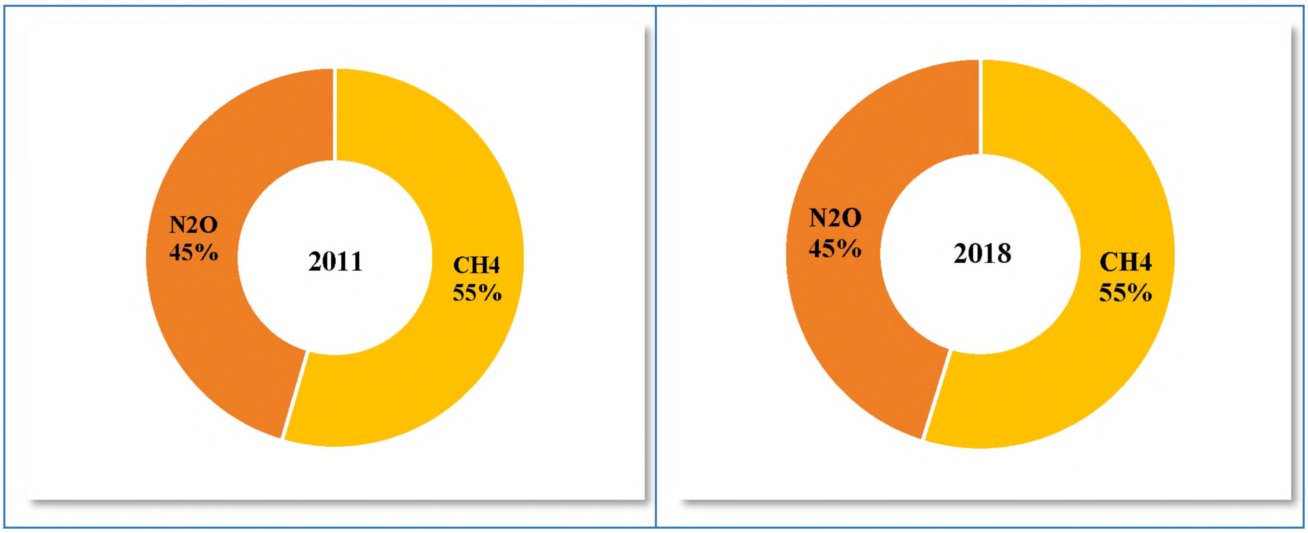
[221] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.

Figure 2.42. The dynamic of GHG emissions in the Agriculture subsector during the period 2011-2018 (Gg CO_2 eq.)[222]



As noted above, the main greenhouse gases in this sector are methane and nitrous oxide. Methane prevailed in the total volume of GHG emissions in the sector during the reporting period and the proportional ratio of gas emissions remained changed at 55% for methane and 45% for nitrous oxide, both in 2011 and 2018. However, in terms of global warming potential, the values of both gases in CO_2 eq are commensurate. (See Figure 2.43).

Figure 2.43 The composition of GHG emissions in the Agriculture subsector between 2011 and 2018[223]

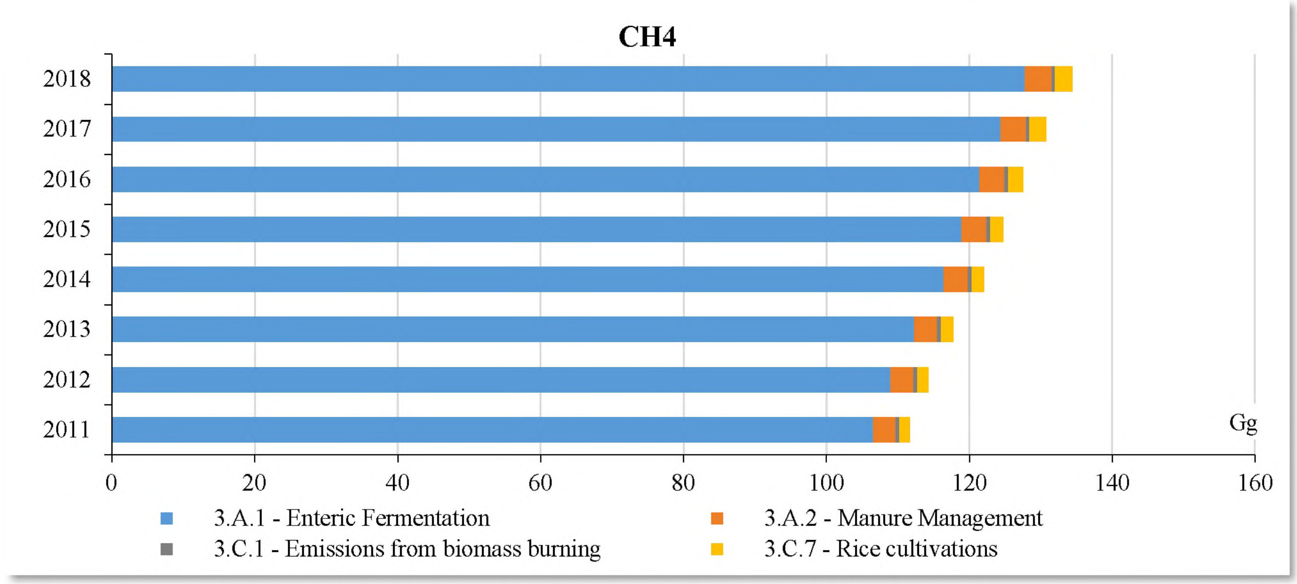


Methane (CH_4) is the main greenhouse gas in the Agriculture sector. The main sources of its emissions in the IPCC categorization are subcategories 3.A.1. - Enteric fermentation; 3.A.2 - Manure management and subcategories 3.C.1. - Biomass burning in croplands and 3.C.7 - Rice cultivation.

The dynamics of methane emissions by the main emission categories of the Agriculture sector are shown in Figure 2.44.

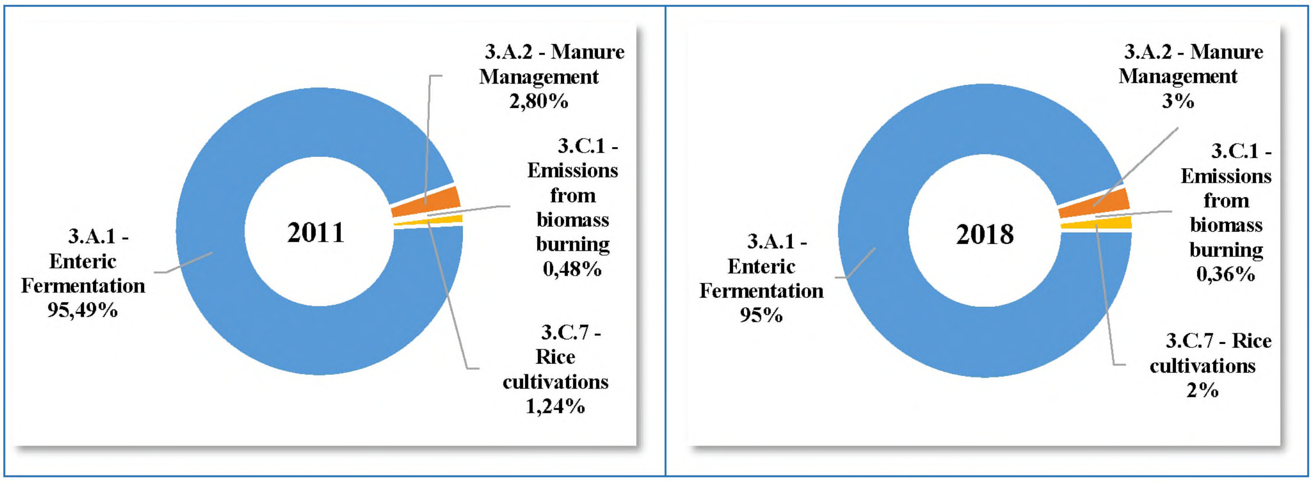
222 Ibid.
223 MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.

Figure 2.44 The dynamics in methane emissions between 2011 and 2018 by sources[224]



The main source of methane (CH_4) emissions are domestic animals and category 3.A.1. - Enteric fermentation, where emissions increased from 106,617 Gg in 2011 to 127,840 Gg in 2018, [225] and associated with the growing number of livestock. Category 3.C.7 - Rice cultivation has also increased in 2018 compared to 2011 by 75,86% due to the considerable increase in the rice crops area. (See Figure 2.45.)

Figure 2.45 The comparison of methane emissions by the contributions from different source categories in 2011 and 2018 [226]

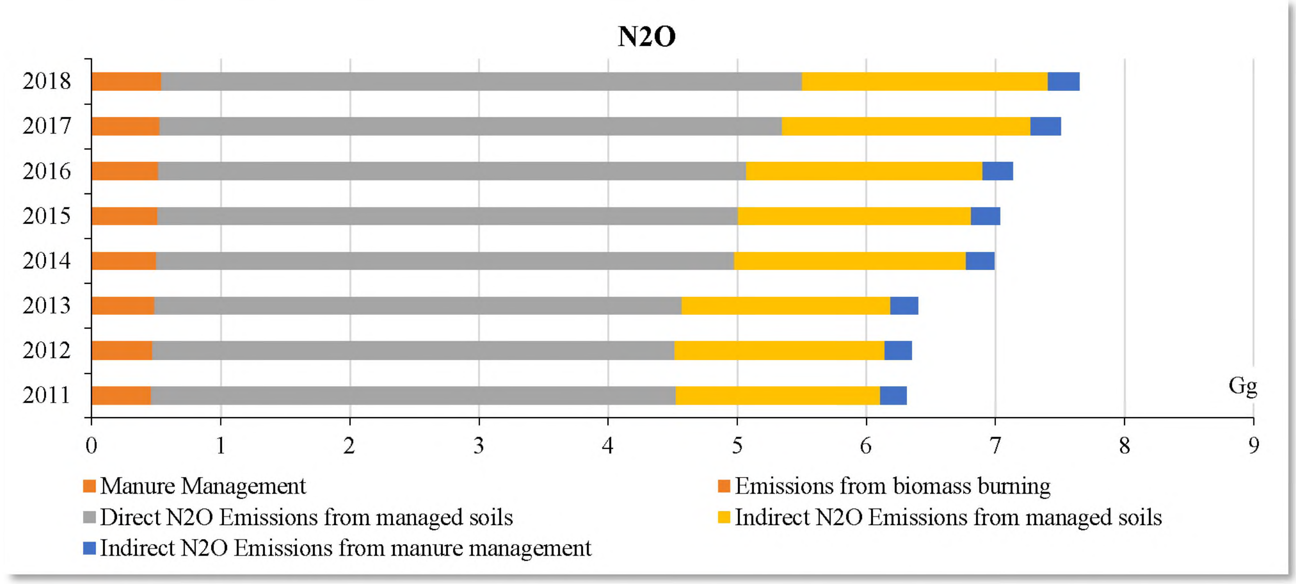


The second important gas for estimating GHG emissions in the Agriculture sector is nitrous oxide (N2O). The main source of this gas is subcategory 3.A.2 - Manure management, 3.C.1. Emissions from biomass combustion, 3.C.4 - Direct N2O emissions from managed soils; 3.C.5 - Indirect N2O emissions from managed soils, 3.C.6 - Indirect N2O emissions from manure management. At the same time, the largest volume of nitrous oxide emissions in the sector comes from category 3.C.4 - Direct emissions from managed soils, which is primarily associated with an increase in the use of fertilizers on arable land. These emissions increased by 22,15% up to 4,967 Gg in 2018 compared to 4.066 Gg

[224] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.
[225] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.
[226] Ibid.

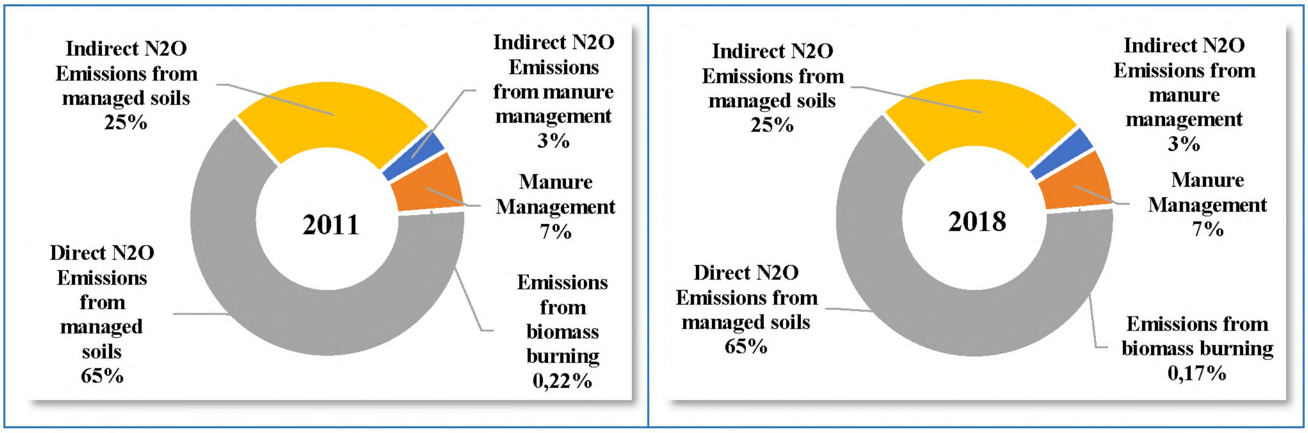
in 2011. [227] The volume of nitrous oxide emissions from other sources remained almost unchanged. The dynamic of nitrous oxide emissions by main emission sources, in the period 2011 -2018 is shown in Figure 2.46.

Figure 2.46 The dynamic of nitrous oxide emissions in the Agriculture sector by main emission sources in the period 2011 - 2018[228]



N2O emissions contribution from different sources remained almost unchanged in 2018 compared to 2011 (see Fig.2.47).

Figure 2.47 The comparison of nitrous oxide emissions by sources in 2011 and 2018[229]



The 4th National Inventory in the Agriculture sector identified two types of precursor gas emissions: nitrogen oxide (NO_X) and carbon monoxide (CO). Emissions of these gases decreased during the period 2011-2018 due to reduced burning of crop residues. The changes in emissions of gases of precursors for the reporting period are shown in Figure 2.48.

Figure 2.48 The dynamic of the precursor gases emissions in Agriculture in 2011-2018[230]

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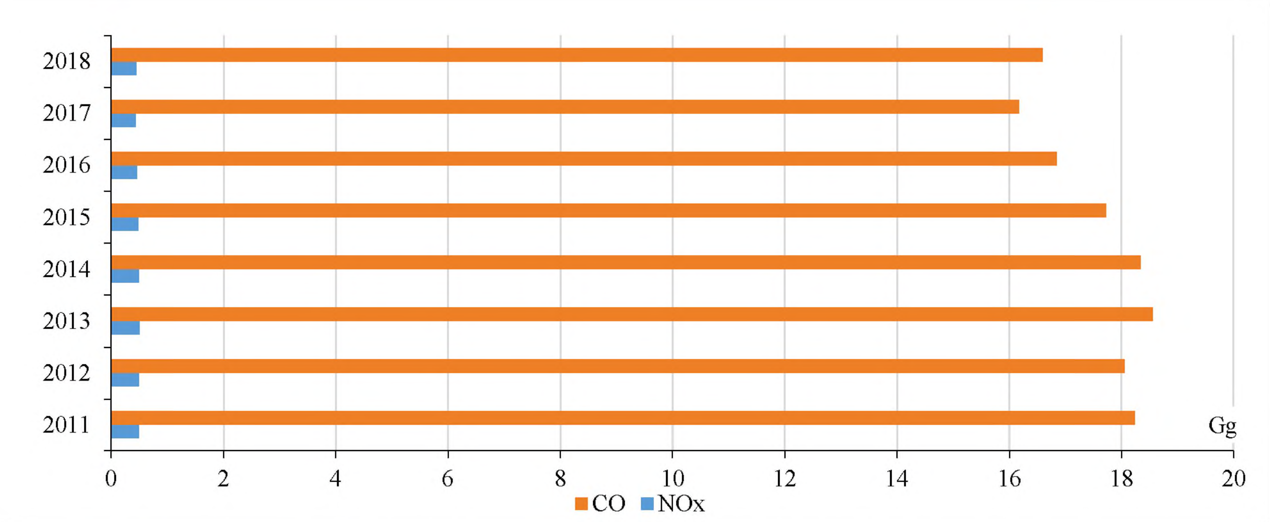
[227] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.
[228] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.
[229] Ibid.
[230] Ibid.



2.5.3.3.1.4. Recalculation and Improvements

The transition to the new 2006 IPCC methodology and the use of the new IPCC software to estimate GHG emissions in the Agriculture sector during NGHGI 4 was a key factor in improving the GHG emission estimates for the sector and made it necessary to recalculate the results of the previous NGHGI 3 for the sector presented in NC 3. In addition, the activity data for all long time series were updated and further refined during the 4th NGHGI, which increased the completeness and accuracy of the estimates.

Comparative analysis of the results of both NGHGIs showed that the final changes in the GHG emissions of the sector were caused, to a greater extent, by changes in the values of the new emission factors used, adopted by default under the IPCC methodology, and, to a lesser extent, by changes in activity data. For the analysis, the results of emissions assessment of the third and fourth NGHGIs for both methane and nitrous oxide were compared, as well as the total GHG emissions of the sector in CO2 equivalent for the entire period under review from 1990 to 2010. The results of a comparative analysis of methane emissions assessment in the Agriculture sector during the third and fourth NGHGIs and the revealed difference are presented in Table 2.23.

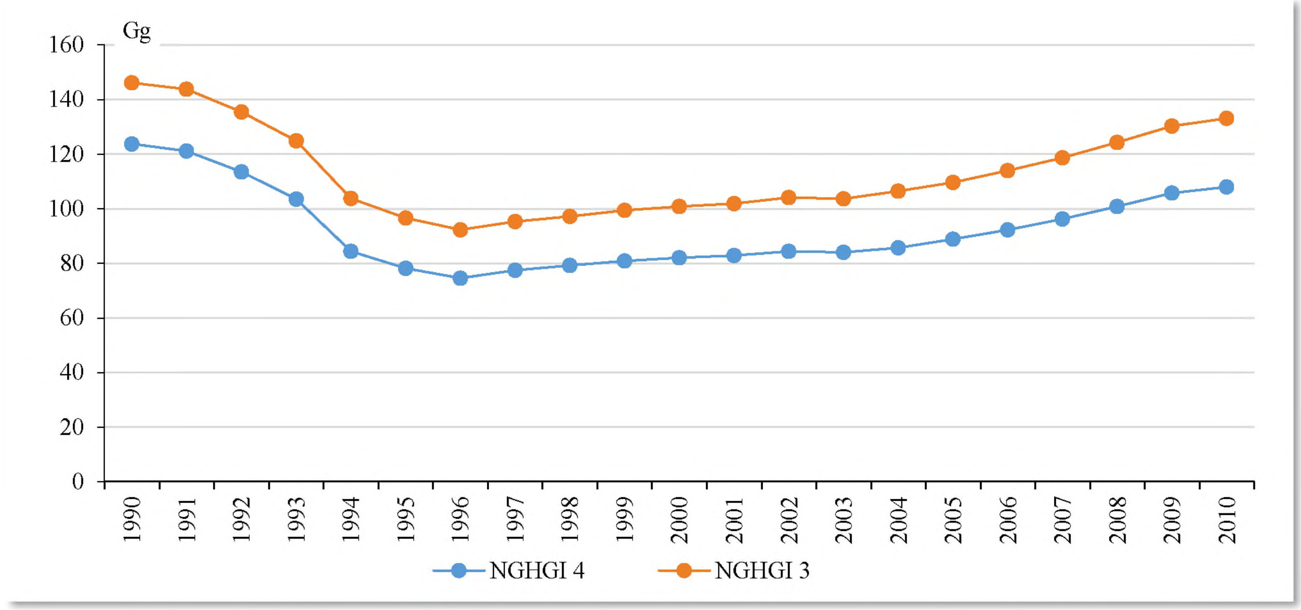
Table 2.23 The comparative analysis of the estimation of methane emissions from the Agriculture sector during the period 1990-2010 (Gg) [231]

Results	1990	1991	1992	1993	1994	1995	1996
NGHGI 4	123,711	121,080	113,440	103,468	84,314	78,158	74,538
NGHGI 3	146,070	143,724	135,352	124,771	103,693	96,578	92,260
Difference in %	-15	-16	-16	-17	-19	-19	-19
Results	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
NGHGI 4	77,462	79,155	80,884	81,958	82,819	84,341	83,940
NGHGI 3	95,217	97,081	99,326	100,751	101,843	104,027	103,551
Difference in %	-19	-19	-19	-19	-19	-19	-19
Results	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
NGHGI 4	85,599	88,857	92,238	96,175	100,776	105,671	107,987
NGHGI 3	106,365	109,603	113,884	118,657	124,188	130,194	133,026
Difference in %	-20	-19	-19	-19	-19	-19	-19

[231] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022. SAEPF, GEF-UNEP. NC 3. Bishkek. 2016.

As can be seen from the table, the transition to the new GHG emissions assessment methodology for methane resulted in a change in the annual values of methane emissions over the entire time series. Thus, the estimates of emissions from the fourth NGHGI showed a decrease in methane emissions by 15-29%. At the same time, the general trends in methane emissions have approximately the same trend for this time series. (See Figure 2.49).

Figure 2.49 Comparison of the methane emissions estimation results of the third and the fourth NGHGIs [232]



Comparative analysis of the results of the 3rd and 4th NGHGIs on the nitrous oxide emissions assessment in the Agriculture sector for the period 1990-2010 showed wider discrepancies in emission estimates due to the adoption of a new emissions estimation methodology and activity data update with a range from 32 to 60% (see Table 2.19).

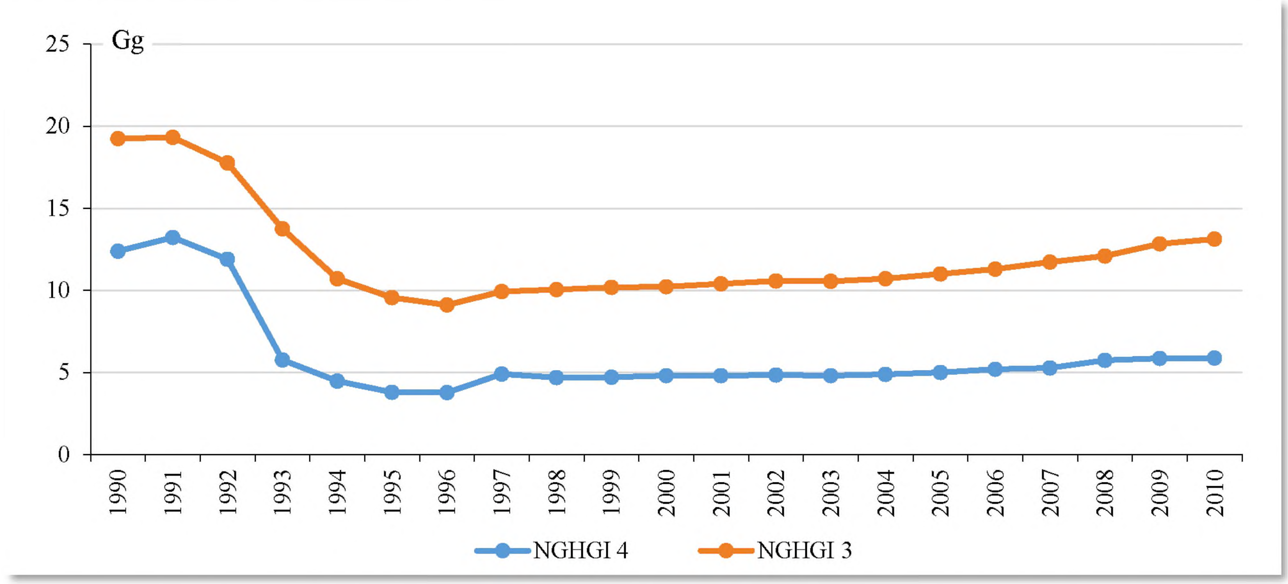
Table 2.24 Comparative analysis results of the nitrous oxide emissions estimation from the Agriculture sector between 1990 and 2010 (Gg) [233]

Results	1990	1991	1992	1993	1994	1995	1996
NGHGI 4	12,386	13,222	11,899	5,758	4,463	3,785	3,770
NGHGI 3	19,252	19,322	17,76	13,746	10,707	9,554	9,106
Difference in %	-36	-32	-33	-58	-58	-60	-59
Results	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
NGHGI 4	4,897	4,686	4,697	4,803	4,798	4,836	4,811
NGHGI 3	9,935	10,045	10,18	10,229	10,403	10,567	10,546
Difference in %	-51	-53	-54	-53	-54	-54	-54
Results	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
NGHGI 4	4,873	4,996	5,202	5,265	5,732	5,854	5,876
NGHGI 3	10,712	11,008	11,294	11,715	12,099	12,835	13,125
Difference in %	55	55	54	55	53	54	55

232 MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022. SAEPF, GEF-UNEP. NC 3. Bishkek. 2016.
233 Ibid.

At the same time, as in the case of methane emissions, the nitrogen oxide emission estimate from NGHGI 4 showed lower emissions in the period under review. (See Figure 2.49).

Figure 2.50 Nitrous oxide emissions estimation results of the Agriculture sector in the 3rd and 4th NGHGIs for the period 1990 – 2010 [234]



The results of the recalculation of methane and nitrous oxide emissions to CO_2 equivalent, based on Global Warming Potential factors, also showed some discrepancies in the estimates between 27% and 44%. (See Table 2.25).

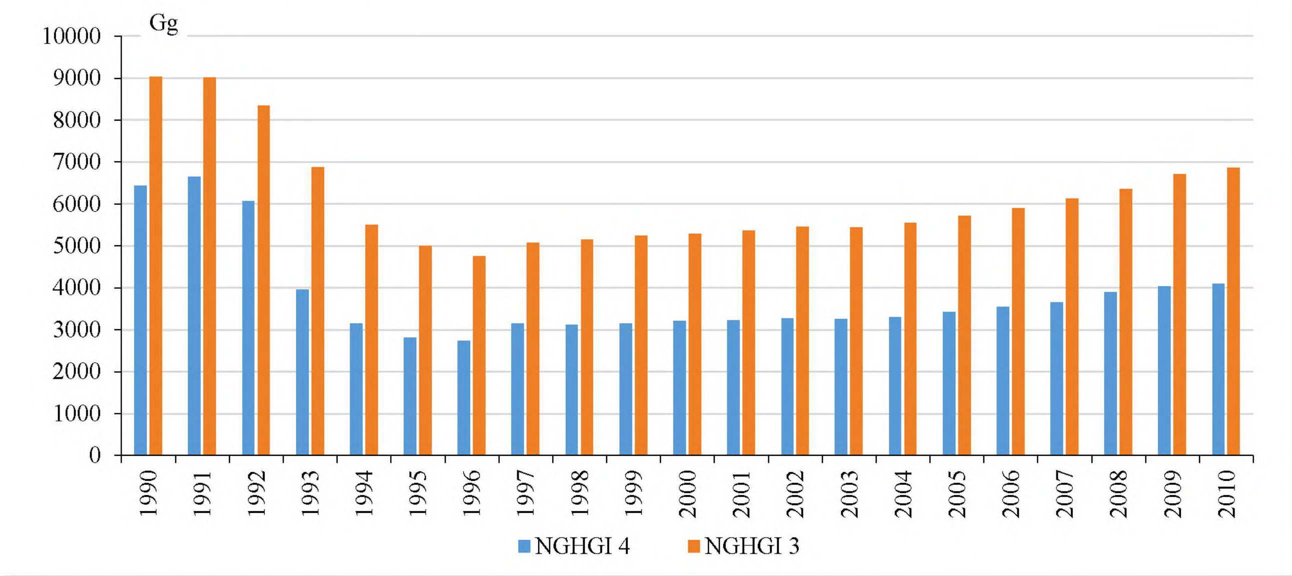
Table 2.25 Comparative analysis results of the total CO2 equivalent emissions estimate of the Agriculture sector between 1990 and 2010 (Gg) [235]

Results	1990	1991	1992	1993	1994	1995	1996
NGHGI 4	6437,637	6641,579	6071,064	3957,862	3154,111	2814,657	2734,142
NGHGI 3	9035,536	9008,162	8348,127	6881,409	5496,854	4989,819	4760,382
Difference, %	-29	-26	-27	-42	-43	-44	-43
Results	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
NGHGI 4	3144,841	3114,813	3154,514	3210,044	3226,578	3270,211	3254,211
NGHGI 3	5079,251	5152,789	5241,692	5286,677	5363,733	5460,256	5443,692
Difference, %	-38	-40	-40	-39	-40	-40	-40
Results	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
NGHGI 4	3308,048	3414,776	3549,578	3651,920	3893,094	4033,822	4089,427
NGHGI 3	5554,26	5714,229	5892,839	6123,497	6358,669	6712,831	6862,419
Difference, %	-40	-40	-40	-40	-39	-40	-40

The main conclusion of the comparative analysis of the assessment results of the 3rd NGHGI, conducted according to the 1996 IPCC methodology, and the 4th NGHGI, conducted according to the 2006 IPCC methodology, is that the total amount of GHG emissions in the Agriculture sector was lower than expected in the period 1990- 2010 (See Figure 2.51).

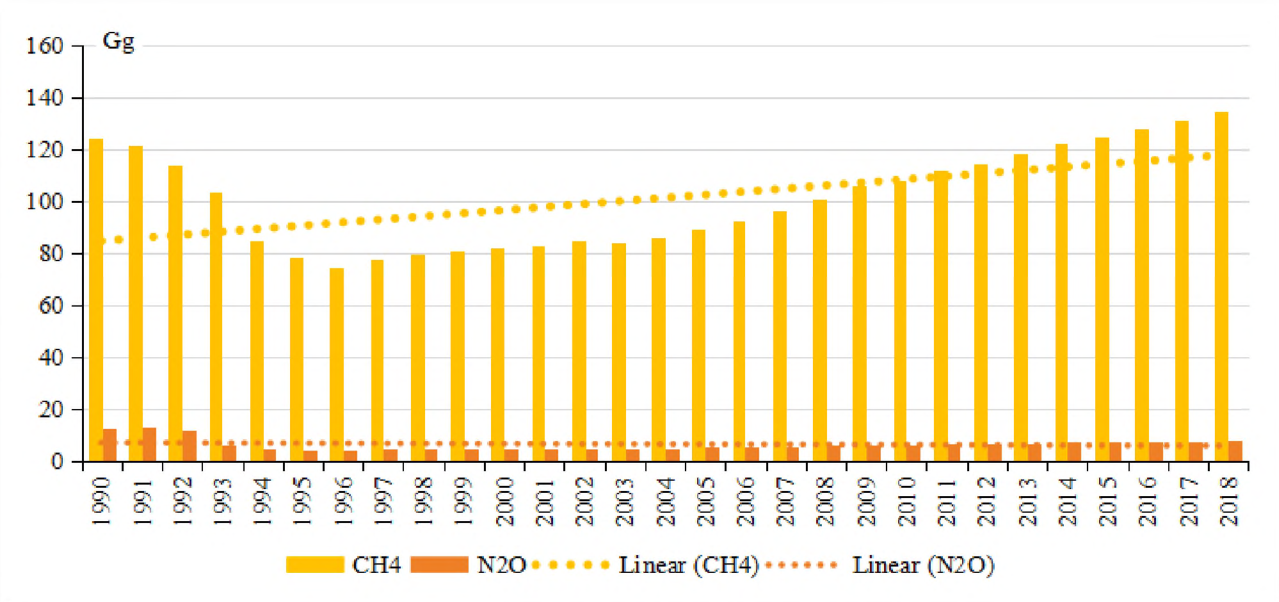
234 MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022. SAEPF, GEF-UNEP. NC 3. Bishkek. 2016.
235 Ibid.

Figure 2.51 Comparative analysis of the GHG emission estimates of the Agriculture sector resulting from the 3rd and 4th NGHGIs[236]



Recalculation and estimation of GHG emissions in the Agriculture sector for the entire period from 1990 to 2018 showed changes in emissions of major GHGs, both in terms of growing total emission volumes, and in their distribution by major sources of GHG emissions. And, while the level of nitrous oxide (N_2O) emissions in the sector have not reached the baseline 1990 level yet, methane (CH_4) emissions in Kyrgyzstan have already exceeded the 1990 level (see Figure 2.52).

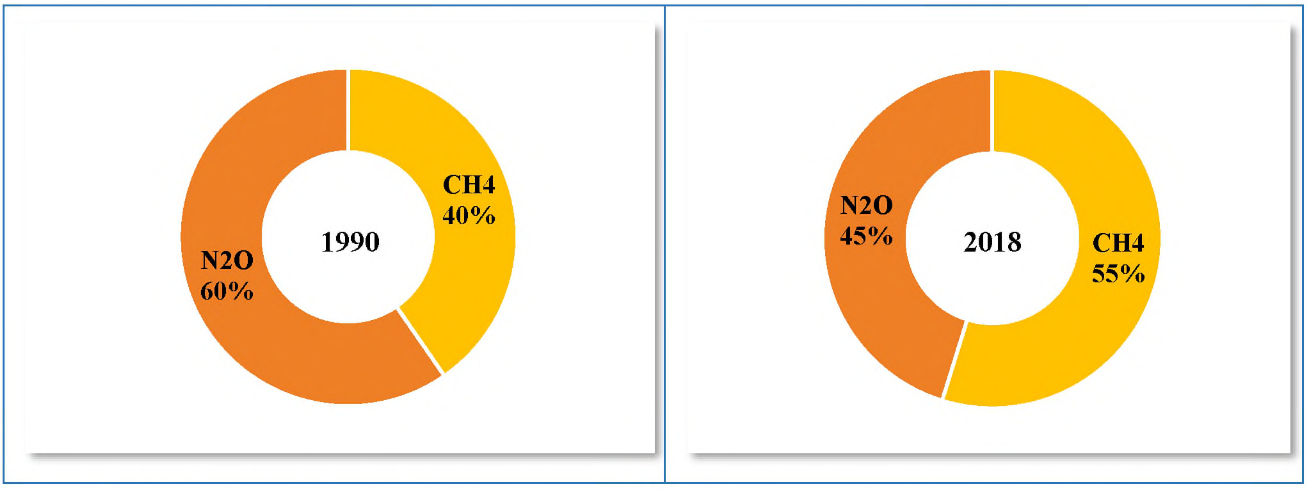
Figure 2.52 Trends in methane and nitrous oxide emissions in the Agriculture sector in the period 1990-2018. [237]



[236] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022. SAEPF, GEF-UNEP. NC 3. Bishkek. 2016.
[237] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.

Consequently, there has been a proportional increase in the share of methane emissions in the total GHG emissions of the sector (see Figure 2.53).

Figure 2.53 Ratio of methane and nitrous oxide emissions in 1990 and 2018. [238]



The recalculation of the GHG emission estimate in the Agriculture sector in CO_2 equivalent for major emission source categories for the period 1990-2018 are presented in Table 2.26.

Table 2.26 The recalculation of GHG emissions in the Agriculture sector between 1990 and 2018 (Gg CO_2 eq.)[239]

Categories	1990	1991	1992	1993	1994
3 - Agriculture	**6437,637**	**6641,579**	**6071,064**	**3957,862**	**3154,111**
3.A - Livestock	**2786,007**	**2721,300**	**2543,450**	**2306,957**	**1864,790**
3.A.1 - Enteric Fermentation	2510,217	2454,496	2299,012	2092,111	1698,494
3.A.2 - Manure Management	275,790	266,803	244,438	214,846	166,296
3.C - Aggregate sources and non-CO2 emissions sources on land	**3651,630**	**3920,279**	**3527,614**	**1650,905**	**1289,322**
3.C.1 - Emissions from biomass burning	9,625	9,465	10,509	12,391	11,853
3.C.4 - Direct N2O Emissions from managed soils	2633,558	2849,909	2554,821	1091,803	854,647
3.C.5 - Indirect N2O Emissions from managed soils	909,996	975,598	875,904	469,910	361,367
3.C.6 - Indirect N2O Emissions from manure management	92,861	77,439	77,956	65,803	47,835
3.C.7 - Rice cultivations	5,589	7,869	8,426	10,998	13,619
Categories	1995	1996	1997	1998	1999
3 - Agriculture	**2814,657**	**2734,142**	**3144,841**	**3114,813**	**3154,514**
3.A - Livestock	**1716,650**	**1625,871**	**1685,591**	**1726,623**	**1761,677**
3.A.1 - Enteric Fermentation	1565,027	1484,892	1539,642	1577,063	1609,096
3.A.2 - Manure Management	151,624	140,979	145,949	149,561	152,581
3.C - Aggregate sources and non-CO2 emissions sources on land	**1098,007**	**1108,271**	**1459,250**	**1388,190**	**1392,838**
3.C.1 - Emissions from biomass burning	12,625	15,789	18,168	17,628	17,695
3.C.4 - Direct N2O Emissions from managed soils	716,080	725,603	982,649	929,903	934,835
3.C.5 - Indirect N2O Emissions from managed soils	305,256	301,486	387,804	371,048	373,013
3.C.6 - Indirect N2O Emissions from manure management	43,968	41,306	43,269	45,057	40,039
3.C.7 - Rice cultivations	20,079	24,087	27,360	24,554	27,256
Categories	2000	2001	2002	2003	2004
3 - Agriculture	**3210,044**	**3226,578**	**3270,211**	**3254,211**	**3308,048**
3.A - Livestock	**1782,683**	**1803,772**	**1832,627**	**1826,004**	**1864,219**
3.A.1 - Enteric Fermentation	1628,789	1649,542	1676,181	1671,764	1705,596
3.A.2 - Manure Management	153,893	154,231	156,447	154,240	158,623
3.C - Aggregate sources and non-CO2 emissions sources on land	**1427,361**	**1422,805**	**1437,583**	**1428,207**	**1443,829**
3.C.1 - Emissions from biomass burning	18,620	19,244	18,163	16,793	16,484
3.C.4 - Direct N2O Emissions from managed soils	954,028	952,826	959,780	956,264	965,012
3.C.5 - Indirect N2O Emissions from managed soils	379,392	378,440	381,280	378,680	384,658
3.C.6 - Indirect N2O Emissions from manure management	46,508	47,051	47,899	48,509	49,970

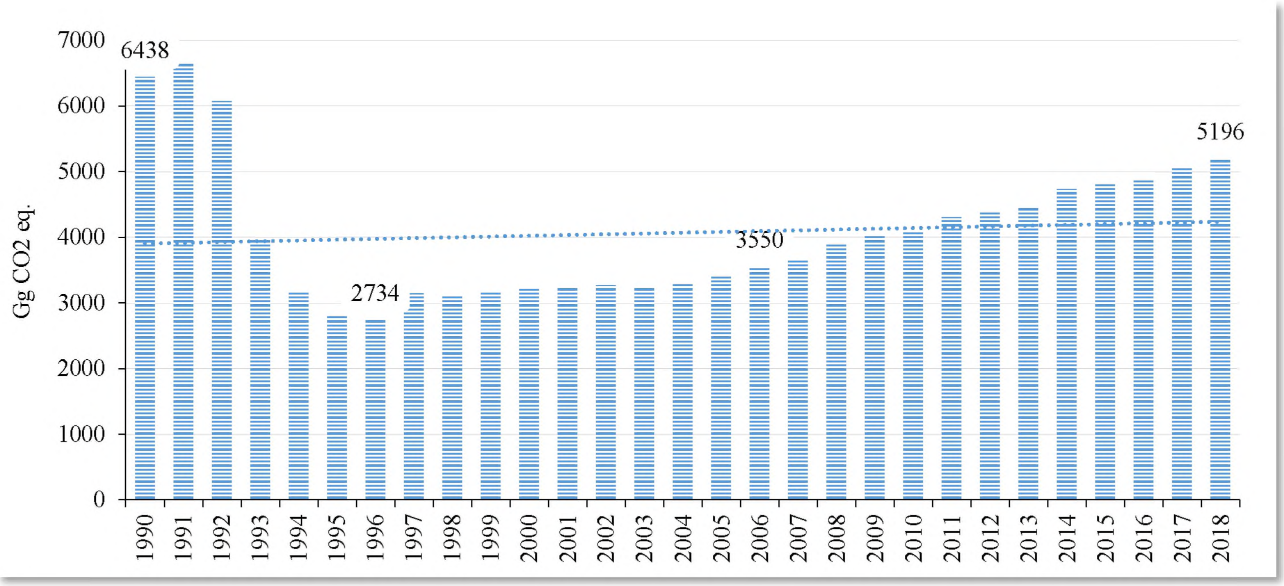
[238] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.
[239] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.

3.C.7 - Rice cultivations	28,814	25,245	30,461	27,961	27,705
Categories	**2005**	**2006**	**2007**	**2008**	**2009**
3 - Agriculture	**3414,776**	**3549,578**	**3651,920**	**3893,094**	**4033,822**
3.A - Livestock	**1936,077**	**2009,311**	**2098,542**	**2200,471**	**2308,393**
3.A.1 - Enteric Fermentation	1773,976	1841,284	1923,578	2017,821	2116,505
3.A.2 - Manure Management	162,101	168,027	174,963	182,650	191,888
3.C - Aggregate sources and non-CO2 emissions sources on land	**1478,699**	**1540,267**	**1553,378**	**1692,623**	**1725,429**
3.C.1 - Emissions from biomass burning	16,881	16,411	15,139	16,168	16,587
3.C.4 - Direct N2O Emissions from managed soils	991,088	1032,752	1039,968	1140,001	1157,891
3.C.5 - Indirect N2O Emissions from managed soils	393,569	409,865	415,749	452,768	463,477
3.C.6 - Indirect N2O Emissions from manure management	50,820	52,748	54,839	56,636	59,265
3.C.7 - Rice cultivations	26,341	28,491	27,683	27,050	28,208
Categories	**2010**	**2011**	**2012**	**2013**	**2014**
3 - Agriculture	**4089,427**	**4302,008**	**4369,795**	**4459,238**	**4732,395**
3.A - Livestock	**2360,179**	**2442,979**	**2498,325**	**2573,582**	**2668,138**
3.A.1 - Enteric Fermentation	2163,425	2238,959	2289,738	2358,474	2445,579
3.A.2 - Manure Management	196,754	204,019	208,587	215,108	222,559
3.C - Aggregate sources and non-CO2 emissions sources on land	**1729,248**	**1859,029**	**1871,470**	**1885,656**	**2064,257**
3.C.1 - Emissions from biomass burning	15,527	15,620	15,467	15,947	15,788
3.C.4 - Direct N2O Emissions from managed soils	1156,890	1260,449	1254,372	1267,259	1388,175
3.C.5 - Indirect N2O Emissions from managed soils	466,586	491,281	504,882	500,776	555,569
3.C.6 - Indirect N2O Emissions from manure management	60,681	62,695	64,142	66,194	68,265
3.C.7 - Rice cultivations	29,564	28,985	32,607	35,480	36,459
Categories	**2015**	**2016**	**2017**	**2018**	
3 - Agriculture	**4803,018**	**4891,298**	**5074,368**	**5196,342**	
3.A - Livestock	**2725,350**	**2781,755**	**2847,827**	**2926,145**	
3.A.1 - Enteric Fermentation	2498,201	2550,357	2611,931	2684,639	
3.A.2 - Manure Management	227,149	231,398	235,896	241,505	
3.C - Aggregate sources and non-CO2 emissions sources on land	**2077,668**	**2109,543**	**2226,541**	**2270,197**	
3.C.1 - Emissions from biomass burning	15,566	14,421	13,965	14,282	
3.C.4 - Direct N2O Emissions from managed soils	1393,952	1412,113	1495,674	1539,647	
3.C.5 - Indirect N2O Emissions from managed soils	559,633	567,386	595,954	590,657	
3.C.6 - Indirect N2O Emissions from manure management	69,863	71,157	72,858	74,639	
3.C.7 - Rice cultivations	38,654	44,467	48,089	50,971	

The results of recalculation of GHG emissions in the sector show that after the reduction in GHG emissions in the early 1990s from 6438,637 Gg CO2 eq. in 1990 to 2734,141 Gg CO2 eq. in 1996 (by 57.53%), GHG emissions exhibited a stable growth trend up to 5196,342 Gg CO2 eq. in 2018. However, the total GHG emissions in the sector in 2018 were still lower than the 1990 emissions by 19,28%. The general dynamic of changes in GHG emissions from the sector in the period 1990-2018 are shown in Figure 2.54.

Figure 2.54 GHG emissions dynamic in the Agriculture sector between 1990 and 2018 (Gg CO_2 eq.)[240]

[240] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.



2.5.3.3.1.5. Uncertainty Assessment Results of the Agriculture Sector in NGHGI 4

Since Tier 1 was used in estimating GHG emissions, the Tier 1 approach was also used for uncertainty analysis for the quantitative assessment of uncertainties. Tier 1 is based on error propagation and is used to estimate the uncertainty of individual categories, for the inventory as a whole, and for trends between the year of interest and base year. The approach assumes that the relative ranges of uncertainties for emissions and activity factors are the same for the base year and year t.[241]

A special working form (Table 3.2. of the 2006 IPCC Guidelines)[242] was used to conduct a quantitative calculation of the uncertainty, which determined the percentage of uncertainty in the general inventory for the Agriculture sector at 12,357%, and uncertainty of the emission trend in 2018 relative to base 1990 at 3,540%.

2.5.3.3.2. GHG Inventory in the Subsector "Forestry and Other Land Use"

According to the IPCC methodology, the FOLU sector considers GHG emissions and removals associated with anthropogenic activities on the ground. It considers six categories of land use: forest land, cropland, grassland, wetlands, settlements, and other land and land-use changes associated with the transfer of land from one category to another. This sector accounts for greenhouse gas emissions and removals due to changes in biomass of forest land and permanent crops of cropland.

The 2006 IPCC Guidelines deal with managed forests that have been in the forest land category for more than 20 years or during a country-specific transition period. The Greenhouse Gas Inventory for Forest Land Remaining Forest Land includes an estimate of carbon stock changes for five carbon pools (i.e. aboveground biomass, belowground biomass, deadwood mass, litter, and soil organic matter) emissions, other than CO2, gases. The Guidance provides a set of general equations for estimating annual changes in forest carbon stocks to make the appropriate calculations.[243]

According to the National Forest Inventory (2008-2010), all forests in Kyrgyzstan have been classified as a forest land category for more than 20 years, therefore they are classified as forest land remaining

[241] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 3, p. 3.47
[242] Ibid., Table 3.2
[243] Ibid., v.4., г.4, стр.4.12.

forest land and considered as managed forests because they are subject to anthropogenic intervention and human activity to perform productive, environmental and social functions.

Cropland includes land under all annual and perennial crops. Carbon can accumulate in the biomass of croplands that contain perennial woody vegetation. Changes in biomass are estimated for perennial woody crops only. For annual crops, the increase in biomass reserves for one year is assumed to equal the loss of biomass from harvesting and death in the same year. Therefore, the resulting carbon stocks of biomass do not exist.[244]

2.5.3.3.2.1. Assessment methodology, level and coefficients

Since Kyrgyzstan does not have nationally developed and approved GHG emission/removal factors for the FOLU sector, the Tier 1 method of the 2006 IPCC Guidelines was used for the 4th NGHGI with the corresponding values of the "default" equations (for example, emission/removal factors and changes in biomass stocks, etc.). [245] At this stage, data for only 2 of 6 land use categories - forest land and cropland - were used to estimate GHG removals in the sector, since long time series of data were collected and agreed for these categories. For the rest of the land categories, long data series have yet to be refined from a historical perspective, which will be done in the next NGHGI.

Greenhouse gas emissions and removals from forest land and perennial crops of cropland are estimated using the biomass yield and loss method. Inputs include total (aboveground and underground) biomass yield. Losses are removal/harvesting of round wood, removal / harvesting/harvesting of fuelwood, harvesting/stocking of perennial tree crops, and losses from natural impacts on managed lands such as insect infestations and extreme weather events (e.g. hurricanes, floods, etc.)[246]

Using data on area and biomass growth for each type of forest and each climate zone of the country, the annual biomass growth of the forest remaining forest land (ΔC_G) is estimated using the following equation:

$$\Delta C_G = A * G_{total} * CF \quad (1)$$

Where:
ΔC_G = annual increase in biomass carbon stocks, tons C/yr
A = area of managed forest lands, ha
G_{total} = mean annual biomass growth, tons d. m. / ha per year
CF = carbon fraction of dry matter, tons C/(tons d.m.) [247]

The following equation was used to calculate the average annual biomass growth:

$$G_{total} = GW * (1+R) \quad (2)$$

Where,
G_{total} = mean annual biomass growth, tons d. m. / ha per year,
GW = average annual aboveground biomass growth for a specific woody vegetation type; tons of dry matter/ha per year (tables 4.9, 4.10 and 4.12[248]);

[244] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 5, p. 5.7.
[245] Ibid, vol. 4, ch. 1, p.1.12.
[246] Ibid, vol. 4, ch. 2, p. 2.12, and ch. 5, p. 5.8.
[247] Ibid, vol. 4, ch. 4, p. 4.57.
[248] Ibid, vol. 4, ch. 4, p. 4.66; 4.68; 4.72.

R = ratio of below-ground biomass to above-ground biomass (ton d.m. belowground biomass)/(ton d.m. above-ground biomass). [249]

Estimated annual biomass loss, i.e. the sum of losses of wood removals, removals of fuel wood and other losses as a result of various impacts is conducted by calculations using another equation:

$$\Delta C_L = L_{wood\text{-}removals} + L_{disturbance} \quad (3)$$

Где,
ΔC_L – annual decrease in carbon stocks due to biomass loss, C/yr.;
$L_{wood\text{-}removals}$ – annual carbon loss due to wood removals, tons C/yr.;
$L_{disturbance}$ - annual biomass carbon losses due to disturbances, tons C/yr.

And the wood removal is calculated using the fourth equation:

$$L_{wood\text{-}removals} = H * BCEF_R * (1+R) * CF \quad (4)$$

Where,
H – annual wood removals, roundwood m^3/year;
$BCEF_R$ – biomass conversion and expansion factor;
R – ratio of below-ground biomass to above-ground biomass, tons d.m.;
CF – carbon fraction of dry matter, C/tons d.m.[250];

The default IPCC Tier 1 method was also used to estimate greenhouse gas removals by perennial crops of arable land, which is to multiply cropland area under long-term tree crops by the resulting estimate of biomass accumulation from growth and subtract losses associated with harvesting or stocking and negative impacts, following the equation 5.[251]

$$\Delta C = \Delta C_G - \Delta C_L \quad (5)$$

Where:
ΔC - annual carbon stock change in the biomass, tons C/yr,
ΔC_G - annual gain of carbon, tons C/yr;
ΔC_L - annual loss of carbon, tons C/yr.

Losses are estimated by multiplying carbon stocks by the area of cropland harvested for perennial woody crops.

The 2006 IPCC Guidelines provide estimates of biomass stocks and biomass gains, as well as biomass loss data for major climatic regions and agricultural systems. [252]

In all forest lands and croplands, human intervention and activities take place to fulfill productive, ecological and social functions. Therefore, all forests and croplands of the Kyrgyz Republic are classified as managed and information on emissions/removals of greenhouse gases for them will be presented below.

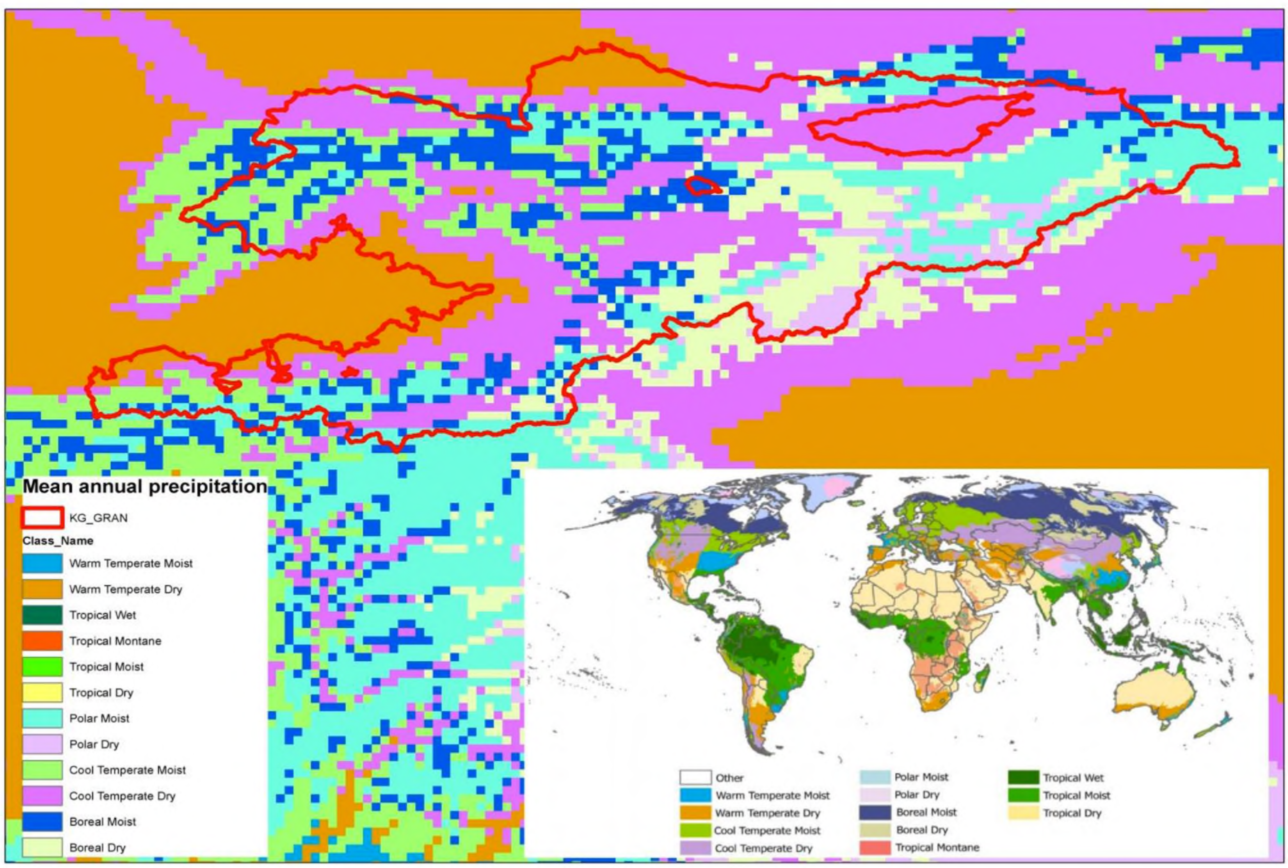
[249] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 4, p. 4.58.
[250] Ibid, vol. 4, ch. 4, p. 4.59.
[251] Ibid, ch. 5, p. 5.10
[252] Ibid, ch. 5, p. 5.10.

The country territory is stratified into climatic or ecological zones, soil type or vegetation, etc. to connect land area data with methods for estimating carbon stock changes, as well as greenhouse gas emissions and removals using emission factors and carbon stock changes to estimate changes in biomass and soil carbon stocks.

The classification scheme for climatic zones is adopted by default according to the 2006 IPCC Guidelines. The classification is based on the data of the land surface height, average annual temperature (a.a.t), average annual precipitation (a.a.p.).[253]

The corresponding vector layers were loaded into the GIS to determine the climatic zones of the Kyrgyz Republic, resulting in the determination that territory of the Kyrgyz Republic is located in 7 (moderately cold, humid; moderately cold, dry; warm moderate dry; polar humid; polar dry ; boreal wet; boreal dry) from 12 global climatic zones (see Figure 2.55).

Figure 2.55 Territory of the Kyrgyz Republic by global climate zone [254]



Forest area stratification by climatic zone was made using the Collect Earth software, climate domains, climatic regions, and ecological zones are grouped according to the 2006 IPCC Guidelines.[255] The distribution of forest areas by climatic zones is shown in Figure 2.56.

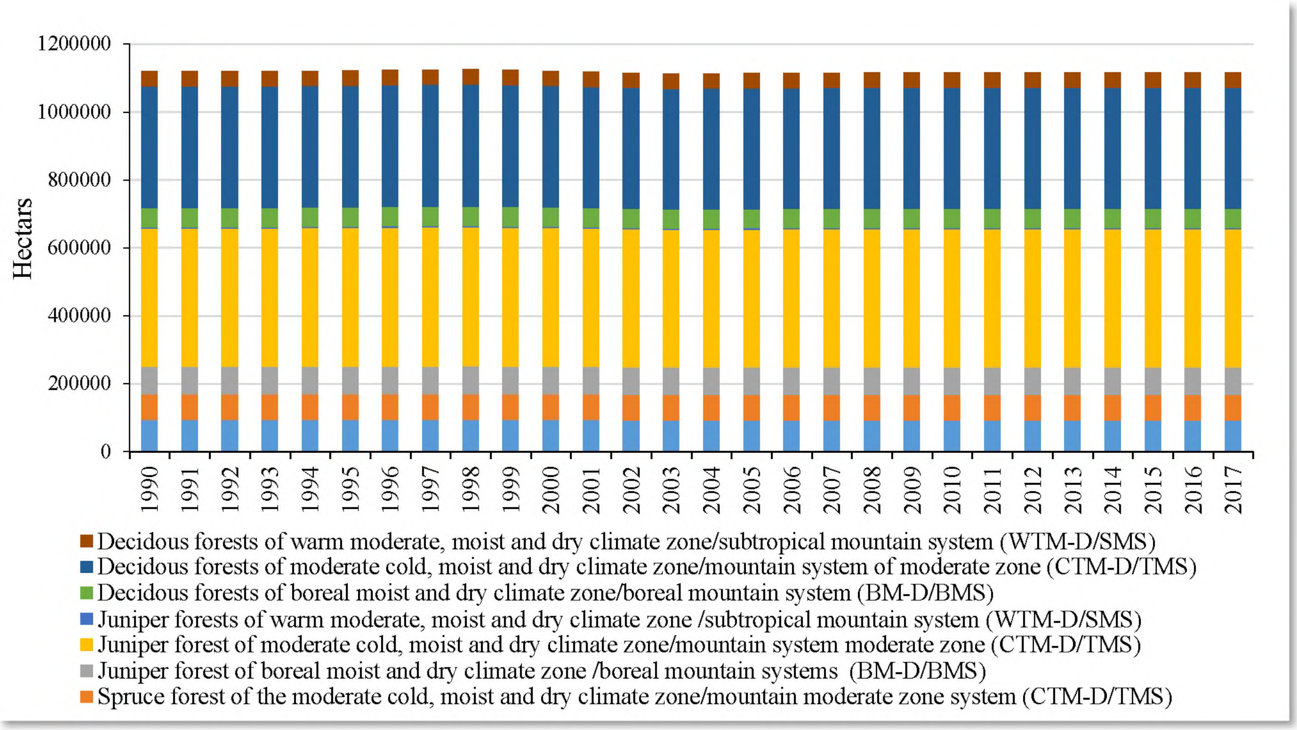
Figure 2.56 Forest areas of Kyrgyzstan by climatic zones[256]

[253] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, ch. 3, p. 3.43-3.45.

[254] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 3, p. 3.43-44. GIS maps: https://esdac.jrc.ec.europa.eu/projects/RenewableEnergy/Data/Climate_Zone.zip

[255] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 4, p. 4.55.

[256] State EnterPrise “Kyrgyz Forest and Hunting Inventory”. Collect Earth Data Base.2020



From figure 2.56 it can be seen that the forests of the country are classified as arches, spruces and deciduous forests, which grow in the boreal humid; moderately cold, dry; and warm temperate as well as dry climatic zones.

The general structure of reporting on GHG emissions of the Forestry and Other Land Use Subsector (FOLU) includes the following categories:

- 3.B Land
  - 3.B.1. Forest land
    - 3.B.1.a Forest land Remaining Forest land
    - 3.B.1.b Land Converted to Forest land
      - 3.B.1.bi Cropland converted to Forest Land
      - 3.B.1.bii Grassland converted to Forest Land
      - 3.B.1.biii Wetlands converted to Forest Land
      - 3.B.1.biv Settlements converted to Forest Land
      - 3.B.1.bv Other Land converted to Forest Land
  - 3.B.2 Cropland
    - 3.B.2.a Cropland Remaining Cropland
    - 3.B.2.b Land Converted to Cropland
      - 3B2bi Forest Land converted to Cropland
      - 3B2bii Grassland converted to Cropland
      - 3B2biii Wetlands converted to Cropland
      - 3B2biv Settlements converted to Cropland
      - 3B2bv Other Land converted to Cropland
  - 3.B.3 Grassland
    - 3.B.3.a Grassland Remaining Grassland
    - 3.B.3.b Land Converted to Grassland
      - 3B3bi Forest Land converted to Grassland
      - 3B3bii Cropland converted to Grassland

        - 3B3biii Wetlands converted to Grassland
        - 3B3biv Settlements converted to Grassland
        - 3B3bv Other Land converted to Grassland
- 3.B.4 Wetlands
    - 3.B.4.a Wetlands Remaining Wetlands
        - 3.B.4.ai Peat Extraction remaining Peat Extraction
        - 3.B.4.aii Flooded land remaining flooded land
    - 3.B.4.b Land Converted to Wetlands
        - 3.B.4.bi Land converted for peat extraction
        - 3.B.4.bii Land converted to flooded land
- 3.B.5 Settlements
    - 3.B.5.a Settlements Remaining Settlements
    - 3.B.5.b Land Converted to Settlements
        - 3.B.5.bi Forest Land converted to Settlements
        - 3.B.5.bii Cropland converted to Settlements
        - 3.B.5.biii Grassland converted to Settlements
        - 3.B.5.biv Wetlands converted to Settlements
        - 3.B.5.bv Other Land converted to Settlements
- 3.B.6 Other Land
    - 3.B.6.a Other land Remaining Other land
    - 3.B.6.b Land Converted to Other land
        - 3.B.6.bi Forest Land converted to Other Land
        - 3.B.6.bii Cropland converted to Other Land
        - 3.B.6.biii Grassland converted to Other Land
        - 3.B.6.biv Wetlands converted to Other Land
        - 3.B.6.bv Settlements converted to Other Land
- 3.C Aggregate sources and non-CO2 emissions sources on land
    - 3.C.1.a Biomass burning in Forest Land
- 3.D.1 Harvested Wood Products
- 3.D.2 Other.[257]

The annual change in biomass carbon stocks at the 4th NGHGI was estimated using the gain-loss method, which estimates the annual increase in carbon stocks associated with the increase and growth of biomass and the annual decline in carbon stocks, related to the loss of biomass.

According to the 2006 IPCC Guidelines, the annual increase in biomass carbon stock was estimated using an equation that multiplies the area of each forest subcategory by the average annual increment in tons of dry matter per hectare per year. Since the increase in biomass is usually expressed in terms of the marketable volume of above-ground biomass, below-ground biomass is estimated using the ratio of below-ground biomass to above-ground biomass.

In addition to the various default coefficients proposed for use, the 2006 IPCC Guidelines also provide mean values of the above-ground biomass of forest areas affected by disturbances; the values of the gross annual increase in above-ground biomass; gross annual volumetric increment values; density of absolutely dry wood; and the ratio (R) of underground biomass to above-ground biomass. In addition, a detailed explanation is given to convert and increase the amount of wood growing, increasing, and removing to biomass.[258]

[257] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 1, p. 1.5.
[258] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 4.

2.5.3.3.2.2. Activity Data

The information on classification, land area data and samples that represent different land-use categories are needed to estimate carbon stocks, greenhouse gas emissions and removals associated with forestry and other land use activities.

Various methods are used to obtain data, including annual census, periodic surveys, and remote sensing. Each of these data collection methods provides a different type of information (for example, maps or tabular data) at different intervals and with different attributes.[259]

Following the above, the main sources of information for the 4th NGHGI of the Kyrgyz Republic:

- Forest Resources Database of the State Institution "Kyrgyz Forestry Management" of the State Agency on Environmental Protection and Forestry under the Government of Kyrgyz Republic,
- Land Resources Database of the State Institution "Cadastre" of the State Agency of Land Resources under the Government of Kyrgyz Republic, as well as
- Statistics from the National Statistical Committee.

According to the 2006 IPCC Guidelines, forest area includes all land with woody vegetation that meets the threshold criteria used to define forest area in the national greenhouse gas inventory, also includes vegetation-based systems that currently does not exceed, but in situ potentially able to meet the threshold criteria used by the country to categorize forest area.[260]

The national definition of the forest includes several quantitative indicators. Forest - tree and shrub vegetation growing on the lands of the forest fund and other categories of the land fund with a minimum area of 0.2 hectares, minimum width of 25 m, a minimum crown cover of 10%, a minimum density of 0.1, a minimum planting height of 1.9 m (shrubs - 0.5 m). [261] Therefore, the activity data for the 4th NGHGI by forest area includes those forests that meet the above national threshold criteria.

Since activity, data may be available only every few years, extrapolation from another longer time series was used to form the consistency of the time series according to the IPCC methodology, using the information on changes in forest policy, and in the absence of data, linear interpolation method can be used.[262]

Data from the SAEPF on National Forest Inventory[263] and the Forest Fund Inventory for the years 1993, 1998, 2003, were used by to compile long time series of data on forest areas of Kyrgyzstan. In addition, data from the National Statistics Committee were used to compare and fill in the gaps. The ongoing process of the second National Forest Inventory provide the new data on the forest area which was not accounted before. The total amount not accounted exceed more than 90 thousand ha. This number was added to the forest area data of 2018, received output being used for the National GHG Inventory.

The generated time series of data on forest areas located on the lands of the State Forest Fund (SFF), specially protected natural areas (SPNA) and beyond the previous categories are presented in Table 2.27.

Table 2.27 Forest area between 1990 and 2018, by location (thousand ha) [264]

Location	1990	1991	1992	1993	1994	1995	1996	1997

[259] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 3, p. 3.5.
[260] Ibid, vol. 4, ch. 3, p. 3.7
[261] Resolution of the Government of Kyrgyz Republic of October 13, 2015, No.706
[262] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 4, p. 4.51.
[263] Approved by Decree of the Government dated 26 July 2011 No. 407
[264] Resolution of the Government of Kyrgyz Republic dated July 26, 2011, No. 407, NSC, Forest Fund Inventory

Forest areas of the Kyrgyz Republic, including	1120	1120	1120	1120	1121,3	1122,6	1123,9	1125,2
SFF forests and SPNA	843	843	843	843	844,3	845,6	846,9	848,2
Forests outside SFF and SPNA	277	277	277	277	277	277	277	277
Location	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Forest areas of the Kyrgyz Republic, including	1126,5	1123,8	1121,1	1118,4	1115,7	1113	1113,7	1114,4
SFF forests and SPNA	849,5	846,8	844,1	841,4	838,7	836	836,7	837,4
Forests outside SFF and SPNA	277	277	277	277	277	277	277	277
Location	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Forest areas of the Kyrgyz Republic, including	1115,2	1115,8	1116,6	1116,6	1116,6	1116,6	1116,6	1116,6
SFF forests and SPNA	838,2	838,8	839,6	839,6	839,6	839,6	839,6	839,6
Forests outside SFF and SPNA	277	277	277	277	277	277	277	277
Location	**2014**	**2015**	**2016**	**2017**	**2018**			
Forest areas of the Kyrgyz Republic, including	1116,6	1116,6	1116,6	1116,6	1206,7			
SFF forests and SPNA	839,6	839,6	839,6	839,6	891,7			
Forests outside SFF and SPNA	277	277	277	277	315			

The table shows that changes in the forest area of the country are rather minor and reflect the stable state of forest ecosystems under state control. Forests and protected areas organize and manage forest use appropriately, carrying out the necessary forestry activities within the existing regulatory framework, including expanding the capacity of forests to absorb and retain carbon emissions in biomass.

Data on forest felling provided by the National Statistical Committee of the Kyrgyz Republic were used to calculate the loss of biomass from forest areas. The generated time series of data on this activity are presented in Table 2.28.

Table 2.28 Felling of forest area between 1990 and 2018 (thousands m^3) [265]

Activity	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Forest felling	35	31	32,3	35,04	35,03	33,1	39,02	42,05	37,1	36
Activity	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Forest felling	47,04	38,02	33,85	32,98	30,15	24,81	16,98	30,04	13,5	25,13
Activity	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	
Forest felling	22,85	34,84	26,85	23,71	25,01	18,1	33,21	13,65	10,3	

Besides forest areas, an estimate of changes in the biomass of perennial tree crops on cultivated land has been applied to estimate GHG removals in the FOLU sector, since there are no resulting biomass carbon stocks for annual crops.[266] However, according to the IPCC methodology, perennial crops include trees and shrubs in combination with grass crops or orchards, vineyards and plantations, unless these lands meet the criteria for classifying them as forest land.[267]

According to the Regulation on the Procedure for Conducting an Inventory of the Land Fund of the Kyrgyz Republic,[268] tree and shrub vegetation includes useful forest strips and other plantations on agricultural land, except for pasture, and perennial plantations include orchards, berry fields, vineyards, mulberry trees and others. These land areas (tree and shrub vegetation and perennial plantations) are classified by the IPCC as perennial crops of cropland.

[265] NSC. http://www.stat.kg/ru/publications/sbornik-okruzhayushaya-sreda-v-kyrgyzskoj-respublike/
[266] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 5, p. 5.7.
[267] Ibid, vol. 4, ch. 5, page 5.6
[268] Resolution of the Government of Kyrgyz Republic dated March 3, 2014, No. 114.

The annual Reports on the availability of land in the Kyrgyz Republic and their distribution by categories, owners, land users and lands, approved by decisions of the Government of the Kyrgyz Republic, were used to collect data on the activity of perennial plantations. Compiled long time series of data on perennial crops of arable land are presented in Table 2.29.

Table 2.29 Area of perennial cropland between 1990 and 2018 (thousands ha) [269]

Crops	1990	1991	1992	1993	1994	1995	1996	1997
Perennial crops	**492,8**	**494**	**494,2**	**496,4**	**497,5**	**497,5**	**496,4**	**496,6**
Perennial plantings	44,7	45	44,2	45,5	45,7	44,8	42,7	42
Tree and shrub plantations	448,1	449	450	450,9	451,8	452,7	453,7	454,6
Crops	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Perennial crops	**497,1**	**500,1**	**502,7**	**502,3**	**502**	**500,4**	**501,2**	**500,7**
Perennial plantings	41,6	40,1	39,9	39,3	38,9	37,4	37,2	36,8
Tree and shrub plantations	455,5	460	462,8	463	463,1	463	464	463,9
Crops	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Perennial crops	**500,1**	**500,2**	**499,7**	**499,6**	**499,7**	**499,9**	**500,2**	**499,7**
Perennial plantings	36,3	36,2	35,9	36,1	36,2	36,5	36,8	37
Tree and shrub plantations	463,8	464	463,8	463,5	463,5	463,4	463,5	462,8
Crops	**2014**	**2015**	**2016**	**2017**	**2018**			
Perennial crops	**499,9**	**499,8**	**500,2**	**500,2**	**500,6**			
Perennial plantings	36,9	36,9	37,2	37,3	37,7			
Tree and shrub plantations	463	463	463	463	462,9			

Loss of biomass of perennial crops occurs in the case of cutting down trees and shrubs on cropland, therefore, they were calculated not for all years of the long time series, but only for those years when the area of perennial crops decreased (see Table 2.30).

Table 2.30 Changes in perennial croplands between 1990 and 2018(thousands ha) [270]

Plants	1990	1991	1992	1993	1994	1995	1996	1997
Perennial crops	**492,8**	**494**	**494,2**	**496,4**	**497,5**	**497,5**	**496,4**	**496,6**
Area change	0	1,2	0,2	2,2	1,1	0	-1,1	0,2
Plants	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Perennial crops	**497,1**	**500,1**	**502,7**	**502,3**	**502**	**500,4**	**501,2**	**500,7**
Area change	0,5	3	2,6	-0,4	-0,3	-1,6	0,8	-0,5
Plants	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Perennial crops	**500,1**	**500,2**	**499,7**	**499,6**	**499,7**	**499,9**	**500,2**	**499,7**
Area change	-0,6	0,1	-0,5	-0,1	0,1	0,2	0,3	-0,5
Plants	**2014**	**2015**	**2016**	**2017**	**2018**			
Perennial crops	**499,9**	**499,8**	**500,2**	**500,2**	**500,6**			

[269] State Agency of Land Resources under the Government of Kyrgyz Republic. Reports on the Availability of Land in the Kyrgyz Republic and Distribution by Categories, Owners, Land Users, etc. Changes in the area of many perennial crops. Form 22 (annual).

[270] State Agency of Land Resources under the Government of Kyrgyz Republic. Reports on the Availability of Land in the Kyrgyz Republic and Distribution by Categories, Owners, Land Users, etc. Changes in the area of many perennial crops. Form 22 (annual).

Area change	0,2	-0,1	0,4	0	0,4

Unfortunately, during the 4th NGHGI, it was not possible to reach a consensus on the distribution of the country's territory for all six categories of land use (forests, cropland, grassland, wetlands, settlements and other lands) according to the IPCC Guidelines and to draw up an appropriate land matrix by area, due to the difference in the categorization of lands and the methodological apparatus of land management and reporting of the Kyrgyz Republic and the absence of approved criteria for determining the boundaries and areas of such categories. The proposed division of the country into these categories caused controversial comments, therefore it was decided to leave this issue as well as the collection of activity data (on changes in area) of other land use categories for the next round of the NGHGI. It was noted that compiling a long time series of land use change was the basis for calculating GHG emissions in land use in combination with the distribution of soil types in these categories is possible only through the analysis of archival documents and relevant government decrees for the period 1990-2018.

2.5.3.3.2.3. Estimate of GHG emissions and removals over the period 2011-2018

GHG emissions from the FOLU sector related to the management of the sector determined by fuel combustion and electricity consumption are accounted for in the Energy sector, and GHG emissions from soils are accounted for in the Agriculture Sector.

This section deals mainly with CO_2 absorption and sinks in category 3.B. Land subcategories 3.B.1 - Forest Land and 3.B.2 - Cropland (perennial crops), and minor GHG emissions in category 3.C. - Emissions of gases other than CO_2 subcategory 3.C.1 - Emissions from biomass combustion (methane CH_4 and nitrous oxide N_2O) and in the same category emissions of the precursor gases (CO and NOx), mainly caused by forest fires.

In 2018, the total removals in the FOLU sector amounted to 10940,831 Gg CO_2 equivalent, after deducting emissions from biomass burning. The 2018 data on the inventory of GHG emissions and removals in the FOLU sector for all inventory gases are presented in Table 2.31.

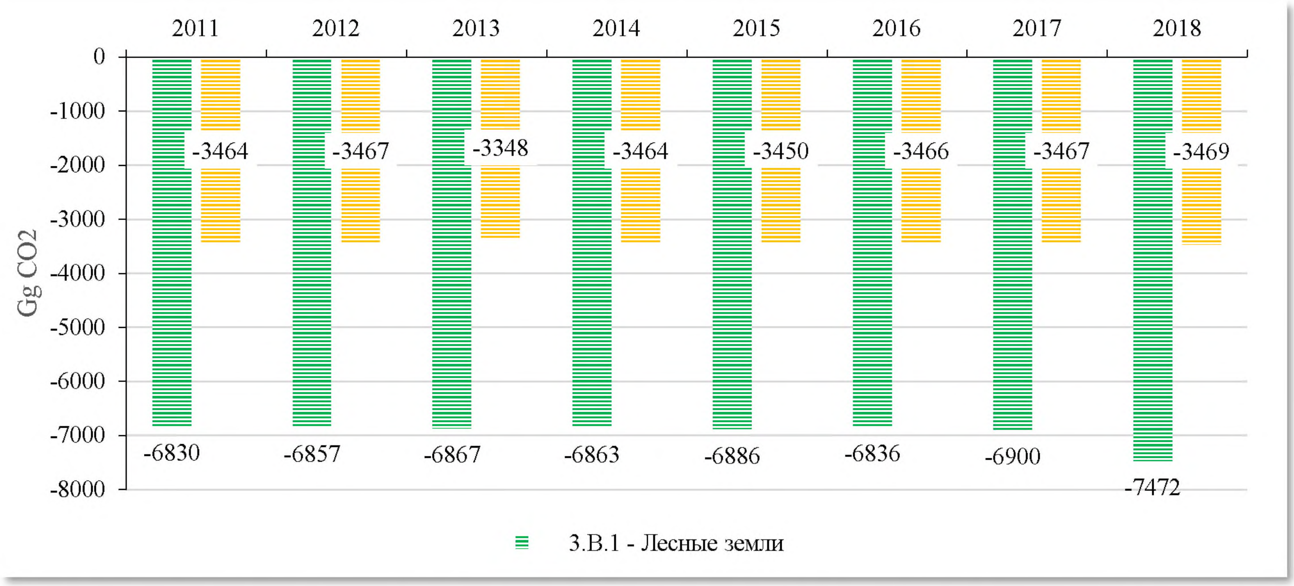
Table 2.31 Emissions and removals of GHGs and precursor gases from the FOLU sector in 2018 (Gg)[271]

Categories	Net CO2	CH4	N2O	NOx	CO
3.B – Land	-10940,831	0,000	0,000	0,000	0,000
3.B.1 – Forest Land	-7471,735	0,000	0,000	0,000	0,000
3.B.2 – Cropland	-3469,096	0,000	0,000	0,000	0,000
3.B.3 – Grassland	0,000	0,000	0,000	0,000	0,000
3.B.4 – Wetlands	0,000	0,000	0,000	0,000	0,000
3.B.5 – Settlements	0,000	0,000	0,000	0,000	0,000
3.B.6 – Other Land	0,000	0,000	0,000	0,000	0,000
3.C – Aggregated sources and non-CO_2 emissions sources on land	0,000	0,491	0,013	0,453	16,681
3.C.1 – Emissions from biomass burning		0,491	0,013	0,453	16,681
3.C.1.a – Biomass burning in Forest Land		0,004	0,000	0,002	0,082
3.C.1.b – Biomass burning in Cropland		0,487	0,013	0,451	16,599
3.D – Other	-0,540	0,000	0,000	0,000	0,000
3.D.1 – Harvested Wood Products	-0,540			0,000	0,000

In the reporting period 2011-2018, cumulative absorption of CO_2 by sinks into forests and perennials in croplands remained stable at one annual level of about 10 million tons (see Figure 2.57).

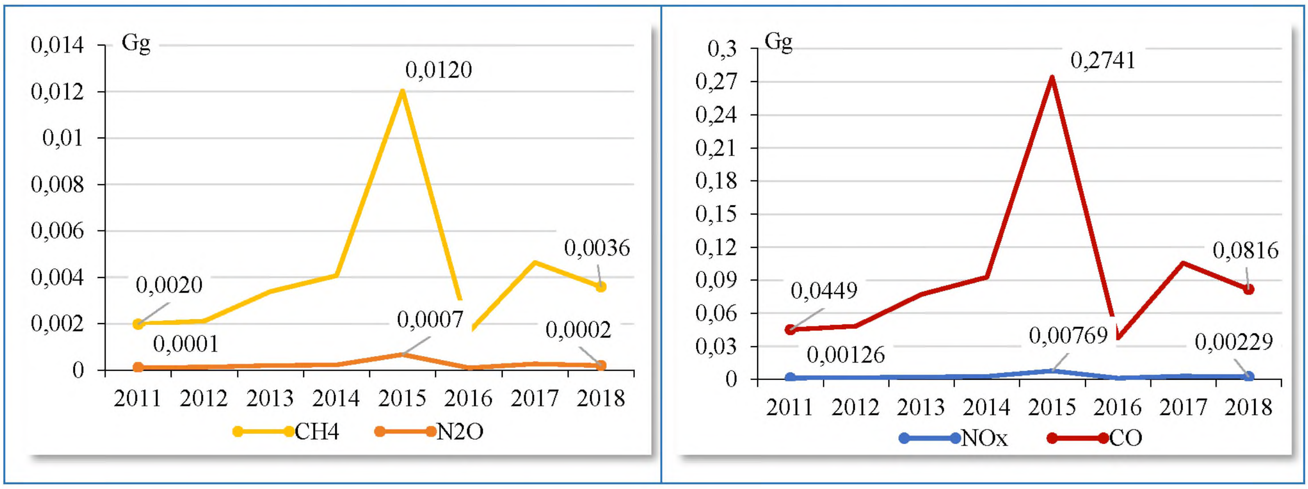
[271] MNRETS, GEF_UNEP. Data Base of the IPCC Inventory Software V2.54. Bishkek. 2022.

Figure 2.57. CO_2 sink of into forest and perennial crops of cropland between 2011 and 2018[272]



Insignificant emissions of other GHGs - methane (CH_4) and nitrous oxide (N_2O), as well as precursor gases (CO and NO_x) by the source category "Biomass burning" for the reporting period, directly depended on the scale of forest wildfires and were defined in small annual values from several tons to kilograms. The dynamics of emissions of these GHGs and precursor gases is shown in Figure 2.58.

Figure 2.58 Emissions of methane, nitrous oxide and precursor gases from 2011 to 2018 [273]



2.5.3.3.2.4. Recalculation and Improvements

It should be noted, that the GHG inventory of the "Forestry and other land use" sector under the IPCC Guidelines (2006) was a major innovation and improvement over all previous assessments, where the main potential of this sector for GHG absorption remained underestimated.

During NGHGI 4, the FOLU sector, the carbon stocks changes were assessed for the forest land biomass and perennial (woody) crops of the cropland. Other types of land use require additional study and research; therefore, the assessment of their carbon potential will be an improvement in the next rounds of the NGHGI in Kyrgyzstan. The transition to the new methodology made it necessary to

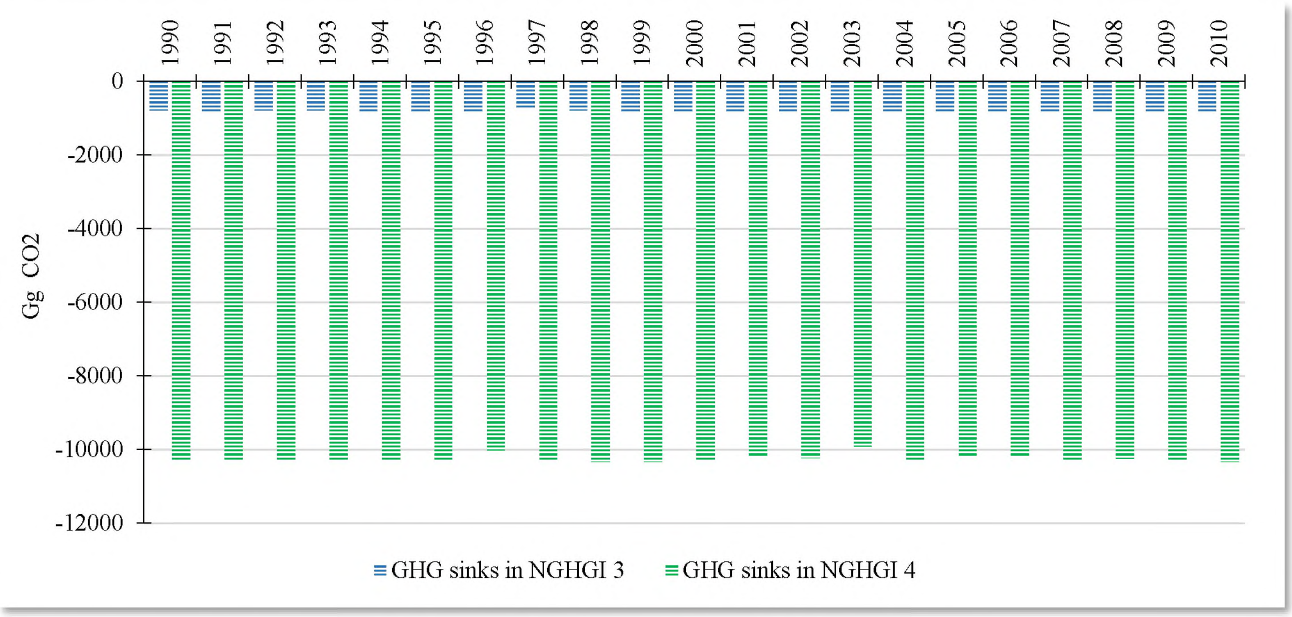
[272] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.
[273] Ibid.

revise the data of the previous 3rd NGHGI and recalculate the GHG emissions and removals of the FOLU sector for the entire historical period from 1990 to 2018.

The focus during NGHGI 4 in the FOLU sector was given to the assessment of biomass stocks in ecosystems with land use and there is sufficient data available for the review. Plant biomass forms the largest carbon stock in many ecosystems and especially forests. Biomass is represented by above-ground and below-ground parts of perennial and annual plants. The biomass of annual and perennial herbaceous plants (i.e., non-woody) is relatively short-lived, i.e. it is decomposed and regenerated annually or every few years. [274].

The transition to a new methodology during the 4th inventory and the recalculations related to the biomass assessment resulted in a significant increase of CO_2 absorption in forests and perennial crops precisely due to recalculations of the volumes of biomass growth. A comparative analysis of the results of the assessment of removals in the FOLU sector for the same period of 1990-2010 showed that the CO_2 values of removals obtained during the 4th inventory are higher than the values of CO_2 removals of the previous inventory (see Figure 2.59).

Figure 2.59 Comparison of the CO2 removals estimates in the FOLU sector of the 3rd and 4th NGHGIs during 1990-2010 [275]



This big difference occurs due to the following reasons:

1. Estimates of biomass growth from the previous 3rd NGHGI were made according to the provisions 1996 IPCC Guidelines, which emphasized that using the "default" methodology could lead to high uncertainty, [276] therefore, national biomass growth factors were used to calculate the annual biomass growth. The methodology of the 2006 IPCC Guidelines used in the 4th NGHGI resulted in the use of a Tier 1 formula when the average annual biomass increment is used.
2. The values of the used biomass growth factors in NGHGI 4 according to the methodology 2006 IPCC Guidelines were several times higher. During the initial NGHGI in early 2000s, the Institute of Forestry and Walnut of the National Academy of Sciences of Kyrgyz Republic pro-

[274] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 3, p. 2.12.
[275] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.
[276] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 4, ch. 5, p.5.4.

posed an estimate of the annual accumulation of dry organic matter in tons per hectare by species and species groups separately for different administrative territories. Based on these estimates, national biomass expansion factors were developed and used to estimate carbon sinks in forests. Note that those coefficient values did not take into account the growth of the underground biomass, since the IPCC recommendations on accounting for the below-ground biomass growth were published later in 2003. During the 2nd NGHGI, considering the IPCC recommendations, the national coefficients were revised to reflect the increase in the below-ground, and an expert correction was made for the natural and climatic factors. The same biomass growth factors were used in the 3rd NGHGI.

From 2015 to 2018, the Forest Institute under the National Academy of Sciences of the Kyrgyz Republic conducted scientific research to revise the growth rates of biomass for 8 tree species (spruce, juniper, walnut, poplar, elm, loch, pistachio, and almonds) and 1 shrub (rosehip). The results of the study show that the biomass conversion and expansion factors (BCEF) for the above species are higher than those used in the 3rd NGHGI and similar to the "default" coefficient values presented in the 2006 IPCC Guidelines. New data from the Forest Institute obtained as a result of research and the coefficients used in the 4th NGHGI are presented in Table 2.32.

Table 2.32 Biomass growth factors used in NGHGI by species[277]

No	Species	Biomass Conversion and Expansion Factors (BCEF)		
		NGHGI 3 (2000)	Forest Institute of the National Academy of Sciences (2015 г.)	NGHGI 4 (2019)
1	Spruce	0,45	1,21	1,4
2	Archa	0,27	1,32	1,4
3	Poplar	0,59	1,16	1,3
4	Elm	0,59	1,24	1,3
5	Oleaster	0,59	1,23	1,3
6	Pistachio	0,59	1,44	1,3
7	Almond	0,59	1,22	1,3
8	Walnut	0,59	1,30	1,3
9	Rose hip	0,59	1,31	1,3

Considering that national scientific research is still ongoing on other tree species and shrubs, refining the coefficients of the annual biomass growth of other tree and shrub species, the assessment of CO2 absorption and stocks of forest land and cropland in the 4th NGHGI was conducted using all coefficients proposed by the IPCC "by default."

3. The third cause for the large difference in the results of CO2 sinks estimates is a more careful examination of sinks into perennial plantations of cropland. Thus, in the 3rd NGHGI, assessment calculations of CO2 absorption of cropland perennial crops were made in the same way as for forest lands, and in the 4th NGHGI according to the 2006 IPCC Guidelines using a different "default" coefficient for above-ground woody biomass and taking into account harvesting cycles in farming systems with the cultivation of perennial crops.

The results of CO_2 removals recalculation for the main sinks of category 3.B. "Land" for the period 1990-2018 are presented below in Table 2.33.

Table 2.33 CO2 removals by main sinks between 1990 and 2018 [278]

Categories	1990	1991	1992	1993	1994	1995	1996	1997

[277] NC 3, IPCC. Guidelines for National Greenhouse Gas Inventories. 2006. Forest Institute of the National Academy of Sciences.

[278] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek, 2022

3.B - Land	**-10266,120**	**-10287,797**	**-10284,340**	**-10290,681**	**-10306,606**	**-10321,216**	**-10029,454**	**-10301,190**
3.B.1 - Forest land	-6850,850	-6864,058	-6859,755	-6850,699	-6858,848	-6873,306	-6861,825	-6859,905
3.B.2 - Cropland	-3415,270	-3423,739	-3424,584	-3439,983	-3447,758	-3447,911	-3167,629	-3441,286
Categories	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
3.B - Land	**-10329,239**	**-10336,867**	**-10301,640**	**-10219,422**	**-10237,451**	**-9912,145**	**-10301,114**	**-10204,269**
3.B.1 - Forest land	-6884,336	-6871,174	-6817,929	-6830,883	-6827,891	-6813,973	-6827,798	-6849,918
3.B.2 - Cropland	-3444,903	-3465,693	-3483,711	-3388,539	-3409,560	-3098,172	-3473,316	-3354,351
Categories	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
3.B - Land	**-10207,372**	**-10307,978**	**-10248,144**	**-10301,426**	**-10332,755**	**-10294,539**	**-10323,169**	**-10215,273**
3.B.1 - Forest land	-6880,279	-6841,592	-6900,723	-6862,298	-6869,834	-6830,232	-6856,630	-6866,986
3.B.2 - Cropland	-3327,093	-3466,386	-3347,421	-3439,128	-3462,921	-3464,307	-3466,539	-3348,287
Categories	**2014**	**2015**	**2016**	**2017**	**2018**			
3.B - Land	**-10326,798**	**-10335,815**	**-10301,950**	**-10366,814**	**-10940,831**			
3.B.1 - Forest land	-6862,692	-6885,509	-6835,627	-6900,206	-7471,735			
3.B.2 - Cropland	-3464,106	-3450,306	-3466,324	-3466,608	-3469,096			

It should be noted that subcategory 3.D.1 - Harvested Wood Products (HWP) are also added to the final total removals, which together with 3.B - Land give the final national total CO_2 removals. These values in CO_2 Gg are calculated automatically by the software and presented in Table 2.34.

Table 2.34 CO_2 removal values for Harvested Wood Products subcategory 1990-2018 (Gg) [279]

Categories	1990	1991	1992	1993	1994	1995	1996	1997
3.D.1 – HWP	-7,405	-6,686	-5,191	-2,893	-3,128	-2,431	-2,705	-2,096
Categories	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
3.D.1 – HWP	-2,272	-2,228	-2,237	-1,976	-1,809	-2,171	-1,752	-1,717
Categories	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
3.D.1 – HWP	-1,557	-1,923	-2,561	-1,976	-1,790	-1,235	-1,171	-0,919
Categories	**2014**	**2015**	**2016**	**2017**	**2018**			
3.D.1 – HWP	-0,920	-0,716	-0,590	-0,500	-0,540			

The recalculations of other GHG (CH_4 and N_2O) emissions in the FOLU sector during the period of 1990-2018 caused by wild fires and attributed to category 3.C.1 –Biomass burning in Forest Lands are presented in Tab. 2.35.

Table 2.35 Emissions of methane and nitrous oxide from biomass burning between 1990 and 2018 (Gg) [280]

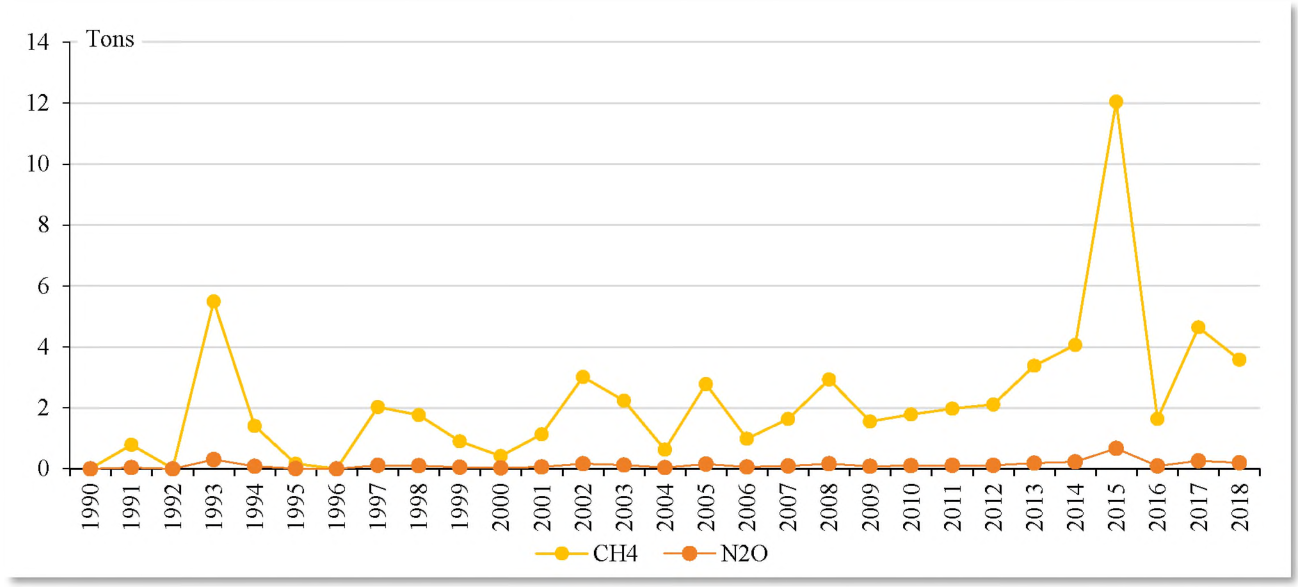
Gas	1990	1991	1992	1993	1994	1995	1996	1997
CH4	0,0000	0,0008	0,0000	0,0055	0,0014	0,0002	0,0000	0,0020
N2O	0,0000	0,0000	0,0000	0,0003	0,0001	0,0000	0,0000	0,0001
Gas	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CH4	0,0018	0,0009	0,0004	0,0011	0,0030	0,0022	0,0006	0,0028
N2O	0,0001	0,0000	0,0000	0,0001	0,0002	0,0001	0,0000	0,0002
Gas	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
CH4	0,0010	0,0016	0,0029	0,0016	0,0018	0,0020	0,0021	0,0034
N2O	0,0001	0,0001	0,0002	0,0001	0,0001	0,0001	0,0001	0,0002
Gas	**2014**	**2015**	**2016**	**2017**	**2018**			
CH4	0,0041	0,0120	0,0016	0,0046	0,0036			
N2O	0,0002	0,0007	0,0001	0,0003	0,0002			

[279] Ibid.

[280] Ibid.

As can be seen from the table, the emissions of these greenhouse gases in the FLOU sector from 1990 to 2018 are relatively small and depends on the size of the forest fires. The dynamics of methane and nitrogen emissions from biomass burning have always been determined by the scale of these events occurring in the country (see Figure 2.60).

Figure 2.60. Trends in emissions of methane and nitrous oxide in the period 1990-2018[281]



Aside from methane and nitrous oxide, biomass burning is also associated with the emissions of precursor gases as CO - carbon monoxide and NOx - nitrogen oxides, which are also taken into account in the NGHGI. The results of the recalculation of the emissions of the precursor gases of the FOLU sector for the period 1990-2018 are presented in Table 2.36.

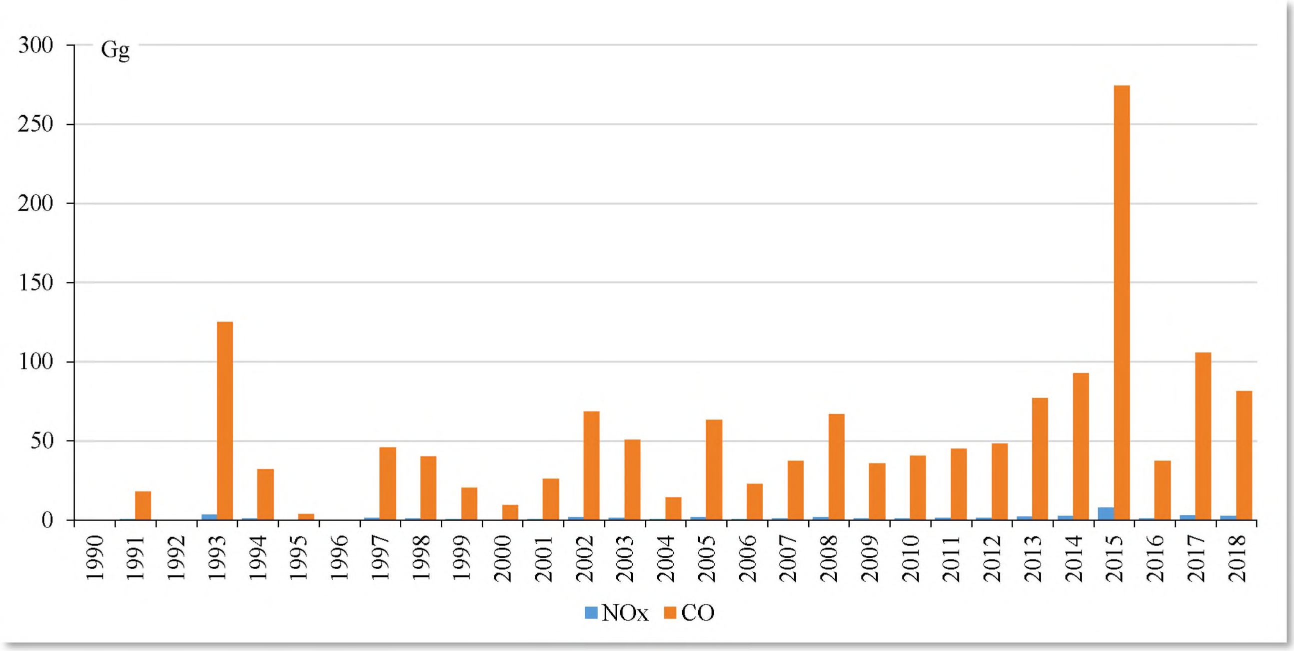
Table 2.36 Emissions of precursor gases from the FOLU sector between 1990 and 2018 (Gg) [282]

Gas	1990	1991	1992	1993	1994	1995	1996	1997
NOx	0,00001	0,00050	0,00001	0,00350	0,00090	0,00011	0,00000	0,00129
CO	0,0002	0,0178	0,0002	0,1250	0,0320	0,0038	0,0000	0,0460
Gas	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
NOx	0,00112	0,00058	0,00027	0,00072	0,00192	0,00143	0,00040	0,00178
CO	0,0400	0,0206	0,0095	0,0258	0,0686	0,0508	0,0142	0,0633
Gas	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
NOx	0,00063	0,00105	0,00187	0,00099	0,00113	0,00126	0,00135	0,00216
CO	0,0225	0,0373	0,0667	0,0354	0,0405	0,0449	0,0481	0,0769
Gas	**2014**	**2015**	**2016**	**2017**	**2018**			
NOx	0,00260	0,00769	0,00105	0,00296	0,00229			
CO	0,0926	0,2741	0,0373	0,1055	0,0816			

The emissions dynamic of the FOLU precursor gases during the period 1990-2018 were also directly related to and determined by the extent of forest fires (see Figure 2.61).

281 Ibid.
282 MNRETN, GEF-UNEP. IPCC Inventory Software V2.54 Database. - B., 2021.

Figure 2.61 The dynamic of emissions of the precursor gases in the FOLU sector between 1990 and 2018 [283]



2.5.3.3.2.1. Uncertainty Assessment

The following sources of uncertainty were taken into account estimating CO_2 changes in the forest lands:

- Area of forest land remaining forest land.
- Average annual growth of above-ground biomass.
- Ratio of underground biomass and above-ground biomass.
- Fraction of carbon in dry matter.
- Factor of conversion and expansion of biomass.

The following sources of uncertainties were taken into account in estimating CO_2 changes in perennial cropland:

- Annual area of cropland with perennial woody biomass.
- Annual growth of perennial woody biomass.
- Loss of biomass carbon.

The 2006 IPCC Guidelines were applied to combine the uncertainties after determining the uncertainty values for each of the above sources.[284] The resulting values were then entered into the software and the uncertainty of the GHG inventory of the whole FOLU sector was determined, which in terms of the level amounted to 40,222% and uncertainty of trends 34,168%.

2.5.3.4. Waste

There are 406 landfills in the Kyrgyz Republic as of 2018 according to the inventory of consumption waste disposal sites carried out by the SAEPF. To date, about 16 million 409,629 thousand tons of

283 Ibid.

284 IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 5, ch. 3, p. 3.34

consumption waste have been accumulated at the landfills of the Kyrgyz Republic. There are no specialized dumps and landfills for separate disposal of industrial waste (except for tailing dumps, sludge collectors, etc.) in the republic, and a significant part of production waste is located on the territory of enterprises. On average, about one percent of the volume of waste generated per year is transferred to other enterprises, mainly for use or disposal. Waste is transferred or taken away mainly to municipal dumps. There is no separate accounting for medical waste, it is placed in landfills together with solid household waste, some of them are exposed to open burning and constitute a part of solid household waste.[285]

The existing drainage system provides spontaneous discharge of wastewater through the main collectors to the municipal treatment facilities. From the outskirts, located below the treatment plant, wastewater is pumped by a sewage pumping station. Wastewater from residential areas, administrative and public buildings, and industrial enterprises are discharged into the municipal sewerage system. From deprived areas, wastewater is transported to a drainage station. Some urban dwellings have filtered pit latrines, which also serve as additional factors for soil and groundwater pollution by pathogenic microbes and products of organic degradation.

Both municipal and industrial wastewater is discharged into the centralized sewerage system in the Kyrgyz Republic. Industrial wastewater is generally treated together with municipal wastewater from settlements. The highly polluted effluents of individual industrial enterprises are pre-treated at the treatment plants before entering the public utilities.

The National Statistical Committee of the Kyrgyz Republic is the main provider of information and data for the estimation of GHG emissions in the Waste sector. In addition, valuable information in the field of waste and wastewater management was also provided by the MNRETS, the Municipal Enterprise - Production and Operations Directorate “Bishkekvodokanal” and the Scientific and Production Association “Preventive Medicine” under the Ministry of Health of Kyrgyz Republic.

2.5.3.4.1. Assessment methodology, level and coefficients

According to the IPCC methodology, the structure of the GHG inventory for the Waste sector has the following structure by categories of emission sources:

- 4 Waste
  - 4.A Solid Waste Disposal
    - 4.A.1 Managed Waste Disposal Sites
    - 4.A.2 Unmanaged Waste Disposal Sites
    - 4.A.3 Uncategorized Waste Disposal Sites
  - 4.B Biological Treatment of Solid Waste
  - 4.C Incineration and Open Burning of Waste
    - 4.C.1 Waste Incineration
    - 4.C.2 Open Burning of Waste
  - 4.D Wastewater Treatment and Discharge
    - 4.D.1 Domestic Wastewater Treatment and Discharge
    - 4.D.2 Industrial Wastewater Treatment and Discharge
  - 4.E Other.[286]

Solid Waste Disposal

[285] Analytical report on the management of medical waste (MMW) and handling mercury-containing products. Bishkek. Reply to a request dated 14.08.2019, No.01-3/183

[286] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, vol. 5, ch. 1, p. 1.5.

The First Order Decay (FOD) method was used to assess CH_4 methane emissions from waste disposal at landfills. This method assumes that degradable organic components (i.e. degradable organic carbon - DOC) in waste degrade slowly over several decades when CH_4 and CO_2 are formed. If conditions are constant, then the CH_4 production rate depends solely on the amount of carbon remaining in the waste. As a result, CH_4 emissions from wastes disposed of in landfills remain high for the first few years after disposal and then gradually decrease as the degradable carbon in the waste is destroyed by the bacteria responsible for the decomposition.[287]

The lack of data on waste management activities in the Kyrgyz Republic over the past 50 years prevented the inventory team from using Tier 2 of the FOD method, but to accurately assess the Soviet period (until the 1990s). If the emissions were estimated for the period from 1990 to 2018, then the volume of emissions could be underestimated, so the estimation of emissions for this category was extended with an additional time series 1969 - 1989.

Biological treatment of solid waste

Composting and anaerobic processing of organic waste such as food waste, waste generated in gardens (yards) and parks, sewage sludge is a common practice in both developed and developing countries. Benefits of biological treatment include: reducing the volume of waste material, stabilizing waste, killing pathogens in the waste material, and generating biogas for further energy use. The end products of biological treatment may, depending on their quality, be processed either as organic fertilizer or disposed of in solid waste landfills.[288]

Emissions of methane (CH_4) and nitrous oxide (N_2O) from biological treatment have been estimated using the IPCC "default" method, which is based on an estimate of the amount of waste composted, the emission factor for wet weight treatment, the share of fossil carbon and the oxidation coefficient. This method is based on the total amount of composted waste.

Incineration and Open Burning of Waste

IPCC waste incineration refers to the incineration of solid and liquid waste at controlled incineration plants, which are not available in Kyrgyzstan. Open burning of waste refers to the incineration of unwanted combustible materials such as paper, wood, plastics, textiles, rubber, used oils and other outdoor waste when the emissions are released directly into the atmosphere. Like any other incineration, open burning is a source of greenhouse gas emissions: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Typically, this produces significantly more CO_2 than CH_4 and N_2O.[289]

The calculation of CO_2 emissions is based on an estimate of the amount of waste (weight of wet matter) exposed to open burning, considering dry matter content, total carbon content, fossil carbon fraction and oxidation factor. CH_4 and N_2O calculations are also based on the total mass of waste incinerated and the IPCC emission factors.[290]

Due to the absence of accurate long series of data on the quantity of waste incinerated, the calculation of the total amount of municipal solid waste, exposed to open burning, was used according to the equation of the 2006 IPCC Guidelines.

$$MSW_B = P * P_{frac} * MSW_P * B_{frac} * 365 * 10^{-6}$$

Where:

MSW_B = Total amount of municipal solid waste open-burned, Gg/yr

[287] Ibid, ch. 3, p. 3.6.

[288] Ibid, ch. 4, p. 4.4.

[289] Ibid, ch. 5, p. 5.6.

[290] Ibid, vol. 5, ch. 5, page 5.15.

P = population (capita)
P_{frac} = fraction of population burning waste, (fraction)
MSW_P = per capita waste generation, kg waste/capita/day
B_{frac} = fraction of the waste amount that is burned relative to the total amount of waste treated, (fraction)
365 = number of days by year
10^{-6} = conversion factor from kilogram to Gigagram.[291]

Domestic and Industrial Waste Water

Wastewater can generate methane (CH_4) and nitrous oxide (N_2O) emissions during anaerobic treatment or disposal. Carbon dioxide (CO_2) emissions from wastewater are not accounted for because they are biogenic and are not included in national totals.

Wastewater originates from a variety of domestic, commercial, and industrial sources and can be treated locally (without collection), discharged into a sewer or removed untreated through drainage. Domestic wastewater is defined as wastewater generated from domestic use, and industrial wastewater, in turn, only as a result of industrial activities. Emissions from these two types of domestic and industrial wastewater were calculated separately.[292]

The amount of methane released primarily depends on the amount of degradable organic material in the wastewater, temperature and treatment system. As the temperature rises, so does the amount of CH_4 released, which is important in uncontrolled systems and warm climates.

The main factor in determining the CH_4 generation potential in wastewater is the amount of organic products degradable in wastewater. The standard parameters used to measure the volume of organic components in wastewater are Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). Under the same conditions, wastewater with a higher COD or BOD level tends to produce more CH_4 than wastewater with a lower COD (or BOD) concentration.

Nitrous oxide (N2O) accompanies the breakdown of nitrogenous components in wastewater such as urea, nitric acid and protein in domestic wastewater. Direct N2O emissions can occur during both nitrification and denitrification of the present nitrogen. Both of these processes can take place at treatment plants and waste-receiving ponds. [293]

The methodology for estimating methane and nitrous oxide emissions includes three stages for each gas:

- calculation of the total amount of CH4 emissions from domestic wastewater;
- calculation of the CH4 emission factor for each path or wastewater treatment/discharge system;
- emission estimate.

The method for calculating GHG emissions from industrial wastewater is similar to that used for domestic wastewater. Nitrous oxide emissions are directly related to its release from human waste. The volume of these emissions is directly related to the amount of protein food consumed.

Due to the lack of sufficient national data, the coefficients and parameters for estimating GHG emissions in the Waste sector were adopted in the proposed IPCC values.

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[291] IPCC. Guidelines for National Greenhouse Gas Inventories. 2006, ch. 5, p. 5.18.
[292] Ibid, ch. 6, p. 6.6.
[293] Ibid, ch. 6, p. 6.7.

2.5.3.4.2. Activity Data

The official NSC data on the volume of household solid waste disposal is the initial information to form activity data time series under the category of Solid Waste Disposal. It should be noted that in the Kyrgyz Republic there is no clear relationship, usually observed for other countries, between the amount of generated solid waste (SW) and the standard of living of the population, and significant fluctuations in the amount of waste disposed of are often explained by the quality of the functioning of waste collection and accounting systems.

For the category of waste “Snow and Other Cargo” officially accounted for by the NSC, according to the expert assessment, it is assumed that only half of this category belongs to solid household waste in terms of morphological composition. Accounting for the category “Snow and Other Cargo” was carried out from 1990 to 2008, and since 2009 accounting for this category was terminated.

Since NSC accounts for the annual volume of solid waste disposal in cubic meters and only starting from 2010, the amount of waste is provided in tons, the waste density is used for conversion. For the period (1990–2010), there are no official data on waste density, which led to the need to use the interpolation method by applying the dependency recovery method from small samples with an unknown structure, nonparametric regression recovery algorithm.

The data on the morphological composition of solid waste in the republic is not available because regular observations are not conducted, and there are fragmentary research data obtained in the frame of international projects on waste management. Therefore, non-parametric interpolation is also used to recover missing values.

According to the assessment of most experts, all landfills in Kyrgyzstan can be classified as unmanaged. Of these, according to expert estimates, polygons of large cities (6,5%) were attributed to landfills with a depth of more than 5 m, all the rest (93,5%) - to unmanaged polygons (dumps) with a depth of less than 5 m.

An integrated approach was used to generate a long time series of data on the volumes of solid waste disposed in landfills between 1969 and 2018. Rows from 1990 to 2018 were obtained from the NSC, and from 1969 to 1989 series were calculated using population data and the value of the average solid waste accumulation rate according to the IPCC methodology. Table 2.37 presents the long time series of the volumes of removed waste from 1969 to 2018.

Table 2.37 The solid waste disposed of in landfills between 1969 and 2018 (thousand t) [294]

1969	1970	1971	1972	1973	1974	1975	1976	1977
497,57	509,98	520,05	531,73	542,95	554,57	567,34	578,43	590,38
1978	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**
601,14	612,39	623,69	635,17	647,47	660,77	674,98	687,93	700,68
1987	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
714,48	727,84	740,16	732,19	871,53	826,04	677,93	400,63	457,09
1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
373,27	433,03	346,67	385,27	384,75	410,16	382,35	372,94	479,55
2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
414,94	463,16	496,33	754,57	1283,88	1114,56	1173,77	980,36	1174,37

[294] NSC data and the expert calculations.

2014	**2015**	**2016**	**2017**	**2018**				
994,85	1113,27	995,72	981,46	1047,77				

The National Statistical Committee does not keep records of the proportion of waste compostable, but records for households that dispose of waste by burial. Data «Garbage Disposal by Territory and Place of Residence» is provided by the NSC for the whole republic for the period 2009 - 2018.

Data on the number of households are provided by the 1999 and 2009 censuses. Data on the population of the Kyrgyz Republic for the period from 1990 to 2009, data on the number of households burning waste from 2009 to 2018, and data on the number of households in the country were used to calculate the share of households composting waste for the period from 1990 to 2009. [295] Data on the number of people who dispose of waste by burial and the share of composting waste of 0.05 (adopted by the IPCC "by default") were also used to calculate the volume of composted waste. The data obtained were used to reconstruct the time series from 1990-2009 by interpolation.

Data on the proportion of the population with access to adequate sanitation was provided by the NSC for the period 2009-2018. The population covered by wastewater collection systems is taken to calculate the estimate of the total amount of organic matter in wastewater. Population covered by wastewater collection systems from 1990 to 2009 was calculated by using data on the actual population and the proportion of the population with access to adequate sanitary and hygienic conditions (sewerage, septic tank, toilet).

The filling of gaps in the data on the proportion of the population with access to sewerage, flush toilets (with a central and individual sewerage system) and latrines for the period from 1990 to 2009 was carried out using the interpolation method.

Data on industrial output were provided by the NSC in full from 1990 to 2018 for the following industrial products:

- meat and food offal;
- vegetable oil;
- beer;
- ethyl alcohol;
- fish and fish products, processed and canned;
- processed and canned fruits, vegetables and mushrooms;
- sugar;
- whole milk products;
- wine production;
- paper production;

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories provide data on COD and wastewater generated per unit of production, excluding COD kg/m^3 for vegetable oil and generation of wastewater from sugar production and fish processing. The missing data are taken according to the reference literature. Additionally, the NSC provided data on protein consumption from 1990 to 2018.

2.5.3.4.3. Estimated GHG emissions for the period 2011 - 2018

In 2018, the total GHG emissions in the Waste sector amounted to 576,037 Gg CO_2 equivalent. The key share in the total volume of emissions was methane emissions in category 4.A - Solid Waste Disposal in the subcategory "Unmanaged Waste Disposal Sites", as well as emissions of methane and

[295] NSC. Population and Housing Census of the Kyrgyz Republic in 2009. Book in V tables. Households and Families of Kyrgyzstan. Bishkek, 2011

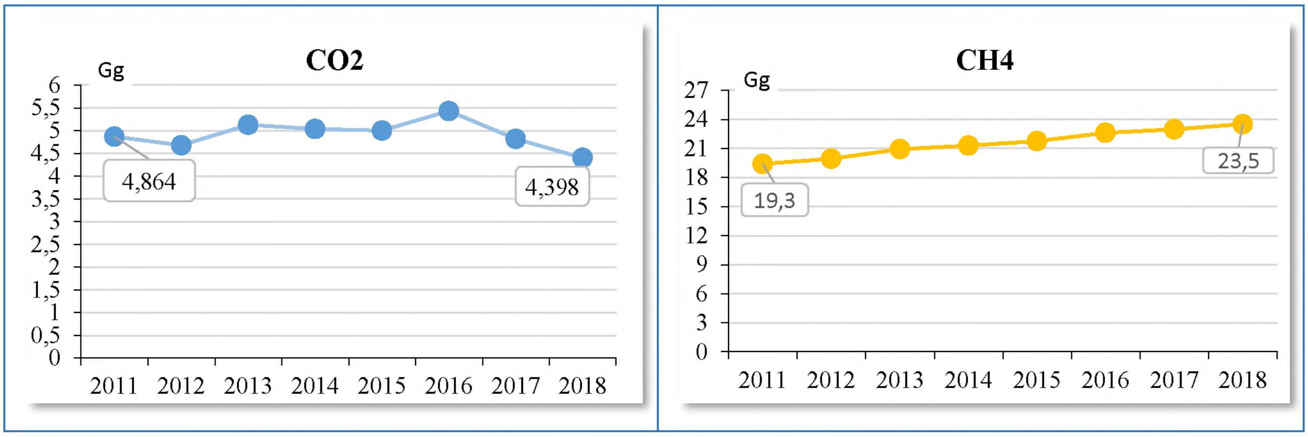
nitrous oxide in the source category 4.D - Wastewater Treatment and Discharge. The results of the Inventory of the Waste Sector in 2018 are presented in Table 2.38.

Table 2.38 Estimated emissions of the Waste sector by gases and sources in 2018 (Gg) [296]

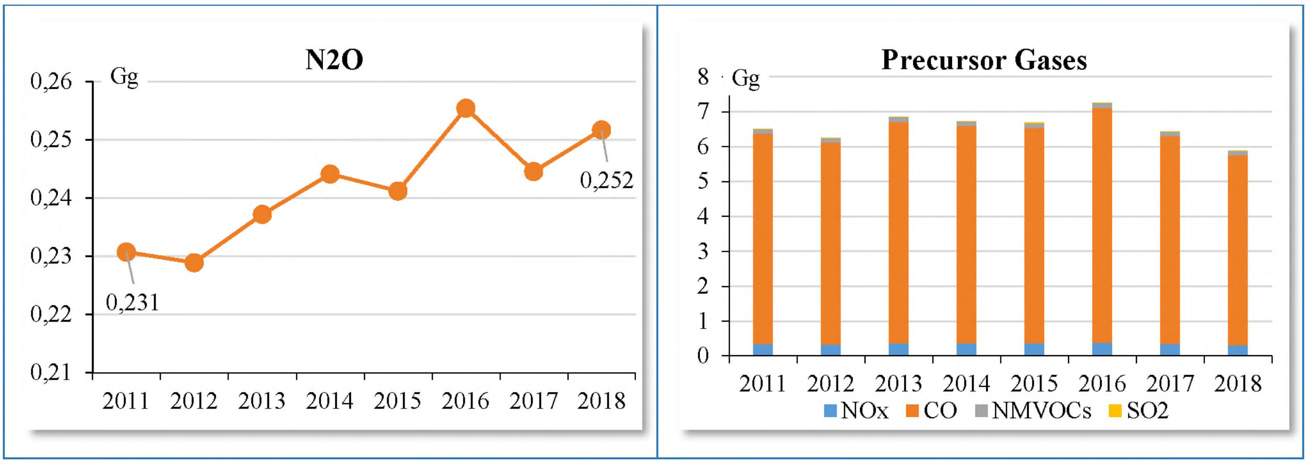
Categories	CO2	CH4	N2O	NOx	CO	NMVOC	SO2
4 - Waste	4,398	23,506	0,252	0,310	5,444	0,120	0,011
4.A - Solid Waste Disposal	0,000	15,522	0,000	0,000	0,000	0,000	0,000
4.A.1 - Managed Waste Disposal Sites				0,000	0,000	0,000	0,000
4.A.2 - Unmanaged Waste Disposal Sites				0,000	0,000	0,000	0,000
4.A.3 - Uncategorized Waste Disposal Sites				0,000	0,000	0,000	0,000
4.B - Biological Treatment of Solid Waste		0,087	0,005	0,000	0,000	0,000	0,000
4.C - Incineration and Open Burning of Waste	4,398	0,634	0,011	0,310	5,444	0,120	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	4,398	0,634	0,011	0,310	5,444	0,120	0,011
4.D - Wastewater Treatment and Discharge	0,000	7,264	0,235	0,000	0,000	0,000	0,000
4.D.1 - Domestic Wastewater Treatment and Discharge		6,519	0,235	0,000	0,000	0,000	0,000
4.D.2 - Industrial Wastewater Treatment and Discharge		0,745		0,000	0,000	0,000	0,000

The emission volumes by gases varied during the reporting period 2011-2018. Thus, in 2018, emissions of carbon dioxide (CO_2) and nitrous oxide (N_2O) remained at the same level as in 2011, while methane (CH_4) emissions increased by 20%. The level of emissions of precursor gases remained at the same level (see Figure 2.62).

Figure 2.62 The dynamic of direct GHG and precursor gases emissions from the Waste sector between 2011 and 2018 [297]

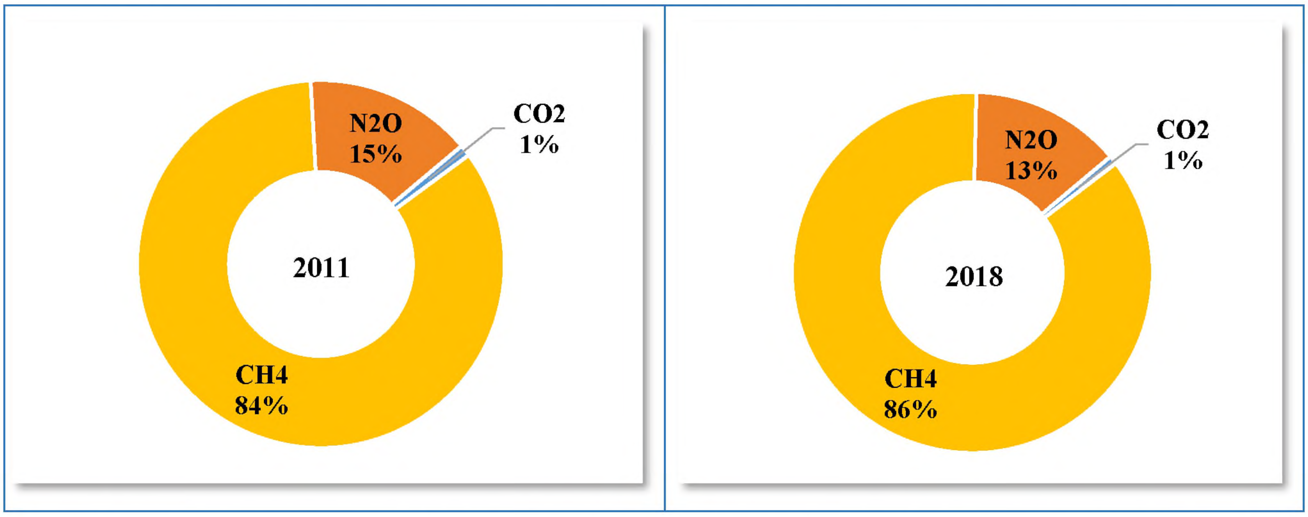


296 MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.
297 Ibid.



The proportionate structure of emissions of different gases as a share of the sector's total GHG emissions during the period 2011 - 2018 has changed due to the increase in methane emissions due to the reduction of nitrous oxide emissions (see Figure 2.63).

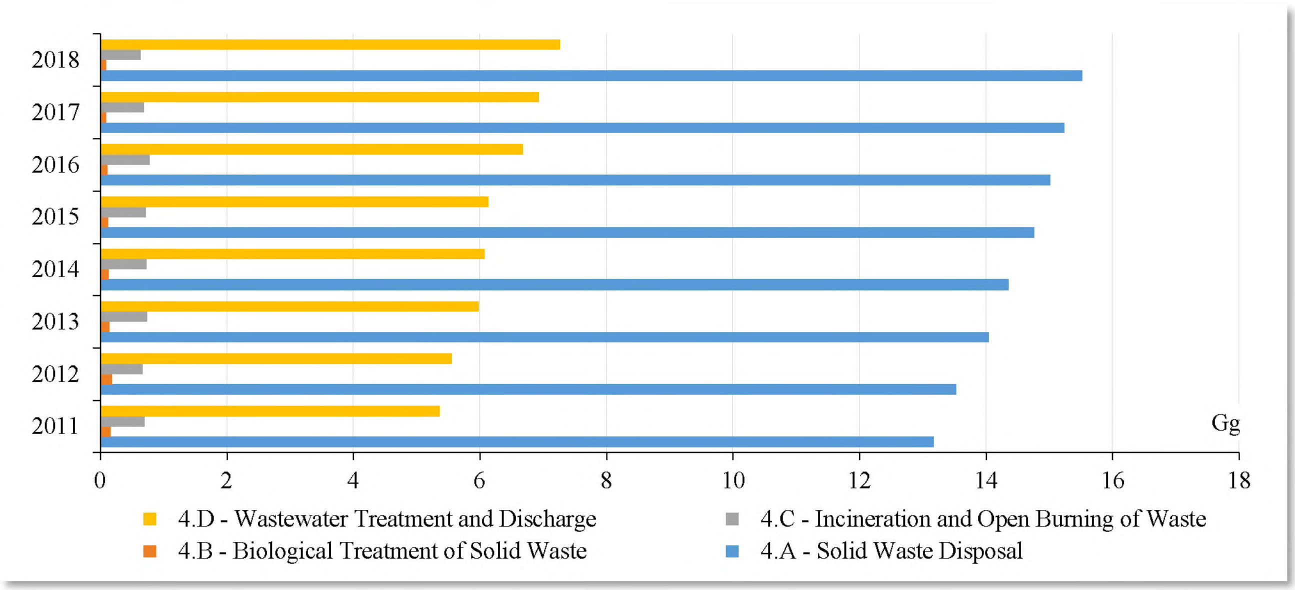
Figure 2.63 Structural composition of GHG emissions in the Waste sector in 2011 and 2018/[298]



The main and only source of carbon dioxide (CO_2) emissions in the Waste sector was category 4.A - Incineration and Open Burning of Waste. Sources of methane (CH_4) emission were all the categories of the sector (see Figure 2.64).

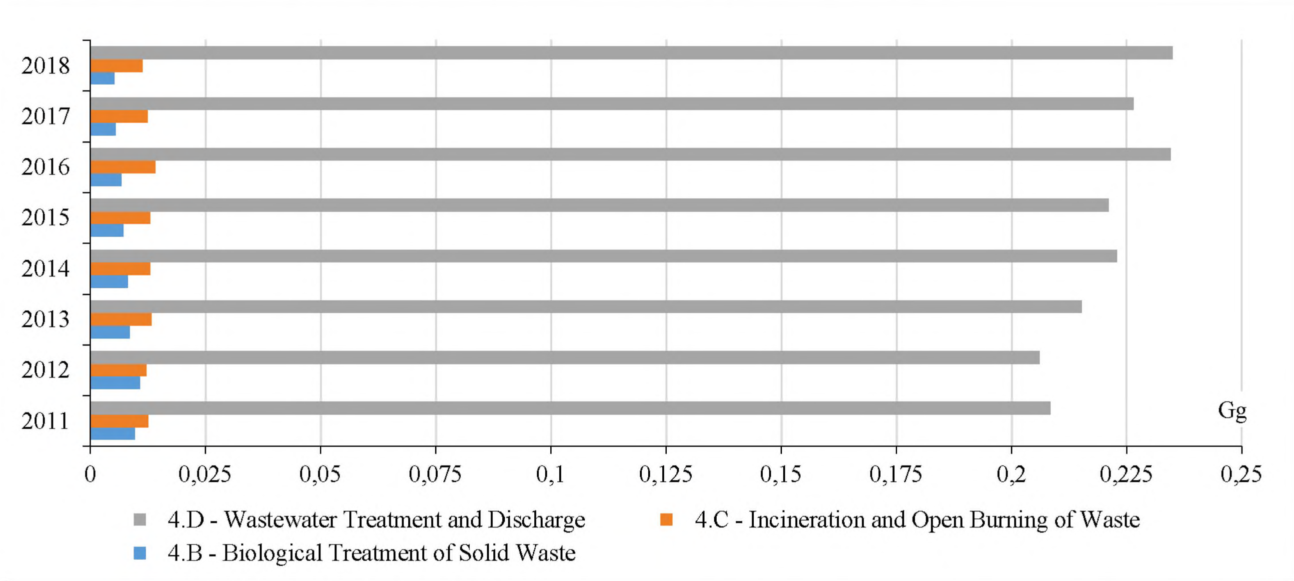
Figure 2.64 Methane emissions by sources in the period 2011-2018.[299]

[298] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022
[299] Ibid.



Sources of nitrous oxide emissions from the sector (N_2O) 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 Figure 2.65).

Figure 2.65 Emissions of Nitrous Oxide by sources in the period 2011-2018. [300]



The source of precursor gas emissions was category 4.C - Incineration and Open Burning of Waste.

The results of the Waster sector NGHGI 4 by sources and greenhouse gases for the period 2011 - 2018 are presented in the Table 2.39.

Table 2.39 The Waster sector inventory results by gases and emission sources in 2011-2018.(Gg) [301]

CO2								
Categories	2011	2012	2013	2014	2015	2016	2017	2018
4.C - Incineration and Open Burning of Waste	4,864	4,671	5,122	5,034	4,995	5,428	4,813	4,398

[300] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.
[301] Ibid.

CH4								
Categories	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
4.A - Solid Waste Disposal	13,173	13,523	14,046	14,357	14,761	15,020	15,242	15,522
4.B - Biological Treatment of Solid Waste	0,161	0,179	0,143	0,136	0,119	0,112	0,093	0,087
4.C - Incineration and Open Burning of Waste	0,701	0,673	0,738	0,725	0,720	0,782	0,693	0,634
4.D - Wastewater Treatment and Discharge	5,363	5,557	5,978	6,069	6,137	6,677	6,933	7,264
N2O								
Categories	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
4.B - Biological Treatment of Solid Waste	0,010	0,011	0,009	0,008	0,007	0,007	0,006	0,005
4.C - Incineration and Open Burning of Waste	0,013	0,012	0,013	0,013	0,013	0,014	0,012	0,011
4.D - Wastewater Treatment and Discharge	0,208	0,206	0,215	0,223	0,221	0,235	0,226	0,235

2.5.3.4.4. Recalculation and improvement of emission estimates in the Waste sector

The adoption of the new methodology for estimating the GHG emissions of the sector Waste in NGHGI 4 made it necessary to recalculate the entire time series of greenhouse gas emissions. Recalculations of the sector's GHG emissions for the period 1990 - 2018 are presented in tab. 2.40.

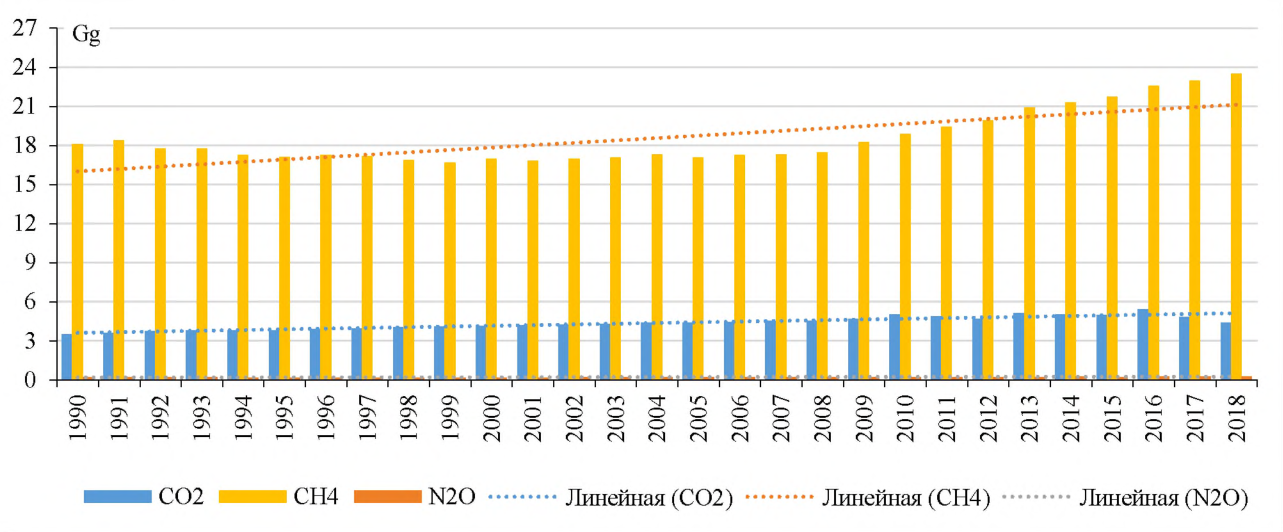
Table 2.40 GHG emissions of the Waste sector in 1990-2018 (Gg) [302]

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO2	3,533	3,630	3,735	3,793	3,803	3,828	3,897	3,961	4,031	4,102
CH4	18,109	18,380	17,781	17,783	17,283	17,112	17,292	17,186	16,857	16,688
N2O	0,219	0,200	0,201	0,200	0,180	0,194	0,190	0,178	0,186	0,191
Gas	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
CO2	4,165	4,210	4,255	4,299	4,355	4,414	4,464	4,520	4,562	4,646
CH4	16,946	16,844	16,971	17,089	17,337	17,092	17,291	17,295	17,456	18,248
N2O	0,185	0,188	0,199	0,204	0,207	0,215	0,216	0,212	0,221	0,230
Gas	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	
CO2	5,034	4,864	4,671	5,122	5,034	4,995	5,428	4,813	4,398	
CH4	18,879	19,397	19,933	20,904	21,288	21,736	22,591	22,962	23,506	
N2O	0,230	0,231	0,229	0,237	0,244	0,241	0,255	0,245	0,252	

GHG emission trends for selected gases in the period 1990-2018 increased. During this period, carbon dioxide emissions grew by 24,48%, methane emissions by 29,81%, and nitrous oxide emissions by 14,95%. The dynamics of emissions by gases are shown in Figure 2.66.

Figure 2.66 GHG emissions dynamic in the period 1990-2018[303]

[302] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.
[303] Ibid.



The results of GHG emissions recalculation from the Waste sector to CO_2 equivalent by emission sources for the period 1990-2018 are presented in Table 2.41.

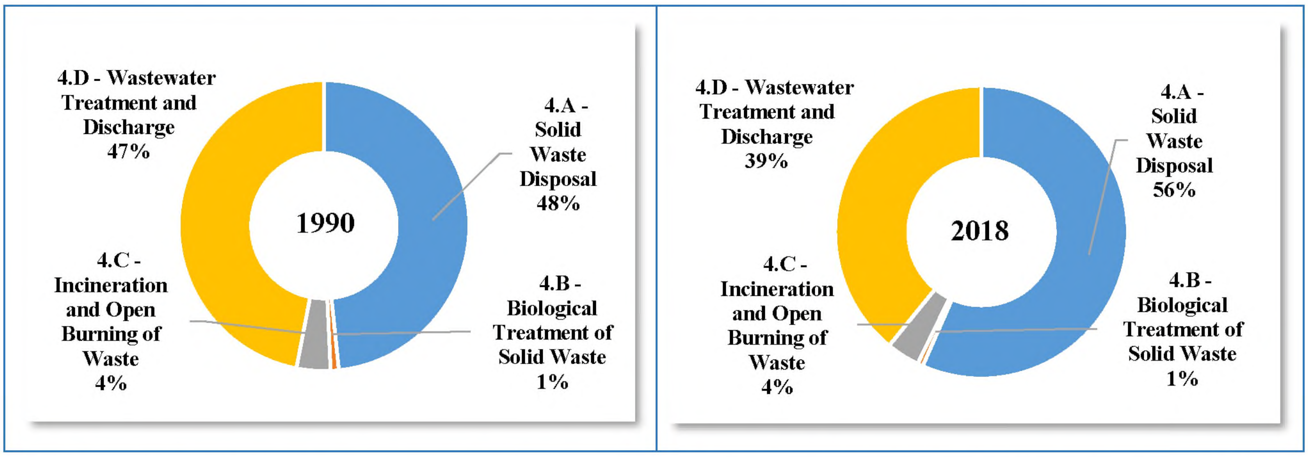
Table 2.41 GHG emissions from the Waste sector in the period 1990-2018 in CO_2 equivalent (Gg) [304]

Categories	1990	1991	1992	1993	1994	1995
4 - Waste	**451,682**	**451,686**	**439,378**	**439,104**	**422,415**	**423,188**
4.A - Solid Waste Disposal	218,446	229,609	239,171	244,740	243,392	243,466
4.B - Biological Treatment of Solid Waste	4,091	4,122	4,166	4,166	4,190	4,308
4.C - Incineration and Open Burning of Waste	17,061	17,529	18,035	18,316	18,366	18,486
4.D - Wastewater Treatment and Discharge	212,085	200,425	178,006	171,883	156,467	156,928
Categories	1996	1997	1998	1999	2000	2001
4 - Waste	**425,864**	**419,987**	**415,535**	**413,694**	**417,481**	**416,263**
4.A - Solid Waste Disposal	241,523	241,136	238,658	237,220	235,831	235,108
4.B - Biological Treatment of Solid Waste	4,451	4,483	4,518	4,558	4,803	4,942
4.C - Incineration and Open Burning of Waste	18,819	19,131	19,464	19,808	20,111	20,331
4.D - Wastewater Treatment and Discharge	161,072	155,238	152,894	152,108	156,735	155,882
Categories	2002	2003	2004	2005	2006	2007
4 - Waste	**422,325**	**426,328**	**432,714**	**429,963**	**434,549**	**433,423**
4.A - Solid Waste Disposal	233,645	231,912	232,609	231,649	231,587	231,970
4.B - Biological Treatment of Solid Waste	4,966	4,990	5,025	5,291	5,520	5,599
4.C - Incineration and Open Burning of Waste	20,549	20,760	21,033	21,314	21,558	21,828
4.D - Wastewater Treatment and Discharge	163,165	168,666	174,046	171,710	175,883	174,025
Categories	2008	2009	2010	2011	2012	2013
4 - Waste	**439,495**	**459,145**	**472,887**	**483,717**	**494,216**	**517,627**
4.A - Solid Waste Disposal	237,494	253,218	264,616	276,626	283,986	294,956
4.B - Biological Treatment of Solid Waste	5,797	5,948	5,100	6,360	7,088	5,671
4.C - Incineration and Open Burning of Waste	22,031	22,438	24,310	23,488	22,558	24,735
4.D - Wastewater Treatment and Discharge	174,174	177,541	178,861	177,243	180,583	192,266
Categories	2014	2015	2016	2017	2018	
4 - Waste	**527,741**	**536,210**	**559,009**	**562,812**	**576,037**	
4.A - Solid Waste Disposal	301,501	309,974	315,417	320,091	325,958	
4.B - Biological Treatment of Solid Waste	5,374	4,712	4,427	3,671	3,445	
4.C - Incineration and Open Burning of Waste	24,312	24,120	26,214	23,242	21,238	
4.D - Wastewater Treatment and Discharge	196,554	197,404	212,950	215,808	225,397	

[304] Ibid.

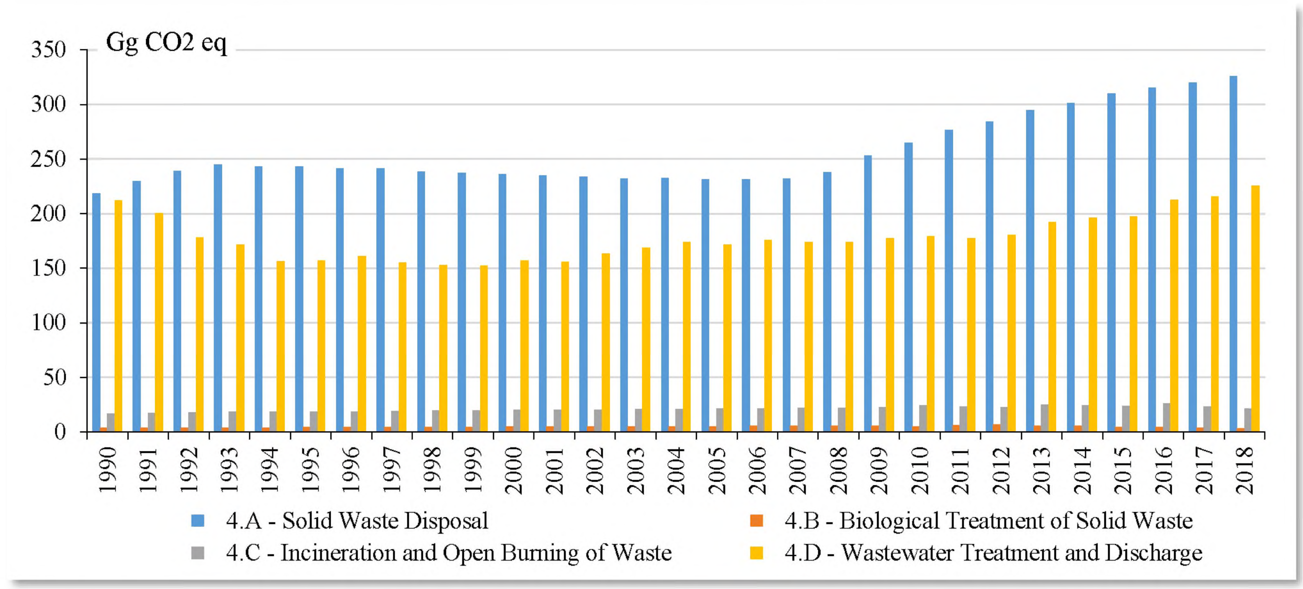
The results of NGHGI 4 show, in contrast to other sectors, there was not observed a sharp fall in the early 1990s in the trends of GHG emissions in the Waste sector. The emissions in the sector are growing more smoothly and increased in 2018 compared to 1990 in terms of total CO_2 equivalent by 27,53%. The increase in category 4.A - Solid Waste Disposal was 49,22%, in category 4.C - Incineration and Open Burning of Waste – 24,48%, in category 4.D - Wastewater Treatment and Discharge – 6,48%. While emissions of category 4.B - Biological Treatment of Solid Waste decreased by 15,78%. Accordingly, the structural distribution of GHG emissions by emission sources has also changed with an increase in the share of emissions from solid waste disposal to 56% due to a decrease in the share of emissions from treatment and wastewater discharge to 38% (see Figure 2.67).

Figure 2.67 GHG emissions from the Waste sector by source in 1990 and in 2018 [305]



The dynamics of GHG emissions from the sector by major emission sources from 1990 to 2018 are shown in Figure 2.68.

Figure 2.68 The dynamic in GHG emissions by sources for the period 1990-2018. [306]



A comparative analysis of the results of the 3rd and 4th NGHGIs was made during recalculations for the assessment of the GHG emissions of the sector. Analysis results of the estimation of the GHG

305 MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022.

306 Ibid.

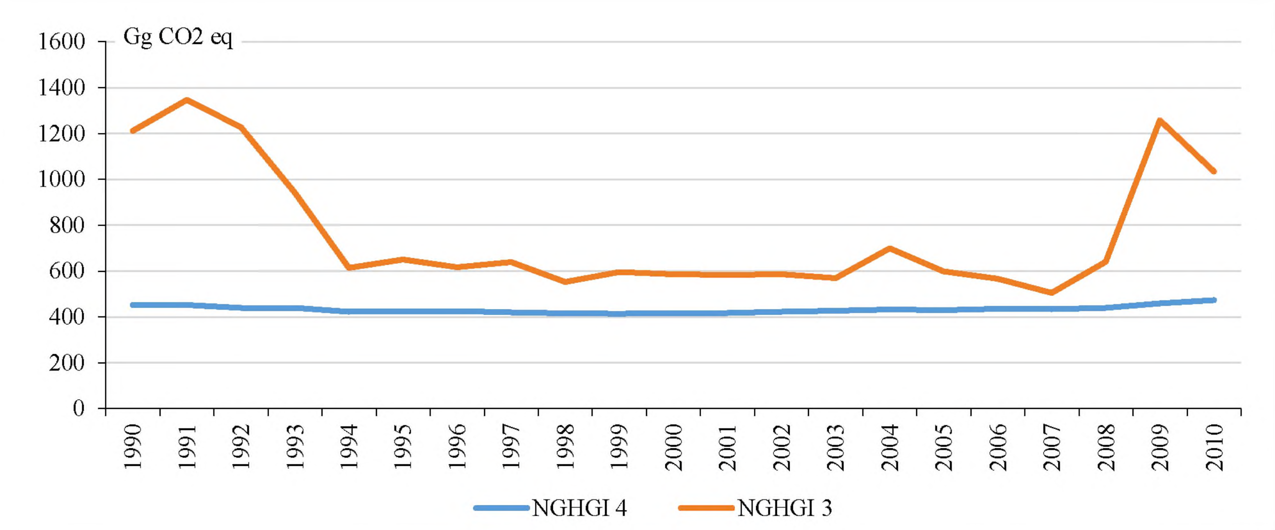
emissions in the Waste sector in CO2 equivalent for the period 1990-2010 obtained during the 3rd and 4th NGHGIs are presented in Table 2.42.

Table 2.42 Comparative analysis of GHG emissions in the sector from 1990 to 2010 (Gg) [307]

	1990	1991	1992	1993	1994	1995	1996
NGHGI 4	451,682	451,686	439,378	439,104	422,415	423,188	425,864
NGHGI 3	1210,832	1346,168	1225,991	941,636	613,144	649,354	615,879
Difference, %	-62,70	-66,45	-64,16	-53,37	-31,11	-34,83	-30,85
	1997	1998	1999	2000	2001	2002	2003
NGHGI 4	419,987	415,535	413,694	417,481	416,263	422,325	426,328
NGHGI 3	638,144	552,399	595,715	585,929	583,275	585,57	569,556
Difference, %	-34,19	-24,78	-30,56	-28,75	-28,63	-27,88	-25,15
	2004	2005	2006	2007	2008	2009	2010
NGHGI 4	432,714	429,963	434,549	433,423	439,495	459,145	472,887
NGHGI 3	698,381	598,172	566,511	504,515	639,754	1256,888	1034,191
Difference, %	-38,04	-28,12	-23,29	-14,09	-31,30	-63,47	-54,27

The significant differences in the results of the emission estimation in NGHGI 4 process, caused by the application of the new methodology, required additional efforts in terms of quality control and quality assurance involving all stakeholders. The trends of GHG emissions from the sector based on the results of the 3rd and 4th NGHGIs are shown in Figure 2.69.

Figure 2.69 Trends in GHG emissions from comparative analysis of the 3rd and 4th NGHGIs for the period 1990-2010 [308]



The difference occurred in NGHGI 4 on the volumes of total GHG emissions of the Waste sector is stipulated with the difference in the methodology on estimating emissions from waste and wastewater disposal.

Thus, the difference in methane emissions by the source category "Solid Waste Disposal" at unmanaged sites is associated with the transition to the "First Order Decay" (FOD) assessment method. This method assumes that the degradable organic components in the waste slowly degrade over several decades, during which CH_4 is formed. In the 3rd NGHGI, in order to estimate the same CH_4 emissions in accordance with the Revised IPCC Guidelines for National Inventories 1996, calculations were

[307] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. - B., 2021 SAEPF, GEF, UNEP, Climate Change Center. Third National Communication. Bishkek, 2016.
[308] Ibid.

made using the "Deficiency" method. The "Deficiency" method is based on the assumption that all CH_4 is released in the year the waste is disposed of in the landfill. The method provides an acceptable annual estimate of real emissions if the amount and composition of the disposed waste are constant or change slowly over the years. Therefore, results of the CH_4 assessment of the 3rd NGHGI show a larger increase in CH_4 emissions which is related to the volume of disposed waste and the correction factor for the methane flux. Significant is the change in the ratio of actually degradable organic carbon, which was 0.77 in accordance with the 1996 IPCC Guidelines and 0.5, i.e. 1.5 times less in the 2006 IPCC Guidelines, than the coefficient used in the 3rd NGHGI.

Another difference in the approaches is that the 3rd NGHGI did not assess GHG emissions from waste incineration.

The CH_4 emission estimates from the 4th NGHGI show an increase in emissions from domestic wastewater due to the full coverage of the population and wastewater collection systems. The increase in emissions is also due to the applied estimation method (estimation of emissions from collected and uncollected wastewater) and the default factors used. It should also be noted that the changes in the applied coefficients are as follows:

- in NGHGI 3, the value of the maximum methane production CH_4 / kg BOD was 0.25, while in the NGHGI 4 the value was 0.6.
- in NGHGI 3, CH_4 emissions were calculated based on wastewater data passed through the treatment plant. In NGHGI 4, the assessment was based on the ratio of the population with access to sanitation and the proportion of the population with access to adequate sanitary and hygienic conditions.
- in NGHGI 4, a correction factor for the BOD of industrial waste discharged into the sewage with a value of 1.25 was included in the calculation of CH_4 emissions.

According to the 2006 IPCC Guidelines, CH_4 emissions from industrial wastewater are estimated based on chemical oxygen demand (COD) and the amount of wastewater generated, taking into account production with the highest COD and the volume of wastewater generated. The decrease in the results of CH_4 emissions estimation in the 4th NGHGI is due to the fact that during the 3rd NGHGI the evaluated list of industries included such industries as washed wool production, hard leather goods, chrome leather goods. The unavailability of these industries in the assessment of the 4th NGHGI is explained by their absence in the list of industries of the 2006 IPCC Guidelines.

NGHGI 4 estimate of N_2O emissions from human activities shows a decrease in emissions due to the application of a typical coefficient of 0.005 according to the 2006 IPCC Guidelines and 0.01 from the 1996 IPCC Guidelines. In addition, the calculation included the coefficient of the share of industrial and commercial associated protein release, which is 1.25.

2.5.3.4.5. Uncertainty assessment of NGHGI 4 results

There are no national uncertainty estimates for the Waste Sector, therefore, the estimates proposed by the 2006 IPCC Guidelines "by default" are used. Two approaches are presented to assess the combined uncertainty. Approach 1 uses simple equations prone to the propagation of errors, while Approach 2 uses Monte Carlo or similar methods. Each approach can be used for emission sources or stocks, considering the assumptions and constraints for each approach and the availability of resources.

Since Tier 1 was used in estimating emissions, i.e. generalized estimate obtained using simple equations, Approach 1 was applied accordingly to quantify the uncertainties. Approach 1 assumes that the relative scopes of uncertainties for emissions and activity factors are the same for the base year and year t. This assumption is often correct or relatively correct.

Uncertainty was estimated in IPCC Inventory Software 2.54. According to the calculations, in 2018, the uncertainty of the total inventory was 70.82% and the uncertainty in the trend was 98.56%. The high percentage is due to the lack of statistical data from 1990 to 2009 by category of incineration, composting, domestic wastewater, and waste disposal for the period 1969-1990.

2.5.4. National Inventory Improvement Planning

In fact, it should be noted that Kyrgyzstan has never prepared National GHG Inventory Improvement Plan (NIIP) before. At the same time, preparing and reporting an improvement plan is consistent with future reporting requirements under the Enhanced Transparency Framework (ETF).[309] "To facilitate continuous improvement, countries should identify, regularly update and report information on areas of improvement. In addition to areas noted above, improvements should also address capacity constraints related to use of flexibility and in the future, responding to improvements identified by technical expert review teams."[310]

While considering UNFCCC recommended US Environment Protection Agency developed Template Workbook "Developing a National Greenhouse Gas Inventory System", [311] provisional NIIP was compiled as per propose template including the following sections:

1. Institutional Arrangement
2. Methods and Data Documentation
3. Quality Assurance and Quality Control Procedures
4. Archiving System
5. Key Categories Analysis
6. National Inventory Improvement Plan

Kyrgyzstan National Inventory Improvement Plan (NIIP) will options for improving the national GHG inventory system to support compilation of a high-quality inventory consistent with the 2006 IPCC Guidelines. The NIIP will guide future efforts to increase the transparency, consistency, comparability, completeness, and accuracy of future inventories. It will also inform the overall improvement of the national GHG inventory over the coming years. These improvements will be identified through documentation of existing institutional arrangements, category-by-category analyses of methods and data, QA/QC procedures, key categories, and the archiving system, all the recommendations formulated as appropriate.

When finalized this NIIP will be sent together with the NC 4, which is currently under development and which will prolong NGHGI reporting integrating data on 20019-2020, as well as recalculations of the 1990-2020 time series emissions by source and removals by sinks completing the fourth round of Kyrgyzstan GHG emissions and removals inventory.

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[309] See 18/CMA.1, Modalities, Procedures and Guidelines (MPGs), Annex Chapter II, Section D. Facilitating improved reporting and transparency over time (available at http://unfccc.int/decisions).

[310] UNFCCC. https://unfccc.int/sites/default/files/resource/Template_7._National_Inventory_Improvement_Plan.pdf

[311] US Environment Protection Agency. https://www.epa.gov/ghgemissions/toolkit-building-national-ghg-inventory-systems

2.5.5. Projections of future GHG emissions

2.5.5.1. Methodology

Projections of future emissions and removals coincided with the preparation of BUR 1 and with the revision of the Nationally Determined Contribution (NDC) of the Kyrgyz Republic to the Paris Agreement through a consultation process supported by the UNDP Climate Outlook project and the World Natural Resources Institute's "NDC Partnership" initiative.

A historical analysis of the correlation of the dynamics between the main factors of development and GHG emissions was carried out to develop a projection of future emissions. Data on changes in GDP and population were used as indicators of these factors (see Figures 2.70 and 2.71).

Figure 2.70 Trends in GHG emissions and population in Kyrgyz Republic between 1990 and 2018 [312]

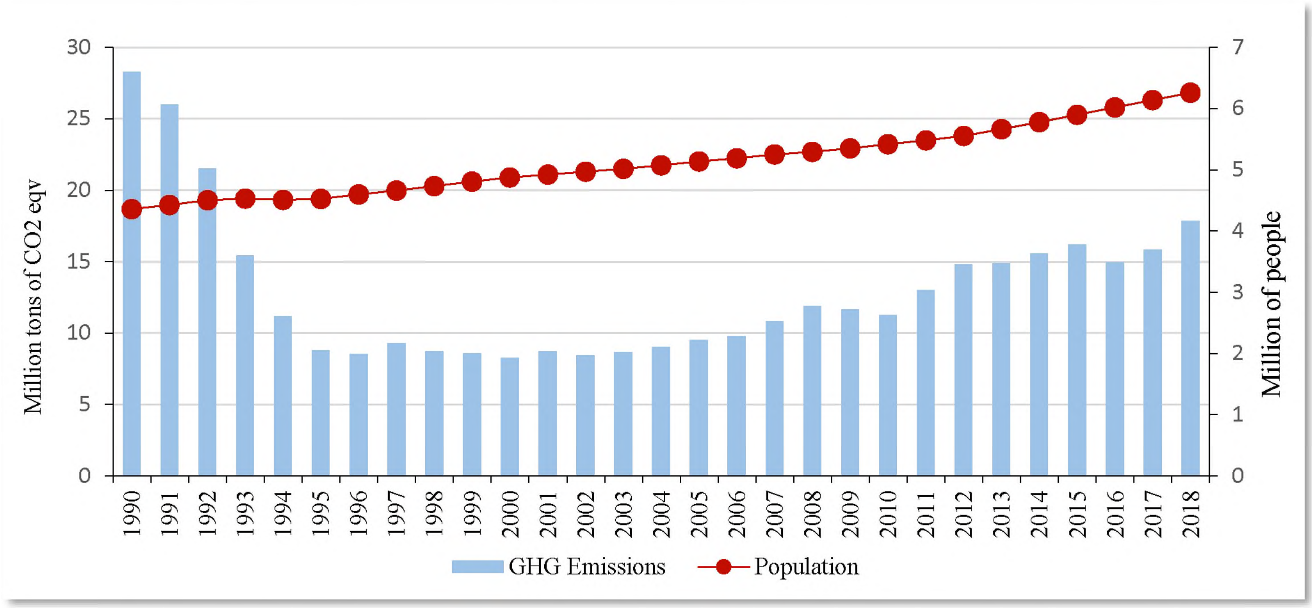
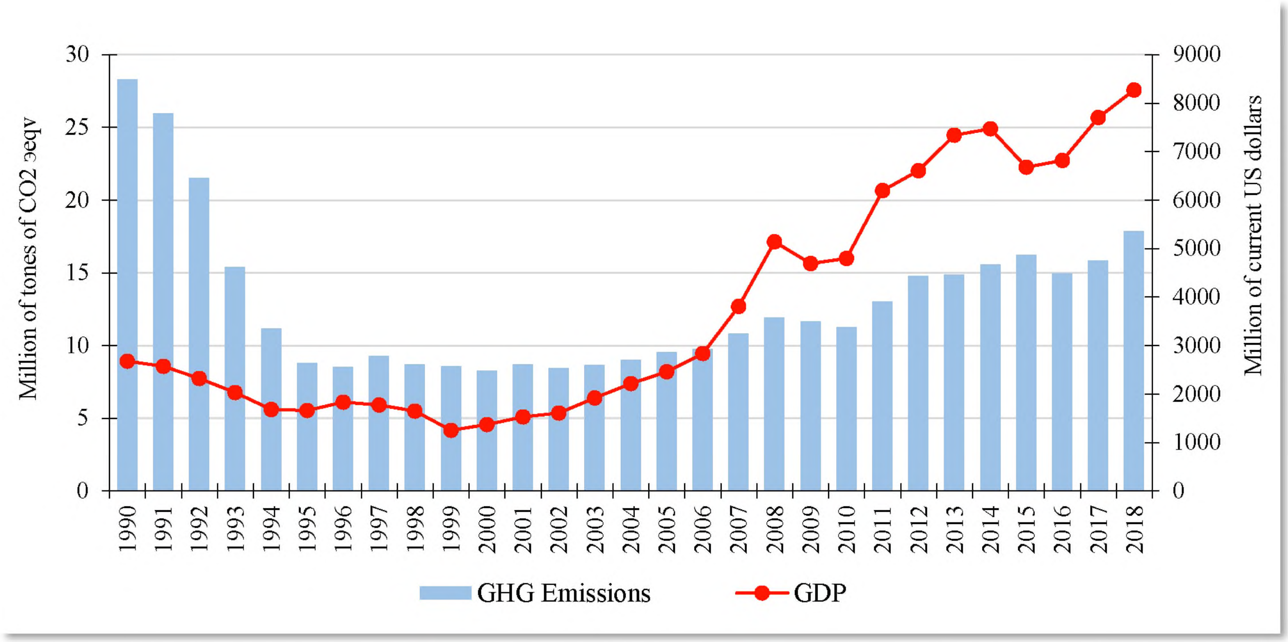


Figure 2.71 Trends in GHG emissions and GDP in the Kyrgyz Republic between 1990 and 2018. [313]

[312] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022. And data of the NSC KR - http://www.stat.kg/ru/statistics/naselenie/

[313] MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022. And WB open data - https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=KG



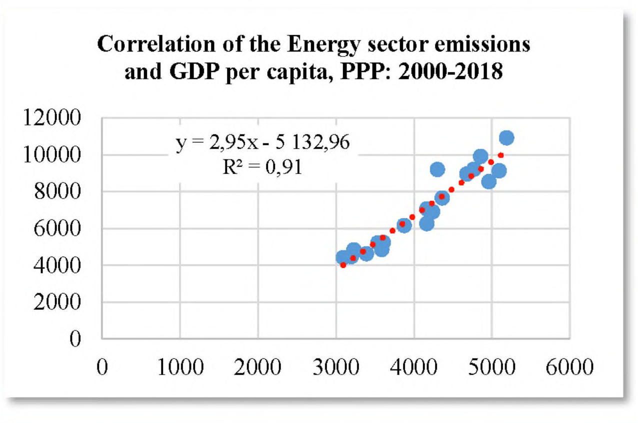
The analysis and expert consultations identified a common indicator that integrates the above development factors, both in terms of the economy and population growth and corresponding consumption - GDP per capita based on PPP. Based on the analysis of the historical time series of this indicator, the values of this indicator were calculated for the time series up to 2050, which became the basis for determining the correlations and trend equations. Since this work was carried out with the involvement of experts from different sectors, during the discussions it was decided to focus on the linear trend of future projections of GHG emissions.

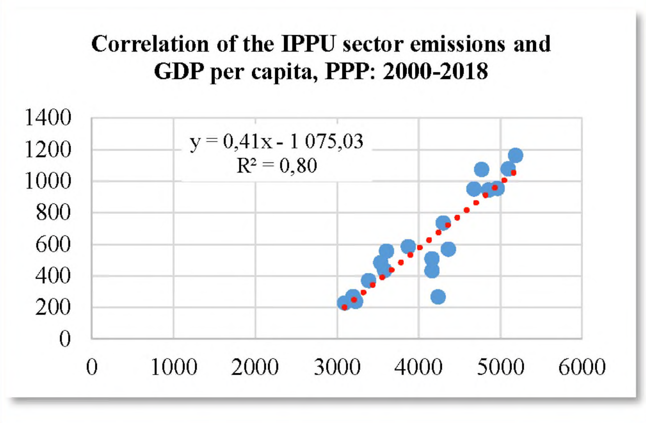
All sectors, as well as national total and net emissions, were analyzed to determine correlations. As a result, the trends with the highest coefficients of determination (R^2) were selected on a linear trend. Trends in the correlation of GHG emissions and GDP per capita based on PPP were considered for the time series: 1990-2018; 1996-2018; 2000-2018 and 2006-2018.

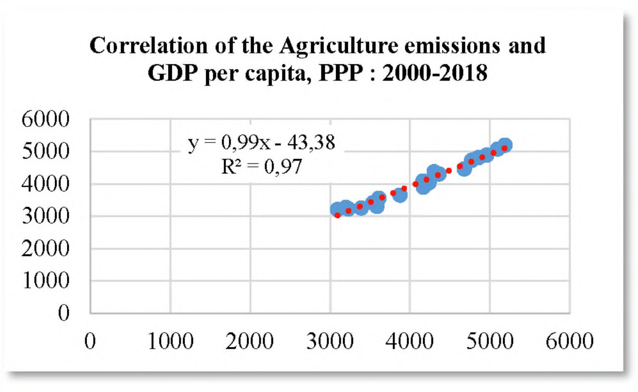
Taking into account the sharp drop in GDP and living standards between 1990 and 1996, the most appropriate trend in the time series of correlation of total CO_2 equivalent emissions with GDP per capita based on PPP in US dollars in 2018 was determined as the basis for projecting future emissions. The highest correlation determination rate (R^2) ranging from 0,80 for IPPU to 0,97 in Agriculture was obtained for the correlation trends during the 2000-2018 time period. Therefore, the corresponding linear trend equations for all sectors (see Figure 2.72), except for the FOLU sector were used to model future emissions for the "Business As Usual" (BAU) scenario, i.e. “without measures”.

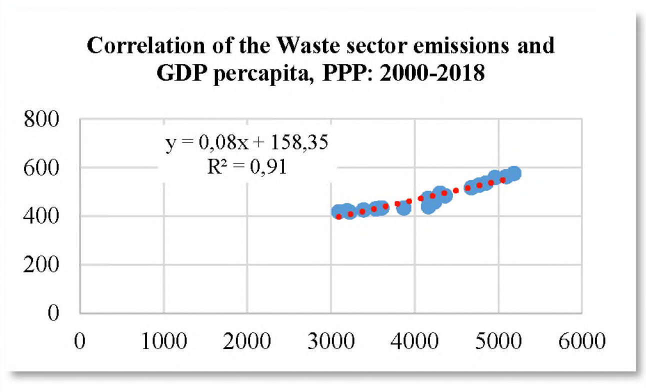
Figure 2.72 Diagrams of the correlation between GHG emissions from sectors and GDP based on PPP between 2000 and 2018. [314]

[314] Developed by authors based on MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022 and Kadyraliev A. Technical report of the UNDP expert on economic modeling. Bishkek. 2021.









This approach of linear trend equations is rather simplified and was used only to demonstrate the need for mitigation actions and draft the low-carbon development strategies for Kyrgyzstan as a contribution to the achievement of the Paris Agreement objectives. More complex multifactor models for the design of future emissions will be applied in future, as national models of prospective economic development, changes in the structure of consumption and social development, also taking into account the deviation of various development factors and their indicators will be developed. Accordingly, as the models become more sophisticated, the projected values of future emissions will also change.

2.5.5.2. Energy

The results of modelling future GHG emissions in CO_2 eq. in the Energy sector up to 2050 are presented in Table 2.43.

Table 2.43 The values of the projected GHG emissions in the Energy sector for the period 2018-2050 (Gg)[315]

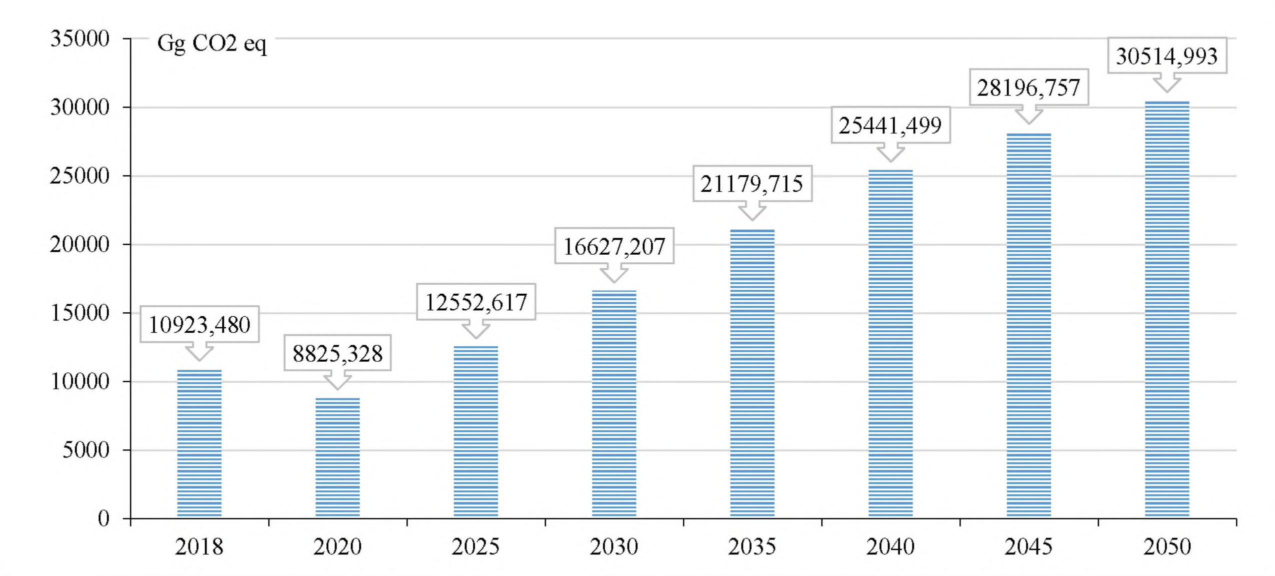
2018	2019	2020	2021	2022	2023	2024
10923,480	10527,145	8825,328	9819,819	10515,909	11235,967	11884,156
2025	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
12552,617	13242,098	14113,996	15023,280	15811,098	16627,207	17472,937
2032	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**
18349,535	19258,519	20201,402	21179,715	21984,390	22812,717	23664,957
2039	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**
24541,192	25441,499	26041,687	26593,963	27158,467	27671,927	28196,757
2046	**2047**	**2048**	**2049**	**2050**		

[315] Developed by authors based on MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022. And Kadyraliev A. Technical report of the UNDP expert on economic modeling. Bishkek. 2021.

28667,367	29148,105	29639,359	30072,516	30514,993

The dynamics of future GHG emissions in the Energy sector projected up to 2050 as per scenario "business as usual" (BAU) is shown in Figure 2.73.

Figure 2.73 Projection of future GHG emissions from the Energy sector up to 2050 under the BAU scenario [316]



2.5.5.3. Industrial Processes and Product Use

The values of projected GHG emissions in CO_2 eq. in the IPPU sector according to the projected results are presented in Table 2.44 below.

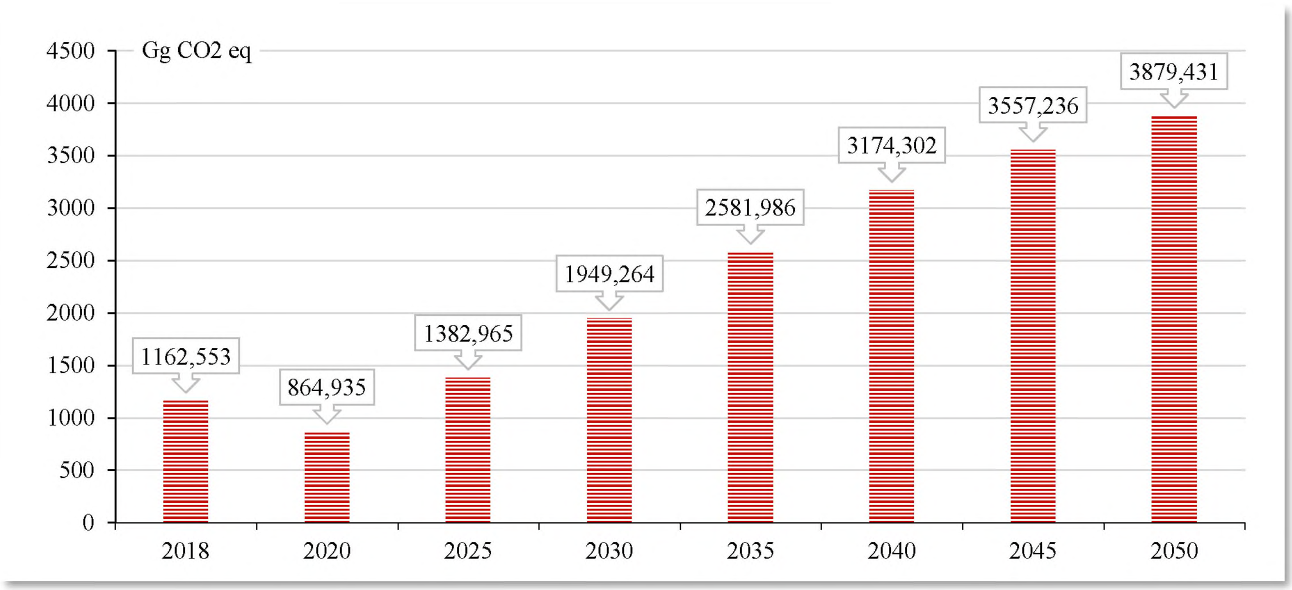
Table 2.44 The values of the projected future GHG emissions in the IPPU sector between 2018 and 2050 (Gg) [317]

2018	2019	2020	2021	2022	2023	2024
1162,553	1101,459	864,935	1003,153	1099,898	1199,973	1290,061
2025	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
1382,965	1478,792	1599,971	1726,346	1835,839	1949,264	2066,807
2032	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**
2188,639	2314,972	2446,017	2581,986	2693,822	2808,945	2927,392
2039	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**
3049,174	3174,302	3257,718	3334,475	3412,931	3484,293	3557,236
2046	**2047**	**2048**	**2049**	**2050**		
3622,643	3689,457	3757,733	3817,934	3879,431		

The projected trends of the GHG emissions in the IPPU sector up to 2050 is shown in Figure 2.74.

Figure 2.74 Projection of future GHG emissions in IPPU sector under the BAU scenario up to 2050 under the BAU scenario. [318]

[316] Developed by authors based on MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022. And Kadyraliev A. Technical report of the UNDP expert on economic modeling. Bishkek. 2021.
[317] As above.
[318] As above.



2.5.5.4. Agriculture

Projected GHG emissions in the CO_2 eq. of the Agriculture subsector are presented in Table 2.45 below.

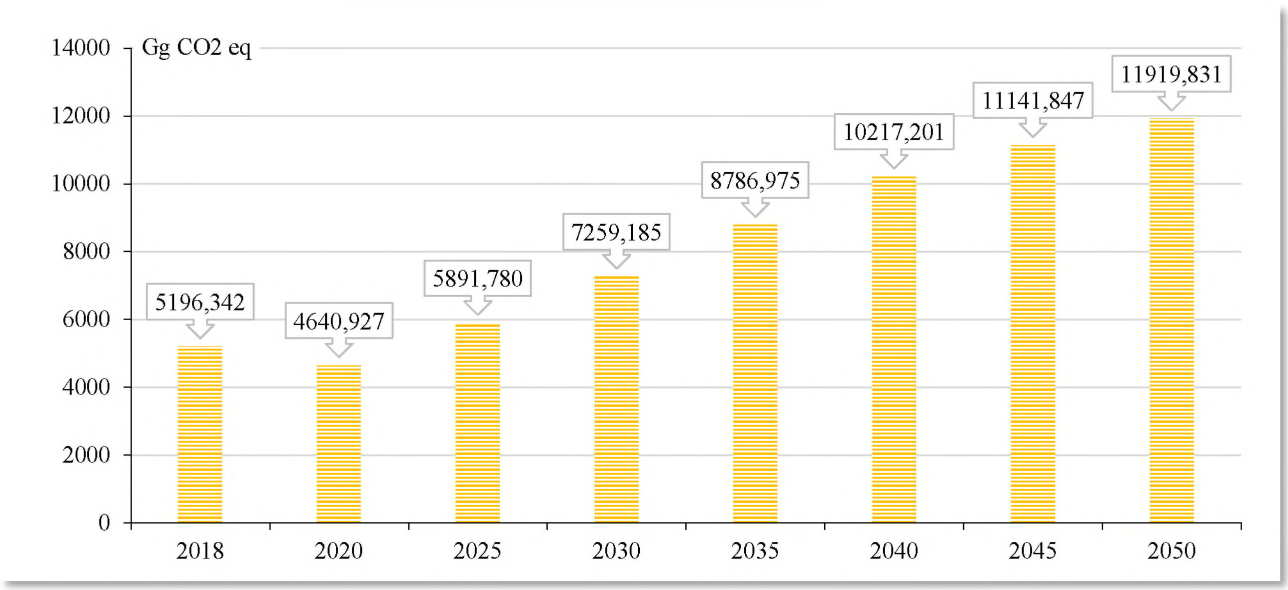
Table 2.45 The projected GHG emissions values from the Agriculture sector between 2018 and 2050 (Gg) [319]

2018	2019	2020	2021	2022	2023	2024
5196,342	5212,04497	4640,92671	4974,67129	5208,27447	5449,92098	5667,44873
2025	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
5891,77978	6123,16485	6415,76794	6720,91761	6985,30379	7259,18456	7543,00588
2032	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**
7837,18607	8142,23498	8458,66012	8786,97521	9057,01895	9334,99975	9621,00573
2039	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**
9915,06421	10217,2013	10418,6201	10603,9604	10793,404	10965,7178	11141,847
2046	**2047**	**2048**	**2049**	**2050**		
11299,7805	11461,1131	11625,9744	11771,3391	11919,8315		

The dynamics of future GHG emissions in the Agriculture sector projected up to 2050 is shown in Figure 2.75.

Figure 2.75. The projection of future GHG emissions from the Agriculture sector up to 2050 under the BAU scenario[320]

[319] Developed by authors based on MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022. And Kadyraliev A. Technical report of the UNDP expert on economic modeling. Bishkek. 2021.
[320] As above.



2.5.5.5. Forestry and Other Land Use

The development and natural expansion of forest ecosystems are less dependent on economic growth and social development but experience a certain anthropogenic pressure. However, the expansion of perennial plantations and their biomass is directly dependent on human activities. Therefore, the planning of future removals was carried out differently.

As noted above, no emissions from land-use change for the IPCC land-use categories were reported in the 4th NGHGI due to a lack of consensus on land distribution for these categories, and accordingly, it was impossible to compile long time series for such an estimate.

The projection of forest land growth was based on the historical analysis of the national forest inventory materials and the corresponding rate of forest growth being determined, specified by archival data of the state land report forms of the early 1990s. Each new round of the forest inventory was carried out in all forest management units in the country with the frequency of 10-15 years. Perennial areas were also determined through historical analysis and agreed upon through a consultation process.

The values of the CO_2 absorption in the FOLU sector based on the calculated projection results are presented in Table 2.46 below

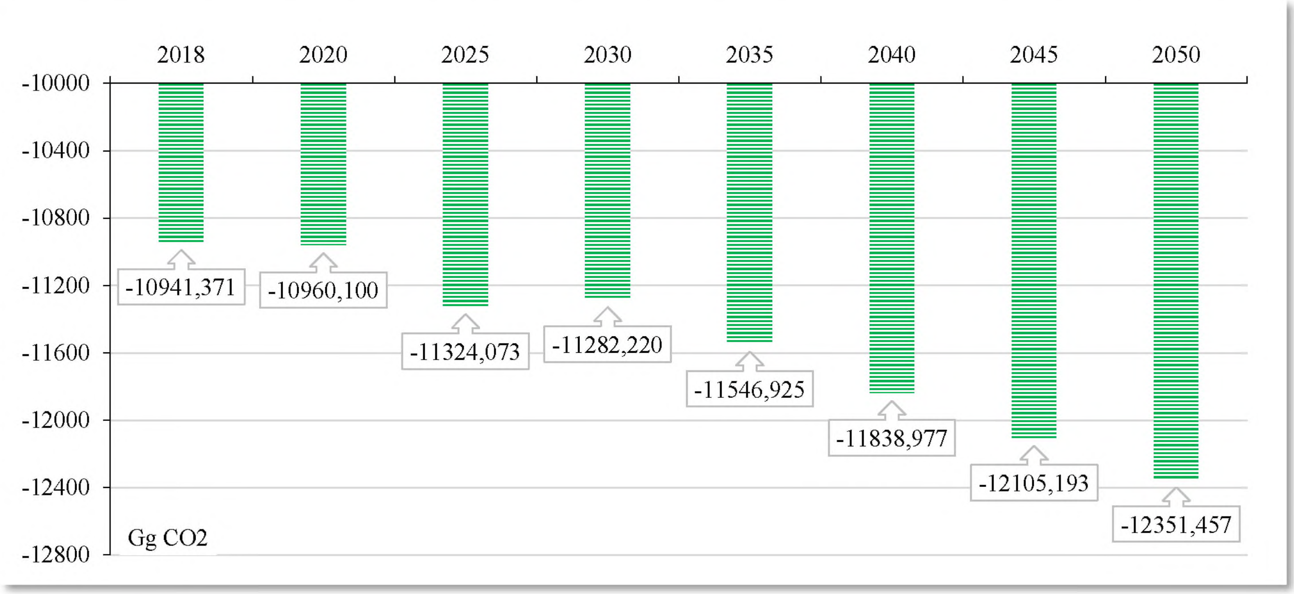
Table 2.46 The projection of future CO_2 removals to forests and croplands perennials from 2018 to 2050 (Gg) [321]

Years	2018	2019	2020	2021	2022	2023	2024
CO_2 sink	-10941,371	-10954,624	-10960,100	-10972,929	-10989,208	-11206,443	-11295,388
Years	2025	2026	2027	2028	2029	2030	2031
CO_2 sink	-11324,073	-11357,230	-11148,484	-11193,383	-11235,712	-11282,220	-11328,053
Years	2032	2033	2034	2035	2036	2037	2038
CO_2 sink	-11375,963	-11425,027	-11479,923	-11546,925	-11629,049	-11680,759	-11732,509
Years	2039	2040	2041	2042	2043	2044	2045
CO_2 sink	-11785,651	-11838,977	-11892,641	-11946,618	-12000,237	-12053,559	-12105,193
Years	2046	2047	2048	2049	2050		
CO_2 sink	-12155,710	-12204,738	-12251,483	-12301,910	-12351,457		

[321] Developed by authors based on MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022. And Kadyraliev A. Technical report of the UNDP expert on economic modeling. Bishkek. 2021.

The dynamics of future CO_2 removals in the FOLU sector according to the calculated projection up to 2050 is shown in Figure 2.76.

Figure 2.76 The projection of the future GHG emissions in the FOLU sector under the BAU scenario to 2050 [322]



2.5.5.6. Waste

The values of the projected GHG emissions in CO2 eq. expected from the Waste sector are presented in Table 2.47 below.

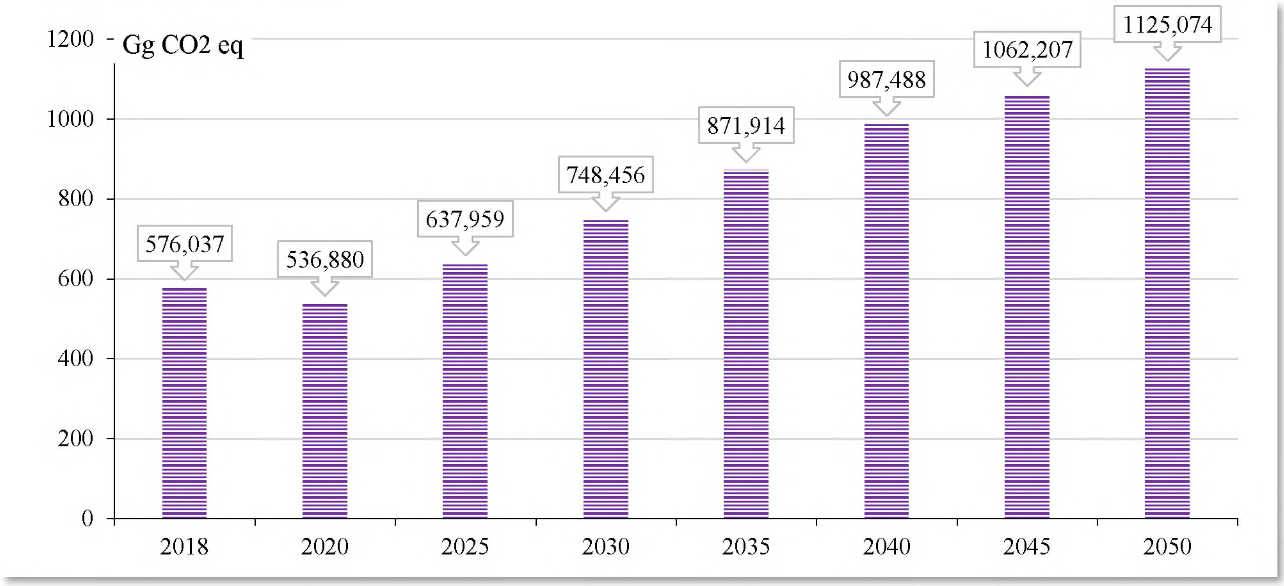
Table 2.47 The projection of future GHG emissions values in the Waste sector for the period 2018-2050, (Gg) [323]

2018	2019	2020	2021	2022	2023	2024
576,037	583,031	536,880	563,849	582,726	602,253	619,831
2025	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
637,959	656,657	680,301	704,960	726,324	748,456	771,391
2032	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**
795,163	819,814	845,384	871,914	893,736	916,199	939,310
2039	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**
963,073	987,488	1003,764	1018,741	1034,050	1047,974	1062,207
2046	**2047**	**2048**	**2049**	**2050**		
1074,969	1088,006	1101,328	1113,075	1125,074		

The projection of future GHG emissions in the Waste sector up to 2050 is shown in Figure 2.77.

Figure 2.77 Projection of future GHG emissions from the Waste sector in the BAU scenario up to 2050 [324]

[322] Developed by authors based on MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022. And Kadyraliev A. Technical report of the UNDP expert on economic modeling. Bishkek. 2021.
[323] Ibid.
[324] Ibid.



2.5.5.7. Projection of total and net GHG emissions

The projection of total and net emissions was also initially based on the linear trend equation, however, the values of the sector sums did not coincide with the values of the modeled sector emissions due to the volatility of the contribution of sectors to GDP based on PPP, therefore, the projection of future total and net emissions was determined by a simple sum of the GHG emission and removal values in all sectors. The values of the projected GHG emissions in CO2 eq. presented in Table 2.48.

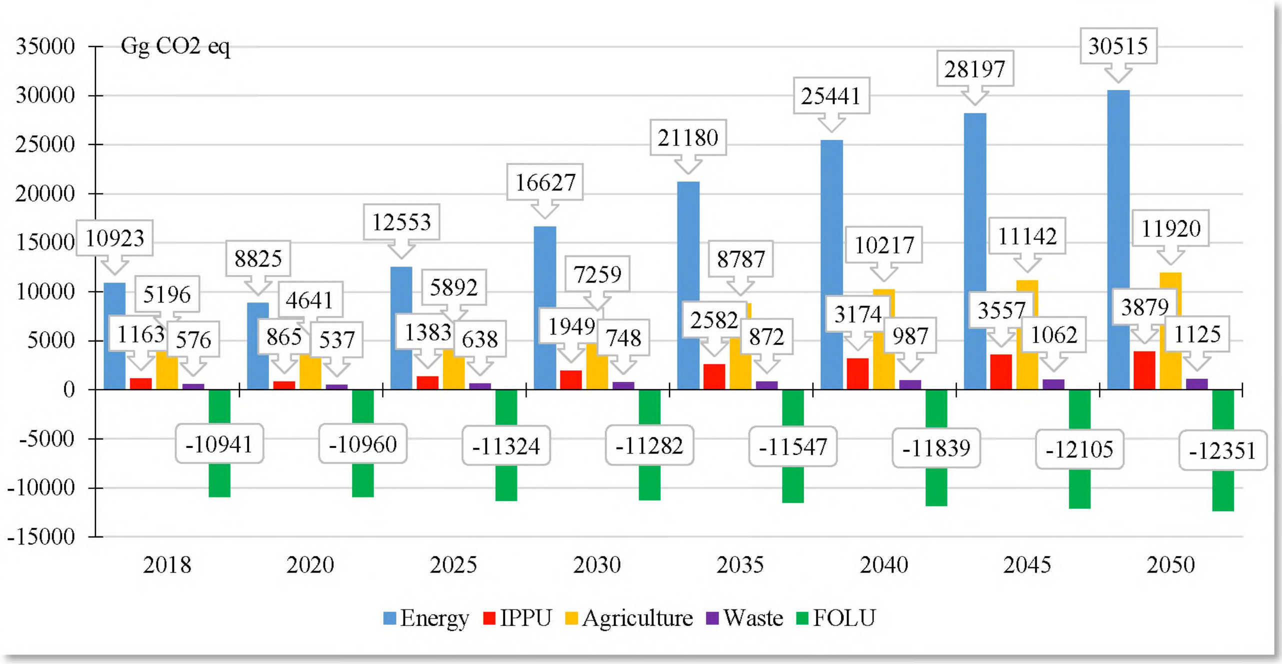
Table 2.48 Projection of future total and net GHG emissions of Kyrgyzstan between 2018 and 2050 (Gg) [325]

	2018	2019	2020	2021	2022	2023	2024
Net emissions	17858,411	17423,680	14868,070	16361,492	17406,808	18488,115	19461,496
Total emissions	6917,040	6469,056	3907,970	5388,564	6417,599	7281,672	8166,109
	2025	2026	2027	2028	2029	2030	2031
Net emissions	20465,321	21500,711	22810,036	24175,504	25358,565	26584,112	27854,141
Total emissions	9141,249	10143,481	11661,552	12982,121	14122,853	15301,892	16526,088
	2032	2033	2034	2035	2036	2037	2038
Net emissions	29170,523	30535,540	31951,463	33420,590	34628,967	35872,861	37152,666
Total emissions	17794,560	19110,513	20471,540	21873,665	22999,918	24192,102	25420,157
	2039	2040	2041	2042	2043	2044	2045
Net emissions	38468,503	39820,490	40721,788	41551,139	42398,852	43169,913	43958,046
Total emissions	26682,852	27981,513	28829,148	29604,522	30398,615	31116,354	31852,854
	2046	2047	2048	2049	2050		
Net emissions	44664,759	45386,681	46124,394	46774,864	47439,330		
Total emissions	32509,049	33181,944	33872,911	34472,954	35087,873		

The dynamics of the future total and net GHG emissions of Kyrgyzstan according to the projection until 2050 and the main sources is shown in Figure 2.78.

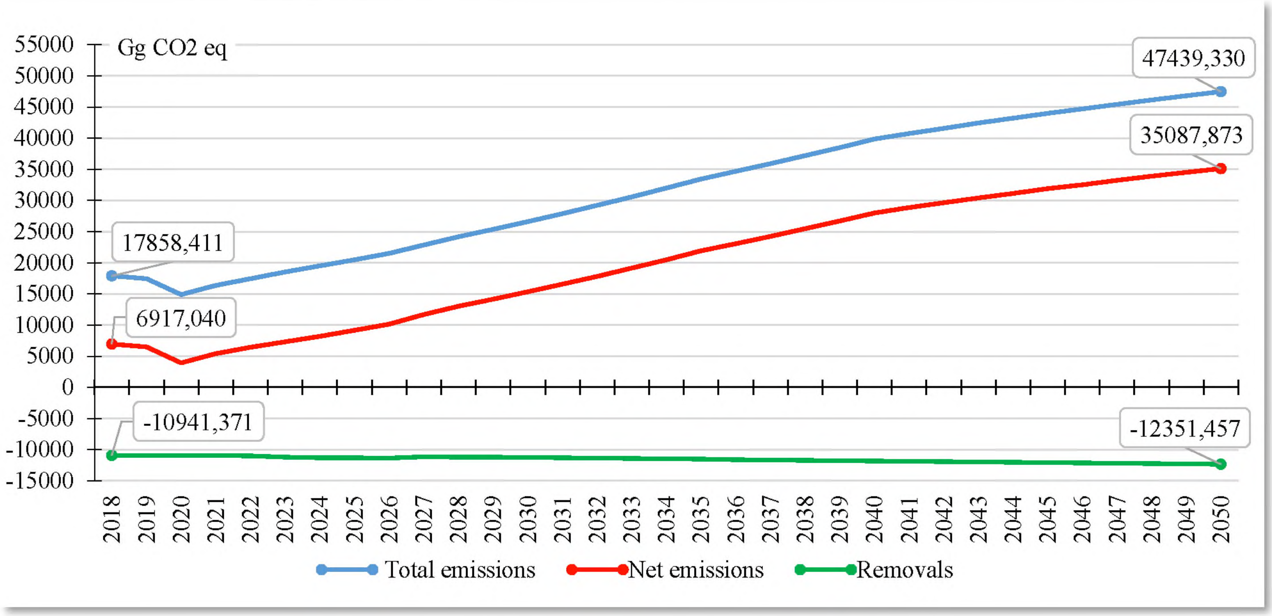
Figure 2.78. The projection of future GHG emissions of Kyrgyzstan up to 2050 by sources.[326]

[325] Developed by authors based on MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022. And Kadyraliev A. Technical report of the UNDP expert on economic modeling. Bishkek. 2021.
[326] As above.



The projection of future total and net GHG emissions and removals by Kyrgyzstan between 2018 and 2050 is given on fig. 2.79

Figure 2.79 Projection of future total and net GHG emissions and removals until 2050. [327]



[327] Developed by authors based on MNRETS, GEF-UNEP. IPCC Inventory Software V2.54 Database. Bishkek. 2022. And Kadyraliev A. Technical report of the UNDP expert on economic modeling. Bishkek. 2021.

3. Mitigation Actions and their Effects

“Mitigation”, sometimes “mitigation or prevention”, of the climate change in IPCC terminology for the Russian language is translated as “mitigation of consequences” and means human intervention to reduce sources or expand sinks of greenhouse gases. [328]

This chapter provides updated information on actions and policies to address climate change in the Kyrgyz Republic and their impact in various sectors during the period 2011-2018.

In September 2015, at the 21st Conference of the Parties to the UNFCCC in Paris, Kyrgyzstan presented its mitigation targets for 2030 and 2050 in an Intended Nationally Determined Contribution (INDC). The conference adopted and submitted to countries for signature and ratification the UNFCCC Paris Agreement of the UNFCCC - a new international treaty that replaced the Kyoto Protocol.

The Paris Agreement aims to strengthen the global response to the threat of climate change in the context of sustainable development and poverty reduction by:

- Definition of a long-term mitigation target - Maintaining the average global temperature increase at “below 2°C” compared to the pre-industrial period, while making efforts to limit the temperature increase by 1.5°C compared to the pre-industrial period (1850-1900) (Art. 2). In doing so, recognizing that reducing GHG emissions could significantly reduce the risks and impacts of climate change (Art. 4);
- Definition of a global adaptation goal - Strengthening adaptive capacity, increasing resilience and reducing vulnerability to climate change in the context of the temperature target of the Agreement; and
- Necessity to provide developing countries with financial support and technology transfer from developed countries to strengthen the capacity of all signatory countries to achieve the objectives of the agreement (Art. 9, 10, 11).

The Paris Agreement entered into force on 4 November 2016. By 2020, it has been ratified by 189 countries worldwide. Kyrgyzstan signed the agreement in September 2016 at the 71st session of the UN General Assembly and ratified it by the Law of the Kyrgyz Republic on November 12, 2019, forming a legal basis for its implementation

Nationally Determined Contributions (NDCs) are voluntary commitments by countries that declare their national adaptation and mitigation goals as a contribution to the agreement's global temperature target of “below 2°C”. The NDC of the Kyrgyz Republic was developed with the support of the GEF-UNEP project "Preparation of the intended NDC of KR into the UNFCCC Agreement at the 21st Conference of the Parties" and approved by the decision of the Coordination Commission on Climate Change Problems of the Government of Kyrgyz Republic. [329]

NDC 1 determined the objectives of the Kyrgyz Republic's actions on adaptation and reduction of greenhouse gas emissions (meetings), as well as the financing of these actions. Funding is considered in two aspects through identifying the required own resources and identifying the required resources of international assistance. The period for achieving the goals stated in the NDC of Kyrgyzstan covers the period from 01.01.2020 to 31.12.2030 and up to 2050.

[328] IPCC, 2013: Glossary [C. Planton (Editor)]. Contained in Climate Change publication, 2013: Physical Science Framework. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, JC. Plattner, M. Tigner, S. K. Allen, J. Boshung, A. Nauels, Y. Xia, V. Becks and P. M. Midgley (editors)]. Cambridge University Press, Cambridge, United Kingdom, and New York, USA.

[329] Minutes of meeting of the Coordination Commission on Climate Change Problems No. 19-87 dated September 22, 2016, chaired by the First Vice Prime Minister.

The document defines the long-term goal of the Kyrgyz Republic's mitigation - Achievement of GHG emissions by 2050 not exceeding 1.23 t CO2 equivalent per capita or, as a limit, 1.58 t CO2 eq./person, as the Kyrgyz Republic's contribution to the achievement of the temperature goal of the Paris Agreement "below 2ºC ", with a probability of 66% and 50%, respectively.

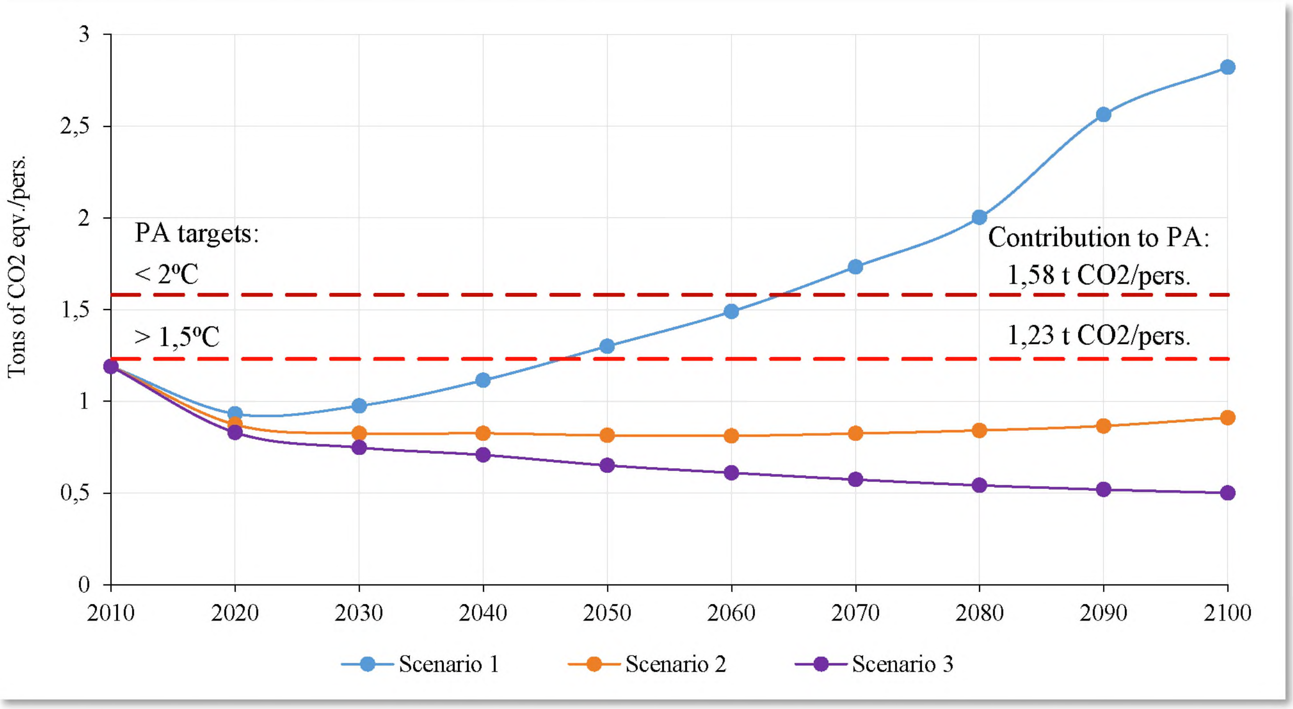
To achieve this, the NDC presents targets for mitigation actions in the medium term perspective:

- In 2030, the Kyrgyz Republic will reduce GHG emissions by 11.49-13.75% relative to the "business as usual" (BAU) scenario. With international support in 2030, Kyrgyzstan can implement mitigation measures to reduce GHG emissions by 29-30.89% relative to the BAU scenario.
- In 2050, the Kyrgyz Republic will reduce GHG emissions by 12.67-15.69% relative to the BAU scenario. In 2050, with international support, Kyrgyzstan can implement measures to achieve GHG emissions reduction by 35.06-36.75% relative to the BAU scenario.

The SHAKYR model and its three scenarios were used to calculate quantitative NDC targets as well as to determine the projections of GHG emissions presented in the TNC of Kyrgyzstan (see Figure 3.1.):

- Scenario 1. Low population growth - high economic growth;
- Scenario 2. Average population growth - average economic growth;
- Scenario 3. High population growth - low economic growth.

Figure 3.1 The projection of GHG emissions in CO2 equivalent per capita, Paris Agreement targets and Kyrgyzstan first NDC contribution intention.[330]



As can be seen from the graph, only the development according to scenario 1 will not allow Kyrgyzstan to adhere to its obligations to contribute to the Paris Agreement in the long term (from 2065), and the development according to scenarios 2 and 3 seems to be preferable. However, it is only a model with the purpose to show possible development and assist make informed decisions about development paths under any circumstances.

[330] INDC of the Kyrgyz Republic (2015).

Mitigation measures are supposed to be implemented in the main sectors - GHG emitters: energy and transport; industry and construction; agriculture, forestry and land use, and waste management to achieve the selected goals.

Capacity analysis for climate change mitigation was carried out as part of the preparation of BUR 1 based on the experience and best practices of a number of technical documents: (i) NC 3, (ii) Self-Assessment Report on the Preparation of the National Communication of Kyrgyzstan, (iii) Technical Report on Risk Analysis of Accession to the Paris Agreement by the Kyrgyz Republic; (iv) The proposed NDC, (v) the draft Strategy for the Long-term Development of the Kyrgyz Republic with low GHG emissions until 2050. However, this analysis included, for the first time, an assessment of current national policies, actions and measures in terms of their mitigation prospect. For this, for the first time, calculations of quantitative indicators of possible reductions in GHG emissions were conducted covering all key sectors according to the IPCC, using its methodology.

As this section describes the country's commitment to climate change mitigation by reducing GHG emissions in the context of achieving sustainable development goals, the objectives of the analysis were the main development strategies at the national, sectoral and territorial levels, containing measures to reduce GHG emissions, as well as existing measures and developments noted in the above-mentioned documents. In doing so, the analysis of specific sectoral actions was conducted using an approach that, in terms of climate reporting classifies these actions into two scenarios: 1) with (ongoing, planned) measures (WM) and 2) with additional measures (WAM) that can be implemented in the presence of additional climate investments. Note that the “business as usual” scenario presented in the previous section in this case will be the baseline, the third scenario, which can be defined as the “without measures” (WM) scenario.

Most actions to mitigate climate change are being undertaken in the Energy sector, there are mitigation measures in the urban transport sector, there are measures in forestry and land use, there are activities to reduce GHG emissions in waste management, but not in the industrial sector.

In 2020, with the support of the UNDP Climate Promise Program and the NDC Partnership in Kyrgyzstan was launched a process of updating the Intended Nationally Determined Contributions of the Kyrgyz Republic (NDC 1) with the participation of all stakeholders. As a result of this work, the goals of the sectors were defined, both for adaptation and for mitigation. At the same time, conducted the process of expanding the coverage of stakeholders involved, developing a sectoral and national multi-year plan for the implementation of NDC 2, defining monitoring, reporting and verification system, increasing the capacity of participants, and raising public awareness of climate actions and their goals.

The mitigation measures and their expected effects have been documented in accordance with the UNFCCC Guidelines for the Preparation of BUR 1, including a description of assumptions and methodology, and archived in the PIU of the SCECC.

3.1. Legal and Policy Framework for Climate Mitigating Actions

Country development in the period 2010-2018 took place against the background of the global financial crisis, increasing uncertainty in world markets, which posed risks for all market participants, including the main trading partners of Kyrgyzstan - Russia, Kazakhstan and China.

The internal political events of 2010 marked a new milestone in the development of the Kyrgyz Republic, which will go down in the history of the country as a test of the strength of the Kyrgyz statehood and the entire system of public administration, including socio-political, economic, environmental, financial and other spheres of development management.

The most important result of this period for Kyrgyzstan as a whole was the transition of the Kyrgyz Republic to a parliamentary form of government and overcoming the unpredictable economic decline against the background of the consequences of the global financial crisis of 2008-2009, the change of the ruling regime and the interethnic conflict in April and June 2010 and an accident at the largest gold mining enterprise "Kumtor" in 2012.

The result of deep socio-political and economic turmoils was a noticeable decline in the standard of living of the population. Thus, in 2012, about 2.1 million people or 38% of the total population lived below the poverty line, where almost 66% were residents of rural settlements.[331]

The beginning of the development stabilization period of Kyrgyzstan after the change of the regime was characterized by the absence of long-term political strategies, and the Government used the mid-term forecasting tool of the socio-economic development of the Kyrgyz Republic to determine the target socio-economic benchmarks for solving the problems of the country's socio-economic development at that time. Thus, another such document was adopted in early 2011. [332]

At that time, the mobilization and rational use of all reserves and resources to embark on a sustainable development path, including economic, human, natural, financial and other aspects was a pressing issue. The new political leadership of the country has officially declared a course towards sustainable development. For Kyrgyzstan, as a country with limited natural and financial resources, the transition to sustainable development seems to be a logical and politically justified choice.

The idea of sustainable development turned out to be consonant with the traditions, spirit, and mentality of the peoples of Kyrgyzstan, since, regardless of ethnicity and party affiliation, the peoples of Kyrgyzstan today are unanimous in their desire to overcome difficulties and live in a country that has a “future” and stable positions in development.

The political commitment of the Kyrgyz Republic to sustainable development was confirmed by the establishment of the National Council for Sustainable Development under the President of Kyrgyz Republic on November 24, 2012, which started its work uniting the efforts of all branches of government, private sector and civil society on future development. On 21 January 2013, following the results of the second meeting of the Council, the National Strategy for the Sustainable Development of the Kyrgyz Republic for 2013-2017 was approved by a decree of the President of Kyrgyz Republic.[333]

This document outlined the strategic guidelines for the new sustainable development model, the main priorities and the 78 largest investment projects for this period. Considering that the implementation of the National Strategy for Sustainable Development of the Kyrgyz Republic for 2013-2017 requires a real management tool for the next five years, the Government of the Kyrgyz Republic adopted the Program for the Transition of the Kyrgyz Republic to Sustainable Development for 2013-2017. [334] These two strategic documents determined the development of the country in the period covered by this document.

Unfortunately, the strategic project document “Concept of long-term actions for the development of low greenhouse gas emissions in the Kyrgyz Republic until 2050”, developed by the SAEPF in 2015 together with NDC 1, allowing systematic implementation, monitoring and collection of information on the results of mitigation measures, was not adopted, which is due to the late ratification of the Paris Agreement only in 2019. This circumstance did not allow the collection of information on mitigation measures for monitoring and reporting on NDC 1 from 2011 to 2018, i.e. in the reporting time period covered by this BUR 1.

Therefore, the analysis of the implementation of previous mitigation measures for NDC 1, which was conducted only during the updating and development of NDC 2, based on the information collected

[331] Program on the transition of the Kyrgyz Republic to sustainable development for 2013-2017.

[332] Medium-term forecast of socio-economic development of the Kyrgyz Republic for 2011-2013. Approved by the Resolution of the Government of Kyrgyz Republic dated January 26, 2011 No. 25.

[333] Approved by the Decree of the President of Kyrgyz Republic dated January 21, 2013 No. 11.

[334] Approved by the Resolution of the Government of Kyrgyz Republic dated April 30, 2013, No. 218.

from various stakeholders on the results of mitigation measures implemented by 2020 in comparison with the obligations of NDC 1 will be presented in NC 4.

In this document, mitigation measures included in NDC 1 are presented in terms of recalculated values of their mitigation capacity, based on newly obtained estimates of the 4^{th} NGHGI emissions and recalculated projections of future GHG emissions.

3.2. Mitigation Actions by Sectors

Kyrgyzstan NDC 1 presented at COP 21 in Paris in 2015 did not explicitly present the measures by which the declared mitigation targets would be achieved, focusing only on their results in the form of targets, therefore BUR 1 will present these measures in this section, and the measures of the updated NDC 2 will be presented in NC 4. An assessment of the measures proposed in the last NC 3 of Kyrgyzstan and included in NDC 1 will be presented here.

Mitigation measures to achieve the goals of NDC 1 were calculated according to the three scenarios of socio-economic development presented above and represented the mitigation capability, assessed based on data from the 3rd NGHGI. The base year was defined as 2010. The focus of NDC 2 shifted from capacity, reflecting opportunities, to their practical implementation, therefore, the weighted average values of indicators of future development were adopted to assess reductions, which correspond to scenario 2 of NDC 1. For comparability in further analysis, the mitigation measures and their results for scenario 2 are presented below (Table 3.1).

Table 3.1 Mitigation measures by categories included into Kyrgyzstan NDC 1, projected GHG emission reductions in 2020 and the status of their implementation[335]

№	Measures Category	Coverage of sectors, gases	Quantitative Goals / Objectives	Indicators of progress	Methodologies / Assumptions	Measures taken / envisaged	Outcomes	Estimated emissions reductions, Gg of CO2 eqv.
1.	Reduction of heat energy losses	Energy. CO_2, CH_4, N_2O, precursor gases (NO_x, CO, NMVOC, S_2O	Reduction of losses from 22.48% (2010) to the level of 10 - 12%	% of reduced losses	Calculation based on CO_2 emissions per unit of heat energy and the number of subscribers to heating networks in Bishkek, Osh and regions.	Installation of metering devices, replacement of boilers, replacement of heating networks, re-equipment of control rooms.	Beginning of the process	80,54
2.	Implementation of new Building Codes on energy efficiency of buildings	Energy. CO_2, CH_4, N_2O, precursor gases (NO_x, CO, NMVOC, S_2O	Reduction of energy consumption by new buildings by 30 - 40% compared to 2010	% reduction in energy consumption	Calculation based on CO2 emissions per heat unit and the number of newly connected buildings. All new buildings are being built with im-	Fulfillment of the requirements for energy efficiency of buildings in accordance with SNiP KR 23-01: 2009, Construction heat engineering (thermal protection of buildings) and	Beginning of the process	74,16

335 Developed by authors based on materials: SAEPF, UNEP, Climate Change Center. Intended Nationally Determined Contributions of the Kyrgyz Republic. –B. 2015 and SAEPF, GEF-UNEP. Assessment of the Risks of the Kyrgyz Republic Joining the Paris Agreement. - B., 2019

№	Measures Category	Coverage of sectors, gases	Quantitative Goals / Objectives	Indicators of progress	Methodologies / Assumptions	Measures taken / envisaged	Outcomes	Estimated emissions reductions, Gg of CO2 eqv.
					proved thermal insulation in accordance with SNIP	SNiP KR 23-101: 2009, Design of thermal protection of buildings.		
3.	Energy Efficiency Improvement of the Existing Building Stock, SDM	Energy. CO_2, CH_4, N_2O, precursor gases (NO_x, CO, NMVOC, S_2O	Reducing energy consumption of existing buildings.	% reduction in energy consumption	Calculation based on CO_2emissions per unit of thermal energy and the number of existing buildings. Until 2050, all existing knowledge will increase energy efficiency according to SNIP	Fulfillment of the requirements for energy efficiency of buildings in accordance with SNiP KR 23-01: 2009, Construction heat engineering (thermal protection of buildings) and SNiP KR 23-101: 2009, Design of thermal protection of buildings.	Beginning of the process	123,57
4.	Reduction of energy losses	Energy. CO_2, CH_4, N_2O, precursor gases (NO_x, CO, NMVOC, S_2O	Reduction of total losses to the level of 14.88%	Reducing energy losses			Beginning of the process	109,91
4.1	Reducing electricity losses during generation		Reduction of losses up to 0.4%	0.38% in 2014 (HPP + TEPP)	According to the methodology on the average monthly planned load of transformers, the Kyrgyz Scientific and Technical Center "Energia" with using the "method of greatest losses", the recommended standard for electricity losses is 0.4%.	Not provided	Achieved	
4.2	Reduction of electricity losses during transmission		Reduction of losses from 863.3 million kWh 6.03% (2014) to 4.5%	Reduction of losses by 230	The action plan of OJSC "NESK Kyrgyzstan" will be implemented	Commissioning of the high-voltage line 500 kV Datka-Kemin, con-	Beginning of the process	

№	Measures Category	Coverage of sectors, gases	Quantitative Goals / Objectives	Indicators of progress	Methodologies / Assumptions	Measures taken / envisaged	Outcomes	Estimated emissions reductions, Gg of CO2 eqv.
				million kWh (according to indicators of 2014)		struction and replacement of the overhead line section, reduction of electricity losses by controlling reactive power flows in the power system, reduction of electricity losses by increasing the capacity of the reconstruction of the TEPP in Bishkek to 500 MW, reduction of daily electricity consumption for electric heating , decrease in daily consumption of electricity in the Kyrgyz energy system due to gasification of the republic, export of electricity 1.5 billion kWh in summer, import of electricity 0.6 billion kWh, transfer of the output of KAGES-2 from 110 kV to 500 kV, the introduction of a differentiated electricity tariff in 2014-15, compliance with power consumption limits on the part of consumers will reduce losses by 5-10 million kWh		

№	Measures Category	Coverage of sectors, gases	Quantitative Goals / Objectives	Indicators of progress	Methodologies / Assumptions	Measures taken / envisaged	Outcomes	Estimated emissions reductions, Gg of CO2 eqv.
4.3	Reduction of electricity losses during distribution		Reduction of losses 16.3% (2014) to 10% per year	Reduction of losses in million kWh	Losses reduction plans are being implemented by Severelectro OJSC, Vostokelectro OJSC, Oshelectro OJSC, Jalal-Abadelectro OJSC	Replacement of overloaded networks, reconstruction, transfer to self-supporting insulated wires (SIP), transfer to Automated system for commercial metering of electricity (ASKUE), new construction	Beginning of the process	
5.	Reducing gas losses	Energy. CH_4	Bringing losses up to 7%	Reduction of losses in million m^3	Plan of Gazprom Kyrgyzstan LLC implemented	Reconstruction and replacement of main gas pipelines, gas branches to the GDS. Reconstruction of gas compressor stations. Major repairs and installation of gas pipelines and gas technical facilities. Acquisition of household gas meters (13500 pcs.). Scheduled replacement of unreliable sections of gas distribution pipelines (5,850 linear meters).	Beginning of the process	860,06
6.	Transport	Energy. CO_2.	Not defined	Reducing emissions from road transport	The proposed measures have been taken for implementation	Legal and economic measures; Public transport development; Traffic management and road infrastructure planning; Cycling infrastructure development: Creation of pedestrian zones; Implementation	Capacity assessment	1395,80

№	Measures Category	Coverage of sectors, gases	Quantitative Goals / Objectives	Indicators of progress	Methodologies / Assumptions	Measures taken / envisaged	Outcomes	Estimated emissions reductions, Gg of CO2 eqv.
						of green driving programs.		
7.	Biomass use	Energy. CH_4.	Not defined	Energy generated from biomass	Converting Energy Units to Emissions	Capacity assessment of the animal husbandry, crop production, food industry and municipal solid waste	Capacity assessment of the of livestock and sugar industry	347,00
8.	Energy of the sun: Electricity	Energy. CO_2.	100 thousand by 2030, 200 thousand by 2060, and total 400 thousand roofs in 2100	Number of "solar roofs" with photovoltaic panels	Reduction of emissions from heating in the residential sector after implementation of the 100 thousand solar roof program	Development and implementation of the 100 thousand solar roofs program.	Capacity assessment	12,95
9.	Energy of the Sun: Heat	Energy. CO_2.	10% of households by 2030, an additional 10% by 2060, and total coverage 35% by 2100.	% of households with solar collectors	Assumption: Coverage of 10% of households by 2030, an additional 10% by 2060, and total coverage of 35% by 2100.	It is planned to implement a program similar to that for electric power, i.e. - coverage of 10% of households by 2030, an additional 10% by 2060 and total coverage of 35% by 2100. Coverage is generally consistent with global growth trends for this type of renewable energy	Capacity assessment	78,44
10.	Geothermal energy	Energy. CO_2.	There are more than 30 geothermal springs in the Kyrgyz Republic, but only a few of them are used in the sanatorium-resort economy exclusively to meet the own needs	Heat energy generated by heat pumps	In the Kyrgyz Republic, the share of using heat pumps for heating and hot water supply will reach 75% only by 2100.	Development of projects and search for investors.	Beginning of the process	137,22

№	Measures Category	Coverage of sectors, gases	Quantitative Goals / Objectives	Indicators of progress	Methodologies / Assumptions	Measures taken / envisaged	Outcomes	Estimated emissions reductions, Gg of CO2 eqv.
			of these institutions, because their power is small.					
11.	Hydropower	Energy. CO_2, CH_4, N_2O, Indirect (NO_x, CO, NMVOC, S_2O	Currently, the republic's hydropower capacity is already being used by 18% (for large hydroelectric power plants by 19.5%, and for small ones by 4%).	During the construction of all planned HPPs, the use of potential - up to 46.0% (for large HPPs up to 48.8%, and for small ones - up to 21.3%).	By 2050, Kambar Ata 1 and 2 will be constructed.	Construction of Kambarata-1 and 2, Narynskaya 1, 2, and 3, Akbulunskaya, Sary-Jaz, Kara-Kolskaya, Kokomerenskaya 1 and 2, as well as all planned small hydroelectric power plants by 2100.	Beginning of the process, search for investors	49,0

The list of mitigation categories and the estimated GHG emission reductions, as well as their current implementation status are presented in Table 3.2.

Table 3.2 Summary data on the main categories of mitigation measures of Kyrgyzstan included in NDC 1, projected GHG emission reductions in 2020 and implementation status [336]

№	Main categories of mitigation measures	Reduction of GHG emissions, Gg CO_2 eq.	Status
1	Reduction of heat energy losses	80,54	On-going
2	Implementation of adopted Building Codes on energy efficiency of buildings	74,16	On-going
3	Improving the energy efficiency of the existing buildings	123,57	On-going and Resource mobilization
4	Reduction of energy losses	109,91	On-going
5	Reducing gas losses	860,06	On-going
6	Transport	1395,80	On-going and Resource mobilization
7	Biomass	347,00	Resource mobilization
8	Solar energy - electricity	12,95	Resource mobilization
9	Solar energy - heat	78,44	Resource mobilization

[336] Developed by authors on NDC 1.

№	Main categories of mitigation measures	Reduction of GHG emissions, Gg CO_2 eq.	Status
10	Geothermal energy	137,22	Resource mobilization
11	Hydropower	49,0	On-going and Resource mobilization
Total		**3269,73**	
% from BAU		**23,24**	

The results of calculating scenarios with planned measures show that the goal for the near term, as defined in the official voluntary commitments of the Kyrgyz Republic to reduce GHG emissions by 2020 (to reduce its GHG emissions by 20% by 2020, relative to the "business as usual" scenario, with appropriate and adequate support from the international community) is achievable through planned measures for all development scenarios.

These calculated values were based on the results of the assessment of the GHG emissions of the 3rd NGHGI. The obtained results of estimating emissions of the 4th NGHGI cover a longer time series and were obtained using a modern IPCC methodology, which necessitates recalculations, which will be presented in NC 4.

4. Information on support received and needs

In the considered period 2011-2018, Kyrgyzstan has received and is receiving significant support in climate finance and capacity building. However, the technology transfer mechanism has been underutilized so far.

Article 4.5 of the United Nations Framework Convention on Climate Change states that "developed country Parties and other developed Parties included in Annex II shall take all practical steps to promote, facilitate and finance, as appropriate, the transfer of environmentally sound technologies and know-how to other Parties, especially developing country Parties, to enable them to implement the provisions of the Convention. "

Achieving the ultimate goal of the UNFCCC, as articulated in Article 2, will require technological innovation and the rapid and broad transfer and implementation of technologies, including know-how, to reduce the impact of greenhouse gas emissions. Technology transfer for adaptation to climate change is also an important element in reducing vulnerability to climate change. This technological innovation must occur quickly enough and continue for some time to allow greenhouse gas concentrations to stabilize and reduce vulnerability to climate change. Environmentally Sound Technology (EST) must be a technology for mitigation and adaptation to climate change, and it must support sustainable development.

Sustainable development on a global scale will require radical technological and related changes in both developed and developing countries. Economic development was the fastest in developing countries, but it will not be sustainable if these countries follow the historical greenhouse gas emission trends of developed countries. In this regard, technology transfer, in particular from developed countries to developing countries, should be carried out on a large scale, covering software and hardware issues, and ideally as part of helping to find new sustainable pathways for the economy as a whole. Thereby, it is important to ensure that transferred technologies meet local needs and priorities, thus increasing the likelihood that they will be successful and that an appropriate enabling environment exist to facilitate ESTs.

The term "technology transfer" is defined as a broad set of processes that encompasses flows of know-how, expertise, and equipment for mitigating and adapting to climate change among various actors such as governments, private sector organizations, financial institutions, non-governmental organizations (NGOs) and research/training institutes. The broad and comprehensive term "transfer" includes technology diffusion and technological cooperation between and within countries. It covers the transfer of technology between developed countries, developing countries, and countries with economies in transition. It includes the process of learning to understand, use and replicate the technology, including the ability to select and adapt it to local conditions, as well as incorporate it into local technologies.[337]

Among the mechanisms for technology transfer are the following:

National Systems of Innovation (NSI), which incorporate elements of capacity building, access to information, and an enabling environment in overarching EST transfer concepts, are more supportive than individual components and foster a culture of innovation. The NSI concept can be expanded through partnerships with international companies. The partnerships will be an oriented system that covers all stages of the technology transfer process and ensures the participation of the private and public sectors, including business, legal, financial, and other service providers from developed and developing countries.

[337] IPCC. Special report. Methodological and technical aspects of technology transfer. 2000 - p. 3.

Official development assistance (ODA) is still essential for developing countries and the successful transfer of ESTs. ODA can also help improve policy frameworks and build long-term capacity. It is increasingly recognized that ODA can best focus on mobilizing and increasing additional financial resources.

The Global Environment Facility (GEF), the operating entity of the UNFCCC financial mechanism, is the key multilateral institution for the transfer of ESTs. Compared to the magnitude of technology transfer, these efforts are modest, even when they complement contributions from bilateral development assistance. The GEF's current goal is additional one-off investments in mitigation projects that are experiencing and demonstrating a variety of financial and institutional models to facilitate expansion.

Multilateral Development Banks. Governments can use their influence to guide the activities of multilateral development banks (MDBs) through their respective boards and councils to strengthen MDB programs for reporting on the environmental impact of their lending:

The Kyoto Protocol and UNFCCC mechanisms, which, if implemented, may have the potential to influence the transfer of ESTs.

A dedicated Technology Mechanism (Technology Mechanism) has been established to facilitate the provision of convention obligations on the development and transfer of technologies in the most direct way. The importance of further technology transfer development was emphasized to accelerate the implementation of the Convention at 8-10 of the 2009 Copenhagen Agreement, adopted at the 15th session of the Conference of the Parties to the UNFCCC and the 5th Meeting of the Parties to the Kyoto Protocol (Copenhagen, December 7-19, 2009), which is a political statement of intent.[338] In paragraph 11 of the Agreement, a decision was taken to establish the Technology Mechanism, described as an institutionalized way to accelerate the development, promotion and support of technology transfer to developing countries. The Mechanism was formally established by decision 1/CP.16 9 of the Parties to the Convention, where paragraph 117 stated that the institutional framework was intended to facilitate the implementation of enhanced technology development and transfer activities to support mitigation and adaptation measures to achieve full implementation of the Convention.

The legally binding basis for the functioning of the Mechanism is the provisions of Art. 10 of the Paris Agreement. Structurally, the Mechanism consists of two bodies working together, the Technology Executive Committee (TEC) and the Climate Technology Center and Network (CTCN). The Executive Committee, like the Center and the Network, operates under the authority of the Conference of the Parties, providing communications and advice to it through the Subsidiary Body for Implementation. Although the Mechanism is represented by two bodies, they initially seek to develop coherence and synergy in their work in the process of providing targeted technology support and responding to the needs of countries.

4.1. Support received

During the reporting period 2011-2018, the Kyrgyz Republic received significant support from international donors in the area of climate change. In addition, since 2018, the country has been implementing the project "Support to Kyrgyzstan in the preparation of the First Biennial Update Report and the Fourth National Communication of the Kyrgyz Republic to the UNFCCC" with financial support from the GEF. The aim of the project is to assist the country in preparing NC 4 and BUR 1 for the Conference

[338] Copenhagen Accord (18 December 2009) // FCCC. Report of the Conference of the Parties on its fifteen session, held in Copenhagen from 7 to 19 December 2009. Addendum. Part Two: Action taken by the Conference of the parties at its fifteenth session. Decision 2/CP.15. FCCC/CP/2009/11/Ad.1 (30 March 2010), pp. 5–7. URL: [http://unfccc.int/ resource/docs/2009/cop15/eng/11a01.pdf] (date of communication: 14.04.2018).

of the Parties to fulfill the obligations under the Convention Decision 1/CP.16 (paragraph 60), Decision 2/CP.17 (paragraph 41) and its Annex III.

The project is being implemented by UNEP jointly with the Ministry of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic.

The support received from external sources, including some technology transfer, capacity building, and climate finance from multilateral and bilateral sources, contributed significantly to the country's adaptation and mitigation needs. It supported the country's progress towards a low-emission development path through the implementation of sectoral policies and programs, and the promotion of environmentally friendly business solutions. Complete and reliable information on these flows and analysis of the results achieved will help to optimize the use of resources and improve climate policy development. Here BUR 1 plays an important role as a source of such information.

The following are projects of various donors providing different types of support (financial, technical, and capacity development support).

Table 4.1 Projects to support climate action of the Kyrgyz Republic by international development partners [339]

#	Funding organization	Executing Agencies	Name of the program and / or project	Deadlines of implementation	Budget	Activities: Adaptation, Mitigation, Technology Transfer, Monitoring (MRV), Capacity Building, Awareness Raising, etc.	Status
1	German Federal Office for Agriculture and Food (BLE)	• Central-Asian Institute for Applied Geosciences (CAIAG), Kyrgyzstan, • University of Central Asia, Kyrgyzstan, Tajikistan, • University of Applied Sciences for Sustainable Development Eberswalde (HNEE), Germany, • University of Stuttgart, Germany.	Balancing and optimizing the multifunctional use of juniper forests in Central Asia.	2019-2021	478.235,19 €	Promotion of bilateral forest research projects, guidance for the development of bilateral (Kyrgyzstan, Tajikistan) co-operation in research and knowledge exchange for international forest management).	At the stage of development
2	German Federal Ministry of Education and Research (BMBF)	• University of Central Asia, Kyrgyzstan, • Helmholtz Research Center Potsdam GFZ, Germany, • Kyrgyz-Russian Slavic University, Kyrgyzstan, • Central-Asian Institute for Applied Geosciences (CAIAG), Kyrgyzstan, • MNRETS.	Paleoclimatic Environmental Change and Social Interaction in Central Asia – linking Institutional and Citizen Science - PALESCA	01.10.2017-30.09.2019	149,891.33 €	The project will focus on coordinating and expanding monitoring / training activities for students from Kyrgyzstan (2 summer schools, fieldwork, master's work) and citizen engagement at the local level through civic science projects and local educational centers.	Project at stage of completion
3	German Society for International Cooperation (GIZ)	• Central-Asian Institute for Applied Geosciences (CAIAG), Kyrgyzstan, • Berlin Humboldt University	Adaptation to climate change based on the ecosystem approach in the high mountainous regions of Central Asia	01.02.2019-31.08.2020	30 800 €	Adaptation to Climate Change based on the ecosystem approach in high mountain areas of Central Asia is focused on adaptation of local communities to climate change in pilot sites such	In the process of implementation

[339] Source: MNRETS.

#	Funding organization	Executing Agencies	Name of the program and / or project	Deadlines of implementation	Budget	Activities: Adaptation, Mitigation, Technology Transfer, Monitoring (MRV), Capacity Building, Awareness Raising, etc.	Status
						as the Bartang River Basin (Tajikistan) and the Bash-Kayindy River Basin (Kyrgyzstan).	
4	British Foundation for the Global Challenges Study	• Central-Asian Institute for Applied Geosciences (CAIAG), Kyrgyzstan, • University of Reading, GB	Solutions to Ensure Clean Water in the Central Asia Glacier Drainage Basin - What Happens After the Ice?	2018 - 2020	7 560 £	Monitoring of water pollution from industrial, household and especially agricultural sources on the territory of Kazakhstan, Kyrgyzstan, Uzbekistan and Tajikistan.	In the process of implementation
5	Swiss Agency for Development and Cooperation (SDC)	• Central-Asian Institute for Applied Geosciences (CAIAG), Kyrgyzstan, • University of Friborg (Switzerland) on behalf of the World Glacier Monitoring Service (WGMS).	Project "CICADA" (Climate Services of the Cryosphere to Improve Adaptation)	2017 -2021	Unknown	The aim of the Project is to facilitate the systematic exchange of water and climate-related data between data users and decision-makers to improve modeling and forecasting of water flow scenarios and reduce the associated disaster risks in Central Asia.	In the process of implementation
6	UNESCO	• CAIAG • Ministry of Emergency Situations	Reducing the vulnerability of the population in the Central Asian region from the outburst of glacial lakes under the climate change conditions.	2019-2024	6 500 000 $	The project aims to enhance adaptation to climate change in Central Asia by reducing social risks and vulnerability to floods from the outburst of glacial lakes. This is achieved by strengthening monitoring, analytical skills and response capacities for institutions and government officials responsible for disaster risk reduction, through	Project is under development

#	Funding organization	Executing Agencies	Name of the program and / or project	Deadlines of implementation	Budget	Activities: Adaptation, Mitigation, Technology Transfer, Monitoring (MRV), Capacity Building, Awareness Raising, etc.	Status
						the provision of training for local communities, as well as through awareness campaigns and the installation of Early Warning Systems (EWS) based on the latest monitoring strategies.	
7	Niigata University, Japan	• CAIAG, Bishkek, Kyrgyz Republic • Niigata University, Japan • Ministry of Emergency Situations	Tien Shan Glacial and Periglacial Lakes Research Project (GlaP)	2019-2024	Not specified	The project aims to • Glacial and pereglacial studies in the Tien Shan; • Study of glacial and periglacial lakes using remote sensing and GIS methods in the Tien Shan; • Providing information on glacial hazards to the local population;	In the process of implementation
8	CAWa	• CAIAG, Kyrgyz Republic • German Center for Geosciences (GFZ)	Scientific and technical cooperation in the field of climatology, hydrology, glaciology	2014-2020	6500€	Hydrological modeling and forecasting of river flow in Kyrgyzstan for the flood period. Preparation and implementation, in March 2013, of the methodology for river water forecasting based on CAIAG snow-cover satellite data. Methodological assistance in the preparation of initial data for modeling and installation in March 2017.	In the process of implementation

#	Funding organization	Executing Agencies	Name of the program and / or project	Deadlines of implementation	Budget	Activities: Adaptation, Mitigation, Technology Transfer, Monitoring (MRV), Capacity Building, Awareness Raising, etc.	Status
						GFZ software products to operational hydro-forecasting units of Kyrgyzhydromet.	
9	Multilateral Fund for the Montreal Protocol	• UNDP • UNEP	HCFC phase-out plan	2016-2020	712 000 USD	Mitigation (decommissioning HCFCs in the Kyrgyz Republic will reduce total emissions by 1,303,200 tons of CO2 equivalent in the period from 2011 to 2020). Technology transfer (transition to alternative green technologies using natural refrigerants propane, isobutane, ammonia, and CO2). Capacity building (communities of specialists in the refrigeration sector of “ROO Ecoholod” were organized, training centers “Samsung Service”, Buudan, a network of vocational schools (7 units) and universities for training young specialists was involved, equipment was transferred for training and certification of technicians) Awareness-raising (regular training and seminars in the technical sector, training for law enforce-	In the process of implementation

#	Funding organization	Executing Agencies	Name of the program and / or project	Deadlines of implementation	Budget	Activities: Adaptation, Mitigation, Technology Transfer, Monitoring (MRV), Capacity Building, Awareness Raising, etc.	Status
						ment agencies on preventing illegal trade in refrigerants	
10	International Fund for Agricultural Development (IFAD)	• Department for the implementation of agricultural projects under the MAFILR • Community Development and Investment Agency of the Kyrgyz Republic (ARIS)	Livestock and Market Development Project (LRM)	2014-2019	IFAD Grant: 7,752 thousand USD; IFAD loan: 9,964 thousand USD; ASAP Grant*: 9,229,000 USD; Government of the Kyrgyz Republic: about 130 thousand USD to cover taxes.	Improved livestock productivity and resilience of local communities to climate change, expressed in increased and commensurate incomes for livestock keepers, which should ultimately lead to poverty reduction and increase economic growth in rural communities.	In the process of implementation
11	International Development Association (IDA), World Bank	• Community Development and Investment Agency of the Kyrgyz Republic (ARIS)	Kyrgyz Republic Heat Supply Improvement Project (IHS)	2019-2024	10,000 thousand USD;	Improving energy efficiency and seismic resistance of public buildings.	In the process of implementation
12	International Development Association (IDA), World Bank	• Community Development and Investment Agency of the Kyrgyz Republic (ARIS)	Project on "Sustainable Development of Rural Water Supply and Sanitation" (SDRWS)	2018-2025	43.2 million USD	Aims to increase investment in rural water supply and sanitation	In the process of implementation
13	International Development Association (IDA), World Bank	• Department for the implementation of agricultural projects under the MAFILR	Project "Improved Pasture and Livestock Management" (IPLM)	2014-2019	15.0 million USD	Aims to improve community-based pasture and livestock management by improving the quality of	At the stage of completion

#	Funding organization	Executing Agencies	Name of the program and / or project	Deadlines of implementation	Budget	Activities: Adaptation, Mitigation, Technology Transfer, Monitoring (MRV), Capacity Building, Awareness Raising, etc.	Status
		• Community Development and Investment Agency of the Kyrgyz Republic (ARIS)				services provided by Pasture User Associations (PUAs) and their executive bodies - zhayit committees and private veterinary services for local communities	
14	Islamic Development Bank	• Community Development and Investment Agency of the Kyrgyz Republic (ARIS)	Project "Rural Water Supply and Sanitation Improvement" (RWSI)	2017–2022	23.0 million USD	Aims to assist the Kyrgyz Republic in improving the availability and quality of water supply in targeted rural communities, improve sanitation services in selected villages, and strengthen the capacity of institutions in the water supply and sanitation sector.	In the process of implementation
15	World Bank	• Community Development and Investment Agency of the Kyrgyz Republic (ARIS)	Project "Urban Development" (UDP)	2017 - 2020	14.4 million USD	Aims at improving access to basic services such as water supply, solid waste management and other urban infrastructure, while applying technologies to improve energy efficiency and earthquake resistance of buildings.	In the process of implementation
16	Islamic Development Bank (IDB)	• Community Development and Investment Agency of the Kyrgyz Republic (ARIS)	Project "Sustainable Rural Development" (SRDP)	2017 - 2021	11.0 million USD	Aims at agriculture and rural development, human development, rural infrastructure development (health, education, water and sanitation), employment creation, empowerment of women,	In the process of implementation

#	Funding organization	Executing Agencies	Name of the program and / or project	Deadlines of implementation	Budget	Activities: Adaptation, Mitigation, Technology Transfer, Monitoring (MRV), Capacity Building, Awareness Raising, etc.	Status
						community-based development and the promotion of microfinance based on Islamic principles.	
17	GEF	• American University in CA, • UNEP, • UNCCD, • GIZ	Reporting on the Neutral Balance of Land Degradation in the Kyrgyz Republic	2018-2020	80 000 USD	Adaptation, Capacity Building, Awareness Raising	In the process of implementation
18	Green Climate Fund (GCF)	• World Food Program • MPRETS • MAFILR • MES • MLSP	Improving climate services and diversifying climate-sensitive livelihoods to enhance food security for vulnerable communities in the Kyrgyz Republic.	2020-2024	9 600 000 USD	Adaptation, health, food and water security, livelihoods of people and communities	In the process of implementation
19	Green Climate Fund (GCF)	• Food and Agriculture Organization (FAO)	Support to Kyrgyzstan in capacity-building and the development of a strategic framework for working with the GCF	2018-2019	300 000 USD	Capacity Building of National Designated Authority and Country Programming for GCF	At the stage of completion
20	Green Climate Fund (GCF)	• MNRETS.	Carbon sequestration through climate finance in forests and pastures in the Kyrgyz Republic (CSFOR)	2020-2027	50 000 000 USD	Mitigation and adaptation Spheres of GCF: • Forestry and land use; • Livelihoods of people and communities; • Ecosystems and ecosystem services	In the process of implementation

#	Funding organization	Executing Agencies	Name of the program and / or project	Deadlines of implementation	Budget	Activities: Adaptation, Mitigation, Technology Transfer, Monitoring (MRV), Capacity Building, Awareness Raising, etc.	Status
21	GEF	• UNEP, • MNRETS.	Support to Kyrgyzstan in the preparation of BUR 1 and NC 4 under the UNFCCC.	2018-2021	853 000 USD	UNFCCC BUR 1 and NC 4	In the process of implementation

4.2. Financial, Technical and Capacity Building Needs

The list of problems and measures to address during the preparation of BUR 1, formulated during the preparation of the Third National Communication, was revised, updated and discussed with all stakeholders of climate action. Table 4.2. provides a list of the main constraints and gaps that reduce the effectiveness of the results of activities under the UNFCCC in the Kyrgyz Republic, reflecting the country's needs for international support (see Table 4.2 below).

Table 4.2 Constrains and gaps, and actions to address them, related to inventories of GHG emissions and sinks and climate change.

№	Constraints and Gaps	Explanations	Actions to address them
1	**Greenhouse Gas Inventory**		
1.1	Absence of institutional mechanisms to conduct regular inventories	• Inventory is carried out only within the framework of the preparation of national communications. • Increased regularity is required considering the increased frequency requirements. • It is also necessary to include climate indicators in many programs and development plans	• Preparation of by-laws for the Law "On State Regulation and Policy in the Field of Emission and Absorption of Greenhouse Gases," defining the mechanism of its implementation. • Calculation of greenhouse gas emissions according to the baseline approach by the statistical authorities and integration of the results in the current official statistical reporting
1.2	Discrepancies between forms of official statistics and inventory	• Inconsistency complicates inventory taking and adds further uncertainty to the results	• Work on improvement has already started with the fuel and energy balance, but it takes a long time to complete
1.3	Some of the necessary information is not maintained by statistical agencies but only available in organizations	• Specific information is needed for inventory	• Enhanced cooperation between different sectors is needed
1.4	Some of the necessary information is missing or highly uncertain	• First of all, this is the morphological composition of waste, biomass growth factors, humus content in soils	• Additional studies, in some cases regular studies, are needed
2	**Mitigation**		
2.1	Insufficient emission forecasting capacity	• Long-term projection is required, including macroeconomic, demographic and other projections as baseline data	• Capacity of public authorities dealing with long-term forecasting needs to be improved
2.2	Lack of a national strategy to reduce greenhouse gas emissions	• The absence of a strategy complicates the monitoring of emission reductions and reduces the ability to attract international support for mitigation actions	• National Strategy based on the Nationally Determined Contribution of the Kyrgyz Republic needs to be developed
2.3	Insufficient legal enforcement of incentives for the	• The introduction of clean technologies in many cases	• Further improvement of the legal framework is needed

№	Constraints and Gaps	Explanations	Actions to address them
	adoption of clean technologies	is not economically viable in the short term. • Implementation actions should be proactive. The country has already adopted a number of incentive measures, but they are not enough	
2.4	Insufficient capacity to use forecasting models linking emissions to raw data (such as Markal) or to develop proprietary models	• Long-term emission projections require correct and user-friendly models	• Training of a team of specialists is needed to support the regular forecasting process
2.5	Lack of an integrated national measurement, reporting and verification (MRV) system	• There are certain prerequisites for the establishment of an integrated MRV system for adaptation and mitigation • However, methodological and legal tools for implementing the system into practice are needed	• Development of the necessary tools of standards and formats • Legitimation of tools by legal acts • Training of stakeholder staff on MRV tools.

In general, the main constraints are the lack of financial resources and available information in all activity areas.

The main reasons for the lack of information are inadequacy of the monitoring system, incomplete transfer of departmental archives to digital media and limited access to information by some departments.

The main reasons for the lack of information are insufficient monitoring system, incomplete digitization of departmental archives and limited access to information by some agencies.

4.2.1 Financial needs

Since this report covers the period of 2011-2018, the financial needs for the identified as per three scenarios mitigation actions at that period were calculated and estimated within the process of the NDC 1 development. All the estimations of the financial resources required to implement identified mitigation measures by categories were calculated in constant 2005 US dollars up to 2100. Those estimations for the medium Scenario 2 are given in tab.4.3 below.

Table 4.3 Financial resources required to achieve first NDC targets (mln. 2005 USD)[340]

№	Mitigation measures category	Internal resources	External resources	Totally required
1.	Reduction of heat energy losses	0,00	241,65	241,65
2.	Implementation of adopted Building Codes on energy efficiency of buildings	0,05	0,00	0,05
3.	Energy efficiency improvement of the existing buildings	0,05	0,00	0,05

[340] SAEPF, UNEP. INDC Report. 2015.

№	Mitigation measures category	Internal resources	External resources	Totally required
4.	Reduction of electricity loss	0,00	29,35	29,35
5.	Reducing natural gas loss		386,39	386,39
6.	Transport	2,96	20,92	23,87
7.	Biomass	14,69	14,69	29,38
8.	Solar energy - electricity	400,00	400,00	800,00
9.	Solar energy - heat	64,75	64,75	129,50
10.	Geothermal energy	654,78	654,78	1309,56
11.	Hydropower		331,17	331,17
Totally		**1137,27**	**2143,70**	**3280,97**

In 2021. Kyrgyzstan has elaborated its NDC 2 while revising its mitigation potential and mitigation measures, as well as funds requirements. Thus, the above estimations of financial needs are of historical value reflecting climate action efforts undertaken at that time.

Newly developed mitigation measures planned by Kyrgyzstan and presented in NDC 2, as said in the corresponding section above, as well as financial needs, will be duly described in Kyrgyzstan NC 4.

5. Domestic (national) Monitoring, Reporting and Verification System (MRV)

5.1. Prerequisites for the establishment of the MRV system

The Monitoring, Reporting and Verification System (MRV) is an essential tool for tracking the progress made by a country to achieve the NDCs of the Paris Agreement, but also in achieving the Sustainable Development Goals (SDG 13). The MRV is considered to be the main tool that allows to plan and manage mitigation and adaptation actions, track the progress of their implementation and analyze their effect.

The MRV system is structured around three key areas: MRV of GHG emissions, MRV of mitigation and adaptation actions, and MRV of support (financial, technological and capacity building).

The 2015 Paris Agreement calls for a strengthened transparency framework, noting that all Parties to the agreement need to work to establish common rules, procedures and guidelines based on the experience of UNFCCC transparency reporting, including national communications, biennial update reports, and an international consultation and analysis process for developing countries. It is expected that these countries will receive support to build a strengthened transparency framework.

According to the Law on State Regulation and Policy in the field of Emissions and Removals of Greenhouse Gases the monitoring of emissions and removals of greenhouse gases is conducted to provide state bodies, that regulate and control climate change, as well as individuals and legal entities with timely and reliable information on the emissions level and absorption of greenhouse gases from facilities emitting and absorbing greenhouse gases. It also states that State monitoring of greenhouse gas emissions and removals is an integral part of environmental monitoring, and the results of monitoring greenhouse gas emissions are subject to registration in the state cadaster of greenhouse gas emissions and removals after verification in accordance with the established procedure by a specially authorized state body.[341]

The results of inventories, monitoring of greenhouse gas emissions and the results of climate projects leading to a reduction in greenhouse gas emissions and an increase in greenhouse gas absorption are subject to verification. Information on verification is reflected in the State Inventory of Greenhouse Gas Emissions and Removals.[342]

Unfortunately, these provisions of the Law did not work due to the lack of necessary by-laws: developed methodologies, instructions and procedures, as well as the absence of the necessary human resources.

Currently, the key elements of the domestic (national) MRV system are found in the UNFCCC mechanisms established for country reporting on current and expected emissions, as well as reporting on mitigation and adaptation projects implemented in the country. In this context, Kyrgyzstan already reports on national emissions and their trends in regular national communications. These documents are developed on the basis of research, analysis, reports of leading national experts, as well as reports of international consultants of various climate projects.

Selected products that can be used for the domestic MRV system in Kyrgyzstan have been developed in the framework of various projects implemented by international development partners. Thus, in 2013, the Guidelines on National Indicators for Monitoring and Evaluating Green Growth Indicators

[341] Law of the Kyrgyz Republic "On State Regulation and Policy in the field of Emission and Removals of Greenhouse Gases" dated May 25, 2007 No. 71. Article 10, paragraph 1.
[342] Ibid, Art. 11, paragraphs 3, 4

in the Kyrgyz Republic were developed under the UNDP and UNEP Poverty and Environment Initiative project, with the involvement of the OECD. The document has a methodological nature and is intended for practical use by civil servants, although it can be useful to any of the parties interested in assessing progress in the transition to sustainable development in terms of the conservation and rational use of human and natural capital. Moreover, the set of indicators presented can be used for comparison with neighboring countries and at the international level.

The Guidelines presents five categories of indicators grouped into blocks:

- Block 1. Carbon and Energy productivity (17 indicators);
- Block 2. Environmental assets (15 indicators);
- Block 3. Environmental quality of life (12 indicators);
- Block 4. Economic opportunities and response policy (12 indicators);
- Block 5. Socio-economic context and characteristics of growth (9 indicators).

For each of the indicators, the following information is provided:

- Definition of the indicator consistent with the national methodology (National Statistical Committee or agency);
- Interpretation of the indicator in terms of "green" growth;
- Methodology for data collection, processing and calculation, based on methodological materials of the National Statistical Committee and/or relevant agency.

Block 1 of this Guidelines, relevant to mitigation, proposes that the effects of human economic activity on the atmosphere and on the formation of CO2 in relation to GDP should be the subject of statistical observation, both for the country as a whole and for the sectors of the economy; as well as the energy cost of GDP production in kWh. It is proposed to take into account the areas of energy-efficient buildings and the generation of electricity by small hydropower plants and renewable energy sources.

In 2018, under the GEF-UNDP project "Strengthening Institutional and Legal Capacity to Ensure Improved National Environmental Information Management and Monitoring System," an analysis and methodological comparison of 39 main indicators developed by the UNECE working group on a set of key statistics related to the climate change was conducted. A preliminary analysis showed that out of 39 indicators, out of which 17 had a methodology at the national level, but only a few of them were fully in line with the approaches proposed by the UNECE working group. Data were collected for 14 indicators, 14 data were collected partially, and data for 11 indicators were not collected.

However, this set of 39 indicators could form the basis for the development of national climate change statistics in Kyrgyzstan.[343]

Possible climate indicators for the MRV system:

[343] UNDP. Guidance on national Green Growth indicators of Monitoring and Evaluation in the Kyrgyz Republic. –B. 2013.

1. Total Primary Energy Volume (TPEV)
2. Share of fossil fuels in total primary energy.
3. Loss of land covered by (semi-) natural vegetation
4. General support for fossil fuel use / GDP
5. Total energy intensity of production activities
6. Intensity of CO_2 emissions for the economy
7. Intensity of CO_2 emissions in the output of agricultural products
8. Energy consumption by households per capita
9. Total greenhouse gas emissions
10. CO2 emissions from fuel burning
11. GHG emissions from land use
12. Total GHG emissions in industrial production
13. Intensity of GHG emissions during production
14. Direct GHG emissions from households
15. Carbon footprint
16. Average annual surface temperature
17. Proportion of land exposed to unusually wet or dry conditions (Standard Precipitation Index)
18. Level of water scarcity: fresh water consumption as a share of available fresh water resources
19. Total number of exotic species
20. Carbon stocks in soil
21. Proportion of degraded land in relation to total land area
22. The number of deaths and missing persons associated with hydrometeorological disasters, per 100,000 people
23. Frequency of extreme weather events (Frequency of dangerous meteorological events)
24. Direct economic losses associated with hydrometeorological disasters in relation to GDP
25. Number of people whose homes were destroyed due to hydrometeorological disasters
26. The spread of cases of vector-borne (transmitted) diseases.
27. Heat-related mortality
28. Direct losses in agriculture associated with hydrometeorological disasters
29. Share of renewable energy in total final energy consumption.
30. Share of spending on climate change mitigation in relation to GDP
31. Share of taxes on energy and transport as a percentage of total taxes and social contributions
32. General climate change subsidies and similar transfers / GDP
33. Average Carbon Price
34. Sum of USD mobilized per annum starting from 2020 responsible for a commitment of USD 100 billion
35. Share of government spending on adaptation to GDP
36. Change in water use efficiency over time
37. Proportion of the population living in residential buildings with air conditions or air conditioning.
38. Results in the management of forest resources
39. Share of agricultural land in productive and sustainable agriculture

The establishment of the Ministry of Natural Resources, Ecology and Technical Supervision of the Kyrgyz Republic in 2021 not only strengthened the prerequisites but also laid a solid institutional basis for the development of the national MRV system in Kyrgyzstan.

5.2. Recommendations for development of the domestic MRV system

The development of a domestic MRV system for Kyrgyzstan will be carried out in full compliance with the UNFCCC guidelines on greenhouse gases, mitigation and adaptation actions and will also include the MRV on climate finance. This system will reflect the Kyrgyz Government's vision of a designed MRV system, inter alia, tracking its progress towards achieving the NDC targets of the Paris Agreement and the implementation of the UNFCCC requirements on the Enhanced Transparency Framework.

The MRV system of the Kyrgyz Republic will follow the principles of cost-efficiency and maximum use of existing infrastructure and processes for data collection, reporting and verification, including quality control and quality assurance procedures. The creation of the MRV system is a complex process that requires adequate time and resources. In addition to the establishment of working organizational structures, there is a need for the legal consolidation of the system through the relevant Government decrees on the MRV. The existing legislative framework provides the initial legal basis for the implementation of the MRV system. However, the practical application of the MRV system in Kyrgyzstan today is limited by the lack of the necessary measurement, reporting and verification tools.

The implementation of the MRV in Kyrgyzstan should be preceded by the development of detailed standards and rules for the MRV, including appropriate templates and forms for measurements and reporting, establishing a baseline or reference point, as well as the establishing an accreditation system for validators, checking the reliability of submitted reports, which also requires the development of appropriate tools. All these instruments will be approved by the relevant decisions of the Government of Kyrgyz Republic. In doing so, the development of these tools will be accompanied by measures to build the necessary human capacity in the relevant organizations and institutions.

According to the decisions of COP 24 in Katowice, the parties to the UNFCCC will also prepare communications on adaptation, which should be aimed at (i) expanding the representation of adaptation actions in balance with mitigation; (ii) strengthening support for adaptation actions in developing countries; (iii) ensuring a global account of adaptation actions; and (iv) enhancing research and understanding of adaptation needs and measures. It was also agreed that communications on adaptation will be determined by the countries themselves, including the choice of the type of document under Article 7, paragraphs 10 and 11 of the Paris Agreement and will not pose additional difficulties for developing countries, parties to the Convention, will not become the basis for comparison of the parties and will not be verified.

Based on the experience of Kyrgyzstan in reporting on adaptation actions in previous NCs and on the availability and collection of data on adaptation actions in the country. At this stage, it is proposed to use the adaptation tracking system as an information base for communications on adaptation to the Convention. As there are a lot of organizations in Kyrgyzstan involved in the implementation of adaptation projects in different organizational forms and ownerships, at different levels and in different regions, it is envisaged that a harmonized reporting format on adaptation actions will be developed at different levels and in different regions to include adaptation actions in the national MRV system.

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