MINISTRY OF ENVIRONMENT, WATERS AND FORESTS

Romania’s Fourth Biennial Report under the UNFCCC

December 2020

Table of Contents

Introduction

This report and its accompanying BR CTF Tables represents the fourth Biennial Report (BR4) of Romania, as required under Article 18(1) of Regulation (EU) No 525/2013, Regulation (EU) no. 749/2014 and Decision 2/CP.17 of the Conference of the Parties under the United Nations Framework Convention on Climate Change (UNFCCC).

Benefiting of consultancy services during the second part of 2020, Romania updated the information on mitigation actions and their effects, as well as the information on greenhouse gas emission projections in the national economic sectors. Considering the availability of this updated information, Romania resubmitted its Fourth Biennial Report, as well as the corresponding CTF tables, in December 2020.

Tabular information as defined and required by the UNFCCC Biennial report guidelines are enclosed in the CTF annexes and submitted electronically through UNFCCC Application and Network Access Portal. The report was prepared by the Ministry of Environment, Waters and Forests, with external consultancy assistance coordinated by the Institute for Studies and Power Engineering (ISPE PC).

1. Information on GHG emissions and trends

This section summarizes information on the Romania's greenhouse gases (GHG) emissions in the period 1989 - 2018. The GHG emissions data presented in this Biennial Report are consistent with the GHG emissions reported by Romania in 2020 under the Convention to the UNFCCC secretariat and correspond to the totals in the CRF tables under the Convention.

The presented data cover all sectors and all direct gases in the period 1989-2018 and is complete in terms of geographical coverage.

1.1. *Summary information on GHG emissions and trends*

The emission data presented is based on national greenhouse gas inventory covering the period 1989 to 2018, submitted to the UNFCCC on May 6, 2020[1]. The inventory is in line with the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention (Decision 24/CP.19) and with Regulation (EU) No. 525/2013 (and Regulation (EU) no. 749/2014).

In 2018 total GHG emissions, excluding LULUCF, were estimated at 116,115.12 Gg $CO_{2\,eq}$. The values for the Global Warming Potential (GWP) used to convert GHG emissions in $CO_{2\,eq}$ are from the IPCC Fourth Assessment Report (AR4), as presented in CTF -Table 2 (c) and subsequently

[1] https://unfccc.int/documents/227648

as GWPs for 100 years time horizon: CH4 = 25; N2O = 298; SF6 = 22 800; NF3 = 17 200; HFCs and PFCs consist of different substances, therefore GWPs have to be calculated individually depending on substances.

For Romania, the base year under Convention and Kyoto Protocol is 1989 based on Decision 24/CP.19[2], II.D in accordance with the provisions of Article 4, paragraph 6 of the Convention and Decisions 9/CP.2, 11/CP4 and 7/CP.12.

As a Member State of the EU, Romania has committed to contributing to the achievement of the joint EU economy-wide emission reduction target of 20 per cent below the 1990 level by 2020, the base year for this target and for all gases being 1990 for all Member States.

Between 1989 and 2018, total GHG emissions (excluding LULUCF) decreased by 62.10% and net GHG emissions (including LULUCF) decreased by 68.32 %.

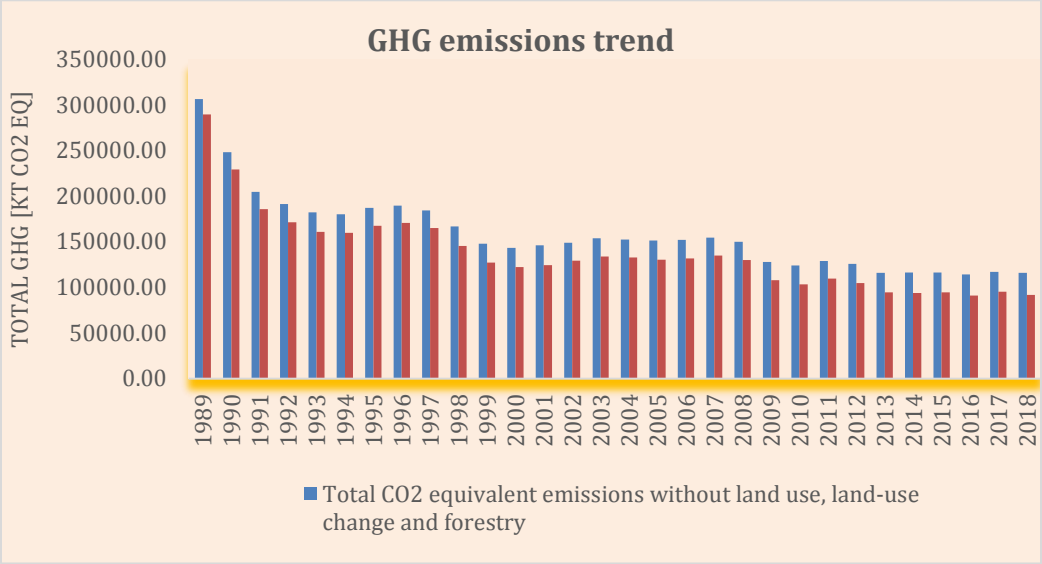

Figure 1. Trends in total GHG emissions

The general trend of GHG emissions in Romania shows a strong decrease compared to the base year; the evolution of GHG emissions can be divided into three periods: 1989-1999, 2000-2007 and 2008-2018.

The 1989-1992 period was characterized by a decrease in total GHG emissions, a direct result of the decline in economic activities and, in consequence in energy demand. The transition period at the economic level, involved the reduction of activities carried out by certain energy-intensive industries, which led to the decrease of GHG emissions. GHG emissions have seen an upward trend until 1996 because of revitalizing economic activity. In 1997, GHG emissions declined again due to the significant change in the energy mix after the start of operation of Unit 1 of Cernavoda nuclear power plant (1996); the decrease continued until 1999. After 1999, the GHG emissions

2 Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention, Decision 24/CP.19, FCCC/CP/2013/10/Add.3, http://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf#page=2

trend reflects the economic development during the period 2000-2007. The decrease of GHG emissions in 2005, compared to the levels recorded in 2004 and 2006, was caused by a change in the energy mix due to a significant contribution of hydropower (hydrological year records).

During the economic and financial crisis, the GHG emissions decreased significantly in 2010 compared to 2008. In the period 2010-2018 the GHG emissions remained relatively constant.

1.2. *Trends in emission by GHG*

The GHG emissions, excluding HFCs and SF_6, decreased compared to the base year. Regarding the contributions of different types of greenhouse gases to total GHG emissions, they did not register significant change over the reported period. The CO_2 has the largest share of total GHG emissions, followed by CH_4 and N_2O.

In the base year, the share from total GHG emissions (without LULUCF), were: 68.13 % for CO_2, 24.15% for CH_4, 6.27% for N_2O and 1.45% for aggregated F-gases.

In 2018, registered shares, relative to total GHG emissions (without LULUCF) were as follows: 68.10 % for CO_2, 24.18% for CH_4, 6.27% for N_2O and 1.45% for aggregated F-gases. Since 1991, F gases have started to be used as substitutes for ODS in air conditioning and refrigeration systems. In 2018, the contribution of these gases to the total GHG emissions is negligible: 1.98% HFCs and 0.05% SF6.

Total GHG emissions trends per gas type (without / with LULUCF) are presented in the next figure.

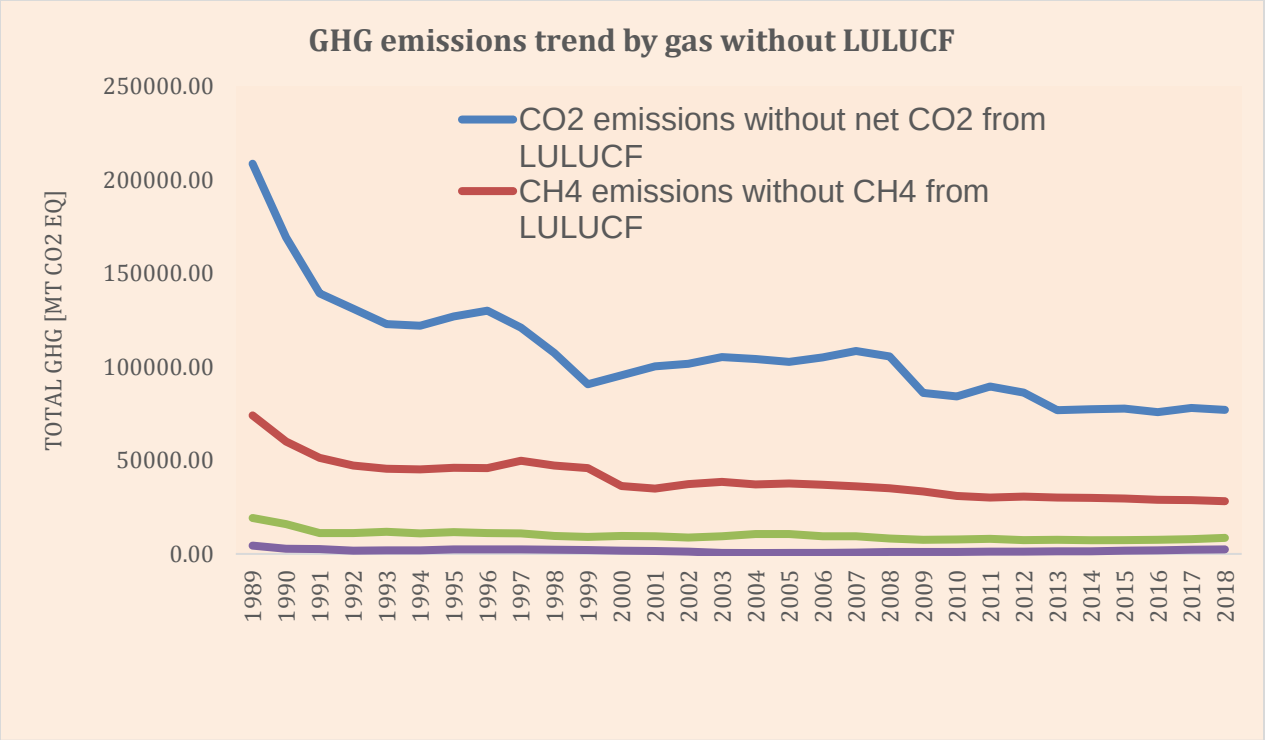

Figure 2. GHG emissions trend (without/with LULUCF) by gas type

Carbon dioxide

Carbon dioxide (CO_2) is the most important anthropogenic greenhouse gas. The decrease in CO_2 emissions (63.12%, from 208,648.62 Gg $CO_{2\,eq}$ in 1989 to 76,951.22Gg $CO_{2\,eq}$. in 2018) is mainly due to the decrease in the amount of fossil fuels used in the energy sector (mainly in the *Public electricity and heat production* and *Manufacturing industries and construction*), a result of the decline in economic activities.

Methane

Methane (CH4) – methane emissions, mainly generated by fugitive emissions from the extraction and distribution of fossil fuels and livestock, fell by 61.95 % in 2018 compared to 1989 levels (from 74,073.58 Gg CO2 eq. in 1989 to 28,183.62Gg CO2 eq. in 2018). The decrease in CH4 emissions in the Agriculture sector is due to the decrease in livestock.

Nitrous oxide

Nitrous oxide (N_2O) – N_2O emissions are mainly generated by the *Agriculture* sector (*Agricultural Soils* activities) and *Industrial Processes and Product Use* (*Chemicals Industry* activities). The evolution of N_2O emissions reflects the downward trend of these activities due to the decrease in livestock, the amount of synthetic nitrogen fertilizer applied to soils and the levels of crop production. In 2018, N_2O emissions decreased by 55.17 % compared to the emissions in the base year.

Fluorinated gases

Fluorinated gases - F gases have begun to be used as a substitute for ODS in refrigeration and air conditioning systems since 1995. PFC emissions generated in the primary aluminum production process declined significantly (by 99.89%) in 2018 compared to 1989.

1.3. *Trends in GHG emissions by sector and sink categories*

The emissions trends by sector and sink categories for the period 1989-2018 according to the latest National GHG Inventory submitted to the UNFCCC in 2020 is presented, in summary, below (more details can be noticed in Chapter 2.2 of the NIR – 2020 & CRF Tables).

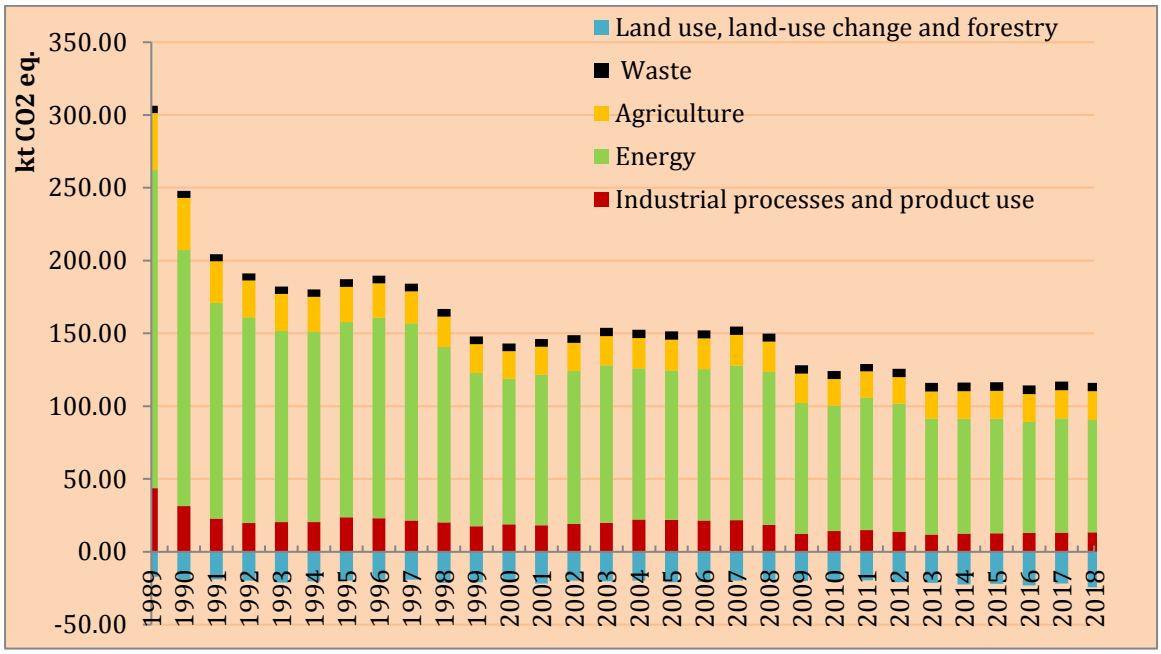

Figure 3. GHG emissions trends by sector and sink categories

In 2018, total GHG emissions from the *Energy sector* accounted for the largest share (66.32%), followed by those from *Agriculture sector* with a share of 17.1 % and those from *Industrial Processes and Product Use sector* with a share of 11.58 %.

Energy Sector

Energy is the most important sector in Romania; in 2018, this sector had a share of approximately 66.32 % from total GHG emissions (without LULUCF), accounting for 77,005.99 Gg $CO_{2\ eq}$. Compared to the base year, GHG emissions in 2018 decreased by 62.10 %. The main reason for this trend is the process of transition to a market economy that has led to a sudden decrease in the demand for heat & power produced by power plants.

In the period 1989-2018 the total GHG emission trends is characterized by substantially decreasing in emissions from the *Manufacturing industries and construction* category (69.84 %), *Other* (75.01 %) and *Energy industries* category (69.84 %) and the significant increase in emissions related to *Transport* category (65.59 %).

In 2018, the total GHG emissions related to the *Energy Industries* category had the highest share (31.53%), followed by *Transport* category (23.94%) and *Manufacturing industries and construction* category (15.8%). Also, CO_2 emissions in the *Energy sector* accounted for 85.68% of total national GHG emissions (without LULUCF), CH_4 emissions (calculated as $CO_{2\ eq}$) represent 13.49% and N_2O (calculated as $CO_{2\ eq}$) represent 0.83%. Compared to 2017, in 2018 GHG emissions from the Energy sector decreased by 2.04%.

Industrial Processes and Product Use sector

In 2018, IPPU sector had a share of 11.58 % from total GHG emissions (without LULUCF), accounting for 13,445.65Gg $CO_{2\ eq}$. Compared to the base year, GHG emissions in 2018 decreased by 69.25 %.

Since 1989, total GHG emissions from the IPPU sector have registered a downward trend due to restructuring and privatization processes, the effects of the economic and financial crisis and the implementation of specific policies and measures (i.e. EU-ETS). These have resulted in a decrease in production levels and in emission factors.

The trend of total GHG emissions over the period 1989-2018 is characterized by a significant reduction in emissions for the following categories: *Chemical industry* (90.31 %), *Metal industry* (79.82%) and *Non-Energy products from fuels and solvent use* (58.10 %) and the significant increase in emissions from the category *Products used as substitutes for ODS*.

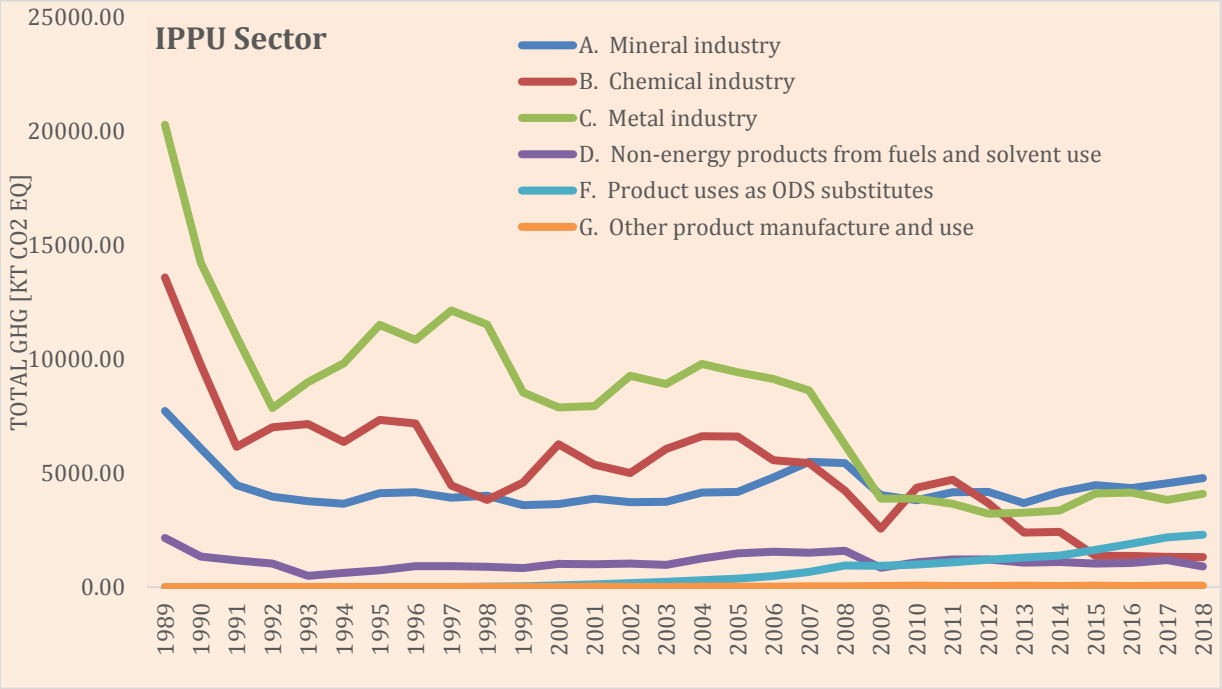

Figure 4. Trends in GHG emissions from IPPU sector, 1989-2018

In 2018, total GHG emissions from *Mineral industry* category had the largest share (35.52 %), followed by those from *Metal industry* category (30.43 %) and those for the category *Products used as substitutes for ODS* (17.07 %). CO_2 emissions also account for 80.62 % of total GHG emissions (without LULUCF), HFC emissions (calculated as $CO_{2\ eq}$) are 17.57% and N_2O (calculated as CO_2 eq.) accounted for 1.74%. Compared to 2017, in 2018, GHG emissions in this sector recorded an increase of 2.41%.

Agriculture sector

In 2018, total GHG emissions for the Agriculture sector accounted for 17.1 % of total GHG emissions (without LULUCF), amounting to 19,854.03Gg $CO_{2\ eq}$. Compared to the base year, GHG emissions in 2018 decreased by 49.26 %.

Since 1989, total GHG emissions in the Agriculture sector have seen a downward trend due to the decrease in livestock, rice cultivated areas, crop production levels and the amount of synthetic nitrogen fertilizer applied to soils.

The total GHG emissions trends between 1989 and 2018 was characterized by a significant decrease in emissions from the following categories: *Liming* (71.28 %), *Rice cultivation* (72.92 %), *Manure management* (67.00 %), *Enteric fermentation* (50.50 %), *Agricultural soils* (34.56 %), *Urea application* (29.56 %) and *Field burning of agricultural residues* (53.44 %).

In 2018, the total GHG emissions from *Enteric fermentation* category had the largest share (56.36 %), followed by the *Agricultural Soils* category (29.57 %) and the category of *Manure Management* (10.96 %). Also, CO_2 emissions in the *Agriculture sector* accounted for 0.63 % of total GHG emissions of the sector, CH_4 emissions (calculated as $CO_{2\ eq}$) accounted for 63.16 % and N_2O (calculated as $CO_{2\ eq}$) for 36.21 %. Compared to 2017, in 2018, GHG emissions in this sector recorded an increase of 3.20%.

Land Use, Land-Use Change and Forestry

Agricultural lands, including arable, orchards, vineyards, pastures and hayfields makes up 62.22% of Romania's total national area. Forests cover 27.92% while constructed areas and road/railways, cover some 4.88%, humid areas, water and lakes some 3.53% and other land 2.1%.

Emissions from LULUCF comprise CO_2, CH_4 and N_2O emissions from biomass burning.
The net GHG removals/emissions level is 43.26 % higher in 2018 in comparison with the base year level due to the decrease trend of emissions from all other sectors. The Romanian land use sector acts as a net sink, at an average uptake of 20,523.91 Gg CO_2/year, being relatively stable over the last 30 years.

Waste

In 2018, total GHG emissions for the Waste sector had a share of 5.00 % of total GHG emissions (without LULUCF), accounting for 5,809.44Gg $CO_{2\ eq}$. Compared to the base year, GHG emissions in 2018 increased by 13.12 %.

Between 1989 and 2018, total GHG emissions from the Waste sector increased due to the changes in population's consumption habits (growth of consumption), increased number of

landfills and increased number of persons with access to sewage and in general, improved waste collection, tracking and improving of the GHG emission estimations in this sector.

The total GHG emissions trends between 1989 and 2018 is characterized by a significant increase in emissions of the category *Solid waste disposal* (173.43 %) and the decrease in emissions of category *Waste water treatment and discharge* (44.76 %).

In 2018, the total GHG emissions of the *Solid waste disposal* category had the highest share (62.44 %), followed by the *Waste water treatment and discharge* (36.18%) category. Also, CO_2 emissions in the Waste sector represent 0.18 % of total Waste sector, CH_4 – 90.25 and N2O - 9.58%, respectively (calculated as $CO_{2\ eq}$).

1.4. *Change in emissions from Key Categories*

The information about changes in the key categories, grouped by gases, by level and by trend can be found in Annex 1 of the National Inventory Report, Romanian 2020 submission[3].

1.5. *Key drivers affecting emission trends*

- **Population Profile**

The evolution of the Romanian population shows a decrease of approximately 8% between 2005 and 2017, with a slowdown of the decrease towards the end of the period (about 0.3% between 2016 and 2015 and 0.6% between 2017 and 2016)

Table 1. Evolution of Romania's population

Year	1990	2005	2010	2011	2015	2016	2017	2018
Population (000 inhabitants)	23,211	21,624	21,431	20,122	19,819	19,760	19,644	19,523

Source: National Institute of Statistics - Usually resident population by age group and ages, sex, urban/ rural area, macro regions, development regions and counties

The main cause of the decrease is migration, followed by the natural growth rate of the population, which, for many years was negative.

- **Geographical profile**

Romania is situated in the northern hemisphere; at the intersection of 45° parallel Northern latitude with the 25° meridian Eastern longitude.
In Europe, Romania is situated in the South-Eastern Central Europe, half the distance between the coast of the Atlantic Ocean and the Ural Mountains, inside and outside the Carpathians arch, within the lower basin of the Danube, having a gateway to the Black Sea.

[3] https://unfccc.int/documents/227662

The Romanian territory is located between parallels 43°37'07" and 48°15'06" Northern latitude and between meridians 20°15'44'' and 29°41'24'' Eastern longitude. Having an area of 238,391 km2, plus 23,700 km² represented by the Black Sea platform.

Figure 5. Romania on the EU map

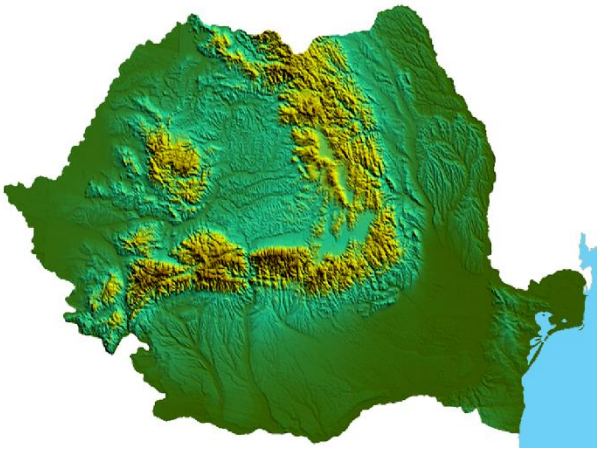

Figure 6. Romania. Geographical profile

Romania's relief components are proportionally distributed, being estimated to: 35% mountains, 35% hills and plateaus and 30% plains.

- **Climate profile**

Romania's climate is a transitional temperate-continental one with oceanic influences from the West, Mediterranean modulations from the South-West and excessive continental effects from the North-East. Climate variations are modulated by geographical elements, the position of the mountains, elevation, the Black Sea.

The average annual temperature varies with latitude, from 8°C in the North to 12°C in the South, with around 2.6°C in the mountains and 11.7°C in the plains.

In the last 116 years, the warmest year was 2015 (with an average temperature of 11.6°C) and the coldest one, 1940 (with an average temperature of 8°C). The classification uses data from 14 meteorological stations with long series of observations.

An absolute minimum temperature of - 38.5°C was recorded in January 1942 at Bod in Brasov County and an absolute maximum temperature of 44.5°C recorded in August 1951 at Ion Sion location in the Bărăgan Plain.

- **Economic Profile**

Since 2000, Romania has experienced 17 years of GDP growth. The last decade's global financial crisis affected Romania's GDP, marking two years of economic decline (2009-2010). The real economic convergence was among the strongest on the European continent, as in 2000,

Romania's GDP was about EUR 40 billion (less than EUR 2,000 per capita), while in 2017 the values hit EUR 188 billion, or EUR 9,600 per capita.[4]
Within a decade of joining the EU (2007), the Romanian economy has grown quickly and has managed to become the largest in the region despite the (temporary) migration of millions of Romanians that have left the country in search of a better life in Western Europe.

Table 2. Romanian GDP evolution within the 2000 – 2017 period

Year	1995	2000	2005	2010	2015	2016	2017
GDP [bill. Euro]	28.6	40.6	79.2	125.4	160.3	170.4	187.8
GDP [bill. Euro 2010]	83.9	82.9	109.1	125.4	145.2	152.2	163.0

In 2017, the year that also registered a significant intensification of the global economic activity, Romania registered the fastest growth rate since the beginning of the last global financial crisis (7.1%), placing itself among the most dynamic economies from the European Union. In 2018 the growth rate was 4.4%. The main driver of the growth of the Romanian economy continued to be represented by population's consumption, driven by the stimulating conditions - from the perspective of wages and the degree of employment - of the labor market and of the relaxation measures in the fiscal-budgetary sphere. Population consumption has accelerated its growth rate to 9%, generating 90% of the real GDP advance. A positive contribution to the economic growth, but of a much smaller size than the one related to consumption (1.1 percentage points), was due to investments, whose dynamics approached 5%. The segment with the fastest development was the one of the residential constructions (acceleration of rhythm up to about 70%). The intensification of the internal economic activity, but also the favorable external context, characterized by high values of the confidence of the economic operators at European level, were found in an acceleration of the equipment purchases (increase of almost 4%), especially in the automotive industry, the machinery and equipment industry, household appliances industry and in the metallurgical industry. These branches had a significant role in accelerating the industrial activity, the contribution of this sector to the real GDP growth reaching 1.9 percentage points in 2017 (+0.6 percentage points compared to 2016).
In 2017, public investments in construction projects have decreased with 21.7%, compared to 2016.
Given the intensification of the global economic activity, as well as the development of new domestic production capacities, exports of goods and services have accelerated their growth rate to 9.7%. Their advance, together with the need to cover expanding domestic demand, however, led to a boost of imports (+ 11.3%), so that the net external demand continued to erode the real GDP growth (by 0.7 percentage points). The dominant contribution to the expansion of supplies

[4] http://business-review.eu/money/br-analysis-romanias-economy-facing-uncertain-end-to-two-decade-growth-cycle-194160

external, this year, belonged to companies producing cars, machinery and equipment, electrical appliances, rubber, these categories of goods accumulating half of the value of exports[5].

Trends of ***GHG emissions per capita and GDP per capita highlight a clear decoupling*** *(though in 2010 and 2011 – because of the financial crisis - they were quite similar)* and a decrease of the GHG emissions per capita.

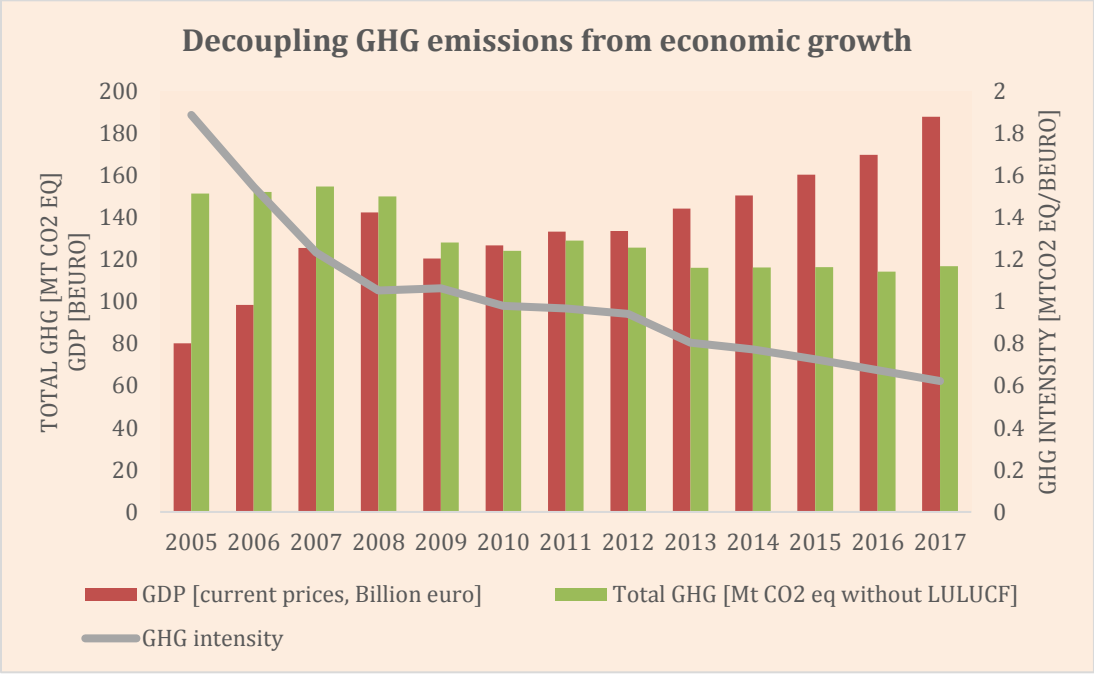

Figure 7. Trends in GDP & GHG emissions per capita

With respect to the GDP formation, in can be noticed that Industry, followed by *Wholesale and retail trade; repair of motor vehicles and motorcycles; transportation and storage; hotels and restaurants* cover more than 40% in the PIB, both in 2017 and the entire time series; however, in the most recent few years, the share of industry seem to be caped below 25%, while the share of services is increasing.

In terms of GHG intensity, Romania reached around 0.6 kg of CO2 equivalent per unit of GDP in 2017 compared with 1.8 kg of CO2 equivalent per unit of GDP in 2005.

Energy

Among the industrial branches, one of the most important, due to its broad impact over the others, both in terms of costs and in terms of carbon emissions, is the energy industry.

[5] http://www.insse.ro/cms/sites/default/files/field/publicatii/starea_economica_si_sociala_a_romaniei_2019.pdf

Romania is endowed with diversified local energy sources, including natural gas, coal, oil, bioenergy, nuclear, hydro, and renewable energy. The country's primary energy supply in 2017 was 39.01 million tons of oil equivalent (mtoe), of which 34.85% was imported, and the rest supplied by domestic sources, with gas as the top at 33.87%, followed by hydro & nuclear electricity at 19.26 %, coal at 17.57 %, biofuels at 14.02 %, oil at 13.96 %, other fuels at 1.07 % and geothermal/wind/solar at 0.24 %.

The final energy consumption has been relatively stable during the period 2009 – 2017, varying between 23269 toe (in 2017) and 21736 toe (in 2014). Since 2014, it has been slowly increasing and the last two years registered an increase of 1.92% in 2016, compared to 2015 and 4.27% in 2017 compared to 2016.

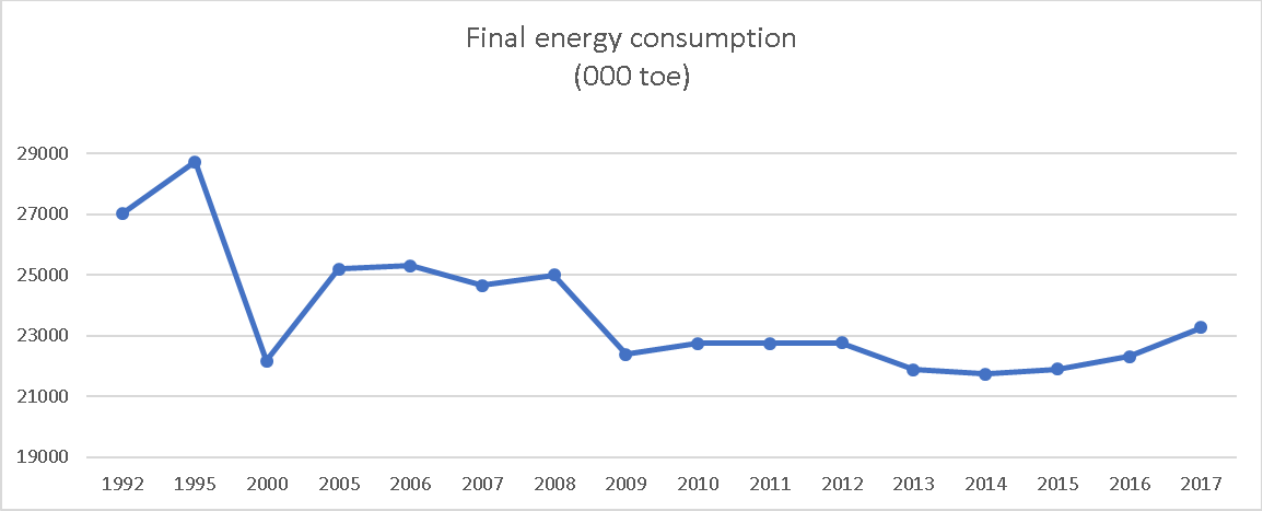

Figure 8. Final energy consumption

Source: The National Institute for Statistics

In 2017, the final energy consumption of the population amounted for 33.11% and was followed by transport (29.76%) and industry (27.53%).

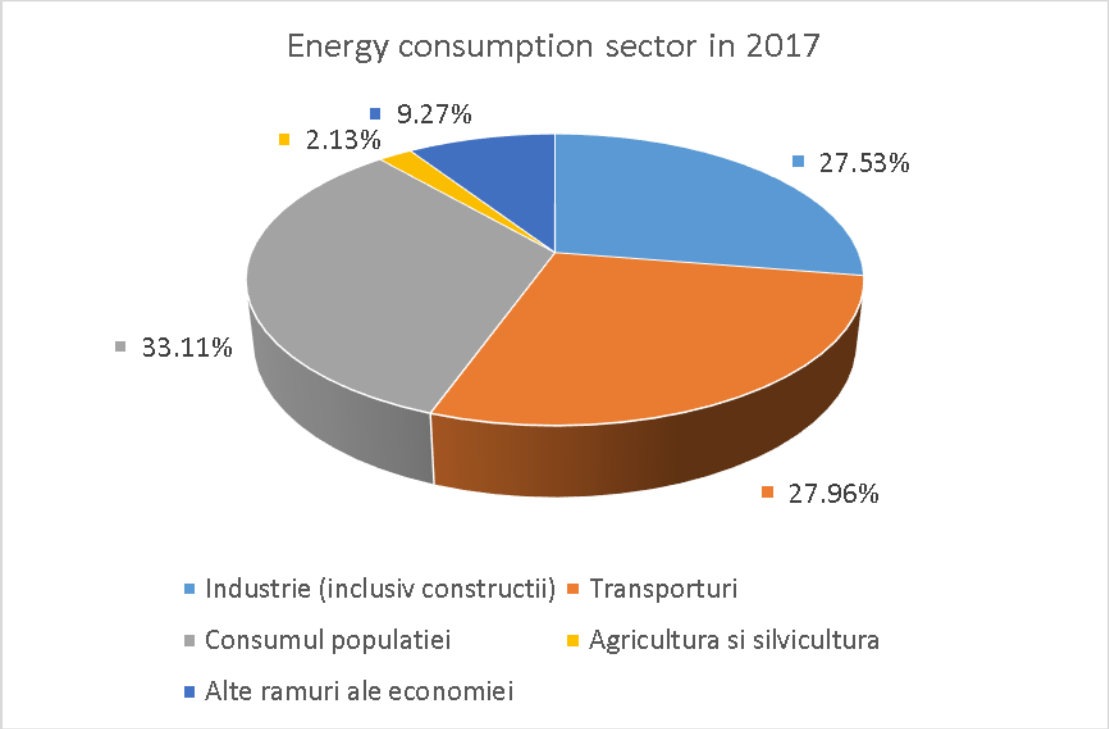

Figure 9. Final energy consumption per sector

Source: The National Institute for Statistics

Electricity generation amounted for 61.32 TWh in 2017, of which about 4.7 % was (net) exported. The supplied energy was 57.48 TWh, while the domestic consumption was 54.59 TWh. The residential sector is the largest energy consumer (12.6 TWh or 23.08%), accounting for one-third of total energy consumption, followed by industry, transport, commercial services, and agriculture.

In terms of share in the electricity mix, coal was holding the largest share (almost 27%), followed by hydro (23%), nuclear (18%), natural gas (15%), wind (12%) and other resources.

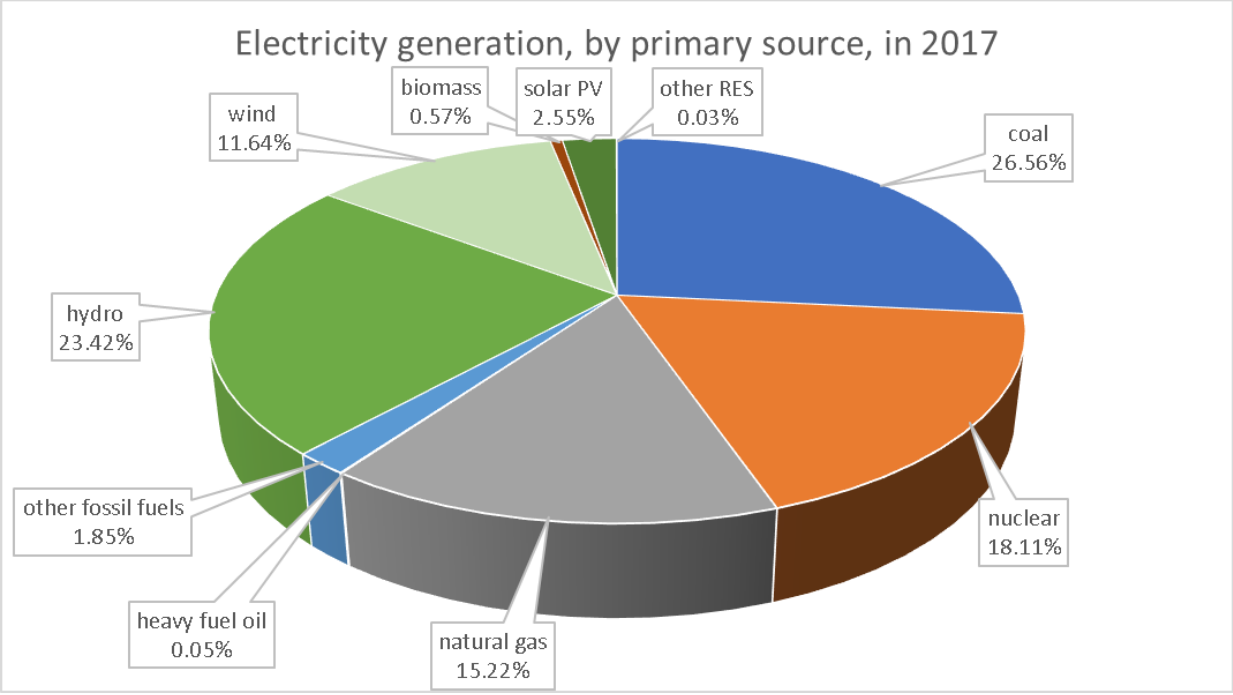

Figure 10. Mix of electricity generation in 2017
Source: The National Energy Regulatory Authority

The reform progress has been limited in electricity generation—especially coal, gas, and hydro—where most generation capacity remains under Government ownership. The state-owned enterprises (SOEs) Termoelectrica and Hidroelectrica own older assets, most of which require an upgrade or need to be decommissioned. Their financial position is weaker than other entities in the electricity supply chain, partly because of less-performing assets, which constrain commercial financing options. However, large private wind and solar generation capacity has been added in recent years, supported by the Green Certificate subsidy scheme, which helped Romania exceed the EU renewable energy target. Thus, Romania has a significant overcapacity in the power generation and became a net exporter of electricity in the region.

The power grid is connected with all five neighboring countries—Hungary, Ukraine, Moldova, Bulgaria, and Serbia—and there are plans for additional connectivity. The gas grid is connected with Hungary and Ukraine for importing gas to Romania. Recently, a gas interconnector was built between Romania and Moldova, but it is not yet operational. For international gas transmission, the network already connects Ukraine, Romania, and Bulgaria, with more connectivity being planned.

District heating (DH) entities are largely owned by local governments and municipalities. However, the government has implemented various models—such as concessions and management contracts—of private participation in secondary cities. As a result, the DH sector is fragmented, and recent attempts to harmonize DH regulation across the country and assure sustainability of DH systems have not yet proven successful.

In the natural gas sector, reform is progressing well across the value chain in line with the EU 3rd energy package. Gas transmission is a regulated monopoly, managed by Transgaz, which is listed on the stock exchange. Gas distribution is liberalized, although the market remains concentrated, with the top two distributors (GDF Suez and E.On) having 97 per cent of market share for households, and the top four distributors (Petrom, Romgaz, GDF Suez, and E.On) serving 90 percent of commercial customers.

*In terms of **primary energy intensity**, though the Romanian economy is still above the average EU 28, this has significantly decreased between 1990 and 2017, about 70%, from 658.8 to 197.6 kg oil eq/1000 Euro. The yearly average decrease rate is 4.3%.*

Transport

The energy consumption for transport has registered an increasing share, from 15.83% in 2000 to 27.96% in 2017 (almost double) in the final energy consumption in Romania and this is the sector growing the fastest; the energy consumption for road transportation represent about 90% in the total energy consumption for transportation and it seems to have decreased about 1% between 2014 and 2017.

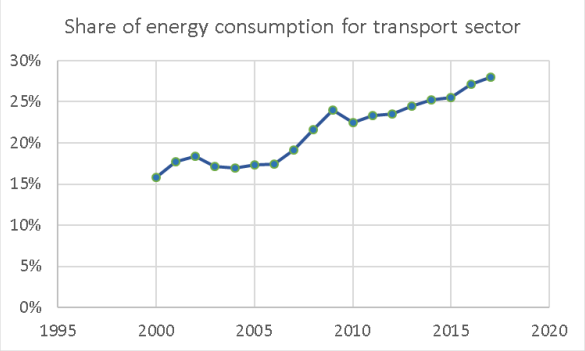

Figure 11. Share of energy consumption for transport sector (in the total final energy consumption)

Source: The National Institute for Statistics

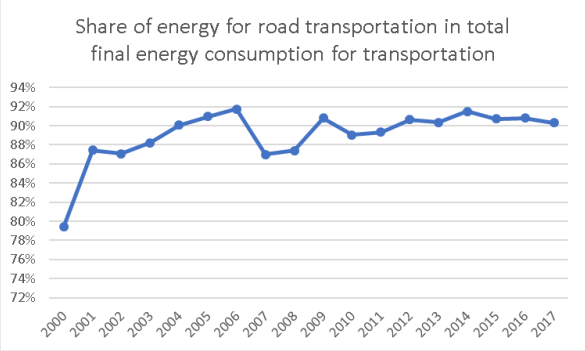

Figure 12. Share of energy for road transportation in total final energy consumption for transportation

Source: The National Institute for Statistics

1.6. *Accuracy/ Uncertainty of the data*

Romania carried out the uncertainty analysis based on Approach 1 according to the provisions in Ch. 3, Vol.1, 2006 IPCC GLs. Considering the 2020 NGHGI and the Tier 1 method:

- the total NGHGI uncertainty for 2018 excluding LULUCF was 17.3%, while including LULUCF was 23.7%;
- the uncertainty introduced into the trend in total national emissions, for 2018, was 2.2% when considering excluding LULUCF criteria and 2.9%, including LULUCF

- the total NGHGI uncertainty for 1989 excluding LULUCF was 10.9%, while including LULUCF was 12%.

1.7. *Summary information on national inventory arrangements in accordance with the UNFCCC reporting requirements*

Since the last submission, some changes have happened with respect to the LULUCF part of the GHG inventory. Further details on the NIS setup are provided below.

Institutional arrangements

The characteristics of the institutional arrangements include:

- Centralized approach – NEPA maintain a large degree of control and decision-making authority over the inventory preparation process;
- In-sourced approach, in majority – the major part of the inventory is prepared by NEPA (governmental agency); the LULUCF part is prepared by a consortia of research institutes as provided in GD 590/8.08.2019;
- Single agency – the single national entity is housed within a single governmental organization;
- Separate approach – the NGHGI related work is not integrated with other air pollutant inventories work; however, cross checking activities are periodically implemented.

The main institutional arrangements include:

- NEPA, as the competent authority, responsible for NS/NGHGI administration;
- Central and territorial public authorities, research and development institutes and other public organizations under the authority, in the subordination/coordination of central public authorities, owners and professional associations, economic operators and other relevant organizations, which have the obligation of providing to NEPA the necessary activity data, emission factors and associated uncertainty data;
- The National Institute for Statistics, as a main activity data supplier, through the yearly-published documents (National Statistical Yearbook, Energy Balance, other documents);
- Several sectors have been significantly improved during 2011 - 2014, as a result of external consultancy;
- The NGHGI Land Use, Land-Use Change and Forestry (LULUCF) Sector, both under the UNFCCC and KP, administrated during 2011 and 2012-2014 period by the National Institute for Research and Development in Forestry “Marin Drăcea” (INCDS), based on contract (for 2011) or Protocol of collaboration no. 2029/MMP-RP/3.07.2012 between Ministry of Environment, Waters and Forests, NEPA and INCDS (for period 2012-2014);
- The preparation of Road transport category estimates, based on COPERT 4 model, administrated also based on the Protocol of collaboration no. 3136/MMP/9.07.2012 between Ministry of Environment and Forests, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Administration and Interior. The period of collaboration is undetermined.

The institutional arrangements currently used in Romania, presented below, were updated during 2011÷ January 2012.

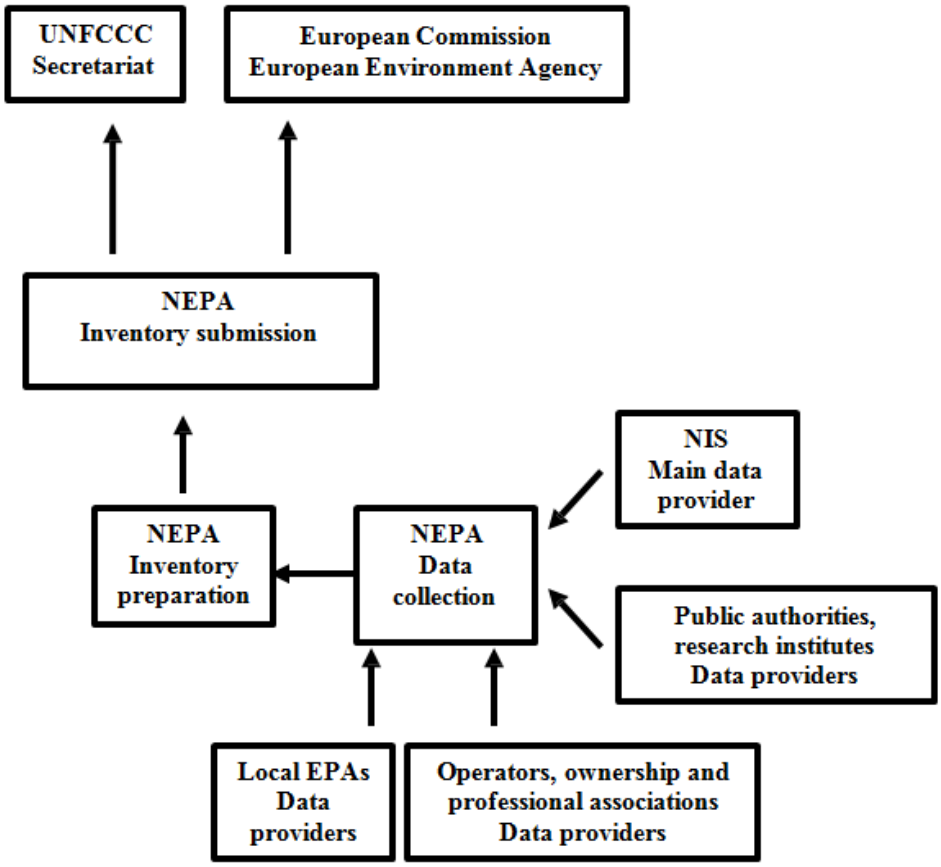

Figure 13 Legal and procedural arrangements

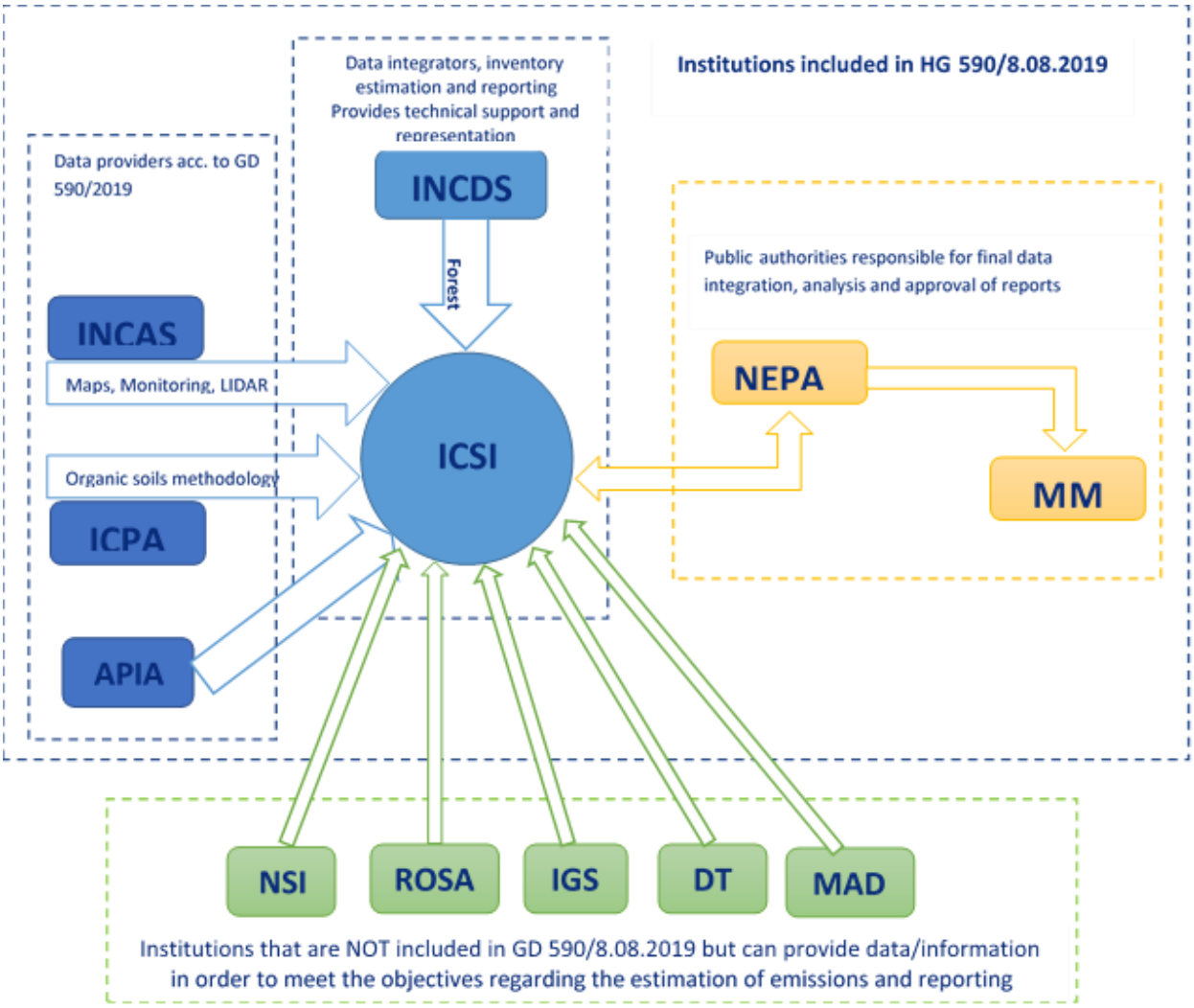

Figure 14 Legal and procedural arrangements for LULUCF part of the NIS

MM - Ministry of Environment, Waters and Forests (MMWF)

NEPA - National Environmental Protection Agency

INCDS - National Institute for Research and Development in Forestry “Marin Drăcea”

INCAS - National Institute for Aerospace Research "Elie Carafoli"

ICPA - "National Research and Development Institute for Soil Science, Agrochemistry and Environment

APIA - National Agency of Payments in Agriculture

DT - Defense Geospatial Information Agency "General Division Constantin Barozzi" (AIGA)

ROSA - The Romanian Space Agency

IGS - General Inspectorate for Emergency Situations

LPIS - Land Parcel Identification System

MAD - Ministry of Agriculture and Rural Development

2. Quantified economy-wide emission reduction target (QEWERT)

2.1. *Description of the EU 2020 target*

In 2010, the EU and its member states submitted a pledge to reduce its GHG emissions by 2020 by 20 % compared to 1990 levels, in order to contribute to achieving the ultimate objective of the UNFCCC: "to stabilize GHG concentrations at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system"[6], or, in other words, to limit the global temperature increase to less than 2°C compared to temperature levels before industrialization (FCCC/CP/2010/7/Add.1).

The definition of the Convention target for 2020 is documented in the revised note provided by the UNFCCC Secretariat on the "Compilation of economy-wide emission reduction targets to be implemented by Parties included in Annex I to the Convention" (FCCC/SB/2011/INF.1/Rev.1 of 7 June 2011). In addition, the EU provided additional information relating to its quantified economy wide emission reduction target in a submission as part of the process of clarifying the developed country Parties' targets in 2012 (FCCC/AWGLCA/2012/MISC.1)[7].

The 2020 EU quantified economy-wide emission reduction target is implemented through the EU Climate and Energy Package. Key assumptions and conditions related to the EU's target are included in the document FCCC/AWGLCA/2012/MISC.1 and under the EU Fourth Biennial Report (ch. 3).

Under the Climate and Energy Package, the EU is committed to reducing its greenhouse gas emissions by 20 per cent by 2020 from the 1990 level. The majority of the reduction will be reached as part of Directive 2003/87/EU- EU emissions trading scheme (EU ETS): in 2020, emissions from sectors covered by the EU ETS will be 21 per cent lower than in 2005. Under the revised EU ETS Directive (Directive 2009/29/EC), a single ETS cap covers the EU Member States and three participating non-EU countries (Norway, Iceland and Liechtenstein). Allowances allocated in the EU ETS from 2013 to 2020 decrease by 1.74 % annually, starting from the average level of allowances issued by Member States for the second trading period (2008–2012).

The Decision no. 406/2009/EC-Effort Sharing Decision (ESD) established binding annual greenhouse gas emission targets for Member States for the period 2013–2020. These targets concern emissions from sectors not included in the EU ETS such as transport, residential, agriculture and waste. The emissions will be cut by approximately 10 per cent from the 2005 level by 2020 within the EU as a whole. The ESD covers emissions from all sources outside the EU ETS, except for emissions from domestic and international aviation (which were included in the

6 First steps to a safer future: Introducing the United Nations Framework Convention on Climate Change, http://unfccc.int/essential/_background/convention/items/6036.php

7 European Union, its member states submission by Denmark and European Commission, http://unfccc.int/resource/docs/2012/awglca15/eng/misc01.pdf

EU ETS from 1 January 2012), international maritime, and emissions and removals from land use, land-use change and forestry (LULUCF). The EU pledge does not include emissions/removals from LULUCF.

While the EU ETS target is to be achieved by the EU as a whole, the ESD target was divided into national targets to be achieved individually by each Member State. The national ESD targets for 2020 are expressed as percentage changes from 2005 levels. These changes have been transferred into binding quantified annual reduction targets for the period from 2013 to 2020 (Commission Decision 2013/162/EU as amended by 2017/147/EU and Commission Decision 2013/634/EU), denominated in Annual Emission Allocations (AEAs).

The national targets have been set on the basis of Member States' relative Gross Domestic Product per capita. In addition, different levels of development in the EU-28 are taken into account by the provision of several flexibility options. Up to certain limitations, the ESD allows Member States to make use of flexibility provisions for meeting their annual targets: carry-over of over-achievements to subsequent years within each Member State, transfers of AEAs between Member States and the limited use of international credits (credits from Joint Implementation and the Clean Development Mechanism). Nevertheless, ESD targets are designed in a strict manner: Every year, once MS emissions are reviewed according to strict criteria (described in Chapter III of the Commission Implementing Regulation 749/2014), the European Commission issues an implementing decision on MS ESD emissions in the given year. MS exceeding their annual AEA, even after considering the flexibility provisions and the use of JI/CDM credits, will face inter alia a penalty – a deduction from their emission allocation of the following year (excess emissions, multiplied by 1.08).

2.2. *National target*

Romania's emission reduction target for the years 2013-2020 is part of the joint target of the European Union and its Member States, the base year being 1990.

Romania's reduction obligation for the sectors not covered by the EU ETS is to limit its GHG emissions to +19 per cent in comparison with 2005 level.

It is up to each Member State to decide how these targets will be achieved, but domestic measures are needed to fulfil the targets. Certified emission reduction units from the clean development mechanism and emission reduction units from joint implementation projects, as well as units transferred from other Member States, can be used to fulfil the targets.

A Member State that fails to meet its annual target will be penalized with an additional 8 per cent emission reduction obligation for the following year. The Climate and Energy Package[8] also requires Romania to increase its use of renewable energy sources to 24 per cent of final energy consumption, the share of biofuels in gasoline and diesel to 10 per cent and the indicative target of energy efficiency to reduce the primary energy consumption by 10 Mtoe (aprox. 43 M toe) by 2020.

8 EU's Climate and Energy Package, http://ec.europa.eu/ clima/ policies/ package/ index_en.html.

The description of the Romania's economy-wide emission reduction target is provided in the table III.1 and in the CTF tables 2 (a)-2 (f).

The binding quantified annual reduction targets for the period from 2013 to 2020 in non-ETS sectors, or the Annual Emission Allocations (AEAs) of Romania are presented below.

Table 3.- *Information regarding Romania's economy-wide emission reduction target*

Year	AEAs (t CO2eq)
2013	75,630,005.00
2014	77,452,128.00
2015	79,274,251.00
2016	81,096,375.00
2017	84,055,283.00
2018	85,973,339.00
2019	87,891,395.00
2020	89,809,451.00

For the monitoring of GHG emissions at the EU and the Member State level, the Monitoring Mechanism Regulation has been adopted, see section 2.2.2.1 of the EU's second Biennial Report and the 4th EU BR, section 3.2.2.

2.3. *Accounting for Market-based Mechanisms under the 2020 QEWERT target*

In the EU the use of flexible mechanisms can take place on one hand by operators in the EU ETS, and on the other hand by governments for the achievement of ESD targets. The amended EU ETS Directive 2009/29/EC (Article 11a(8)) sets the upper limit for credit use for the period from 2008 to 2020 at a maximum of 50 % of the reduction effort below 2005 levels. This is further specified into installation-level limits in the Commission Regulation on international credit entitlements (RICE) (EU No 1123/2013). Since some entitlements are expressed as a percentage of verified emissions over the entire period, the exact overall maximum amount will only be known at the end of the third trading period (2013-2020). The ESD allows Member States to make use of flexibility provisions for meeting their annual targets, with certain limitations. In the ESD sectors, the annual use of carbon credits is limited to up to 3 % of each Member State's ESD emissions in 2005. Member States that do not use their 3 % limit for the use of international credits in any specific year can transfer the unused part of their limit to another Member State or bank it for their own use until 2020.

According to the latest official GHG emission projections, Romania meets its annual ESD targets without the use of international carbon credits, on the basis of the domestic policies and measures.

2.4. *Other EU emission reduction targets*

In addition to the EU target under the Convention, the EU also committed to a legally binding quantified emission limitation reduction commitment for the second commitment period of the Kyoto Protocol (2013 - 2020).

The European Commission presented on 28 November 2018 and adopted its strategic vision out to 2050, the Long Term Strategy (LTS), that call for a climate-neutral Europe by 2050.

The EU's updated Nationally Determined Contribution was submitted on 17 December 2020. The EU and its Member States, acting jointly, are committed to a binding target of a net domestic reduction of at least 55% in greenhouse gas emissions by 2030 compared to 1990. This new increased emission reduction target is enabling the EU to move towards a low-carbon economy to achieve the climate neutrality until 2050 under the EU Green Deal legislative package and implement its commitments under the Paris Agreement. In June 2021 at EU level will be discussed the updating of the 2030 climate and energy policy framework that will allow the EU and its member states to achieve the 2030 new target. Among the legislation that will be updated is the EU emissions trading system (ETS) Directive, Effort Sharing Regulation (2018/842), LULUCF Regulation (2018/841).

3. Progress in achievement of quantified economy-wide emission reduction targets and relevant information

3.1. *General overview on mitigation actions and their effect*

Starting with 2016 is in force the *National Climate Change and Low Carbon Green Growth Strategy* (*National CC/LCGG Strategy*) and the *National Action Plan for implementation of the National Climate Change and Low Carbon Green Growth Strategy for period 2016 – 2020*, that was approved by the **GD no. 739/2016,** is in force.

The *National CC/LCGG Strategy* and the National Action Plan 2016 - 2020, as programmatic documents for the period 2016 - 2020 – 2030, including the roadmap for 2050, establish the Romania's operational actions for GHG emissions mitigation and climate change adaptation.

For GHG emissions mitigation, the National CC/LCGG Strategy adopts quantifiable targets in line with EU targets for 2030 (40 % reduction of GHG emissions compared to 1990 levels and improving the energy efficiency with 27%), and, respectively, considers the Romania's commitments for 2020, as an EU member state (increasing the share of renewable energy by 24% in final energy consumption, reducing the primary energy consumption by 19% comparing with the reference value, the annual emission allocations for ESD sectors, the EU-ETS implementation).

The National Action Plan 2016 – 2020, developed for implementation of the National CC/LCGG Strategy, includes actions, timelines, specific responsibilities for each sector and institution, and criteria and indicators to assess the achievement of proposed objectives.

GD no.739/2016 for approving the National CC/LCGG Strategy and National Action Plan 2016 – 2020, outlines for each priority sector details related to the main strategic objectives for GHG emissions mitigation based on sectoral strategic documents, proposed actions for achieving each objective (per types of actions: political, institutional/capacity building, investments, others), details on associated terms, responsible authorities, financing sources, investments and result indicators.

The estimated overall investment for implementing the proposed actions included in the National Action Plan 2016 – 2020 for GHG emissions mitigation is **EUR 17,835.71 million**; the investment distribution by sectors are as follows: Energy (28.54 %), Transport (26.61 %), Industry (0.01 %), Agriculture and Rural Development (28.54 %), Urban development (0.01 %), Waste management (0.93 %), Water (18.20 %) and Forestry (4.66 %).

3.2. *Information on mitigation actions included in WEM projection scenario*

The estimated total effect of implemented and adopted policy and measures (PAMs) till 2040 was calculated for group of policies and measures, in line with Regulation (UE) No. 749/2014, as the difference between the GHG emissions in the WOM scenario and WEM scenario.

This approach was considered, mainly due to the lack of information related to the effects of individual PAM, the interaction among several PAMs and also the difficulty of estimation the effect of multi-sectoral policy.

The multi-sectoral PAMs included in the WEM scenario were:

- *GD no. 739/2016 approving the National CC/LCGG Strategy and the National Action Plan for implementation of the Strategy for period 2016 – 2020;* the strategic objectives, political actions and proposed investments for achieving the objectives are presented in the following sections, at sectoral level;
- *GD no. 877/2018 approving Romania's Sustainable Development Strategy 2030,* defines the national framework for implementing 2030 Agenda for Sustainable Development and promotes the development of Romania by focusing on three dimensions – economic, social and environmental; the specific dimensions where additional efforts and resources are needed to achieve the convergence objectives with the EU on the main indicators of sustainable development are presented in the following sections, at sectoral level;
- *Law no. 278/2013 on industrial emissions*, which includes common provisions related to integrated pollution prevention and control and special provisions for large combustion plants, waste incineration/co-incineration plants, installations and activities using organic solvents and installation producing titanium dioxide;
- *GD no. 780/2006 establishing the greenhouse gas emission allowance trading scheme* (ETS), with further amendments and supplements, applicable for 2007÷2020 period.
  For *2007-2020* period, the national emissions reduction commitment is part of the EU's commitment to reduce GHG emissions related to ETS sector (21% lower than in 2005).
  For *2021-2030* period, the national emissions reduction commitment is part of the EU's commitment to reduce GHG emissions related to ETS sector (43.9 % lower than in 2005).
- *Decision no. 406/2009/EC on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2013 ÷ 2020*, establishing emissions limit at the national level for non–ETS sectors, such us transport sector, the residential sector, the agricultural sector and the waste sector.
  The national GHG emissions target for non-ETS sector in 2020 is +19% compared to 2005 GHG emissions level.
- *Regulation (EU) 2018/842 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement,* establishing the Member States obligations related to their minimum contribution for the 2021-2030 period to fulfill the Union's target of reducing its GHG emissions by 30% below 2005 levels in 2030 in the sectors covered by article 2 of Regulation;
  For non-ETS sector, Romania GHG emissions reduction in 2030, in relation with 2005 level, is -2%.

In accordance with the draft EU Decision, Annex II, the annual emission levels adjusted in accordance with art. 10 of Regulation (EU) 2018/842 allocated to Romania for each year from 2021 to 2030, calculated by applying the GWP defined in the fifth assessment report prepared by the IPCC (presented in Regulation EU 2020/1044) are presented in the following table.

Table 4. Annual adjusted emission levels allocated to Romania for 2021÷2030 period

Annual allocated emission level [t CO_2]									
2021	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
87,878 ,093	76,914 ,871	76,884 ,391	76,853 ,912	76,823 ,433	76,792 ,954	76,762 ,474	76,731 ,995	76,701 ,516	76,671 ,037

- *Law no. 220/2008 on establishing the promotion system for the production of the energy from renewable energy*, with further amendments and supplements; the national target in 2020 concerning the share of energy from renewable sources in gross consumption of energy is 24%.
- *Law no.121/2014 on energy efficiency*, with further modification, ensuring necessary conditions for implementing measures to increase energy efficiency in all economic and social sectors. According to the third National Action Plan for Energy Efficiency, established in 2014 in accordance with art. 24 (2) of Directive 2012/27 / EU saving measures were oriented towards sectors with the greatest potential to reduce final energy consumption, namely:
  - ✓ Energy supply-sector transformation, transport and distribution;
  - ✓ The industrial sector;
  - ✓ The residential and service, focusing on thermal rehabilitation of residential, government and public buildings;
  - ✓ Transport sector.
- *The 2021-2030 Integrated National Energy and Climate Plan,* establish the national targets and shares in the achievement of the EU climate change targets, as presented below:
  - ✓ *ETS emissions:* the national emissions reduction commitment is part of the EU's commitment to reduce GHG emissions related to ETS sector (43.9 % lower than in 2005);
  - ✓ Non- ETS emissions: according with *Regulation (EU) 2018/842 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement,* Romania GHG emissions reduction in 2030, in relation with 2005 level, is -2%;
  - ✓ *Renewable energy*: Romania's contribution for achieving the EU target (32% renewable energy consumption in 2030) consists in reaching an overall share of

renewable energy in gross final energy consumption of 30.7% in 2030 (of which: RES-E share: 49.4%; RES-T share: 14.2%; RES-H&C share: 33%);

- ✓ *Improvement in energy efficiency:* Romania contribution for achieving the EU target (32.5% for improvements in energy efficiency in 2030), consists in reduction of primary energy consumption (45.1% compared to the PRIMES 2007 projection for 2030, meaning 32.3 Mtoe in 2030) and reduction of final energy consumption (40.4% compared to the PRIMES 2007 projection for 2030, meaning 25.7 Mtoe in 2030).

Until 2020, for several PAMs for GHG emissions mitigation considered in WEM scenario, according with the National Action Plan for implementation of the National CC/LCGG Strategy approved by GD no. 739/2016, there are available information related to the investment costs and funding sources that have to be accessed, as identified in the Partnership Agreement and Operational Programme 2014 - 2020, such as: *Large Infrastructure Operational Programme 2014 - 2020, Regional Operation Programme 2014 - 2020* and *National Rural Development Program 2014 – 2020.*

The Large Infrastructure Operational Programme (LIOP) 2014 - 2020, developed for promoting Romania sustainable economic growth, as identified in 2014 – 2020 Partnership Agreement, focus on the following priorities axis (AP) relevant for climate change, component GHG emissions mitigation:

- AP1 Improving mobility through the development of the TEN-T and the metro network;
- AP2 Development of a multimodal, high-quality, sustainable and efficient transport system;
- AP3 Development of environmental infrastructure based on an efficient management of resources;
- AP6 Promoting clean energy and energy efficiency in order to support a low carbon economy;
- AP7 Increased energy efficiency in centralized heating systems in selected cities;
- AP8 Intelligent and sustainable transport systems for electricity and natural gas.

The Regional Operation Programme (ROP) 2014 – 2020, developed for increasing economic competitiveness and improving living conditions for local and regional communities by supporting business development, infrastructure and services will ensure a sustainable development of the regions in order to efficient manage the resources, to capitalize the innovation potential and to assimilate the technological progress. The ROP 2014 - 2020 priority axes, relevant for climate change, component GHG emissions mitigation, are the following:

- AP 2 Enhancing SMEs' competitiveness;
- AP 3 Promoting the low-carbon economy;
- AP 4 Supporting sustainable urban development;
- AP 6 Improving regional connectivity for road infrastructure;
- AP 8 Developing sanitary and social infrastructure;
- AP 9 Supporting economic and social regeneration of deprived urban areas;
- AP 10 Improving educational infrastructure.

The National Rural Development Program (NRDP) 2014 – 2020, through grants from EU and Romania Government aims to promote the economic and social development of Romania rural areas. This program responds to three of the development challenges established by the Partnership Agreement:

- Competitiveness and local development;
- Human and society;
- Resources.

Through the NRDP 2014 – 2020, 14 rural development measures are funded with a financial allocation of EUR 9.363 billion (EUR 8.015 billion by the European Fund for Rural Development and EUR 1.347 billion as national contribution).

For ***2021-2027 period***, according to the draft Partnership Agreement, under negotiation with the EC, for several PAMs considered in WEM scenario, information on the funding sources to be accessed through the operational programs are available, included in the relevant operational program such as: the Sustainable Development Operational Program, the Transport Operational Program and the Regional Operational Programs.

The Sustainable Development Operational Program 2021 -2027, developed to achieve the strategic objectives assumed in the 2021-2030 Integrated National Energy and Climate Plan, and to support the achievement of the objectives proposed in the package "Clean Energy for All Europeans" by 2030, has the following policy objectives (PO) relevant to climate change, the GHG emission reduction component:

- *PO (i) Promoting energy efficiency measures and GHG emissions reduction,* by respecting the assumed national targets and coherent and continuous development of the national energy sector, by implementing policies and measures related to the five EU dimensions, as well as by achieving common European objectives of the "Clean energy for all Europeans" package;
- *PO (iii) Developing smart energy systems, grids and storage outside TEN-E,* by ensuring an electricity measuring and distributing intelligent infrastructure in order to achieve the transition to renewable energy sources in optimal conditions. The modernization of the national energy market, as part of the European energy market, is an essential intermediate step for ensuring the flexibility of the energy system that provides tangible benefits for operators and end users;
- *PO (v) Promoting sustainable water management,* by connecting the population to compliant water supply systems and providing wastewater collection and treatment systems;
- *PO (vi) Promoting the transition to a circular economy, through investments in the waste field,* by preventing or reducing the quantities of generated waste, waste reusing and recovering through recycling or other operations, as well as stopping the activity and rehabilitation of non-compliant landfills.

The Sustainable Development Operational Program 2021 -2027 will have an allocation of EUR 5.604 billion: EUR 3.085 billion from the European Regional Development Fund (ERDF), EUR 0.837 billion from the Cohesion Fund (CF) and EUR 1.681 billion from the state budget (in case of 30% contribution).

The Transport Operational Program 2021-2027, for the development of transport infrastructure in Romania in order to improve connectivity between regions of the country but also with other EU countries as well as the development of infrastructure and mobility services for people and goods, has the following specific policy objectives:

- *PO 3.2 Developing a sustainable, climate resilient, intelligent, secure and intermodal TEN-T,* by modern communication routes with positive implications for the regional development of the area, traffic flow, transit traffic diversion, increase the users safety, time savings, providing road maintenance system and reducing pollution in transit areas;
- *PO 3.3 Developing sustainable national, regional and local mobility, climate resilient, intelligent and intermodal, including improved access to TEN-T and cross-border mobility,* by modern and safety *network* roads that effectively ensure regional and urban accessibility to the primary transport network;
- *PO 2 National, regional and local sustainable mobility,* for suburban rail and multimodal connections in larger urban centers (nodes of the primary network) and for the development of urban transport systems in less developed regions, such as light rail (metropolitan trains) and metro lines.

The Transport Operational Program will have an allocation of EUR 8.941 billion (EUR 2.041 billion from ERDF, EUR 2.570 billion from CF and EUR 4.329 billion from the state budget, in case of 30% contribution).

The Regional Operational Programs 2021-2027, developed for the sustainable and balanced development of the 8 development regions of Romania, have the following policy objectives relevant to the climate change, the GHG emissions reduction component:

- *PO b(i) Promoting energy efficiency measures and GHG emissions reduction,*
- *PO b(viii) Promoting sustainable multimodal urban mobility*;
- *PO c(iii) Developing sustainable national, regional and local mobility, climate resilient, intelligent and intermodal, including improved access to TEN-T and cross-border mobility.*

The Regional Operational Programs will have an allocation of EUR 13.657 billion (ERDF and 30% state budget contribution).

These framework policies developed in line with EU legislation and defining the main development drivers for a certain time period are presented below.

Energy sector

The evolution of the Energy sector is dependent on socio-economic and demographic development for meeting the energy demand on medium and long term, at the lowest possible

price, adequate to a modern market economy and a civilized living standard, under quality and safety in supply conditions, in compliance with the sustainable development principles and in correlation with the EU energy - environment policy.

The promotion with priority of the energy efficiency policies and measures is required to ensure the energy need afferent to the development requirements, under sustainability conditions, as an alternative solution to the increase of energy sources.

Moreover, the use of renewable energy sources for the electricity and heating production should be encouraged.

According with the *Progress Report of Romania related to promoting and using energy from renewable sources, in accordance with art. 22 of Directive 2009/28/EC*, the overall shares of energy from renewable sources in gross final energy consumption in 2017 and 2018, namely 24.45% and 23.87%, significantly exceeded the share established for the indicative trajectory of 21.83% for period 2017 - 2018, calculated in accordance with the provisions of Directive 2009/28/EC (Annex I).

Energy industry

The national energy regulation framework includes norms specific to the electricity and/or heating generation sector, as well as norms regarding the improvement of consumer energy efficiency.

The ***National CC/LCGG Strategy,*** approved by GD no. 739/2016, establishes the following: strategic objectives for GHG emissions mitigation:

- Objective 1: Reducing the intensity of CO_2 emissions related to energy supply;
- Objective 2: Improving end-user energy efficiency, particularly in buildings and industries;
- Objective 3: Affordable energy for the economically vulnerable groups.

The actions related to this sector included in the National Action Plan 2016 - 2020, approved by GD no. 739/2016, in order to meet the strategic objectives of National CC/LCGG Strategy for GHG emissions mitigation are the following:

- *Objective 1: Reducing the intensity of CO_2 emissions related to energy supply,* estimated value ***EUR 152.15 million****,* for:
  - ✓ Promotion of renewable sources in energy generation, by green certificates scheme, in order to achieve 20 % reduction in CO_2 by 2020, by new installed renewable energy capacities (in 2020: wind - 4000 MW, solar - 260 MW, biomass - 405 MW, biogas - 195 MW, cogeneration capacities); the access to the support scheme is for capacities put into operation by the end of 2016 that will benefit by green certificates till 2031;
  - ✓ Support for cogeneration through cogeneration bonus scheme (high efficient cogeneration up to 4,000 MW supported);
  - ✓ Completion of the energy strategy for 2016 - 2035 and outlines the roadmap for 2050 and, respectively, technical assistance to scale up pilot and demonstrative smart grids projects;
  - ✓ Promotion of renewable sources which are behind targets despite the green certificate scheme (biomass, biogas, geothermal), including their connection to the grids, by additional capacity from renewable sources of 60 MW that is foreseen to reduce the GHG emissions (48,000 t $CO_{2echiv.}$ reduced);

- ✓ Supporting cogeneration for industrial consumers and recovery of waste gas that is foreseen to reduce the primary energy consumption and CO_2 emissions (65,800 t CO_2 reduced);
- ✓ Support for the transmission grid to integrate renewable sources, by increasing the capacity to integrate energy from renewable sources from 2,200 MW to 3,200 MW.

According with the National Action Plan for period 2016 – 2020 for implementation of the National CC/LCGG Strategy, the funding sources for achieving this objective include extra budgetary sources (green certificates and cogeneration contribution) and the need to access EU funds promoted by LIOP 2014 – 2020, within the following priorities axis:

- ➢ *AP6 Promoting clean energy and energy efficiency in order to support a low carbon economy,* that promote investments to increase energy production from renewable resources less exploited (biomass, biogas, geothermal);
- ➢ *AP8 Intelligent and sustainable transport systems for electricity and natural gas,* that promote investments for increasing the capacity of the national transmission grid to integrate energy from renewable sources (140 km power line constructed / upgraded) and, respectively, increasing the interconnection of national natural gas transmission system between Romania and other neighboring countries (160 km natural gas transmission pipeline).

Romania's Sustainable Development Strategy 2030, approved by GD no. 877/2018, within the *Objective 7 Affordable and clean energy* establishes the following national targets that directly influence the GHG emissions related to the Energy sector:

Horizon 2020:

- ➢ Maintain an optimum energy mix by exploiting the country's own resources, diversifying import sources and export destinations, modernizing and improving the efficiency of existing viable infrastructure, promoting renewable energy sources and low carbon conversion technologies;
- ➢ Strengthening energy efficiency policy and consumer protection;
- ➢ Reduce domestic consumption of primary energy by 19%;

Horizon 2030:

- ➢ Expand electricity and gas distribution networks for ensuring household consumer, industrial and commercial access to safe sources of energy at acceptable prices;
- ➢ Decouple the economic growth from the process of resource depletion and environmental degradation by substantially boosting of the energy efficiency (by a minimum of 27% compared with the status quo) and the extensive use of the ETS in stable and predictable market conditions;
- ➢ Increase the share of renewable energy and low-carbon fuel used in the transport sector (electric vehicles), including the use of alternative fuels;
- ➢ Ensure a stable and transparent regulatory framework in the field of energy efficiency in order to attract investments;
- ➢ Strategically support the share of electricity in total household, industrial and transport consumption by establishing performance standards for facilities and equipment.

Romania's Energy Strategy for 2007 ÷ 2020, approved by GD no. 1069/2007, has the following strategic objectives:

- Energy safety by:
  - ✓ Increasing the energy safety by ensuring the energy resource demand and limiting the dependence on imported energy resources;
  - ✓ Diversifying the import sources and the energy resources by using both nuclear fuel and natural gas, as well as by diversifying the transport routes;
  - ✓ Increasing the performance level of national electricity transmission, natural gas and oil transport networks;
  - ✓ Protecting the critical infrastructure;
- Sustainable development by:
  - ✓ Increasing energy efficiency by using modern technologies;
  - ✓ Promoting the production of energy from renewable resources;
  - ✓ Promoting the production of electricity and heating in cogeneration plants, particularly in high efficiency cogeneration facilities;
  - ✓ Rehabilitation of the electricity and heating transmission and distribution systems, correlated with the rehabilitation of buildings to decrease energy losses and the implementation of new smart buildings;
  - ✓ Supporting research-development and applicable research result dissemination activities;
  - ✓ The rational and efficient use of primary energy resources;
  - ✓ Reducing the negative impact of the energy sector on the environment by promoting zero emission modern technologies.
- Competitiveness by:
  - ✓ Developing competitive electricity, natural gas, oil, uranium, green certificate, greenhouse gas emission allowance and energy service markets;
  - ✓ Liberalizing the energy transit and ensuring constant and non-discriminatory access of participants on the markets to the international transmission, transport, distribution networks and interconnections;
  - ✓ Continuing the restructuration and privatization process, particularly on the stock market, in the electricity, heating and natural gas sectors;
  - ✓ Resuming the restructuring process for the lignite sector, to increase profitability and access on the capital market.

Romania's Energy Strategy is being updated for 2019 - 2030 period, with the perspective of 2050, considering the demand and international obligations of Romania, but also the achievement the optimal scenario for the development of the national energy system. The national strategic investments presented by the Romania's Energy Strategy for 2019 - 2030 period, with the perspective of 2050, are the following:

- Completion of groups 3 and 4 from NPP Cernavoda, with an installed capacity of 720 MW each (one group to be put into operation by 2030); by investment implementation, an additional energy input in the energy system of about 11 TWh, as well as an increase in installed capacity by 1,440 MW, shall be ensured;

- New 600 MW group on lignite, with supercritical parameters, to enter in production after 2020; the group will be provided starting with 2035 with technology of capture, transport and geological storage of CO_2 (CSC) ;
- Construction of the Tarnița-Lăpuștești Pumped Hydropower Plant, with a capacity of 1000 MW that could balance the electric power system for durations between 4-6 hours;
- Construction of the Turnu Măgurele-Nicopole Hydrotechnical Complex of approx. 2,200 GWh / year, by the Danube river arrangement on the sector downstream of the Portile de Fier I and II, until immediately downstream of the confluence with the Olt River, within the cooperation between the governments of Romania, Bulgaria and Serbia.

The ***Third National Action Plan for Energy Efficiency (NAPEE)*** for 2014 ÷ 2020, approved by GD no. 122/2015 (in force till 9.04.2019), considers the sustainable development of Romania and it promotes measures contributing to efficient energy use for meeting of the EU commitment (increase energy efficiency by 20 % till 2020).

The primary energy saving measures includes:

- Electricity and heating generation saving measures:
  - ✓ The withdrawal from service of production capacities according to the registered real lifespan and the replacement with high efficiency modern units;
  - ✓ The re-engineering of certain units in the central power plants, according to the technical condition to increase efficiency and expand the operating term, considering the existence of the lignite supply in the country, for competitive prices, for the following 20 ÷ 40 years;
  - ✓ The capitalization of local lignite through the implementation of new, modern, coal-fired thermal power units;
  - ✓ The drawing up by the thermal power operators of their own measure programs to increase energy efficiency;
  - ✓ The promotion of high efficiency cogeneration;
  - ✓ Re-engineering/upgrading district heating supply systems;
- Distribution and transport saving measures by:
  - ✓ Reducing electricity transmission network losses by replacing equipment registering high own technological consumption, upgrading obsolete substations and upgrading obsolete lines;
  - ✓ Reducing losses in the electricity distribution networks by upgrading, increase the safety in operation and quality of the services provided to network users, as well as to reduce energy losses;
  - ✓ Reducing heat transport and distribution network losses.

The ***Fourth National Action Plan for Energy Efficiency (NAPEE 2017 - 2020)***, approved by GD 203/2019, which proposes significant measures to improve energy efficiency, assesses the energy savings achieved in order to reach the national energy efficiency objectives and establishes the energy savings expected to be achieved by 2020, taking as reference NAPEE III, is structured on two components:

- National Action Plan for Energy Efficiency 2017-2020 for the energy supply system, which involves achieving energy savings through:

- ✓ Implementation of investment programs approved by ANRE for the period 2017-2020 for the transmission and distribution of electricity and heat;
- ✓ Promoting high efficiency cogeneration;
- ✓ Continuation of the program "District Heating 2006-2016 Heat and Comfort";

- National Action Plan for Energy Efficiency 2017-2020 for the final energy consumer, which involves achieving energy savings through:
  - ✓ Introduction of new economic sectors: Construction (with energy savings of 31,800 toe) and Agriculture (with energy savings of 49,000 toe);
  - ✓ Increase of projected savings in the following sectors: Residential (by approx. 19.65%), Services (by approx. 15.8%) and Transport (by approx. 6.2%).

The ***National Renewable Energy Action Plan (NREAP)*** promotes the energy from renewable sources per technologies types (hydro, solar, wind power, biomass) in order to meet the national 2020 target for the share of energy from renewable sources in gross final consumption of energy (24%). In 2020, the estimated contribution expected from each renewable energy technology is the following:

- Wind power - 4000 MW installed capacity with 8400 GWh gross electricity generation;
- Hydro energy - 7729 MW installed capacity with 19768 GWh gross electricity generation;
- Solar energy – 260 MW installed capacity with 320 GWh gross electricity generation;
- Biomass energy (solid) - 405MW installed capacity with 1950 GWh gross electricity generation.

The ***2021-2030 Integrated National Energy and Climate Plan,*** involves implementation of the following measures in order to achieve the targets established at national level, with direct implication for energy sector:

- *Decarbonization dimension:*
  - ✓ Decarbonization of energy sector through promotion of investments in new low-carbon power generation capacities (replacement of existing conventional power generation capacities with new low carbon capacities on natural gases, nuclear energy and RES) and promotion of RES and energy efficiency projects;
  - ✓ Decarbonization of industrial sector, through implementation the best available technologies (BAT), in order to reduce GHG emissions and to increase energy efficiency in the industrial sector;
  - ✓ Promotion of circular economy (recycling) for achieving the energy efficiency target by reducing consumption of energy used in the industry, in the processing of raw materials;
- *Energy efficiency dimension:*
  - ✓ Increasing energy efficiency in the industrial sectors regulated by ETS;
- *Energy security dimension:*
  - ✓ Assuring the flexibility of the energy system, through encouraging the development of energy storage capacities and high-efficiency cogeneration;
  - ✓ Implementation of the Decarbonization Plan of CE Oltenia, involving the development of new solar energy and micro-hydro- power capacities which will

contribute to the achievement of RES-E target and will ensure the diversification of energy sources.

For ***2021-2027 period***, the funding sources that will be available through the Multiannual Financial Framework 2021 - 2027 for the Energy Sector are included in the *Sustainable Development Operational Program 2021 -2027*, namely: *PO (i) Promoting energy efficiency measures and GHG emissions reduction* and *PO (iii) Developing smart energy systems, grids and storage outside TEN-E*. The available financial allocation for this sector is included in *Priority 1 - Promoting energy efficiency, smart energy systems and networks and storage solutions*, with a financial allocation of EUR 300 million from ERDF, EUR 100 million from CF and EUR 70 million from the state budget.

Transport

The transport activity holds an important role in the support of the economic and social development of Romania, in close correlation with the energy/fuel consumption and the GHG emissions.

The evolution of this economic activity sector indicates a significant increase of the number of vehicles registered in Romania. Therefore, is necessary to adopt the adequate measures leading to the decoupling of GHG emissions in the transport sector in relation to the economic growth, aiming to ensure sustainable development.

The objective in the Transport area is the development of a sustainable system improving social cohesion, access in peripheral areas, the reduction of environmental impact, including the reduction of GHG emissions, promoting economic competitiveness through the improvement of the infrastructure, ensuring an optimal fuel mix, as well as the use of biofuels from renewable plants and the use of information and communication technology to increase the efficiency of the sector.

The reduction of the CO_2 emissions generated by transport shall be carried out through an integrated, cost-efficient approach, combining innovation in the automobile propulsion technology area and the use of biofuels with the efforts made by the decisional factors and consumers on taking a new attitude in terms of the development of the economic sector.

The technical and financial options, competitiveness and, not lastly, social impact shall be considered in establishing the balance between the demand for mobility and the environmental protection requirements.

The ***National CC/LCGG Strategy,*** approved by GD no. 739/2016, establishes the following: strategic objectives for GHG emissions mitigation:

- Objective 1: Introducing strong economic incentives for a climate friendly transport system through pricing instruments;
- Objective 2: Increasing the efficiency of urban transport;
- Objective 3: Reversing the long-term decline of passenger and freight rail transport and development projects for intermodal terminals;

The actions related to this sector included in the National Action Plan 2016 - 2020, approved by GD no. 739/2016, in order to meet the strategic objectives of National CC/LCGG Strategy for GHG emissions mitigation are the following:

- *Objective 1: Introducing strong economic incentives for a climate friendly transport system through pricing instruments,* estimated value ***EUR 170.4 million,*** for: vehicle registration tax; charging for parking; charging for urban congestions; the „Rabla" program;
- *Objective 2: Increasing the efficiency of urban transport,* estimated value ***EUR 1,973.45 million,*** for: policy measures at local level (speed restrictions, low-emission/green driving, low emissions zones, smarter choices/soft measures); investments in ultra-low emission vehicles, in pedestrian and cycling infrastructure and in the development of non-motorized and electrical vehicle infrastructure; actions for institutional capacity building;
- *Objective 3: Reversing the long-term decline of passenger and goods rail transport and development projects for intermodal terminals*, estimated value ***EUR 2,602 million,*** for: increasing mobility on the TEN-T core network railway; increasing the use of the subway network in Bucharest - Ilfov; increasing the sustainability and quality of rail transport;
- *Urban Development, Objective 1: Promote more compact, mixed use and transmit oriented development measures as a way to reduce vehicle miles travelled, to develop the infrastructure and reduce maintenance costs,* estimated value ***EUR 0.3 million*****,** for: modify local tax policies or floor to area ratio policies in cities to incentivize infill and transit oriented development; modify zoning or land use policies to promote mixed-use development;
- *Urban Development, Objective 2: Promote energy efficiency improvements in buildings and major urban infrastructure systems,* estimated value ***EUR 2.0 million,*** for: establish efficiency update programs for residential buildings; continue shift away from subsidies/market controls on energy prices; establish energy efficiency upgrade programs for major infrastructure systems in the field of urban transportation/vehicle fleets; increased investment in energy efficiency.

According with the National Action Plan 2016 – 2020 for implementation of the National CC/LCGG Strategy, the funding sources for achieving these objectives include state budget, local budgets and the need to access EU funds promoted by LIOP 2014 - 2020 and ROP 2014 – 2020.

LIOP 2014 - 2020 promotes the development of the transport infrastructure within the following priorities axis:

- ***AP1 Improve mobility through development of the TEN-T network and underground transport:***
  - ✓ *Specific objective 1.1 Increased mobility on road TEN-T core network:* the construction of 200 km new roads is foreseen that is expected to reduce the average travel time on the road TEN–T core network (from 79.50 min / 100km in 2013 to 74.10min/100 km in 2023);
  - ✓ *Specific objective 1.2 Increased mobility on rail TEN-T core network:* the completion of the railway corridor is foreseen (connection between Hungary border and Constanţa), through 140 km railway upgraded, that is expected to reduce the average travel time on the rail TEN-T core network (from 103.4 min / 100km in 2013 to 79.2 min / 100km in 2023);

- ✓ *Specific objective 1.3 Increase the use of inland waterways transport through the development of water ways and ports located on the TEN-T Core network:* investments for navigation channel and for modernization of Danube and maritime ports are foreseen, through improvement of 30 km inland waterways, one port modernization and rehabilitation of 4 locks that are expected to increase the freight transport on Danube with 20 % in 2020 compared with 2010;
- ✓ *Specific objective 1.4 Increase the use of the metro network in Bucuresti – Ilfov:* the development of new metro lines and extension of existing metro lines are foreseen that is expected to reduce the energy consumption by 53,000 toe;

➢ ***AP2 Development of a multimodal, high-quality, sustainable and efficient transport system:***

- ✓ *Specific objective 2.1 Increase mobility on road TEN-T network:* the construction of 175 km new roads is foreseen between several Romania regions and urban centers that is expected to reduce the average travel time on the road TEN–T network (from 85.2 min/100 km in 2013 to 78.4 min / 100 km in 2023);
- ✓ *Specific objective 2.2 Enhancing regional mobility by connecting secondary and tertiary nodes to TEN-T infrastructure, including multimodal nodes:* the extending of national road transport network is foreseen for ensuring the accessibility to employment opportunities, by connecting the deficient areas in terms of transport opportunities to TEN-T infrastructure, through 9 km new roads and upgrading 130 km existing roads;
- ✓ *Specific objective 2.3 Increasing the sustainable use of airports:* the modernization of two airports are foreseen for enhancing the regional accessibility and mobility that is expected to increase the number of passengers (from 10.7 Mil. passengers/ year in 2013 to 20 Mil. passengers/year in 2023);
- ✓ *Specific objective 2.4 Increasing the freight volume handled in intermodal units and ports*: investments for intermodal terminals infrastructure (4 terminals) and for 3 ports outside the TEN-T network are foreseen that is expected to increase the containerized cargo volume handle in intermodal terminals (from 25,198 TEU/year in 2011 to 70,000 TEU/year in 2023);
- ✓ *Specific objective 2.7 Increasing the sustainability and quality of rail transport* (rehabilitation of 250 km TEN-T railways, new rolling stock) that is expected to increase the usage of rail network (from 409, 640 passengers/km network/year in 2013 to 555,940 passengers/km network/year in 2023).

ROP 2014 – 2020, through the priorities axis ***AP3 Promoting the low-carbon economy*** and ***AP 4 Supporting sustainable urban development,*** promotes GHG emissions mitigation measures in county municipalities and urban areas, responding to the European Thematic Strategy on Air Quality that warns against the transport impact an air quality in cities and the need to change citizens daily behavior.

For improving the environmental conditions and the life quality, in major urban areas, sustainable urban mobility plans (PMUD) are promoted and therefore the development of sustainable urban public transport and non-motorized and the discouragement in using private cars. These plans aim to create a more efficient and fast public transport, with low consumption, to develop

dedicated public transport infrastructure and to use environmental friendly vehicles in public infrastructure.

Through the PMUDs, the investments related to urban public transport and related infrastructure will be underlined, focusing on efforts for a fast, attractive, accessible, environmentally friendly and comfortable urban transport system that is expected to reduce the traffic jams and therefore diminish their negative consequences.

The main expected impact as a result of promoting the investments within these priorities axis is an increase number of passengers transported by Romania urban public transport (for developed regions from 0.93 billion passengers in 2012 to 1.03 billion passengers in 2023 and, for less developed regions from 0.97 billion passengers in 2012 to 1.11 billion passengers in 2023).

Romania's Sustainable Development Strategy 2030*,* approved by GD no. 877/2018, within the *Objective 9 Industry, innovation and infrastructure* establishes the following national targets that directly influence the GHG emissions related to the Transport sector:

Horizon 2020:

- Improve connectivity between municipalities and regions by increasing the proportion of modernized county and local roads to 61% by 2020 (from 39.4% in 2016);

Horizon 2030:

- Modernize and develop quality, viable, sustainable and powerful regional and cross-border infrastructure, in order to support economic development and human well-being, with a focus on fair and equitable access by all;
- Improve road safety.

In May 2011, the ***Strategy on Intermodal Transport in Romania – 2020*** was approved by Order no. 457/2011, underlining the fact that the intermodal connection of transports leads to the efficient use of high uptake power modes (railway, inland waterways and sea transport), with benefic effects on energy consumptions and polluting emissions.

Table 5. Energy consumption and CO_2 emissions reduction by using intermodal transport

Combined transport versus Road transport	**Accompanied combined transport (motor road)**	**Unaccompanied combined transport (containers/trailers)**
Energy consumption decrease from source to destination	10%	29%
Energy consumption decrease/km	11%	29%
CO_2 emissions decrease from source to destination	18%	55%
Reducing the CO_2 emissions/km	23%	60%

The general objective of the Intermodal Transport Strategy is to develop the national intermodal transport system of goods, to increase the efficiency of goods transport and to improve the environmental impact of transport and on road safety in Romania.

In accordance with this strategy, the general strategy for 2020 is to reach a transport share of at least 40% of the volume of goods carried in intermodal transport units (ITU) on the Romanian territory, through this system.

The increasing energy efficiency measures and the emissions reduction in the transport sector are:

- Use of intelligent transportation systems;
- Reduction of road transport;
- Program on the renewal of the national car park, finance by Environmental Fund budget;
- Measures taken by economic agents and the local and central public administrative units holding over 25 vehicles for the monitoring and management of the fuel consumption for consumption reduction;
- Upgrading railway goods and passenger transport through the procurement of high energy efficiency rolling stock;
- The implementation of an electricity tele-management power factor compensation system for electric traction sub-stations;
- The implementation of the level 2 European Railway Traffic Management System (ERTMS);
- Reducing the electricity consumption afferent to the production of the compressed air required for the operation of the train brake test fixed facilities through the replacement of the old Reșița compressors with efficient, modern equipment;
- Upgrading subway transport by upgrading the electric train park and public lighting systems;
- Using biofuels (reaching the biofuel use share - 10% of the final national consumption, by 2020);
- Decreasing the annual consumption of resources by 303 thousand toe between 2014 and 2020.
- Promoting “clean vehicles” and stimulating the generation thereof. To encourage the procurement of such vehicles, Emergency Ordinance no. 40/2011 promoting non-polluting and energy efficient road transport vehicles, amended by Emergency Ordinance no. 9/2013 on the vehicle environmental stamp, stipulates the granting of a new eco-ticket for each new electric vehicle.
- Promoting alternative transport (cycling, car-pooling, car-sharing, etc.) through urban planning and the development of an adequate cycling infrastructure (bicycle lanes, parking racks, special carts/compartments for bicycles on the subway and trains, etc.) and the expansion of walking areas, particularly in large urban areas.
- Increasing the rate of public transportation use, by optimizing the public transport (trains, buses, trolleys, trams) and the infrastructure required for the adequate operation thereof, expanding the subway network, with the completion of the lines under construction and opening new subway lines, as well as improving the transport quality and connection between the city and the main airport of Bucharest (Otopeni International Airport).

The ***National action plan for GHG emissions mitigation in the civil aviation area,*** approved by Order no. 1801/2011, with further modification, has the following objectives:

- Achievement of EU commitment related to reduction of GHG emissions;
- Capping the CO_2 emissions from activities in the international civil aviation sector, starting with 2020.

In order to meet the target of 10% renewable energy share in the national energy final consumption in transports by 2020, considering the provisions of Directive 2003/30/EC and of Directive 2009/28/EC, transposed at national level by ***GEO no. 80/2018*** *for laying down the conditions for placing on the market gasoline and diesel fuel, introducing a mechanism for monitoring and reducing greenhouse gas emissions and laying down calculation and reporting methods for reducing greenhouse gas emissions and for amending and supplementing the Law no. 220/2008 on establishing the system for promoting the production of energy from renewable energy sources*, the suppliers have the following obligations concerning the fuels placed on the market:

- Diesel:
  - ✓ Biofuel content of at least 6.5% of the total volume traded in a calendar year;
- Gasoline:
  - ✓ Till 31 December 2018, minimum 4.5 % volume-based biofuel content;
  - ✓ From 1 January 2019, gasoline with a biofuel content of at least 8% of the total volume marketed to final consumers in a calendar year.

In accordance with the provisions of the same decision, the GHG emissions savings due to the use of biofuels and bioliquids, in comparison with GHG emissions from fossil fuels, shall be at least:

- 60% for biofuels and bioliquids produced in installations starting operation after 5 October 2015;
- 50% for biofuels and bioliquids produced in installations in operation on or before 5 October 2015.

Regulation (EC) no. 443/2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO_2 emissions from light-duty vehicles sets the average CO_2 emissions generated by new vehicles at 130 g CO_2/km, obtained through the improvement of the vehicle engine technology. Starting with 2020, the regulation establishes the objective of reaching a 95 g CO_2/km emission average for the new vehicle park.

Summarizing the provisions of Regulation no. 443/2009, the average CO_2 emission for new (light-duty vehicles) vehicles shall be:

- *starting with 2020:*

  specific CO_2 emissions= 95 + a*(M-M_0),

where: M = vehicle mass (kg);
M_0 = adopted value in line with art.13, para. (2) Regulation (EC) no. 443/2009;
a = 0.0333.

Regulation (EC) no. 510/2011 establishing the performance standards on emissions for new light-duty utility vehicles, as a part of the Community's integrated approach to decrease CO_2 emissions generated by new light-duty utility vehicles establishes the average CO_2 emission generated by new vehicles at 175 g CO_2/km, obtained by improving the vehicle motor technology. Starting with 2020, the regulation sets the objective of reaching an average emission at 147 g CO_2/km for the new light-duty utility vehicles.

Summarizing the provisions of Regulation (EC) no. 510/2011, the CO_2 average emission for the new light-duty utility vehicles shall be:

- 2020: 147 gCO_2/km.

Starting with 1 January 2020, the ***Regulation (EU) 2019/631 setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles,*** repealing Regulations (EC) No. 443/2009 and (EU) No. 510/2011, will be in force, which include the following provisions:

- Starting with 1 January 2020, the EU fleet-wide average emissions targets are: 95 g CO2/km for new passenger cars and 147 g CO2/km for new light commercial vehicles; until 2024, additional measures will be provided corresponding to a reduction of 10 g CO_2/km;
- Starting with 1 January 2025, the EU fleet-wide average emissions targets for the new passenger car fleet and the new light commercial vehicles fleet shall be reduced with 15% comparing with 2021 target;
- Starting with 1 January 2030, the EU fleet-wide average emissions targets shall be reduced comparing with 2021 target with 37.5% for the new passenger car fleet and with 31% for the new light commercial vehicles fleet;
- Starting with 1 January 2025, a zero and low-emission vehicles' benchmark equal to a 15% share of the respective fleets of new passenger cars and new light commercial vehicles shall apply;
- Starting with 1 January 2030, the following zero and low-emission vehicles' benchmarks shall apply: 35% share of the new passenger cars and 30% share of new light commercial vehicles.

The **General Transport Master Plan (GTMP)** approved by GD no. 666/2016 (in force starting with 4.10.2016), as a strategic planning instrument for for major investments in the transport sector that has the environmental strategic objective to develop a modern transport infrastructure considering the environmental effects, defines the following specific environmental objectives:

- Promotion transport investment projects contributing to the sustainable transport system performance, with measures to avoid and reduce negative effects, such as: air pollution emissions; noise pollution in urban areas and, on heavy traffic routes; water and soil pollution due to diffuse sources; impact on landscape and cultural heritage;
- Reduction GHG emissions from the transport sector;
- Protection the population’s health by improving environmental and transport safety conditions;
- Decrease the impact on biodiversity by ensuring measures for protection and preservation of biodiversity and ensuring the coherence of the national network of natural protected areas.

For ***road transport***, the strategic objectives included in the GTMP for short, medium and long terms are the followings:

- Improvement the mobility of passengers and freight transport on TEN-T core network, including the extended network, through construction of highways and expressways;

- Ensuring the access of passengers and business environment to TEN-T core network, including the extended network, through construction of national connection corridors;
- Ensuring safe and operational road transport network for reducing traffic accidents and travel times;
- Ensuring the international access through links with neighboring countries and an environmental transport networks, through implementation of ring roads projects.

For road transport, the GTMP (Annex II without structural reform clause) includes a low number of investments projects for increasing the average speed and reducing the waiting time in traffic.

For ***rail transport***, the GTMP includes the investment projects for increasing the average speed, namely:

- *For period 2014 - 2020*, new projects are foreseen for: railway rehabilitation (450 km), railway electrification and rehabilitation (283.6 km) and railway electrification and rehabilitation with high speed, cadence schedule and rail services (1,001 km);
- *For period 2021 - 2030*, new projects are foreseen for railway rehabilitation (2,379 km) and railway electrification and rehabilitation (225 km);
- *For period 2030 - 2040*, new projects are foreseen for railway rehabilitation (326 km).

For ***inland waterway transport***, the GTMP includes investment projects for increasing the number of navigability days on the Danube, respectively for ports modernization / rehabilitation works:

- *For period 2014 - 2020,* investments are foreseen for development/improving navigation conditions (length 1,340 km) and for rehabilitation/development of ports infrastructure (Constanta and 15 other ports); the investments for projects implementation are EUR 1,200.58 million.
- *For period 2021 - 2030,* investments are foreseen for rehabilitation/development of ports infrastructure (Constanta and 14 other ports); the investments for projects implementation are EUR 692.62 million.
- *For period 2030 - 2040,* investments are foreseen for rehabilitation/development of Constanta port infrastructure; the investments for projects implementation are EUR 651.65 million.

For ***air transport***, the GTMP includes investment projects for infrastructure (runways, stationary platforms, embarkation / disembarkation runways, passengers and freight terminals):

- *For period 2014 - 2020*, completion of infrastructure rehabilitation/development works for 5 airports are foreseen, till 2018; the investments for projects implementation are EUR 1,756.05 million;
- *For period 2021 - 2030,* completion of infrastructure rehabilitation/development works for 10 airports are foreseen, till 2027; the investments for projects implementation are EUR 517.09 million.

For ***multimodal transport***, the GTMP includes investment projects for multimodal platforms for freight operation and supporting the business environment, connected to the road or rail networks, as appropriate:

- *For period 2014 - 2020,* investments are foreseen for 5 new multimodal platforms (total operation capacity 2,050,000 tons/day), till 2018; the investments for projects implementation are EUR 191.19 million;
- *For period 2021 - 2030,* investments are foreseen for 5 new multimodal platforms (total operation capacity 1,950,000 tons/day), till 2025; the investments for projects implementation are EUR 161.89 million.

The ***Fourth National Action Plan for Energy Efficiency (NAPEE 2017 - 2020)***, approved by GD no. 203/2019, proposes significant measures to improve energy efficiency in the Transport sector, comparing with NAPEE III, by increasing the energy savings (by 6.2%). The potential energy savings in this sector in 2020, of 0.4127 Mtoe, are mainly based on the renewal of the cars fleet - cars and goods vehicles (0.200 Mtoe) and alternative mobility (0.165 Mtoe).

The 2021-2030 Integrated National Energy and Climate Plan involves implementation of the following measures in order to achieve the targets established at national level, with direct implication for transport sector:

- *Decarbonization dimension:*
  - ✓ Decarbonization of the transport sector, through Priority development and fostering the use of rail transport for transportation of passengers (to the detriment of road transport) and its intermodal integration with other modes of transport;
  - ✓ Promotion of use of renewable energy in transport (RES-T);
- *Energy Efficiency dimension:*
  - ✓ Developing and promoting alternative mobility and renewing the vehicle stock.

For ***2021-2030*** period, according with ***the 2021-2030 Integrated National Energy and Climate Plan*** the Transport sector could contribute together with Industry and the Residential sectors to the achievement of the energy efficiency target (cumulative value of energy savings in the period of 10.12 Mtoe), in approximately equal shares (each with a percentage of 29%), by renewing the fleet, modernization of urban and rail public transport, encouraging alternative mobility and promoting the use of electric vehicles.

For ***2021-2027 period***, the funding sources that will be available through the Multiannual Financial Framework 2021 - 2027 for the Transport Sector, relevant for GHG emissions reduction, are included in the following operational programs:

- ***The Transport Operational Program 2021 - 2027:***
  - ✓ *Priority 1 – Improving connectivity by developing the TEN-T road transport network,* for construction of the primary high-speed road infrastructure network, by completing the phased projects from the previous EU funding period and the prioritized projects for the completion of Romania's primary network located on TEN-T CORE and TEN-T COMPREHENSIVE network.

    The financial allocation for this priority is EUR 551,000 million from ERDF and EUR 1,350,000 million from CF.
  - ✓ *Priority 2 - Improving connectivity by developing road infrastructure for territorial accessibility,* by developing / modernizing bypasses variants and municipalities'

access to primary road network sectors (at national road level located on the secondary network), as well as modernizing the national road network sectors located on the secondary network.

The financial allocation for this priority is EUR 350,000 million from ERDF.

- ✓ *Priority 3 - Improving connectivity by developing the TEN-T rail transport network,* for the modernization of Romania's primary railway network (passengers and freight transport) by completing the phased projects of the previous EU funding period and completing the Rhine-Danube corridor and of the other sections of the primary network.

  The financial allocation for this priority is EUR 440,800 million from ERDF and EUR 655,200 million from CF.
- ✓ *Priority 4 - Improving national mobility, sustainability and resilience to climate change by increasing the quality of rail transport services*, for the modernization of the railway network in order to increase the number of rail passengers.

  The financial allocation for this priority is EUR 250,000 million from the ERDF.
- ✓ *Priority 5 - Improving connectivity by increasing the use of subway transport in the Bucharest - Ilfov region,* to increase the number of subway passengers and, implicitly, reduce car traffic and pollution in the Bucharest metropolitan area.

  The financial allocation for this priority is EUR 250,000 million from the ERDF.
- ✓ *Priority 6 - Improving connectivity and urban mobility, sustainable and resilient to climate change by increasing the quality of rail transport services,* to increase the number of rail passengers for metropolitan transport services.

  The financial allocation for this priority is EUR 350,000 million from the ERDF.
- ✓ *Priority 7 - Development of a multimodal transport system, to increase regional accessibility,* by developing / modernizing intermodal terminals and their connections with the main modal hubs.

  The financial allocation for this priority is EUR 30,000 million from CF.
- ✓ *Priority 8 - Increasing the use of waterways and ports*, to increase the volume of goods operated within the ports on the primary network of Romania, increasing the area served by these ports, as well as increasing the transit of goods to Romania's neighbors who do not have access to maritime areas.

  The financial allocation for this priority is EUR 200,000 million from CF.

➢ ***The Regional Operational Programs 2021-2027,*** for the following investments:

- ✓ *Promoting sustainable multimodal urban mobility*, through the development of clean urban infrastructure, modernization / extension of tram lines, acquisition / modernization of rolling stock, trolleybuses / buses, development of mobility route and infrastructures for alternative fuel;
- ✓ *Developing sustainable national, regional and local mobility*, through investments in rehabilitated or new secondary road towards to the road network and TEN-T nodes.

Other sectors (commercial/ institutional/ residential/ agriculture, forestry, fishery)

Land use is an important instrument for the evolution of society, as it is practically the spatial expression of its economic, social and ecological policies.

The energy intensity of the Romanian residential sector is 8 times higher than that of EU 15, following the inefficiency of district heating and the absence of thermal insulation of most housing/apartments.

The ***National CC/LCGG Strategy,*** approved by GD no. 739/2016, establishes the following: strategic objectives for GHG emissions mitigation:

- Objective 1: Promote more compact, mixed use, and transit-oriented development measures as a way of reducing vehicle miles travelled, to develop the infrastructure and reduce maintenance costs;
- Objective 2: Promote energy efficiency improvements in buildings and major urban infrastructure systems.

The actions related to this sector included in the National Action Plan 2016 - 2020, approved by GD no. 739/2016, in order to meet the strategic objectives of National CC/LCGG Strategy for GHG emissions mitigation are the following:

- *Energy, Objective 2: Improving end-user energy efficiency, particularly in buildings and industries,* estimated value ***EUR 3,301 million****,* for:
  - ✓ The liberalization of the electricity and natural gas market for household and non-household consumers and full competitive contracting for energy, at market prices, for 19 % reduction in primary energy consumption (savings of 10 million toe of the primary energy consumption in 2020);
  - ✓ The extension of the “Termoficare 2006 – 2015” program for rehabilitation of district heating capacities (generation, transport and distribution network) for obtaining savings of 10 million toe of the primary energy consumption in 2020;
  - ✓ The promotion of energy efficiency in industry, for achieving in 2023 the energy intensity of 121.5 kgoe / 1,000 Euro, through monitoring energy consumption at industrial platform level;
  - ✓ The promotion of energy efficiency in households, for achieving in 2023 the average annual consumption of energy in households of 1.2 MWh / household / year, through:
    - developing and implementing smart distribution metering system that operate at low and medium voltage levels;
    - increasing the energy efficiency of district heating transmission and distribution in 7 cities for reducing the energy losses in district heating networks;
    - increasing energy efficiency for the centralized heat supply in Bucharest for reducing the energy losses in district heating networks;
  - ✓ Public buildings and services: improving energy efficiency through complete thermal rehabilitation, including thermal insulation, lighting and energy management of public buildings for reduction of energy and primary energy consumption;

- ✓ Residential buildings: rehabilitation and upgrading of the heating distribution network, improvement of the thermal insulation of households and upgrading public lighting for reduction of primary energy consumption and energy consumption for public lighting;

- ➢ *Energy, Objective 3. Affordable energy for the economically vulnerable groups,* estimated value ***EUR 300 million****,* for*:*
  - ✓ Improving public policies on support for vulnerable consumers for increasing energy efficiency in dwellings for low-income persons;
  - ✓ Thermal rehabilitation of housing for consumers affected by energy poverty;
  - ✓ Improving energy efficiency in households (home appliances, lighting, etc.);
  - ✓ *Urban Development, Objective 2: Promote energy efficiency improvements in buildings and major urbane infrastructure systems,* estimated value ***EUR 2 million,*** for: establish efficiency upgrade programs for residential buildings; continue shift away from subsidies/market controls on energy prices; establish efficiency upgrade programs for major infrastructure system in the field of urban transportation/vehicle fleets; increased investment in energy efficiency.

According with the National Action Plan for implementation of the National CC/LCGG Strategy for period 2016 – 2020, the funding sources for achieving these objectives include beside state budget and private funds the need to access EU funds promoted by LIOP 2014 - 2020 and ROP 2014 – 2020, namely:

- ➢ *LIOP 2014 - 2020, AP6 Promoting clean energy and energy efficiency in order to support a low carbon economy* for investments to reduce energy consumption of complex industrial consumers through implementation of complex monitoring energy systems (heat, natural gas, industrial water, process steam, compressed air, industrial water) at approx. 60 large industrial customers (out of approx. 626 large customers with total energy consumption over 1000 toe / year in 2014) and implementation of measures to increase the energy efficiency. These investments are expected to reduce the energy intensity in industry (from 183 kgoe / 1000 Euro in 2012 to 121.50kgoe / 1000 Euro in 2023). Also, for enterprises, investments for GHG emissions reduction through high efficiency cogeneration (max. 8 MWe) on natural gas and biomass and, where possible, on waste gases from industrial processes are promoted. These investments are expected to increase the annual primary energy savings (from 178 thousand toe in 2012 to 232 thousand toe in 2023);
- ➢ *LIOP 2014 - 2020, AP7 Increased energy efficiency in district heating systems in selected cities,* for investments to increase the energy efficiency of district heating networks through rehabilitation of heat transport and distribution networks (630 km rehabilitated / extended network that are expected to reduce the energy losses: from 26.76% of the energy supplied in 2013 to 15% of the energy supplied in 2023);
- ➢ *ROP 2014 – 2020, AP3 Promoting the low-carbon economy, Specific Objective 3.1 Increasing energy efficiency in residential buildings, public buildings and public lighting, especially those with high energy consumptions,* for investments to reduce the energy consumption, namely:

- ✓ for public buildings, the final energy consumption is foreseen to decrease from 0.19Mtoe in 2012 to 0.12 Mtoe in 2023;
- ✓ for residential buildings, the final energy consumption is foreseen to decrease from 0.96 Mtoe in 2012 to 0.47 Mtoe in 2023;
- ✓ for public lighting, the final energy consumption is foreseen to decrease from 669GWh in 2012 to 446 GWh in 2023.

The draft GD for approval of ***National Long-term Renovation Strategy to support the renovation of the national residential and non-residential building stock, public and private, into a highly efficient and decarbonized building stock by 2030***, forecasts an increase rate of renovations of the national building stock in order to improve energy efficiency, reduce GHG emissions and increase the share of renewable energy in total energy consumption.

According to the scenario recommended by the Strategy (scenario 2), the annual renovation rate shall register in the period 2021-2030 a gradual increase from 0.69% to 3.39%; the annual renovation rate in 2031-2040 period shall be 3.79% and in the 2041-2050 period shall be 4.33%.

NAPEE forecasts the co-financing of projects to increase energy efficiency for urban heating, the thermal rehabilitation of public buildings, for public lighting.

The enforcement of the EU regulations established under the "Eco-design" Directive shall lead to the electricity consumption reduction in the service and residential service due to the use of efficient lighting technologies, as well as of efficient equipment.

Measures to reduce energy intensity in the residential sector (energy final consumption in buildings: heating, hot water and lighting), in accordance with the nationally drafted strategies, included in the second NAPEE include:

- ➢ Rehabilitation of the envelopment of buildings through measures for the thermal rehabilitation of buildings,
- ➢ Granting financial aid for low-income owners for the implementation of rehabilitation works;
- ➢ Increasing the efficiency of the existing thermal facilities;
- ➢ Increasing the efficiency of lighting systems, the use of low-power lamps;
- ➢ Establishing the compulsory requirement to enforce the provisions of the directive and of the European standards on efficiency for new buildings;
- ➢ Continuing the metering of heating for end consumers;
- ➢ Implementing a national energy education program for the population in schools and the media, on energy saving, environmental protection and the local use of renewable energy resources;
- ➢ Stimulating the operation of energy service companies (EMAS).

Measures on energy intensity reduction for the public sector:

- ➢ Increase the efficiency and reduce the public lighting consumption;
- ➢ Increase the efficiency and reduce the consumption of water supply facilities;
- ➢ Energy efficiency increasing in public buildings.

The ***Fourth National Action Plan for Energy Efficiency (NAPEE 2017 - 2020)***, approved by GD no. 203/2019, proposes significant measures to improve energy efficiency for final energy consumer, comparing with NAPEE III, through:

- Introduction of new economic sectors: Construction (with energy savings of 31,800 toe) and Agriculture (with energy savings of 49,000 toe);
- Increasing the projected savings for the several sectors: Residential (by approx. 19.5%) and Services (by approx. 15.8%).

According to NAPEE IV, the potential energy savings in this sector, in 2020, are the following:

- Residential sector: savings of 0.519 Mtoe, based mainly on new electrical equipment with superior performance (0.230 Mtoe) and thermal rehabilitation of buildings (0.262 Mtoe);
- Services sector: savings of 0.465 Mtoe, based mainly on the development of energy services / ESCO (0.250 Mtoe) and thermal rehabilitation of buildings (0.181 Mtoe);
- Agriculture sector: savings of 0.025 Mtoe, based on new equipment with superior performance for the irrigation system (0.080 Mtoe).

The 2021-2030 Integrated National Energy and Climate Plan involves implementation of the following measures in order to achieve the targets established at national level, with direct implication for this sector:

- *Energy efficiency dimension:*
  - ✓ Increasing the energy efficiency in Residential sector through implementation of Long-Term Renovation Strategy, which will contribute to the achievement of the RES-E and RES-H&C targets for 2030.

For ***2021-2030 period***, according to the 2021-2030 Integrated National Energy and Climate Plan and in accordance with the National Long-term Renovation Strategy (draft version), the Residential sector shall contribute together with industry and transport to the achievement of the energy efficiency target (cumulative value of energy savings of 10.12 Mtoe in the covered period), in approximately equal shares (each with a percentage of 29%), through renovating buildings in order to increase energy efficiency and use of energy from renewable sources (solar thermal panels, photovoltaic panels, heat pumps).

The financing sources that will be available for this sector through the Multiannual Financial Framework 2021 - 2027 are included in the ROP 2021 - 2027, which finances investments for:

- Promoting energy efficiency through investments in residential and public buildings and measures for the use of alternative energy sources;
- Improving energy efficiency in the field of district heating.

The IPPU Sector

It is essential for the drawing up of strategic documents on the development of the Romanian industry to also consider the need for a GHG emission analysis.

The reduction of emissions from Industrial Processes shall mainly be carried out through the enforcement of measures on increasing energy efficiency stipulated in the **NAPEE**, by optimizing technological flows and promoting green technologies.

Measures on the reduction of energy intensity identified by **NAPEE** for the industry sector include:

- Energy audits and efficient energy management;
- Improving energy efficiency by supporting financing from European union funds;

- Information campaigns;
- Long term volunteer agreements in various sectors of the processing industry.

The ***National CC/LCGG Strategy***, approved by GD no. 739/2016, establishes the following: strategic objectives for GHG emissions mitigation:

- Objective 1: Reducing the carbon intensity in industry;
- Objective 2: Assessing the best available techniques (BAT) from the perspective of GHG emissions;
- Objective 3: Exploring voluntary approaches, emissions trading, taxes.

The actions related to this sector included in the National Action Plan 2016 - 2020, approved by GD no. 739/2016, in order to meet the strategic objectives of National CC/LCGG Strategy for GHG emissions mitigation are the following:

- *Objective 1: Reducing the carbon intensity in industry,* estimated value ***EUR 0.35 million,*** for developing support schemes for SME financing to purchase low carbon technologies (installations for energy efficiency and use of renewable energy);
- *Objective 2: Assessing the best available techniques -BAT- from the perspective of GHG emissions,* estimated value ***EUR 0.6 million,*** for: knowledge improvement and transfer regarding the most cost-effective technologies; opening the debate on successful projects using the cost-effective technologies in various sectors;
- *Objective 3: Exploring voluntary approaches, emissions trading, taxes,* estimated value ***EUR 0.35 million,*** for identifying voluntary instruments for: reducing GHG emission level in industry; providing technical expertise and economic support for the new instruments, to stimulate the industry to reduce GHG emissions; analysis of Member States experience on voluntary agreements, emissions trading scheme and internal taxes applicable to industrial sectors.

According with the National Action Plan for implementation of the National CC/LCGG Strategy for period 2016 – 2020, the funding sources for achieving these objectives include state budget, professional associations' contributions and ETS funds.

Romania's Sustainable Development Strategy 2030*,* approved by GD no. 877/2018, within the *Objective 9 Industry, innovation and infrastructure* establishes the following national targets that directly influence the GHG emissions:

Horizon 2030:

- Rehabilitate the industrial sector in order to make it sustainable through a more efficient use of resources and increased adoption of clean and ecological industrial technologies and processes;
- Boost the scientific research and modernize the technological capacity of the industrial sectors;
- Promote inclusive and sustainable industrialization and increase the rate of employment.

By implementing adequate economic policy instruments between 2008 and 2030, the productivity of the used material and energy resources shall increase by a 3÷4% annual average rate, by

reducing the shares of the energy-intensive subsectors, through the upgrade of technologies and management development.

Considering that Europe requires a strong, competitive and innovative industry to be internationally competitive, based on excellence, clusters and cluster networks were promoted, as key factors of innovation and economic growth, through the development of a collaborative and multi-sectoral approach and through the stimulation of interactions between innovative participants.

Through public funds, the Romanian Government shall support the increase of competitiveness in industrial enterprises, the production of high added value products, the production of exported products, and respecting the environmental operating permits.

The industrial policy aims to implement the best technologies to increase energy efficiency and provide quality products for competitive prices, in accord with environmental permits. The result is that **industrial processes** require re-engineering operations and the use of new technologies for the efficient processing of raw material and energy resources, leading to the reduction of GHG emissions.

Regulation no. 517/2014 on fluorinated greenhouse gases (F-gases) which repeal Regulation No. 842/2006 are applying since 1 January 2015 and aim to reduce these emissions by two thirds in 2030 compared to 2015 levels.

Regulation lays down rules on the containment, use, recovery and destruction of F gases and prohibits the sale of certain products containing F-gases. Also, sets an annual limit on the overall climate impact of HFC which will be phased out between 2015 and 2030.

The Regulation establishes the following obligations:

- Prohibits the deliberate release of gases F if it is not technically necessary for the intended use of a product; manufacturers must strive to limit emissions during production, transport and storage of gas F;
- Operators of equipment containing F gases must take every precaution possible to prevent any leakage and must ensure that equipment's are regularly checked for leakage; requirements vary depending on the potential impact on the climate or how hermetically sealed are;
- National authorities are responsible for establishing training and certification programs for businesses and individuals involved in the installation, providing the service, maintenance, repair or decommissioning of equipment containing F gases, and recovery;
- From 2015 until 2025, are phased ban on the sale of new items, such as certain types of refrigerators and freezers, air conditioning systems, foams and aerosols containing F gases, where safer and less polluting alternatives exist;
- Annual limit for HCF quantities placed on the market in 2030 represent 21% of 2009-2012 levels; to ensure the compliance with the limits the Commission allocates producers and importers annual quotas which must not be exceeded;
- Manufacturers, importers, exporters, users and businesses that destroy F gases must report annually to the Commission; importers of equipment containing F gases must do

the same and, from 2017 must present evidence on accounting of the quantities of HFCs contained in imported equipment.

Directive 40/2006/EC (MAC Directive) on emissions from air conditioning systems of the motor vehicles provides the gradual replacement of air-conditioning systems using HFC-134a. It also limits the possibility of retrofitting motor vehicles with air conditioning systems designed to contain fluorinated greenhouse gases with a global warming potential higher than 150 and prohibit the charging of the air conditioning systems with such gases.

Automotive manufacturers must provide the competent authority all relevant technical information regarding the installed air conditioning systems and the gases used in the respective systems. If air conditioning systems designed to contain fluorinated greenhouse gases with a global warming potential higher than 150, the manufacturer must make available the leakage rate of these systems. The measures provided for in this Directive are expected to take effect from 2011.

Romania has adopted the Montreal Protocol Amendment on substances that deplete the ozone layer (Kigali Amendment, 2016) by Law no. 30/2020 published in the Official Gazette. no. 275/2 Apr. 2020. The Kigali Amendment sets emission limits for substances in category F (HFCs and HCFCs) by 2045.

Agriculture

The ***National CC/LCGG Strategy***, approved by GD no. 739/2016, establishes the following: strategic objectives for GHG emissions mitigation:

- Objective 1: Promoting climate change knowledge transfer and advisory services among farmers;
- Objective 2: Investment support for farm modernization;
- Objective 3: Promoting best practices in agriculture;
- Objective 4: Promoting carbon sequestration in agriculture.

The actions related to this sector included in the National Action Plan 2016 - 2020, approved by GD no. 739/2016, in order to meet the strategic objectives of National CC/LCGG Strategy for GHG emissions mitigation are the following:

- *Objective 1: Promoting climate change knowledge transfer and advisory service among farmers,* estimated value ***EUR 93.7 million,*** for: knowledge transfer and information actions; advisory services, farm management and farm relief services;
- *Objective 2: Investment support for farm modernization,* estimated value ***EUR 2,206.5 million,*** for: investments in physical assets (manure management, manure treatment, investment in livestock management to reduce GHG emissions); investment in the creation and development of non-agricultural activities;
- *Objective 3: Promoting best practices in agriculture,* estimated value ***EUR 2,643.8 million,*** for: payments for agro-environmental and climate commitments; organic farming; support for converting to organic farming methods and for maintaining organic farming practices; payments to areas facing natural constrains or other specific constrains;

- *Objective: Promoting carbon sequestration in agriculture,* estimated value ***EUR 146 million,*** for payments for agro-environmental and climate commitments in order to improve the soil and/or to prevent land erosion.

According with the National Action Plan for implementation of the National CC/LCGG Strategy for period 2016 – 2020, the funding sources for achieving these objectives include beside state budget the need to access EU funds promoted by the NRDP 2014 – 2020.

Romania's Sustainable Development Strategy 2030*,* approved by GD no. 877/2018, within the *Objective 2 Zero hunger* establishes the following national targets that directly influence the GHG emissions:

Horizon 2020:

- Continue to implement the National Programme for the Rehabilitation of the Main Irrigation Infrastructure in Romania;
- Support the production and diversification of indigenous species with a high genetic merit but lacking on the domestic market in the fields of vegetable farming, high-value species of swine, bull and buffalo, the poultry sector, the collection and commercialization of wool, beekeeping, and fishing and aquaculture, including through the stimulation of research and development in the agri-food sector;
- Increase the amount of certified ecological agricultural land;
- Promote good agricultural practices in order to prevent and combat soil pollution;

Horizon 2030:

- Double the share of agriculture in Romania's GDP, relative to 2018;
- Increase the share of ecological agriculture in total agricultural production.

The National Rural Development Program 2014 ÷ 2020 is designed to support Romania's rural development between 2014 and 2020, by strategically approaching the following objectives:

1. Increasing the feasibility, upgrade and restructuring of agricultural holdings, particularly of small and medium-sized holdings, rejuvenating the population of farmers, developing the processing sector, and consolidating the market position of agricultural producers;
2. Sustainable management of natural resources and actions against climate change;
3. Diversifying economic activities, creating jobs, improving the infrastructure and services to improve life quality in rural areas.

Such priorities are correlated with the nationally defined strategic objectives, with the **Common Agricultural Policy** and with the **Europe 2020 Policy**.

EU Regulation no. 1305/2013 establishes six rural development priorities:

- Encouraging the knowledge transfer and innovation in agriculture and forestry and in rural areas;
- Increasing the holdings feasibility and the competitiveness of all types of agriculture in all regions and promoting innovative agricultural technologies and the sustainable management of forests;

- Promoting the organization of the food chain, including the processing and trading of agricultural products, of animal welfare and the management of agricultural risks;
- The restoration, conservation and consolidation of ecosystems related to agriculture and forestry;
- Promoting the efficient use of resources and supporting the transition to a low carbon emission economy, that is resistant to climate changes in the agricultural, food and forestry sectors;
- Promoting social inclusion, the poverty reduction and economic development in rural areas.

The ***Strategy on the medium and long term organization of the pasture improvement and operation at the national level*** by the joint Order no. 226/2003 of the Ministry of Agriculture, Food and Forests and the Ministry of Public Administration has the main goal of increasing the total production of green mass and the quality thereof, while increasing the economic efficiency of livestock farms, particularly of cow and sheep flocks.

The specific objectives of this strategy are:

- Increasing the green mass quantity and hay production on the entire area of pastures and grasslands;
- Increasing the nutritional value of the herbaceous carpet, providing balanced and efficient food for various animal's categories included in the cow and sheep species, to obtain non-pollutant zoo-technical products and adequate animal health state;
- Carrying out the entire annual demand of legume and perennial grass seeds, specific to the pasture surfaces improvement;
- Developing scientific research actions concerning the production of new plant varieties specific to pastures, carrying out regeneration, fertilization and maintenance works, fighting erosion and excess humidity, pasture irrigation works, as well as the efficient use of the green mass and grassland production;
- Implementing the production technologies specific to natural areas, while also benefitting from the same financing and credit conditions applied to plant sector crops.

Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources was transposed in the Romanian legislation by GD no. 964/2000 approving the Action plan concerning the protection of waters against pollution caused by nitrates from agricultural sources. GD no. 964/2000 stipulates that Romania shall re-examine, revise or supplement, at least every 4 years, the list of areas vulnerable to nitrates, appointed to consider the changes and factors occurring from the previous appointment. Therefore, the joint Order 1552/2008 of the Ministry of Environment and Sustainable Development and of the Ministry of Agriculture and Rural Development approves the list of localities per counties, where sources of nitrates from agricultural activities have been identified. Following the approved list, the Inter-ministry Commission on the enforcement of the Action Plan on concerning the protection of waters against pollution caused by nitrates from agricultural sources approved the Action program for areas vulnerable to nitrates by Decision 21130/DC/14.10.2010. According to this program, the provisions of the Code of good agricultural practices concerning the protection of waters against

pollution caused by nitrates from agricultural sources approved by the joint Order 1182/1270/2005 of the Ministry of Environment and Sustainable Development and of the Ministry of Agriculture and Rural Development are compulsory in areas declared to be vulnerable to nitrate pollution. The nutrient management plan is carried out under the guidance of the Soil and Agrochemical Study Offices, based on the nutrient framework management plan drawn up and provided by the Ministry of Agriculture and Rural Development.

The Action plan implementation control for areas vulnerable to nitrates from agricultural sources shall consider the following indicators:

- Monitoring the nitrate content of underground and surface waters in the points established by the National Administration "Romanian Waters" and the nitrate content found in soil, in the points established by the National Institute of Research & Development for Soil, Agrochemistry and Environmental Protection;
- The manure storage capacity on individual or collective platforms;
- Observing the manure land application period;
- The animal load per hector, and the technical pasture planning measures and actions are observed on communal pastures;
- Observing the protective strips bordering the surface waters or the drinking water catchments, according to the Action program indicators.

It should be noted that Romania has a ***National system on integrated soil management, surveillance, control and decisions*** to reduce the share of pollutants resulting from agricultural sources and the management of organic waste resulting from zootechnics, in nitrate pollution vulnerable and potentially vulnerable areas, within the structures of the Integrated national system on the monitoring of water resources and protected areas, managed by the National Research & Development Institute for Soil, Agrochemistry and Environmental Protection.

Romania receives funds under the **European Economic Recovery Plan** (EERP) to comply with the priorities established by the **Health Check of the Common Agricultural Policy** (CAP). Such funds shall be used to implement certain measures initiated in the Strategic National Plan, respectively:

- Improving the efficiency of using nitrogen-based fertilizers, as well as of storing fertilizers to reduce CH4 and N2O emissions and to contribute to the decrease of climate changes;
- Stimulating/encouraging the equipment use to treat waste waters in agricultural holdings.

Land Use, Land-Use Change and Forestry

The LULUCF sector makes a significant contribution to meeting the EU's efforts to reduce global GHG emissions by at least 40% by 2030, compared to 1990 levels.

In accordance with the provisions of *Regulation (EU) 2018/841 of the European parliament and of the council on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework*, for EU Member States have established commitments that contribute to meeting the objectives of the Paris Agreement and achieving the EU's GHG reduction target for 2021-2030.

The Regulation introduces an updated system of rules for accounting for emissions and removals from the LULUCF sector and for verifying Member States' compliance with these commitments, as well as flexibility mechanisms for the transfer of emissions and accounting discharges with the Effort Sharing Regulation.

The ***National CC/LCGG Strategy***, approved by GD no. 739/2016, establishes the following strategic objectives for the reduction of GHG emissions related to the LULUCF sector:

- *Objective 1: Managing existing forests to sequester carbon in the context of sustainable forest management;*
- *Objective 2: Expansion of afforested areas;*
- *Objective 3: Promoting the sustainable management of private forest ownership;*
- *Objective 4: Opportunities for carbon stock management in forests in protected areas.*

Political actions and investments proposed by National Action Plan for implementation of the *National CC/LCGG Strategy* for period 2016-2020, approved by GD no. 739/2016, in order to meet the strategic objectives of the National CC/LCGG Strategy for reducing GHG emissions related to this sector are the following:

- *Objective 1: Managing existing forests to sequester carbon in the context of sustainable forest management:*
  - ✓ Adoption of the Development Strategy of forest sector, including the measures for GES emission reduction and adapting the forest sector to the climate changes, taking into consideration the economic aspects of the sector;
  - ✓ Updating the forestry technical norms regarding the forest management and applying forest systems, in order to effect and operationalize the management of estate and privately owned forests, by taking into consideration the new knowledge regarding the conservation and increment of carbon stock in the ecosystem deposits;
  - ✓ Promoting the production and utilization of wood products with long-time use and wood products with substitution capacity of some materials traditionally used;
  - ✓ Consolidating the national system of estimation and prediction GES regarding the sector of land use and forestry by ensuring the continuity of National Forest Inventory;
  - ✓ Strengthen the capacity of central-level authority of forestry, as well as administrative-territorial unity-level, for implementing the forestry regime in order to monitor the forest degradation phenomenon due to anthropogenic and natural causes, and to monitor the regeneration/ecological reconstruction following perturbations;
  - ✓ Improvement of the forest accessibility through rehabilitation and new forest road construction with the aim to apply suitable management measures, wood harvesting and forest stand regeneration according to the forest planning, as well as making better use of non-forest products of forests;
  - ✓ Promote carbon sequestration and conservation in forests, both estate- and privately-owned;
  - ✓ Diminish the emissions from forest fires;
  - ✓ Promoting and investing in new technologies usable in forestry administration, wood harvesting and processing for enforcing a sustainable management.
- *Objective 2: Expansion of afforested areas:*

- ✓ Updating the Afforestation National Programme and the National System of Forest Shelterbelts to correspond to land availability and financial sources, and to highlight the role of greenhouse gas emission reduction due to afforestation activities;
- ✓ Finalizing the identification and operationalizing the national database of the lands to be forested: degraded lands, degraded agricultural lands, agricultural lands and prioritizing their afforestation in relation to initial size of carbon deposits associated with the land use and risk zoning;
- ✓ Promoting system of existent measures for afforestation of degraded lands and establishment of forest shelterbelts, built around the attribution of programme implementation of central authority and forest guards;
- ✓ Establishing a system for promoting and stimulating the establishment of energy plantations and short – rotation forestry for wood biomass and use making of residual biomass from forest harvesting;
- ✓ Afforestation of degraded and agricultural lands;
- ✓ Establishing forest shelterbelts, including the associated "greening" measures – Pylon 1 of Commune Agriculture Policy of the European Union, CAP;
- ✓ Investments in establishing and maintaining the plantations and in machinery for wood biomass harvesting and processing.

➢ *Objective 3: Promoting the sustainable management of private forest ownership;*

- ✓ Simplifying the regulations and technical norms for observing the requirements concerning the sustainable management of small-size privately- owned properties.
- ✓ Strengthening the central authority in charge of forestry in order to improve the assistance for small-size forest property owners for sustainable utilization of forest resources, also in case of natural perturbation;

➢ *Objective 4: Opportunities for carbon stock management in forests in protected areas:*

- ✓ Improving the capacity of the central and local environmental authority in order to assess the quality of the process of elaboration and implementation of management plans of protected areas, including administering the situations caused by natural and anthropogenic perturbations;
- ✓ Analyzing the possibility of developing a compensation system for restrictions imposed by the requirements of the Nature 2000 for ensuring the sustainable management of forests within the protected natural areas due to the management change.

The strategic goals for adapting the forestry sector to the climate changes and the goal specific actions are as follows:

➢ *Objective 1: Improving the forest management for enhancing their adaptive capacity to climate changes,* by:

- ✓ Updating the technical norms based on robust research regarding the forest management, in order to promote an efficient and effective management, able to support the adaptation process to the effects of climate changes*;*
- ✓ Improving the economic knowledge and market functionality for the operators in forestry and wood product chain in order to anticipate and ensure the resilience of the economy of the forestry sector at the local- and regional level;

- ✓ Analyzing the scenarios regarding the effect of the climate changes on forest and the needs to adapt the forest operations to the new climate conditions;

➢ *Objective 2: Adapting the forest regeneration practices to the necessities imposed by the climate changes,* by:

- ✓ Updating the technical norms regarding the forest regeneration in order to integrate the newest scientific discoveries in the domain of species distribution, and of the opportunity to use them in the context of climate changes;
- ✓ Simulating the future distribution of species in the context of climate changes and prioritizing the areas in which changes in forest composition may take place for the adaptation to climate changes;
- ✓ Ongoing research in genetic resources and the implications of climate change on forest genetic resources;
- ✓ Revising the network of genetic resources for forest species;

➢ *Objective 3: Minimizing the risk of climate changes for forest and by means of forests,* by:

- ✓ Maintaining and improving the monitoring system and controlling the forest-based biotic and non-biotic harmful agents, forest fires, forest decline, windfalls, and evolution of invasive wood species in the forests;
- ✓ Further research for a better comprehension of the effects produced by the climate changes on forests and for identification of scientifically grounded solutions for practical actions against harmful forest agents, of forest drying phenomena and evolution of invasive species;
- ✓ Strengthening signaling systems and fast reaction in case of forest fires;
- ✓ Continuous research for comprehending the impact of climate changes effects on forests in order to mitigate the effects of landslides, drought, as well as supporting the management process of water resources;
- ✓ Action taking, especially through favorable solutions from the viewpoint of environment protection, for torrents management in the forested watersheds, in order to moderate the risks caused by extreme phenomena: e.g. torrential rains, floods.

The main actors involved in implementing the strategy are as follows: the central public authority responsible for forestry and the Ministry of Agriculture. The amounts provided for the implementation of the effective measures derive from specific sources: synergy with measures in the National Programme for Rural Development; Administration Fund for Environment (including the income from trading the emission reductions in the framework EU ETS); The fund for improving the land fund destined to forestry; Fund for forest conservation and reforestation; funds for forest accessibility. These should be supplemented by co-financing with necessary amounts from the local budgets or from private sources.

Romania's national strategy for sustainable development 2030, approved by GD no. 877/2018, within *Objective 15 Terrestrial life. Protecting, restoring and promoting the sustainable use of terrestrial ecosystems, sustainable forest management, combating desertification, stop and repair halting land degradation and biodiversity loss*, sets the following national targets that directly influence GHG emissions associated with this sector:

Horizon 2020:

- Ensuring the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and arid lands, in accordance with the obligations set out in international agreements;
- Attracting and involving local communities and non-governmental organizations in actions to conserve sensitive habitats and biodiversity; compensation for the loss of income of the owners of forests or agricultural lands located in the protected natural areas;

Horizon 2030:

- Development of green infrastructure and the use of services provided by natural ecosystems through integrated management of river basins and wetlands;
- Ensuring the conservation of mountain ecosystems, including their biodiversity, in order to increase their capacity to provide essential benefits for sustainable development;
- Sustainable forest management, elimination of illegal logging, development of integrated computer system for monitoring the exploitation and transport of timber, including at border points, ensuring afforestation and reforestation of forest lands and those degraded or subject to desertification, development of scheduled planting forest curtains for the protection of crops and infrastructure in order to limit the impact of climate change;
- Combating desertification, restoring degraded lands and soils, including lands affected by desertification, drought and floods.

The National Forestry Strategy 2018-2027 has as main objective the harmonization of forest functions with the present and future requirements of the Romanian society through the sustainable management of the national forest resources.

The strategic objectives of the Strategy are the following:

- *The efficiency of the institutional framework and regulation of necessary activity in the forestry field;*
- *Sustainable management of the National Forest Fund (NFF);*
- *Increasing the competitiveness and sustainability of the forest industries, bioenergy and bio economy as a whole;*
- *Developing an efficient system of public awareness and communication;*
- *Development of scientific research and forestry education.*

The most important measures derived from the objectives on the sustainable management of the National Forest Fund are the following:

- *Extension of the surface of forests and other lands with forest vegetation:*
  - ✓ Identification of forest vegetation that fulfills the conditions of classification as a forest and its inclusion in the National Forest Fund (NFF), through the creation of mechanisms of co-interest of the owners;
  - ✓ Identification and afforestation of lands unfit for agricultural uses;
  - ✓ Implementation of the national system of forest protection belts;
  - ✓ Assuring the availability of forest reproductive material;
  - ✓ Supporting measures for degraded land afforestation and for the creation of forest belts;

- *Harmonizing the national system of indicators for the sustainable management of forests with the European system*
  - ✓ Permanent update of indicators for the sustainable management of forests in European and national context;
  - ✓ Implementing and correlating the national forestry program with the sustainable forest management indicators;
- *Conservation and improvement of forest ecosystems biodiversity:*
  - ✓ Identification and conservation of virgin and quasi-virgin forests, riparian forests, forest habitats and rare, threatened, endangered species;
  - ✓ Protecting the biological diversity of forest ecosystems, forests with natural and quasi-natural structures;
  - ✓ Conservation of marginal habitats, wetlands occupied by forest vegetation, and of protected and vulnerable species;
  - ✓ Building a compensation system for the restrictions imposed by the requirements of the Natura 2000 network in order to ensure the sustainable management of forests within the protected natural areas;
- *Continuous adaptation of forests to climate change:*
  - ✓ Adapting forest regeneration practices to the needs imposed by climate change;
  - ✓ continuous adaptation of the forest management system in order to improve their capacity to adapt to climate change;
  - ✓ Maintaining and improving the system for monitoring and surveilling the action of destabilizing biotic and abiotic factors;
  - ✓ Promoting natural regeneration by applying the appropriate intensive and semi-intensive treatments;
  - ✓ Promote diversified compositions, focusing on the conservation and restoration of the genetic biodiversity of forest species with ecological requirements compatible with the local environmental conditions;
  - ✓ Restoration of destroyed forests as a result of the effects of climate change;
  - ✓ Selecting and promoting biotypes of trees resistant / adapted to climate change and extending their use in forest regeneration systems;
- *Development of the National Forest Fund management system:*
  - ✓ Increasing the forest fund by raising proportion of national forest covered in management plans;
  - ✓ Supporting certification systems compatible with management practices adopted at national level;
  - ✓ Continuous monitoring of forest management plans implementations;
- *Evaluation and monitoring, forest functions, ecosystem services provided by forest and forest resources*:
  - ✓ Implementation the national forest inventory;
  - ✓ Building / improvement of the methodological system regarding the quantification of the forest functional services and the ecosystem services; designing a payment system for ecosystem services;

- ✓ Increasing the capacity of carbon storage forests in the context of sustainable forest management; creating the framework for capitalizing on carbon stocks;

➢ *Extension in the integrated system of the torrential hydrographic basins:*

- ✓ Creating a singular and integrated system for the management of torrential hydrographic basins to reduce the effects of extreme natural events;
- ✓ Continuous monitoring of the watershed correction process state from the National Forest Fund;

➢ *Increasing the degree of accessibility of the National Forest Fund:*

- ✓ Increasing the density of forest transport routes;
- ✓ Accessibility of stands;
- ✓ Rehabilitation / safeguarding of forest transport routes affected by natural disasters;
- ✓ Adaptation of the forest road network to the current technical characteristics of the means of forest transport;
- ✓ Promoting the construction of forest roads on hillslopes;

➢ *Development an integrated information system for forestry:*

- ✓ Achieving the interoperability of the forestry information system;
- ✓ Optimization of the SUMAL subsystem for wood traceability. Interconnection with users' computer systems;
- ✓ Improving the subsystem's statistical indicators for forestry;

➢ *Extension of wood harvesting technologies which are performant in terms of technical, ecological and economic rates;*

- ✓ Stimulating the acquisition and use of efficient wood harvesting technologies with low environmental impact;
- ✓ Limiting the use of aggressive technologies towards the environment;

➢ *Increasing the contribution of the forestry sector to rural development:*

- ✓ Prioritize the use of forest goods and services for the benefit of local communities;
- ✓ Involving local communities in decision-making processes for forest management and protection.

These measures will have as effect an increase of the area occupied by forests and forest vegetation in Romania; building the national system of forest protection belts; maintaining and improving the forest ecosystems biodiversity; decrease the share of illegal cuts by the existence of a national, functional, harmonized system with the European system to monitor the origin and the traceability of the wood material; stimulating the use of efficient and low impact wood harvesting technologies.

The National Rural Development Program (NRDP) 2014-2020 is the EU's non-reimbursable financial instrument for supporting rural development and unlocking the economy and rural life, which contributes to the implementation of rural development priorities in order to meet national strategic objectives and Common Agricultural Policy objectives.

A large number of measures and sub-measures contained in the NRDP have an implicit potential to support LULUCF actions to reduce GHG emissions and adapt to the effects of climate change. Specific support measures range from better management of soil and land resources to promoting

renewable energy production and use, from avoiding land abandonment and addressing emissions from the application of nitrogen fertilizers to "green" measures".
The environmental and climate measures of PNDR 2014-2020, both in the case of permanent natural and semi-natural grassland and in the case of traditional orchards used extensively or cropland, promote the practice of agriculture which involves avoiding or limiting the use of heavy machinery and avoiding chemicalization. The application of the traditional agricultural techniques used (which are basically reduced to non-intensive grazing and the establishment of data and methods of mowing). The maintenance of priority habitats and important species, the traditional cultural background, as well as the rational use of natural resources, are favored. Efforts to date to achieve ambitious environmental protection targets are further supported by the NRDP 2014-2020, with the allocation of environmental and climate measures in the current programming period exceeding 30% of total EAFRD allocations.

In order to achieve the objectives, the essential contribution represents the public expenditures in the European Fund for Agriculture and Rural Development (EFARD) set by regulation in the National Programme for Rural Development (NPRD 2013-2020) addressed by the “Measure M04 – Investment in physical actives, Sub measure 4.3 – Investment Aid in infrastructure in connection with the development, modernizing and adjustment of agricultural and forestry sector”, and “Measure M08 – Investments in the development of the forested areas and in improving the viability of forests, Sub-measure 8.1 – Aid for afforestation/establishment of forested areas” from the NPRD.

Joint Order MADR / MMAP / ANSVSA no. 352/636/54/2015, as subsequently amended, establishes a set of rules that all beneficiaries are required to comply with on all agricultural parcels on the holding, including those for which they do not request support and those which are not used for production purposes. The cross-compliance norms concern a series of standards constituted by the Good Agricultural and Environmental Conditions (GAEC) and the Statutory Management Requirements (SMR), grouped by areas:

- *Soil and carbon stock:*
  - ✓ Minimum soil cover;
  - ✓ Minimal land management that reflects the specific local conditions for limiting erosion;
  - ✓ Maintaining the level of organic matter in the soil, including the prohibition of burning arable fields.
- *Landscape, minimum maintenance level:*
  - ✓ Preservation of landscape elements, including isolated trees and existing terraces on cropland; taking appropriate measures to prevent unwanted vegetation and to ensure a minimum level of maintenance of cropland.

Regulation (EU) no. 1305/2013 of the European Parliament and of the Council of 17 December 2013 regarding the support for rural development granted by the European Agricultural Fund for rural development (EAFRD) and repealing Regulation (EC) no. 1698/2005 of the Council, imposes mitigation actions that must aim both at limiting the emissions from agriculture and forestry, generated by key activities such as growing animals and fertilizer

use, as well as the conservation of carbon absorbents and the intensification of carbon capture activity regarding land use, land-use change and forestry.
Measures According to Regulation (EU) no. 1305/2013 of the European Parliament and of the Council of 17 December 2013 are included in *Package 1 - high natural value grasslands and Package 2 - traditional agricultural practices.*
Using the criteria proposed by the European Forum for Nature Conservation and Pastoralism (http://www.efncp.org/policy/indicators-highnature-value-farming) they could be classified in this category: natural and semi-natural grasslands, especially those in the mountain and hilly areas, the extensive traditional orchards in which the fund of the old grasslands is almost entirely preserved, making them one of the most valuable and best preserved conventional habitats in the Carpathian, Transylvania and peri- Carpathian areas. In addition, these traditional orchards conserve, in most cases, old native varieties of fruit trees, which constitutes an endangered ancestral cultural species, which must be preserved, extensively used permanent grasslands, which are generally associated with a great floristic diversity in Romania, which ensures by default the great wildlife diversity (birds, insects, small and large animals).
In the previous designation (NRDP 2007-2013), the eligible area of grasslands located in the 1,038 *administrative-territorial units* framed in the High Natural Value (HNV) areas, was approx. *Two thousand one hundred sixty-nine million hectares*, while in the designation applied for NRDP 2014-2020 the resulting area of croplands used as permanent grasslands defined as areas of high natural value (HNV) is approx*. 2 million ha* (according to LPIS 2013 - APIA), is located on the territory of 958 administrative-territorial units.
National support programme for vineyards and wine producers for 2019 - 2023, National support program for the wine sector 2019 - 2023, generates an indirect benefit by increasing the area of vineyards or at least preserving the current area of vineyards by supporting the promotion of Romanian wines on third country markets.

Through the National Support Programme in the Wine Sector 2019-2023, Romania aims to restructure, annually, an area of vines of approx. 1000 - 1800 ha, which would represent an annual percentage of 0.5 - 1% of the total wine area.

GD no. 34/2013 on the organization, administration and use of permanent grassland focuses on improving the management of grassland and preserving their total area occupied by grasslands in Romania on January 1, 2007 (although without land conversion restrictions). By GD no.34/2013 it is established annual centralization obligation surfaces of permanent grassland category of use, allocation of specific tasks to various local and county institutions.

Waste Sector

Waste Management

Based on the continuous decrease and degradation of natural resources, as well as on the need to conserve them (mainly biological resources), the re-assessment of the anthropogenic origin waste management options is required, concerning the increase of the recovery level thereof and the drastic reduction of the quantities requiring disposal.

Judicious waste management is a mean to identify, totalize and assess eco -systemic services, to adopt the best decisions on environmental preservation, conservation and management, and, therefore, a means of GHG emission reduction.

The ***National CC/LCGG Strategy***, approved by GD no. 739/2016, establishes the following: strategic objectives for GHG emissions mitigation:

- Objective 1: Promote waste prevention;
- Objective 2: Increase the reuse or recycling of the materials included in the waste stream, reducing the amount of material that must be managed as waste by promotion of industrial synergy processes and application of the resource-efficient sustainable management of waste concept;
- Objective 3: Separate collection and composting of biodegradable waste;
- Objective 4: Produce energy from waste;

The actions related to this sector included in the National Action Plan 2016 - 2020, approved by GD no. 739/2016, in order to meet the strategic objectives of National CC/LCGG Strategy for GHG emissions mitigation are the following:

- *Objective 1: Promote waste prevention,* estimated value ***EUR 79.56 million,*** for: integrated programs for strengthening and expanding integrated waste management systems, respecting the waste hierarchy (prevention, preparation for reuse, recycling, other recovery methods, including treatment and disposal); closure and rehabilitation of non-compliant landfills and opening/extension of new compliant landfills;
- *Objective 2: Increase the reuse or recycling of the materials included in the waste stream, reducing the amount of material that must be managed as waste by promotion of industrial synergy processes and application of the resource–efficient sustainable management of waste concept,* estimated value ***EUR 18.9 million****,* for: implementation of Separate collection systems; solid waste management upgrades in towns/regions (including composting facilities, anaerobic digestion facilities and recycling programs); studies on tariff levels to assess the support schemes (“polluter pays principle”);
- *Objective 3: Separate collection and composting of biodegradable waste,* estimated value ***EUR 67.8 million****,* for construction of transfer and recovery/treatment installations (including composting platforms and individual composting units and mechanical biological treatment, MBT plants);
- *Objective 4: Produce energy from waste,* estimated value ***EUR 0.5 million,*** for research on processes, costs, standards, international experience on producing energy via solid wastes combustion.

According with the National Action Plan for implementation of the National CC/LCGG Strategy for period 2016 – 2020, the funding sources for achieving these objectives include beside state budget the need to access EU funds promoted by LIOP 2014 - 2020, *AP3 Development of environmental infrastructure based on an efficient management of resources, Specific Objective 3.1 Reducing the number of non-compliant landfills and increasing the quantity of waste prepared for recycling.* The foreseen results by promoting the investments within this priority axis are the following:

- Closure of non-compliance landfills in line with the commitments assumed through Accession Treaty of Romania to the European Union;
- Reduce the amount of biodegradable waste: by additional capacity for waste recycling (sorting/MBT/composting stations) with capacity of 940,000 tons/year (693,000 tons/year for MBT and composting and 247 tons/year for sorting) and additional capacities for waste recovery of 340,000 tons/ year there is expected to reduce the amount of biodegradable waste (from 3.0 Mil. tons/ year in 2011 to 1.68 Mil. tons/year in 2023);
- Recycling and recovery of packaging waste: from 2013 the overall recycling target is 55%, the recovery/incineration target in waste incineration plants with energy recovery is 60 %;
- Reuse and recycling of municipal waste: the recycling rate for household and similar waste is foreseen to increase (from 7.3 % of the waste collected in 2011 to 50 % of waste collected in 2023).

Romania's Sustainable Development Strategy 2030*,* approved by GD no. 877/2018, within the *Objective 12 Responsible consumption and production* establishes the following national targets that directly influence the GHG emissions for this sector:

Horizon 2020:

- Transition from the current economic model based on production and consumption to a circular economy by changing mentalities through education, changing consumer behavior and developing financial mechanisms to facilitate the transition period;
- Reduce food waste throughout the entire production, transport, processing, sale and consumption chain, from harvesting on the farm to the final disposal of waste;
- Improve the level of preparedness of society for reuse and recycling in keeping with the waste hierarchy;

Horizon 2030:

- Halve per capita food waste at the level of retail and consumption and reduce food waste throughout the production and supply chain, including post-harvest losses;
- Recycle 55% of municipal waste by 2025 and 60% by 2030;
- Recycle 65% of packaging waste by 2025 (plastic materials 50%, wood 25%, ferrous metals 70%, aluminum 50%, glass 70%, paper and cardboard 75%) and 70% by 2030 (plastic materials 55%, wood 30%, ferrous metals 80%, aluminum 60%, glass 75%, paper and cardboard 85%);
- Implement the separate collection of household hazardous waste by 2022, of biological waste by 2023 and of textile waste by 2025;
- Establish extended producer responsibility schemes for all types of packaging by 2024.

The ***National Strategy on Waste Management*** (SNGD), approved by GD no. 870/2013, occurred from the need to identify the action objectives and policies that Romania shall follow in the waste management area, to reach the recycling company status.

The SNGD establishes the strategic policy and objectives of Romania in the short (2015) and medium term (2020) waste management area. The National plan on waste management (PNGD) is drawn up for the short-term implementation of the strategy, containing details on the actions to be taken to meet the strategy objectives, the performance of such actions, including targets, terms and responsibilities for implementation.

The SNGD scope is to establish the strategic direction for the prevention of waste generation and management, by 2020, by:

- Setting the efforts top priority in the waste management area, based on the waste hierarchy;
- Encouraging waste generation prevention and reuse, to increase resource efficiency;
- Developing and expanding the separate waste collection systems to promote high quality recycling;
- Developing/implementing recycling technologies/facilities and/or recovery with a high efficiency in the extraction and use of waste raw material;
- Supporting waste-to-energy recovery, as applicable, for waste that cannot be recycled;
- Reducing the quantities of waste disposed through storage.

A set of 8 strategic objectives was drawn up to meet the SNGD scope:

- Improving environmental quality and the protection of the population's health through the integrated approach of waste management environmental issues;
- Supporting research/development activities on waste management by identifying the areas of intervention and attracting financing sources for waste sector research/management activities;
- Encouraging green investments through the development of green investment project support mechanisms;
- Increasing the efficiency of using resources to promote eco-innovation and apply the extended responsibility of producers;
- Sustainable waste management by:
  - ✓ Applying the waste hierarchy, according to the order of priorities (encouraging actions on the prevention of efficient waste generation and management, by preparing for reuse, recycling, recovery, and, as a last option - disposal);
  - ✓ Approaching the life cycle analysis;
  - ✓ Diversifying the use of economic tools;
  - ✓ Consolidating the surveillance and control system through regulations;
  - ✓ Developing the waste management infrastructure.
- Correlating the waste management policy provisions with those on climate changes, by integrating issues on climate change in the waste management plans and supporting investments reducing the carbon footprint;

- Developing responsible behavior on waste generation prevention and management through the promotion of community awareness/information campaigns and the involvement of civil society;
- Strengthening institutional capacity.

The enforcement of Directive 2008/98/EC sets ambitious objectives for Romania: the recycling of 50 % household waste and of 70 % construction and demolition till 2020. Romania shall adopt measures on the development of waste treatment facilities, simultaneous with the enforcement of a policy encouraging separate waste collection and recycling in the country, in observance of the proximity principle.

According to the National Waste Management Strategy, at least 15% of the total amount of municipal waste shall be recovered for energy.

The national strategy on sludge management in Romania

The general objective of the strategy is the long-term improvement of environmental quality factors by minimizing the negative effects of inadequate sludge management.

The scope of the strategy and of the action plan is to provide a framework for the planning and implementation of the sludge management systems and practices in an economically and environmentally efficient way.

The specific objectives of the national strategy can be defined as:

- Improving the national legal and institutional system and the reporting system;
- Minimizing the treatment sludge production by preventing excessive waste and prohibited substance discharges in the sewage system, e.g. by improving control on industrial discharges in the sewage system;
- Improving the treatment of waste waters and sludges to improve sludge quality, so that it becomes adequate for use or for beneficial disposal;
- Providing guidance for sludge producers (water and waste water operators) in the development of sludge usage/recovery or beneficial disposal paths;
- Providing guidance on the improvement of the generated sludge quality analysis and monitoring capacity;
- Improving public and institutional information on the acceptable uses/methods of recovery of treatment sludge;
- Guidance on the monitoring of sludge-receiving agricultural lands and potential constraints on the sludge use/beneficial recovery options.

The ***National Waste Management Plan,*** approved by GD no. 942/2017 (in force since 05 January 2018), includes clear and coherent measures to achieve the objectives of preparation for reuse and recycling of waste by 2020, in accordance with Article 11 (2) of Directive 2008/98 / EC; the measures considered are mainly based on the existence and use of key economic instruments such as:

- Adequate storage rates (and / or prohibitions on the storage of recyclable waste);
- Incineration pricing policy able to favor recycling / reuse;

- Other economic instruments identified during the elaboration of the plan, in accordance with the specific national situation;
- Additional capacities for collection, treatment, recycling, if applicable;
- In 2020 - gradual increase of the readiness degree for reuse and recycling of municipal waste - target of 50% of the total amount of recyclable waste generated, calculated by Method 2 of Annex I of Decision 2011/753 / EU, ensuring compliance current legal provisions;
- In 2025 - gradual increase of the readiness degree for reuse and recycling of municipal waste - target in 2025 - 50% calculated by Method 4 of Annex I of Decision 2011/753 / EU, correlated with the provisions of the proposed amendment to the Directive framework of the Circular Economy Package, published in December 2015.

The introduction of the contribution for the circular economy (80 lei / ton) will influence the stored and recycled quantities.

The ***Circular Economy package***, adopted by the European Commission in December 2015, aims to stimulate the transition to a circular economy at European level. The package includes legislative proposals on waste, as well as a related action plan. Waste proposals set long-term goals to reduce waste disposal and increase recycling and reuse.

The adoption of the circular economy package entails the revision of the following Directives:

- Directive 2008/98 / EC on waste and repealing certain Directives;
- Directive 2006/66 / EC on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157 / EEC;
- Directive 2011/65 / EC on restrictions on the use of certain hazardous substances in electrical and electronic equipment;
- Directive 2012/19 / EU on waste electrical and electronic equipment;
- Directive 2000/53 / EC on end-of-life vehicles;
- Directive 94/62 / EC on packaging and packaging waste.

Adopted in May 2018 following the interinstitutional negotiations between Parliament and the Council, the four Directives (Directive 2018/849 amending Directive 2000/53 / EC on end-of life vehicles, Directive 2006/66 / EC on batteries and accumulators and waste batteries and accumulators and Directive 2012/19 / EU on waste electrical and electronic equipment, Directive 2018/850 amending Directive 1999/31 / EC on the landfill of waste, Directive 2018/851 amending Directive 2008/98 / EC on waste and Directive 2018/852 amending Directive 94/62 / EC on packaging and packaging waste), include the following main elements:

- Reuse and recycling of 65% of the mass of municipal waste by 2035 (with an intermediate target of 55% by 2025 and 60% by 2030). To achieve this goal, Romania can benefit from an additional period of five years, provided that by 2025 and 2030, respectively, the preparation rate for reuse and recycling of municipal waste reaches a minimum of 50% and 60% by weight;

- Reuse and recycling of 65% of the weight of all packaging waste by 2025 and at least 70% by 2030. Minimum targets are also set for the preparation for reuse and recycling of specific materials contained in packaging waste for both 2025 and for the year 2030;
- Storage of a maximum of 10% of municipal waste by 2035. Romania may benefit from an additional period of five years provided that by 2030 the amount of municipal waste stored is reduced to 20% of the total amount of waste generated;
- Prohibition of the storage of separately collected waste, which requires the separate collection of biological waste until 2023 and textiles and hazardous waste from households until 2025;
- Promoting economic instruments to discourage storage;
- Simplified and improved definitions and harmonized methods for calculating recycling rates at EU level;
- Promoting reuse and stimulating industrial symbiosis - transforming a by-product of one industry into a raw material for another industry;
- Economic incentives for manufacturers to market greener products and support recycling and recovery schemes (e.g. for packaging, batteries, electrical and electronic equipment, vehicles);
- Reducing the generation of food waste in primary production, processing and processing, in wholesale and retail trade, in restaurants and food services, as well as in households.

The action plan provides for measures aimed at closing the loop of the circular economy, following all stages of the life cycle of a product: from production and consumption, to waste management and the secondary raw materials market.

For the period 2021 - 2027, the sources of funding that will be available through the Multiannual Financial Framework 2021 - 2027 for the Waste Management sector are included in the *Sustainable Development Operational Program 2021*, PO (vi) *Promoting the transition to a circular economy, through investments in waste sector*, which aims to prevent or reduce the amount of waste generated, reuse and recovery of waste through recycling or other operations, as well as cessation of activity and rehabilitation of non-compliant landfills.

The financial allocation available for this sector is included in *Priority 2 - Development of water and wastewater infrastructure and the transition to a circular economy to ensure investment in the water and wastewater sector and efficient waste management to accelerate the transition to the circular economy*, which has a financial allocation of EUR 2.230 billion from the ERDF, EUR 0.737 billion from the CF and EUR 523.729 million from the State Budget.

Waste water treatment

The legislation in force shall be observed to prevent the pollution of surface water sources with waste waters resulting from anthropogenic sources. The legislation mainly refers to the quality indicators of the waste waters discharged in tributary streams.

The basis of the European Union legislation on waste waters is Directive 91/271/EEC of May 21st, 1991 on the treatment of urban waste waters, amended and supplemented by Commission Directive 98/15/EC of February 27th, 1998. Directive 91/271/EEC was fully transposed in the Romanian legislation by Romanian Government Decision no. 188/2002 approving certain norms on the conditions for the aquatic discharge conditions of waste water, amended and supplemented by Romanian Government Decision no. 352/2005. GD no. 188/2002 contains the following capital importance annexes in the collection, transport, treatment and discharge of waste waters:

- Annex 1. Technical norms on the collection, treatment and discharge of municipal waste waters, NTPA – 011;
- Annex 2. Norm on the conditions on the discharge of waste waters in the sewage systems of localities and directly in treatment stations, NTPA – 002;
- Annex 3. Norm on establishing the pollutant loading limits of industrial and municipal waste waters, on discharge in natural receptors, NTPA – 001.

The main objective of Directive 91/271/EEC is to protect the environment from the negative impacts of the discharges of urban waste waters and of waste waters from certain industrial sectors (mainly food industry product processing and manufacturing).

In Romania, the European legislation on the treatment of waste water and discharge in the aquatic environment was transposed between 2002 and 2005, however, implementation stages for full conformity with the Directive requirements are still required.

Considering both Romania's positioning in the hydrographic basin of the Danube river and in the Black Sea basin, as well as the need for environmental protection in such areas, Romania declared its entire territory as a sensitive area. The decision materializes through the fact that agglomerations with over 10000 equivalent inhabitants shall ensure an infrastructure for the treatment of urban waste waters enabling advanced treatment, particularly in terms of the nitrogen and phosphor nutrients. Secondary treatment (the biological step) is a general rule for agglomerations under 10000 equivalent inhabitants.

The Directive implementation terms vary and depend on the size of the agglomeration and the impact thereof on the receptor waters. The final transition term for the implementation of the Directive was set for December 31st, 2018, with interim terms for the collection and treatment of urban waste waters.

Measures for the limitation and/or reduction of GHG emissions resulting from the treatment of household waste waters are as follows:

- Increasing the connection level to waste water sewage and treatment services;
- Construction and commissioning new waste water treatment stations;
- The rehabilitation and upgrade of the existing waste water treatment stations;
- Using modern, low power technologies;
- The automation of the waste water treatment facility operation, with positive implications on the optimum operation thereof, respectively the avoidance of methane gas emissions;

- Collecting household sludge's per geographic areas, the processing thereof through anaerobic fermentation in modern and safe biogas production facilities.

The ***National CC/LCGG Strategy***, approved by GD no. 739/2016, establishes the following: strategic objectives for GHG emissions mitigation:

- Objective 1: Reduce GHG emissions from water supply and waste water treatment;
- Objective 2: Increase energy efficiency of pumping in large water delivery systems.

The actions related to this sector included in the National Action Plan 2016 - 2020, approved by GD no. 739/2016, in order to meet the strategic objectives of National CC/LCGG Strategy for GHG emissions mitigation are the following:

- *Objective 1: Reduce GHG emissions from water supply and wastewater treatment,* estimated value ***EUR 3,235.4 million,*** for: implement effective management of the sludge resulting from the wastewater treatment process; finance wastewater treatment system upgrades in towns/cities/regions;
- *Objective 2: Increase energy efficiency of pumping in large water delivery systems,* estimated value ***EUR 10 million****,* for high efficiency pumps to reduce GHG emissions from the water and wastewater systems investments.

LIOP 2014 - 2020 through priority axis *AP3 Development of environmental infrastructure based on an efficient management of resources, Specific Objective 3.2 Increase the collection and treatment of urban wastewater, and ensure the supply of drinking water to the population;* the foreseen results by promoting the investments within this priority axis are the following:

- Construction/rehabilitation of sewerage networks and wastewater treatment plants in agglomerations with more than 2,000 population equivalents (p.e.) till 31.12.2018 and with more than 10,000 p.e. till 31.12.2015 in order to comply with the transition periods for wastewater collection and treatment; depending on the agglomeration type the following are foreseen:
  - ✓ For agglomerations between 2,000 – 10,000 p.e: increase the number of compliant wastewater treatment plants (from 5 in 2014 to 1,629 in 2023) and the connection biodegradable organic rate (in p.e.) to agglomerations collection systems (from 13.4% in 2013 to 100% in 2023);
  - ✓ For agglomerations with more than 2,000 – 10,000 p.e: increase the number of compliant wastewater treatment plants (from 5 in 2014 to 223 in 2023) and the connection biodegradable organic rate (in p.e.) to agglomerations collection systems (from 83.95% in 2013 to 100% in 2023).

Romania's Sustainable Development Strategy 2030*,* approved by GD no. 877/2018, within the *Objective 6 Clean water and sanitation* establishes the following national targets that directly influence the GHG emissions for this sector:

Horizon2020:

- Ensure access to drinking water and sewerage systems on the periphery of towns and cities; support the connection of a greater number of households to these networks with the involvement of the local authorities;

Horizon 2030:

- Substantially increase the efficiency of water use in industrial, commercial, and agricultural activities; expand the rational reuse of treated and recycled water in order to meet the requirements of a circular economy
- Connect at least 90% of households in towns, communes and compact villages to the drinking water and sewerage network;
- Improve water quality by reducing pollution, eliminating waste disposal and reducing to a minimum the number of chemical products and dangerous substances, thereby reducing the proportion of untreated waste water and significantly increasing recycling and safe reuse.

LIOP 2014-2020 will continue the integrated actions for the development of water supply and sewerage systems; the EU funding support is EUR 1.26 billion for the development of drinking water supply systems and EUR 1.31 billion s for collection systems and domestic wastewater treatment, for agglomerations with more than 2,000 equivalent inhabitants.

In order to achieve the objectives of water bodies quality by 2027, additional measures are needed such as construction of sewerage systems and treatment plants in human settlements of less than 2,000 equivalent inhabitants.

For ***2021 - 2027 period***, the funding sources that will be available through the Multiannual Financial Framework 2021 - 2027 for the Wastewater Treatment sector are included in Sustainable Development Operational Program 2021 - 2027, *PO (v) Promoting sustainable water management,* which aims to connect the population to compliant water supply systems and the provision of wastewater collection and treatment systems.

The financial allocation available for this sector is included in *Priority 2 - Development of water and wastewater infrastructure and the transition to a circular economy to ensure investment in the water and wastewater sector and efficient waste management to accelerate the transition to the circular economy,* which has a financial allocation of EUR 2.230 billion from the ERDF, EUR 0.737 billion from the CF and EUR 523.729 million from the State Budget.

3.3. *Information on mitigation actions included WAM projection scenario*

The estimated overall effect of ***planned PAMs*** till 2040 was calculated for group of policies and measures, in line with Regulation (UE) No. 749/2014, as the difference between the GHG emissions in the WEM scenario and WAM scenario.

The PAMs included in the WAM scenario includes a set of additional measures that are likely to be implemented by accessing the available funding sources at national level or by companies/business/industrial association, as voluntary agreements. So, the additional PAMs considered in WAM scenario per sector are as follows:

- ***Energy sector (excluding Transport sector)***

For the Energy sector, a set of additional measures was considered, in accordance with the EC recommendations (*Commission Staff Working Document Assessment of the final national energy*

and climate plan of Romania SWD (2020) 922 final of 14.10.2020) regarding the final version of *2021-2030 Integrated National Energy and Climate Plan,* as well as and with the provisions of *GEO no. 155/2020 on some measures for the elaboration of the National Recovery and Resilience Plan necessary for Romania to access reimbursable and non-reimbursable external funds within the Recovery and Resilience Mechanism,* which substantiates the reform priorities and investment areas at national level in order to ensure the improvement of the national economy after the crisis generated by COVID 19, economic growth and job insurance, supporting the green and digital transition.

The additional measures, considered to be implemented in this scenario, possibly to be implemented by the government, focus on the rehabilitation / modernization / expansion of centralized heat production and distribution systems, increasing the penetration of renewable energy sources, promoting rehabilitation of existing public buildings, and, respectively, by companies / private sector / industrial associations based on voluntary agreements (e.g.: modernization of the industrial sector).

- ***Transport sector***

A set of additional measures was considered for this sector, in accordance with the EC recommendations (*Commission Staff Working Document Assessment of the final national energy and climate plan of Romania SWD (2020) 922 final of 14.10.2020)* regarding the final version of *2021-2030 Integrated National Energy and Climate Plan* as well as and with the provisions of *GEO no. 155/2020 on some measures for the elaboration of the National Recovery and Resilience Plan necessary for Romania for accessing reimbursable and non-reimbursable external funds within the Recovery and Resilience Mechanism*.

Additional measures considered to be implemented in this scenario focus on modernizing / expanding / rehabilitating / developing transport infrastructure, increasing urban mobility, promoting the development of alternative fuel infrastructure (installation of recharging points for electric vehicles) and promoting the use of clean road transport vehicles and energy efficient.

- ***Agriculture Sector***

For this sector potential implementation of investments projects was considered, as voluntary agreements, such as improving the feed quality for livestock, increasing methane recovery from anaerobic fermentation of manure, modern methods of fertilizer application.

- ***LULUCF Sector***

For this sector was considered implementation through voluntary agreements and / or negotiated of a larger number of investment projects to reduce GHG emissions, such as investments to improve sustainable management of forest and forestry, expand forested areas, restore degraded lands, afforestation of degraded lands.

- ***Waste Sector***

For Solid Waste Disposal category this scenario considered the completion of new County Waste Management Plans that will include clear and coherent measures for fulfilling the objectives regarding preparation for reuse and recycling by 2025 and 2040; the measures considered are based primarily on the existence and use of key economic instruments such as:

- Adequate storage rates (and / or prohibitions on the storage of recyclable waste);
- Pay-as-you-throw (PAYT) schemes (or equivalent systems) at local level, which progressively cover a growing part of the population;
- Producer responsibility schemes (which ensure the financing of separate collection and recycling of relevant waste streams) or equivalent systems (such as landfill systems);
- Strategies, policies or rules to stimulate the competent municipal waste management authorities (municipalities / regions) to respect the waste hierarchy and to adopt ad-hoc instruments (such as PAYT systems);
- Additional capacities for collection, treatment, recycling, especially anaerobic digestion facilities;
- Selective collection of textile waste.

The contribution of PAMs reported in **CTF Table 3** to GHG emissions reduction shall be assessed against targets assumed by Romania for 2020 and 2030, as EU member state, and presented as follows:

Targets and contributions assumed at national level, 2020 and 2030

Targets and contributions assumed at national level	**2020**	**2030**
ETS* emissions, compared to 2005, in %	-21	-43.9
Non-ETS emissions, compared to 2005, in %	19	-2

NOTE:

***** part of the EU's commitment to reduce GHG emissions related to the ETS sector

The GHG emissions (excluding LULUCF) forecasted in WEM scenario and WAM scenario are presented in the Table below.

Table 6. GHG emissions (excluding LULUCF) forecasted in WEM scenario for ETS and non-ETS sectors

Scenario	**Total / Sector**	**GHG emissions, kt $CO_{2\ eq}$**				
		2020	**2025**	**2030**	**2035**	**2040**
WEM	**Total GHG emission (excluding LULUCF), of which:**	105,302.22	103,136.14	98,457.40	103,271.12	106,670.76

	ETS	32,112.23	26,203.39	19,351.25	20,691.27	21,710.80
	Non-ETS	73,189.99	76,932.75	79,106.15	82,579.85	84,959.97
WAM	**Total GHG emission (excluding LULUCF), of which:**	104,383.58	101,173.11	96,625.11	100,754.79	102,031.02
	ETS	32,112.23	26,081.83	19,231.40	20,568.74	20,563.62
	Non-ETS	72,271.35	75,091.28	77,393.71	80,186.05	81,467.40

In 2030 perspective, the GHG emissions forecasted in WEM scenario (98,457.40 Gg CO_{2eq}) are reduced by 60% compared to the emissions recorded in 1990 (247,994.30 Gg CO_{2eq}) thus respecting the commitments assumed at national level, through the National CC/LCGG Strategy. In WEM scenario, the quantified contribution of implementation of PAMs, estimated as difference between GHG emissions (excluding LULUCF) in WOM and WEM scenarios and, respectively, in WEM and WAM scenarios are presented in the following table.

Table 7. Contribution of implementation of PAMs per ETS and non-ETS sectors

Scenario	Total / Sector	GHG emission reductions, kt $CO_{2\ eq}$				
		2020	**2025**	**2030**	**2035**	**2040**
WEM	**Total GHG emission reductions (excluding LULUCF), of which:**	52,415.91	61,250.83	73,352.07	78,537.74	84,958.49
	ETS	-	-	-	-	-
	Non-ETS	-	-	-	-	-
WAM	**Total GHG emission reductions (excluding LULUCF), of which:**	**918.64**	**1,963.03**	**1,832.29**	**2,516.34**	**4,639.74**
	ETS	0.00	121.56	119.84	122.53	1,147.18
	Non-ETS	918.64	1,841.47	1,712.45	2,393.80	3,492.57

The GHG emissions forecasted in WEM scenario highlight that in 2020, the GHG emissions for non-ETS sector are under the annual adjusted allocated emissions level for 2020, namely, 89,809.451 kt $CO_{2\ eq}$.

For 2021-2030 period, the GHG emissions for non-ETS sector were compared with proposed annual allocated emissions levels, considering the following:

- The GHG emissions forecasted were performed considering the data reported in the last submission of the NGHGI (May 2020), calculated by applying the GWP defined in the fourth assessment report prepared by the IPCC;
- The proposed annual allocated emissions levels for non-ETS sector are calculated by applying the GWP defined in the fifth assessment report prepared by the IPCC.

The GHG emissions projected in WEM scenario highlight that in 2030, the GHG emissions for non-ETS sector would be around 80,000 kt $CO_{2\ eq}$.

3.4. *Changes in domestic institutional arrangements*

National Entity

According to Governmental Decision (GD) no. 43/2020 regarding the organization of the Ministry of Environment, Water and Forests (MEWF), MEWF as competent authority ensuring the fulfilment of Romania reporting requirements in the climate change area, has the following attributions, in accordance with Chapter 5 of the *Regulation (EU) No. 525/2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change* and Articles 20, 22, 23 of *Commission Implementing Regulation (EU) No. 749/2014 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) no. 525/2013*:

- Ensuring the coordination of reporting process, in line with the requirements of *Regulation (EU) No. 525/2013 on a mechanism for monitoring and reporting GHG emissions*;
- Ensuring the development of the National system on GHG emission projections, in line with EU requirements;
- Contract research services as well as consulting services for necessary studies in order to fulfill its attributions.

In accordance with the responsibilities in the climate change field, MEWF ensured the development of the National system on GHG emission projections, approved by *GD no. 267/2019 on the establishment of the National System for Reporting on Policies and Measures and for reporting on Projections of anthropogenic GHG emissions by sources and removals by sinks* (NSPMPGHG), which establishes the legal, institutional and procedural framework for obtaining and collecting data necessary to fulfill the reporting obligations assumed by Romania at European and international level. By GD, the following responsibilities are established:

- MEWF, as competent authority, is responsible for the development and submission of the Report on Policies and Measures (RpPM) and the Report on Projections (RpP) of anthropogenic GHG emissions by sources and removals by sinks;
- The central public authorities and public institutions ensure the provision of necessary data and information for the elaboration of RpPM (according to Annex XI of Regulation (EU) no. 749/2014) and RpP (information associated with projections parameters according to Annex XII, Table 3, of Regulation (EU) no. 749/2014), specific to their competence field;
- The competent authority elaborates the GHG emission projections and ensure the completeness of the data and information related to projections, which shall include all GHG emissions and removals for all years, all GHGs and all projections scenarios considered;
- The competent authority ensures the implementation of the Plan on quality assurance and quality control (QA / QC) of data and information developed and / or processed and the archiving and storage of all specific documentation related to RpPM and RpP;
- The central public authorities and the public institutions responsible for providing the necessary data and information for the elaboration of the RpPM and RpP respect the quality control procedures regarding the specific data provided (policies and measures and, respectively, the projections parameters specific to their competence field).

Relevant institutional, legal and procedural arrangements established within a Member State for evaluating policy and for making projections of anthropogenic greenhouse gas emissions by sources and removals by sinks

In order to meet Romania's reporting requirements in accordance with Chapter 5 of Regulation (EU) No. 525/2013 as well as Articles 20, 22, 23 of Commission Implementing Regulation (EU) No. 749/2014, MEWF, as the national entity that administrates the NSPMPGHG, signed the Service Contract for research services for the study on *"Developing elements of the Report on policies and measures for reduction of GHG emissions and Report on GHG emissions projections, in accordance with the Regulation (EU) no. 525/2013".*

The public acquisition contract was awarded to a consortium with technical expertise on National Greenhouse Gas Inventory (NGHGI) sectors, coordinated by the Institute for Studies and Power Engineering (ISPE PC).

ISPE PC, as consortium leader, had the following responsibilities related to the above mentioned study:

- Establishing the legal, institutional and procedural framework for carrying out the study by signing the contract between MEWF and ISPE PC, as well as the by signing the agreement between consortium partners in order to assure the NGHGI sectoral technical expertise, as follows:
  - ✓ ISPE PC - for Energy, Agriculture and Waste Sectors;
  - ✓ BEIA CONSULTING INTERNATIONAL SRL - for Industrial Process and Products Use sector;

- Expanding confidentiality requirements of data and information used to develop GHG emissions projections to all consortium partners;
- Experts involving and meetings establishment to discuss in detail the roles and responsibilities, to plan the activities and other important aspects of implementation of activities, communication, reporting;
- Preparation the RpPM and RpP, in accordance with chapter 5 of Regulation (EU) No. 525/2013, as well as Commission Implementing Regulation (EU) No. 749/2014, through compiling data and information provided by consortium' partners, including the data received from MEWF for LULUCF sector;
- Documentation of the activities on quality assurance and quality control (QA/QC) of data and information developed, collected and/or processed through aggregation of the consortium partners documentation, including the data received from MEWF for LULUCF sector;
- Close collaboration with MEWF, as study's beneficiary, and with consortium partner in all study's development stages.

Data and information flow for drawing up the RpPM and RpP is presented in the figure below:

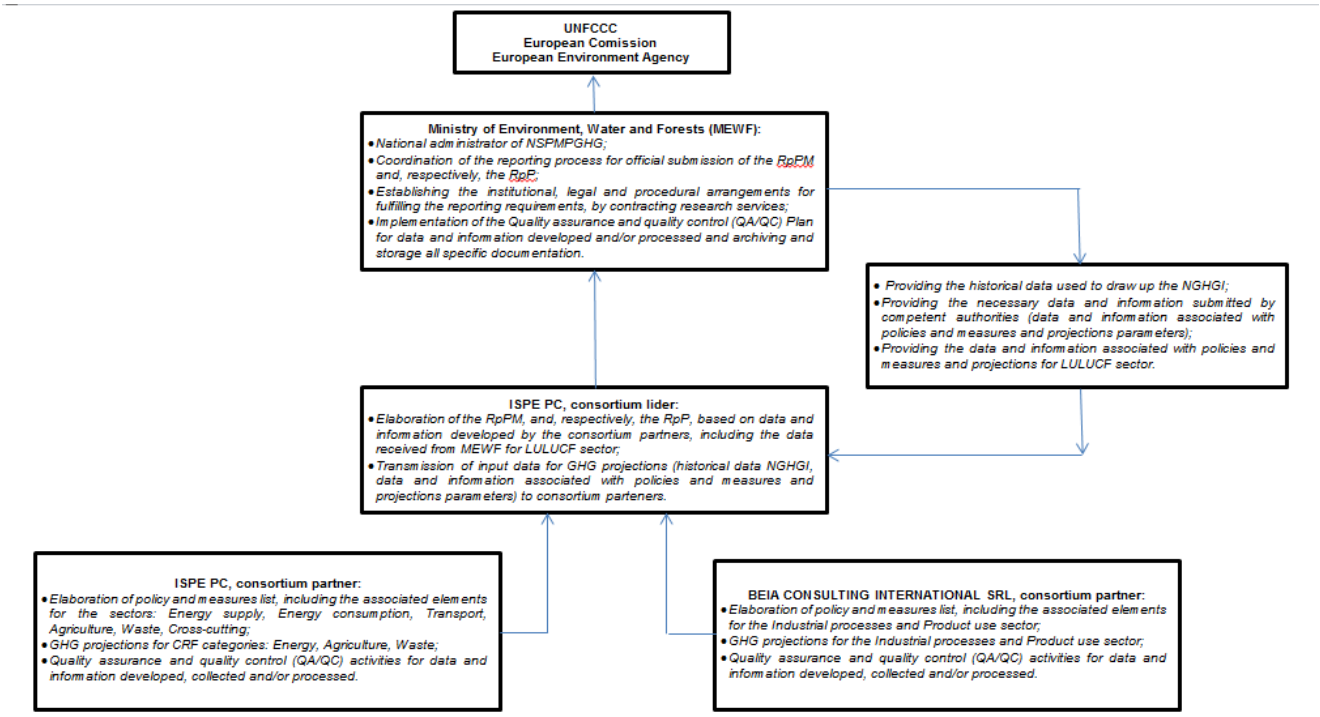

Figure 15 RpPM and RpP data and information flow

Relevant procedural arrangements and timescales to ensure the timeliness, transparency, accuracy, consistency, comparability and completeness of the information reported on policies and measures and the information reported on projections

MEWF, as national entity that administers the NSPMPGHG, established the following procedural arrangements in order to ensure timeliness, transparency, accuracy, consistency, comparability and completeness of the information reported on policies and measures and projections:

- Assigning the public acquisition contract for the study on *"Drawing up the Report on policies and measures to reduce GHG emissions and Report on GHG emissions projections in accordance with the Regulation (EU) No. 525/2013"* to a consortium with NGHGI sectoral expertise related to UNFCCC reporting requirements (for carrying out the NGHGI and National Communication);
- The implementation of the study in sequent stages (interim report and final report) for detailed planning of the activities, providing inputs for the projections, identifying and resolving difficulties, recording progress and forecasted results;
- Providing historical data used to draw up NGHGI submitted to the UNFCCC Secretariat, to the European Commission and to the European Environment Agency, as input for GHG emissions projections;
- Providing the necessary data and information submitted by competent authorities (data and information associated with policies and measures and projections parameters);
- Providing the data and information associated with policies and measures and projections for LULUCF sector;
- Collaboration between consortium partners at all stages of the study development to meet specific reporting requirements at EU level.

ISPE PC, as the consortium leader, has established the following procedural arrangements between consortium partners, in line with the contract's requirements:

- For their specific competence domain, the consortium partners have drawn up the list of policies and measures, have elaborated the projections of anthropogenic GHG emissions by sources and removals by sinks and have carried out activities on quality assurance and quality control (QA/QC) of data and information developed, collected and / or processed;
- ISPE PC has elaborated the interim report and final report through compiling the data and information provided by consortium partners and by MEWF for LULUCF sector regarding policies, measures and projections and has carried out activities on quality assurance and quality control (QA/QC) of data and information developed, collected and / or processed;
- ISPE PC has closely collaborated with national competent authority, as study's beneficiary, and with consortium partner in all the study stages in order to meet the European reporting requirements, including the reporting templates used for the submission.

For the interim and final report of the study *"Drawing up the Report on policies and measures to reduce GHG emissions and Report on GHG emissions projections in accordance with the Regulation (EU) No. 525/2013",* the data reported in the last submission of the NGHGI were considered (May 2020).

Overall process for the collection and use of data, evaluation of policies and measures and making of projections

The overall process of collection and usage of data on policies, measures and projection of anthropogenic GHG emissions by sources and removals by sinks that involves identifying the data needed, potential data providers and data collection for each NGHGI sector was carried out as follows:

- ISPE PC, as consortium leader, has had the following responsibilities related to the elaboration of the RpPM and RpP:
  - ✓ Preparation of the RpPM by aggregating data and information related to policies / measures / group policies and measures (specific indicators, ex-ante and ex-post assessment, costs and benefits of policies and measures, estimation methodologies) provided by the consortium partners (ISPE PC, BEIA CONSULTING INTERNATIONAL SRL), including the data received from MEWF for LULUCF sector, in accordance with the tabular formats set out in Regulation (EU) No. 749/2014, *Annex XI. Reporting information on policies and measures* pursuant Article 22, Table 1 - 3;
  - ✓ Collection of the necessary data for the projections of anthropogenic greenhouse gas emissions by sources and removals by sinks and handing them over to the consortium partners (ISPE PC, BEIA CONSULTING INTERNATIONAL SRL) namely:
    - Historical data used for drawing up the NGHGI submitted to the UNFCCC Secretariat, the European Commission and the European Environment Agency;
    - National macroeconomic indicators established in line with the strategies and policies adopted for the national socio-economic development, provided by National Commission for Strategy and Prognosis, in correlation with European legislation;
  - ✓ Preparation of the RpP, by aggregating the projections of GHG emission by sources and removals by sinks, as well as the related data and information (description of: models, data sources, assumptions, mathematic models, sensitivity analysis performed for the projection, QA/QC activities) provided by the consortium partners (ISPE PC, BEIA CONSULTING INTERNATIONAL), including the data received from MEWF for LULUCF sector, in accordance with the tabular formats established by Regulation (EU) No. 749/2014, *Annex XII. Reporting on prognoses* pursuant to Article 23, Table 1, 2, 4;
  - ✓ Presenting the projection parameters used through completion of the tabular format established by Regulation (EU) No. 749/2014, *Annex XII. Reporting on prognoses* pursuant to Article 23, Table 3;
  - ✓ Presenting the results of the sensitivity analysis together with a brief explanation on which parameters were changed and how;
  - ✓ Documentation of the activities on quality assurance and quality control (QA/QC) of data and information developed, collected and/or processed through aggregation of the consortium partners documentation;
- ISPE PC and BEIA CONSULTING INTERNATIONAL, as consortium partners, as well as the data provider for LULUCF sector, have had the following responsibilities related to the elaboration of the RpPM and RpP:

- ✓ Drawing up the list of policies and measures, including the associated elements (specific indicators, ex-ante and ex-post assessments, associated costs and benefits, estimation methodologies), in accordance with tabular format established by Regulation (EU) No. 749/2014, *Annex XI. Reporting information on policies and measures,* pursuant to Article 22, Table 1 - 3;
- ✓ Performing the projections of anthropogenic GHG emissions by sources and removals by sinks organised by gas or group of gases and NGHGI sectors for three scenarios – without measures scenario (WOM), with existing measures scenario (WEM) and with additional measures scenario (WAM) – in accordance with tabular format established by Regulation (EU) No. 749/2014, *Annex XII. Reporting on prognoses* pursuant to Article 23, Table 1, 2, 4;
- ✓ Selection and description of the projection methodologies, including a brief description of models used at sectoral level as well as the description of the assumptions and parameters used;
- ✓ Carrying out / documentation of the activities regarding quality assurance and quality control (QA/QC) of data and information developed, collected and/or processed.

Description of the process for selecting assumptions, methodologies and models for policy evaluation, and for making projections of anthropogenic greenhouse gas emissions

The overall process for collection and usage of data on policies, measures and projection of anthropogenic GHG emissions by sources and removals by sinks involves identifying needed data, potential data providers and data collection for each NGHGI sector.

The evaluation process of the effects of policies and measures was performed by the consortium, as well as the data provider for LULUCF sector, based on available data and information, thus:

- ➢ Estimation of the effects of policies/ measures/ group of policies and measures has been performed on group of policies and measures associated to the following sectors, as defined by Regulation (EU) No. 749/2014: Energy Supply, Energy Consumption, Transport, Industrial Processes, Agriculture, LULUCF, Waste and cross-cutting;
- ➢ Ex-ante assessment of the effect of groups of policies and measures associated to each sector mentioned above has been performed as difference between the forecasted GHG emissions in WOM and WEM scenarios, respectively the forecasted GHG emissions in WEM and WAM scenarios;
- ➢ The GHG emissions projections for ETS and non-ETS sectors considered the data reported in accordance with Annex V of Regulation (EU) No. 749/2014 regarding the format for reporting information on the consistency of reported emissions with emissions trading scheme, data pursuant to Article 10;
- ➢ Ex-post assessment of the effect of groups of policies and measures at sectoral level was not possible to be performed, considering the incompleteness data and information on the monitoring sectoral policies and measures;

- Estimation of the cost/benefits associated to the policies/ measures/ group of policies and measures were not possible to be performed due to the lack of data at sectoral and policy level.

The methodology for GHG emissions projections is based on historical data from NGHGI for period 1989 - 2018, on macroeconomic indicators forecasts considered by National Commission for Strategy and Prognosis in October 2020 considering the strategies and policies adopted in order to achieve economic and social development of the country in accordance with EU Directives, as well as on supra-nationally parameters recommend by the Commission.

Considering that the Energy sector is the main source of GHG emissions, the GHG emissions projections were split in energy and non-energy sectors of the national economy.

The non-energy sectors of the national economy that contribute to GHG emissions are:

- Forestry - in terms of atmospheric carbon sequestration options;
- Agriculture - CH_4 emissions from animal digestion and manure fermentation and N_2O emissions from the application of nitrogen fertilizers;
- Industry - emissions from industrial processes;
- Liquid and solid waste management - CH_4, N_2O and CO_2 emissions.

The GHG emissions projections for the Energy sector were based on data provided by the National Commission for Strategy and Prognosis in October 2020 that present the energy demand (total and per type of resources) for the IPCC sectors (electric and thermal energy production, refineries, transport, industry, agriculture, construction, services, population, etc.), which allows the development of GHG emissions projections using the emission factor defined by fuel types.

For non-energy sectors, the methodologies specified in the NGHGI were used to determine the GHG emissions projection, based on the following equation:

$$E_{GHG\ emission} = AD \times EF$$

Where: AD – projected activity data;
EF- projected emission factor.

In the RpP are presented the assumptions considered for GHG emissions projections for Energy, IPPU, Agriculture, LULUCF and Waste sectors.

Description of the quality assurance and quality control activities and of the sensitivity analysis for GHG projections

The national competent authority managing NSPMPGHG has conducted the following activities on the quality control and quality assurance (QA/QC) of data and information, collected and/or processed through the study:

- Check the specific requirements regarding the reporting deadlines at Community level, as well as specific requirements relating to tabular formats established for reporting;

- Check the completeness of the RpPM, including data and information associated to policies / measures / group of policies and measures (specific indicators, ex-ante and ex-post assessments, associated costs and benefits, as well as estimation methodologies);
- Check the qualitative information about the connections between different policies and measures and how policies and measures contribute to different projections scenarios, including the assessment of their contribution to the achievement of a low carbon development strategy;
- Check the completeness of the RpP, namely the completeness of data and information related to the outputs of GHG emissions projections and the associated elements (methods description, data sources, assumptions and mathematical models, information on sensitivity analyses);
- Check the disaggregation level for GHG emissions projections, as required by the tabular format, by NGHGI categories, GHG types, ETS and non-ETS; verification was performed for all years and all projections scenarios;
- Check the correlation of estimated effects of policies and measures reported in the RpPM with projections, for all projections scenarios;
- Check the presentation of elements associated to RpP (methods description, data sources, assumptions and mathematical models, information on sensitivity analyses), so that they are described clearly and completely;
- Check the proper use of notation keys, in agreement with the relevant official documents;
- Check that consortium partners work properly on control and quality assurance (QA/QC) of developed data and information collected and/or processed.

ISPE PC, as consortium leader, has performed the following activities related to control and quality assurance (QA/QC) on developed data and information collected and / or processed by the consortium:

- Check the correct aggregation of data and information related to policies / measures / group of policies and measures referring to specific indicators, the results of ex-ante and ex-post assessments and the estimation methodology developed by the consortium partners;
- Check transmission of data and information necessary to GHG emissions projections - national development macroeconomic indicators and NGHGI historical data to consortium partners;
- Comparing national parameters used for GHG emissions projections with those used at Community level;
- Check the correlation between projection parameters and measure units used and those requested by the tabular format;
- Check the transmission of data and information associated with the RpP, by the consortium partners, for their specific area of expertise;

- Check the correct aggregation of GHG emissions projections developed by the consortium partners, for all the years and all projections scenarios;
- Check the correct aggregation of associated elements to GHG emissions projections (methods description, data sources, assumptions and mathematical models, information on sensitivity analyses) developed by the consortium partners, for all the years and all projections scenarios.

Consortium partners (ISPE PC, BEIA CONSULTING INTERNATIONAL), as well as data provider for LULUCF sector, conducted the following activities on control and quality assurance (QA / QC), on their specific area of expertise:

- Check the proper identification of policies and measures considered, though coherence with policies and measures at Community level;
- Check the completeness of data and information related to policies / measures / group of policies and measures, including specific indicators, ex-ante and ex-post assessments and estimation methodology;
- Check the existence of explanations for lack of data and information related policies / measures / group of policies and measures referring to specific indicators, ex-ante and ex-post assessments and estimation methodology;
- Check the disaggregation level for GHG emissions projections, as required by the tabular format, by NGHGI categories, GHG types, ETS and non-ETS; verification was performed for all years and all projection scenarios (WOM, WEM, WAM);
- Check the correlation of developments considered nationally on the demand for energy and types of energy resources, with the assumptions considered at European and international level;
- Check the GHG emissions projections trend and also the parameters used, compared with the historical evolution, considering the effect of implementation of policies and measures, in order to identify and analyse exceptional values;
- Check the existence of explanations for the lack of estimations;
- Check the proper use of notation keys, in accordance with relevant official documents.

The GHG emissions projections are based on assumptions with high degree of uncertainty regarding macroeconomic indicators in the time horizon 2040. Thus, economic and social development is an important factor affecting the GHG emissions projections.

In the RpP are presented the results of the sensitivity analysis, including the details related to considered parameters.

3.5. *Information on the assessment of the economic and social consequences of response measure*

The UNFCCC biennial reporting guidelines encourage Parties to provide, to the extent possible, detailed information on the assessment of the economic and social consequences of response measures. Romania as member of the EU strives to implement policies and measures under

Article 2 of the Kyoto Protocol in such a way as to minimize adverse effects on other parties. More information are provided in Section 4.3.4.3 of the EU's 6NC, chapter 15 of the EU NIR 2020, and section 4.4. of EU's 4BR.

According to the Article 3.14 of the Kyoto Protocol, Annex I countries will take mitigation measures in such a way as to minimize adverse social, environmental and economic impacts on developing countries.

Romania has a comprehensive approach to climate change mitigation from policy development, addressing all sources as well as sinks, in order to minimize adverse effects of climate policies and measures on the economy. The purpose is to promote sustainable development for the benefit of the individual, society and future generations. The vulnerability due to climate change is included in Strategic Environmental Assessments of the national strategies and programs.

The reduction of emissions in Romania was mainly the consequence of the decline of the economic activities, the upgrading of technologies and energy efficiency projects promoted as a result of the implementing the European Union Community acquis.

The GHG emissions reduction achieved have allowed our country to participate from the early stage at the implementation of the AIJ and JI mechanism in order to upgrade and refurbish the old technologies and improve energy efficiency. An important role in the reduction of GHG emissions was played by the participation since 2007 at the application of the Emission Trading Scheme. Therefore, the national climate change policy developed so far to reduce GHG emissions has no impact abroad and especially on developing countries.

Romania considers that technical and financing assistance towards the developing countries is very important for the development of international policies on climate change and is willing to join the European Union initiative to provide a "fast start financing" for the developing countries. Under the fast start financing Romania decided to focus its contribution for the benefit of developing countries associated to the Copenhagen Accord (see Section 4.1.3 of the Romania 2BR). In 2010 was signed between the Governments of Romania and Republic of Moldova the Accord on implementation of the technical and financial assistance based on 100 million euros granted by the Romanian Government. In this context the 15 million Euros Romanian contribution planned for the fast start financing mechanism will be used for energy efficiency and transport infrastructure projects with a view to develop climate change mitigation policy and efficiency of natural resources use in the Republic of Moldova.

Also, Romania is member of IRENA (International Renewable Energy Agency) since 22 July 2010. This international organization develops renewable energy policies and promotes its wider utilization worldwide. One of the main functions of IRENA is to offer advice to its member states regarding selection and adaptation of energy sources, technologies, business models, organizational and regulatory frameworks. The cooperation within IRENA contributes the increased sectoral administrative capacity – the information available through the Agency enables Romanian authorities to learn more about the experiences of sectoral policy implementation and to provide advice on developing the renewable energy sector to other members. Romania has valuable experiences in connection with the use renewable energy and joint implementation projects based on the Kyoto Protocol of the UN Framework Convention on Climate Change.

Romania contribute to the EU Eastern Europe Energy Efficiency and Environment Partnership (E5P) Fund (270,000 RON in 2016) who support energy efficiency and environmental

sustainability projects. The E5P Fund activities started first with Ukraine, but since 2013 have been extended to Georgia, Moldova and Armenia. As part of bilateral cooperation Romania offered also support for Georgia for disaster prevention and preparedness as part of adaptation measures.

More information on the approach of the EU on the assessment of the economic and social consequences of response measures can be found in the fourth EU Biennial Report, chapter 4.4. To ensure that all relevant possible impacts are considered, the EU has established processes that assess the economic and social consequences of climate policy measures.

4. Estimates of emission reductions and removals and the use of units from the market-based mechanisms and land use, land-use change and forestry activities

4.1 Non-ETS emission reductions

This chapter of the 4th Biennial Report briefly outlines policies and measures to reduce GHG emissions and progress in meeting the QEWER target.

From the chart below, it can be noticed that Romania will not face difficulties in achieving its target for 2020. It is projected that emissions in 2020 to count 73.189 Mt CO_2 eq., the target of the non-ETS sectors being 89.80 Mt CO_2 eq, according to the compliance analysis at the EU level (see the following link:

https://ec.europa.eu/clima/ets/transactionsCompliance.do?languageCode=en&esdRegistry=RO&esdYear=&search=Search&currentSortSettings=. On the entire commitment period 2013-2020, the allocated budget of the non-ETS sectors under EU Effort Sharing Decision of 661.18 Mt CO_2 eq is forecasted to be overachieved with approx. 66 Mt CO_2 eq in 2020. However, Romania will have to considerably enhance its efforts in order to meet its current target for 2030.

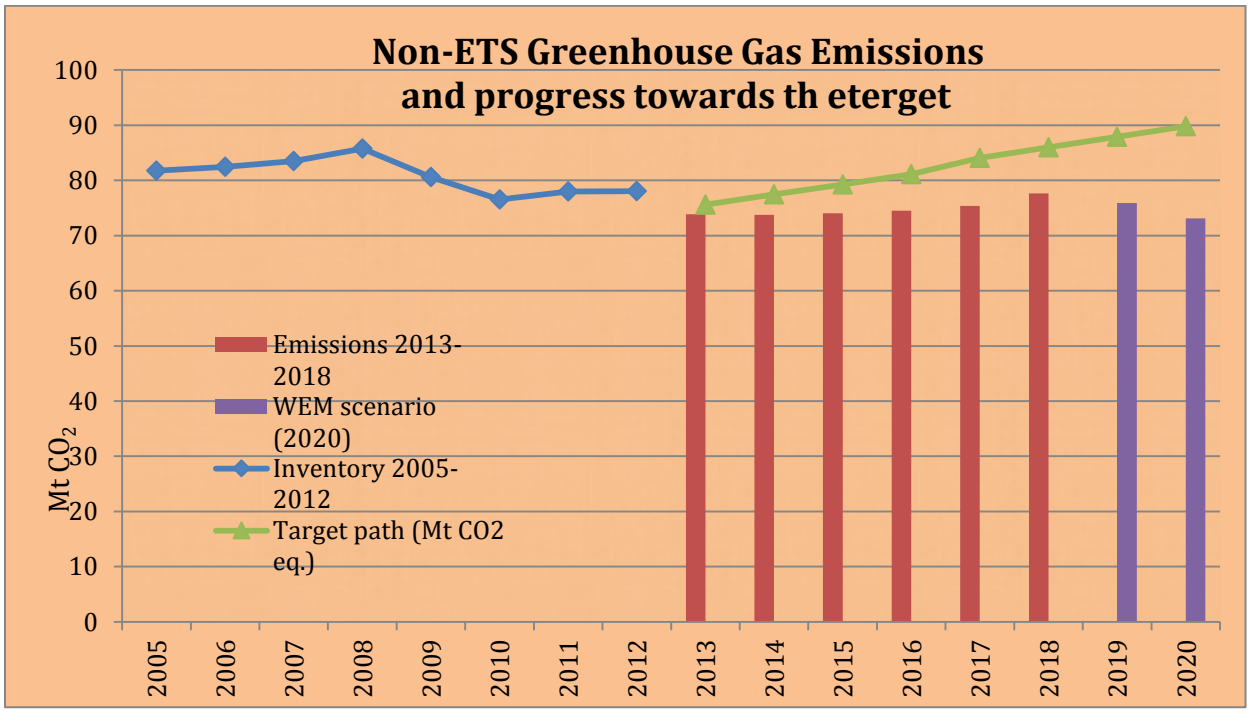

Figure 16. Progress in achieving the target

Further information on mitigation actions and progress is provided in CTF Tables, namely:

- Table 3: Progress in achievement of the quantified economy-wide emission reduction target: information on mitigation actions and their effects;
- Table 4: Report on progress;
- Table 4(a)I: Progress in achieving the quantified economy-wide emission reduction targets - further information on mitigation actions relevant to the contribution of the land use, land-use change and forestry sector.

5. Projections

5.1 Methodology for elaboration of the GHG emission projections by National Inventory GHG sectors

The methodology for achieving emission forecasts for greenhouse gas (GHG) emissions is both based on historical data from the National Emissions Inventory (NIGHGE) between 1989 – 2018 and on forecasts of macroeconomic indicators considered in the strategies of the Romanian Government and policies adopted for the economic and social development of the country in conjunction with the EU Directives.

Given the fact that according to the National Emissions Inventory the energy sector is the main source of greenhouse gas (GHG) emissions (about 70% of total emissions), GHG emissions forecasts are determined on energy and non-energy sectors of the national economy.

Non-energy sectors of the national economy that contribute to GHG emissions are:

- forestry - in terms of atmospheric carbon sequestration options;
- agriculture - to evaluate CH_4 emissions from livestock digestion and manure fermentation and N_2O emissions from the application of nitrogen fertilizers;
- industry - to assess emissions from industrial processes;
- solvents and other products;
- liquid and solid waste management to assess emissions of CH4, N2O and CO2.

Projections of GHG emissions are performed for three scenarios. specifically:

- a reference scenario "business as usual" (**scenario without measures-WOM**) feasible in the future that does not include special activities to reduce GHG emissions;
- a reduction scenario that is similar to the reference scenario in terms of development of socio-economic indicators, but contains policies and measures to reduce GHG emissions (**scenario with measures- WEM**);
- a reduction scenario with additional measures that is similar to the reduction scenario but contains additional measures to reduce GHG emissions (**scenario with additional measures-WAM**).

According to the National Inventory, technological processes that determine GHG emissions and mitigation options were identified for each sector.

Hierarchy of options within a sector is based on detailed analyses. using various criteria. specifically:

- degree of reduction of CO2 and other GHG emissions;
- cost-benefit ratio of the GHG emission reduction option;
- indirect economic impact (jobs. lower imports);
- slight possibilities of implementation;
- long-term support of the reduction option, etc.

For each sector analyzed, it is explained how the reference scenario was defined and the two alternative scenarios given the specificity of each sector.

Achieving the GHG emission forecasts and evaluation of alternatives to reduce them is particularly difficult, and therefore we resort to special programs that allow identification of sectors of low importance to GHG emissions correlated with the socio-economic development of the country.

5.2. Methodology for elaboration of the GHG emission projections for energy sector

Projections of GHG emissions of the energy sector are determined with regard to the energy demand sub-sector (industry, transport, agriculture, households and commercial consumers) and supply sub-sector (primary energy resource extraction, their conversion in refineries, power plants, thermal power plants, transmission and distribution of energy products to consumers).

The National Commission for Prognosis has determined the evolution of energy needs by total and by types of energy resources for the sectors defined according to the IPCC: electricity and heat generation, transport sector, industry, agriculture, construction, services, population using the methodology for drawing up the *Energy Balance Forecast.*

The determination of energy consumption and resources is carried out separately for each energy carrier highlighted in the Annex of INS - *The energy balance and the structure of the energy equipment* -, but at the end, in order to obtain the *Energy Balance Forecast*, some of the results are aggregated (consumptions and exports), so results total energy quantities, not on the carriers, In this case, the indicators are extracted from the energy balances drawn up for each energy carrier at the prior stage of results aggregation, for which the following steps are considered:

Determination of energy consumption

A particular energy carrier may be used in the final consumption as such or may require conversion to another energy carrier. Use for final consumption is realized separately. at least for the below economic branches (but also for export where appropriate):

- industry;
- non-energy use;
- agriculture;
- construction;
- transport;
- services (less transport);
- residential sector;
- the consumption in the energy sector benefits from similar treatment of final consumption, although it does not represent final consumption.

Final consumptions are determined as a product between a macroeconomic indicator of the activity level within the given economic branch (gross added value. production of goods and services, etc.) and the intensity of the energy consumption of the branch. calculated for the energy carrier in question. The intensity of consumption (or its increase) is generally determined with econometric equations.

The energy quantities used in the transformation results in such a way as to cover a specific consumption for the energy carrier resulted from the transformation (electricity. heat. petroleum products, etc.) and for a certain of the transformation yield.

Determination of resources

The production and import of a particular energy carrier shall be determined in such a way as to balance consumption (final consumption and for processing). For production determination. are taken into consideration the following elements:

- the own historical values;
- the opening of new deposits;
- the evolution of the energy equipment structure;
- information on the hierarchy of production costs;
- restrictions in fossil fuels use. imposed by international commitments, etc.

The import results either as a quantity of completion of the need, or substitutes a part of production as a result, for example. of the resources price variation at international level, the change in production costs, etc.

The methodology explicitly captures how substitutions take place between different resources, which contribute either to final consumption balancing, or to a consumption balancing for transformation.

Scenarios for consumption evolution and how it is balanced with different resources

The implementation of a specific scenario at the level of the calculation for the determination of consumptions and resources can be realized by means of some elements, as follows:

- the evolution of macroeconomic indicators, which directly influence final energy consumption and indirectly the consumptions in transformation;
- the final consumptions obtained in the frame of a "business as usual" scenario can be amended with "energy savings" of the type given in the National Energy Efficiency Action Plan, described for a scenario that involves increasing measures of the consumption efficiency;
- modification of the fleet of energy production equipment as a result, for example, of a plan of measures to reduce emissions in the energy sector. This leads to changes in the production structure, to an increase of transformation yield, to the change of the energy mix, to the appearance of a substitution between import and export, etc.;
- the imposition of a resource's substitution on the basis of the provisions of a strategy, international commitment, etc.

Accepted hypotheses

1. The production of crude oil and natural gas does not go through any significant increase (for example, determined by the opening of new deposits);
2. The efficiency of energy consumption at the level of the economy branches goes through a rate of improvement;
3. There are/are not extensive substitutions of the resources used by households as a result, for example, of the expansion of gas supply, electrification of household consumption, etc.;
4. The increase of electricity production from renewable sources accompanies the increase of renewable generation capacities described in the Adopted Plans;
5. The production of nuclear energy shall correspond to the plans adopted;
6. Coal follows to gradually substituted with natural gas. both in the case of electricity generation and in the case of heat production;
7. The yield of the different resources conversion into electricity remains constant and is equal with that of the agreed period.

To establish the GHG emission projections, the following equation is used in accordance with NIGHGE 2018:

GHG Emissions = AD x EF

where: AD is the projected activity date;
EF - forecast emission factor.

5.3. Methodology for elaboration of the GHG emission projections for the Industrial Processes and Product Use sector

According to the 2006 IPCC guidelines, this sector includes GHG emissions from activities related to the production process in the industry and emissions associated with the use of the products.

Table below presents the categories and types of greenhouse gases resulting from the Industrial Processes and Product Use sector for which forecasts have been made.

Table 8.Categories and types of GHG emissions from the Industrial Processes and Product Use sector

CRF Category	CO_2	CH_4	N_2O	HFC	PFC	SF_6	NF_3
2 A Mineral industry							
2.A.1. Cement production	✓						
2.A..2. Lime production	✓						
2.A.3 Glass production	✓						
2.A.4. Other uses of carbonates in processes	✓						
2 B Chemical industry							
2.B.1. Ammonia production	✓						
2.B.2. Nitric acid production			✓				
2.B.3. Production of adipic acid							
2.B.4. Caprolactam, glyoxal and glyoxylic acid production							
2.B.5. Carbide production	✓	✓					
2.B.6. Titanium dioxide production							
2.B.7. Caustic soda production	✓						
2.B.8. Petrochemistry and black smoke production	✓	✓					
2.B.9. Production of fluorochemical compounds							
2.B.10. Other							
2 C Metal industry							
2.C.1. Iron and Steel production	✓	✓					
2.C.2. Ferroalloys 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. 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							

CRF Category	CO_2	CH_4	N_2O	HFC	PFC	SF_6	NF_3
2.E.5. Other							
2 F Products used 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 use							
2.G.3. N_2O from product uses			✓				
2.G.4. Other							
2.H. Other							

GHG emissions for non-energy sectors were calculated using spreadsheet models. Activity data are correlated with various parameters such as: gross value added in industry, production structure by types of industrial processes. The emission factors used are either category-specific (determined based on the analysis of historical data) or in accordance with the IPCC 2006 guidelines. The sub-sector-specific assumptions, presented in subchapter 2.3, were also considered. The following calculation formula was used to estimate emissions:

$$E_g(t) = \sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{p} A_j(t-1)\cdot p_k\cdot\left(1+r_j(t)\right)\cdot EF_{g,k}(t)$$

where:

$E_g(t)$ – projected greenhouse gas emissions g in year t;

i – sector of activity, which is a source of GHG emissions;

j – sub-sector of activity, which is a source of GHG emissions;

k – product or material used for the production or use of which GHG emissions result;

p_k – the share of the product / quantity of material used in the activity data of the sub-sector;

$r_j(t)$ – factor of increase or decrease of activity data at the level of the activity sub-sector;

$EF_{g,k}(t)$ – emission factor for the greenhouse gas g for the product or material used, in year t.

For categories 2.B, 2.D, 2.F and 2.G, considering the difficulty to estimate in the long run the way of carrying out the activities that determine the occurrence of GHG emissions, in the realization of the forecasts the method of extrapolation of historical data is adopted.

5.4. Methodology for elaboration of the GHG emission projections in Agriculture

The following direct GHG emissions occur in the Agricultural sector:

- CH_4 from enteric fermentation;
- CH_4 and N_2O from manure management;
- CH_4 from rice cultivation;
- N_2O from use of fertilizers:

- CH_4 and N_2O from agricultural residue burning in the field.

To establish the GHG emission projections, the following equation is used in accordance with NIGHGE 2018:

GHG Emissions = AD x EF

where: AD is the projected activity date;
EF - forecast emission factor.

5.5. Methodology for elaboration of the GHG emission projections in Land Use, Land Use Change and Forestry

The LULUCF sector is divided into six types of land use for reporting GHG emissions/removals, namely:

- 4A *Forest Land;*
- *4B Cropland*;
- *4C Grassland*;
- *4D Wetlands*;
- *4E Settlements*;
- *4F* Other lands;
- 4G Harvested wood products.

The main components of GHG emissions in the LULUCF sector are: carbon dioxide, methane and nitrous oxide. The only chemical element of carbon dioxide is absorbed.

The projections were established based on historical data from the *National Greenhouse Gas Inventory*.

The *reference scenario* is based on historical evolution of the chemical components of GHG removals/emissions at the LULUCF sector from 1989-2017 on each predefined land category, using historical data from the National Greenhouse Gas Inventory.

The procedure for estimating the net quantity of GHG in the LULUCF sector was carried out as follows:

The values of the surfaces were estimated using the method of modifying the absolute annual average. The determination of the trend by the method of modifying the absolute mean implies that *the adjusted values are determined by the following* ***recurrence relation:***

$$\hat{y}_k = y_0 + k \cdot \overline{\Delta}, k = \overline{0, T}$$

where $y_0$is the term considered as the basis of adjustment (the year 1990, and for 1989 the value of K is -1), and $\overline{\Delta}$ represents the absolute average change that is calculated as simple arithmetic mean of the absolute changes based on the chain:

$$\overline{\Delta} = \frac{(y_1 - y_0) + (y_2 - y_1) + \ldots + (y_{T-1} - y_{T-2}) + (y_T - y_{T-1})}{T-1} = \frac{y_T - y_0}{T-1}.$$

The first and last adjusted value is equal to the first and last empirical value, as follows:

- for $k = 0 \rightarrow \hat{y}_0 = y_0 + 0 \cdot \overline{\Delta} = y_0$;
- for $k = T \rightarrow \hat{y}_T = y_1 + (T-1) \cdot \overline{\Delta} = y_1 + (T-1) \cdot \frac{y_T - y_0}{T-1} = y_T$.

For extrapolation, we have continued the *k* series until the last unit of time for the investigated time horizon. Thus, the value *k* is attached to each year starting with the value 0 for 1990, continuing in arithmetic progression with the ratio 1 to the value 60, which corresponds to the year 2040. From the analysis of the evolution of the surfaces over time, we have noticed that they have evolved in arithmetic progression with ration, equal to the absolute annual average change.

The evolution of the surfaces related to the specified areas has a linear trend over time, a trend that will be estimated by the method of modifying the absolute average. Based on the method of modifying absolute averages, it was projected the evolution of the surfaces for the time horizon 2018-2040.

Once the surfaces were estimated, it was assumed that the quantitative level of GHG is based on the surface of the specified area, a function that is determined using the unifactorial regression method. In some situations, it was applied the method of mobile environments to highlight the trend of the GHG series for establishing the linear function used in the forecast of emissions/removals in correlation with the land surface.

The *unifactorial regression* envisages the quantification of the dependence relations in the form of unifactorial models, the verification of the hypotheses and the foundation of the forecast calculations.

The *unifactorial models* describe the connection between two variables X and Y, the other factors being considered with constant action.

The theoretical equation of this regression is of the form:

$$y_i = f(x_i) + u_i, i = \overline{1,n},$$

where u_i represents the action of other factors (perturbation), and n the number of observations.

The estimation of the parameters of this model is done using *the method of least squares* (MLS), which implies minimizing the sum of square deviations for the empirical values (y_i) starting from the estimated values ($\hat{y}_i$):

$$\sum_{i=1}^{n}(y_i - \hat{y}_i)^2 \to 0$$

In the unifactorial linear models, the resultant variable y depends on a single x factor through the relation:

$$y_i = a + b \cdot x_i + u_i,\ i = \overline{1,n}$$

where u_i represents the action of factors other than the analyzed factor (perturbation), and n the number of observations.

The estimation of the parameters of this model can also be done using the *method of least squares (MLS)*, which implies minimizing the sum of square deviations of the empirical values (y_i) from the estimated values ($\hat{y}_i$):

$$\sum_{i=1}^{n}(y_i - \hat{y}_i)^2 = \sum_{i=1}^{n}\left(y_i - \hat{a} - \hat{b} \cdot x_i\right)^2 \to 0,$$

where $\hat{a}$ and $\hat{b}$ are the estimators of the linear model parameters.

Minimizing the sum involves determining the stationary points that result from solving the system obtained by the cancellation of the partial derivatives of the function :

$$F(\hat{a},\hat{b}) = \sum_{i=1}^{n}\left(y_i - \hat{a} - \hat{b} \cdot x_i\right)^2$$

the following system of equations is reached:

$$\begin{cases} na + b\sum x_i = \sum y_i \\ a\sum x_i + b\sum x_i^2 = \sum x_i y_i \end{cases},$$

and after the calculations, the following relations of determining the estimators are obtained

$$\hat{a} = \frac{\sum_{i=1}^{n} y_i \sum_{i=1}^{n} x_i^2 - \sum_{i=1}^{n} x_i \sum_{i=1}^{n} x_i y_i}{n\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2} \qquad \hat{b} = \frac{n\sum_{i=1}^{n} x_i y_i - \sum_{i=1}^{n} x_i \sum_{i=1}^{n} y_i}{n\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2}.$$

The projection of the quantitative levels was made on the basis of linear models in which the surface is assimilated as a factorial variable. In determining the parameters of the linear models, the *Data Analysis* module from *Excel* was used.

The **scenario with measures** is based on the requirement that GHG emissions be reduced by 40% in 2030 compared to the base year. This requirement was valid only for GHG emissions from other economic sectors. For this purpose, for the year 2030, the projected level of emissions is calculated as the amount of GHG emissions recorded in the reference year multiplied by the value of the index resulting from the 40 % reduction. On the basis of this information, the change in the annual absolute average is determined as the change in the absolute annual average applied starting with the year 2017.

The **scenario with additional measures** is similar to the scenario with measures, the change in the annual absolute average applying from the reference year (1990).

The following tables present the estimated emissions for the year 2030, representing 60% of the 1990 level and the absolute average changes expressed in tons of CO2 equivalent.

Table 9. The calculation elements necessary for the emission projection in the scenario with measures and additional measures

Types of land use	1990	2030	The average level	Absolute mean change, tons CO_2 equivalent /year
A	(1)	(2)=0,6x (1)	(3)	(4) =[(2)- (1)] /40
N_2O emission				
4A. Forest	26,924	16,154	27,223	-269
4B. Cropland	425,845	255,507	425,841	-4,258
4C. Grassland	31,338	18,803	31,339	-313
4D. Wetlands	33,004	19,802	33,004	-330
4E. Settlements	249,757	149,854	249,755	-2,498
4F. Other land	564,892	338,935	1,071,802	-5,649
CH_4 emission				
4A. Forest	87	52	1,247	-0.87
CO_2 emission				
4C. Grassland	532,532	319,519	453,536	-5,325

4D. Wetlands	1,499,766	899,859	1,515,657	-14,998
4E. Settlements	3,573,527	2,144,116	3,682,484	-35,735
4F. Other land	790,224	474,135	806,604	-7,902

Table 10. The calculation elements necessary for the projection of absorption in the scenario with measures and additional measures

Removals by areas	The average level determined for the period 2005-2017	Absolute mean change, tone CO_2 equivalent/year
A. Forest (-)	23.230.797	-218.303
B. Cropland (-)	2.026.265	7.280
G. Harvested wood products (-)	4.008.631	277.945

Based on the average values and changes of the absolute average values, the level of emissions/removals for the period 2018-2050 has been estimated according to the following algorithm:

$$\widehat{y_t^i} = \bar{y^i} + t \times \overline{\Delta_{1990-2030}^i}$$

where: i – represents the type of greenhouse gas (CO_2, CH_4 or N_2O);

$t = 1, 2, 3, \ldots, 33$, where $t = 1$ represents the year 2018,

$t = 33$ represents the year 2040;

$\widehat{y_t^i}$ – the projected value for the "i" gas, corresponding to the year "t";

$\bar{y^i}$ – represents the average level of the "i" gas, calculated on the basis of information from 2005-2017;

$\overline{\Delta_{1990-2030}^i}$ – absolute average change calculated as the average of the absolute changes from one year to another for the level of emissions or removals recorded for each of the years from 1990 to 2030.

Finally, the estimated values of GHG emission/removals in the LULUCF sector will be determined as the sum of the estimated values for each year from 2018-2040.

5.6. Methodology for elaboration of the GHG emission projections in the Waste sector

Waste disposal in landfills has a direct impact on the environment, including by generation of GHG emissions.

Waste degradation is a complex of chemical and biological reactions, whose result is the generation of biogas with the basic composition: CH_4 and CO_2. The biogas decomposition and removal continues over 10 to 30 years. 50% of degradable organic waste is decomposed during the last 10 years, 12.5% of the remaining decompose over 30 years.

Projections of GHG emissions are made in accordance with the IPCC 2006 Guidelines.

To achieve emission forecasts, we started from the basic parameters on which base emissions from the waste sector are estimated in the National Inventory of Greenhouse Gases Emissions.

Methodology for the GHG emissions projections for waste water sector

CH_4 emissions from domestic and commercial wastewater treatment and sludge

The IPCC 2006 documentation applied to Romania's conditions highlights the existence of the following possible sources of methane gas emissions:

- Household waste water collected in sewerage networks and discharged into emissary without treatment. These waters undergo an aerobic self-purification process with minor methane emissions;
- Household waste water collected in sewerage networks and treated in city treatment plants using aerobic and anaerobic biological processes;
- Household waste water from non-sewer areas is collected in septic tanks or cesspools, where aerobic and anaerobic processes are carried out that cannot be controlled. Anaerobic processes. the source of methane. are more developed in high temperature areas and when the interval between vacuums is high.

The large wastewater treatment plants are equipped with active sludge basins containing aerobic, anoxic and oxic areas. The oxic areas can become anoxic and even anaerobic if the treatment process is not properly driven. In this case, methane gas may occur.

The sludge from the treatment plants is subjected to stabilization processes that can be anaerobic or aerobic. Biogas with a high methane content is produced in the case of anaerobic treatment of sludge. Typically, biogas is used in electricity or heat generation facilities. In case of malfunctions. methane can reach the atmosphere.

As a result of the above mentioned. household waste water that can be a significant source of methane emissions comes from:

- Population not connected to sewerage system;
- Population connected to sewerage system, with treatment.

The CH4 emissions from the treatment of domestic waste water depend directly on the population, biochemical oxygen consumption, methane emission factor (kg CH4/kg BOD). the usability of wastewater treatment plants, the organic component removed by sludge and the amount of CH4 recovered from wastewater.

CH4 Emissions from Industrial Wastewater Treatment

The estimation of methane production potential from industrial wastewater treatment was based on the concentration of organic components in wastewater, the volume of waste water and the treatment of industrial waste water in anaerobic systems.

The sectors with the highest potential methane emissions from wastewater treatment are: Pulp and paper manufacturing, Food (dairy products, beer, alcohol) and Crude oil refining.

The CH_4 emissions from industrial wastewater treatment depends directly of specific industrial production, the amount of wastewater generated, chemical oxygen consumption, methane emission factor (CH_4/kg COD kg), the organic component removed by sludge and the amount of CH_4 recovered.

N_2O emissions from wastewater treatment

N_2O emissions from human waste are related to the presence of nitrogen from proteins consumed. According to IPCC 2006. N_2O emissions are:

- Direct emissions in the case of modern wastewater treatment plants equipped with nitrification and denitrification steps;
- Indirect waste water emissions after their discharge into the receptors.

Considering the small share of modern wastewater treatment plants. only indirect N_2O emissions are reported in INEGES.

Indirect N_2O emissions depends directly on population, annual protein consumption per capita and on protein factors and emission factor for N_2O emissions.

5.7. Assumptions considered for the GHG emission projections in the three scenarios

Macroeconomic indicators

In order to define the hypotheses regarding the evolution of Romania in the period 2018÷2040, it was carried out a SWOT analysis of the period 1989÷2018 with the aim of:

- economic growth;
- demographic development;
- social development;
- structural adjustment of the economy;
- structural adjustment of the industry;
- technological modernization and reduction of energy intensity in industry, agriculture, construction;
- development and modernization of the transport sector;
- development and modernization of the services sector;
- development and modernization of living conditions.

The average annual GDP growth rate for 2018-2040 period shall be considered in the forecast for the period indicated by the National Commission for Strategy and Prognosis in the document **Projection of the main macroeconomic indicators** (from August 2020) for the period 2018 to 2021 and by the European Commission in June 2020.

Table 11. Average annual GDP growth rate 2005-2040 (%)

Year	2005	2016	2017	2018	2019	2020	2021-2025	2026-2030	2031-2035	2036-2040
	Achievements					Forecasts				
National Commission for Strategy and Prognosis (September 2020)	4.7	4.8	7.1	4.4	4.1	-3.8	4.1	3.0	2.3	1.8
Parameters recommended by the European Commission (June 2020)						-5.96	4.50	3.01	1.84	1.39

The table below shows the GDP growth rates for the 2020 to 2040 period provided by the National Commission for Strategy and Prognosis, which were considered in the implementation of GHG forecasts.

Table 12. Average annual GDP growth rate 2005-2040 (%)

Year	2005	2016	2017	2018	2019	2020	2021-2025	2026-2030	2031-2035	2036-2040
	Achieved					Forecasted				
Growth rate	4.7	4.8	7.1	4.4	4.1	-3.8	4.1	3.0	2.3	1.8

The positive evolution of the Romanian economy in the period 2000 - 2018 led to a 2.32-fold increase in gross domestic product per capita (9814 $Euro_{2016}$/resident at 2018 level). In the period 2007-2016 gross domestic product per capita increased by almost 20% compared to the European Union average. So, if in 2007 it stood at 40% of the average, in 2016 the value of this indicator reached 60% of the average. It follows that Romania must make important progress in economic development.

The table below shows the structure of the **GVA** (Gross Value Added) by branches in the period 2017 - 2040 provided by the National Commission for Strategy and Prognosis.

Table 13.GVA structure by branches (%)

Year	2017	2018	2020	2025	2030	2035	2040
	Achievements		Forecasts				
TOTAL GVA (%). out of which:	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Industry	27.1	27.2	24.7	24.3	23.3	22.8	22.4
Agriculture	4.8	5.2	4.7	4.2	3.8	3.5	3.3
Construction	5.8	5.5	6.9	7.5	7.8	7.7	7.6
Services	62.3	62.1	63.8	64.0	65.0	66.0	66.7

The table below shows the evolution of the main macroeconomic indicators used in the methodologies for determining GHG emission forecasts.

Table 14. Macroeconomic indicators in the period 2005 – 2040

Specification/ Year	2005	2016	2017	2018	2020 estimated	2025	2030	2035	2040
	Achieved					Forecasted			
Population (mill. inhabitants)	21.62	19.71	19.59	19.42	19.16	18.62	18.06	17.74	17.41
GDP (mld. Euro $_{2016}$)	122.13	170.38	182.49	190.59	190.89	233.88	271.22	303.62	331.72
GDP per capita (Euro $_{2016}$/capita)	5649.11	8644.26	9315.71	9814.20	9962.87	12560.61	15017.81	17115.16	19053.50
TOTAL GVA (mld. Euro $_{2016}$)	108.17	152.84	163.82	170.23	160.90	203.87	231.50	264.02	291.08
Industry	30.64	40.92	44.35	46.32	41.73	50.32	56.21	61.61	66.31
Agriculture	7.35	6.92	7.93	8.78	7.77	9.52	9.70	10.07	10.23
Construction	7.37	10.30	9.47	9.37	10.05	14.03	17.45	20.71	22.45
Services	62.80	94.70	102.07	105.75	101.34	130.00	148.14	171.63	192.09

Assumptions for elaboration of the projections in the ETS and non-ETS sectors

The share of ETS sectors from total GHG emissions reported in NIGHGE

The estimation of the share of ETS sectors from total GHG emissions reported in NIGHGE is a determining factor for GHG emissions projection, considering the different legal requirements applicable to ETS, respectively, non-ETS sectors and the need to respect the annual targets established for non-ETS sectors, according with the Decision no. 406/2009/EC. For the period 2013 - 2020, the GHG emissions from non-ETS sectors is expected to grow by 19% compared to 2005 GHG emissions level.

The annual levels of emissions allocated to Romania for each year between 2013 and 2020, calculated by applying the global warming potential defined in the fourth assessment report drawn up by the IPCC, established in Annexes I and II of the Decision no. 162/2013/EU, amended by Decision (EU) 2017/1471 are presented, as follows:

Table 15. Annual emission levels allocated to Romania for each year between 2013 and 2020

Global warming potential	Annual allocated emission level [t CO_2]							
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
The 4th IPCC report	83,080,513	84,765,858	86,451,202	88,136,547	90,958,677	92,739,954	94,521,231	96,302,508

The adjustments of the annual emission levels allocated to Romania for each year between 2013 and 2020, calculated by applying the global warming potential values defined in the fourth assessment report drawn up by the IPCC, established in Annexes I and II of the Decision no. 634/2013/EU, are presented in the following table.

Table 16. Adjustments of the annual emission levels allocated to Romania for each year between 2013 and 2020

Global warming potential	Annual allocated emission level [t CO_2]							
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
The 4th IPCC report	7,450,508	7,313,730	7,176,951	7,040,172	6,903,394	6,766,615	6,629,836	6,493,057

For estimation the shares of ETS sectors from total GHG emissions, the reporting data in accordance with Regulation (EU) no. 749/2014 (article 10) related to consistency of reported emissions with data from the ETS and, respectively, the findings from the 2020 review of the GHG emissions inventory of Romania pursuant to Article 4(3) of Regulation (EU) no. 2018/842 and to Article 3 of Decision no. 406/2009/EC were considered.

Considering that CO_2 emissions related to some ETS sectors are higher than NIGHGE for certain CRF categories, differences that generally rely on different reporting requirements (ETS, respectively, NIGHGE) and allocation method of combustion and process emissions by CRF

categories, for developing the GHG emissions projections the additional emissions were redistributed.

For assuring the consistency of reported data, the distributions of ETS emissions on NIGHGE categories also consider the previous Romania's reports related to GHG emissions projection.

The shares of ETS sectors from total GHG emissions considered for the projections are presented in the **table below:**

The shares of ETS sectors from total GHG emissions, 2018

CO_2 emissions	
CRF category	**ETS from NIGHGE (%)**
1. Energy	**44.14**
A. Fuel combustion	**45.52**
1. Energy industries	**93.37**
a. Public electricity and heat production	94.71
b. Petroleum refining	100
c. Manufacture of solid fuels and other energy industries	24.21
2. Manufacturing industries and construction	**54.17**
a. Iron and steel (including non-ferrous metals)	99.29
c. Chemicals	89.54
d. Pulp, paper and print	100
e. Food processing, beverages and tobacco	29.57
f. Non-metallic minerals	99.36
g. Other	6
2. Industrial Processes	**99.58**
A. Mineral industry	**99.42**
1. Cement production	100
2. Lime production	98.38
3. Glass production	95.32
4. Other process uses of carbonates	96.86
B. Chemical industry	**99.47**

1. Ammonia production	100
3. Nitric acid production	NO
4 Caprolactam, glyoxal and glyoxylic acid production	NO
5. Carbide production	NO
6. Titanium dioxide production	NO
7. Soda ash production	100
8. Petrochemical and carbon black production	99.79
C. Metal production	**99.79**
1. Iron and steel production	100
2. Ferroalloys production	NO
3. Aluminum production	100
4. Magnesium production	NO
5. Lead production	NO
6. Zinc production	NO
7. Other metal production	NO
N_2O emissions	
B. Chemical industry	
2. Nitric acid production	100.00
3. Adipic acid production	NO
4 Caprolactam, glyoxal and glyoxylic acid production	NO
PFC emissions	
2C. Metal industry	
3. Aluminum production	100.00

5.8. Assumptions for the Energy sector

Introduction

According to the National Action Plan in the Energy Efficiency field NAPEE IV at the level of 2015 Romania had the following characteristics:

- final energy consumption per capita of 1.102 toe, being 1.93 times lower than the EU28 average;
- the share of final energy consumption in primary domestic energy consumption was close to the EU28 average (1.02 higher than the EU28 average);
- the primary energy intensity was 0.227 toe/1000Euro, 1.89 times higher than the value of this indicator for the EU28 average;
- the structure of primary internal energy consumption has changed between 2005 and 2015, the natural gas having the highest share, followed by oil and coal;
- the final consumption of electricity per capita was 2171kWh, being about 2.6 times lower than the average value of the EU28 (5380kWh/capita); the share of electricity consumption in final energy consumption increased between 2005 and 2015, reaching 16.9% which still shows the low level of electricity penetration in social and economic activities.

The National Commission for Strategy and Prognosis presented in December 2019 the Energy Balance Forecast for 2019-2023 period, in correlation with the projection of macroeconomic indicators and Romania's national targets for energy efficiency. greenhouse gas emissions, the use of renewable energy resources, etc. The forecasts will be corrected considering economic developments during the pandemic period. It means that Romania's primary domestic energy consumption will be about 33 million toe in 2020, representing about 77% of the national target of 42.99 million toe indicated in PNAEE IV.

The final energy consumption of Romania will be about 24 million toe in 2020 representing about 79.2% of the national target of 30.32 toe.

Table 17. Forecast of primary energy consumption and final energy consumption [thou toe]

Year	2015	2016	2017	2018	2019	2020	2021	2022	2023
Internal primary energy consumption	**31844**	**31638**	**33391**	**33510**	**32971**	**33335**	**33680**	**34055**	**34390**
Consumption in the energy sector	3244	3326	3436	3281	3175	3190	3210	3230	3250
Losses	1078	1051	998	1002	975	965	950	940	930
Non-energy consumption	1299	1150	1075	1021	1000	990	980	970	965

Year	2015	2016	2017	2018	2019	2020	2021	2022	2023
End energy consumption, out of which in:	**21896**	**22317**	**23269**	**23611**	**23830**	**24135**	**24470**	**24815**	**25110**
- Industry	6059	5948	6057	6285	6180	6250	6335	6425	6485
- Construction	379	353	349	334	385	400	420	440	460
Transport and telecommunications	5591	6049	6506	6462	6675	6825	6980	7135	7285
Residential	7387	7438	7705	7776	7805	7825	7845	7870	7890
Agriculture. forestry and fishing	461	455	495	566	540	550	556	560	565
Services	2019	2074	2157	2188	2245	2285	2335	2385	2425

(Source: National Commission for Strategy and Prognosis. For the period 2019-2023. ***National Institute of Statistics*** *for 2015-2018)*

National Commission for Strategy and Prognosis considered the following assumptions for the elaboration of energy requirements forecasts for 2020-2040:

1. The production of crude oil and natural gas does not register any significant increase (determined for example by the opening of new deposits);
2. The efficiency of energy consumption at the economy branches level is improving from the level of the recent past (after 2010);

3. There are no large substitutions of the resources used by households as a result, for example, expansion of gas supply, electrification of household consumption, etc.;

4. The increase of electricity generation from renewable sources accompanies the increase of renewable generation capacity described in the NIECCP.

Electricity and heat production in cogeneration

In order to establish the development programme of power plants in the 2018 – 2040 period, are taken into consideration the forecast of the evolution of electricity and heat consumption in cogeneration, the diversification of primary energy resources, the retrofitting and modernization of the sector, modern technologies for the electricity and heat generation, environmental requirements.

Establishing the electricity generation structure in the 2018 - 2040 period is particularly difficult due to the high degree of uncertainty regarding:

- the evolution of electricity demand and fuel prices on international markets;

- compliance of existing thermal energy groups with environmental requirements;
- the ability of investors to carry out the investment programmes provided in the National Investment Plan. in the National Renewable Energy Action Plan (NREAP).

This is why different scenarios for the electricity generation structure are analyzed in the period 2018 to 2040 in order to consider different hypotheses regarding variations in key parameters influencing this structure.

Key assumptions for defining scenarios are related to:

- forecasts of electricity consumption;
- diversification of primary energy resources used;
- modern technologies for the production of electricity and heat in cogeneration;
- environmental requirements;
- the situation of existing energy groups in NES;
- investment programs of different companies in the country and abroad.

The table below shows the forecast of fuel prices for the 2020 – 2040 period according to EC recommendations.

Table 18. Hypotheses regarding the evolution of import fuel prices in the 2020 – 2040 period. according to EC recommendation

Fuel type	Price (€2016/toe)				
	2020	**2025**	**2030**	**2035**	**2040**
Crude oil	278.3	493.9	586.1	633.6	680.2
Natural gas	146.9	238.2	249.4	285.8	341.4
Coal	74.2	111.7	121.9	131.3	137.8
Price (€2016/GJ)					
	2020	**2025**	**2030**	**2035**	**2040**
Crude oil	6.6	11.8	14.0	15.1	16.2
Natural gas	3.5	5.7	6.0	6.8	8.2
Coal	1.8	2.7	2.9	3.1	3.3

For the reference scenario, the below table shows the evolution of electricity production in the 2005 – 2040 period which was envisaged for determination of the production capacities structure within NES.

Table 19. Evolution of domestic consumption and electricity generation in 2005 – 2040 period

Indicators	M.U.	2005	2016	2017	2018	2020	2025	2030	2035	2040
		Achievements				Forecasts				
Gross domestic electricity consumption	TWh	56.51	59.58	60.47	61.04	55.51	59.90	61.76	62.76	63.73
Total gross production	TWh	59.41	65.10	64.30	64.88	56.78	61.25	63.16	64.18	65.18

In 2018 the installed capacity in Romanian power plants was 23,178 MW as shown in **table below**.

Table 20.Installed capacity in Romanian power plants in 2018

Power Plant Type	Installed capacity (MW)
Power plants	
- on coal	6466.870
- on liquid hydrocarbons	50.775
- on gaseous hydrocarbons	4220.128
Nuclear power Plants	1414.000
Hydroelectric Power Plants	6609.153
Wind Power Plants	3032.258
Photovoltaic power plants	1385.280
TOTAL INSTALLED CAPACITY	23178.464

The development programme of power plants for the period 2018 - 2030 is presented considering the provisions of the Romanian Energy Strategy 2019 - 2030 with the perspective of 2050 and the 2021-2030 Integrated National Energy and Climate Change Plan presented in April 2020.

The programme of measures shall consider the provisions of INECCP 2021 - 2030 regarding the evolution of installed capacities for 2020 – 2030 period compared to installed capacities in 2018 in view of the policies and measures foreseen and the trend of increasing electricity demand.

According to this plan, by 2030, is expected to increase the installed capacity in wind power plants (WPP) to a power of 5255 MW and in photovoltaic power plants (PPP) to 5054 MW.

In order to meet the trajectory of the RES quota assumed by Romania, the new net energy production capacities in the RES needed to be installed are:

- Wind Power Plants (WPP)
  - 822 MW additional installed capacity in 2022 compared to 2020;
  - 559 MW additional installed capacity in 2025 compared to 2022;
  - 556 MW additional installed capacity in 2027 compared to 2025;
  - 365 MW additional installed capacity in 2030 compared to 2027.
- Photovoltaic Power Plants (PPP)
  - 994 MW additional installed capacity in 2022 compared to 2020;
  - 1.037 MW additional installed capacity in 2025 compared to 2022;
  - 528 MW additional installed capacity in 2027 compared to 2025;
  - 1.133 MW additional installed capacity in 2030 compared to 2027.

In the 2027-2030 horizon it will be necessary to preserve the existing capacity to take measures to rehabilitate about 3000MW in the WPP and 1250 MW in the PPP.

The INECCP provides the development and decarbonization plan for the Oltenia Energy Complex in the period 2020-2030. In this respect, the following actions are envisaged, which will be implemented by 2030:

- Construction of three photovoltaic parks, with a total installed capacity of about 300 MW on closed slag and ash deposits (related to Rovinari, Turceni and Işalnița thermal power plants). Works will begin in 2023, commissioning will be carried out in 2024(150 MW), respectively 2025 (additional 150 MW);
- Construction of a new cogeneration unit of 200 MW on natural gas at SE Craiova, which will replace from 2024 the current lignite capacities of 2x150 MW;
- Construction of a 400 MW unit on natural gas at SE Turceni, which will replace an existing capacity of 330 MW on lignite from 2026;
- Construction of 2 x 400 MW units (total installed additional capacity of 800MW) on natural gas at SE Işalnița which will replace unit 8 of 315 MW on lignite from 2024 and from 2025 unit 7 of 315 MW on lignite.

From 2024 onwards, a sustainable transition is foreseen by developing new natural gas units with a total installed capacity of 1400 MW. This fuel has the advantage of allowing flexibility on operation, which will allow greater integration of RES into the national energy system whereas natural gas can ensure the balancing of the system, considering the intermittent nature of the RES.

The INECCP states that nuclear energy is an important element for Romania's energy security. According to this plan, the extending of the operating life for Units 1 and 2 at CNE Cernavoda is an efficient solution, since the extension by another life cycle is made at costs of around 40% of the value of a new objective of the same capacity, through which can be ensured the supply of electricity free of greenhouse gas emissions, with minimal impact on the environment, at competitive costs, thus contributing sustainably to the decarbonization of the energy sector and the achievement of Romania's energy and environmental targets for 2030, in line with the objectives assumed at European and even global level (Paris Agreement). Unit 1 will be retrofitted in 2027-2028 period and Unit 2 will be retrofitted after 2037.

According to the INECCP, units 3 and 4 of CNE Cernavoda are expected to be put into operation in 2030 and 2031.

The INECCP provides for the development of high-efficiency cogeneration capacities/integration of RES into heat production for centralized heating systems. According to the plan, the implementation of cogeneration units or the rehabilitation of existing ones, achieving them as a priority for a number of local communities in Romania:

- Implementation of a combined cycle cogeneration unit within CTE Grozavesti, which involves the construction of a new high energy efficiency cogeneration unit (in the gas-steam combined cycle technology), operating on natural gas;
- Implementation of a combined cycle cogeneration unit within CTE Bucuresti Sud, which involves the construction of a new high efficiency cogeneration unit (gas-steam combined cycle) of about 200 MWe and about 200 MWt;
- Implementation of a new energy generation capacity, in high efficiency cogeneration, on natural gas, within CTE Progresu;
- Rehabilitation of the combined cycle in CTE Bucuresti Vest, with a view to extending the lifetime period / implementation of new combined cycle unit of approx.186 MWe and approx. 170 Gcal/h;
- Implementation of a new cogeneration power plant (CHP), operating on natural gas, at CET;
- Implementation of a new cogeneration unit at Midia (cca. 70 MW);
- In the scenario with additional measures is designed to increase the amount of renewable energy used in district heating, with geothermal energy source, from 31 ktoe in 2016 to 45 ktep at 2030 level.

In order to ensure NES maneuverability, it is appropriate to carry out hydroelectric power plants with accumulation and pumping of 1000 MW, provided for in the investment programme of SC Hidroelectrica SA for the 2020÷2030 period.

This programme is envisaged in the case of the scenario with measures for 2020-2040 period.

In the scenario with additional measures, it is expected that the installed capacity in wind and photovoltaic power plants to be supplemented by about 2000 MW in 2030 – 2040 period. The The table below shows the structure of electricity generation in the 2018 - 2040 period for the scenario with measures and the one with additional measures.

Table 21. Structure of electricity generation in the 2005 - 2040 period

Specification/Scenario/Year	Scenario	2005	2018	2020	2025	2030	2035	2040
		Achievements		Forecasts				
Total electricity production (GWh), out of which based on:	**WEM**	**59412**	**64877**	**55586**	**61252**	**63163**	**64210**	**65182**
- Liquid fuel		1816	28	19	0	0	0	0
- Solid fuel		21915	15646	11005	5530	0	0	0
- Gaseous fuel		9612	10538	9079	9545	6654	7379	8055
- Renewable resources		20207	26190	23227	34076	38428	38718	39009

Specification/Scenario/Year	Scenario	2005	2018	2020	2025	2030	2035	2040
		Achievements		Forecasts				
- Uranium		5555	11377	11354	11400	17319	17319	17319
- Biomass		307	1098	902	701	762	794	799
Total electricity production (GWh), out of which based on:	**WAM**	**59412**	**64877**	**55586**	**61252**	**63163**	**64210**	**65182**
- Liquid fuel		1816	28	19	0	0	0	0
- Solid fuel		21915	15646	11005	5530	0	0	0
- Gaseous fuel		9612	10538	9079	9545	6654	7379	5374
- Renewable resources		20207	26190	23227	34076	38428	38718	39009
- Uranium		5555	11377	11354	11400	17319	17319	20000
- Biomass		307	1098	902	701	762	794	799

Corresponding to the structure of electricity generation, results the total demand for energy resources as presented in the table below:

Table 22. Electricity demand structure in 2018 – 2040 period

Specification/Scenario/Year	Scenario	2018	2020	2025	2030	2035	2040
		Achievements	Forecasts				
Total demand for energy resources in PJ, out of which based on:	**WEM**	**392.6**	**324.44**	**255.89**	**242.69**	**247.77**	**252.65**
- Liquid fuel		9.05	6.14	0	0	0	0
- Solid fuel		178.69	125.69	63.16	0	0	0
- Gaseous fuel		73.88	63.66	62.92	46.65	51.73	56.60
- Renewable resources		4.08	3.05	2.61	2.84	2.84	2.85
- Uranium		126.9	125.9	127.2	193.2	193.2	193.2
Total demand for energy resources in PJ, out of which based on:	**WAM**	**392.6**	**324.44**	**255.89**	**242.69**	**247.77**	**263.63**
- Liquid fuel		9.05	6.14	0	0	0	0

Specification/Scenario/ Year	Scenario	2018	2020	2025	2030	2035	2040
		Achievements	Forecasts				
- Solid fuel		178.69	125.69	63.16	0	0	0
- Gaseous fuel		73.88	63.66	62.92	46.65	51.73	37.68
- Renewable resources		4.08	3.05	2.61	2.84	2.84	2.85
- Uranium		126.9	125.9	127.2	193.2	193.2	223.1

In the following **tables** are presented the GHG emissions evolution in the 2018 – 2040 period in the without measures scenario, in the with measures scenario and in the with additional measures scenario.

Table 23. Evolution of CO2 emissions from 2005 to 2040, in the analyzed scenarios

Scenario	Total emissions (kt CO_2)						
	2005	2018	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	33222.29	20245.79	33222.29	33222.29	33222.29	33222.29	33222.29
WEM			14843.91	8954.11	2594.2	2876.70	3153.64
WAM			14843.91	8954.11	2594.2	2876.70	2095.38

Table 24. Evolution of CH4 emissions from 2005 to 2040, in the analyzed scenarios

Scenario	Total emissions (kt CH_4)						
	2005	2018	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	0.50	0.39	0.50	0.50	0.50	0.50	0.50
WEM			0.29	0.20	0.13	0.13	0.14
WAM			0.29	0.20	0.13	0.13	0.12

Table 25. Evolution of N2O emissions from 2005 to 2040, in the analyzed scenarios

Scenario	Total emissions (kt N_2O)						
	2005	2018	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	0.38	0.30	0.38	0.38	0.38	0.38	038
WEM			0.26	0.11	0.016	0.016	0.012
WAM			0.26	0.11	0.016	0.016	0.011

Refineries

In accordance with the Energy Strategy of Romania 2019-2030 with a view to 2050, Romania has a higher crude oil processing capacity than the domestic demand for petroleum products. Romanian refineries, which purchase domestic crude oil production and import about two-thirds of what is needed, currently have an operating capacity of 12 million t /year.

The refining sector in Romania consists of four operational refineries: Petrobrazi (owned by OMV Petrom), Petromidia and Vega (owned by Rompetrol), Petrotel (owned by Lukoil), which have a total operating capacity of approximately 12 million tons per year.

In 2017, refineries in Romania processed 11.2 million tons of crude oil and additives (gross domestic deliveries were 11.17 million tons of crude oil and additives, out of which 3.52 million tons from domestic production), resulting: 5.47 million tons of diesel; 1.55 million tons of gasoline and kerosene; 0.56 million tons of coke oil; 0.7 million tons of LPG; 0.38 million tons of fuel oil; 0.2 million tons of naphtha; 0.5 million tonnes of refinery gas and 0.81 million tonnes of other refinery products. The total consumption of petroleum products was 9.45 million tons.

In 2018, the net import of crude oil was 8.265 million tons, mainly from Kazakhstan and the Russian Federation, but also from Azerbaijan, Iraq, Libya and Turkmenistan, while imports of petroleum products were about 3,290 million tons. Romania is an exporter of petroleum products - according to statistics. In 2018, Romania exported petroleum fuels and lubricants worth 2285.3 million euros (of which 943.4 million euros for motor fuels).

According to the Order 1401/2020 for the approval of the number of GHG emission certificates allocated free of charge related to the year 2020 for each installation in the stationary sector in which one or more activities provided in Annex 1 to GD no. 780/2006, 4 refineries are operational at national level; the fuels used in the combustion processes in the refineries falling under the EU-ETS, according to the GHG Emissions Authorizations issued for the period 2013-2020, are presented below**.**

Table 26. Fuels used in combustion processes in refineries

Name of the economic operator	Fuels used
SC Rompetrol Rafinăria SA VEGA- Workstation Rafinăria Vega Ploieşti	Natural gas, fuel oil, torch gas
SC OMV SA- Petrobrazi	Refinery gas, natural gas, fuel oil, torch gas, diesel
SC Rompetrol Rafinare - Workstation Petromidia	Refinery gas, natural gas, torch gas
SC Petrotel – Lukoil SA	Refinery gas, natural gas

The National Forecast Commission estimated the forecasts regarding the energy balance of Romania for the period 2018 - 2040, resulting the demand for liquid fuel to be used in industry, transport, agriculture, services, etc. To cover the internal demand of liquid fuels, it turned out that the four existing refineries will efficiently use their operational capacity of 12 million t / year. Therefore, in order to achieve the operation of the refineries during 2018-2040 at this capacity, it is necessary to ensure the fuel demand presented in following **table** considering the requirements of NAPEE IV and NIECCP.

Table 27. Evolution of the energy demand during 2005 - 2040

Fuel demand in PJ	**2005**	**2017**	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**
	Achievements			**Forecasts**				
Liquid fuels	48.17	25.32	21.69	21.0	20.8	20.6	20.6	20.4
Gaseous fuels	28.00	9.78	7.98	7.6	7.6	7.4	7.2	7.0
Biomass	-	0.001	0.0005	-	-	-	-	-
Other fuels	0.9	-	-	-	-	-	-	-
TOTAL (PJ)	**77.09**	**35.10**	**29.67**	**28.6**	**28.4**	**28.0**	**27.8**	**27.4**

Given that no information is available on the measures taken by businesses to increase energy efficiency and reduce GHG emissions, the same evolutions in GHG emissions are considered in the three scenarios for refineries.

The following tables present the evolutions of the GHG emissions during 2018-2040 for all the analysed scenarios.

Table 28. Evolution of the CO2 emissions during 2018 - 2040

	Total emissions (kt CO_2)					
	2018	**2020**	**2025**	**2030**	**2035**	**2040**

Scenario	Achieved	Forecasts				
All	1804.69	1740.18	1727.63	1703.95	1692.83	1669.07

Table 29. Evolution of the CH4 emissions during 2018 - 2040

Scenario	Total emissions (kt CH_4)					
	2018	2020	2025	2030	2035	2040
	Achieved	Forecasts				
All	0.04	0.04	0.04	0.04	0.04	0.04

Table 30. Evolution of the N2O emissions during 2018 - 2040

Scenario	Total emissions (kt N_2O)					
	2018	2020	2025	2030	2035	2040
	Achieved	Forecasts				
All	0.0	0.0	0.0	0.0	0.0	0.0

Fuel production and other energy industries

According to the Romanian Energy Balance, electricity, liquid and gaseous fuels are necessary for the extraction and handling of coal. Below is represented the fuel demand evolution corresponding to years 2015, 2010, 2016, 2017 and 2018, according to the data used in the 2018 NGHGI.

Table 31. Evolution of fuel demand for fuels preparing during 2005-2018

Type of fuel	2005	2010	2015	2016	2017	2018
	Quantity (PJ)					
Liquid fuels	22.75	11.68	8.19	4.44	10.38	9.94
Solid fuels	6.70	0.08	0.007	0.015	0.008	0.001
Gaseous fuels	56.06	48.45	22.02	26.97	27.79	25.51
Biomass	0.006	0.001	0.001	0.001	0.001	0.0005
TOTAL	85.516	60.21	30.22	31.43	38.18	35.45

The fossil fuels were used in the combustion processes resulting the GHG emissions presented in **below**. In 2018, these emissions were 3.18% of total GHG emissions, according to NGHGI 2018.

Table 32. Evolution of GHG emissions for fossil fuels preparing during 2005-2018

Type of GHG	2005	2010	2015	2016	2017	2018
	Quantity (kt)					
CO_2	5078.0	3522.0	1799.7	1808.3	2296.2	2121.0
CH_4	0.13	0.08	0.04	0.04	0.05	0.05
N_2O	0.02	0.01	0.00	0.01	0.01	0.01

It is difficult to establish the demand for fuel and electricity used in the production of fossil fuels during 2018-2040 given the restructuring of the sector and the changes foreseen with the use of different types of fuels in economic and environmental conditions. According to NIECCP, the use of coal after 2025 is expected to be restricted and instead, larger amounts of natural gas to be used.

The table below presents, for all 3 scenarios, the evolution of the fuel demand for the production of fossil fuels (extraction and handling of fossil fuels).

For the scenario “without measures”, the fuel demand reported in 2005 remains constant. For the scenarios “with measures” and “with additional measures”, the fuel demand of 2020 was extrapolated with an annual growth rate of 1% while also modifying the structure, given the given the priority use of gaseous fuel.

Table 33. Evolution of fuel demand for preparing fuels during 2020-2040

Scenario	Fuel demand (PJ)	2018	2020	2025	2030	2035	2040
WOM	Liquid fuels	-	22.75	22.75	22.75	22.75	22.75
	Solid fuels	-	6.70	6.70	6.70	6.70	6.70
	Gaseous fuels	-	56.06	56.06	56.06	56.06	56.06
	Biomass	-	0.006	0.006	0.006	0.006	0.006
	TOTAL, in PJ	-	85.516	85.516	85.516	85.516	85.516
WEM and WAM	Liquid fuels	9.94	8.85	8.50	9.70	8.00	7.50
	Solid fuels	0.001	0.00	0.00	0.00	0.00	0.00
	Gaseous fuels	25.51	24.65	26.71	27.3	30.9	33.35
	Biomass	0.0005	0.00	0.00	0.00	0.00	0.00
	TOTAL, in PJ	35.45	33.50	35.21	37.00	38.90	40.85

The table below shows the evolutions of GHG emissions during 2018 – 2040 from fuel production and other energy industries.

Table 34. Evolution of GHG emissions for preparing fossil fuels during 2020-2040

Scenario	GHG type	2005	2020	2025	2030	2035	2040
		Quantity (kt)					
WOM	CO_2	5078.0	5078.0.	5078.0	5078.0	5078.0	5078.0
	CH_4	0.13	0.13.	0.13	0.13	0.13	0.13
	N_2O	0.02	0.02	0.02	0.02	0.02	0.02
WEM and WAM	CO_2	-	1996.22	2086.04	2203.65	2283.71	2384.63
	CH_4	-	0.04	0.05	0.05	0.05	0.06
	N_2O	-	0.00	0.01	0.01	0.01	0.02

Fugitive emissions from fuels

GHG emissions result from the handling of fossil fuels. The following direct GHG emissions by source categories are quantified and reported in the NGHGI:

- CH_4 emissions due to handling of the solid fuels;
- CH_4, CO_2 and N_2O emissions due to handling of the oil and natural gas.

In 2018, GHG emissions from the fugitive emissions category from handling of the fossil fuel were 9878.62 kt $CO_{2equivalent}$, which represents 8.50% of total GHG emissions in that year. GHG emissions from coal handling account for 57.78% of fugitive emissions and those from oil and gas handling account for 42.22%

Fuel emissions of CH_4 result from coal handling. In 2018, these emissions were about 10.4% of CH_4 emissions due to the energy sector, 33% of total CH_4 emissions in Romania.

The table below shows the evolution of fugitive emissions, in 2005 and 2018, in the handling of the fossil fuels. It is noted that CH_4 emissions in 2018 were reduced by about 45% compared to 2005, in close correlation with the production of fossil fuels used and restructuring actions in these sectors.

Table 35. The evolution of fugitive emissions in 2005 and 2018 years

Fuels	Activity	CH_4 emissions (thous tons)		CO_2 emissions (thous tons)	
		2005	2018	2005	2018
Coal	**Handling of coals**	**455.85**	**228.32**	**-**	

	Underground mines	**433.48**	**208.19**	**-**	
	Mining activity	**64.85**	**5.92**	**-**	
	Post-mining activity	**9.09**	**0.89**	**-**	
	Abandoned mines	**359.54**	**201.38**	**-**	
	Surface mines	**22.37**	**20.14**	**-**	
	Mining activity	**20.65**	**18.59**	**-**	
	Post-mining activity	**1.72**	**1.55**	**-**	
Oil and natural gas		**221.79**	**144.70**	**1143.52**	**552.15**
Oil	**Total**	**17.03**	**10.30**	**877.59**	**388.47**
	Extraction	**1.34**	**0.80**		
	Production	**15.23**	**9.13**		
	Transport	**0.09**	**0.07**		
	Storage	**0.37**	**0.29**		
Natural gas	**Total**	**142.16**	**96.35**	**3.50**	**2.81**
	Production	**16.24**	**13.77**		
	Processing	**7.15**	**6.06**		
	Transport and storage	**4.78**	**3.25**		
	Distribution	**19.12**	**12.97**		
	Other activities	**94.87**	**60.29**		
Open flames at oil and natural gas		**62.60**	**38.05**	**262.46**	**160.87**

Taking into consideration the difficulty to make the forecast regarding the emission sources due to handling of fossil fuels for 2020 – 2040, the following assumptions were considered:

- for the scenario “without measures” - the value of emissions reported in 2005 remains constant;
- for the scenarios “with measures” and “with additional measures” - the value of reported emissions in 2018 is reduced with an average annual rate of about 4% during 2018-2020, with an average annual rate of 1% during 2020-2030 (compared to 2020) and with an average annual rate of 1.5% during 2030-2040, given the reduction of coal used, in the process of closing uneconomical deep-sea coal mines and the use of CH_4 emissions for preparing the domestic warm water.

The evolutions of CH_4 emissions during 2018 - 2040, in the three analyzed scenarios: without measures, with measures and with additional measures are presented below.

Table 36. The evolution of CH4 emissions during 2018 – 2040

Scenario	Total emissions (kt CH_4)						
	2005	2018	2020	2025	2030	2035	2040
	Achieved		Forecasts				
WOM	678.49	373.03	678.49	678..49	678.49	678.49	678.49
WEM			344.88	328.14	312.21	289.81	269.02
WAM			344.88	328.14	312.21	289.81	269.02

The systems corresponding to the oil and natural gas sector cover the entire chain from extraction (crude oil or natural gas) to the final consumer, including transformation processes to meet consumer requirements. The fugitive CO_2 emissions also result from these systems. In 2018, these emissions were 552.15 kt CO_2 representing about 1.2% of total CO_2 emissions in Romania.

Taking into consideration the difficulty to make forecasts on the evolution of the oil and natural gas sector in the future until 2040 and to make forecasts on fugitive CO_2 emissions, the following assumptions were considered for all three scenarios:

- for the scenario “without measures”, the value of emissions reported in 2005 remains constant;
- for the scenarios “with measures” and “with additional measures”, for the period 2020-2040, the value from 2018 is extrapolated with the average rate of 1%.

Table 37. The evolution of CO2 emissions during 2020 – 2040

Scenario	Total emissions (kt CO_2)						
	2005	2018	2020	2025	2030	2035	2040
	Achieved		Forecast				
WOM	1143.52	552.15	1143.52	1143.52	1143.52	1143.52	1143.52
WEM			563.25	591.98	622.17	653.91	687.27
WAM			563.25	591.98	622.17	653.91	687.27

Energy consumption in the industry sector

The following types of energy utilisation are considered within the energy sector:

- Fuels (gas, diesel);
- Strictly electric uses, without alternative (lighting, electrolysis, electric motors, etc.);
- Heat uses (space heating and domestic hot water, steam, furnace heating and direct heat generation, etc.);
- Special treatments.

Table 38. Alternative forms of energy by end-use categories for the industry sector

Forms of energy	Mining			Processing Industry				
						Thermal use		
	Electrical use	Engines	Thermal use	Power use	Engines	Space and water heating	Steam Productio	Furnaces /direct combusti on
Fossil fuels	X		X			X	X	X
Electricity	X		X	X		X	X	X
Fuels		X			X			
Heat						X	X	
Solar energy			X			X	X	
Traditional fuels (firewood, agricultural waste)			X			X	X	X
Modern biomass (biofuels, bioliquids)			X			X	X	X

Considering the assumptions on the development of different industrial sectors, the policies and measures specified in NIECCP 2021-2030 and in NAPEE IV, an evolution of the fuel demand within the industry sector on the 2018-2040 horizon, resulted for the two scenarios for which GHG emissions are forecast.

Table 39. The evolution of fuel demand for 2005 – 2040 (PJ)

Fuel demand	2005	2017	2018	2020	2025	2030	2035	2040
WEM Scenario	**Achieved**			**Forecasts**				
Total in PJ, out of which:	**258.52**	**200.887**	**207.740**	**174.5**	**166.7**	**161.2**	**157.2**	**154.1**
Liquid fuel	49.409	41.528	42.419	31.0	29.8	28.2	26.8	25.1
Solid fuel	34.483	4.763	5.420	3.2	0.0	0.0	0.0	0.0
Other fuels	2.534	7.660	13.780	6.2	4.9	4.0	3.5	2.5
Gaseous fuels	161.006	131.739	134.343	123.9	122.0	119.5	118.9	119.5
Biomass	11.088	15.197	11.778	10.2	10.0	9.5	8.0	7.0
WAM Scenario	**Achieved**			**Forecasts**				

Fuel demand	2005	2017	2018	2020	2025	2030	2035	2040
Total in PJ, out of which:	**258.52**	**200.887**	**207.740**	**174.5**	**166.7**	**161.2**	**155.1**	**151.2**
Liquid fuel	49.409	41.528	42.419	31.0	29.8	28.2	25.9	24.2
Solid fuel	34.483	4.763	5.420	3.2	0.0	0.0	0.0	0.0
Other fuels	2.534	7.660	13.780	6.2	4.9	4.0	1.5	0.0
Gaseous fuels	161.006	131.739	134.343	123.9	122.0	119.5	120.7	121.0
Biomass	11.088	15.197	11.778	10.2	10.0	9.5	7.0	6.0

The forecast of GHG emissions in the industrial sector is obtained for each type of fuel considering the specific emission factors used within the NGHGI.

The following tables present the evolutions of GHG emissions, in the period 2018 - 2040, in the 3 analysed scenarios. In the „without measures" Scenario, the values of GHG emissions obtained in 2005 are maintained for the period 2005-2040.

Table 40. Evolution of the CO2 emissions during 2005 - 2040

Scenario		Total emissions (kt CO_2)					
	2005	2018	2020	2025	2030	2035	2040
	Achieved		Forecast				
WOM	15951.62	12098.27	15951.62	15951.62	15951.62	15951.62	15951.62
WEM			9980.92	9595.89	9256.64	8934.91	8733.85
WAM			9980.92	9371.49	9035.41	8708.71	8466.36

Table 41. Evolution of the CH4 emissions during 2005 - 2040

Scenario		Total emissions (kt CH_4)					
	2005	2018	2020	2025	2030	2035	2040
	Achieved		Forecast				
WOM	1.01	1.03	1.01	1.01	1.01	1.01	1.01
WEM			0.70	0.62	0.58	0.51	0.45
WAM			0.70	0.62	0.58	0.43	0.35

Table 42. Evolution of the N2O emissions during 2005 - 2040

Scenario		Total emissions (kt N_2O)					
	2005	2018	2020	2025	2030	2035	2040
	Achieved		Forecast				
WOM	0.14	0.14	0.14	0.14	0.14	0.14	0.14
WEM			0.09	0.08	0.08	0.07	0.06
WAM			0.09	0.08	0.08	0.06	0.04

Energy consumption in the Transport sector

Romania has a national transport system (infrastructure, vehicles, etc.) located, to a large extent, both in terms of functional structure, and services provided, at the level of the average standards of conventional transport systems in Europe.

The strategic framework on sustainable transport policy in Romania is in line with the European policy defined in the White Paper on Transport.

In the field of transport, Romania holds a key position at the eastern border of the EU, as a transit area both on the east-west direction (connection with Asia via the Black Sea) and north-south (from the Baltic Sea to the Mediterranean Sea). Three of the TEN-T priority axes cross the Romanian territory.

The development of the Transport sector is conducted in close correlation with the socio-economic development of Romania.

For a coherent and correct analysis of the Transport sector from the energy point of view, two distinct areas are considered, namely: freight transport and passenger transport.

Considering the economic and social development of Romania, the transport sector must ensure in conditions of efficiency both the freight and passengers transports over different distances.

Table 43. Freight transport evolution during 2013 - 2018

Year	2005	2013	2014	2015	2016	2017	2018
Transported freight		thd tons					
Rail transport	69175	50596	52932	60723	55755	50348	50739
Road transport	306994	293409	174551	183629	188415	191486	190932
Inland naval transport	16632	24743	32088	29396	27946	26858	27834
Oil pipeline transport	13378	8520	6551	6020	5771	5625	6365

Year	2005	2013	2014	2015	2016	2017	2018
Freight routes		**mill. tons-km**					
TOTAL	75471	58361	53471	53354	56439	60038	61143
Rail transport	16582	11088	12275	14719	13472	12941	12264
Road transport	51531	34265	25883	26347	29662	34026	36135
Inland naval transport	5147	11765	14317	11409	12520	12242	11760
Oil pipeline transport	2211	1243	996	879	785	829	984

It is noted that during the period 2013-2018 of economic growth with an average annual growth rate of 4.5%, the freight routes increased from 58361 million tonne-km to 61143 million tonne-km with an average annual growth rate of about 1%.

The freight transport is conducted, mainly, by road (59.09%).

Table 44. Passenger transport evolution during 2013 - 2018

Year	2005	2013	2014	2015	2016	2017	2018
Transported passengers		**thou passengers**					
Rail transport	92424	57433	64760	66482	64456	69057	66500
Road transport	238017	274393	282018	275548	302951	325532	361338
Inland naval transport	218	140	167	169	153	153	120
Passenger routes		**mill. passengers-km**					
TOTAL	19820	21510	23326	22630	23740	23850	25520
Rail transport	7985	4411	4976	5149	4988	5664	5577
Road transport	11811	17082	18339	17471	18744	18178	19937
Inland naval transport	24	17	11	10	8	8	6

It is noted that during the period 2013-2018 of economic growth with an average annual growth rate of 4.5%, the passenger routes with an average annual growth rate of about 3.6%.

The passenger transport is conducted, mainly, by road (78%).

According to NAPEE IV and NIECCP, for the 2020-2040 horizon the following measures are going to be adopted in the transport sector:

- Renewal of the fleet of vehicles for all means of transportation;

- Development and promotion of alternative mobility;
- Limiting the circulation of the conventional vehicles in city centres;
- Promoting electric mobility in road transport;
- Promoting the use of biofuels in transport;
- Promoting the use of renewable energy in rail transport;
- Priority development of railway transport and its intermodal integration with other means of transportation;
- Electrification and modernization of railway lines;
- Modernization of urban and interurban passenger transport in major cities.

Considering the policies and measures specified in NIECCP 2021-2030 and in NAPEE IV, an evolution of the fuel demand within the transport sector on the 2018-2040 horizon, resulted for the two scenarios for which GHG emissions are forecast.

Table 45. The evolution of the fuel demand during 2018 - 2040 in the "with measures" scenario

Fuel demand	2005	2017	2018	2020	2025	2030	2035	2040
	Achieved			Forecasts				
Total in PJ, out of which:	**168,100**	**236,175**	**253,422**	**223,707**	**271,480**	**311,850**	**348,180**	**378,820**
Liquid fuel	166.262	223.716	240.973	212.695	259.466	306.630	344.935	377.55
Solid fuel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gaseous fuels	1.393	0.009	0.009	0.009	0.009	0.010	0.015	0.020
Biomass	0.445	12.450	12.440	11.003	9.005	5.210	3.230	1.250
a. Air transport	**2.640**	**2.064**	**2.325**	**2.050**	**2.500**	**2.900**	**3.400**	**4.300**
Gasoline	0.445	0.038	0.047	0.050	0.100	0.100	0.200	0.300
Kerosene	2.195	2.026	2.278	2.000	2.400	2.800	3.200	4.000
b. Road transport	**159.205**	**227.795**	**245.255**	**216.600**	**262.625**	**300.810**	**335.065**	**363.290**
Gasoline	66.490	55.733	55.154	50.600	63.800	69.300	75.900	81.500
Diesel fuel	89.987	155.845	173.739	151.500	181.825	218.710	246.865	268.690
Liquefied petroleum gas	2.311	3.773	3.924	3.500	5.000	7.600	9.100	11.900
Biomass	0.417	12.444	12.437	11.000	12.000	5.200	3.200	1.200
c. Rail transport	**3.123**	**4.627**	**4.028**	**3.462**	**4.320**	**5.500**	**6.530**	**7.500**
Liquid fuels	3.095	4.622	4.025	3.458	4.315	5.490	6.500	7.450
Biomass	0.028	0.005	0.002	0.002	0.005	0.010	0.030	0.050

Fuel demand	2005	2017	2018	2020	2025	2030	2035	2040
	Achieved			Forecasts				
d. Naval transport	**1.739**	**1.641**	**1.757**	**1.540**	**1.970**	**2.550**	**3.080**	**3.600**
Diesel fuel	1.697	1.617	1.721	1.530	1.940	2.500	3.000	3.500
Gasoline	0.042	0.024	0.036	0.010	0.030	0.050	0.080	0.100
e. Other types of transport	**1.393**	**0.047**	**0.057**	**0.055**	**0.065**	**0.090**	**0.105**	**0.130**
Liquid fuel	0.00	0.038	0.048	0.041	0.056	0.080	0.090	0.110
Gaseous fuels	1.393	0.009	0.009	0.009	0.009	0.010	0.015	0.020

Table 46. The evolution of the fuel demand during 2018 - 2040 in the "with additional measures" scenario

Fuel demand	2017	2018	2020	2025	2030	2035	2040
	Achieved		Forecasts				
Total in PJ, out of which:	**236.175**	**253.422**	**223.707**	**271.480**	**299.850**	**330.450**	**352.720**
Liquid fuel	223.716	240.973	212.695	259.466	296.630	330.435	352.700
Solid fuel	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gaseous fuels	0.009	0.009	0.009	0.009	0.010	0.015	0.020
Biomass	12.450	12.440	11.003	12.005	3.210	0.000	0.000
a. Air transport	**2.064**	**2.325**	**2.050**	**2.500**	**2.900**	**3.400**	**4.300**
Gasoline	0.038	0.047	0.050	0.100	0.100	0.200	0.300
Kerosene	2.026	2.278	2.000	2.400	2.800	3.200	4.000
b. Road transport	**227.796**	**245.255**	**216.600**	**262.625**	**288.810**	**317.365**	**337.190**
Gasoline	55.733	55.154	50.600	63.800	69.300	85.900	110.500
Diesel fuel	155.845	173.739	151.500	181.825	208.710	222.365	214.790
Liquefied petroleum gas	3.773	3.924	3.500	5.000	7.600	9.100	11.900
Biomass	12.445	12.438	11.000	12.000	3.200	0.000	0.000
c. Rail transport	**4.627**	**4.028**	**3.462**	**4.320**	**5.500**	**6.500**	**7.500**
Liquid fuels	4.622	4.026	3.459	4.315	5.490	6.500	7.500
Biomass	0.005	0.002	0.003	0.005	0.010	0.000	0.000
d.Naval transport	**1.641**	**1.757**	**1.540**	**1.970**	**2.550**	**3.080**	**3.600**

Diesel fuel	1.617	1.721	1.530	1.940	2.500	3.000	3.500
Gasoline	0.024	0.036	0.010	0.030	0.050	0.080	0.100
e. Other types of transport	**0.047**	**0.057**	**0.055**	**0.065**	**0.090**	**0.105**	**0.130**
Liquid fuel	0.038	0.048	0.046	0.056	0.080	0.090	0.110
Gaseous fuels	0.009	0.009	0.009	0.009	0.010	0.015	0.020

The forecast of GHG emissions in the transport sector is obtained for each type of fuel considering the specific emission factors used within the NGHGI.

The following tables present the evolutions of GHG emissions, in the period 2018 - 2040, in the three analysed scenarios. In the „without measures" Scenario, the values of emissions achieved in 2005 are extrapolated with an average annual growth rate of 3% for the period 2005 - 2040.

Table 47. Evolution of the CO2 emissions during 2018 - 2040

Scenario		Total emissions (kt CO_2)					
	2005	2018	2020	2025	2030	2035	2040
	Achieved		Forecasts				
WOM	12360.920	18177.850	19257.910	22325.190	25679.020	30003.190	34781.920
WEM			16034.029	19767.620	23093.104	25977.021	28406.760
WAM			16034.029	19535.991	22321.007	24800.510	26322.506

Table 48. Evolution of the CH4 emissions during 2018 - 2040

Scenario		Total emissions (kt CH_4)					
	2005	2018	2020	2025	2030	2035	2040
	Achieved		Forecast				
WOM	2.800	1.360	4.360	5.050	5.860	6.800	7.870
WEM			1.221	1.505	1.675	1.848	2.009
WAM			1.221	1.517	1.643	1.934	2.341

Table 49. Evolution of the N2O emissions during 2018 - 2040

Scenario		Total emissions (kt N_2O)					
	2005	2018	2020	2025	2030	2035	2040

	Achieved		Forecast				
WOM	0.500	0.750	0.780	0.900	1.050	1.210	1.400
WEM			0.657	0.792	0.919	1.033	1.129
WAM			0.657	0.796	0.884	0.969	1.025

Energy consumption in the Services sector

The energy consumption of the services sector is closely related to the economic activity level of the sector characterized by the added value and the working force involved. The service sector includes two main categories, namely: trade and public services.

The service sector requires space heating/cooling, preparation of hot water and food, lighting, operation of electric motors, computer powering, etc. For this purpose, the service sector uses fuels, as well as electricity and heat.

Considering the policies and measures specified in NIECCP and in NAPEE IV, an evolution of the fuel demand within the services sector on the 2018-2040 horizon, resulted for the three scenarios for which GHG emissions are forecast. The table below shows the evolution of the fuel demand for the „with measures" scenario and the „with additional measures" scenario.

Table 50. The evolution of the fuel demand on the period 2018 - 2040

Fuel demand	**2005**	**2017**	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**
WEM Scenario	**Achieved**			**Forecasts**				
Total in PJ, out of which:	**42.924**	**37.876**	**38.513**	**38.300**	**38.800**	**39.400**	**38.300**	**36.000**
Liquid fuel	10.183	3.722	4.304	4.300	4.300	4.500	4.000	3.500
Solid fuel	0.015	0.0	0.026	0.02	0.0	0.0	0.0	0.0
Gaseous fuels	32.726	33.998	34.057	33.980	34.500	34.900	34.300	32.500
Other fuel	0.0	0.156	0.123	0.0	0.0	0.0	0.0	0.0
Biomass	0.0	0.0	0.001	0.0	0.0	0.0	0.0	0.0
WAM Scenario	**Achieved**			**Forecasts**				
Total in PJ, out of which:	**42.924**	**37.876**	**38.513**	**38.300**	**38.800**	**39.400**	**37.500**	**35.500**
Liquid fuel	10.183	3.722	4.304	4.300	4.300	4.500	3.500	3.000
Solid fuel	0.015	0.0	0.026	0.020	0.0	0.0	0.0	0.0
Gaseous fuel	32.726	33.998	34.057	33.980	34.500	34.900	34.000	32.500
Other fuels	0.0	0.156	0.123	0.0	0.0	0.0	0.0	0.0
Biomass	0.0	0.0	0.001	0.0	0.0	0.0	0.0	0.0

The following tables present the evolutions of GHG emissions, in the period 2018 - 2040, in the three analysed scenarios. In the „without measures" Scenario, the evolution of GHG emissions was determined by extrapolating the values achieved in 2005 with an average annual rate of 0.5%.

Table 51. Evolution of the CO2 emissions during 2018 - 2040

Scenario		Total emissions (kt CO_2)					
	2005	2018	2020	2025	2030	2035	2040
	Achieved		Forecast				
WOM	2513.41	2206.91	2708.65	2777.04	2847.16	2919.05	2992.76
WEM			2190.21	2217.40	2253.54	2185.44	2050.60
WAM			2190.21	2217.40	2253.54	2134.02	2015.86

Table 52. Evolution of the CH4 emissions during 2018 - 2040

Scenario		Total emissions (kt CH_4)					
	2005	2018	2020	2025	2030	2035	2040
	Achieved		Forecast				
WOM	0.25	0.24	0.27	0.277	0.284	0.291	0.298
WEM			0.21	0.21	0.21	0.21	0.19
WAM			0.21	0.21	0.21	0.20	0.19

Table 53. Evolution of the N2O emissions during 2018 - 2040

Scenario		Total emissions (kt N_2O)					
	2005	2018	2020	2025	2030	2035	2040
	Achieved		Forecast				
WOM	0.01	0.01	0.011	0.011	0.0113	0.0116	0.0119
WEM			0.01	0.01	0.01	0.01	0.00
WAM			0.01	0.01	0.01	0.00	0.00

Energy consumption in the residential sector

The energy consumption of the residential sector is closely related to the number of households (dwellings), the level of family wellbeing, the average number of persons per household, climatic and cultural conditions.

The income level per household is an important element for energy consumption. Individuals with a higher income are able to occupy larger dwellings and to consume more energy using air conditioning equipment, multiple TVs and domestic appliances.

In order to determine the energy demand evolution in the residential sector it is estimated the average surface evolution of a dwelling, as well as, the evolution of indicators used for calculation of the energy demand differentiated between urban and rural area.

Table 54. Evolution of average surface for a dwelling [m2]

Type of dwelling	2018	2020	2025	2030	2035	2040
Apartment in multifamily building	56.3	58.5	60.0	62.0	64.0	66.0
Single family dwelling placed in the urban area	69.5	74.0	78.0	82.0	84.0	86.0
Individual dwelling placed in the rural area	45.0	48.0	50.0	52.0	54.0	56.0

Considering the assumptions and projections of the National Forecast Commission (NFC), the policies and measures specified in NIECCP and in NAPEE IV, an evolution of the fuel demand for the residential sector on the 2018-2040 horizon, resulted for the two scenarios for which GHG emissions are forecast.

Table 55. The evolution of fuel demand for 2018 – 2040

Fuel demand	2005	2017	2018	2020	2025	2030	2035	2040
WEM Scenario	**Achieved**			**Forecasts**				
Total in PJ, out of which:	**239.640**	**242.297**	**245.532**	**249.4**	**253.2**	**255.6**	**258.5**	**261.3**
Liquid fuel	28.399	11.763	12.233	13.4	15.2	15.9	16.5	17.9
Solid fuel	0.522	1.443	1.420	1.5	0.0	0.0	0.0	0.0
Gaseous fuel	96.324	101.372	105.249	106.7	108.5	110.7	113.5	116.4
Biomass	114.395	127.719	126.630	127.8	129.5	129.0	128.5	127.0
WAM Scenario	**Achieved**			**Forecasts**				
Total in PJ, out of which:	**239.640**	**242.297**	**245.532**	**249.4**	**253.2**	**255.6**	**257.0**	**259.5**
Liquid fuel	28.399	11.763	12.233	13.4	15.2	15.9	16.0	17.0
Solid fuel	0.522	1.443	1.420	1.5	0.0	0.0	0.0	0.0
Gaseous fuel	96.324	101.372	105.249	106.7	108.5	110.7	113.0	116.5
Biomass	114.395	127.719	126.630	127.8	129.5	129.0	128.0	126

The following tables show the evolutions of GHG emissions, in the period 2018 - 2040, in the three analysed scenarios. In the „without measures" scenario, the evolution of the GHG emissions was determined by extrapolating the values achieved in 2005 with an average annual rate of 1% for the period 2005-2040.

Table 56. Evolution of the CO2 emissions during 2018 – 2040

Scenario	Total emissions (kt CO_2)						
	2005	2018	2020	2025	2030	2035	2040
	Achieved		Forecasts				
WOM	7240.88	6766.68	8406.43	8835.25	9285.93	9759.61	10257.45
WEM			6929.74	7017.23	7184.85	7379.38	7631.21
WAM			6929.74	7017.23	7184.85	7319.23	7578.56

Table 57. Evolution of the CH4 emissions during 2018 - 2040

Scenario	Total emissions (kt CH_4)						
	2005	2018	2020	2025	2030	2035	2040
	Achieved		Forecasts				
WOM	35.13	39.01	40.75	42.83	45.01	47.31	49.72
WEM			39.39	39.47	39.34	39.20	38.78
WAM			39.39	39.47	39.34	39.05	38.47

Table 58. Evolution of the N2O emissions during 2018 - 2040

Scenario	Total emissions (kt N_2O)						
	2005	2018	2020	2025	2030	2035	2040
	Achieved		Forecasts				
WOM	0.48	0.52	0.56	0.58	0.61	0.65	0.68
WEM			0.53	0.53	0.53	0.53	0.52
WAM			0.53	0.53	0.53	0.53	0.52

Energy consumption in Agriculture and Forestry

Romania has actively participated in the debate on the Common Agricultural Policy (CAP) for the period 2021 - 2027. The post-2020 CAP reform package contains three legislative proposals:

- A regulation on strategic plans in the field of the CAP (which addresses direct payments, sectoral interventions and rural development);
- A regulation on the single common organization of the market (single CMO);
- A horizontal regulation on the financing, management and monitoring of the CAP.

The common objectives of the CAP are the following:

- to increase competitiveness;
- to ensure a fair income to farmers;
- to protect food and health quality;
- vibrant rural areas;
- to support generational renewal;
- to preserve landscapes and biodiversity;
- environmental care;
- climate change action,
- to rebalance the power in the food chain.

A total amount of EUR 20.5 billion is proposed by EC for Romania in the 2021-2027 period, out of which:

- EUR 13.3 billion are allocated for direct payments;
- EUR 363 million are directed to market support measures (EAGF);
- EUR 6.7 billion are assigned for rural development (EAFRD).

The implementation of the post-2020 CAP reform package aims to:

- Increase the productivity and competitiveness of the agri-food sector;
- Increase the degree of resistance of agricultural holdings to climatic factors and ensuring food security;
- Increase the added value of agricultural products;
- Diminish the dependence of farmers on the incomes obtained from the agricultural production by achieving integrated productions in the agricultural farms in order to reduce the variability of the agricultural incomes;
- Increase the incomes of farmers and the rural population;
- Attract young people to agriculture;
- Increase the degree of association;
- Increase the role of research in obtaining agricultural production in the context of climate change and the efficient use of agricultural resources;
- Increase the quality of life in rural areas.

According to the 2021-2030 NIECCP, in the agricultural and rural development sector, the following measures will be taken to reduce GHG emissions and pollutants:

- Supporting investments for modernization of farms;
- Promoting good agricultural practices;
- Promoting carbon sequestration in agriculture;
- Rehabilitating and modernising of irrigation and drainage infrastructure;
- Adequately managing of agricultural lands for adaptation to the effects of climate change.

For the period 2018 - 2040 it is estimated the reduction of energy intensity. The specific fuel consumption for agricultural works will have a decreasing trend due to the concentration of agricultural land, but also an increasing effect due to the replacement of animals for agricultural work with cars. Action will be taken to modernize irrigation systems.

Considering the hypotheses and forecasts of the National Forecast Commission regarding the development of the agricultural sector, the policies and measures specified in NIECCP and in NAPEE IV, an evolution of the fuel demand for the 2018-2040 horizon, resulted for the scenario with measures and additional measures for which GHG emissions are forecast.

Table 59. The evolution of fuel demand for 2018 – 2040

Fuel demand	**2005**	**2017**	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**
WEM Scenario	**Achieved**			**Forecasts**				
Total in PJ, out of which:	**6.623**	**17.068**	**20.746**	**18.6**	**23.1**	**27.9**	**31.9**	**34.3**
Liquid fuel	4.842	11.894	15.227	15.1	18.1	21.0	22.5	24.1
Solid fuel	0.008	0.0	0.004	0.0	0.0	0.0	0.0	0.0
Gaseous fuels	1.518	4.425	4.675	3.1	4.5	6.5	9.0	10.0
Other fuel	0.141	0.495	0.621	0.2	0.1	0.0	0.0	0.0
Biomass	0.114	0.254	0.219	0.2	0.4	0.4	0.4	0.2
WAM Scenario	**Achieved**			**Forecasts**				
Total in PJ, out of which:	**6.623**	**17.068**	**20.746**	**18.6**	**23.1**	**27.9**	**29.4**	**32.7**
Liquid fuel	4.842	11.894	15.227	15.1	18.1	21.0	20.5	23.0
Solid fuel	0.008	0.0	0.004	0.0	0.0	0.0	0.0	0.0
Gaseous fuel	1.518	4.425	4.675	3.1	4.5	6.5	8.5	9.5
Other fuels	0.141	0.495	0.621	0.2	0.1	0.0	0.0	0.0
Biomass	0.114	0.254	0.219	0.2	0.4	0.4	0.4	0.2

The following tables show the evolutions of GHG emissions, in the period 2018 - 2040, in the three analyzed scenarios. In the "without measures" scenario, the evolution of GHG emissions was not determined by extrapolating the values achieved in 2005 given that the restructuring that took place in agriculture led to an increase in fuel consumption in the sector 3.1 times between 2005 and 2018. In view of this increase, in order to determine the CO_2 emissions, the values obtained in 2017 will be extrapolated with an average annual rate of 3.5% for the period 2017 - 2040. To determine the values of CH_4 and N_2O emissions, the values obtained in 2018 will be extrapolated at a rate annual average of 3.5% for the period 2018 - 2040.

Table 60. Evolution of the CO2 emissions during 2018 – 2040

Scenario		**Total emissions (kt CO_2)**					
	2017	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**
	Achieved		**Forecast**				
WOM	1241.79	1382.52	1376.80	1635.23	1942.28	2306.42	2739.84
WEM			1242.10	1517.67	1819.67	2062.86	2229.57

WAM			1242.10	1517.67	1819.67	1896.17	2125.38

Table 61. Evolution of the CH4 emissions during 2018 - 2040

Scenario		Total emissions (kt CH_4)					
	2017	2018	2020	2025	2030	2035	2040
	Achieved		Forecast				
WOM	0.36	0.43	0.46	0.55	0.65	0.770	0.951
WEM			0.28	0.35	0.36	0.39	0.35
WAM			0.28	0.35	0.36	0.36	0.33

Table 62. Evolution of the N2O emissions during 2018 - 2040

Scenario		Total emissions (kt N_2O)					
	2017	2018	2020	2025	2030	2035	2040
	Achieved		Forecast				
WOM	0	0.42	0.45	0.53	0.63	0.75	0.89
WEM			0.41	0.50	0.57	0.62	0.66
WAM			0.41	0.50	0.57	0.56	0.63

5.9. Assumptions for the Industrial processes and other products use

Mineral industry

Cement Production

The cement industry is highly concentrated in Romania, 7 business units being held by three large international companies. These units are vertically integrated upstream, because they have their own career to ensure raw materials and carry out the processing to the final product - the cement. All these units are included in the EU-ETS, so that emissions from the industrial processes are found entirely under this legislation.

Due to the relatively high transport costs, cement or clinker is not usually transported over long distances (+/- 200 km at most). At the national level, between 2014÷2018 imported or exported quantities of clinker were very small. Thus, it appears that the cement industry in Romania is closely related to the socio-economic development of the country.

Clinker production in Romania had a downward trend from a peak in 1989 (10,571kt) to a minimum of 4,971 kt in 1999 with a slight revival in 2006 when they were produced approx. 6,000 kt clinker. There was a period of 5 years when production was around 5,000 kt clinker. Since 2003, with the economic recovery, production began to increase reaching a maximum value of 7,780 kt in 2008, followed by a decrease of about 25% in 2009 (5,801 kt). In 2015 the production

continued to increase compared to 2014, and in 2016 there was a decrease of approx. 4.5% compared to the previous year. In 2017, the registered clinker reached 6322 kt, returning to a level close to that of 2015. In 2018, there was a new increase in production that reaches a value of 6696 kt of clinker.

Cement manufacturing technologies existing in Romania are within the limits set by the BAT-BREF and are expected that by applying the new conclusions regarding the Best Available Technologies from 2010/75/UE Directive regarding Industrial Emissions, supplementary emissions reduction will be reached.

It is difficult to forecast the evolution of clinker production in circumstances where there are the following potential threats:

- competition from imports from non-EU economies that are not subject to the regulations related to carbon
- high costs of energy, particularly electricity costs as an indirect effect of legislation on climate change (higher than for competitors)
- relocation of investments outside the EU.

CO_2 emissions from cement production sector are mainly influenced by the clinker production, emission factor associated with clinker production, the amount of kiln dust not reintroduced into the system, its associated emission factor and correction factor for kiln dust. CO_2 emission factor associated with clinker production is calculated based on the contents of CaO and MgO.

For emissions projections in the WOM scenario, the average value of 0.529 tonnes CO_2/ tonne of clinker will be used, which represents the value of the emission factor in 2005. The activity data will be the same as in the WEM and WAM.

Considering the effects of the 2010/75/EU Directive, for the WEM and WAM scenarios the assumption is that EF will decrease in the period 2019-2025 to a value of 0.52 tonnes CO_2/ tonne of clinker and will continue to decrease to 0.50 tonnes of CO_2/tonne of clinker till 2035, after which it will remain constant.

Considering the evolution of GVA in the construction sector during 2019÷2040, it is estimated that in the year 2025 it will reach a value of 7200 kt clinker and in 2035 this production will be about 8600 kt clinker and will remain constant until 2040.

Table 63. The CO2 emissions projection for category A.1. Cement production, in the period 2020-2040

Scenario	Total CO2 emissions, kt CO2							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	3174.810	3310.254	3504.830	3650.100	3808.800	4073.300	4549.400	4549.400
WEM, WAM				3601.800	3744.000	3927.000	4300.000	4300.000

Lime production

Lime is a material used for a long time and with many applications. In the EU 27 in 2004, 30÷40% of the lime production was used in metallurgy, 30% in environmental applications, agriculture and forests, 15÷20% in construction and soil stabilization and 10÷15% in other applications (chemical industry, food industry, paper making, medicine, etc.).

Lime production declined in the late 1980s as a result of changes in consumption pattern, mainly because of the largest consumer, the iron and steel industry, which has drastically reduced its specific consumption of lime (from 100 kg/t steel to 40 kg/t steel). Lime production began to rise again in the mid-1990s, mainly due to the new environmental uses.

Lime kilns are a big, long-term investment, making difficult adaptation of this industry to short-term fluctuations in demand or quick compliance to legislative changes related to energy or air emissions.

Lime industry in Romania is quite concentrated, with eight business units, non-captive in terms of production, owned by 4 companies. These units are vertically integrated upstream, because they have their own career to ensure raw materials and carry out the processing to the final products. There are also economic units who own lime factories, resulting products being used in their flows (captive units).

Captive and non-captive lime production (quicklime and dolomite lime) in Romania had a downward trend from a peak in 1989 (3,141 kt) to a value of 1,295 kt in 1994. The highest value of production after 1989 was recorded in 2007 and reached a value of 2,010 kt (around 64% of 1989 production). Because of the economic crisis the total of lime production decreased in 2008 compared to 2007 and continued this trend in 2009 (by 32% compared to 2008). In the period 2014-2018 the average production was around 1127 kt. The year 2015 marked a decrease in production to a value of 1050 kt (15% lower than in 2014). In 2014 and 2016-2018 the production of dolomite lime was ceased, but in 2015 it was produced a small quantity (about 0.815 kt dolomite lime).

Lime manufacturing technologies existing in Romania are within the limits set by the BAT-BREF and are expected that by applying the new conclusions regarding the Best Available Technologies from 2010/75/UE Directive regarding Industrial Emissions, supplementary emissions reduction will be reached.

Possible threats faced by the lime industry are:

- rising energy prices affecting the competitiveness of industry
- imposing unilateral carbon-related constraints on the lime producers which could lead to increased imports of lime from neighbouring EU countries
- increased compliance costs with environmental legislation.

Lime is heavy product and with a relatively low selling price, therefore transport costs have an important share and can determine the distance on which lime it can be viably transported. Therefore, long-distance delivery of lime is limited (<300 km), except for certain special products, or in areas that do not have any natural source of limestone. Only a very small percentage of total production is exported, and this is usually done in neighbouring countries. If a large manufacturer has identified potential markets, it usually took the decision to invest in production capacity in these markets.

Given the current economic situation, it is considered as a hypothesis that in the short term no new production capacities will be closed or opened. Regarding the activity data, the following assumptions are used:

- For the WOM scenario, the production structure will be the same as in 2005 (87% calcium lime, 13% dolomite lime); the total lime production will be the same as in the WEM and WAM scenarios.
- For the WEM and WAM scenarios the production structure will consider only calcium lime production. Given the demand of the internal market, the production of calcium lime is estimated to increase to 1,650 kt in 2025, to 2,040 kt in 3035 and will remain constant until 2040. The maximum value production registered in 1989 will not be reached (3,141 kt).

CO_2 emission factor associated with lime production are estimated based on CaO and MgO contents. For CO_2 emissions projections the following assumptions will be used:

- for the WOM scenario, the default values presented in the 2006 IPCC guidelines will be used (0.75 tonnes CO_2/tonne of high calcium lime, respectively 0.80 tonnes CO_2/tonne of dolomitic lime);
- for WEM and WAM scenario the effects of 2010/75/UE Directive will be considered. Thus, the EF for high calcium lime will decrease in the period 2019-2025 to a value of 0.74 tonnes of CO_2/tonne of high calcium lime (99% of the value in the period 2014-2018) and will remain constant until 2040.

Table 64.The CO2 emissions projection from 2A.2. Lime production, in the period 2020-2040

Scenario	Total CO_2 emissions, kt CO_2							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	908.892	838.135	868.137	945.625	1248.225	1475.175	1815.600	1815.600
WEM, WAM				928.750	1221.000	1443.000	1776.000	1776.000

Glass Production

Glass is a material used to manufacture a wide range of products, for example: flat glass, glass for liquids, glass containers, special glass, glass wool, glass fibre, glass for liquid bottling. The melting process of raw material for production glass is often similar even the fused glass is used for manufacturing different types of products.

Production of flat glass, glass for liquids and glass fibre occurs predominantly in multinational companies, while domestic production of glass (manufacture of tableware and decorative glassware) in most cases occurs in small and medium enterprises. Unlike the production of technical glass, domestic glass production is characterized by a greater diversity of products and processes, including manual glass shaping

National glass production decreased from a peak in 1989 (1,137 kt) to a value of 286 kt in 1999. It followed a period of 4 years in which the amounts of glass produced increased to a maximum of 538 kt (2003). On the economic crisis, quantities of glass products decreased in Romania by

about 20% in 2009 compared to 2008. In the period 2014÷2016 the total glass production followed an upward trend, reaching values of 411 kt (in 2016), and in the period 2017÷2018 it will decrease up to 394 kt.

The main weaknesses of this sector are the high energy intensity of production process. Also, the production technologies have reached a high level of maturity, and in some areas, the process is highly automated (flat glass production). Thus, the ability to improve energy performance and reduce CO_2 emissions is limited. The high cost of starting production and distribution channels in some sub-sectors may hinder innovation. Moreover, production facilities are capital intensive and require long investment cycles. In some sub-sectors, product range is very diverse, making it difficult to obtain a sufficiently large production volume to ensure adequate profit margin.

Glass manufacturing technologies existing in Romania are within the limits set by the BAT-BREF and are expected that by applying the new conclusions regarding the Best Available Technologies from 2010/75/UE Directive regarding Industrial Emissions, supplementary emissions reduction will be reached.

Considering the current economic situation, the following assumptions regarding the activity data are considered:

- on the short-term, no new facilities will be closed or opened
- the production structure considered will be that of the period 2014÷2018
- considering the requirement of the internal market it is projected that the glass production will increase up to 500 kt in 2020, to 700 kt in 2035 and will remain constant until 2040 resulting that the value of the maximum production from 1989 will not be reached (1137 kt). These activity data will be used in all three scenarios.

For the CO_2 emission projections, the following assumptions are considered for the value of the composite emission factor:

- for the WOM scenario, the value registered in the year 2005 will be used (0.16 tones CO_2/tone glass)
- for WEM and WAM scenarios, the effects of 2010/75/UE Directive will be considered. Thus, the EF (0.133 tons of CO_2/tone of glass) representing the average value for the period 2016-2018 will be used and will be constant until 2040.

Table 65. The CO2 emissions projection from A.3. Glass Production, in the period 2020-2040

Scenario	Total CO_2 emissions, kt CO_2							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	46.902	53.391	50.818	62.000	77.500	93.000	108.500	108.500
WEM, WAM				53.200	66.500	79.800	93.100	93.100

Other process uses of carbonates

Carbonates (i.e. limestone, dolomite) are naturally occurring materials, non-processed, with commercial use in many industries such as metallurgy (mainly iron and steel production), glass

manufacturing, agriculture, construction and environmental pollution control. CO_2 emissions are generated in industrial processes due to exposure to high temperatures.

According with IPCC 2006 for category 2.A.4, within this category are considered all uses of carbonates in industrial processes, such as: ceramics manufacturing, soda ash use, non-metallurgical magnesia production and other uses.

In the period 2014-2018, the quantities of dolomite, limestone and other raw materials with carbon content used in the ceramic industry increased from a minimum value of 1,158 kt in 2014 to a maximum value of 1,470 kt in 2018.

The evolution of the quantities of caustic soda used in the period 2014-2018 shows a downward trend, decreasing to 66 kt in 2018, with approx. 9% lower than in 2014. However, a maximum production of about 73 kt was recorded in 2017.

An upward trend is recorded for subcategory 2.A.4.d – *Other uses of limestone and dolomite*, from a value of 312 kt in 2014 to 554 kt in 2018.

For the WOM scenario, the CO_2 emissions projection are realised by using the extrapolation method. Thus, the total emission values were extrapolated with factors based on annual growth indices (3% in the period 2020-2025, 2% in the period 2026-2035 and 1% in the period 2036-2040).

For the CO_2 emission projection in WEM and WAM scenario, the following assumptions are considered:

- an 1% annual increase of activity data compared to 2018 AD for sub-categories 2.A.4.a and 2.A.4.b
- increasing the amount of limestone used to desulfurize wet gases, for sub-category 2.A.4.d;
- for the values of the emission factors, the effect produced by the application of Directive 2010/75/EU will be considered. Thus, the emission factor for sub-category 2.A.4.a is considered to be equal to its average value from 2016-2018 and will remain constant until 2040. For sub-categories 2.A.4.b and 2.A.4.d the emission factor values are equal to the stoichiometric ratio.

Table 66. The CO2 emissions projection for category 2.A.4. - Other uses of carbonates category, in the period 2020-2040

Scenario	Total CO_2 emissions, kt CO_2							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	39.473	356.600	352.568	465.583	539.738	595.915	657.938	691.499
WEM, WAM				386.720	371.583	356.698	342.128	320.958

Chemical industry

GHG emissions resulting from chemical industry results from production processes of ammonia, nitric acid), carbide and other substances (ethylene, methanol, sulphuric acid, etc.).

These emissions represented 9.78% of the total GHG emissions of the Industrial Processes and Product Use sector in 2018, representing 1.13% of the total GHG emissions of 2018 in Romania.

GHG emissions from the chemical industry have dropped from about 12000 Gg CO_{2eq} in 1989 at about 3500 Gg CO_{2eq} in 1998 and stabilised around the value of 5000 Gg CO_{2eq} in the period 2000÷2007. In the period 2014÷2018, GHG emissions had a downward trend, reaching the minimum value in 2018 (1315 Gg CO_{2eq}). These large fluctuations in emissions are due to the instability of the economic activities of producers who had stopped and suspended their production according to market requirements.

Given the impossibility of long-term forecasting of the activity carried out by different manufacturers, the method of extrapolation was used to make the forecast of GHG emissions.

For the WOM scenario, the values of CO_2 emissions from 2005 were extrapolated with a variable index that considers the evolution of domestic demand for the period 2006-2019 and with an average annual rate of 0.3% for the period of 2020÷2040. For the calculation of the values of N_2O and CH_4 emissions, the structure of emissions from 2005 has been preserved.

For the WEM and WAM scenarios, the values of CO_2 emissions in 2018 were extrapolated with an average annual rate of 1.8% between 2018 and 2040 based on the value of the average annual rate recorded in the period 2016÷2018. For the calculation of the N_2O and CH_4 emissions values, the structure of the average emission values from 2016-2018 was kept.

Table 67. CO2 emissions for category B Chemical industry, 2020-2040

Scenario	Total CO2 emissions, kt CO2							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	3546.409	1064.470	1078.039	3063.993	3110.230	3157.165	3204.807	3253.167
WEM, WAM				1117.198	1221.432	1335.391	1459.982	1596.197

Table 68. CH4 emissions for category B Chemical industry, 2020-2040

Scenario	Total CH4 emissions, kt CH4							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	2.917	0.205	0.240	2.519	2.557	2.595	2.634	2.674
WEM, WAM				0.267	0.292	0.319	0.349	0.381

Table 69. N2O emissions for category B Chemical industry, 2020-2040

Scenario	Total N2O emissions, kt N2O							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	9.999	0.839	0.776	8.640	6.220	6.314	6.410	6.506
WEM, WAM				0.982	1.074	1.174	1.283	1.403

Metal industry

Emissions from this category cover the production of iron and steel, ferro-alloys production, primary aluminium production, magnesium production, lead production and zinc production.

As magnesium is not produced in Romania, no emissions were estimated for this sub-category, and no projections were made.

Iron and steel production

The main technological flows generally available worldwide in manufacturing of steel products are:

- integrated route (BF-BOF) based on iron ore and coking coal used in blast furnaces, followed by oxygen steelworks, and rolling mills
- electric route (EAF) based on the use of scrap in electric arc furnaces, followed by rolling mills
- "direct reduction" route, following the chain: iron ore used in reduction furnaces - electric steelworks – rolling mills.

The first flow is specific to large integrated factories, the last two being found in smaller factories. Currently, in Romania, steel production is based on the first two flow types presented above.

World steel production has grown exponentially in recent years. Thus in 2001, the production of liquid steel worldwide was 851,073 kt, in 2015, it was 162,0408 kt, and in 2018 reached a value of 1,816,611 kt representing an increase of approx. 113% compared to 2001.

In what concerns the weight of the steelmaking route, worldwide, in 2018, the BF-BOF steel weight was 74.0%, the EAF steel represented 25.5%, and the rest (0.5%) was OH steel. In the same year in the EU-28 the BF-BOF steel represented 60.5 %, and the EAF steel was 39.5%. In Romania, in 2018, the BF-BOF steel represented 59%, and the EAF steel was 41%.

The iron and steel industry in Romania were initially develop based on local reserves of iron ore and coal and was designed in integrated flow.

In the integrated factories, process flow structure underwent several changes over time. Maintaining the main stages of the flow (pig iron production, steel making and rolling), changes was made mainly in intermediate stages.

Factories, and, in recent years, mini-mills based on electric arc furnaces were widely developed as Siemens Martin furnaces (BF-OH flow) were decommissioned and the amount of available scrap increased. At the same time, relatively low cost of scrap used in electric arc furnace

compared with the high cost of pig iron used in LD converters (BF-BOF flow) made the share of electric steel in steel production to increase.

Table 70. Overview of factories and steelmaking processes in Romania

Factory location	Year of foundation	Steelmaking route		
		Past	Actual	Future
Galaţi	1961	BF - BOF	BF- BOF	DRI-EAF
Hunedoara	1882	BF- OH	EAF	EAF
Târgoviște	1973	EAF	EAF	EAF
Câmpia Turzii	1920	EAF	EAF	EAF
Reșiţa	1771	BF-OH	EAF	EAF
Oţelu Roşu	1796	EAF	EAF	EAF
Călăraşi	1976	EAF	EAF	EAF

EAF = electric Arc Furnace; BF = Blast Furnace; BOF = Basic Oxygen Furnace; OH = Siemens Martin/Open Hearth Furnace, DRI = Direct Reduction Iron

The main sectors that use steel are construction, with a share of around 38%, followed by automotive industry (16%) and mechanical engineering (14%).

Because on the BF-BOF route, the CO_2 emissions per tone of steel are much higher (around 5 times) than those resulted on EAF route, nationwide manufacturing structure significantly influences the emissions level.

The most important quantity of steel in Romania is made on BF-BOF route. It must be noted that the entire production of BOF steel are made in only one facility.

At national level, in terms of the weight of steel making processes, in 2001 the share of BOF steel was 72.2%, steel produced in EAF was 33.8%, the rest (3.2%) being produced by the OH process.

In 2011 the share of BOF steel was 48.7% and EAF steel share 51.3%. 2011 is the first year that production of EAF was greater than the BOF steel. This trend was maintained in 2012 (50.4% EAF steel vs. 49.6% BOF steel).

However, from 2013, due to the insolvency of the group Mechel, the national production of EAF steel has decreased and consequently the share of this steel type (38% in 2013). 2018 production structure by types of flows was: 59% BOF steel and 41% EAF steel.

The economic crisis has strongly affected Romania's steel production, which decreased in 2009 by about 45% compared to 2008 and approx. 55% compared to 2007. The year 2010 marked an increase in the amount of steel produced (by 37% compared to the previous year) to a value of 3,734 kt (but still by 27% lower than in 2008). In 2014-2018, the steel production at the national level increased from 3,275 kt in 2014 to 3,700 kt in 2018 (13%). It should be noted that over 99% of the steel produced in Romania is carried out in industrial facilities covered by the EU-ETS.

Given the current economic situation, it is considered an assumption for the projection of GHG emissions the low production of some production units (for example, those owned by Mechel Romania). Considering the evolution of domestic and international market demand, the activity data presented in the below **table** will be used for this category.

Table 71. Total steel production projection for Romania for the period 2020÷2040

Product	Quantities of steel produced, kt				
	2020	2025	2030	2035	2040
Steel	3700	4000	4000	5000	6000

For the scenario without measures, the following hypotheses are considered:

- the activity data are those presented in the above table
- two manufacturing flows are used integrated and electric flow
- the manufacturing structure at the national level changes compared to 2005 to increase the share of electric steel. Thus, from 27% in 2005, in 2025, it is estimated that electric steel will have a share of 34%, which will continue to grow up to 40% in 2040
- the values of the emission factors for CO2 are constant for each type of flow and are equal to the values from 2005. The emission factor value for CH4 is the default, presented in the 2006 IPCC guidelines.

For WEM and WAM scenarios, the effect of Directive 2010/75/EU will be considered, and the following assumptions will be considered:

- the activity data are those presented above**;**
- in the medium term, the change of the manufacturing flow at the Galati plant from integrated to flow using the direct reduction of ores followed by steel production in electric arc furnaces is considered. Starting in 2030, no more integrated steel will be produced in Romania.
- CO_2 emission factor values are constant for each type of steel and the entire forecast period. The emission factor value for CH_4 is the default EF, presented in the 2006 IPCC guidelines.

Table 72. The EFs values used in CO2 emissions projections for category 2.C.1.–Iron and Steel Production

Product	Emission factor, t CO_2/t steel	
	WOM	WEM, WAM
BOF steel	1.911	1.683
EAF steel	0.026	0.014

Direct ore reduction	-	0.700

Table 73. The CO2 emissions projection from C.1. Iron and steel production, in the period 2020÷2040

Scenario	Total CO2 emissions, kt CO2							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	8663.811	3470.249	3734.356	4699.370	5080.400	5005.000	5973.500	6942.000
WEM, WAM				3723.600	3017.250	1806.000	2170.000	2884.000

Table 74. The CH4 emissions projection from C.1. Iron and steel production, in the period 2020÷2040

Scenario	Total CH4 emissions, kt CH4							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	0.462	0.164	0.172	0.250	0.271	0.266	0.318	0.369
WEM, WAM				0.173	0.099	0.000	0.000	0.000

Ferro-alloys production

Since 1989 till 1993, ferro-alloys production in the Romanian steel industry declined with almost 60 %. The next period is characterized by a slow recovery till 1996 and then decreased again 1999. After this historic low, production increased in 2004 to a value close to that of 1989, after which it decreased sharply in 2008 considering the economic crisis. In 2009, ferro-alloy production rose slightly compared to 2008. 2010 marked an increase in the amount of ferro-alloy produced (by 200% over the previous year) but still 17% compared to production in 2004.

In 2011, ferroalloys' production decreased again to 23 kt, and 13.65 kt in 2012. In the period 2013-2018, the production of ferroalloys was ceased.

The main uncertainties affecting this subcategory are related to the developments in the steel sector, and foreign market (share of transportation costs in the cost of production of ferro-alloys is low).

Given the current economic situation we assume assumes that national ferro-alloys production will not resume and will not be realised projections for this sub-category.

Aluminum production

Primary aluminium industry in Romania is represented by a single production unit which is vertically integrated upstream as it has its own alumina processing factory and makes up processing to the final product.

This unit is included in the EU-ETS, so that emissions from the industrial processes are found entirely under this legislation.

Since 1989, primary aluminium production in Romania decreased from about 265 kt to 107 kt in 1992. This period is followed by 16 years of continuous production growth, the maximum recorded being 265 kt in 2008. On the economic crisis, quantities of primary aluminium produced in Romania decreased by about 25% in 2009 compared to 2008. 2010 marked a slight increase in the amount of aluminium produced to a value of 206 kt (but still 22% less than in 2008). In 2011, aluminium production registered a slight increase compared to 2010 to a value of 224 kt, followed by a decrease in 2012 to 202.6 kt. In 2013 and 2014, the average production was approx. 195 kt of primary aluminium and increased to 207 kt in 2016. In 2018, the production of primary aluminium was 210 kt.

It is worth noting that between 1989÷2012 there were significant changes in manufacturing technology of primary aluminium, changes which reflect in the evolution of emission factors for CO_2 and PFC. Thus since 2003 only the technology with pre-baked anode cells operated by the centre (CWPB) is used.

Aluminium production technology is at mature stage of development, so that emission reduction potential is limited, and there are no prospects for the development of new technologies in the near future.

Prices for most non-ferrous metals (including aluminium) are determined by the London Metal Exchange (LME) and therefore, they are not necessarily correlated with the volume of production conducted by an individual factory. Contracts between producers of non-ferrous metals and their customers always refer to the LME price, regardless of the size of the contract. Thus, the aluminium industry operates in a global marketplace.

Given the current economic situation, the following assumptions are considered:

- on the short-term, no new facilities will close or open
- considering the domestic and international market demand, it is projected that the production of primary aluminium will increase up to 220 kt in 2025, to 240 kt in 2035, and will remain constant until 2040.

For CO2 emissions projections the following assumptions for emission factors are considered:

- for the WOM scenario, the maximum value of the emission factor from 2014-2018 will be used, and it will be kept constant for the forecast period (1.626 t CO_2/t primary aluminium)
- for WEM and WAM scenarios, the effect produced by the application of Directive 2010/75/EU will be considered. Thus, the emission factor will decrease in the period 2019-2025 to a value of 1.6 t CO_2/t primary aluminium (98% of the average value between 2014-2018) and will remain constant until 2040.

Table 75. The CO2 emissions projection for 2.C.3. Aluminum production, in the period 2020÷2040

Scenario	Total CO2 emissions, kt CO2							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	372.620	334.606	339.071	343.086	357.720	373.980	390.240	390.240
WEM, WAM				339.288	352.000	368.000	384.000	384.000

For PFC emissions projections the following assumptions for emission factors are considered:

- for the WOM scenario, the value of the emission factor from 2005 will be used, and it will be kept constant for the forecast period (0.399 t CO_{2eq}/t primary aluminium)
- for WEM and WAM scenarios, the effect produced by the application of Directive 2010/75/EU will be considered. The emission factor used represents the average value from the last five years (2014-2018), respectively 0.028 t CO_{2eq}/t primary aluminium, and will remain constant until 2040.

Table 76.The PFC emissions projection from 2.C.3. Aluminum production, in the period 2020÷2040

Scenario	Total PFC emissions, kt CO2eq							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	95.279	5.564	4.956	84.189	87.780	91.770	95.760	95.760
WEM, WAM				5.908	6.160	6.440	6.720	6.720

Lead production

Lead is obtained from two types of raw materials: concentrated lead ores (primary lead) and recycled lead (secondary lead). The primary lead is obtained from ore containing sulphur and other lead compounds and from other metal (mainly zinc, silver and copper). The main techniques applied to the melting process are based on using shaft furnace or electric furnace. The main refining techniques are pyrometallurgical or hydrometallurgical.

The secondary production of refined lead amounts to the processing of recycled lead to prepare it for reuse. Most of this recycled lead comes from scrapped lead acid batteries.

Lead production in Romania decreased from 1989 to 1992. This period was followed by a series of 16 years of a continuous increase in production, the maximum value being recorded in 2005 (exceeding even the production of 1989). Due to the economic crisis, the quantities of lead produced in Romania decreased by approx. 85% in 2009 compared to 2008.

In 2014-2018, CO_2 emissions resulting from lead production increased about ten times, from 0.677 kt CO_2 in 2014 to 7.735 kt CO_2 in 2018, with a maximum value of 9.159 kt CO_2 in 2017.

Considering the current economic situation, the following assumptions are considered:

- on the short-term, no new facilities will close or open
- for the WEM and WAM scenarios, an annual growth rate of 2% is estimated (based on the average value from 2016-2018) compared to the values from 2018
- for the WOM scenario, an annual growth rate of 3% is estimated starting with 2020. The evolution of growth rates in the period 2006-2019 followed economic development and did not include policies' effect.

Table 77. The CO2 emissions projection from 2.C.5. Lead production, in the period 2020-2040

Scenario	Total CO2 emissions, kt CO2							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	18.27	9.159	7.735	14.813	17.172	19.908	23.079	26.755
WEM, WAM				8.048	8.885	9.810	10.830	11.957

Zinc production

Zinc are manufactured from two type of raw materials: from zinc concentrate (primary zinc) and from recycled zinc (secondary zinc).

The primary zinc are manufactured from ore which content around 85% zinc sulphide and 8-10% of iron sulphide, with a total zinc concentration of approx. 50%. Significant activities for primary zinc production are: the transfer and storage of raw materials and products; oxidation of zinc concentrates in the presence of air; manufacture of electrochemical or zinc pyrometallurgical and refining of zinc.

Secondary zinc is obtained from metallic waste and materials containing zinc - other than the extracted ores / concentrates obtained by mining operations.

Zinc production in Romania decreased from 1989 to 1991 when it reached a value of 30% of the output of 1989. This period was followed by 18 years of a continuous increase in production, the maximum value being recorded in 2008 (double value compared to 1989). Due to the economic crisis, the quantities of zinc produced in Romania decreased being almost zero. In 2014-2018, CO_2 emissions resulting from zinc production had values lower than 1.5 kt CO2.

Considering the current economic situation, the following assumptions are considered:

- on the short-term, no new facilities will close or open
- for the WEM and WAM scenarios, an annual growth rate of 2% is estimated (based on the average value from 2016-2018) compared to the values from 2018
- for the WOM scenario, an annual growth rate of 2% is estimated from 2020. The evolution of growth rates in the period 2006-2019 followed economic development and did not include policies' effect.

Table 78. The CO2 emissions projection for category 2.C.6. Zinc production, in the period 2020-2040

Scenario	Total CO2 emissions, kt CO2							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	97.694	1.445	0.999	6.965	7.503	8.083	8.708	9.383
WEM, WAM				1.039	1.148	1.267	1.398	1.544

Non-energy products from fuels and solvent use

In this sector are included the resulted emissions from non-energy use of products, and the emissions from solvents used.

Given that 2014 ÷ 2018 emissions from sub-sector. D Non-energy products from fuels and the use of solvents contributed by approx. 0.8% of the total net GHG emissions in Romania (excluding LULUCF) and the difficulty of projection, in the long run, the way of carrying out the activities that determine these emissions' occurrence, the extrapolation method will be used.

Thus, the emissions forecast for the WOM scenario is made by extrapolating the 2005 emission value at different rates depending on the economic evolution (the value of emissions in 2020 represents 90% of the value of 2005) and with an average annual rate of 1% for the interval 2020 ÷ 2040.

For WEM and WAM scenarios, technological improvements, environmental protection investments are considered, contributing to the reduction of emissions.

Thus, CO_2 emissions will gradually decrease and represent 75% of the projected emissions in the WOM scenario in 2040, for the WEM and WAM scenarios.

In establishment of the annual growth rates were considered the CO_2 emission trends from 1989÷2018.

Table 79. The CO2 emission of for category 2.D.- Non-energy products from fuels and solvent use, 2020-2040

Scenario	Total CO2 emissions, kt CO2							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	1482.850	1189.630	903.162	1332.017	1399.963	1471.376	1546.432	1625.315
WEM, WAM				921.316	968.311	1027.821	1112.720	1216.534

Product uses as substitutes for ODS

Category 2.F. - *Products uses as substitutes for ozone depleting substances* includes the following subcategories: *Refrigeration and Air conditioning* (2.F.1), *Foams blowing agents* (2.F.2), *Fire protection* (2.F.3), *Aerosols* (2.F.4) and *Solvents* (2.F.5).

At national level, estimates for fluorinated gas emissions include emissions from the manufacture, operation and decommissioning of equipment. For most of the subcategories in estimating emissions presented in the national GHG inventory a Tier 2 method from 2006 IPCC GLs are used.

In the period 1989-2018, there is a tendency of accentuated increase of fluorinated gas emissions, from a value of 0.15 kt CO_{2eq} (1989) to 2295 kt CO_{2eq} (2018). However, in the period 2014-2018, there is a tendency to decrease the annual growth rate. Thus, it was approx. 20% in 2015 and 5% in 2018. This trend is maintained for most of the subcategories.

Category Air conditioning and refrigeration equipment – 2.F.1. weights about 97.7% of the total category 2.F, Aerosols - 2.F.4 represents 2%, Foams – 2.F.2. (0.05%) and Fire-fighting installations - 2.F.3. (0.25%). These weights were calculated as average values for the period 2014-2018.

For the Solvents category – 2.F.5. no fluorinated gas emissions are recorded, and no projections will be presented.

In the period 2014-2018, there was an increase in emissions from sub-category 2.F.1 of approx. 68%, from 1.338 kt CO_{2eq} (2014) to 2.247 kt CO_{2eq} (2018).

In the period 2008-2016, there is a tendency to sharply decrease emissions from sub-category F.2 - Foams, from 89.09 kt CO_{2eq} (2008) to 0.04 Gg CO_{2eq} (2015). In 2017 this value increased to 2.55 kt CO_{2eq}, and in 2018 it decreased again to 1.68 kt CO_{2eq}.

The same trend can be found in category 2.F.3 Fire protection, for which there is an increasing trend in emissions from 1996 to 2015, from 0.014 kt CO_{2eq} (1996) to 4.36 kt CO_{2eq} (2015). In the period 2016-2018, HFC emissions were constant at 4.65 kt CO_{2eq}.

Emissions from category 2.F.4. Aerosols recorded an increasing trend from 31.32 kt CO_{2eq} (2014) to 40.93 kt CO_{2eq} (2018).

In WEM and WAM scenarios were considered the effects of the following regulations:

- Regulation no. 517/2014 on fluorinated greenhouse gases (F-gases) which repeal Regulation No. 842/2006 are applying since 1 January 2015 and aim to reduce these emissions by two thirds in 2030 compared to 2015 levels
- Directive 40/2006 / EC (MAC) on emissions from air conditioning systems in motor vehicles who provides the gradual replacement of air-conditioning systems for vehicles using HFC-134a.
- Law 30/2020 (Kigali Amendment, 2016) published in the Official Gazette. no. 275/2 Apr. 2020 by which emission limits are set for substances in category F gases (HFCs and HCFCs) until 2045.

Given the high uncertainties on the use of fluorinated gases for the projections extrapolation method for emissions was used. For each sub-category and scenario, emissions were

extrapolated using the methodology and factors set out in guidelines for achieving sectoral emission projections[9].

Table 80. CO2eq emissions for category F, 2020-2040

Scenario	Total CO2eq emissions, kt CO2eq							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	371.175	2179.085	2295.108	2629.404	2864.720	3042.477	3090.806	3100.472
WEM, WAM				2365.731	2179.575	2028.381	1966.880	1905.379

Other product manufacture and use

This category includes emissions from electronic equipment production, emissions of SF6 and PFCs from products other than those of the previous categories and N_2O emissions from the use of products.

Considering that emissions from category G *Other product manufacture and use* represent around 0.04% of the total net GHG emissions (without LULUCF) in the period 2014÷ 2018 and the difficulty to conduct long-term projections of activities that causes these emissions, the extrapolation method for emissions was used.

Thus, the projection of N_2O emissions for the WOM scenario is made by extrapolating the emission value from 2005 with the average annual rates of 2% in the period 2006 ÷ 2040. For the WEM and WAM scenarios, it is considered that they will evolve at different annual average rates (between 1% and 2%).

For SF_6 emissions in the no-measures scenario, the emissions were extrapolated, considering the methodology and coefficients presented in the *Sectoral Guidelines for making emission projections* for this type of scenario.

For WEM and WAM scenarios for SF6 emissions, the effects of the Regulation no. 517/2014 on fluorinated greenhouse gases application are considered, emissions being extrapolated using the methodology and coefficients presented in the *Sectoral Guidelines for the realization of emission forecasts.*

In the below **tables** is presented the projected evolution of N_2O and SF_6 emissions for category G - Production and use of other products for the period 2020-2040 in the three scenarios considered.

[9] 1GHG Projection Guidelines, Part B: Sectoral Guidance, Final report, CLIMA.A.3./ SER/ 2010/0004, 2012

Table 81. N2O emissions for category G - Production and use of other products, 2020-2040

Scenario	Total N2O emissions, kt N2O							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	0.008	0.010	0.008	0.0102	0.0113	0.0125	0.0138	0.0152
WEM, WAM				0.008	0.009	0.009	0.010	0.011

Table 82. SF6 emissions projection for category G - Production and use of other products, 2020-2040

Scenario	Total SF6 emissions, kt CO2eq							
	2005	2017	2018	2020	2025	2030	2035	2040
	Inventory			Forecasts				
WOM	15.664	57.456	60.078	65.778	76.266	88.396	102.463	118.778
WEM, WAM				65.276	46.238	27.155	26.106	25.800

5.10. Assumptions for the Agriculture sector

In 2018, the contribution of agriculture to GHG emissions was about 17.1% of total GHG emissions in Romania, reaching the value of 116,115.12kt CO_{2equiv}.

In 2018 the contribution of the various sub-sectors of agriculture in its GHG emissions was as follows:

- 54.60 % from enteric fermentation;
- 9.96 % from manure management;
- 32.70% from fertilizers use;
- 0.26% from rice cultivation;
- 1.82% from field burning of agricultural residues;
- 0.42% from urea application;
- 0.22% from lime application.

It turns out that the largest contributions to GHG emissions are form enteric fermentation, fertilizer use and manure management.

The following table presents the evolution of the agricultural area in Romania by form of use between 2005 and 2014. In the Statistical Yearbook of Romania in 2019 it was specified that until the completion of the country cadastre action by the National Agency for Cadastre and Real Estate Advertising, the series of presented data will remain blocked at the level of 2014 for the period 2018 ÷ 2040 it is considered as a hypothesis to maintain the same forms of use as in 2014.

Table 83. The evolution of the agricultural land in Romania between 2005÷2014

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Agricultural area in thousand ha out of which:	**14742.1**	**14730.9**	**14699.3**	**14702.3**	**14684.9**	**14634.5**	**14621.5**	**14615.1**	**14611.9**	**14630.1**
- **arable**	9420.2	9434.5	9423.3	9415.1	9422.5	9404	9379.5	9392.3	9389.3	9395.3
- **pastures**	3364	3334.4	3330	3330	3313.8	3288.7	3279.3	3270.6	3273.9	3272.2
- **meadows**	1514.6	1524.9	1531.4	1532.4	1528	1529.6	1554.7	1544.9	1541.9	1556.3
- **vineyards and nurseries**	224.1	223.7	218	214.5	215.4	213.6	211.3	210.5	210.3	209.4
- **orchards**	219.2	213.4	206.6	207.3	205.2	198.6	196.7	196.8	196.5	196.9

Regarding the consumption of chemical fertilizers used in Romania, it can be stated that during 2005 - 2014 about 47 kg/ha were used more extensive analysis of the consumption of chemical fertilizers used in agriculture in Romania highlights the fact that in 1989 160 kg/ha were used, and in 1995, 52 kg/ha were used. This indicates that fertilization is not compensated by the number of elements per unit area at a level allowing compensation of nutrients extracted and a production level compared to other countries in the European Community. When establishing the need for nutrients, the full use of manure from agricultural holdings is considered. It should be noted that the amount of natural fertilizer decreased significantly between 1989 and 2018 from 41603 thousand tons to 14714 thousand tons in close correlation with the evolution of livestock.

Table 84. The evolution of quantities of chemical and natural fertilizers used in agriculture in 2005 - 2040

Fertilizers, out of which	**Fertilizers (thd tons)**										
	Achieved						**Forecasts**				
	2005	2010	2015	2016	2017	2018	2020	2025	2030	2035	2040
	461	381	535	514	581	722	**543**	**568**	**587**	**628**	**660**
-nitrogen	299	206	359	344	381	469	363	370	374	400	420
-phosphate	138	123	133	126	145	188	135	138	148	158	165
-potassic	24	52	43	44	55	65	45	60	65	70	75
Natural fertilizers	18670	16283	15212	14927	12625	14714	**13500**	**14500**	**16000**	**17600**	**19000**

As there are no long-term forecasts on the evolution of the quantities of chemical fertilizers that will be used in agriculture, the quantities used in 2018 of 14714 thousand tons are extrapolated with an average annual growth rate of about 0.65%.

Chemical fertilizers based on nitrogen (technical urea, ammonium nitrate, etc) belong to the category of chemical fertilizers that have GHG emissions. These nitrogen oxide emissions vary depending on the method of administration and the periods of application. Therefore, in order to reduce N_2O emissions, it is considered to improve the technologies for the use of fertilizers.

Another possible source of GHG is rice cultivation, resulting in CH_4 emissions from anaerobic fermentation of organic matter during flooding or irrigation. Rice crops occupy very small surfaces. These areas decreased continuously after 1989 when they occupied 49.3 thousand ha to 0.1 thousand ha in 2003 and then increased to 1.2 thousand ha in 2004, 3.9 thousand in 2005, 12.4 thousand ha in 2010 and 12.7 thousand ha in 2011.

In 2012 this area decreased to 11.3 thousand ha and increased to 11.1 thousand ha in 201, while during 2016-2018 it continued to decrease reaching 8.3 thousand ha. It is considered as assumption, maintaining for the future period of a surface of 8 thousand ha for rice cultivation. Considering that the value of CH_4 emissions from rice cultivation were 0.00512 g/m^2 in 2018, which represents 0.000048122% of the total methane emissions assessed for the whole country, no measures are proposed to reduce GHG emissions in rice cultivation.

There are two main sources for methane emissions resulted from livestock raising: emissions from the digestion process of ruminants and emissions resulted from anaerobic fermentation of organic materials from animal manure.

The evolution of livestock during 2018 - 2040 should be made in the hypothesis of reaching a balanced domestic consumption and creating a surplus for export. As there is no such information in the National Strategy for Sustainable Development of Romania and there is no strategy for the development of agriculture for the time horizon 2020 - 2040, for the evolution of livestock during 2018 ÷ 2040, the estimated achieved value for 2020 was extrapolated with the following average annual rates:

- 1.1% for cattle;
- 1.2% for pigs;
- 1.2% for sheep;
- 1.1% for goats;
- 0.5% for horses;
- 1.1% for poultry.

Table 85. The evolution of livestock in the period 2005 - 2040

Livestock categories (thousands)	2005	2010	2015	2016	2017	2018	2020	2025	2030	2035	2040
	Achieved						Forecasts				
TOTAL	105168	98543	97420	92276	91672	92058	92200	97444	102687	108523	114486

Cattle, out of which:	**2862**	**2001**	**2092**	**2050**	**2011**	**1977**	**2000**	**2113**	**2232**	**2357**	**2490**
Cows, buffalo cows and heifers	*1812*	*1299*	*1311*	1315	1295	1280	1290	1310	1360	1404	1530
Pigs, out of which:	**6622**	**5428**	**4927**	**4708**	**4406**	**3925**	**4000**	**4245**	**4506**	**4783**	**5077**
Sows for breeding	*494*	*356*	375	361	350	309	315	325	355	360	380
Sheep out of which:	**7611**	**8417**	**9810**	**9875**	**9982**	**10176**	**10200**	**10827**	**11492**	**12198**	**12947**
Ewes and ewe lambs	*6453*	*7338*	8330	9388	8445	8394	8500	8700	9030	9500	9800
Goats out of which:	**687**	**1241**	**1440**	**1483**	**1503**	**1539**	**1550**	**1637**	**1729**	**1826**	**1928**
She goats	*581*	*1032*	1133	1161	1184	1213	1250	1340	1490	1560	1605
Horses	**834**	**611**	**503**	**520**	**481**	**448**	**450**	**462**	**474**	**486**	**498**
Poultry out of which:	**86552**	**80845**	**78648**	**75690**	**73289**	**73993**	**74000**	**78160**	**82254**	**86873**	**91546**
Adult laying poultry	*49725*	*44504*	**43663**	40833	38312	38134	38500	39500	41500	43250	45500

In order to estimate the forecasts of CH_4 emissions from agriculture in the "without measures" scenario, the following elements were considered: the forecasts for the evolution of the livestock and the emission factors in kg CH_4 / head of animal / year used in the Inventory for 2018. It was assumed that methane emissions resulting from the cultivation of rice and from the field burning of agricultural residues, will remain constant throughout the forecast period. This assumption was adopted considering the low share of these emission sources in total methane emissions (0.2% and 1.6% respectively).

To reduce methane emissions from the digestion process, the following measures are considered:

- improving the quality of nutrition, by increasing the percentage of protein, which leads to an increase in food by 5%. It is estimated that the improvement of animal husbandry technology will lead to a decrease in methane emissions by up to 10% by 2030 and by up to 25% in 2040 in the "with measures" scenario;
- increase in the weight gain of meat per kg of feed, as well as the increase in milk per kg of feed which ensures the increase of animal performance and ensures a reduction of methane emissions of 5% by 2030 and 10% by 2040, in the scenario "with additional measures".

In order to reduce the methane emissions from the animal manure, the anaerobic fermentation of the manure will be carried out and the recovered methane will be used as fuel within the livestock farms.

The sludge resulting from the livestock farms will be used as organic fertilizers or will be composted for the same purpose by applying the aerobic method to avoid the release of methane.

In the "with measures" scenario, it is estimated that in 2030 about 10% of the methane resulting from the anaerobic fermentation of animal manure will be recovered, in 2035 about 15%, and in 2040 about 25%. In the scenario "with additional measures", the degree of methane recovery will increase up to 40% in 2040.

N_2O emissions result from the application of fertilizers, the management of manure and the burning of agricultural waste in the field for the period 2018 - 2040.

Considering the inability to forecast 2018 - 2040 the volume of activities that are a source of N_2O emissions, in order to estimate the emission forecasts in the scenario "without measures", an extrapolation of these emissions is performed by categories of activities with an average annual rate of about 2.0%.

Given the large share of emissions due to the application of fertilizers, the "with measures" scenario considers the improvement of the technologies for the use of nitrogen fertilizers that contribute to increasing the use of nutrients and reducing losses through leaching. We consider the technique of phasial fertilization and improving the range of machines for a more uniform distribution of chemical fertilizers and balancing the ratio between different nutrients (nitrogen, phosphorus, potassium, etc.). For the scenario "with additional measures", the use of fertilization will be considered. For the scenarios with measures and with additional measures, the reduction by up to 20% in 2040 of the emissions due to the modern methods of fertilizer application is estimated. From 2030, agricultural residues will no longer be burned in the fields.

Table 86. Evolution of CO2 emissions, in 2005 and 2018 - 2040

Scenario	Sources	Total emissions (kt CO_2)						
		Achieved		Forecasts				
		2005	2018	2020	2025	2030	2035	2040
WOM	**TOTAL**	**138.54**	**125.42**	**94.77**	**96.48**	**98.41**	**100.40**	**102.62**
	3.G Lime application	85.79	42.79	31.52	32.03	32.67	33.33	34.00
	3.H Urea application	52.75	82.63	63.25	64.45	65.47	67.07	68.62
WEM	**TOTAL**	**-**	**125.42**	**94.77**	**96.48**	**96.50**	**95.50**	**92.36**
	3.G Lime application	-	42.79	31.52	32.03	32.33	31.33	30.60
	3.H Urea application	-	82.63	63.25	64.45	64.17	64.17	61.76
WAM	**TOTAL**	**-**	**125.42**	**94.77**	**96.48**	**93.93**	**90.20**	**82.10**
	3.G Lime application	-	42.79	31.52	32.03	31.33	30.50	27.20

	3.H Urea application	-	82.63	63.25	64.45	62.60	59.70	54.90

Table 87. Evolution of CH4 emissions, in 2005 and 2018 - 2040

Scenario	Sources	Total emissions (kt CH_4)						
		Achieved		Forecasts				
		2005	2018	2020	2025	2030	2035	2040
WOM	**TOTAL**	**583.09**	**501.61**	**503.68**	**531.73**	**559.96**	**591.77**	**623.85**
	3.A Enteric fermentation	475.06	433.68	435.52	460.29	485.06	513.20	541.40
	3.B Manure management	85.89	55.16	55.39	58.67	62.13	65.80	69.68
	3.C Rice cultivation	1.04	2.20	2.20	2.20	2.20	2.20	2.20
	3.F Field burning of agriculture residues	21.10	10.57	10.57	10.57	10.57	10.57	10.57
WEM	**TOTAL**	**-**	**501.61**	**503.68**	**508.72**	**482.12**	**473.13**	**460.51**
	3.A Enteric fermentation	-	433.68	435.52	437.28	424.00	415.00	406.05
	3.B Manure management	-	55.16	55.39	58.67	55.92	55.93	52.26
	3.C Rice cultivation	-	2.20	2.20	2.20	2.20	2.20	2.20
	3.F Field burning of agriculture residues	-	10.57	10.57	10.57	0.00	0.00	0.00
WAM	**TOTAL**	**-**	**501.61**	**502.68**	**473.74**	**452.52**	**446.83**	**427.66**
	3.A Enteric fermentation	-	433.68	419.53	404.50	396.60	390.90	375.40
	3.B Manure management	-	55.16	54.36	58.67	55.92	55.93	52.26
	3.C Rice cultivation	-	2.20	0.00	0.00	0.00	0.00	0.00
	3.F Field burning of agriculture residues	-	10.57	10.57	10.57	0.00	0.00	0.00

Table 88. Evolution of N2O emissions, in 2005 and 2018 - 2040

Scenario	Sources	Total emissions (Gg N_2O)						
		Achieved		Forecasts				
		2005	2018	2020	2025	2030	2035	2040
WOM	**TOTAL**	**21.56**	**24.12**	**29.03**	**32.05**	**35.38**	**39.06**	**43.13**
	3.B Manure management	2.76	2.01	3.71	4.09	4.52	4.99	5.51
	3.D Agricultural soils	18.16	21.79	24.68	27.32	30.22	33.43	36.98
	3.F Field burning of agriculture residues	0.64	0.32	0.64	0.64	0.64	0.64	0.64
WEM	**TOTAL**	**-**	**23.83**	**25.59**	**28.66**	**31.86**	**35.35**	**36.95**
	3.B Manure management	-	2.01	2.47	2.86	3.32	3.85	4.46
	3.D Agricultural soils	-	21.79	23.09	25.76	28.54	31.50	32.49
	3.F Field burning of agriculture residues	-	0.032	0.034	0.04	0.00	0.00	0.00
WAM	**TOTAL**	**-**	**23.83**	**25.59**	**28.66**	**31.86**	**35.35**	**36.95**
	3.B Manure management	-	2.01	2.47	2.86	3.32	3.85	4.46
	3.D Agricultural soils	-	21.79	23.09	25.76	28.54	31.50	32.49
	3.F Field burning of agriculture residues	-	0.032	0.034	0.04	0.00	0.00	0.00

5.11. Assumptions for the Waste sector - Data considered for the elaboration of GHG emission forecasts for the Waste sector

➢ ***Waste disposal***

In *WOM scenario*, the forecasted evolution of the amount of waste disposal to landfill sites, estimated based on projected demographic developments, considered the following rates of variation compared to the historical year 2005:

- for the quantities of waste stored in unmanaged waste disposal sites, an annual growth rate of 5% until 2020 was considered, followed by an annual growth rate of 2%;
- for the quantities of waste stored in managed waste disposal sites, the historical value registered in 2005 was considered constant;
- for the quantities of composted waste, the historical value registered in 2005 was considered constant;
- for the quantities of incinerated waste, the historical value registered in 2005 was considered constant.

In *WEM scenario*, the forecasted evolution of the quantities of waste deposited in the landfills considered the following general assumptions:

- the evolution of the population both in urban and rural areas;
- the evolution of household income and the evolution of GDP;
- composition of municipal waste;
- European and national legislation concerning the characteristics and composition of waste to be disposed of in landfills;
- operation of household waste landfills;
- the economic evolution of the society, especially regarding the packaging waste and similar waste;
- investments to be made in the Waste sector, to comply with European Directives,
- implementation at national level of long-term investment plans and integrated waste management systems at county level.

Thus, for the quantities of waste stored in household waste landfills, based on projected demographic developments in the analyzed period and the need to respect the commitments assumed at European level, the following rates of variation were considered compared to the historical years 2014-2018:

- for the quantities of waste stored in unmanaged waste disposal sites, an annual decrease of 12.5% per year until 2020 was considered, followed by a decrease of 5% per year until 2025; the quantities of waste stored in unmanaged waste disposal sites will be zero after 2026;
- for the quantities of composted waste, an annual growth rate of 20% until 2025 was considered, and, respectively, an annual growth rate of 2% until 2040;
- for the quantities of incinerated waste, the historical value registered in 2018 was considered constant;
- starting with 2025, a constant quantity of 650,000 t / year is considered, which will be treated with energy recovery in recovery plants and / or cement factories.

In *WAM scenario*, the forecasted evolution of the quantities of waste deposited in the landfills considered the following rates of variation compared to the historical period 2014-2018:

- the estimated quantities of incinerated waste and the additional quantities from composting were deducted from the estimated quantities;
- considered an annual decrease of 25% per year until 2020, following a decrease of 10% per year until 2025, following that they will be zero after 2026;
- for the quantities of composted waste, an annual growth rate of 25% until 2020 was considered, and, respectively, an annual growth rate of 1% until 2035;
- for the quantities of incinerated waste, the historical value registered in 2018 was considered constant;
- starting with the year 2025, a constant quantity of 800,000 t / year is considered to be treated with energy recovery in recovery plants and / or cement factories,

For all scenarios forecast, together with the implementation at national level of long-term investment plans and integrated waste management systems at county level, a decrease in landfill gas was considered starting with 2016 of 40% in each year, this amount being burned at the flare.

- ***Composted waste***

In *WOM scenario*, the quantities of composted waste were considered constant, equal to the historical value recorded in 2005.

In *WEM scenario*, for the quantities of waste treated by composting was considered an annual growth rate of 20% until 2025, and, respectively, an annual growth rate of 2% per year until 2040.

In *WAM scenario*, for the quantities of waste treated by composting was considered an annual growth rate of 25% until 2025 and, respectively, an annual growth rate of 1% per year until 2040.

- ***Incinerated waste***

In *WOM scenario*, no waste incineration plants were considered to be built.

In *WEM scenario*, an incineration capacity of about 400,000 t / year starting with 2025 and of about 250,000 t / year residual waste coming from sorting stations or from mechano-biological treatment plants, with high PCI, was considered, which will be treated in cement plants or will be thermally recovered by another process.

In *WAM scenario* was considered an incineration capacity of about 500,000 t / year starting with 2025 and about 300,000 t / year residual waste from sorting stations or mechanical-biological treatment plants, with high LHV, which will be treated in cement plants or will be thermally recovered by another process.

Table 89. Evolution of CH4 emission in kt, in the period 2005 - 2040

Emission sources CH_4	**Scenario**	**2005**	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**
		Achievements		**Forecasts**				
5.A Solid waste disposal	WOM	**102.60**	**145.56**	**195.85**	**214.50**	**235.02**	**257.58**	**282.40**
5.A.1 Managed waste disposal sites		9.35	70.39	9.35	9.35	9.35	9.35	9.35
5.A.2 Unmanaged waste disposal sites		93.25	75.17	186.5	205.15	225.67	248.23	273.05
5.B Biological treatment of solid waste		**3.24**	**1.35**	**3.24**	**3.24**	**3.24**	**3.24**	**3.24**

5.B.1 Composting		3.24	1.35	3.24	3.24	3.24	3.24	3.24
5.C Incineration and open burning of waste		**0.01**	**0.00**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
5.C.1 Waste incineration		0.01	0.00	0.01	0.01	0.01	0.01	0.01
TOTAL		**105.85**	**146.91**	**199.10**	**217.75**	**238.27**	**260.83**	**285.65**
5.A Solid waste disposal	WEM	**102,60**	**145,56**	**100,31**	**81,01**	**35,73**	**32,90**	**30,23**
5.A.1 Managed waste disposal sites		9.35	70.39	43.93	38.73	35.73	32.90	30.23
5.A.2 Unmanaged waste disposal sites		93.25	75.17	56.38	42.28	0.00	0.00	0.00
5.B Biological treatment of solid waste		**3.24**	**1.35**	**1.95**	**4.84**	**5.34**	**5.90**	**6.51**
5.B.1 Composting		3.24	1.35	1.95	4.84	5.34	5.90	6.51
5.C Incineration and open burning of waste		**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
5.C.1 Waste incineration		0.01	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL		**105.85**	**146.91**	**102.25**	**85.86**	**41.07**	**38.80**	**36.75**
5.A Solid waste disposal	WAM	**102.60**	**145.56**	**80.31**	**52.90**	**29.69**	**25.81**	**22.39**
5.A.1 Managed waste disposal sites		9.35	70.39	42.72	34.11	29.69	25.81	22.39
5.A.2 Unmanaged waste disposal sites		93.25	75.17	37.59	18.79	0.00	0.00	0.00
5.B Biological treatment of solid waste		**3.24**	**1.35**	**2.11**	**6.44**	**6.77**	**7.12**	**7.48**
5.B.1 Composting		3.24	1.35	2.11	6.44	6.77	7.12	7.48
5.C Incineration and open burning of waste		**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
5.C.1 Waste incineration		0.01	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL		**105.85**	**146.91**	**82.42**	**59.35**	**36.46**	**32.92**	**29.87**

Table 90. Evolution of N2O emissions in kt during 2005 - 2040

Emission sources N_2O	Scenario	2005	2018	2020	2025	2030	2035	2040
		Achievements		Forecasts				
5.B Biological treatment of solid waste	WOM	**0.1942**	**0.0811**	**0.1942**	**0.1942**	**0.1942**	**0.1942**	**0.1942**
5.B.1 Composting		0.1942	0.0811	0.1942	0.1942	0.1942	0.1942	0.1942
5.C Incineration and open burning of waste		**0.0280**	**0.0015**	**0.028**	**0.028**	**0.028**	**0.028**	**0.028**
5.C.1 Waste incineration		0.0280	0.0015	0.028	0.028	0.028	0.028	0.028
TOTAL		**0.2222**	**0.0826**	**0.2222**	**0.2222**	**0.2222**	**0.2222**	**0.2222**
5.B Biological treatment of solid waste	WEM	**0.1942**	**0.0811**	**0.117**	**0.290**	**0.321**	**0.354**	**0,391**
5.B.1 Composting		0.1942	0.0811	0.117	0.290	0.321	0.354	0,391
5.C Incineration and open burning of waste		**0.0280**	**0.0015**	**0.0015**	**0.0015**	**0.0015**	**0.0015**	**0.0015**
5.C.1 Waste incineration		0.0280	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015
TOTAL		**0.2222**	**0.0826**	**0.118**	**0.292**	**0.322**	**0.356**	**0.392**
5.B Biological treatment of solid waste	WAM	**0.1942**	**0.0811**	**0.1266**	**0.3865**	**0.4062**	**0.4269**	**0.4487**
5.B.1 Composting		0.1942	0.0811	0.1266	0.3865	0.4062	0.4269	0.4487
5.C Incineration and open burning of waste		**0.0280**	**0.0015**	**0.0015**	**0.0015**	**0.0015**	**0.0015**	**0.0015**
5.C.1 Waste incineration		0.0280	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015
TOTAL		**0.2222**	**0.0826**	**0.1281**	**0.3880**	**0.4077**	**0.4284**	**0.4502**

In *WOM scenario*, the CO_2 emissions resulting from waste incineration was considered constant and equal to the historical value recorded in 2005, respectively 89.77 kt.

In *WEM scenario* and *WAM scenario*, the CO_2 emissions was considered constant and equal to the historical value recorded in 2018, respectively 10.20 kt.

5.12. Assumptions for the GHG emissions projections from the waste water

Waste water treatment

Directive 91/271/EEC concerning urban waste water treatment, amended and completed by Directive 98/15/EC, is the legal basis for EC legislation in the field of wastewater. This directive

was fully transposed into Romanian legislation by GD no. 188/2002 for the approval of the norms regarding the discharge conditions of the wastewater in the aquatic environment, modified and completed by GD no. 352/2005, as well as by amending and supplementing some normative acts that transpose the Community acquis in the field of environmental protection.

In order to implement and comply with the provisions of Directive 91/271 / EEC concerning urban waste water treatment, Romania has obtained transition periods. In this way, on December 31st, 2015, all agglomerations with a population equivalent of more than 10,000 to comply with the provisions in terms of waste water collection and treatment, and on December 31st, 2018, all agglomerations with a population equivalent of between 2,000 –and 10,000 to comply in terms of secondary waste water collection and treatment. The final deadline for the implementation of the Directive was December 31st, 2018.

Table 91. Waste water discharged in 2018 year and type of the treatment

Category	Volume (million m^3)	Percentage of total (%)
Domestic waste water discharged	1233.89	51.91
Industrial waste water discharged	1128.37	47.47
Treated domestic waste water	1160.73	48.83
Treated industrial waste water	972.94	40.93
Total waste water which must be treated	2370.69	99.73
Sufficiently treated waste water	1541.83	64.86
Insufficiently treated waste water	604.37	25.42
Untreated waste water	224.49	9.44
Total of waste water discharged	**2,377.09**	-

Source: National Inventory Report (NIR) 2018

The works on waste water collection and treatment were mainly conducted within the Large Infrastructure Operational Program 2014 – 2020. In order to comply with the commitments assumed by the Accession Treaty on the levels of collection and treatment, they provide for measures to reduce CH4 emissions in the period 2020-2030.

For the “without measures” scenario, the forecasted evolution of CH4 emissions was estimated by extrapolating the historical emissions recorded in 2005, with an average annual growth rate of 0.1% between 2005 and 2030, which considers the forecasted population decline. The value from 2030 remains constant in the period 2030-2040.

For the “with measures” scenario and, respectively, the scenario “with additional measures”, the forecasted evolution of CH4 emissions was estimated by extrapolating the historical emissions registered in 2018 with an average annual decrease rate of 1% considering the following:

- population decline;
- increase of the population connected to the sewerage system, with treatment;

- construction of modern wastewater treatment plants and, respectively, modernization of existing ones.

For the "without measures" scenario, the projected evolution of N_2O emissions was estimated by extrapolating the historical emissions recorded in 2005, with an average annual growth rate of 0.2%, which considers the increase in protein consumption per capita.

For the "with measures" scenario and, respectively, the scenario "with additional measures", the forecasted evolution of CH_4 and, respectively, the scenario with additional measures, the forecasted evolution of N_2O emissions was estimated for the period 2018 - 2020 by extrapolating the historical emissions registered in 2018, with an average annual decrease rate of 0.5% for the period 2018 – 2020, and for the period 2021-2040 by extrapolating the emissions related to the year 2020, with an average annual decrease rate of 2.5%, taking into account the following:

- population decline;
- increase of the population connected to the sewerage system, with treatment;
- construction of modern wastewater treatment plants with nitrification and denitrification.

Table 92. Evolution of CH4 emissions in the period 2005 - 2040 - scenario WOM

Source of CH_4 emissions	**Scenario**	**2005**	**2020**	**2025**	**2030**	**2035**	**2040**
		Achieved	**Forecast**				
Treatment of domestic and commercial waste water	**WOM**	83.75	85.02	86.02	86.45	86.45	86.45
Treatment of industrial waste water		9.45	9.59	9.64	9.69	9.69	9.69
TOTAL CH_4 emissions (kt)		**93.2**	**94.61**	**95.66**	**96.14**	**96.14**	**96.14**

Table 93. Evolution of CH4 emissions in the period 2018 - 2040 - scenario WEM and WAM

Source of CH_4 emissions	**Scenario**	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**
		Achieved	**Forecasts**				
Treatment of domestic and commercial waste water	**WEM**	55.34	55.11	54.56	54.01	53.56	53.02
Treatment of industrial waste water		7.47	7.44	7.36	7.29	7..22	7.08
TOTAL CH_4 emissions (kt)		**62.81**	**62.55**	**61.92**	**61.30**	**60.78**	**60.10**

Treatment of domestic and commercial waste water	**WAM**	55.34	55.11	54.56	54.01	53.56	53.02
Treatment of industrial waste water		7.47	7.44	7.36	7.36	7.22	7.08
TOTAL CH_4 emissions (kt)		**62.81**	**62.55**	**61.92**	**61.30**	**60.78**	**60.10**

Table 94. Evolution of N2O emissions in the period 2005 – 2040

Treatment of waste water	**Scenario**	**2005**	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**
		Achieved		**Forecasts**				
TOTAL N_2O emissions (kt)	**WOM**	1.87	1.87	1.87	1.87	1.87	1.87	1.87
	WEM	-	1.78	1.76	1.59	1.44	1.30	1.18
	WAM	-	1.78	1.76	1.59	1.44	1.30	1.18

5.13. Assumptions for the Land Use, Land Use Change and Forestry Sector (LULUCF)

The LULUCF sector can lead to net annual emissions or the removal of GHG emissions and changes in carbon stocks in the land categories related to this sector.

For the period 2021-2030 at EU level the LULUCF sector is included into the EU emissions reduction efforts by the provisions of the LULUCF (EU) 841/2018 Regulation as part of the EU's energy and climate framework for 2030.

In the LULUCF sector, the most important contribution as net removals of CO_2 refers to the following categories of land: *"forest land remaining forest land", "lands in conversion to forest land"* and *" cropland remaining cropland "*. The largest sources of emissions are represented by the following categories of lands: *"lands in conversion to other lands",* and *"lands in conversion to human settlements".*

The results of the forecast were obtained following the processing of the existing information from the National Greenhouse Gas Inventory, the following scenarios resulted:

1.The reference scenario based on the projection of the data according to the evolution trends of GHG emissions and removals from LULUCF (historical trend) between 1989-2017.

2. The scenario with measures is based on the EU 2030 legislative framework that requires that the GHG emissions be reduced by 40% in 2030 compared to the base year (1990) at EU level. For the year 2030, the projected level of emissions is determined considering the amount of GHG emissions recorded in the reference year multiplied by the value of the index resulting from the EU 2030 target. On the basis of this information, the change in the absolute annual average is calculated starting from the absolute average of the year 2017.

3. The **scenario with additional measures** are similar to the scenario with measures, the change in the annual absolute average applying from the reference year (1990).

Analysis of trends in GHG removals and emission in the LULUCF sector

The land use classification is made according to the IPCC guidelines of 2006, which defines six main categories of land use: forest land, cropland, grassland, wetlands, settlements, other lands and conversions between them.

In Romania, the average annual level of removals in the LULUCF Sector was about 20.2 thousand kt of CO_2 equivalent per year during the period 1990-2005, and after 2005 the average annual level increased to about 21.0 thousand kt CO_2 equivalent per year. In both periods analyzed, in Romania, the net removal, increased by 133 kt of CO_2 equivalent in the period 1990-2005, and in the period 2005-2017 this increase decreased to 64 kt of CO_2 equivalent per year.

Table 95. Evolution of net removal in the period 1990-2017

Period	Annual average level, kt CO2 eq / an	Absolute average change, kt CO2 eq / an	The average rate annual, %
1990- 2005	20.967	133	0,7
2005-2017	20.157	64	0,3
1990-2017	20.507	102	0,5

In Romania, the gross removal of the LULUCF sector has increased. Between 1990-2005, the average annual amount absorbed by CO2 was 28.2 thousand kt, dynamically the average amount absorbed increased by 165 thousand kt of CO2 per year, respectively by 0.6% per year. Between 2005 and 2017, the average gross amount absorbed was 29.2 thousand kt of CO2, a value that increased on average every year by 67 kt of CO2, respectively by 0.2% per year. The dynamics recorded in the period 2005-2017 was lower than the previous period, 1990-2005, which determined the average annual amount absorbed by 28.7 thousand kt of CO2 per year, an average annual rate of 0, 4%, respectively an average annual increase of 121 kt of CO2 absorbed per year.

Table 96. Evolution of gross absorption in the period 1990-2017

Period	Annual average level, kt CO2 eq / an	Absolute average change, kt CO2 eq / an	The average rate annual,%
1990- 2005	28.237	165	0,6
2005-2017	29.266	67	0,2
1990-2017	28.681	121	0,4

Emissions of CO_2 equivalent in the LULUCF sector are much lower than the gross CO_2 removals. In Romania, the gross removals are approximately 3.5 times higher than emissions. The fact that the gross removals values are several times higher than the emissions makes the LULUCF sector a net absorber**.**

Table 97. Evolution of GHG emissions from the LULUCF sector in the period 1990-2017

Period	Annual average level, kt CO2 eq / an	Absolute average change, kt CO2 eq / an	The average rate annual, %
1990- 2005	8.080	32	0,4
2005-2017	8.299	2	0,0
1990-2017	8.175	19	0,2

In Romania, the annual average of GHG emissions increased in the period 2005-2017 compared to 1990-2005. The average of increasing is about 0.2% per year.

In the period 1989-2017, the amount carbon absorbed was about 28.54 thousand kt CO_2 equivalent per year, the average level of emissions is about 8.16 thousand kt of CO_2 equivalent/ year, which determined the level of annual average of net absorption of 20.39 thousand kt of CO_2 equivalent/ year on the analyzed period.

In 2017, in comparison with the reference year, the gross absorption increased by 21.3%, which in absolute figures represents an increase of approximately 5.3 thousand kt CO_2 equivalent. In comparison with 2005, in 2017 the increase was about 2.8%, slightly over 800 kt of CO_2 equivalent.

The GHG emissions in the LULUCF sector increased in 2017 compared to 1989 by 8.7%, respectively with 667 kt of CO2 equivalent, and compared to 2005 by 0.4%, respectively with 29 kt of CO2 equivalent.

Table 98. Dynamics of GHG emissions and removals from the LULUCF sector the period 1989-2017

Year	Removal CO_2 (-)	Emission CO_2 eq (+)	LULUCF (-)
	Kt CO_2 equivalent(eq)		
A	(1)	(2)	(3)=(1)-(2)
1989	24710	7637	17037
2005	29181	8274	20906
2017	29984	8304	21680

The increasing trend of the gross absorption is higher than the evolution trend of emissions. It determined an increase of the net absorptions in 2017 compared to 1989 by 27%, and compared to 2005 by 3.7%.

During the 1989-2005 period the gross removals have increased at an annual average rate of 1.05% in comparison with emission increasing that increase at a rate of 0.5% per year. Throughout the analyzed period, net removals increased by 240 kt CO2 equivalent, respectively with an annual average rate of 1.27% per year.

In the period 2005-2017, the growth rates of gross removals, net emissions/removals in the LULUCF sector were: gross removals slowed down to 0.23% per year, emissions to 0.03%/ year, and net removals to 0.3 % /year.

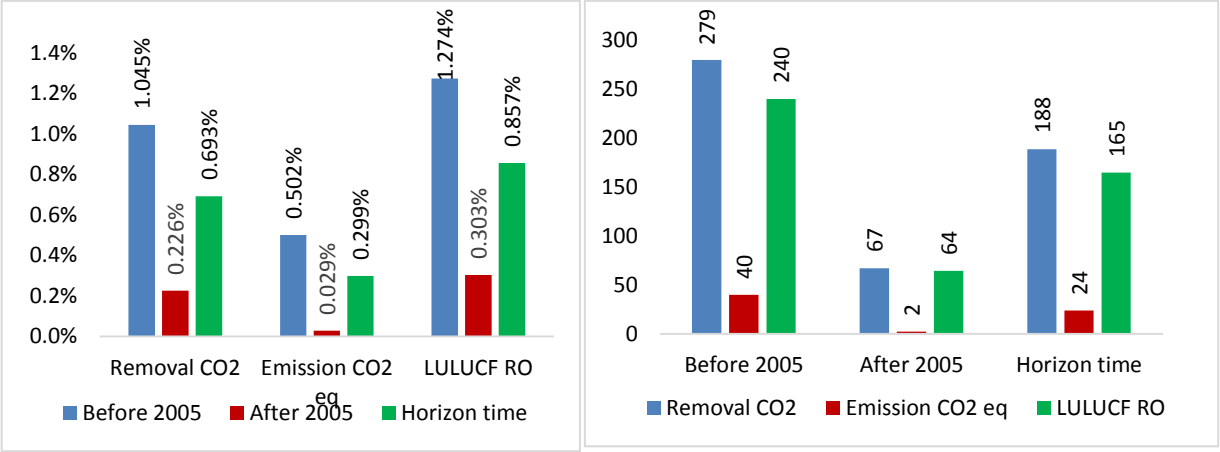

Figure 17. Dynamics of gross removals, emissions and net absorption of the LULUCF sector in Romania

The dynamic of the LULUCF sector is analyzed in comparison with 2005 (the year for applying a series of policies and measures to reduce greenhouse gases to reach the targets at EU level), or in comparison with the base year.

The dynamics of emissions increased compared to 1989, stabilizing this increasing up to 10%. In comparison with 2005 the emissions level remained relatively constant. The removals have a trend of accentuated growth compared to 1989, and compared to 2005. This increase was manifested especially after 2011.

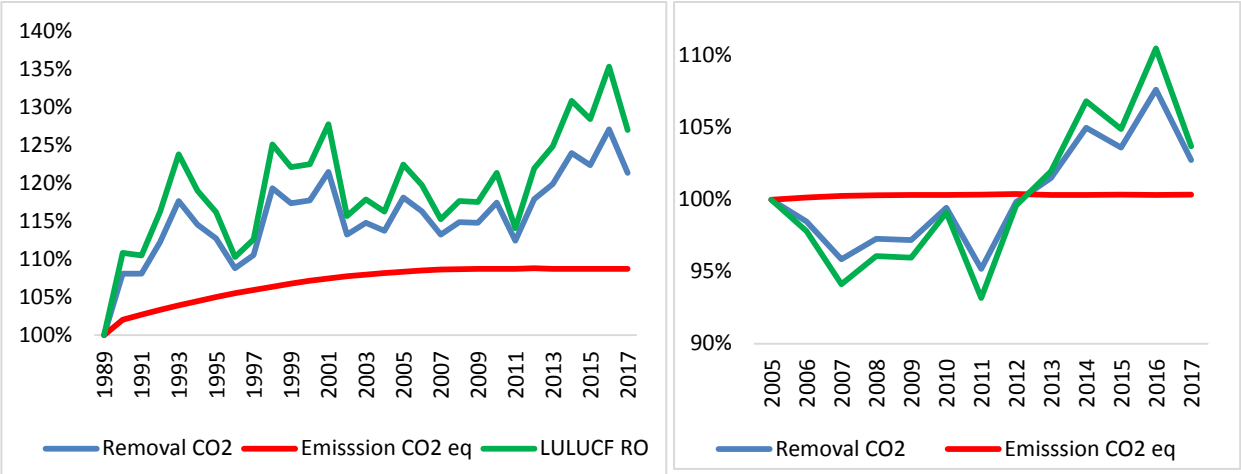

Figure 18. Comparative dynamics of gross removals, net emissions and removals of LULUCF sector in Romania (1989 = 100%, respectively 2005 = 100%)

GHG emissions in the LULUCF sector

The main components of GHG emissions in the LULUCF sector are: carbon dioxide, methane and nitrous oxide, as well as the carbon removal.

The GHG emissions increased in 2017 compared to emissions in 1989 and 2005. This increase is 666 kt of CO2 equivalent compared to emissions in 1989, over 90% from N2O emissions, 0.3% from CH4 emissions and 9.3% from CO2 emissions.

In 2017, the amount of GHG emissions at the level of LULUCF was 8.3 million tons of CO2 equivalent, being 8.7% higher than the level reached in 1989 (7.64 million tons of CO2 equivalent) and 0.4% higher than in 2005, over 8.27 million CO2 equivalent.

In 2017, compared to 2005, the amount of GHG increased by only 29.32 kt of CO_2 equivalent, being about 96% lower compared to 1989. In 2017, compared to 2005, the N_2O emissions increased by approximately 94% and CH_4 by 6%. The CO2 encoutered relatively constant values after 2005, which makes the contribution to the previous growth irrelevant.

Table 99. Absolute change in GHG emissions by chemical elements (kt CO2 equivalent)

2017	Compared to 1989	Compared to 2005
Emissions CO_2 (+)	62.23	0.00
Emissions CH_4 (+)	1.90	1.82
Emissions N_2O (+)	602.46	27.49
Total emissions, eq CO_2 (+)	666.60	29.32

It is noted that CH_4 emissions have a sharp increase in growth, the CO_2 emissions have a relatively constant evolution and the N_2O emissions have increased relatively accelerated until 2005 after which the value remained relatively constant until 2017.

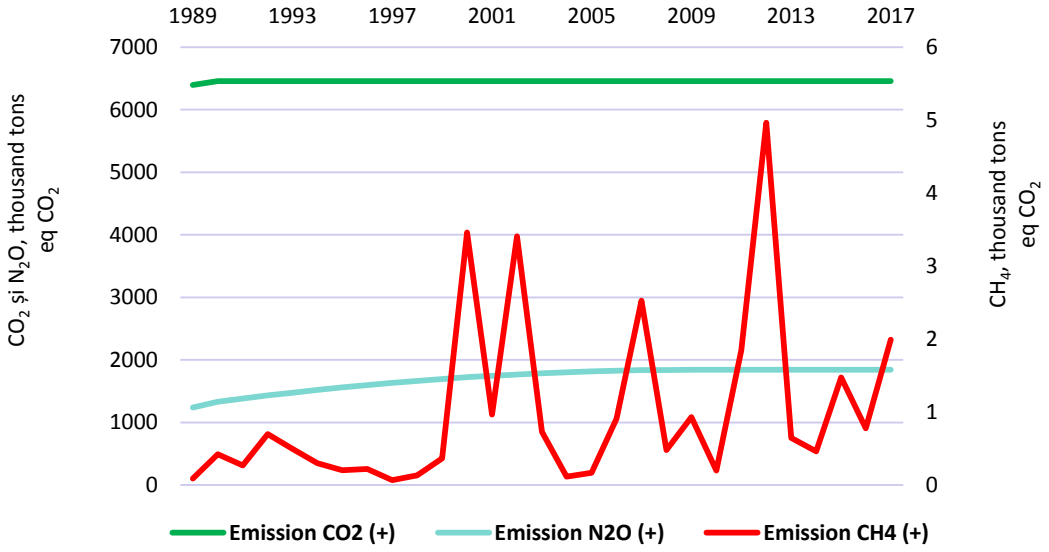

Figure 19. Dynamics of the chemical components of the GHG emissions from the LULUCF sector (period 1989-2017)

In the LULUCF sector, in 1989 the share of CO2 emissions in total GHG emissions was about 84%. This share has decreased slowly in 2017 to reach about 78%. The N2O emissions represent 16.25% in 1989, and 22% in 2005. The share of the CH4 emissions is insignifiant.

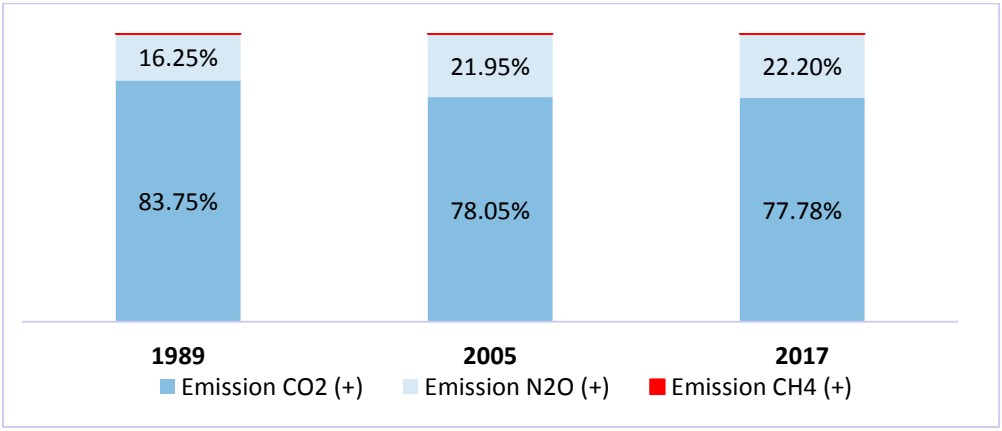

Figure 20. The weight of GHG emissions after the chemical structure LULUCF in Romania

Evolution of GHG emissions by types of land

The evolution of the emissions by geographical areas specific to the LULUCF sector were analyzed before 2005, and after 2005 they have stabilized around values that remained unchanged.

Table 100. Dynamics of GHG emissions in 1989-2017

Year	GHG emissions, in $ktCO_2$ equivalent						Total emissions
	Forest land	Cropland	Grassland	Wetlands	Settlements	Other lands	$ktCO_2$ equivalent
1989	0.0 27	0.405	0.562	1.531	3.871	1.301	7.637
2005	0.0 27	0.426	0.485	1.549	3.932	1.856	8.274
2017	0.0 29	0.426	0.485	1.549	3.932	1.883	8.304

The *"Settlements"* had a share of about 50% in 1989, this share decreased in both 2005 and 2017 to about 47.5%.

The "*Wetlands*" emitted about one fifth of the GHG at LULUCF level in 1989, a share that subsequently stabilized at around 18.7%.

The "*Other lands*" area of the LULUCF sector increased from 17% in 1989, to over 22% in 2005 and 2017. The other two areas remained relatively constant over time (*"cultivated lands" (Cropland) and "pastures" (Grassland).*

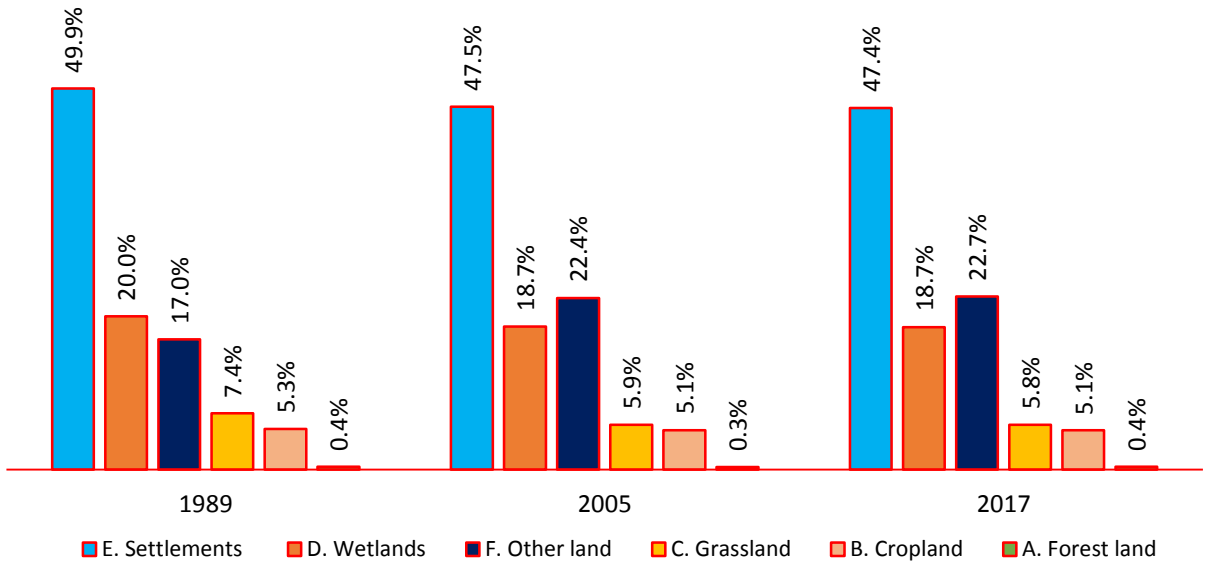

Figure 21. The share of GHG emissions by types of land

In the "*Other lands*" category the emissions registered an increase about 45% in 2017 compared to the reference year, and about 1.4%. compared to 2005. Also, before 2005, the average of annual growth rate of emissions was 2.2%, respectively 34.6 kt of CO_2 equivalent. After 2005, the growth rate decreased compared to the previous period to about 0.1% per year, respectively an average of annual growth by 2.2 kt of CO2 equivalent, respectively an increase lower than the one registered previously, by 95%. Between 1989-2017, emissions increased by an average of

1.3% per year, respectively increased by 20.76 kt of CO2 equivalent, being the largest absolute annual average increase compared to the other components of the LULUCF sector.

Between 1989 and 2005, the GHG emissions from forest areas remained constant, whereas after 2005, emissions increased by about 0.5% per year, respectively by 200 tons of CO2 equivalent per year.

In the area of "cultivated land", before 2005, emissions increased on average by 0.3% annually, respectively by 1.3 kt of CO2 equivalent. After 2005, they remained constant, at 426 kt of CO2 equivalent.

The *grassland areas* have an emission reduction of approximately 4.8 kt of CO_2 equivalent, respectively decreasing at an average of annual rate of 0.9%. After 2005, they remained constant at around 485 kt annually.

The absorptions dynamic of the "wood products" area was different from the evolution of the absorption capacity in the forest land and cultivated land in the LULUCF sector. During both periods, the absorption has shown growth rates of annual averages**.**

Figure 22. Dynamics of the structure of GHG removals in the LULUCF sector in Romania, by geographical structure

The share of forest land in the absorption of GHG is the largest, amounting to over 84% in 1989 as opposed to *cultivated lands and the products obtained from wood*. In 2005, this share increased slightly to about 86.3%, reaching over 75% in 2017. This decreasing in the share of absorption of forest land was due to the share of wood products increasing. The share of wood products increased after 2005, from 6.9%, to about 18% in 2017.

In 2017, the absorption capacity of the forest land increased compared to the reference year by 7.8%, and compared to 2005 decreased by 10.4%.

The absorption in cultivated land decreased in 2017 compared to 1989 by 5.8%, and it increased by 4.4% in 2017 compared to 2005. The absorption of the wood products area registered a substantial increase by 3.3 times in 2017 compared to the reference year; the growth was 2.6 times in 2017 compared to 2005.

Prior to 2005, absorption in forest land increased at an average of the annual rate of about 1.2%, a rate that did not continue in the following period, when the absorption decreased at an annual average rate of about 0.9%. This situation led to a slight increase in absorption of 0.3% per year over the analyzed time horizon. It is noted that before 2005, the absorption capacity increased by 266 thousand tons of CO2 equivalent per year, and after 2005 it decreased by 218 thousand tons of CO2 equivalent. The evolution of the absorption capacity after 2005 practically determined the growth cancellation from the previous period.

Regarding absorption in the area of *cultivated land*, it is noted a decrease by 0.6% /year during 1989-2005, respectively by 13 kt of CO_2 equivalent per year. After 2005, the pace has changed radically, meaning that we have an annual average increase in absorption of 0.4% /year, respectively an absolute average increase of 7 kt of CO_2 equivalent /year. In the analyzed time period, the average annual rate decreased by 0.2% per year, expressed in absolute figures of 5 kt of CO_2 equivalent per year**.**

Table 101. Annual average change in absorption of GHG LULUCF (kt of CO2 equivalent/ year)

Periods defined	A Forest land	B Cropland	G Harvested wood products
Before 2005	266	-13	27
After 2005	-218	7	278
1989-2017	59	-5	134

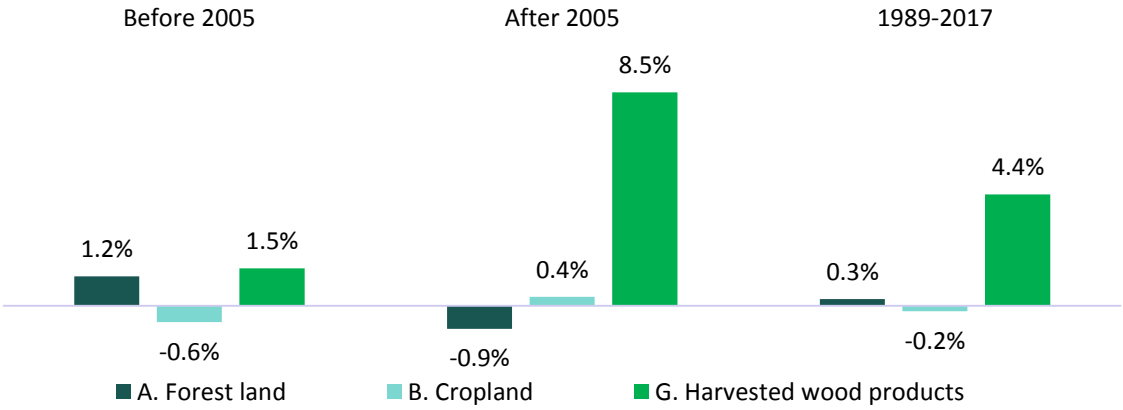

Figure 23. Dynamics of LULUCF components in terms of GHG absorption

Thus, before 2005, we record an absorption rate of about 1.5% per year, in absolute figures of 27 kt of CO_2 equivalent, a change about 5.7 times higher after 2005, reflecting an increase in quantity by over 10 times on average / year. This situation explains the rapid increase in the share of this component in total LULUCF absorption as opposed to forest land.

GHG emissions in the considered scenarios

Forested lands

In the **tables below** are presented projections of CO_2, CH_4, N_2O and GHG emissions for the 3 scenarios analyzed for the period 2017-2040.

Table 102. The evolution of CO2 emissions in the period 2017 - 2040

Scenario		Total emissions (kt)					
	2005	2017	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	-25173,52	-22553,89	-22462.50	-21856.48	-21250.61	-20644.74	-20038.87
WEM			-20326.79	-21311.81	-19341.78	-18356.76	-17371.74
WAM			-20326.79	-21311.81	-19341.78	-18356.76	-17371.74

Table 103. The evolution of CH4 emissions in the period 2017 - 2040

Scenario		Total emissions (kt)					
	2005	2017	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	0.0067	0.0796	0.0791	0.0901	0.1012	0.1122	0.1232
WEM			0.079	0.079	0.079	0.079	0.079
WAM			0.0024	0,0023	0.0021	0.019	0.017

Table 104. The evolution of N2O emissions in the period 2017 - 2040

Scenario		Total emissions (kt)					
	2005	2017	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	0.0901	0.0921	0.0921	0.0924	0.0928	0.0931	0.0934
WEM			0.089	0.085	0.080	0.076	0.071
WAM			0.063	0.059	0.054	0.050	0.045

Table 105.The evolution of GHG emissions in the period 2017 - 2040

Scenario		Total emissions ($ktCO_2$ equivalent)					
	2005	2017	2020	2025	2030	2035	2040

	Achievements		Forecasts				
WOM	-19677.178	-20862.937	-20862.811	-20840.645	-20842.812	-20808.80	-20793.142
WEM			-21359.966	-21525.466	-22683.966	-24338.967	-25166.467
WAM			-24282.231	-25462.791	-26306.048	-27149.305	-27992.562

Compared to the baseline scenario (WOM), all other scenarios highlight the fact that the LULUCF sector is a net absorber.

Cropland

The "cropland" category is an absorbent because it includes land that is subject to revegetation, consisting of planting trees that do not meet the conditions to be classified as afforestation or reforestation. The main greenhouse gases in the landfill category are carbon dioxide CO_2 and nitrous oxide (N_2O).

Starting from the presented hypotheses from the above analyzes, the following tables present the projections of CO_2, N_2O and GHG emissions for the 3 scenarios analyzed on period 2017-2040.

Table 106. The evolution of CO2 emissions in the period 2017 - 2040

Scenario		Total emissions (kt)					
	2005	2017	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	-1982.59	-2069.94	-2040.33	-2059.25	-2075.17	-2091.09	-2107.01
WEM			-2091.785	-2128.185	-2164.584	-2200.984	-2237.384
WAM			-2091.78	-2128.18	-2164.58	-2200.98	-2237.38

Table 107. The evolution of N2O emissions in the period 2017 - 2040

Scenario		Total emissions (kt)					
	2005	2017	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	1.429	1.429	1.4304	1.4310	1.4315	1.4321	1.4326
WEM			0.089	0.085	0.080	0.076	0.071
WAM			1.00	0.929	0.857	0.786	0.715

Table 108.The evolution of GHG emissions in the period 2017 - 2040

Scenario		Total emissions ($ktCO_2$ equivalent)					
	2005	2017	2020	2025	2030	2035	2040
	Achievements		Forecasts				

WOM	-1556.745	-1644.104	-1617.060	-1632.817	-1648.574	-1664.331	-1680.087
WEM			-1668.719	-1736.412	-1794.104	-1851.796	-1909.488
WAM			-1793.693	-1851.385	-1909.077	-1966.769	-2024.461

In the period 2020-2040, the amount of emissions/removals projected in the reference scenario increases, on average annually, by approximately 3.15 kt of CO_2 equivalent compared to the other scenarios where the growth is more obvious. In the case of the scenario with measures, we have an average annual growth of 7.3 kt of CO_2 equivalent, and in the WAM scenario, the increase is over 11.54 kt of CO_2 equivalent/year.

Grassland

The main greenhouse gases in the category of forested areas are: carbon dioxide (CO_2) and nitrous oxide (N_2O).

Based on the assumptions and analysis presented, the projections of CO_2, N_2O and GHG emissions in the 3 scenarios analyzed for the period 2017-2040 are, as follows:

Table 109. The evolution of CO2 emissions in the period 2017 - 2040

Scenario		**Total emissions (kt)**					
	2005	**2017**	**2020**	**2025**	**2030**	**2035**	**2040**
	Achievements		**Forecasts**				
WOM	453.54	453.54	447.03	444.33	441.62	438.91	436.21
WEM			437.56	410.934	384.307	356.681	331.054
WAM			372.77	345.15	319.52	292.89	266.27

Table 110. The evolution of N2O emissions in the period 2017 - 2040

Scenario		**Total emissions (kt)**					
	2005	**2017**	**2020**	**2025**	**2030**	**2035**	**2040**
	Achievements		**Forecasts**				
WOM	0.1052	0.1052	0.1056	0.1058	0.1060	0.1061	0.1063
WEM			0.103	0.097	0.091	0.086	0.082
WAM			0.07	0.07	0.06	0.06	0.05

Table 111. The evolution of GHG emissions in the period 2017 – 2040

Scenario		**Total emissions ($ktCO_2$ equivalent)**					
	2005	**2017**	**2020**	**2025**	**2030**	**2035**	**2040**

	Achievements		Forecasts				
WOM	484.875	484.875	478.502	475.849	473.197	470.544	467.892
WEM			467.959	439.766	411.572	383.379	355.185
WAM			394.709	366.515	338.322	310.128	281.935

Wetlands

The main greenhouse gases in the category of forested areas are: carbon dioxide (CO_2) and nitrous oxide (N_2O).

Table 112. The evolution of CO2 emissions in the period 2017 - 2040

Scenario		Total emissions (kt)					
	2005	2017	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	1515.66	1515.66	1516.97	1517.52	1518.07	1518.62	1519.17
WEM			1470.66	1395.67	1320.68	1245.69	1170.71
WAM			1049.84	974.85	899.86	824.87	749.88

Table 113. The evolution of N2O emissions in the period 2017 - 2040

Scenario		Total emissions (kt)					
	2005	2017	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	0.1108	0.1108	0.1109	0.1109	0.1110	0.1110	0.1110
WEM			0.107	0.102	0.096	0.091	0.085
WAM			0.0775	0.0720	0.0665	0.0609	0.0554

Table 114. The evolution of GHG emissions in the period 2017 – 2040

Scenario		Total emissions ($ktCO_2$ equivalent)					
	2005	2017	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	1548.661	1548.661	1550.011	1550.573	1551.134	1551.696	1552.257
WEM			1502.678	1426.039	1349.401	1272.762	1196.124

WAM			1072.939	996.300	919.662	843.023	766.385

Settlements

The main greenhouse gases in the category of forested areas are: carbon dioxide (CO_2) and nitrous oxide (N_2O).

Forecasts of CO_2, N_2O and GHG emissions for the 3 scenarios analyzed for the period 2017-2040.

Table 115. The evolution of CO2 emissions in the period 2017 - 2040

Scenario		Total emissions (kt)					
	2005	2017	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	3682.48	3682.48	3691.50	3695.26	3699.01	3702.77	3706.53
WEM			3575.278	3396.652	3217.926	3039.249	2860.573
WAM			2501.47	2322.79	2144.12	1965.44	1786.76

Table 116. The evolution of N2O emissions in the period 2017 - 2040

Scenario		Total emissions (kt)					
	2005	2017	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	0.838	0.838	0.8389	0.8393	0.8396	0.8396	0.8402
WEM			0.813	0.771	0.729	0.696	0.645
WAM			0.269	0.175	0.080	0.015	0.011

Table 117. The evolution of GHG emissions in the period 2017 - 2040

Scenario		Total emissions ($ktCO_2$ equivalent)					
	2005	2017	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	3932.239	3932.239	3941.507	3945.360	3949.213	3953.067	3956.92
WEM			3817.541	3626.376	3435.212	3244.048	3052.884
WAM			2581.758	2374.837	2167.916	1960.995	1754.074

Other lands

The main greenhouse gases in the category of forested areas are carbon dioxide (CO_2) and nitrous oxide (N_2O).

Forecasts of CO_2, N_2O and GHG emissions for the 3 scenarios analyzed for the period 2017-2040.

Table 118.The evolution of CO2 emissions in the period 2017 - 2040

Scenario		Total emissions (kt)					
	2005	2017	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	806,604	806,604	807,958	808,522	809,086	809,650	810,214
WEM			782,897	743,386	703,875	664,364	624,853
WAM			553,157	513,646	474,135	434,623	395,112

Table 119.The evolution of N2O emissions in the period 2017 - 2040

Scenario		Total emissions (kt)					
	2005	2017	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	3.520	3.611	4.208	4.525	4.841	5.158	5.475
WEM			3.554	3.459	3.364	3.269	3.175
WAM			1.327	1.232	1.137	1.043	0.948

Table 120.The evolution of GHG emissions in the period 2017 - 2040

Scenario		Total emissions ($ktCO_2$ equivalent)					
	2005	2017	2020	2025	2030	2035	2040
	Achievements		Forecasts				
WOM	1855.647	1882.544	2061.930	2156.867	2251.803	2346.740	2441.676
WEM			1841.891	1774.135	1706.379	1638.623	1570.867
WAM			948.581	880.825	813.070	745.314	677.558

Harvested wood products

"*Harvested wood products*" sector is a component of the LULUCF sector where carbon dioxide is stored in products resulting from deforestation.

Table 121. Evolution of GHG emissions/removals in the period 2017 – 2040

Scenario		Total emissions ($ktCO_2$ equivalent)					
	2005	2017	2020	2025	2030	2035	2040

	Achievements		Forecasts				
WOM	-2024.449	-5359.786	-4844.781	-5516.132	-6187.483	-6858.835	-7530.186
WEM			-6193.620	-7583.344	-8973.068	-10362.791	-11752.515
WAM			-6193.620	-7583.344	-8973.068	-10362.791	-11752.515

In terms of removals, the scenarios with measures and additional measures have similar evolutions because they do not deal with the specific reduction measure for GHG emissions in the LULUCF sector.

5.14. Sensitivity analysis of GHG emission projections to changes in economic and social development of Romania

The achievement of GHG emission projections is based on assumptions about high-uncertainty macroeconomic indicators on the forecast horizon until 2040 due to the national and global economic crisis due to the COVID19 pandemic and the lack of strategies for the 2030-2040 horizon on industry, agriculture, transport, etc. Since December 2020, the National Recovery and Resilience Plan (NRRP) is under public debate, a strategic document of Romania setting out the areas and priorities of investments as well as the reforms developed for each investment area, in line with the Country Specific Recommendations (CSR), as well as the European Commission Regulations, the financing of which is provided from the Redress and Resilience Facility (RRF) which aims as a general objective to improve Romania's economic status, strengthening resilience in periods of pandemic crisis and ensuring long-term economic growth. Economic development is a dominant factor affecting the results of forecasts.

The overall objective of the NRRP derives from a number of specific objectives concerning:

- Infrastructure investments aim to develop specific infrastructure in areas considered strategic for Romania such as transport, climate change, energy and renewable energy, environment, energy efficiency, modernisation of local public services, health and education
- Investments in digitalisation and green transition aim to align with the objectives set by the European Union and contained in the European Green Deal, as well as increasing of Romania's resilience capacity in times of pandemic crisis.
- Investments in the competitiveness of the business environment and access to research and innovation are intended to strengthen the economic competitiveness of SMEs on the European market, increase added value, improve the quality of products and services obtained, refurbish, robotics and automate industrial processes, digitise the activity of SMEs, as well as the development of research, innovation and smart specialisation activities by the National Institutes for Research and Development and SMEs, which ultimately aim to place competitive products and services on the market in line with quality requirements and prices of consumers.

In view of the uncertainties regarding Romania's economic and social development in 2020 in order to analyse the sensitivity of GHG emission forecasts to the assumptions envisaged, minimum and maximum scenarios for the economic recovery are carried out against the reference scenario for which the forecasts were made. Sensitivity analysis refers to economic development because the effect of other factors is substantially lower.

Taking into consideration the share of about 70% of emissions from the combustion of fuels in total GHG emissions in Romania, the sensitivity analysis focuses on GHG emissions due to the energy sector.

The main indicators considered in the sensitivity analysis for alternative scenarios compared to the reference scenario. Population evolution is considered the same in all 3 scenarios. The evolution of macroeconomic indicators determines variation in energy and electricity consumption with significant influences on GHG emissions.

To elaborate forecasts for the 2018 – 2040 period, the average annual GDP growth rates were used indicated by the National Commission for Strategy and Prognosis (reference scenario) and the European Commission in June 2020 (minimum scenario).

Table 122. The average annual growth rate of GDP during 2005 – 2040 (%)

Year	2005	2016	2017	2018	2019	2020	2021-2025	2026-2030	2031-2035	2036-2040
	Achievements					Forecasts				
National Commission for Strategy and Prognosis (September 2020)	4.7	4.8	7.1	4.4	4.1	-3.8	4.1	3.0	2.3	1.8
Parameters recommended by the European Commission (June 2020)						-5.96	4.50	3.01	1.84	1.39

Table 123. The evolution of macroeconomic and energy indicators in 2018÷2040 period in all three scenarios

Scenario	INDICATOR	MU	2018	2020	2025	2030	2035	2040
			Achieved	Forecasted				
MINIMUM	Gross domestic product	10^9Euro$_{2016}$	190.59	186.77	232.75	269.95	295.72	316.85
	Primary energy consumption	10^6tep	33.51	30.53	30.98	31.75	32.98	33.33
	Final energy consumption	10^6tep	23.61	21,50	22,90	23,55	24,20	24.90

Scenario	INDICATOR	MU	2018	2020	2025	2030	2035	2040
			Achieved	Forecasted				
	Gross electricity consumption	TWh	61.04	53.84	57.20	59.40	60.70	61.75
REFERENCE	Gross domestic product	10^9Euro$_{2016}$	190.59	190.89	233.88	271.22	303.62	331.72
	Primary energy consumption	10^6tep	33.51	31.48	31.55	31.33	31.47	32.09
	Final energy consumption	10^6tep	23.61	21.85	23.17	24.19	24.99	25.62
	Gross electricity consumption	TWh	61.04	55.51	59.90	61.76	62.76	63.73
MAXIMUM	Gross domestic product	10^9Euro$_{2010}$	190.59	190.89	237.83	275.87	305.13	333.42
	Primary energy consumption	10^6tep	33.51	31.48	33.54	34.76	35.10	36.34
	Final energy consumption	10^6tep	23.61	21.85	24.63	26.83	27.87	29.01
	Gross electricity consumption	TWh	61.04	55.51	61.85	64.75	66.25	67.98

Macroeconomic restructuring assumptions in 2018÷2040 period for the alternative scenarios considered for sensitivity analyses are presented in the below table**.**

Table 124. The evolution of the structure of Gross Added Values in 2018÷2035 period

Scenario	Value	2018	2020	2025	2030	2035	2040
		Achieved	Forecasted				
MINIMUM	Gross value added, out of which:	100%	100%	100%	100%	100%	100%
	Industry	28.9	28.7	28.5	28.3	28.1	27.9
	Agriculture	6.0	5.8	5.5	5.3	5.2	5.1
	Construction	8.5	8.0	8.0	8.0	8.0	8.0

	Services	56.6	57.5	58.0	58.4	58.7	59.0
REFERENCE	Gross value added, out of which:	100%	100%	100%	100%	100%	100%
	Industry	28.9	24.7	24.3	23.3	22.8	22.4
	Agriculture	6.0	4.7	4.2	3.8	3.5	3.3
	Construction	8.5	6.9	7.5	7.8	7.7	7.6
	Services	56.6	63.7	64.0	65.0	66.0	66.7
MAXIMUM	Gross value added, out of which:	100%	100%	100%	100%	100%	100%
	Industry	28.9	24.7	24.5	23.7	23.1	22.9
	Agriculture	6.0	4.7	6.0	4.5	4.5	4.0
	Construction	8.5	6.9	7.50	8.00	8.00	8.00
	Services	56.6	63.7	62.0	63.9	64.40	65.10

The evolution of CO_2 emissions due to the energy sector is presented in the reference scenario and in the alternative scenarios (minimum and maximum).

Table 125. Evolution of CO2 emissions for alternative scenarios in 2018÷2040 (thousand t CO2)

Scenario	Indicators	2018	2020	2025	2030	2035	2040
		Achieved	Forecasted				
Minimum	A. Burning fuels	**65423.74**	**54876.56**	**52971.04**	**50473.22**	**52937.15**	**55072.62**
	1. Energy sector	24173.50	18339.42	12521.35	6414.55	6779.45	7105.59
	2. Manufacturing and Construction sector	12098.27	9765.50	9549.53	9313.39	8705.42	8424.35
	3. Transport	18177.85	15956.56	19672.11	22884.98	25301.14	27133.73
	4. Other sectors	10357.11	10215.08	10597.45	11197.53	11454.57	11676.85
	5.Others	617.01	600.00	630.60	662.77	696.57	732.10
Reference	A. Burning fuels	**65423.74**	**55557.31**	**53514.19**	**50772.38**	**54089.42**	**56991.43**
	1. Energy sector	24173.50	18580.31	12767.78	6501.80	6853.24	7207.34
	2. Manufacturing and Construction sector	12098.27	9980.92	9595.89	9256.64	8934.91	8733.85

Scenario	Indicators	2018	2020	2025	2030	2035	2040
		Achieved	Forecasted				
	3. Transport	18177.85	16034.03	19767.62	23093.11	25977.02	28406.76
	4. Other sectors	10357.11	10362.05	10752.30	11258.06	11627.68	11911.38
	5.Others	617.01	600.00	630.60	662.77	696.57	732.10
Maximum	A. Burning fuels	**65423.74**	**55557.31**	**53620.94**	**50976.21**	**54231.84**	**57297.08**
	1. Energy sector	24173.50	18580.31	12987.42	6652.38	6887.36	7276.27
	2. Manufacturing and Construction sector	12098.27	9980.92	9657.95	9465.99	8915.46	8753.60
	3. Transport	18177.85	16034.03	19767.62	23093.10	26377.02	28656.76
	4. Other sectors	10357.11	10362.92	10577.35	11101.97	11355.43	11878.35
	5.Others	617.01	600.00	630.60	662.77	696.57	732.10

The sensitivity analysis for the combustion of fuels by the energy sector (energy industry, manufacturing and construction, transport and other sectors) in relation to economic development at national level allows the following conclusions to be drawn:

- CO_2 emissions increase with the increase of GDP and decrease with the decrease of GDP. However, the increase in emissions in the maximum scenario is smaller than the decrease in the minimum scenario, given that the higher the GDP, the more funds will be available for new technologies;
- In the case of manufacturing industry and construction, it is also noted that emissions increase with GDP, but the increase is less than the decrease in the minimum scenario which demonstrates the existence of funds for environmental protection and increased energy efficiency;
- In the case of the transport sector in the maximum scenario, there is an increase in emissions accompanied by a GDP growth lower than the decrease in the minimum scenario although the increase in living standards of the population increases mobility but there are funds to renew the fleet of cars with high performance cars (emissions reduced, electric machines);
- The structure of the electricity production facilities does not differ significantly in the analysed scenarios. The difference in emissions in this sector depends mainly on meeting the demand for electricity and heat;
- The impact on emissions in other sectors such as residential, agriculture and services is not significant.

5.15. Conclusions

The report determined the evolution of GHG emissions over the period 2018-2040 for the three scenarios, namely: **without measures, with measures and with additional measures.**

The projections of the GHG emissions in the three scenarios are developed considering the structure of the sectors according to the National Inventory Report, also indicating the GHG emissions under the EU ETS and non-ETS sectors.

In order comply with this requirement, the following activities were performed:

- the NGHGI and CRF were analysed for the period 1989-2018 to determine the activities with significant GHG emissions, for which appropriate methodologies for determining GHG emissions must be adopted;
- the methodologies to develop these forecasts for different sectors of activity were established;
- the share of GHG emissions from EU ETS monitored installations was established by sectors;
- the hypotheses for which these forecasts were developed, have been established considering the requirements of the adopted methodologies and the national strategies regarding the economic and social development of Romania;
- the national strategies and action plans by sectors were analysed to define actions with an impact on reducing GHG emissions.

The report stated that special methodologies are needed to determine GHG emissions in the Energy, Industrial Processes, Waste, LULUCF sectors.

For non-CO_2 emissions due to sectors like Agriculture, Solvents and Other Products, the forecasts can be developed with a high degree of confidence by using the methodologies applied for NGHGI, establishing the most accurate data for the forecasts regarding the activity carried out, the evolution of livestock and fertilizers to be used.

Difficulties were encountered in establishing the assumptions underlying the development of the forecasts, because:

- there is no official data on medium and long term (after 2018 up to 2040) regarding the economic and social development of Romania, the industrial and agricultural policies, etc;
- it was necessary to perform an analysis on the evolution of the sectors during 1989 - 2018, considering the crises and restructurings they have been through, in order to be able to establish the hypotheses for GHG emission forecasts;
- EU studies and comparisons with other former communist countries that joined the EU had to be used to justify the adopted assumptions, in order to ensure credibility

In order for the reporting of projections to meet the requirements under the EU and the UNFCCC reporting requirements, efforts must be further made to increase the quality of the input data used to develop the projections.

6. Provision of financial, technological and capacity building support consistent to developing country Parties

Romania is not a Party included in Annex II to the Convention and is therefore not obliged to adopt measures and fulfil the obligations defined in Article 4, paragraphs 3, 4 and 5, of the Convention.

However, Romania offers information on financial resources for the years 2017 and 2018 provided through multilateral and bilateral channels related to the implementation of the Convention in the tables 7(a) and 7(b) of the CTF tables. These tables include information on the financial support provided and/ or committed for the purpose of assisting non-Annex I Parties to mitigate GHG emissions and to adapt to the side-effects of climate change. The report of the financial support is provided in domestic currency - RON and USD. The USD was determined by using the average National Bank course of USD/ RON in 2017 and 2018 (4.0525 and 3.9416 accordingly - https://www.bnr.ro/Raport-statistic-606.aspx).

The Romanian bilateral and multilateral climate finance flows were fully counted towards ODA. The Romanian climate-specific funding in the years 2017 and 2018 consisted of contributions to the multilateral climate change funds and specialized United Nation bodies.

Romania did not use the Rio markers to assess the activities as climate related. Except UNFCCC which is assessed as climate specific, the rest of contribution are core/ general.

In the years 2017 and 2018 were not developed technology support and transfer and capacity-building activities. Thus, the table 8 and 9 of the CTF tables were not provisioned for these years.

7. Other reporting requirements

7.1 Domestic arrangements established for the process of the self-assessment of compliance with emission reductions in comparison with emission reduction commitments or the level of emission reduction that is required by science

The Ministry of Environment, Waters and Forests has provided funding for relevant studies with the objective to identify the most efficient institutional arrangements for the implementation of the Decision nr. 406/ 2009/ EC on effort sharing.

Under this Decision, the coordination between the central and local authorities and the self-assessment of compliance to evaluate the effects of policies and measures and estimate the projections of emissions are very important. The conclusions of the studies promoted give solutions to the process of the self-assessment of compliance with emission reductions in comparison with emission reduction commitments or the level of emission reduction that is required by science.

The close links with research institutes and the advice from the National Commission on Climate Change enhance our capacity for self-assessment.

For the process of the self-assessment of compliance with emission reductions in comparison with emission reduction commitments Romania also uses:

- the National Greenhouse Gas Inventory;

- the data and information on policies and measures to mitigate GHG emissions and enhance removals and, respectively, on GHG emissions/removals projections, submitted every two years as part of the Biennial Reports;
- data and information are included every four years in the National Communication on Climate Change, officially submitted to the UNFCCC Secretariat.

7.2 Progress made in the establishment of national rules for taking local action against domestic non-compliance with emission reduction targets

So far except for the economic operators under the EU ETS which have to comply with relevant legislation for non-compliance, there is not in place yet a system for taking local action against domestic non-compliance with emission reduction targets. The rules and procedures for noncompliance are being established following the conclusions included in the studies mentioned in the previous section.

7.3 Any other information that the Party considers relevant to the achievement of the objective of the Convention

Not applicable

8. Appendix: CTF for Romania's 4th Biennial Report

The CTF tables are part of the current BR 4 of Romania:

CTF Table 1: Emission Trends

CTF Table 2: Description of quantified economy-wide emission reduction

CTF Table 3: Progress in achievement of the quantified economy-wide emission reduction target: information on mitigation actions and their effects

CTF Table 4: Report on progress

CTF Table 5: Summary of key variables and assumptions used in the projections analysis

CTF Table 6 (a): Information on updated greenhouse gas projections under a 'with measures' scenario

CTF Table 6 (c): Information on updated greenhouse gas projections under a 'with additional measures' scenario

CTF Table 7: Provision of public financial support: summary information in 2017 and 2018

CTF Table 7(a): Provision of public financial support: contribution through multilateral channels in 2017 and 2018

CTF Table 7(b): Provision of public financial support: contribution through bilateral, regional and other channels in 2017 and 2018

CTF Table 8: Provision of technology development and transfer support during 2017-2018

CTF Table 9: Provision of capacity-building support during 2017-2018