



MINISTRY OF ENVIRONMENT

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**This report was prepared in collaboration with:
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Director

Eng. Daniela Cristina Burnete

Project manager

Ph.D(Eng). Claudia Eudora Tomescu

Technical coordinator

Ph.D(Eng). Anca Popescu

Approved by

Eng. Irene Samoilă

Ph.D(Eng).Marian Dobrin

Verified by

Ph.D.(Eng).Valentin Rusu

Eng. Gloria Popescu

Elaborated by

Eng. Oana Falup

Eng. Iulia Bunda

Eng. Cristina Bălăceanu

Ph.D. Mat. Mihaela Bălănescu

Ph.D. (Eng.) Irina Vodă

Eng.Camelia Vasile

Eng. Alexandra Ignat

Eng. Florina Filip

Eng. Irina Grigorovici

National Meteorological Administration

Ph.D.Elena Mateescu

Ph.D.Roxana Bojariu

Ministry of Environment

Ing. Gherghița Nicodim

Ec. Maria Făină

Ing. Evelina Dascălu

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LIST OF ABBREVIATIONS

ANRE	National Electricity and Heat Regulatory Authority
ARoTT	Romanian Association for Technology Transfer and Innovation
CIEM	International Conference Energy and Environment
CMIP	Coupled Model Intercomparison Project
Comecon	Council for Mutual Economic Assistance
CRES	Centre for Renewable Energy Sources and Saving
CRF	Common Reporting Format
CTF	Common Tabular Format
ECA&D	European Climate Programme and Dataset
ECOMET	Economic Interest Grouping of the National Meteorological Services of the European Economic Area
ECVs	Essential Climate Variables
EERP	European Economic Recovery Plan
EF	Emission Factor
ERT	Expert Review Team
ERTMS	European Railway Traffic Management System
EU	European Union
EU-ETS	European Union-Emission Trading Scheme
EUMETNET	European Organisation for the Exploitation of Meteorological Network
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FMIMS	National forest monitoring and management system
GCOS	Global Climate Observing System
GD	Governmental Degree
GDP	Gross Domestic Product
GEO	Government Emergency Ordinance
GeoEcoMar	National Institute of Research and Development on Marine Geology and Ecology
GEOSS	Global Earth Observation System of Systems
Gg	Giga gram
GHG	Greenhouse Gas
GOOS	Global Ocean Observing System
GVA	Gross Value Added
HHI	Hirschman – Herfindahl indicator
ICAS	Forest Research and Management Planning Institute
IEE	Intelligent Energy Europe programme
IGBP	International Geosphere-Biosphere Programme
IHDP	International Human Dimensions Project
IPCC	Intergovernmental Panel on Climate Change
IPCC 2006	IPCC Guidelines for National Greenhouse Gas Inventories
ISPE	Institute for Studies and Power Engineering
ITU	Intermodal Transport Units
JPI	Joint Program Initiative
KCA	Key Category Analysis
KP	Kyoto Protocol
LULUCF	Land Use, Land Use Change and Forestry
M/A	Mitigation/Adaptation
MAWS	Meteorological Automatic Weather Stations

MECC	Ministry of Environment and Climate Change, nowadays Ministry of Environment
MoEO	Ministry of Environment Order
MS	Member States
NAQ	National Authority for Qualifications
NAPCC	National Action Plan for Climate Change
NACPEVT	National Agency for Community Programs in the Field of Education and Vocational Training (ANPCDEFP)
NAE	National Agency for Employment (ANOFM)
NCCC	National Commission on Climate Change
NDP	National Development Plan 2007-2013
NE	Not Estimated
NEPA	National Environmental Protection Agency
NGHGI	National Greenhouse Gas Inventory
NGO	Non-Governmental Organisation
NIR	National Inventory Report
NIS	National Institute for Statistics
NMA	National Meteorological Administration
NPP	Nuclear power plant
NPS	National Power System
NSCC	National Strategy for Climate Change
NTS	National Transmission System
OHL	Overhead Electric Lines
PCF	Prototype Carbon Fund
PMU	Project Management Unit
PNAEE	National Action Plan on Energy Efficiency
PTG	Power Transmission Grid
QA	Quality Assurance
QC	Quality Control
RBCN	Regional Basic Climatological Network
RBSN	Regional Basic Synoptic Network
RCP	Representative Concentration Pathways (concentration scenario for GHG concentrations in future)
SEAP	Sustainable Energy Action Plan
SIMIN	National Meteorological Integrated System
SME	Small and Medium Enterprises
UEDIN	University of Edinburgh
UNFCCC	United Nations Framework Convention on Climate Change
UPB	University "Politehnica" of Bucharest
WAM	with Additional Measures
WCRP	World Climate Research Programme
WEM	with Measures
WEC-RNC	Romanian National Committee of World Energy Council
WMO	World Meteorological Organisation
WOM	without Measures

I. SUMMARY

Romania's Seventh National Communication on Climate Change, updating the progress in addressing climate change, reflects considerable progress since the submission of the Sixth National Communication in 2013.

The key achievements since Romania's Sixth National Communication on Climate Change are the following:

- Improvement of greenhouse gas (GHG) emissions estimation for several sectors, performed by NEPA, following the studies results which involved new data (activity data and emission factors), methods and categories;
- Optimization of the data collection from the operators from the Energy Sector (Power Industries and Manufacturing Industries and Construction) and from the Waste Sector (Solid Waste Disposal on Land and Waste Water Handling) due to the implementation of an integrated informational system;
- Adoption in 2017 of Romania's National Strategy for Climate Change and Low-Carbon Economic Growth for the period 2016-2020" and of the Action Plan for Climate Change and Low-Carbon Economic Growth for the period 2016-2020".

Romania quantified emissions reduction target for 2020 includes the reduction of the Emissions Trading Scheme (EU-ETS) emissions (-21% compared to 2005) and the positive limit established for non-ETS sector (+19% compared to 2005), in line with Decision 406/2009/CE.

The reduction of total GHG emissions at the national level is expected to be achieved as a result of improvement and extending of EU-ETS involving more stringent emissions caps, as well as energy efficiency enhancement (by 19% until 2020), increase of energy share from renewable sources in gross final consumption of energy (by 24% until 2020) and promotion of clean and energy efficient road transport.

Romania's Sixth National Communication includes:

- Description of Romania's national circumstances, as context for emissions profile and responses to climate change (Chapter II);
- The evolution of GHG emissions and the improvement performed for each INEGES sector, in terms of data collection and applied methodologies for emissions estimation (Chapter III);
- Details on the progress on climate change policies and measures, since Romania's Sixth National Communication (Chapter IV);
- Sectoral projections for Romania's GHG emissions (Chapter V);
- Romania's vulnerability to climate change impacts and adaptation measures for addressing those impacts (Chapter VI);
- Details of progress by research programs and institutions in climate research, systematic observation, and adaptation and mitigation technologies (Chapter VIII);
- An overview of efforts to increase knowledge of climate change issues through public awareness-raising education and training activities (Chapter IX).

I.1 NATIONAL CIRCUMSTANCES

Romania is a presidential Republic based on the principle of separation and balance of powers in the state - legislative, executive and judicial - under the rules of constitutional democracy.

The legislative power is held by the Parliament, which gathers the Chamber of Deputies and the Senate. The Chamber of Deputies and the Senate are elected for a four-year mandate and have as their main tasks the adoption of laws and the state budget.

The executive power belongs to the Government, which is responsible for enforcing laws. The government includes the prime minister, ministers and other members appointed by organic law.

The President of Romania is elected by universal, equal, direct, secret and free suffrage for a term of office of 5 years, not more than two consecutive offices.

Justice (the judicial power) is represented by the High Court of Cassation and Justice, which ensures the unitary interpretation and application of the law by the other courts. Judges are independent of the political power and irremovable (they cannot be transferred, replaced or dismissed except by the Superior Council of Magistracy).

The responsibility for addressing climate change in Romania is shared between the Romania Government and 42 local government authorities (including Bucharest).

The Ministry of Environment is the lead authority in the Romania Government's responses to climate change.

The Romanian territory is divided into administrative units, such as communes, towns and counties. Romania is divided into 41 counties and one municipality (Bucharest, the capital). The 41 counties are structured in 2,861 communes (for rural areas) and 320 cities (for urban areas), out of which 103 are municipalities. Communes are divided into villages (which have no individual administration and hence not being an administrative division).

Main cities and towns in Romania account for more than half of the total population, 25 of them have over 100 thousands inhabitants each; this represent in total 54% of the urban population. Among the cities with the largest population, Bucharest ranks first (with 1,844,312 inhabitants), followed by Iași, Prahova, Cluj, Constanța, Timiș, Dolj and Suceava.

The evolution of Romania's population shows a slight decrease of about 7% between 2005 and 2015:

Table I_ 1 Evolution of Romania's population 2005-2011

Year	1990	2005	2010	2011*	2012	2013	2014	2015
Population (mill. people)	23.211	21.624	20,247	20,122	20,060	19,989	19.913	19,820

Source: National Institute of Statistics - Romanian Statistical Yearbook – 2012, *Final results of the Population and Dwellings Census

Romania is situated in the south-eastern part of the Central Europe inside and outside of the Carpathians Arch, on the Danube lower course.

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 (Figure I_1).

During the period 1901-2016, the mean annual air temperature increased by more than 1°C. 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). 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.

As for the precipitation, the analysis of the data recorded during the interval 1901-2016 revealed no tendency in the annual amount of precipitation. The highest annual rainfall amount recorded in Romania was 2401.5 mm in 1941, at the Omu weather station. The largest monthly amount of rainfall, 588.4 mm was recorded in June 2011 at the Bâlea Lac. The highest precipitation amount averaged at the Romanian level was recorded in 1940 (889.5 mm) and the lowest in 2000 (417 mm).

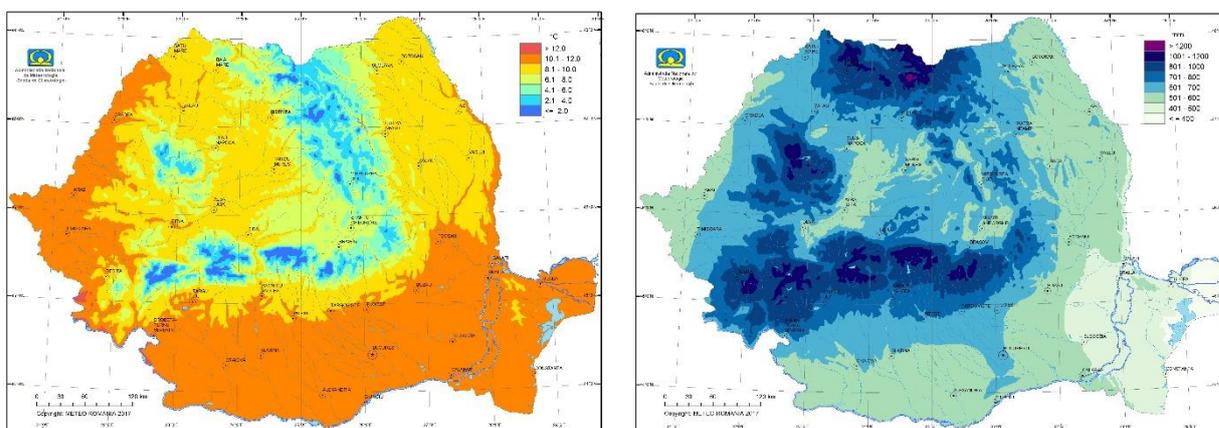


Figure I_1 Multiannual mean of in air temperature (in °C, left panel) and of precipitation amount (in mm, right panel) for the interval 1961-2016

The economic development of Romania during 2000 – 2012, strongly linked to the worldwide economic development, including the global economic-financial crisis, in terms of GDP, is presented in the following table.

Table I_2 Romanian GDP evolution within the 2005 – 2015 period

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
GDP [bill. Euro]	80.23	98.42	125.40	142.40	120.41	126.75	133.31	133.81	144.25	150.33	159.98
GDP [bill. Euro 2010]	109.69	118.58	126.76	137.53	127.77	126.75	128.14	128.91	133.42	137.56	142.92
The GDP annual rate [%]	4.2	8.1	6.9	8.5	-7.1	-0.8	1.1	0.6	3.50	3.10	3.90

Source: National Institute of Statistics – Romanian Statistical Yearbook – collections

Romania's main export goods are: machinery and equipment for transport, metals and metal products, textiles and footwear, chemicals, agricultural products, minerals and fuels. The exports value rose with about 10% in 2015 against 2013 figures. In the structure of exports the main categories in 2015 included: machinery and transport equipment 44.5%, manufactured goods classified mainly by the raw material 16.7%, miscellaneous manufactured articles 15.7%, chemicals and related products 4.9%, mineral fuels 4.5%, lubricants and related materials and other goods 13.7%.

GHG emissions per unit of GDP are continuing to decrease, due to the technical improvements, applications of different policies and due to the structural change of GDP.

One should mentioned a general decreasing trend for the GHG emissions per capita between 1989 and 2015, though during the period 2010 – 2011 by a small increase. All trends are presented in the Figure I_2.

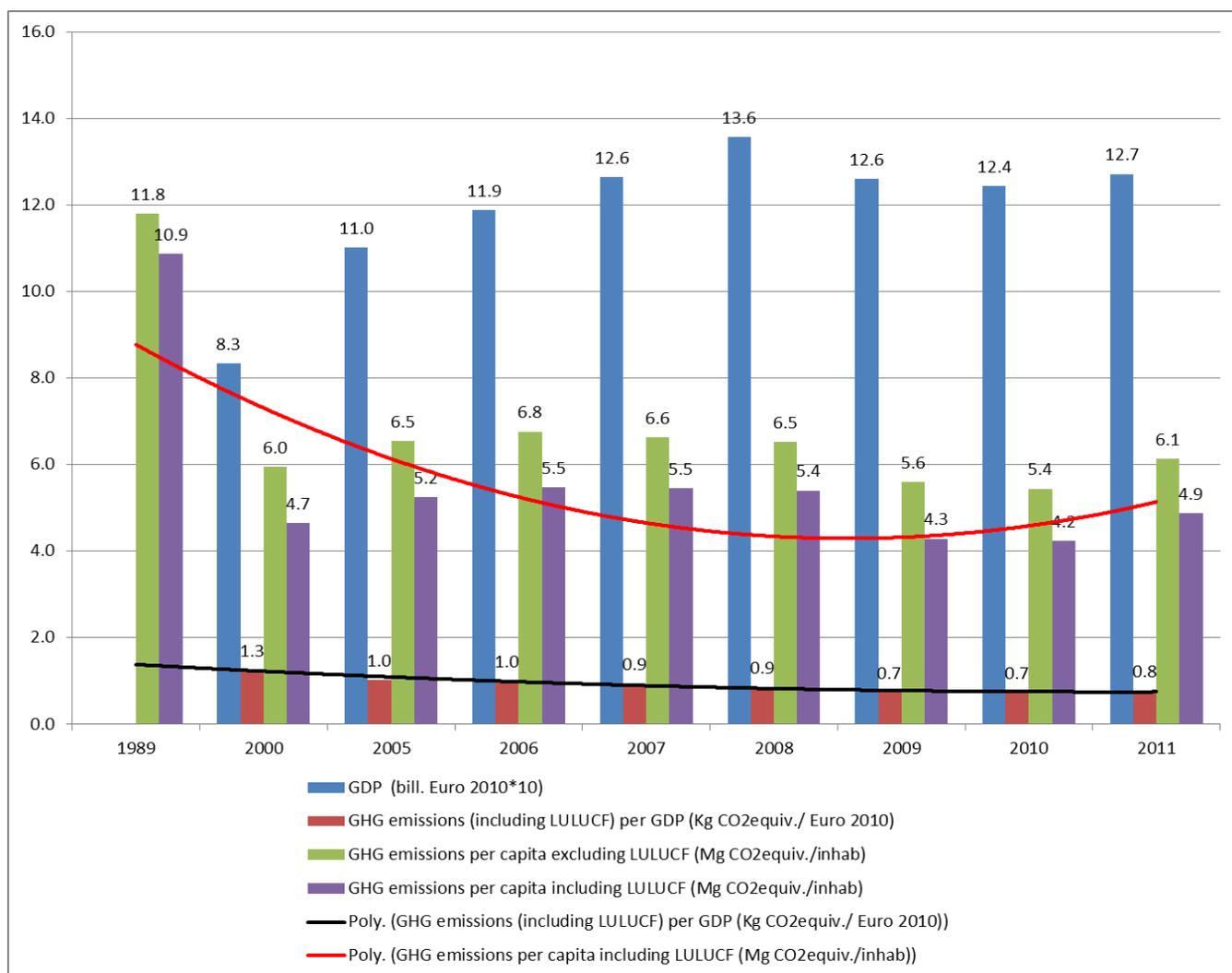


Figure I_2 GHG data and national circumstances

III. GREENHOUSE GAS INVENTORY INFORMATION, INCLUDING ON NATIONAL SYSTEM AND NATIONAL REGISTRY

As a Party to the UNFCCC and the Kyoto Protocol, Romania has the obligation to prepare, publish and update greenhouse gas inventories on an annual basis.

In 2015, the Romania's total GHG emissions, excluding removals by sinks, amounted to 116,426.73 Gg CO₂ eq. The Energy sector has the biggest share of total GHG emissions (81.59 %), followed by the Agriculture sector (18.96 %) and Industrial Processes and Product Use (12.09 %).

In 2015, the carbon dioxide had the largest share of Romania's total GHG emissions (excluding the LULUCF sector) (69.13 %), followed by methane (23.29 %) and nitrous oxide (6.11 %).

The emissions trends reflect the changes in this period characterized by a process of transition to a market economy and by financial/economic crisis (Figure I_3).

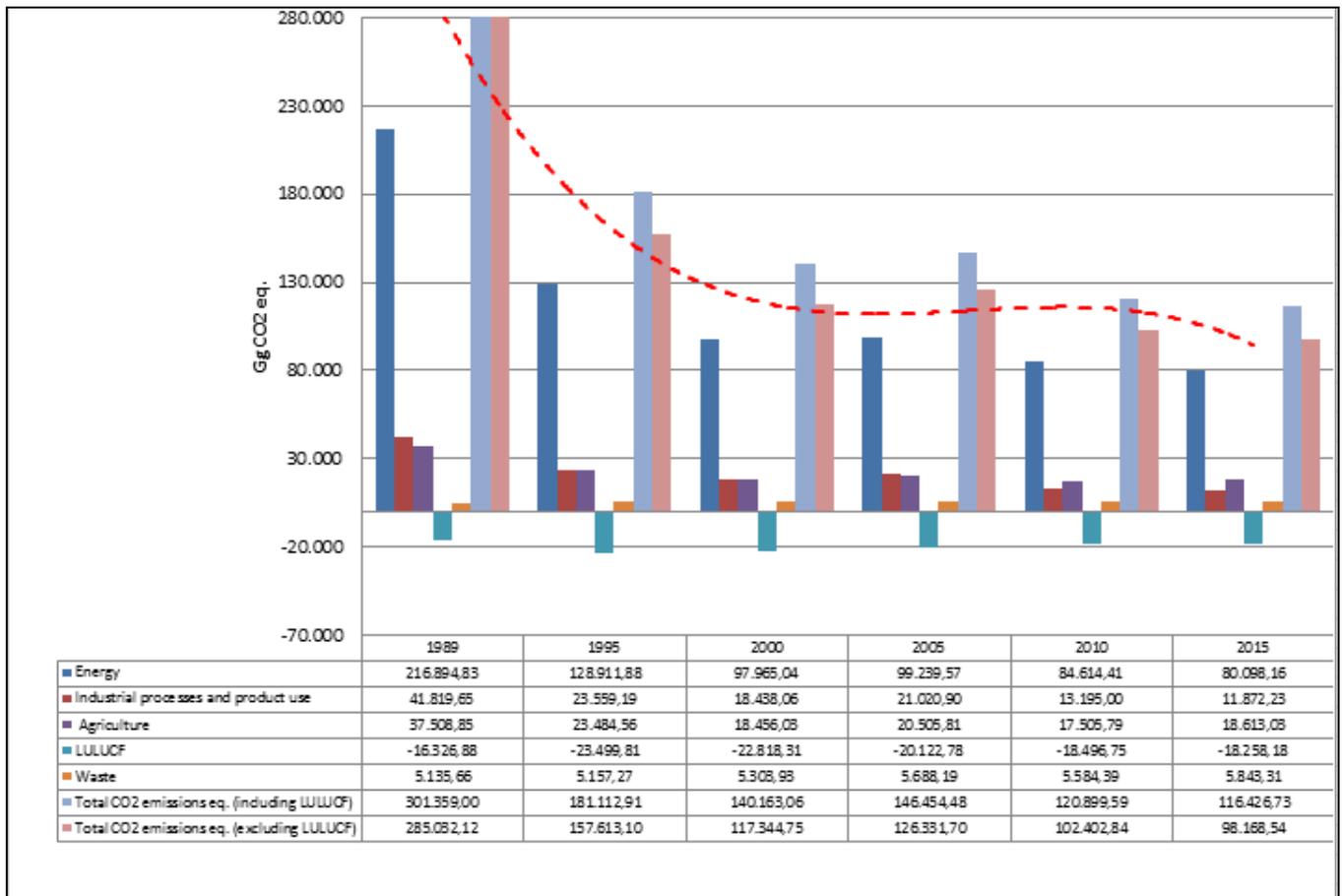


Figure I_3 GHG gas source and sink categories

The trend of GHG emissions between 1989 and 2015 was defined by a substantial decrease of emissions from Industrial Processes and Product use sector (71.61 %), followed by Energy sector (63.07 %) and Agriculture (50.38 %), and, as well as a clear increase of emissions from Waste sector (13.78 %) and LULUCF sector (18.6 %).

Emissions in one sector systematically increases since 1989 – waste sector, as a result of increasing the waste production and improving the data management (Figure I_4).

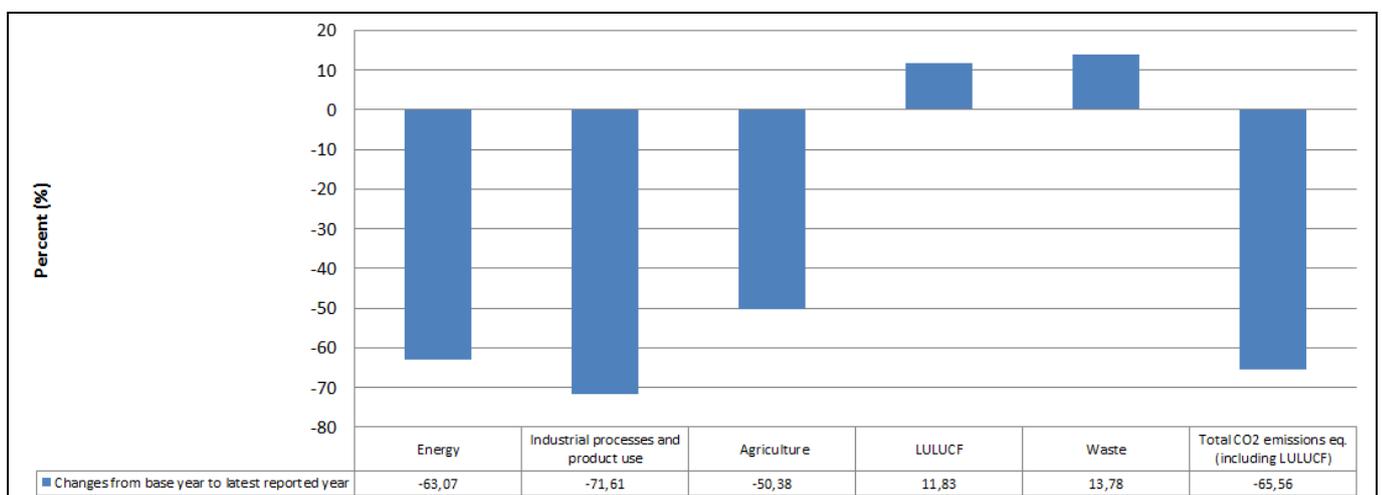


Figure I_4 Change from base (1989) to last reported year (2015)

Based on Article 5 of the Kyoto Protocol, Romania established a National System (NS) for estimating the anthropogenic emissions for all greenhouse gases not covered by the Montreal Protocol. The system complies with the provisions of the subsequent decisions of the CMPs of the Kyoto Protocol and with provisions of the Regulation (EU) no 525/2013.

Before 1 April 2013, the competent authority was the National Environmental Protection Agency (NEPA), under the subordination of the Ministry of Environment and Climate Change (MECC).

Based on the GD no. 48/2013, all NEPA climate change related structure, personnel, attributions and responsibilities were taken over by MECC, in order to improve the institutional arrangements and capacity within the climate change domain, thus increasing the efficiency in activities implementation also in respect to the NS/NGHGI administration; starting with 4 July 2016, NEPA is the the competent authority for National System administration, according with GEO no. 9/2016 and GD no. 284/2016.

Since the Sixth National Communication, Romania has developed a range of measures in order to improve the national greenhouse gas inventory system, based on more accurate emissions estimates.

These measures, described in Chapter III, include the collection of new data and methods for emissions estimation implemented as a result of studies performed.

Since migration to the EU register in June 2012, the European Commission is now responsible for supplying, maintaining and securing the national register information system concerning the commitments of European Member States as Parties to the Kyoto Protocol (KP register) and as participants in the EU ETS (EU-ETS Register).

IV POLICIES AND MEASURES, INCLUDING THOSE IN ACCORDANCE WITH ARTICLE 2 OF THE KYOTO PROTOCOL AND DOMESTIC AND REGIONAL PROGRAMMES AND/OR LEGISLATIVE ARRANGEMENTS AND ENFORCEMENT AND ADMINISTRATIVE PROCEDURES

The adopted and planned policies and measures took into consideration the GHG emissions of the each sector, their potentials of the reductions and the national priorities for economic development. For the attainment of the objectives for the reduction of the GHG emissions up to year 2020 through the applications of EU-ETS and of the objectives defined by Decision no. 406/2009/EC are necessary the substantial contributions of all economic sectors and regulate all sources of GHG emissions.

It is strict necessary to create and to strengthen the institutional structure given in Memorandum "Action Plan for the preparation of Romania for the implementation of the legislative packet Energy-Climate Change" signed by Romanian Government in year 2009.

Adopted policies and measures which established the reduction of GHG emissions are the followings:

- Romania's Energy Strategy for 2007 – 2020 (GD 1069/2007):
 - ✓ Withdrawing from service the generating units whose lifespan has been exceeded and which have become obsolete and the replacement thereof with modern units with superior efficiencies;
 - ✓ Re-engineering 330 MW units operating in lignite-fired power plants;

- ✓ Promoting high efficiency cogeneration; gas turbines with a heat recovery boiler (GT+HRB) and a combined cycle with gas turbines (CC+GT) of approximately 1000 MW and 600 MW biomass-fired units shall be installed;
- ✓ Continuing the upgrade works of district heating supply systems, respectively the units generating heat fluid, the primary heat fluid (hot water) transmission grid, the heating stations and heating modules, the hot water and heat fluid distribution network;
- ✓ Generating electricity from renewable energy sources.
- National Action Plan on Renewable Energy Sources
 - ✓ Evolution of electricity generated from renewable energy sources from 23.6 TWh in 2013 up to 31.4 TWh in 2020.
- The second National Action Plan on Energy Efficiency (PNAEE) for the 2011 - 2020 period
 - ✓ The improvement of the thermal performance of the buildings;
 - ✓ The encouragement of the development of the projects for ecologic houses, passive houses and/or active houses;
 - ✓ The modernization of the infrastructure for transport and distribution of heat in centralized system;
 - ✓ The program for the improvement of efficient energy in the building occupied by the persons with low income;
 - ✓ The program for the encouragement of the consumers for the acquisition of the electrical goods with high energy efficiency taking into consideration the stipulation given by the Regulations no 106/2008/EC;
 - ✓ The reduction of the water consumption;
 - ✓ For the industrial processes sector the retrofitting and the use of new technologies for the efficient processing of raw materials and energy resources.
- The Intermodal Transport Strategy in Romania - 2020
 - ✓ Using smart transport systems;
 - ✓ Reducing road transport;
 - ✓ The program for the renewal of the National car park, funded by the Environmental Fund budget;
 - ✓ Upgrading railway cargo and passenger transport by procuring high energy efficiency rolling stock;
 - ✓ Implementing a tele-management system of electricity and for the compensation of the power factor in electric traction substations;
 - ✓ Implementing the level 2 European Railway Traffic Management System (ERTMS);
 - ✓ Reducing the electricity consumption afferent to the generation of compressed air required for the operation of fixed subsystems testing train brakes by replacing old, Reșița type compressors, with modern and efficient equipment;
 - ✓ Upgrading underground transport by upgrading the electric train park and the public space lighting systems;

- ✓ Using biofuels (meeting the bio-fuel usage share amounting to 10% of the final national consumption by 2020);
 - ✓ Reducing the annual resource consumption by 303 ktoe in the 2014 - 2020 period;
 - ✓ Promoting “clean passenger cars” and stimulating the manufacturing thereof. In order to encourage the procurement of such passenger vehicles, Emergency Ordinance no. 40/2011 on the promotion of non-polluting and energy-efficient road transport vehicles, amended by Emergency Ordinance no. 9/2013 on the environmental stamp for the passenger vehicle, stipulates the granting of a new environmental ticket for each electric passenger vehicle;
 - ✓ Encouraging forms of alternative transport (cycling, car-pooling, car-sharing, etc.) through urban planning and the development of an adequate infrastructure for cycling (bicycle tracks, bicycle racks, special bicycle waggons/compartments in the subway and on trains, etc.) and expanding the pedestrian areas, particularly in large urban agglomerations;
 - ✓ Increasing the degree of using public transportation, by optimizing means of public transport (trains, buses, trolley-buses, trams) and the infrastructure required for the proper operation thereof, expanding the underground.
- The national action plan on the reduction of GHG emissions in civil aviation has the following scopes:
- ✓ Improving the efficiency of using aviation fuel by at least 2%/year (reducing fuel consumption on average by 1.5% per hour of flight);
- National Sustainable Development Strategy of Romania – 2013 - 2020 - 2030 Horizon (GD 1460/2008)
- ✓ Improving the efficiency in the use of nitrate fertilizers, as well as fertilizer storage to reduce CH₄ and N₂O emissions and to contribute to the mitigation of climate change;
 - ✓ Stimulating/encouraging the use of equipment for the treatment of waste waters in farming.
 - ✓ Reducing the fragmentation degree of agricultural surfaces and stimulating the concentration of small farms;
 - ✓ Increasing the nutritional value of the herbaceous carpet, ensuring the balanced and efficient meal of various categories of animals, particularly cattle and sheep, in order to obtain non-polluted zootechnical products and an adequate state of health for animals.
- National Program of Afforestation
- National Rural Development Program 2007-2013, updated in 2012
- ✓ The improvement of the methods of use of agricultural and forest lands;
 - ✓ Best use of forest resources.
- Reduce waste landfill, namely:
- ✓ Prioritization of the efforts in the waste management field in line with the waste hierarchy;

- ✓ Increasing the recycling rate and improving the quality of recycled materials, working closely with the business sector and establishments and undertakings which recover waste;
 - ✓ Promoting the recovery of packaging waste.
- Reduce GHG emissions arising from the wastewater treatment are the following:
- ✓ Increase the degree of connection to the sewerage and waste water services;
 - ✓ Construction and putting into function of new wastewater treatment plants;
 - ✓ Rehabilitation and upgrading of the existing wastewater treatment plants;
 - ✓ Use of modern technology with a low power consumption;
 - ✓ Automating of the wastewater treatment plants operation, with beneficial implications for their optimal functioning, i.e. avoiding methane emission;
 - ✓ Collection of waste sludge by geographical areas, their processing by anaerobic fermentation in modern plants, safe for producing biogas.

V PROJECTIONS AND THE TOTAL EFFECTS OF POLICIES AND MEASURES, AND SUPPLEMENTARY RELATING TO KYOTO PROTOCOL MECHANISM

In the Figure I_5 are presented the GHG emissions projections for three scenarios (without measures, with measures and with additional measures). From this figure result that Romania attained the target imposed in the Kyoto Protocol for the period 2008-2015.

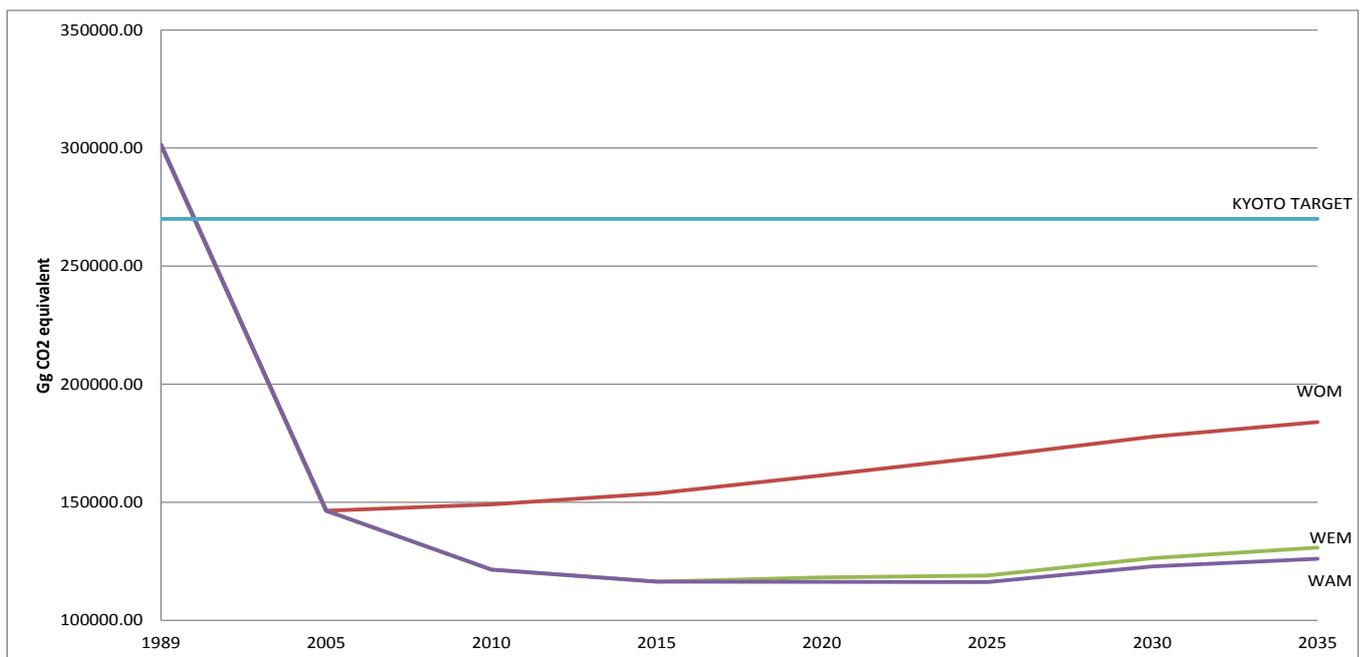


Figure I_5 Evolution of GHG emissions in the period 1989-2035

VI. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

Scenarios on the future climate change

The climate in Romania is expected to undergo significant changes over the coming decades. In near future term (2021-2050), the most pressing consequences are those related to mean annual increase of temperature (up to 3°C in summer) and mean reduction in summer precipitation amount (from 8% to 9%) over Romania, under the worst-case scenario (Figure I_6).

For the worst-case scenario, the mean temperature increase for Romania will reach about 6°C in summer in the interval 2061-2090 compared with the interval 1961-1990.

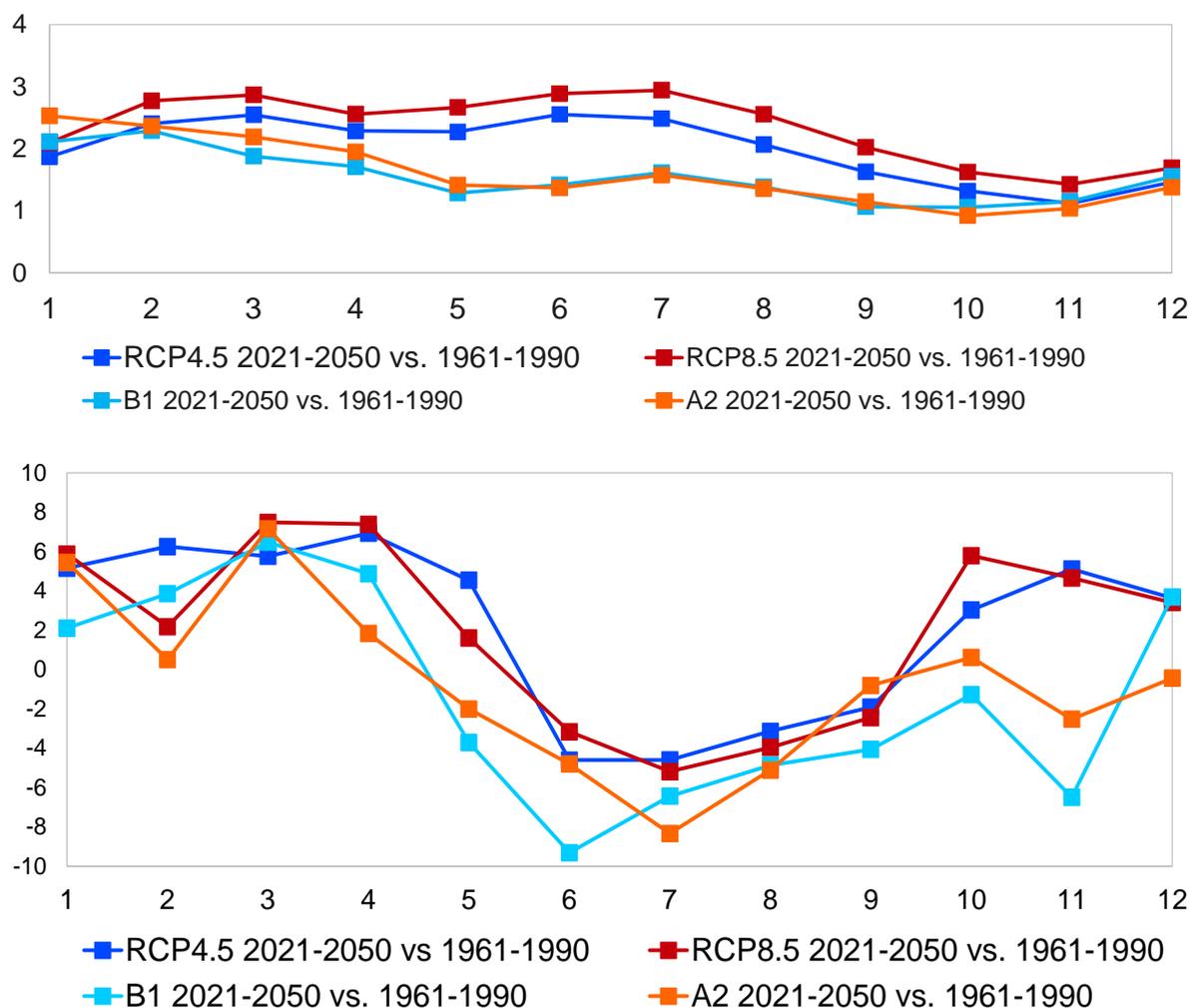


Figure I_6 Multiannual monthly mean changes (2021-2050 vs. 1961-1990) in air temperature (in °C, upper panel) and precipitation (in %, bottom panel)² averaged over Romanian territory.

Also, projections show that changes in mean temperature and precipitation occur along with changes in extreme phenomena statistics (such as increases in frequency and intensity of heat waves, increases in intensity of precipitation).

As for precipitation, climate change signal indicates, in general, a reduction of mean rainfall in summer months, more pronounced for higher emission scenarios and stronger as we approach

² The changes under A2 and B1 scenarios are computed using 11 runs with 11 climate models taken from the CMIP3. The changes under RCP 4.5 and RCP 8.5 scenarios are computed using 15 runs with 15 regional climate models taken from the CMIP5.

the end of the 21st century. The worst-case scenarios show reduction in summer months up to 20% - 30%, for the interval 2061-2090 compared with the reference interval 1961-1990.

Vulnerability and adaptation

Over the last years, adaptation to climate change impacts has reached an important position on the Romanian political agenda. The National Strategy for Climate Change in Romania, which has an important adaptation section, was approved in July 2013. This strategy, updated and approved in October 2016, refers to the effects of climate change on water safety, agriculture, energy, transport, industry, insurance, biodiversity, health, tourism, forestry, infrastructure, and recreational activities.

The updated Strategy aims to develop and operationalize a comprehensive National Climate Change and Low Carbon Green Growth Strategy for 2016-2030 and the associated Action Plan on Climate Change for 2016-2020.

The Action Plan includes state-funded adaptation actions mandated by the EU Common Agricultural Policy (CAP) in order to counteract the potentially negative impact that climate change might have for the Agriculture and Rural Development (ARD) sector. The Action Plan promotes actions that support holistic infrastructure and urban planning in order to better integrate climate change considerations in the design and contents of the plans. The Plan also considers actions aimed at increasing the use of insurance against industrial losses due to climate events, include the development of climate change insurance solutions and the creation of climate risk insurance funds in the industry. Adaptation actions aim at assuring that biodiversity will have the capacity to cope with the impacts of climate change (<http://documents.worldbank.org/curated/en/254931468188327164/Romania-2016-2020-National-action-plan-on-climate-change-summary-report>).

VII. FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

Romania's approach to climate change financing cooperation recognises that early mitigation and adaptation actions will reduce global costs and the costs to individual countries.

VIII. RESEARCH AND SYSTEMATIC OBSERVATIONS

Research activities in Romania consist of themes related to climate system, impact and adaptation for policy support. National research activities are carried out along with participations in international and European programmes such as Horizon 2020, JPI Climate, JPI Water. The main coordinator of Romanian research is the Ministry of Research which financially supports research projects selected from national competitions which are organized by the Executive Unit for Scientific Research (UEFISCDI). Also, The Ministry of Research financially supports a part of the contributions to the European and international research area.

The Ministry of Environment coordinates and financially supports applicative research on water management, climate related environmental risks and sustainable adaptation planning. The Ministry of Regional Developing, Public Administration and European Funds is the focal point on the the Danube Transnational Programme which partially supports projects on adaptation to climate change and climate-related risk assessment in relation to disaster management.

As for the systematic observation, Romania has actively participated in various fields of climate-related monitoring, both nationally and within European and global programmes (such as GCOS). Romania has internationally exchanged data and contributed to European and global databases.

IX. EDUCATION, TRAINING AND PUBLIC AWARENESS

Education and training play a crucial role in the process on the long run of reaching sustainable development in Romania, public outreach, through public engagement and awareness, being very important for a successful implementation of the national strategies and policies in the field of sustainable development. Our national objective, for the 2013-2020 horizon, is to develop human capital and increase competitiveness by linking education and lifelong learning to the labour market and ensuring better opportunities to participate in a modern, inclusive and flexible labour market, environmental friendly oriented.

In the National Sustainable Development Strategy Romania 2013-2020-2030 it is recognized that the Romanian educational and training system is a priority objective of strategic importance and basic preconditions for an effective implementation of the principles of sustainable development in the medium and long run.

In Romania the main responsible authorities for the initial and continuing vocational education and training systems (IVET and CVET) are both Ministry of Education & Scientific Research and Ministry for Labour, Family, Social Protection and Elderly, together with the National Authority for Qualifications (ANC), National Agency for Community Programs in the Field of Education and Vocational Training (ANPCDEFP) and the National Agency for Employment (ANOFM).

IVET is the professional education and training set out within the national education system. The integration of sustainable development principles into initial education and training systems (pre-university, university and post-secondary education) is achieved at the level of the developed learning instruments and methodologies, by raising the awareness of environmental protection, pollution prevention and control, biodiversity conservation.

One of the fundamentals of the Romanian education is to familiarize the children with the natural environment in order to set up the positive attitude towards the protection of the environment. Environmental protection and climate change issues are present into the curricular activities in gymnasium, technical colleges (dual education system) and the high schools. The focus is also on teachers CVET in order to gain attitudes and active civic behaviour of pupils and students in support of sustainable development, such as raising awareness of environmental issues, developing attitudes and specific skills.

The state and private Universities prepare the future specialists in the fields of environmental protection and climate change.

The subject of climate change was also debated in numerous **knowledge sharing and best practices events, training sessions, workshops, conferences and** developed within **dedicated projects**.

Thus, a number of interesting projects aiming at capacity building, policy influencing, increasing the education level and the public awareness (specific target groups / stakeholders and/or the general public) have been developed during the last years.

Related to **training and education projects** developed by Romania in European consortiums the important role of the National Agency for EU Programs in the field of Education and

Vocational Training responsible for managing several UE dedicated programs must be underlined. Thus during 2013-2015 several projects were developed in the field of sustainable development, GHG emission reduction and climate change impact mitigation, by Romanian consortium's leaders or partners, in programs such as: Comenius, Erasmus, Leonardo da Vinci and Grundtvig.

As referring to the **public information, engagement and awareness process** we underline the increasing role of the civil society representatives through different NGOs projects.

The National Administration of the Environmental Fund had and has a major role in promoting and supporting **education and public awareness activities** strongly related to climate change mitigation and GHG emissions reduction.

Further climate change mitigation dedicated **education – training – public awareness actions** are envisaged considering Horizon 2020 Research Funding Program, LIFE 2014-2020, RDI National Programs, and the current EEA and Norwegian Financial Mechanism implementation (2009-2014 and 2014-2021).

II. NATIONAL CIRCUMSTANCES

II. A. Government and administrative structure

Romania is a presidential Republic based on the principle of separation and balance of powers in the state - legislative, executive and judicial - under the rules of constitutional democracy.

The legislative power is held by the Parliament, which gathers the Chamber of Deputies and the Senate. The Chamber of Deputies and the Senate are elected for a four-year mandate and have as their main tasks the adoption of laws and the state budget. The legislative initiative (i.e. the proposal of draft laws) belongs, as the case may be, to members of parliament, members of the government, but also to citizens if a draft law is signed by at least 100,000 citizens with voting rights³ from at least a quarter counties of the country.

The executive power belongs to the Government, which is responsible for enforcing laws. The government includes the prime minister, ministers and other members appointed by organic law. The prime minister is proposed by the president, following consultation with the party or parties holding the parliamentary majority. He, in turn, proposes to the Parliament for approval a list of ministers. The government is politically accountable only to the Parliament for its entire activity.

The president of Romania is elected by universal, equal, direct, secret and freely expressed vote. The term of office of the President is 5 years, but he cannot be elected for more than two consecutive terms. The fundamental role of the President is to exercise the mediation function between the powers of the state, as well as between the state and the society. The President has the following duties: to appoint the Prime Minister, to promulgate the laws (countersign them for approving their entry into force), he may dissolve the Parliament, once in a year, if it has twice rejected a government, is the supreme commander of the army, concludes international treaties, which he proposes to the approval of the Parliament, issues decrees, confers decorations and titles of honor, grants pardon.

Justice (the judicial power) is represented by the High Court of Cassation and Justice, which ensures the unitary interpretation and application of the law by the other courts. Judges are independent of the political power and irremovable (they cannot be transferred, replaced or dismissed except by the Superior Council of Magistracy).

The Superior Council of Magistracy guarantees the independence of the judicial power and consists of 19 members whose mandate is of 6 years³. The Superior Council of Magistracy has the role of a court in the field of disciplinary liability of judges and prosecutors.

The Public Ministry represents the general interests of the society, defend legal order, as well as the citizens' rights and freedoms and discharges its powers through public prosecutors, constituted into public prosecutor's offices.

Administrative institutions at territorial level

According to the Constitution, in terms of administration, Romania's territory is organized in counties, towns and communes, some towns being declared municipalities. Romania has 41 counties and the capital city of Bucharest, which has a similar status to that of the county (Figure II_A_1). The 41 counties are structured in 2,861 communes (for rural areas) and 320 cities (for urban areas), out of which 103 are municipalities. Communes are divided into villages (which are lacking individual administration, and therefore can not be considered administrative

³ *Romanian Senate; Romanian Constitution: <https://www.senat.ro>*

divisions). Bucharest capital has an official division into six sectors, each sector having a sectoral town hall and a council⁴.

The Prefect, appointed by the Government for each county, as well as for Bucharest, is the representative of the Government at local level and directs the decentralized public services of ministries and other central public administration bodies in the territorial - administrative units.

The public administration authorities through which local autonomy is achieved in communes, towns and municipalities are the local, communal, town and municipal councils, which have deliberative authority, and the mayors, who are executive authorities. The mayors' term of office is 4 years⁵.

The county council coordinates the activities of the communal and town councils in order to provide the public services for the county.



Source: <http://www.economica.net>

Figure II_A_1 Administrative map of Romania

According to the law no. 315/2004 on regional development in Romania, 8 development regions have been established on the territory of Romania as a result of a free agreement between the county and local councils, corresponding to the level NUTS-2 (Nomenclature of Territorial Units of Statistics) of EU divisions but without regional administrative capacities (Figure II_A_2). They were grouped into four development macroregions. Macroregions are not administrative and territorial units and do not have legal personality, they are set up to ensure the collection, compilation and transmission of harmonized regional statistics at EU level. The development regions refer to the regional subdivisions of Romania, created in 1998, and operate, mostly, for the coordination of regional development projects.

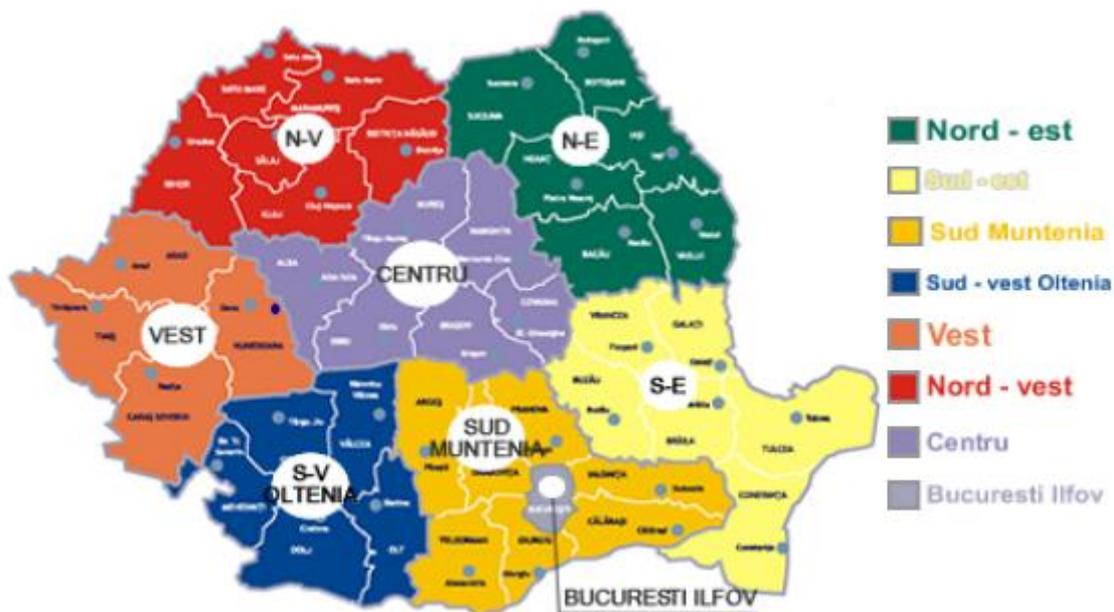
⁴ Ministry of Regional Development, Public Administration and European funds: http://www.dpfb1.mdrap.ro/nr_uat-uri.html (accessed in October 2017)

⁵ Law no. 215/2001 – Local public administration law

The development regions are presented in Table II_1:

Table II_1 Counties grouping, by macroregion and development region

Macroregion	Development region
MACROREGION 1	North - West
	Center
MACROREGION 2	North - East
	South - East
MACROREGION 3	South - Muntenia
	Bucharest - Ilfov
MACROREGION 4	South - West Oltenia
	West



Source: <http://www.mdrap.ro/dezvoltare-regionala/-2257/programul-operational-regional-2007-2013/-2975>

Figure II_A_2 Development regions map of Romania

The eight territorial development regions have been created by gathering several counties and have the following structure⁶:

- **1. The North-East Development Region** includes the counties Bacău, Botoșani, Iași, Neamț, Suceava, Vaslui, and has 3,272,210 inhabitants in 2015 and an area of 36,853 km²;
- **2. The South-East Development Region** includes the counties Brăila, Buzău, Constanța, Galați, Tulcea, Vrancea, and has 2,492,582 inhabitants in 2015 and an area of 35,774 km²;
- **3. The South-Muntenia Development Region** includes the counties Prahova, Dâmbovița, Argeș, Ialomița, Călărași, Giurgiu, Teleorman, and has 3,061,759 inhabitants in 2015 and an area of 34,467 km²;

⁶ National Institute of Statistics, <http://statistici.insse.ro/shop/> (accessed in October 2017)

- **4. South-West Development Region Oltenia** includes the counties Mehedinți, Gorj, Vâlcea, Olt, Dolj and has 2,015,792 inhabitants and an area of 29,206 km²;
- **5. The West Development Region** includes the counties Arad, Caraș-Severin, Timiș and Hunedoara and has a population of 1,812,183 inhabitants and an area of 32,042 km²;
- **6. The North-West Development Region** includes the counties Bihor, Bistrița-Năsăud, Cluj, Maramureș, Satu-Mare and Sălaj and has 2,586,034 inhabitants and an area of 34,159 km²;
- **7. The Center Development Region** includes the counties Alba, Sibiu, Mureș, Harghita, Covasna, and Brașov and has 2,350,539 inhabitants and an area of 34,092 km²;
- **8. The Bucharest-Ilfov Development Region** includes the Municipality of Bucharest and Ilfov County and has 2,284,443 inhabitants and an area of 1,804 km².

II. B. Population Profile

According to the final results of the 2011 Population and Housing Census, carried out according to the provisions of Regulation (EC) no. 763/2008 of the European Parliament and of the Council on the Population and Housing Census, Romania had a population of 20,121,641 inhabitants in 2011, out of which 10,333,064 were women (51.4%). Compared to the previous census situation (2002), the resident population decreased by 1,559,300 (out of which 779,200 women). Since then the Romanian population continued to decrease constantly. The evolution of the Romanian population shows a decrease of approximately 7% between 2005 and 2015 (Table II_2).

Table II_2 Evolution of Romania's population, 2005-2015

Year	1990	2005	2010	2011*	2012	2013	2014	2015
Population (mill. inhabitants)	23,207	21,320	20,247	20,122	20,060	19,989	19,913	19,820

Source: National Institute of Statistics - Romanian Statistical Yearbook – 2016, *Final results of the Population and Dwellings Census

By the number of resident population, the first 7 counties in size in 2016, with the exception of Bucharest (1,844,312 inhabitants), are the following: Iasi (788,547 inhabitants), Prahova (740,456 inhabitants), Cluj (701,358 inhabitants), Constanta (696,613 inhabitants), Dolj (641,133 inhabitants) and Suceava (629,498 inhabitants)⁷.

Tulcea (203,197 inhabitants), Covasna (206,322 inhabitants), Sălaj (217,366 inhabitants), Mehedinți (252,711 inhabitants), Giurgiu (274,592 inhabitants) and Ialomița (264,575 inhabitants) are the counties with the lowest number of persons in 2016⁷.

The main causes that led to the decrease of Romania's population by 14.6% between 1990 and 2015 were migration abroad (labor migration, in particular), rising mortality rates and declining birth rates during this period.

In 2015, the short-term fertility index was 1.6 children / woman. After a sharp decline between 1989 and 2007 from 2.2 to 1.2, it started to grow steadily after 2008⁸.

⁷ National Institute of Statistics, <http://romaniaincifre.ro/> (accessed in October 2017)

⁸ Gandul newspaper: <http://www.gandul.info/stiri/harta-autostrazilor-din-romania-in-ce-stadiu-sunt-lucrarile-care-trebuie-sa-fie-gata-in-2016-15526422> (accessed in October 2017)

On the 1st of July 2015, 21% of the Romanian population was under twenty years of age, while 61.8% of Romanian people were aged between 20 and 64. 23.9% of the population is over 65 years old, with 7.9% of these being over 75⁸.

Life expectancy in 2015 was 78.9 years for women and 71.9 years for men. Since 2000, life expectancy has increased by 4.9 years for men and 4.7 years for women⁸.

The number of Romanians that permanently migrated abroad starting with 2008 is 108,706 (approximately 0.6% of the adult population). The number of people that left the country temporarily is 1.642.488 (approx. 8.3% of the adult population)⁸. Population migration has a negative influence on the development of Romanian economic activity itself as most part of the persons leaving abroad for a job are young and active persons.

In terms of GHG emissions, changes in the quality of living (improvement of quality of living) will naturally drive towards higher emissions.

II. C. Geographical profile

II. C. 1. Geographical position

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 (Figure II_C_1), 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.

The Romanian territory is 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, it is the 13th largest country in Europe.



Figure II_C_ 1 Physical map of Europe

Romania's neighbours are: Ukraine to the North, Republic of Moldova to the East (the complete border being represented by the Prut River), Bulgaria to the South (mainly being a fluvial border, the Danube River), Serbia to the South-West, and Hungary to the West.

The Romanian borders stretch on a distance of 3,149.9 km, out of which, in 2007, 1,876 km became EU borders (towards Serbia, Moldova and Ukraine).

The Black Sea border measures 194 km along the continental platform and 245 km on shore, the Romanian Black Sea coast stretching out between the border with Ukraine (Musura) and the border with Bulgaria (Vama Veche). The exit to the sea enables water way connections with the countries in the Black Sea basin and the rest of the world. Figure II_C_ 2 presents the political map of Romania.

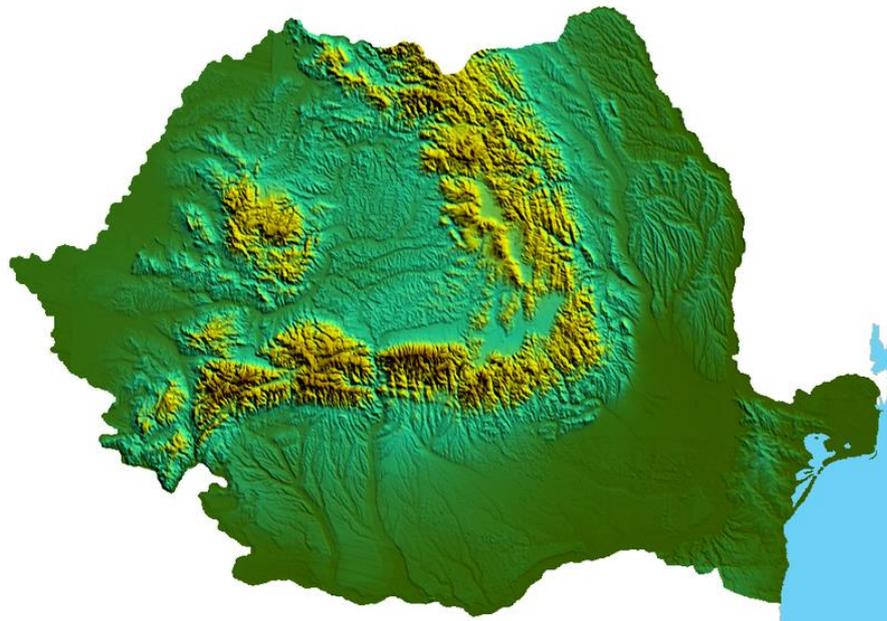


Figure II_C_2 Political map of Europe

The total length of Romania's frontiers is 3,149.9km, out of which 1,085.5 km land and 2,064.3 km rivers and sea.

II. C. 2. Relief

The relief of Romania has three major morphologic steps, proportionately distributed in the form of an amphitheatre. The high step, of the Carpathians (the highest peak Moldoveanu 2,544 m), the medium step, corresponding to the Sub-Carpathians, hills and plateaus and the low step, of the plains, river meadows and Danube Delta (the youngest relief unit, continuously developing and with an average altitude of 0.52 m). The main characteristic of these relief components is their proportional distribution in form of an amphitheatre, characterized by four elements: variety, proportionality, complementary and symmetrical layout, with approximately equal distribution of the main relief units (35% mountains, 35% hills and plateaus and 30% plains) (Figure II_C_3).



Source: https://en.wikipedia.org/wiki/Geography_of_Romania

Figure II_C_3 Physical map of Romania showing the Carpathian Mountains

The Carpathians have an area of 66,303 km², which represents approx. 27.9% of the total area of the country, on a length of 910 km.

In eastern and southern regions there are three large plateaus (Moldova, Dobrogea and Getic) and Mehedinti Plateau, while two great plains lay in the south and west, the Romanian Plain (narrowed towards East) and the Western Plain (Figure 2_C_4).

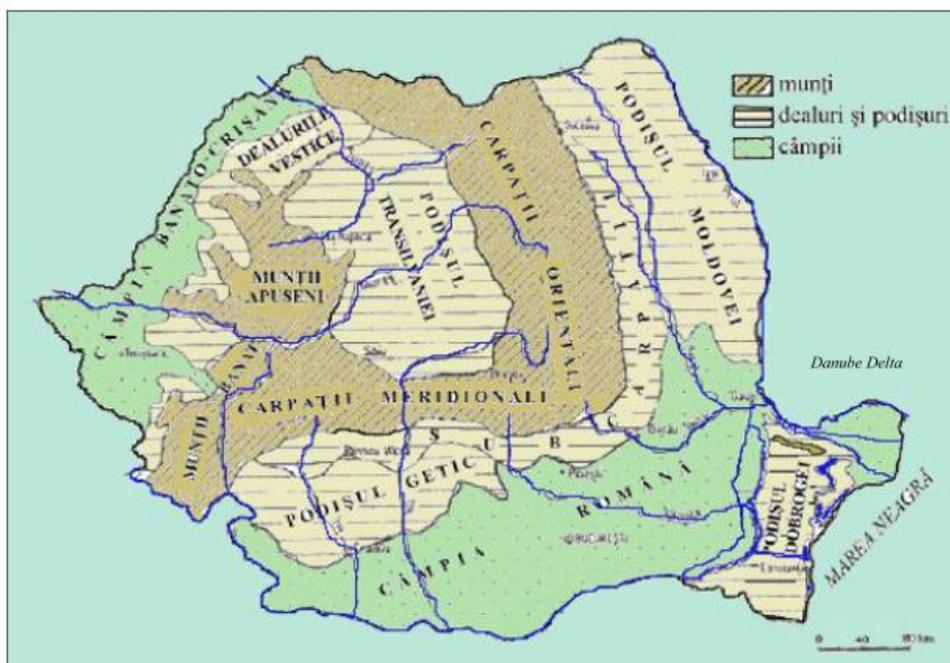


Figure II_C_4 The main relief units of Romania

II. C. 3. Black Sea

The Black Sea is Romania's gate towards seas and oceans, and Black Sea seaside and coast area offers a variety of conditions for harnessing the underground (petroleum, natural gas), aquatic (the fish fauna) and land riches (tourism and leisure). The Black Sea exit gives Romania the possibility of developing the waterways transport.

II. C. 4. Danube and Danube Delta

The Danube, the second longest river in the European Union after the Volga, flows into the Black Sea within Romania's territory forming the Danube Delta, a region with a medium-low altitude (31 cm), the biggest part of this area being under water.

The Danube Delta is the second largest (total surface of 4,178 km²) and best preserved delta in Europe. The Danube delta hosts over 300 species of birds as well as 45 freshwater fish species in its numerous lakes and marshes.

Lakes are interconnected by narrow channels featuring huge expanses of aquatic vegetation. This is the largest continuous marshland on Europe and the second-largest delta (the Volga being the largest), which includes the greatest stretch of reedbeds in the world. The marsh vegetation is dominated by reeds which form floating or fixed islands of decaying vegetation. Reeds cover some 1,700 km² and the floating reed islands (*plaur*) 1,000 km², whereas the total area not inundated is only 148 km².

The Danube Delta has been included in the UNESCO World Heritage List in 1991 as being a natural reserve of the biosphere.

II. C. 5. Rivers

Romania benefits from all types of aquatic facilities: rivers and streams, lakes, groundwaters, marine waters. Romania's hydrographical and hydrological peculiarities are determined mainly by its geographic position within the temperate continental climate and the presence of the Carpathian arch.

A large part of Romania's border with Serbia and Bulgaria is formed by the Danube. The Prut River, one of its major tributaries, forms the border with the Republic of Moldova. Other major rivers are the Siret (596 km), the Olt (614 km), the Someş (388 km), and the Mureş (761 km).

II. C. 6. Natural mineral resources

Given the variety and complexity of the geologic structures, the Romanian territory has optimum conditions to accumulate useful mineral substances: gold and silver deposits, bauxite ore deposits, mineral combustible deposits, salt deposits and salts, useful rocks, mineral waters, geothermal waters, etc. Important reserves of hydrocarbons, gases and coals are quartered within the platform areas and in the intermountain depressions (Transylvania, Pannonian).

A special category of subsoil riches consist in more than 2,000 mineral water springs, with consumption and medical treatment characteristics.

The mineral water is a renewable resource, but insufficiently capitalized, even though some of the mineral water springs received world appreciation for their quality. From the total mineral water reserve of 122 thousands m³/day, which can be bottled, about 40% is capitalized.

II. C. 7. Biodiversity

The vegetation varies, with a high tendency of diversity. The following three areas of vegetation may be distinguished: alpine, forest and steppe. The alpine vegetation from mountain areas is very vulnerable to the environmental factors and anthropogenesis ones, as they regenerate in an extremely difficult manner. This is why some species are only a few left and are easily disappearing as a result of the activity of the interfering factors. The main dangers are the uncontrolled pasturage and tourism.

The steppe and silvosteppe vegetation spreading in areas short on humidity on Dobrogea's Plateau, the Romanian Plain, Moldova's Plateau and West Plain, were mostly replaced by agricultural cultures.

The significant variety of the flora and fauna in Romania derives from the complexity of the relief. Romania's flora and fauna are harmoniously divided and form a highly valuable wealth, based on controlled and rational exploitation. Romania is a country with a great biological variety and a high percentage of natural ecosystems. The fauna is rich in species, some protected, as the black goat, bear, rock aquila, lynx, blackcock, birch cock and other species that present hunting interest.

Romanian forests preserve a genofund of great diversity. In order to preserve this valuable natural capital and to ensure a favourable conservation status for natural habitats of great natural and community importance, Romania has taken important steps, by implementing the legislative elements specific to the European Union, as well as of some programs and projects dedicated to preserving the biodiversity.

In Romania there are protected areas comprising of 79 scientific reservations, 13 national parks, with the largest one named Domogled - Valea Cernei, 190 natural monuments, 671 natural reservations, 15 natural parks (including Danube Delta) 3 biosphere reservations (Danube Delta, Retezat and Rodna) and 273 sites of communitarian importance.

II. D. 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. Climatic variations are modulated by geographical elements, the position of the main mountain chain, elevation, the location of the Black Sea (see Figure II_D_1 and II_D_2).

II. D. 1. Temperature

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 (see Figure II_D_1).

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.

During the period 1901-2016, the mean annual air temperature increased by more than 1 °C (see Figure II_D_3). The increasing trend is higher especially beginning with 1971.

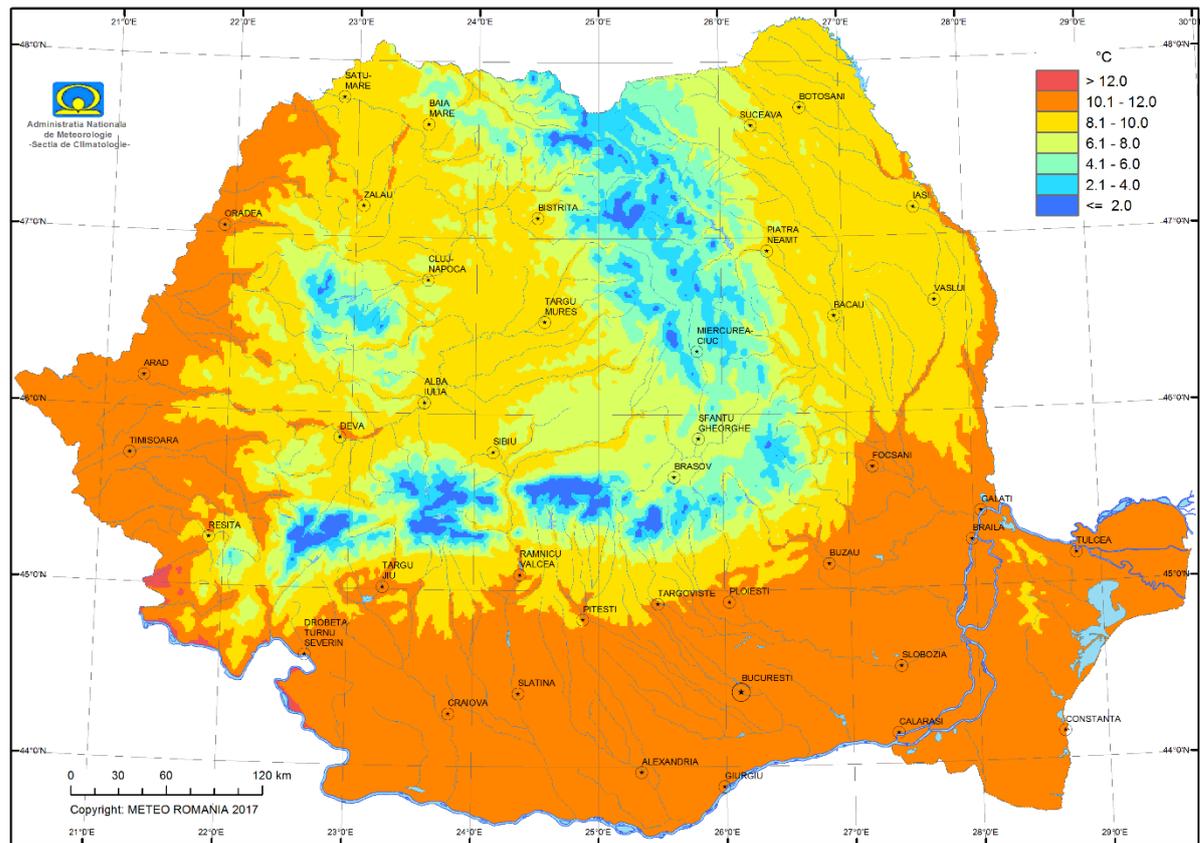


Figure II_D_1 Multiannual mean of air temperature (in °C) for the interval 1961-2016

II. D. 2. Precipitation

Annual average amounts of precipitations vary between less than 400 mm/sqm*yr and more than 1200 mm/sqm*yr (see Figure II_D_2).

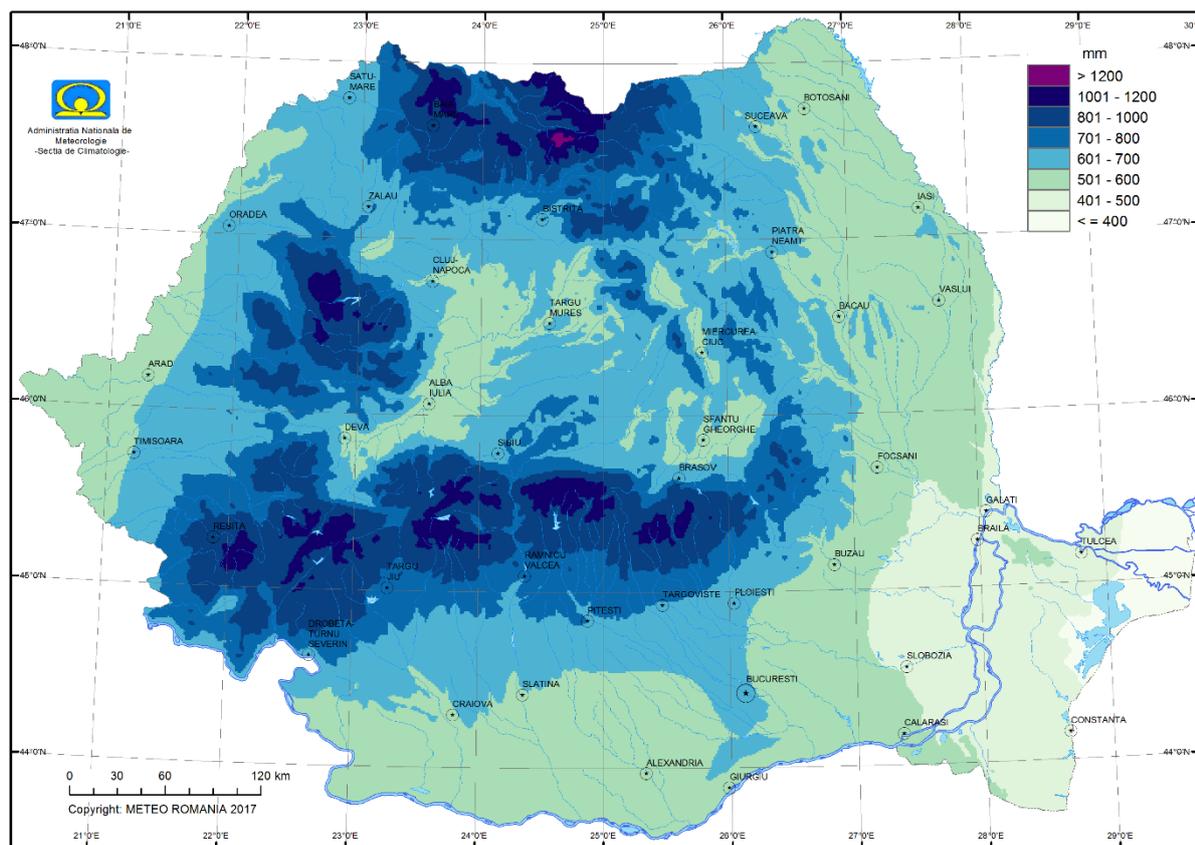


Figure II_D_2 Multiannual mean of precipitation amount (in mm) for the interval 1961-2016

The highest annual rainfall amount recorded in Romania was 2401.5 mm in 1941, Omu weather station. The largest monthly amount of rainfall, 588.4 mm was recorded in June 2011 at the Bâlea Lac. Absolute maximum amount of rainfall in 24 hours was recorded at the meteorological station Deva, on 07/19/1934.

The year with highest precipitation amount at Romanian level was 1941 (889.5). Lowest annual amount of precipitation was recorded in 2000 (417 mm). The classification uses data from 14 meteorological stations with long series of observations.

During the period 1901-2016, the annual precipitation amount shows no significant tendency (see Figure II_D_3).

II. D. 3. Other observed phenomena

The evolution of scorching heat intensity in Romania from 1961 to 2010 shows an increasing trend especially after 1981 (Figure II_D_4). Given the multi-annual means of scorching heat intensity, phenomenon quantified by sums of air temperature highs equal to or above 32°C recorded during the summer months, it has become apparent a significantly higher thermal stress over the critical interval for crops (June-August), an increase from 13 units of scorching heat between 1961 and 1990 to 28 units over 1981-2010 (Figure II_D_5).

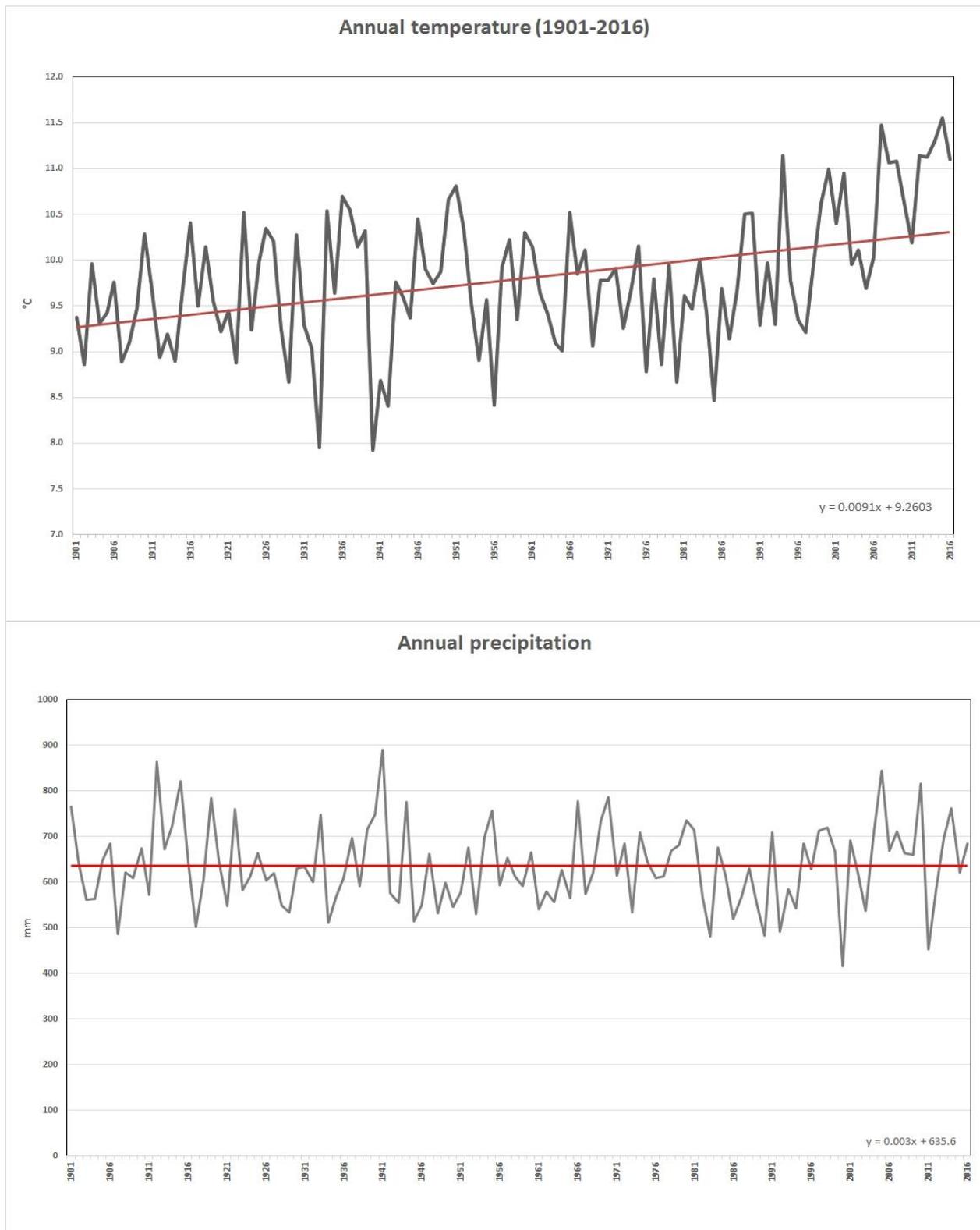


Figure II_D_3 Evolutions of annual temperatures (in °C, top) and precipitation amounts (in mm, bottom) for the interval 1901-2016.

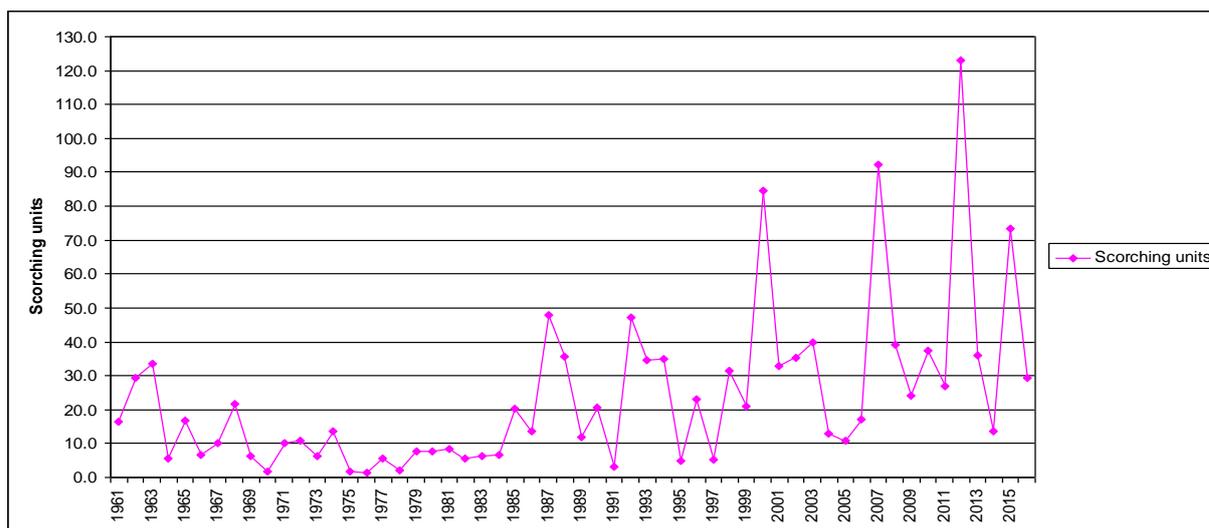
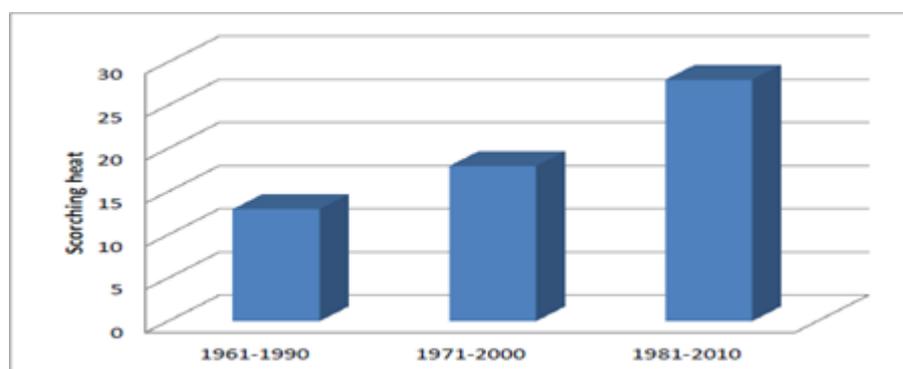


Figure II_D_4 The evolution of scorching heat intensity in Romania, 1961-2016



Units of scorching heat ($\sum T_{max} \geq 32^{\circ}C$, VI-VIII)	
1961-1990	13
1971-2000	18
1981-2010	28
2011-2020	2012 / 123 units 2015 / 73 units

Figure II_D_5 Intensity of scorching heat intensity in Romania, 1961-2016

Romania has seen in every decade one to four extremely droughty/rainy years since 1901, but an increasing number of droughts has been recorded after 1981 (Table II_3).

In summer 2007, the most severe scorching heat ($\sum T_{max} \geq 32^{\circ}C$) has been recorded between 14 and 24 of July, when air temperature frequently reached values between $35^{\circ}C$ and $40^{\circ}C$, across large areas from south, south-east and west Romania.

During the same summer, the maximum intensity of scorching heat index reached 223 units over a total of 61 days with $T_{max} \geq 32^{\circ}C$, at Giurgiu location (southern Romania), as follows: 46 units/17 scorching heat days in June, 127 units/27 days in July and 50 units/17 scorching heat days in August.

The agricultural land in Romania is frequently affected by drought (cca. 7 mil. ha), erosion by water and landslides (cca. 6.4 mil. ha), temporary water excess (cca. 4 mil. ha.), compaction

(cca. 2.8 mil. ha) etc. Thus, drought is the main limiting factor for the crops affecting the largest area.

In the period 2011-2016, in four years out of six, the scorching heat values were higher than the multi-annual mean of 1981-2010. Here are some data: 2012/123 units, 2015/73 units, 2013/36 units and 2016/29 units.

In summer 2012, the most severe scorching heat index ($^{\circ}\text{Tmax} \geq 32^{\circ}\text{C}$) was registered across large areas from south, south-east and locally in the south-western and south-eastern Romania.

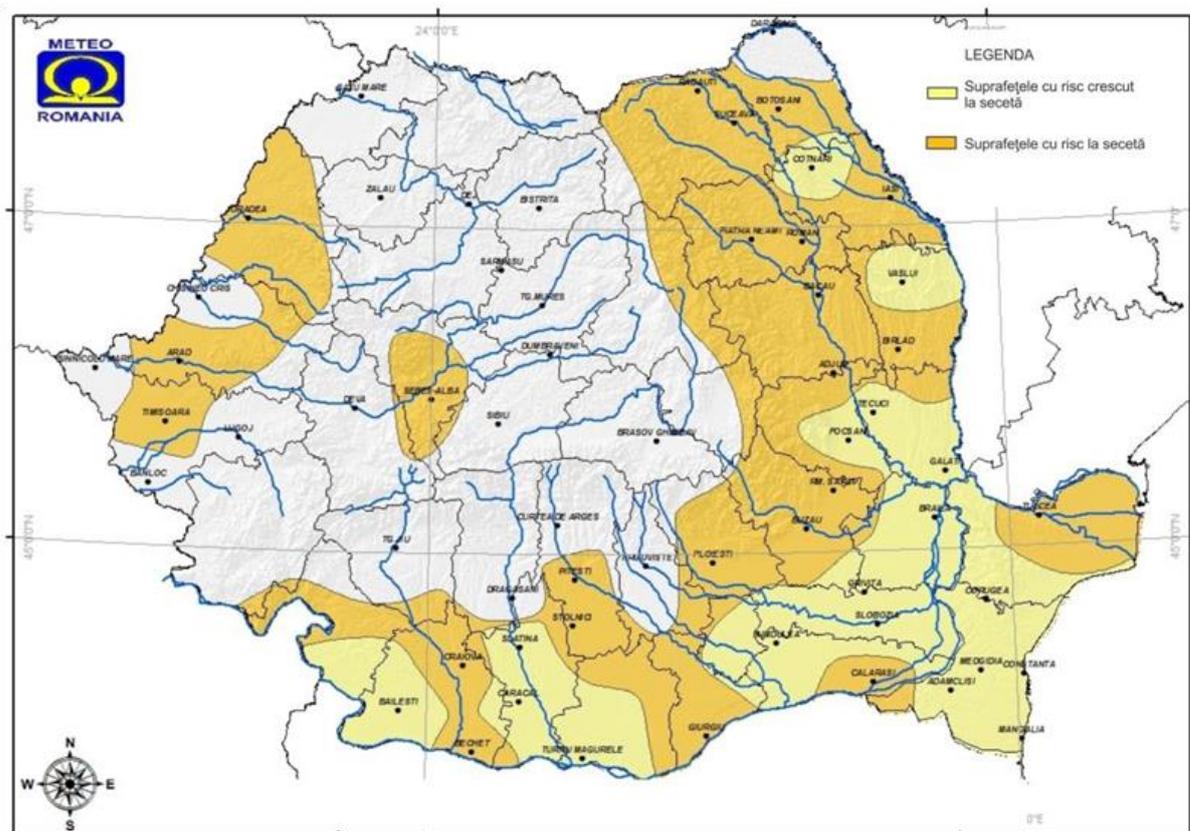


Figure II_D_6 Agricultural surfaces in Romania affected by drought

During the same summer, the maximum intensity of scorching heat index reached 296 units over a total of 67 days with $\text{Tmax} \geq 32^{\circ}\text{C}$, at Giurgiu, as follows: 29 units/13 scorching heat days in June, 149 units/30 days in July and 117 units/24 scorching heat days in August.

An analysis of the annual precipitation amounts (September-August) provided a mean of 583.0mm in the period 1961-1990 (Figure II_D_6) across the agricultural areas in Romania, 569.8 mm over the interval 1971-2000, and 575.1 mm over the period 1981-2010. Thus, the precipitation regime in Romania is moderately droughty (less than 600 mm/year) as regards crop growth and development. Dobrudja agricultural territory is the most agricultural droughty region, with the following multi-annual precipitation means recorded over September 1 – August 31 (agricultural year): 400.9 mm for 1961-1990, 397.7 mm over 1971-2000 and 410.2 mm for 1981-2010. Within each agricultural region, the frequency of the years with scanty annual precipitation varies from 37.4% in Banat - Crisana to 91.2% in Dobrogea region.

The area subjected to desertification, characterized by an arid, semiarid or subhumid-dry climate is cca 30% of the total area of Romania, being mostly situated in Dobrudja, Moldavia, the south of the Romanian Plain and the Western Plain (Figure II_D_6). This area is mostly

used for agriculture (cca. 80%, 60% of which is arable land), forestry (cca. 8%) and water resources (source: National Strategy for the mitigation of the drought effect, preventing and combating land degradation and desertification in the short, mean and long range, Ministry of Agriculture and Rural Development, 2008).

Table II_ 3 Droughty/rainy years in Romania, 1901-2016

DECADE	XX-TH CENTURY	
	EXTREMELY DROUGHTY YEARS	EXTREMELY RAINY YEARS
1901-1910	1907-1908	1910
1911-1920	1917-1918	1911, 1912, 1915, 1919
1921-1930	1923-1924, 1927-1928	1929
1931-1940	1934-1935	1937, 1939, 1940
1941-1950	1945-1946, 1947-1948, 1949-1950	1941, 1944, 1947
1951-1960	1952-1953	1954, 1955, 1957, 1960
1961-1970	1962-1963, 1964-1965	1969, 1970
1971-1980	1973-1974, 1975-1976	1972, 1974, 1975, 1976
1981-1990	1982-1983, 1985-1986, 1987-1988, 1989-1990	1981, 1990
1991-2000	1992-1993, 1999-2000	1991, 1997
	XXI-ST CENTURY	
2001-2010	2000-2001, 2001-2002, 2002-2003, 2006-2007, 2008-2009	2005, 2006, 2008, 2010
2011-2020	2011-2012, 2014-2015, 2015-2016	2013

II. E. Economic profile

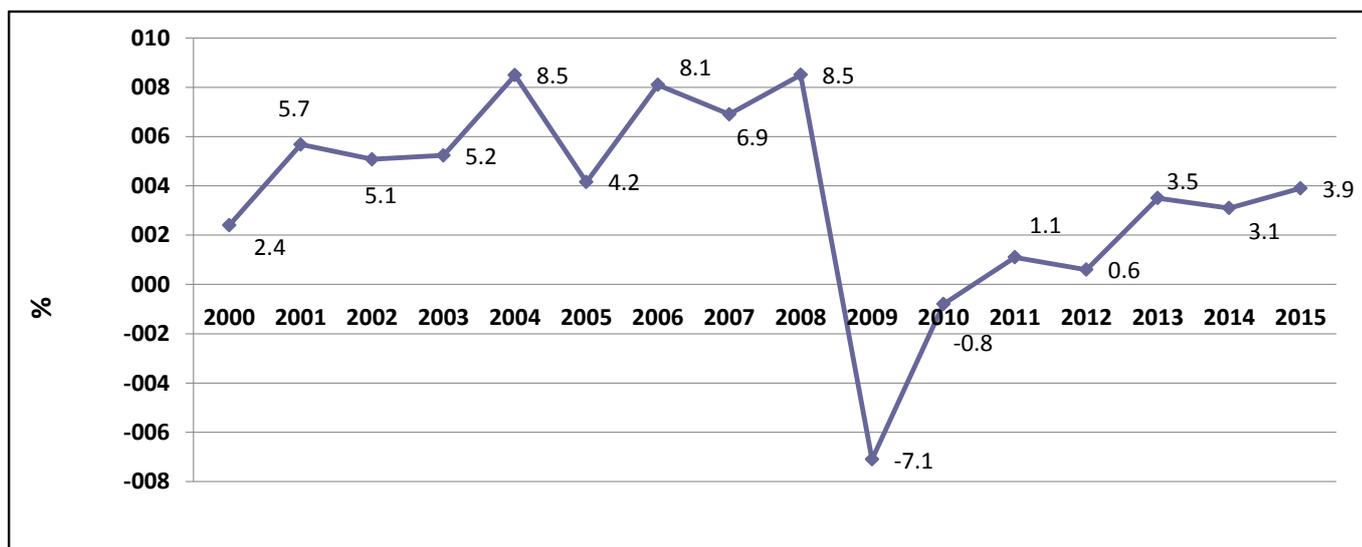
Romania joined the European Union in January 2007. The Romanian economy is a market based economy, promoting freedom of trade, protection against unfair competition, stimulation of domestic and foreign investments and protection of private property.

The economic development of Romania is strongly linked to the worldwide economic development and to that of the European Union one, as it occurs in special complex international environment affected by the global economic-financial crisis.

The analysis of the Gross Domestic Product (GDP) evolution during 2000 – 2012, revealed that the Romania economy experienced three separate periods and respectively: the period 2000 – 2008 of development when the annual average percentage of growth of the GDP was 6.27%, the period 2009 - 2010 of recession and the period 2011 – 2012 of coming out from recession (the Figure II_E_1, Table II_4).

During 2000 – 2010 the annual average percentage of growth was 4.074%, a value around 2.7 times higher than that one of the European Union of 1.5%.

During 2011 – 2015 the GDP annual average percentage of growth was 2.8%.



Source: National Institute of Statistics – Romanian Statistical Yearbook – collections,

Figure II_E_1 GDP growth rate - 2000 – 2015 period

Table II_4 Romanian GDP evolution within the 2000 – 2015 period

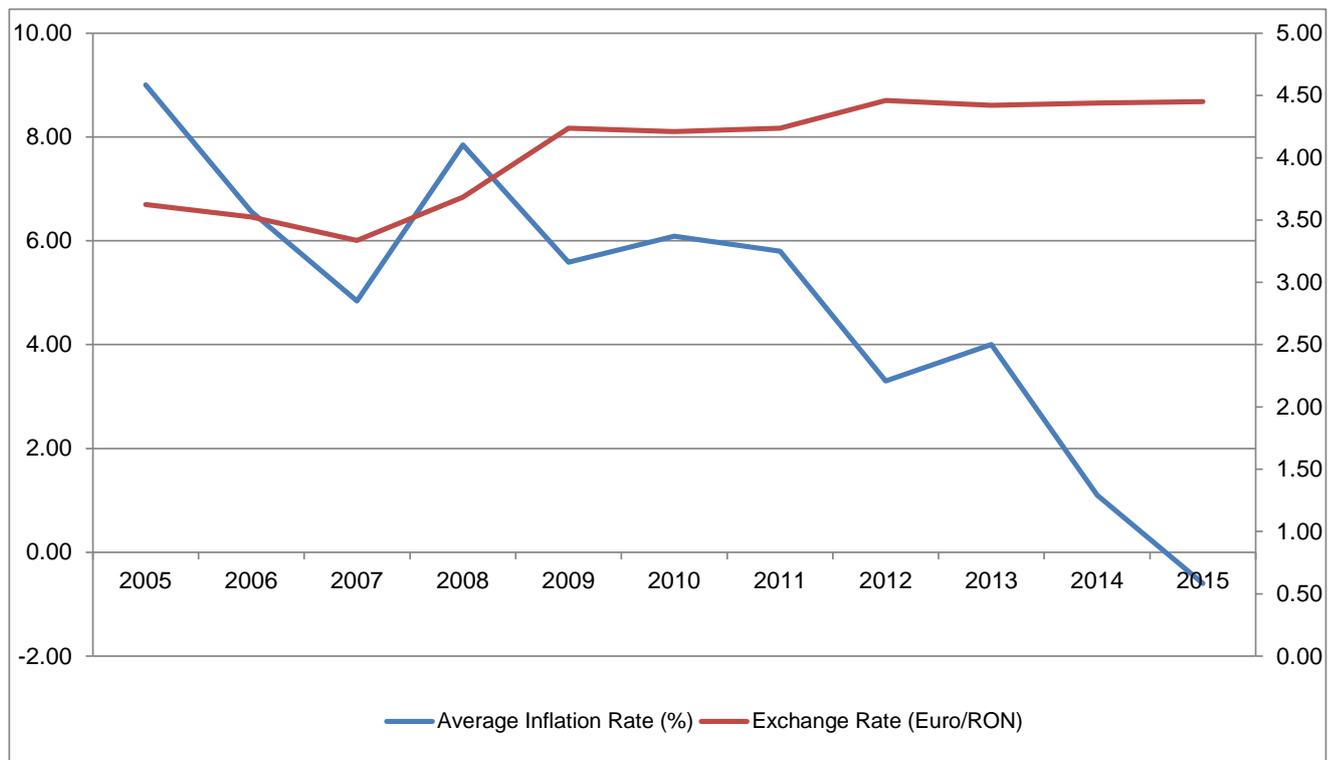
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
GDP [bill. Euro]	80.23	98.42	125.40	142.40	120.41	126.75	133.31	133.81	144.25	150.33	159.98
GDP [bill. Euro 2010]	109.69	118.58	126.76	137.53	127.77	126.75	128.14	128.91	133.42	137.56	142.92

Source: National Institute of Statistics – Romanian Statistical Yearbook – collections
*Estimation based on real GDP growth rate

Romania's main export goods are: machinery and equipment for transport, metals and metal products, textiles and footwear, chemicals, agricultural products, minerals and fuels. The exports value rose with about 10% in 2015 against 2013 figures. In the structure of exports the main categories in 2015 includes: machinery and transport equipment 44.5%, 16.7% manufactured goods classified mainly by the raw material, 15.7% miscellaneous manufactured articles, 4.9% chemicals and related products, 4.5% mineral fuels, lubricants and related materials and 13.7% other goods (source: National Institute of Statistics – Romanian Statistical Yearbook – 2015).

Romania's imports increased by 13.2% in 2015 compared to 2013. Sectors representing 78.4% of total imports are: transport and equipment (37.3%), manufactured goods classified mainly by raw material (21.0%), mineral fuels, lubricants and derived products (13.7%) and chemicals and derived products (6.4%) (Source: National Institute of Statistics - Statistical Yearbook of Romania 2015).

The inflation rate has fallen from around 9% in 2005 to 4.8% in 2007, rising again in 2008 to 7.9% and declining continuously to 3.3% in 2012. There was a slight increase in the year 2013 (4.0%), reaching a negative value in 2015 (-0.6%), while the exchange rate against Euro offered the image of a constantly stronger RON in the same period; though the National Bank of Romania is continuously monitoring and adjusting it, through the market mechanisms (Figure II_E_2).



Source: National Institute of Statistics and National Bank of Romania web site: www.bnro.ro

Figure II_E_2 Romanian Annual Average Inflation Ratio and Exchange Rate for the period 2005 – 2015

According to data provided by the Statistical Yearbook of 2015, the number of registered unemployed at the end of December 2015 was approximately 436242 compared to approximately 626960 at the end of December 2011. The long-term unemployment rate was 2.4% in 2011 and 3 % in 2015. High rates of unemployment were recorded in December 2015 in the following counties: Teleorman (10.97%), Vaslui (10.74%), Mehedinți (10.65%), Buzău (9.64%), Dolj (9.21%), Galati (8.77%), Olt (7.82%), Ialomita (7.51%), Gorj (7.42%). The lowest unemployment rate was in Ilfov (1.25%).

GHG emissions per unit of GDP continue to decrease due to technical improvements, the implementation of reduction policies and the structural change in GDP.

There is a general trend to lower GHG emissions per capita between 1989 and 2015, although there was a small increase between 2010 and 2011. All these trends can be seen in Figure II_E_3.

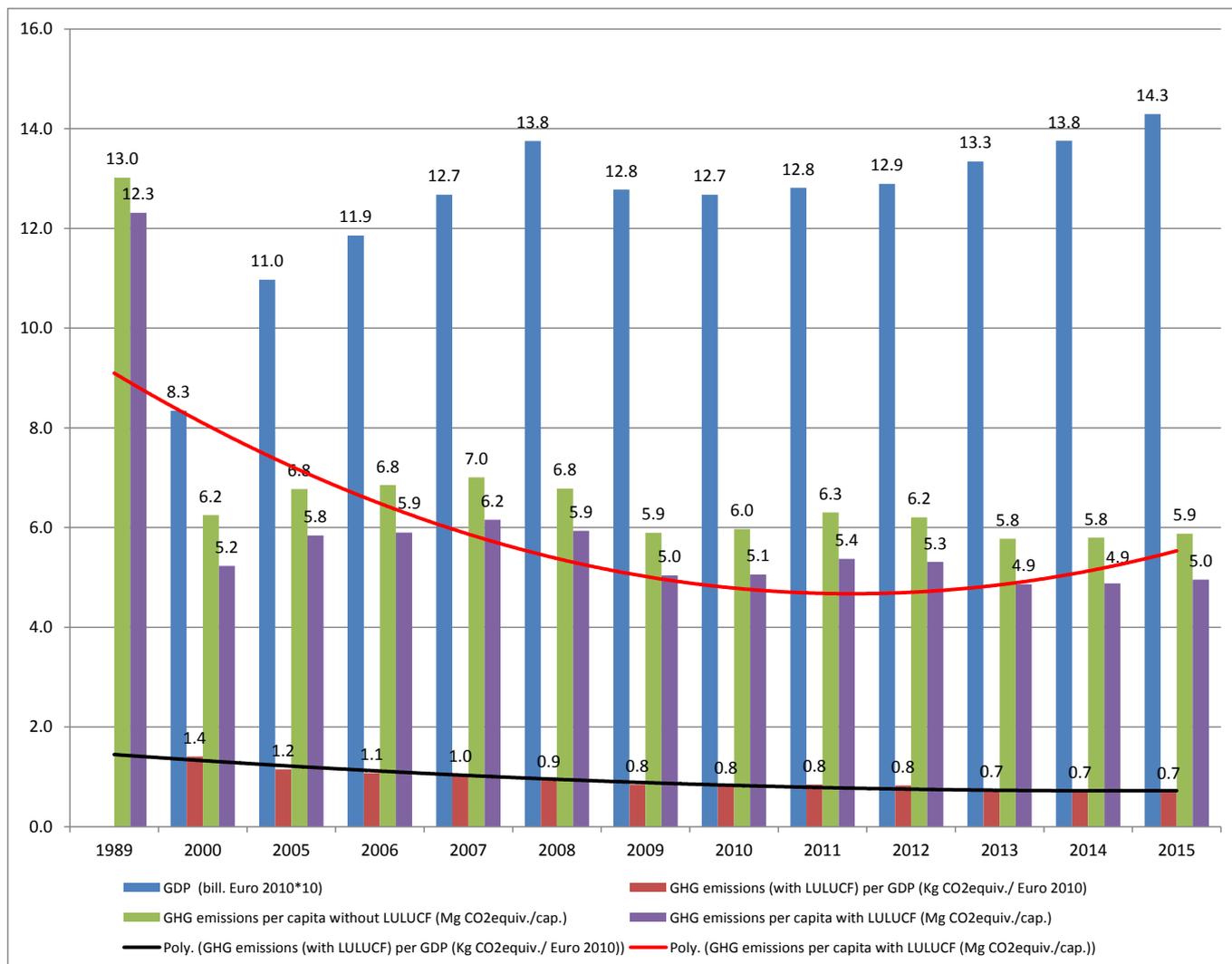


Figure II_E_3 GHG data and national circumstances

II. F. Energy

In Romania, the energy sector has been restructured in order to adapt its regulatory framework in line with EU practices. The successive reorganization and decentralization actions of the sector led to a guarantee competitive regime that works for the benefit of all consumers and to ensuring the functioning of the energy sector and market in terms of efficiency, transparency and consumer protection.

The National Regulatory Authority for Energy (ANRE) is constantly seeking to increase the efficiency of energy markets and their integration into the European market, to harmonize secondary legislation with the provisions of primary legislation and European codes, to develop trading platforms, to apply the provisions of European regulations on integrity and transparency of markets, ensuring the integration of renewable energy sources in a safe and reliable way, encouraging investment in smart grids, consumer information and protection.

The electricity sector in Romania consists of the following operators and companies:

- CNTEE Transelectrica SA, which manages and operates the electric transport system and ensures electricity exchanges between the countries of Central and Eastern Europe as a member of ENTSO-E and having the following ownership structure as of

31.12.2016: 58.6882% the Romanian State, 35,1932% - other legal entities, 6,1186% - other natural persons shareholders;

- Electricity Market Operator (Opcom SA - a subsidiary of CNTEE Transelectrica SA);
- 52 licensed electricity distribution operators, out of which 8 serve over 100,000 customers each. The ownership structure of the 8 distribution operators holding more than 100,000 consumers is as follows:
 - **Distribution Oltenia Energy: CEZ a.s.** - holder of 99.9999986019% of the share capital, CEZ POLAND DISTRIBUTION B.V. - holder of 0.0000013981% of the share capital;
 - **E-Distribution Banat: Enel Investment Holding B.V.** - holder of 51.0036% of shares, S.C. Electrica S.A. - holder of 24.8683% of shares, Fondul Proprietatea S.A. - holder of 24,1281% of shares;
 - **E-Distribution Dobrogea: Enel Investment Holding B.V.** - holder 51,003% of the shares, Energy Management Company SAA (SAE) S.A. - holder of 24,903% of shares, Fondul Proprietatea S.A. - holder of 24,094% of the shares;
 - **E-Distribution Muntenia: Enel Investment Holding B.V.** - holder 64.4251% of the shares, Energy Management Company SAA (SAE) S.A. - Holdere 23.5749% of the shares, S.C. Fondul Proprietatea S.A. - holder of 12% of the shares;
 - **Delgaz Grid: E.ON Romania S.R.L.** - holder of 61.7905% of the shares; MINISTRY OF ENERGY - holding 13.5147% of shares, Fondul Proprietatea S.A. - holder of 18,3474% of the shares, the Shareholding Management Company (SAPE) S.A. - holder of 6.3474% of the shares;
 - **SC FDEE Electrica Distribuție Transilvania Sud SA, SC FDEE Electrica Distribuție Transilvania Nord SA and SC FDEE Electrica Distribuție Muntenia Nord SA**, have the following shareholder structure: S.C. Electrica S.A. - owns 78% of shares and Fondul Proprietatea S.A. - holds 22% of the shares;
- Electricity producers in state and private dispatched units (16);
- Electricity producers in private non- dispatched units but also participating as suppliers on the competitive market (10);
- Suppliers of electricity acting exclusively on the wholesale market (32);
- Electricity suppliers operating on the retail market (105), out of which 21 have a production license and 5 are suppliers of last resort (FUI);
- Suppliers of last resort are: Electrica Furnizare SA, CEZ Vânzare SA, E.ON Energie România SA, Enel Energie Muntenia SA, Enel Energie SA.

The main features of the sector are:

- Excess installed power;
- The legal provisions on the operation of the electricity market in terms of transparency, competition and non-discrimination are observed.

The electricity generation sector is mainly based on the type of primary resource used in the production process (hydro, nuclear, thermal, wind, photovoltaic and biomass). The economic operators in the field of production, both those belonging to the state and the private sector, operate on the basis of a license for commercial exploitation of the electricity generation capacities issued by ANRE, participating in the electricity market.

As a result of the monthly monitoring of the activity of the producers of dissociated units (UD) on the electric power market, the electric power supply was delivered in electric power networks in the year 2016 at 57.93 TWh. According to the results of the process for the achievement of the national electricity label, the total quantity of electricity produced in dispatchable and non-dispatchable units was 64.15 TWh in 2016, of which 60.13 TWh was delivered to the networks by the 732 license holders for the commercial exploitation of the power generation capacities that reported data in accordance with the Electricity Labeling Regulation, approved by the ANRE Order no. 61/2016.

Starting from the data obtained in the process of elaboration of the national label, the structure of the electricity produced in dispatchable and non-dispatchable production units resulted, based on conventional and unconventional types of resources (Figure II_E_4).

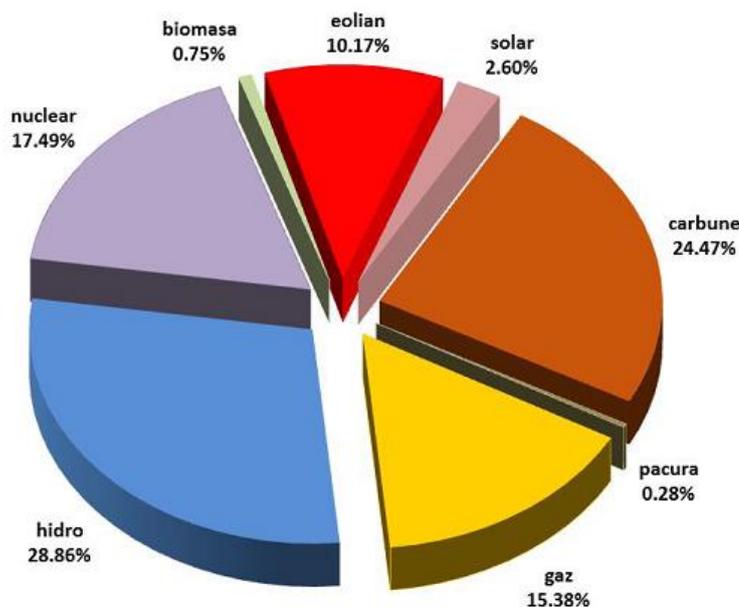


Figure II_E_4 Structure by types of resources of electricity produced in dispatchable and non-dispatchable units (2016)

The electricity generation sector is still dominated by conventional energy producers; market shares of over 5% of the total quantity produced are recorded by the first four producers, totaling approx. 75% of the energy produced in the dispatchable units. Quantities of electricity above 1 TWh register a number of 8 producers, which represents cumulative approx. 86%, a situation similar to that of the previous year.

Figure II_E_5 shows the market shares of dispatchable units producers in 2016, based on the electricity supplied in networks and the average annual values of the main structural indicators for 2010-2016.

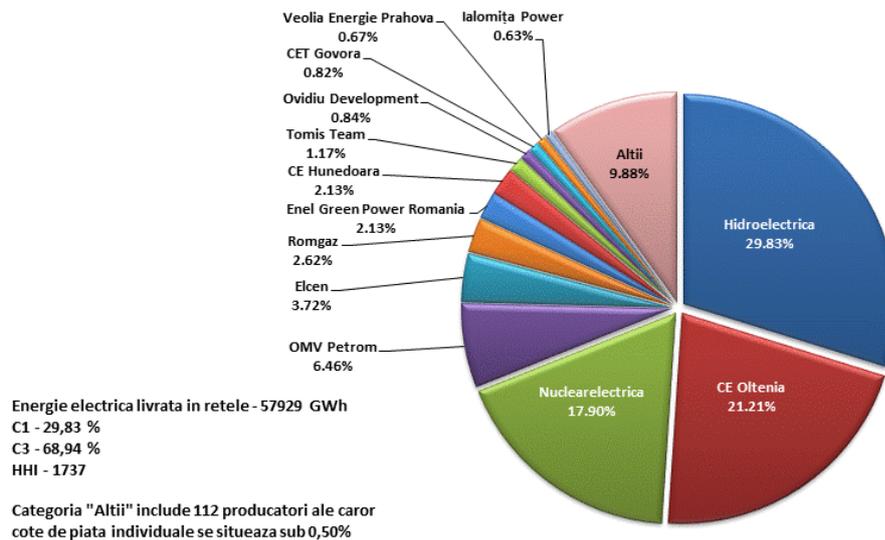


Figure II_E_5 Market shares of market participants with dispatchable units depending on the energy supplied to the networks (2016)

The most important producer in terms of the amount of electricity produced and supplied in the network was Hidroelectrica this year, with an increase of almost 3 percentage points compared to 2015 (from 27.11% to 29, 83%). The hierarchy of the other two producers in the producers' rankings according to the quantity produced and delivered remained the same as in the previous year, but the individual market shares were slightly modified. At the year level, the group of the first three producers accounted for 68.94% of the total quantity of electricity delivered, almost equal to the value recorded in 2015.

This year's 2016 concentration indicator values (C1 30% and HHI-1737) keep the electricity sector within the boundaries of the markets with a moderate degree of concentration from those with a high degree of concentration, according to the literature specialty Romania's energy policy is based on the fundamental objectives of the European Union: sustainability, competitiveness, food security.

Energy efficiency measures have a critical role to play in ensuring that the objectives set out in the Energy Climate Change Package are achieved at the lowest cost, contributing to a large extent to the objectives of sustainability and competitiveness in the European Union.

The Energy Strategy of Romania 2016-2030 with the year 2050 perspective on the website of the Minister for Energy submitted to the Ministry of Environment for analysis highlights the need to increase security of supply, the use of national primary resources and the increase in the use of renewable energy.

II.F.1 Energy resources

Romania has a wide but quantitatively reduced range of fossil and mineral energy resources as: oil, natural gas, coal, uranium ore, and a great potential of renewable energy resources.

A fair assessment of the possibilities for covering the primary energy needs in the future should start from the current situation of proven reserves combined with realistic estimates of potential resources in close correlation with resource consumption forecasts determined by the final energy demand.

In the tables II_5 and II_6 are presented the evolution of the primary energy production and domestic primary energy consumption in the period 2005 - 2015.

Based on the exploitation of fossil energy reserves, coal and oil as well as those of uranium ore, primary energy production in Romania, in the most optimistic case, will not grow in the next 2 - 3 decades.

Table II_5 Domestic Primary Energy Production [thd.toe]

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Primary energy production, out of which:	27,090	27,065	27,300	28,861	28,034	27,428	27,468	27,112	25,853	26,314	26,387
Total coal, out of which:	5,793	6,477	6,858	7,011	6,447	6,795	6,663	6,346	4,657	4,449	4,711
- other hard coals	1,082	837	902	979	751	821	730	654	649	603	443
- lignite	4,698	5,628	5,933	5,985	5,718	5,946	5,933	5,692	4,008	3,846	4,268
- brown coal	13	12	23	47	8	28	0	0	0	0	0
Firewood and agricultural wastes	3,229	3,235	3,304	3,750	3,838	3,900	3,476	3,795	3,657	3,646	3,521
Crude oil	5,326	4,897	4,651	4,619	4,390	4,186	4,129	3,891	4,028	3,952	3,906
Natural gas	9,536	9,395	9,075	8,982	8,964	8,705	8,724	8,770	8,686	8,854	8,873
Other fuels	87	82	127	240	98	88	152	159	188	171	232
Energy from unconventional sources	18	18	21	26	25	26	37	50	46	48	48
Hydroelectric	1,739	1,580	1,370	1,481	1,361	1,769	1,407	1,290	1,743	2,332	2,242
Nuclear energy	1,362	1,381	1,894	2,752	2,881	2,841	2,880	2,811	2,848	2,862	2,854

Source: National Institute of Statistics, Energy Balance - Collections 2005- 2015

Table II_6 Domestic primary energy consumption

Anul	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Primary energy internal consumption, out of which:	37,868	39,381	39,159	39,799	34,328	34,817	35,648	34,851	31,633	31,537	31,844
Coal	8,742	9,540	10,064	9,649	7,436	6,911	8,147	7,552	5,725	5,719	5,858
Crude oil and crude oil products	9,163	9,651	9,658	9,719	8,331	7,855	8,472	8,303	7,706	7,864	8,600
Natural gas	13,820	14,308	12,862	12,476	10,642	10,897	11,187	10,924	9,892	9,458	9,015
Firewood and agricultural wastes	3,185	3,185	3,275	3,710	3,742	3,982	3,458	3,654	3,590	3,618	3,514
Hydroelectric	1,489	1,212	1,195	1,115	1,164	1,573	1,242	1,312	1,569	1,719	1,663
Nuclear energy	1,362	1,381	1,890	2,752	2,881	2,850	2,880	2,811	2,848	2,862	2,853
Other fuels	88	87	194	352	107	723	225	244	257	249	293
Energy from unconventional sources	18	18	21	26	25	26	37	51	46	48	48
Non-energy	2,231	2,044	2,061	2,040	1,704	1,511	2,032	1,953	1,635	1,705	1,299

Source: National Institute of Statistics, Energy Balance - Collections 2005- 2015

Oil

The oil industry is a strategic sector of the national economy and a development support for the other sectors of the Romanian industry and economy. Romania has over 150 years of experience in the oil industry and over 100 years in the natural gas industry, with the highest annual production being achieved in 1977 (14.65 million tons of crude oil), 1986 (36.3 billion m³ of gas natural). Due to the natural decline of crude oil and natural gas deposits, mainly the decrease in the volume of exploration works and investments, the annual production of crude oil and natural gas decreased to 4,00 million tons of crude oil in 2015 11.09 billion m³ of gas.

At present there are 447 oil and natural gas fields exploited in Romania, out of which:

- 255 commercial oil and gas fields with about 9,445 oil wells and 828 natural gas wells, for which oil agreements are owned by a single company, a producer of crude oil and natural gas;

- 153 commercial deposits with approximately 3,200 natural gas wells, for which the oil agreements are owned by a single company operating in the natural gas sector;
- 39 other deposits for which petroleum development, exploitation and oil exploration agreements.

Most of these deposits are mature, with a service life of over 25-30 years. In order to discover new oil and gas fields in Romania, exploration is carried out in 36 perimeters, of which:

- Petrom holds the concession right for 15 onshore exploration, development and production perimeters, respectively 2 offshore.
- Romgaz carries out exploration-development-oil exploration operations in 8 concession perimeters as the sole concessionaire and is a concessionaire associated with other companies in 20 oil exploration, development and exploitation oil deals, of which two offshore.
- Other companies carry out exploration-development-exploitation oil exploration, development and exploitation perimeters.

According to the data of the National Agency for Mineral Resources (ANRM), at the beginning of 2014, the geological reserves of crude oil amounted to 2020 million tons and the safe reserves were 60 million tons.

The vast majority of geological resources and safe reserves identified to date are located onshore (96%) and only 4% in the continental shelf of the Black Sea.

In the average annual output of 4.2 million tonnes and in the context of a steady annual decline of 5% in safe reserves and a 5% replacement rate for oil and fossil reserves, it can be estimated that the current oil reserves of Romania could be exhausted over a period of about 23 years.

In the short and medium term, safe oil reserves can be increased by implementing new technologies to increase recovery in existing deposits and, in the medium and long term, by implementing deep-sea exploration projects (less than 3,000 m), complicated geological areas in the onshore and offshore areas of the Black Sea, especially the deep water area (less than 1,000 m).

Romania has theoretically the largest installed refining capacity in Central and Eastern Europe, with the country's main refineries having a high complexity index.

Of the 10 refineries in Romania, only 4 refineries were in operation in the first half of 2014, namely: Petrobrazi Ploiesti, Petrotel Lukoil Ploiesti, Petromidia, Vega Ploiesti.

The Petrobrazi refinery Ploiesti processes in particular the Romanian crude oil with a reduced sulfur content and the other two refineries can process crude oil with high sulfur content imported from import.

Romania has the largest reserves of natural gas in Central and Eastern Europe, with reliable reserves of about 1,600 TWh (150 billion m³). According to the data provided by ANRM, there are geological resources of 6569 TWh (615 billion m³).

At an annual average production in Romania (11 billion m³ of natural gas), and in the conditions of a constant annual decline of 5% of safe natural gas reserves, combined with a 80% replacement rate of natural gas reserves, one can appreciate that the current gas reserves could be exhausted over a period of about 14 years.

Similar to crude oil, in the short and medium term, secure gas reserves can be increased by implementing new technologies that will lead to increased recovery in deposits, and in the medium to long term by implementing deep-sea exploration projects (less than 3,000 m) and

the exploration of complicated geological areas in the onshore and Black Sea offshore areas, especially the deep water area (below 1,000 m).

Coal

Romania has important coal reserves, although its quality is rather poor. According to the data available to ANRM, the situation of geological coal resources in exploitable perimeters is as follows: pit coal - 592 million tons and lignite-986 million tonnes.

The majority of coal deposits in Romania are concentrated in the carboniferous basin of the Jiu Valley, with the average calorific value of safe reserves being 3650 kcal / kg. Coal deposits in Romania are located in complex geological and mining conditions, and mineralogical characteristics that influence quality are at the lower limit.

Most of the safe lignite reserves (95%) are located in the Oltenia Mining Basin (Gorj, Mehedinti and Valcea Counties), the calorific value of the safe reserves being between 1650 and 1950 kcal / kg, with a mean value of 1800 kcal / kg. The lignite fields in operation have reserves of over 400 million tons.

The concessioned lignite reserves can ensure their efficient exploitation for about 15 years at a production level of about 30 million tons / year.

Considering the characteristics of extracted coal in Romania (coal with a calorific value of 3650 kcal / kg, lignite with a calorific value between 1650-1950 kcal / kg), it can be used only in power stations equipped for this type of fuel and located near exploitation. Table II_7 shows the evolution of coal production over the period 2005-2015 and it can be noted that lignite production accounted for around 90% of total coal production in 2015.

Regarding primary energy resources at national level, it is clear that, apart from renewable energy sources, lignite is the only primary energy source that can significantly contribute to meeting energy demand over the next 2-3 decades.

Table II_ 7 Coal Production (thousand toe)

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Coal, of which	5,793	6,477	6,410	7,011	6,477	5,903	6,661	6,345	4,656	4,448	4,711
Lignite and brown coal	4,698	5,628	5,985	6,032	5,726	5,173	5,932	5,692	4,008	4,039	4,267

Source: National Institute of Statistics, Energy Balance - Collections 2002- 2012

Nuclear

The Cernavoda Nuclear Power Plant is the only nuclear power plant in Romania. Cernavoda NPP is located in the Dobrogea region in the South-East of Romania, near the Danube-Black Sea Canal. The construction began in 1982.

Currently, Romania has two nuclear reactors: Cernavoda NPP Units 1 and 2, with an installed capacity that produces about 18% of the country's electricity. Unit 1 is in operation since December 1996 and Unit 2 is in operation since October 2007.

In 2015, Cernavoda NPP, with both units in operation, produced a total of 11.64 TWh, out of which 10.71 TWh delivered to the National Electricity System.

The owner of CNE Cernavoda is Nuclearelectrica National Company SA, a Romanian state company established in 1998. Both units have a installed capacity of 706.5 MW and are equipped with CANDU 6 type reactors that use natural uranium as fuel and heavy water moderator and cooling agent.

Renewable energy resources

Renewable energy sources in Romania have an important theoretical potential. Compared to this, the usable potential of these resources is much lower due to technological limitations, economic efficiency and environmental restrictions. Table II_8 presents the energy potential of renewable energy sources in Romania.

Of the total economic energy potential of Romania's renewable sources, biomass has more than 50%. Thus, with the efficient use of biomass, the energy potential of renewable sources can be better harnessed.

Table II_ 8 Coal Production (thousand toe)

Renewable sources	Annual energy potential	Economic equivalent energy		Application
		thd. toe	% of total	
Solar energy				
Thermal	60x10 ⁶ GJ	1.433	9.74	Heat
Photovoltaic	1,200 GWh	103	0.70	Electricity
Wind energy	23,000 GWh	1.978	13.44	Electricity
Hydro energy	40,000 GWh	3.440	23.37	Electricity
Up to 10 MW	6,000 GWh	516	3.51	Electricity
Biomass	318x10 ⁶ GJ	7.597	51.62	Heat
Solid biomass	290x10 ⁶ GJ	6.917	47.00	Heat
Biogas	15x10 ⁶ GJ	353	2.40	Heat
Urban waste	14x10 ⁶ GJ	327	2.22	Heat
Geothermal energy	7x10 ⁶ GJ	167	1.13	Heat
TOTAL		14,718		

Source: ISPE

Table II_ 9 Main exploitation data of power plants on renewable energy sources in 2015

Type of generator group	Installed power, (MW)	Electricity produced (MWh)
TOTAL National Power Grid,	23,829.400	66,296,328
Out of which:		
Hydraulic turbines – total	6,638.203	17,006,553
Out of which:		
In hydropower plant - installed power < 1 MW	94.591	210,893
In hydropower plant - installed power 1÷10MW inclusive	436.599	1,084,959
In hydropower plant - installed power >10MW	6,107.013	15,710,701
Steam turbine	89.000	1,027,521
Wind turbinr	3,129.800	7,062,930
Photovoltaic solar panels	1,325.943	1,982,000

Source: Energy Balance and Structure of Energy Equipment in 2015

The production of electricity from hydroelectric and wind energy represents 88.9% of the total amount of electricity produced from renewable energy sources in Romania.

National targets for the share of electricity produced from renewable energy sources in gross final consumption of electricity for the years 2010, 2015 and 2020 are 33%, 35% and 38%, respectively.

II.F.2 Energy transmission infrastructure

National crude oil network

The National Crude Oil Transmission System (SNTT) in Romania is 3800 km long and is operated by CONPET, a listed company, in which the Romanian State holds a 58.7162% stake through the Ministry of Economy (Figure II_F_1).

The transport network is structured in four main subsystems:

- The internal crude oil transport subsystem is 1,540 km long and has a capacity of 6.9 million tonnes / year;
- Import crude oil subsystem, with a length of 1,350 km and a capacity of 20.2 million tonnes / year;
- Gasoline and ethane transport subsystem with a length of 920 km and a capacity of 230,000 tons / year gasoline and 100,000 tons / year for ethane;
- Rail transport subsystem with tank-wagons.

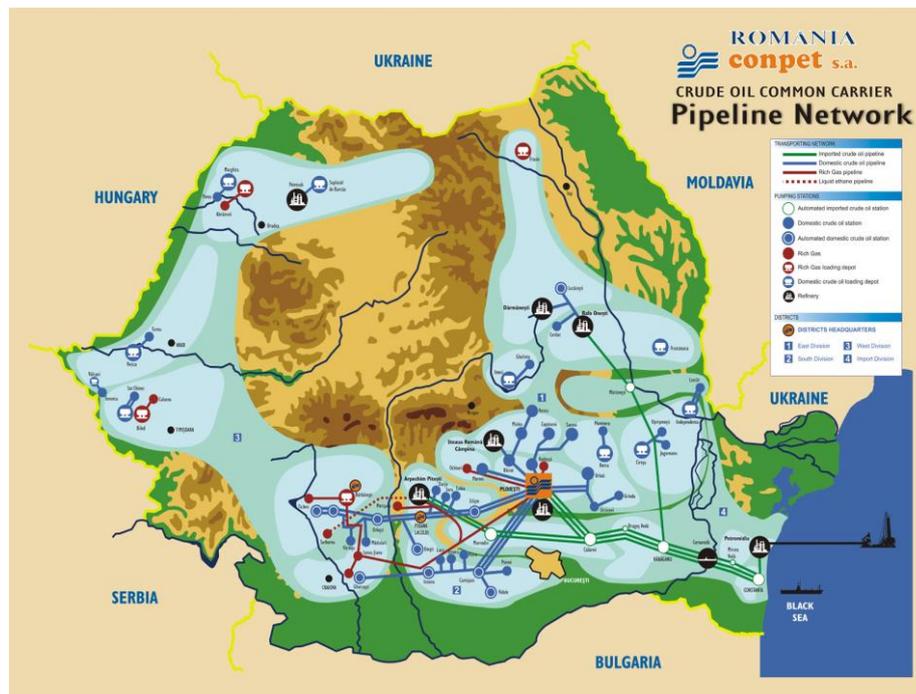


Figure II_F_1 Crude oil national pipeline system

The Crude Oil Pipeline National Transport System has a transport capacity of 27.5 million tons / year.

Since 1996, the system has entered a rehabilitation and upgrading program. The Transmission System Operator carries out activities to improve the technical condition of the national transport system in order to increase the service life of the pipeline system under the conditions of increased safety in operation:

- Upgrading / refurbishing the national crude oil transport system by continuing the pipeline replacement program;
- Rehabilitation of pumping stations on main pipelines and loading / unloading ramps;
- Automation of the transport system and introduction of the SCADA system;
- Introduction of the fiscal measurement systems for crude oil;
- Upgrading and monitoring the cathodic protection system;
- Development of a program for rehabilitation and resizing of reservoirs, in accordance with the volume of the quantities to be transported;
- Establishment of a leakage detection and localization system, a system that brings benefits in reducing damage in case of damage and reducing greening costs.

At present, the degree of use of the crude oil national transport subsystem is 60.8% and the utilization rate of the imported oil subsystem is less than 10%.

Constanta Port connected to the national pipeline network has the largest oil terminal in South East Europe (operated by Oil Terminal), specialized in the import of crude oil and other petroleum products and the export of refined petroleum products. Oil Terminal S.A. Constanța (Oil Terminal) is a listed company, where the Romanian state holds the majority stake. The oil terminal can operate vessels with capacities of up to 165,000 tdw (deadweight), and has a maximum capacity of 24 million tons / year and an oil storage capacity of 550,000 tons. Oil Terminal owns three warehouses to transport the following products: crude oil, gasoline, diesel oil, fuel oil, chemicals and petrochemicals, oils, import or export and transit.

National natural gas transmission and distribution network

The National Transmission System for Natural Gas (SNTGN) in Romania is operated by CN Transgaz SA, the Transmission System Operator (TSO). The natural gas transport capacity is ensured through the pipeline network and supply connections with diameters between 50 mm and 1200 mm and the total length of 12,574 km (13,127 km including the transit pipelines) at regime pressures ranging from 6 to 35 bar.

The National Transmission System (SNTGN) for natural gas is illustrated in Figure II_F_2.

SNTGN is connected with neighboring states, namely with Ukraine, Hungary and Moldova, through four interconnection points, namely:

- Mediesul Aurit (Ukraine-Romania): entry point in the northern area of the country with an annual import capacity of 42.86 TWh (4.01 bill. m³), 700 mm diameter, 70 bar pressure;
- Isaccea (Ukraine, - Romania): entrance point in the eastern part of the country, with an annual import capacity of 91.91 TWh (8.61 bill. m³), 1000 mm diameter, 55 bar pressure;
- Csanédpalota (Hungary-Romania): entry and exit point in / from the western part of the country with an annual import capacity of 18,67 TWh (1,75 bill. m³), 700 mm diameter, regime pressure 63 bar and an annual export capacity of 0.92 TWh (0.087 bill. m³);
- Iasi-Ungheni (Romania-Moldova): exit point from the eastern part of the country with an annual export capacity of 0.46 TWh (0.04 bill. m³).

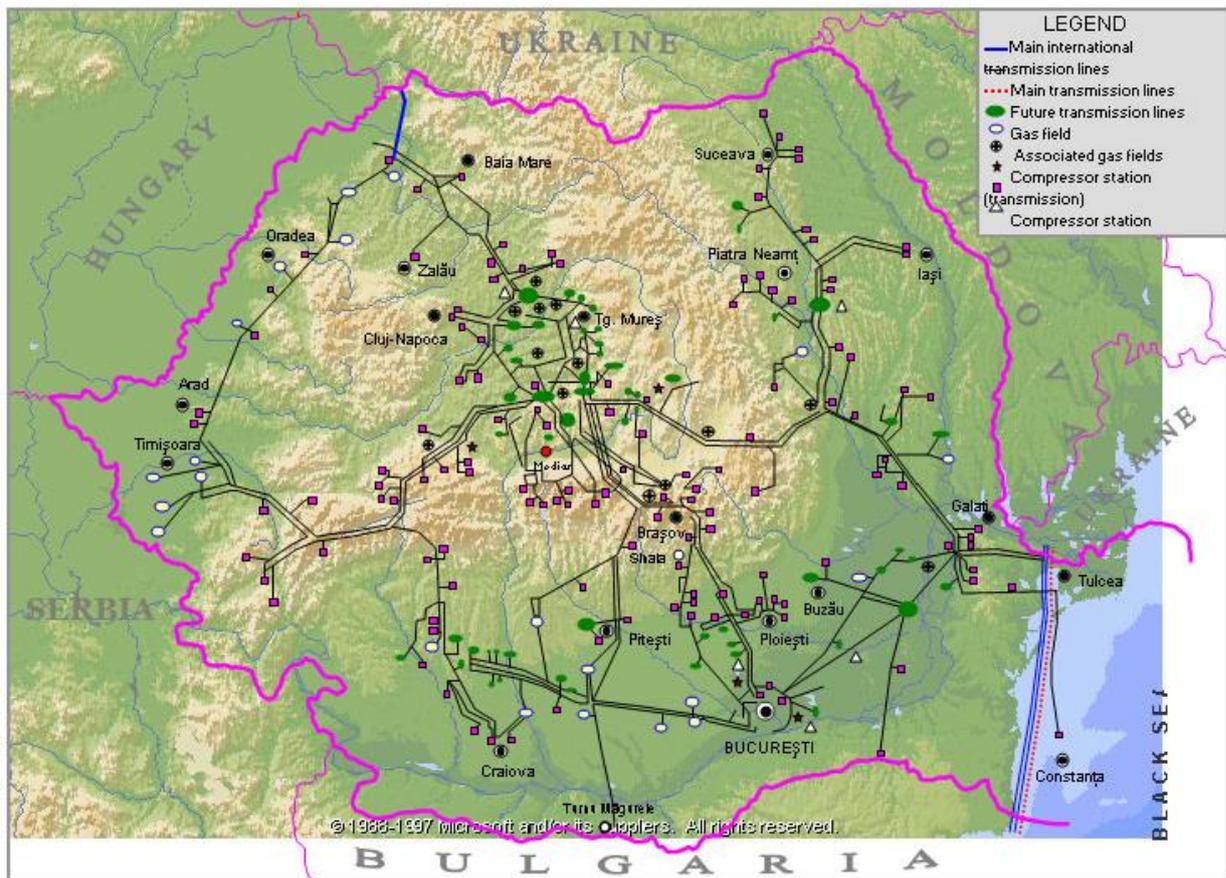


Figure II_F_2 National Gas Transportation System

The maximum annual import capacity is 153.44 TWh (14.37 billion m³). At present, physical export is available with limited capacity only at the interconnection point with Hungary (Csanédpalota) and at the interconnection point with Moldova (Iasi-Ungheni), the annual maximum export capacity being 1.39 TWh (0.13 billion m³).

Romania's interconnection capacity with the adjacent states will increase with the commencement of the Giurgiu-Ruse interconnection pipeline, which will provide an annual capacity of 5.34 TWh (0.5 billion m³) for each flow direction, in a first stage, the maximum design capacity being 16.02 TWh (1.5 billion m³) for each flow direction.

The SNTGN has a maximum technical capacity of 51,316.80 MWh / day and a spare capacity of 27,060.41 MWh/day, which far exceeds current consumption, so there have been no congestion in the network so far.

Underground storage capacity of natural gas registered a permanent development, which is about 47.84 TWh in 2013, of which the useful working volume is about 32.53 TWh.

At present, seven storage depots are located in Romania, out of which six warehouses with a total capacity of 41.72 TWh and a working volume of 30.30 TWh are owned by Romgaz and a warehouse (Târgu Mureș) with a total capacity of 6.11 TWh and a working volume of 3.19 TWh, is owned by GDF SUEZ (majority shareholder) and Romgaz.

The Transmission System Operator carries out a sustained activity to improve the technical condition of the transport system by constantly developing, rehabilitating and upgrading the system, expanding to new consumer areas, and interconnecting with similar systems in neighboring countries to diversify sources of imported natural gas.

The natural gas distribution system consists of 40,300 km of pipelines that feed about 3.2 million consumers. On the Romanian natural gas market, 41 distribution system operators (OSDs) operate. The top two OSDs have a cumulative market share of 89%, while another 39 OSDs have a cumulative market share of about 11%.

Electricity network and interconnections

CNTEE "Transelectrica" - SA carries out the activity of electricity transmission through the Electricity Transmission Network (RET), consisting of electric stations and lines. RET is the national and strategic electricity network with nominal voltage higher than 110 kV.

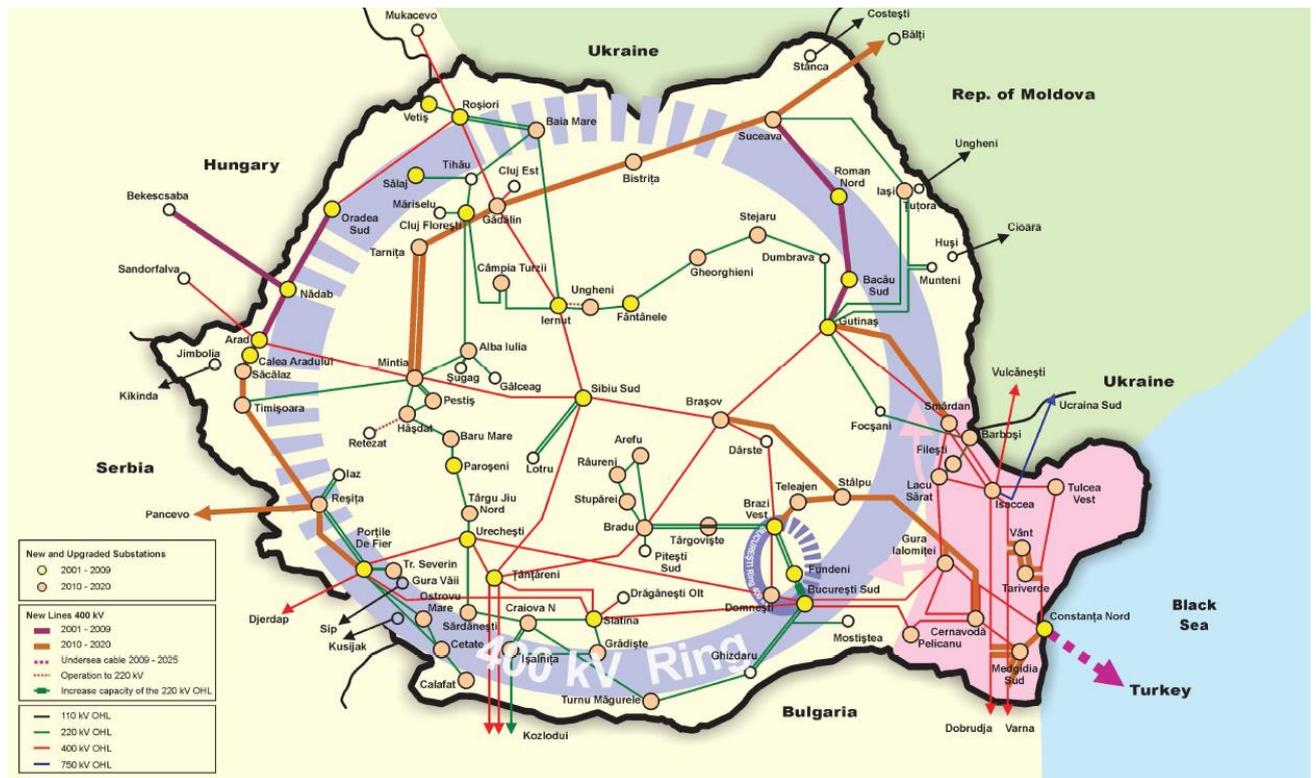
The amount of installations managed by CN "Transelectrica" SA consists of:

- 81 electric substations, of which:
 - ✓ One 750 kV substations
 - ✓ 38 substations at 400 kV
 - ✓ 42 substations at 220 kV
- 8759.4 km overhead electric lines (OHL), of which:
 - ✓ 155.62 km at 750 kV
 - ✓ 4706.8 km at 400 kV
 - ✓ 3059.4 km at 220 kV
 - ✓ 38 km at 110 kV

of which interconnection lines: 425.8 km

- 216 main transformer units amounting to 37,794 MVA.

At present the Romanian Power System is interconnected to the neighbouring power system by means of the following lines (Figure II_F_3):



Source: Transelectrica

Figure II_F_3 Romanian electricity Transmission Network

The Romania - Bulgaria section includes the followings overhead power lines (LEA) and sections:

- OHL 400 kV Isaccea – Dobrudja;
- OHL 400 kV d.c Țânțăreni – Kozlodui.

Section 400 kV Romania – Serbia includes:

- OHL 400 kV Porțile de Fier – Djerdap.

Section 110 kV Romania – Serbia includes:

- OHL 110 kV Ostrovul Mare – Kusjak;
- OHL 110 kV Gura Văii – Șip;
- OHL 110 kV Jimbolia – Kikinda.

Section Romania – Hungary includes:

- OHL 400 kV Arad – Sandorfalva;
- OHL 400 kV Nadab-Bekescsaba.

Section Romania – Ukraine includes:

- OHL 400 kV Roșiori – Mukacevo.

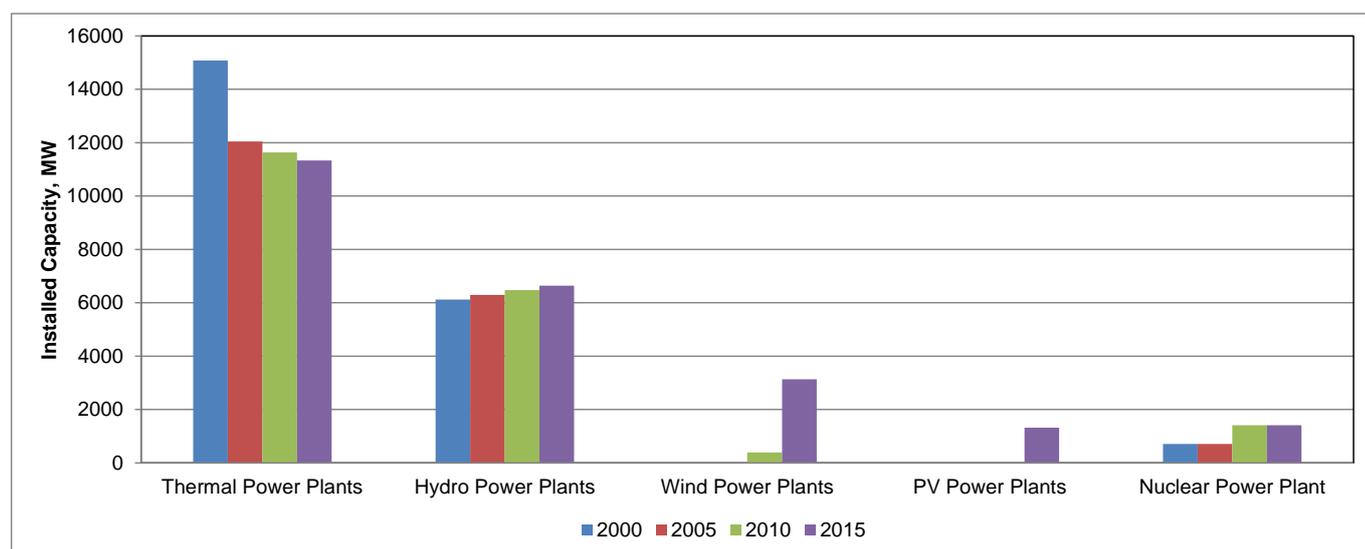
Section Romania – Moldavia Republic with island function includes:

- OHL 400 kV Isaccea – Vulcănești (line only for National Power System imports);
- OHL 110 kV Stâncă – Costești;
- OHL 110 kV Cioara – Huși;

➤ OHL 110 kV Țuțora – Ungheni.

II.F.3 Electricity, generation and consumption

The Romanian Power Grid (SEN) had an installed capacity of 23,829 MW in 2015. The installed power evolution during 2000-2015 registered a decrease of the installed power from 21.905 MW (in 2000) to 19.042 MW (in 2005) due to the decommissioning of the thermo energy units at the expiry of the normal lifetime (Figure II_F_4). After 2005, the installed power increased as a result of the construction and commissioning of new units, especially renewables.



Source: National Institute of Statistics - Energy Balance - collections - 2000-2015
Figure II_F_4 Installed power capacity in Romania within 2000 – 2015 [MW]

Table II_10 and Figure II_F_5 illustrates the main features of NPS within the 2000 – 2015 period as well as the electricity generation evolution per types of power plants.

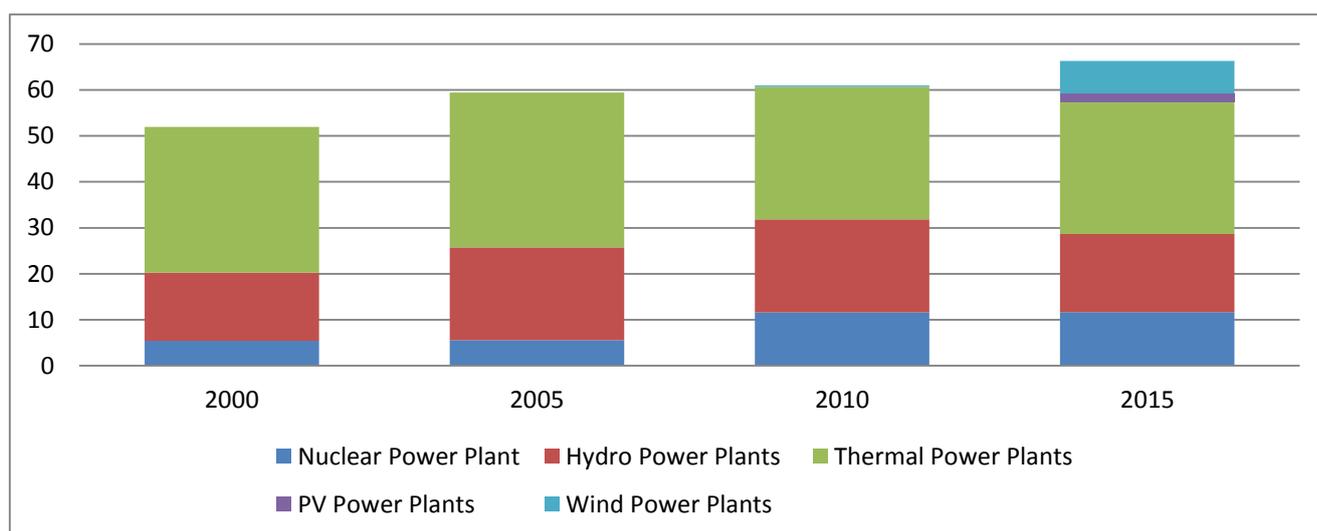
Table II_10 Main features of NPS

Year	Gross electricity generation [TWh]	Net electricity generation [TWh]	Gross peak of electricity demand [MW]
2000	51.935	47.066	8,265
2001	53.866	48.766	8,569
2002	54.935	50.400	8,410
2003	56.645	51.525	8,356
2004	56.482	51.934	8,761
2005	59.413	54.804	8,970
2006	62.696	56.835	9,650
2007	61.673	56.450	9,526
2008	64.956	59.770	9,373
2009	58.016	53.272	8,825
2010	60.979	56.546	9,349
2011	62.216	56.968	9,509
2012	59.047	54.028	9,125

Year	Gross electricity generation [TWh]	Net electricity generation [TWh]	Gross peak of electricity demand [MW]
2013	58.888	53.882	9,005
2014	65.675	60.699	9,435
2015	66.296	61.277	9,625

Source: National Institute of Statistics - Energy Balance - collections - 2002- 2015, CN TranselectricaSA

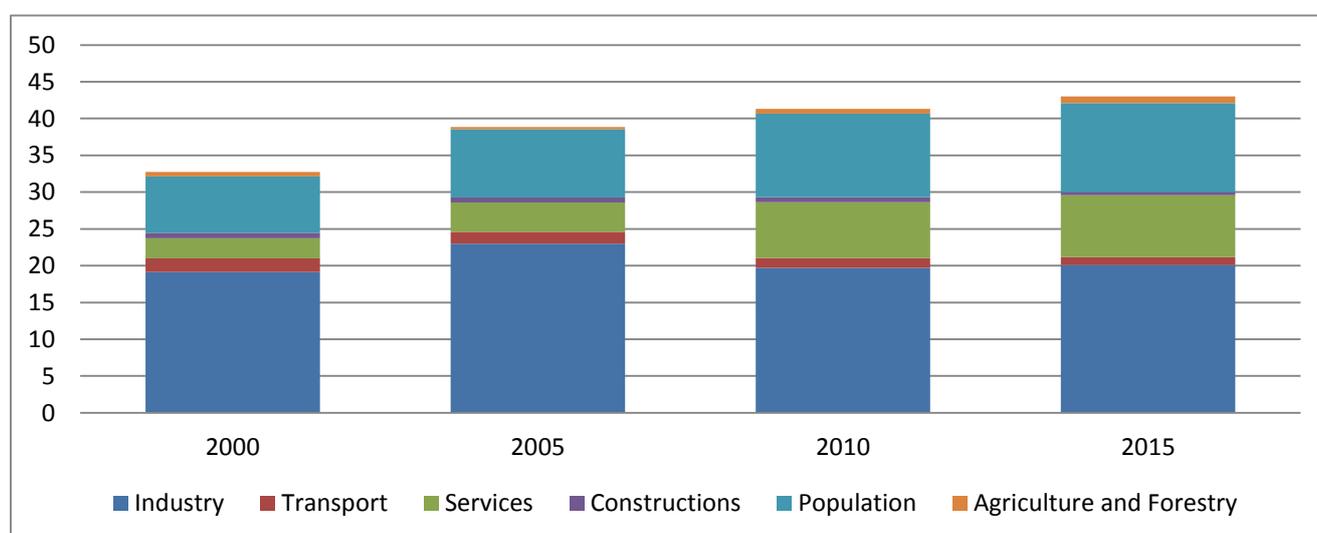
Electricity is generated about 9% at Cernavoda NPP (up to the year 2006) and about 18% in 2015. The share of electricity produced in hydropower plants ranges from 25.5% to 34.0% depending on hydrological conditions.



Source: National Institute of Statistics – Energy balance – collection – 2000 - 2015

Figure II_F_ 5 Evolution of electricity generation per types of power plants

The evolution of electricity consumption on economy main sector is presented in the Figure II_F_6 for period 2010-2015.



Source: National Institute of Statistics – Energy balance – collection – 2000 – 2015

Figure II_F_ 6 Evolution of electricity consumption per consumer's types

Between 2000 and 2015, final electricity consumption increased from 32,734 TWh to 43,027 TWh, at an average annual rate of 1.85%. The largest consumer of electricity is the industry, followed by pollutions and services. In 2015 the consumption of the industry represented 46.6% of the total, the consumption of the population accounting for 38.1% of the total.

The GHG emissions related to electricity sector might vary broadly, depending on the intensity of hydro power use, fossil fuels prices, availability factors etc. From National GHG Inventory data it is obvious that in 2015, there was a decrease of GHG emissions, due to decrease of electricity consumption and also due to the increasing share of the renewable electricity generation.

II. G. Transport profile

Romania has a national transportation system (infrastructure, transport equipment, etc.) largely at the same level with the average standards of conventional transport systems in Europe from the point of view of both the functional structure and services rendered.

Strategic framework for sustainable transport policy in Romania has aligned European policy defined in the White Paper of transport.

In the Transport sector, Romania holds a key position at the eastern border of the EU as a transit area both on the east-west direction (link to Asia via the Black Sea) and north-south (from the Baltic Sea to the Mediterranean Sea). Three of the TEN-T priority axes cross Romania.

Road transport

The public roads network in Romania is classified into five categories:

- Motorways (Autostrăzi) - A;
- Express (European) Roads (Drumuri Europene) – E;
- National Roads (Drumuri Naționale) – DN;
- County Roads (Drumuri Județene) – DJ; and
- Communal Roads (Drumuri Comunale) – DC.

The motorway and national road network accounts for only 20% of the entire network as summarised below.

According to data from the National Institute of Statistics (INS), in 2015 public roads have totalled 86,080 km⁹, out of which:

- 17,606 km (20.5%) were national roads (including motorways and European roads),
- 68,474 km (79.5%) were county roads and communal roads.

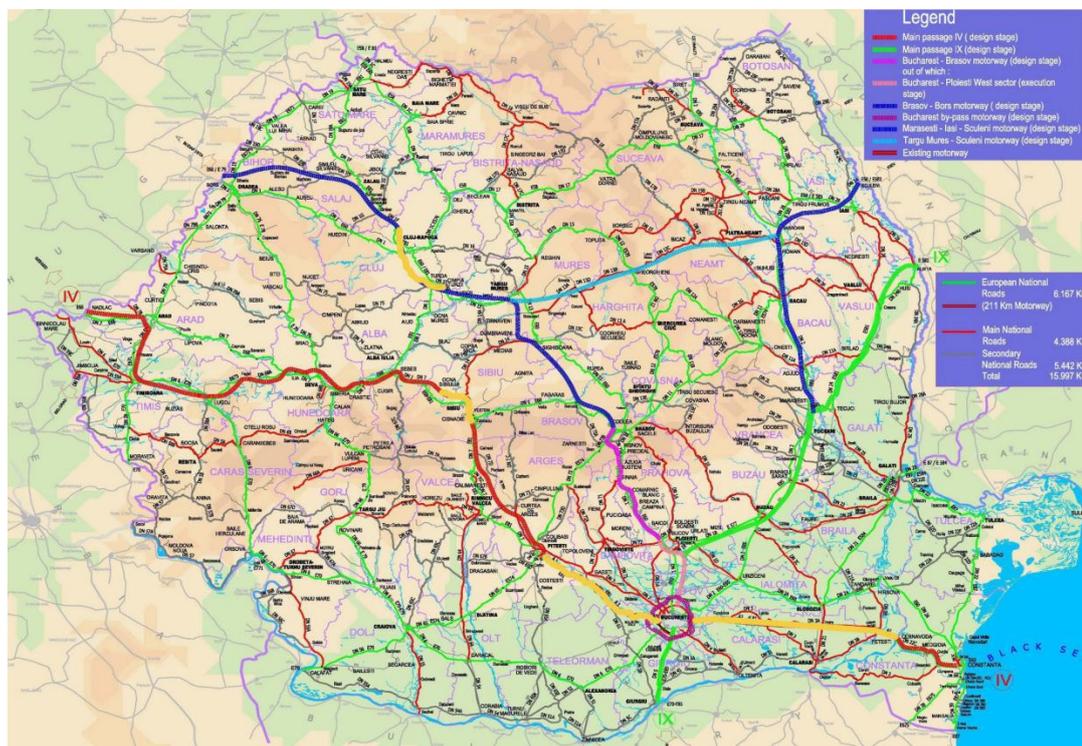
Romania has a very limited network of motorways; in 2015, only 689 km of motorways were finalized¹⁰. In addition, only a small proportion of the road network is built to European standards; only 32,641 kilometres (37.9%) have been upgraded and 21,136 km (24.5%) are still with light asphalt pavement¹¹. Status of road infrastructure and low density of public roads of

⁹ National Institute of Statistics, *Statistical Yearbook of Romania 2016*

¹⁰ *Gandul newspaper*: <http://www.gandul.info/stiri/harta-autostrazilor-din-romania-in-ce-stadiu-sunt-lucrarile-care-trebuie-sa-fie-gata-in-2016-15526422> (accessed in October 2017)

¹¹ National Institute of Statistics, *Statistical Yearbook of Romania 2016*

36.1 km per 100 km² in 2015¹¹ compared to the EU-28 average of 108 km to 100 km² in 2012¹² lead to enhanced distance, traveling time and excessive fuel consumption, with harmful effects on the environment.



Source: Ministry of Environment and Forests National Environmental Protection Agency - National report on the state of environment in 2011, Bucharest 2012

Figure II_G_1 Roads map of Romania

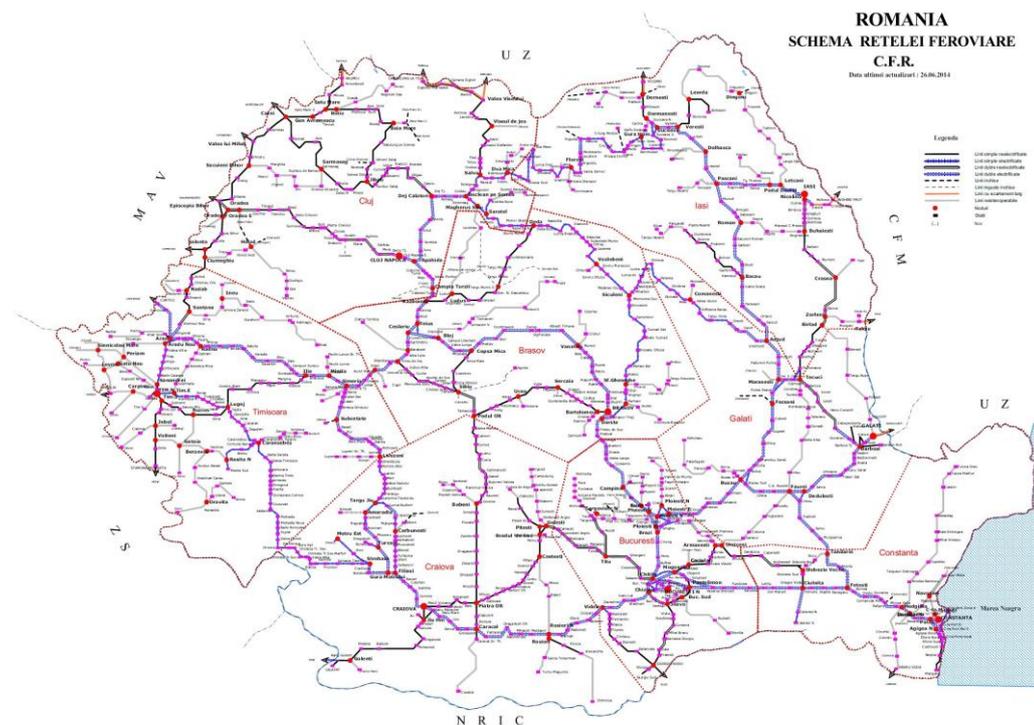
Rail transport

According to INS, in 2015 the Romanian network of rail lines open to commercial traffic was 10,770 km long¹³ (the eighth largest in the EU), out of which the length of electrified rail lines was 4,030 km, which represents 37.4% of the rail network in operation. Between 1990 and 2015, the length of electrified lines increased by about 10%. The map of the railway network is presented in the following figure.

The network is maintained by the state-owned infrastructure company CFR-SA (Compania Națională de Căi Ferate). Since 1998, the Railway Regulatory Authority (Autoritatea Feroviară Română - AFER) monitors the rail sector as a whole, including the infrastructure.

¹² European Union Road Federation - Road Statistics Yearbook 2016: <http://www.erf.be/images/Statistics/ADprint-ERFSTATS2016.pdf> (accessed in October 2017)

¹³ National Institute of Statistics, <http://statistici.insse.ro/shop/> (accessed in October 2017)



Source: Ministry of Transport, 2017

Figure II_G_2 Railway network map

The rail network is in an advanced state of disrepair due to a chronic lack of maintenance. Rail lines and the track-related assets need to be rehabilitated and the rolling stock must be replaced (some with a history of over 30 years). As a consequence, the rail system is very inefficient and it continues to deteriorate. On certain routes, the wear state of railways led to taking measures regarding the restriction of the speed limit, thus increasing the duration of the journey. Moreover, a lot of lines (71.6% of which are single track) are closed for maintenance during the morning. This results in low commercial speeds and poor frequencies. All these factors have contributed to the collapse of the traffic volume; the volume of passengers dropped by 83%¹⁴ between 1990 and 2015, while the volume of freight by 72%¹⁵.

It is estimated that the Trans-European Transport Network (TEN-T) accommodates about 50% of the total rail traffic in Romania and covers some 20% of the total Romanian rail system length. Two core network corridors cross the country: the Rhine - Danube Corridor and the Orient - East-Med Corridor. EU standards for minimum speeds on the Core TEN-T network entailed heavy upgrading work on those segments. The general objective of the rehabilitation and upgrading works, in line with the European Agreement on Main International Railway Lines (AGC) requirements, is to meet speeds of 160 km/h for passenger trains and 120 km/h for freight trains, while implementing interoperability.

The TEN-T infrastructure rehabilitation programme started in 1999 with an European Investment Bank (EIB) loan under which the Bucharest – Campina section (90 km) of the Bucharest – Brasov line has been rehabilitated. The Bucharest – Constanta line (225 km), Bucharest Băneasa – Fundulea sector, has been rehabilitated in 2009 under ISPA funding. During 2009-2011 upgrading works mainly targeted on sectors "Hungarian border - Curtici - Arad" and "Simeria - Coslariu - Sighisoara" have been performed.

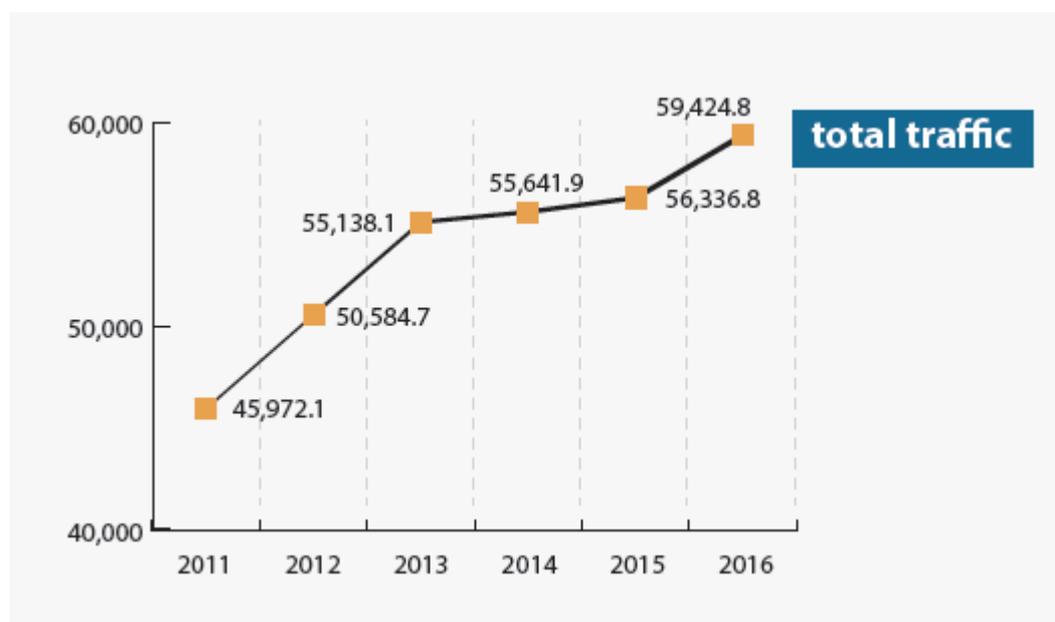
¹⁴ Expressed in passenger-kilometre (pkm). A passenger-kilometre is equivalent to the movement of one passenger over one kilometre.

¹⁵ Expressed in tonne-kilometre (tkm). A tonne-kilometre is equivalent to the movement of one tonne of goods over one kilometre.

Water transport

The Romanian water transport network includes seaports, river ports, and inland waterways. Constanta is the major seaport and the largest on the Black Sea. It is linked via the Danube to Serbia, Hungary, and Austria, and then via the Rhine-Main-Danube Canal to the Rhine as far as Rotterdam on the North Sea. The seaports of Constanta, Mangalia and Midia are on the Black Sea, while Braila, Galati, Tulcea and Sulina on the Danube operate as river/sea ports. The maritime section of the Danube consists of 170 km length from Sulina to Braila.

Constanta has a strategic geographic location that has the potential to provide access to Europe from the Black Sea and a transshipment point between the maritime network and the road, rail and inland waterway networks. It is located at the crossing of TEN-T priority axes 7 (Road), 18 (Rhine/Meuse-Main-Danube inland waterway), and 22 (Rail) and thus has the potential to become an alternative gateway for the Central/East Europe – Asia corridor. Its two satellite ports, Midia and Mangalia, are located nearby, and share functions with the main port. The direct access to TEN-T priority axis 18 is done via the Danube Black Sea Canal, potentially offering lower cost waterway transport links with Central Europe. It has good links to rail, road, river, air transport and pipeline modes. Its container capacity has grown with the development of a new Container Terminal on Pier II South, and it has Ro-Ro terminals allowing development of short sea shipping serving the Black Sea and Danube river-side countries.



Source: Constanta Port Annual Report 2016 [18]

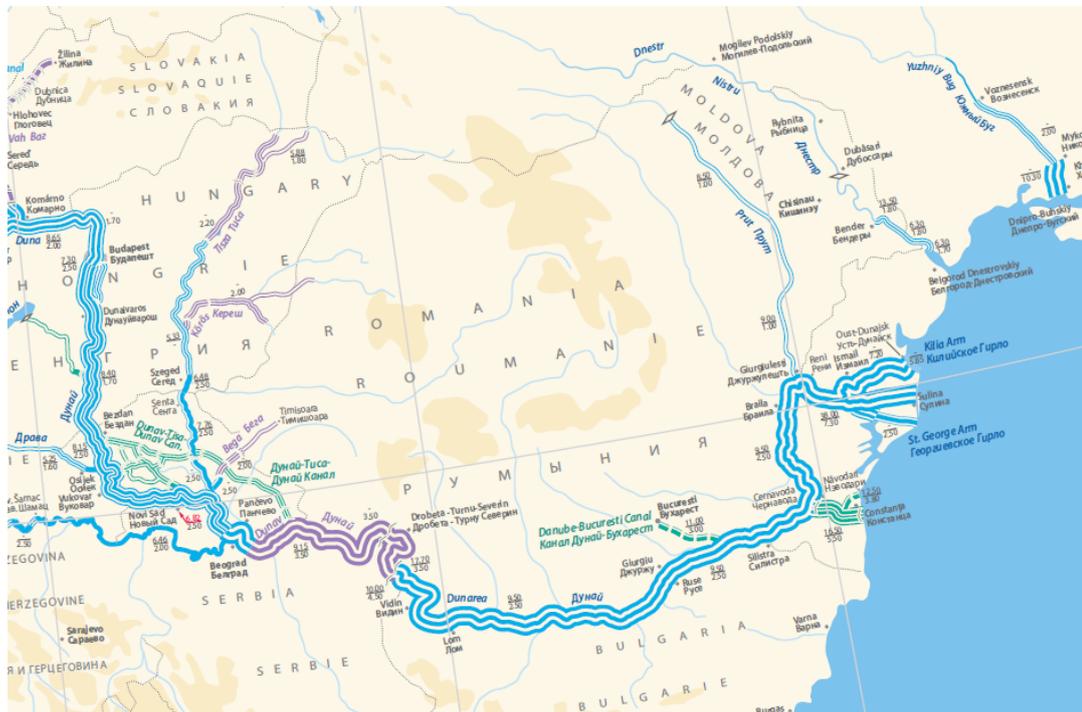
Figure II_G_3 Total traffic in Constanta Port (thousand tons)

Traffic through Constanta Port increased from 46 to 59 million tons between 2011 and 2016. Maritime traffic increased from 37 to 46 million tons, while river traffic increased by 51% to 13 million tons. Constanta's new status as a container hub port for the Black Sea is reflected in the 59% growth in transit traffic, to almost 15 million tons in 2015¹⁶.

The Romanian sector of the Danube River, between Bazias and Sulina, has a total length of 1,075 km of which 320 km is entirely on Romanian territory. The remainder is shared as a State Border with Ukraine (55 km), Moldova (0.97 km), Bulgaria (470 km) and Serbia and

¹⁶ Port of Constanta, Annual Report 2016

Montenegro (230 km). In practice this means that rehabilitation projects on all but the section where Romania has sole responsibility, must be agreed and coordinated by both countries and put into effect at the same time.



Source: UNECE website¹⁷

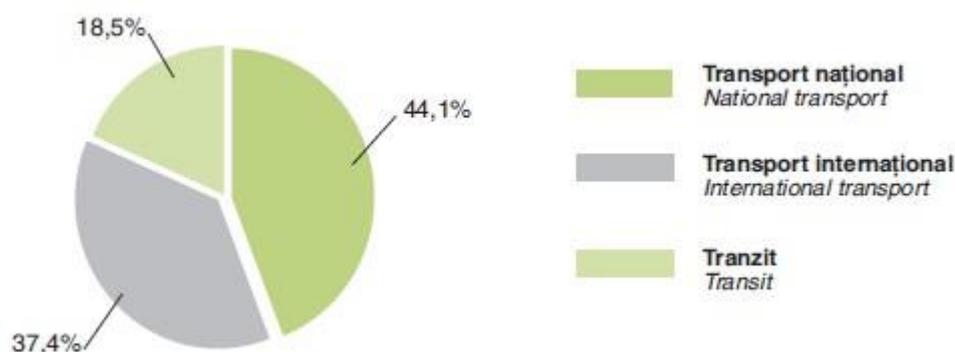
Figure II_G_4 Romanian inland waterways

The Romanian inland waterway system is shown on the map above. It is focused on the Danube in the south of the country. It also includes the secondary navigable branches of the Danube and the Danube - Black Sea and Poarta Alba - Midia Navodari canals between the Danube and the coast in the vicinity of Constanta. In addition, there are various small branches, including in the Danube Delta, mostly used for leisure and local (low volume) freight traffic. The branches of the Danube offer an additional 530 km of navigable waterway.

In Romania, a section of 170 km between Braila and the Black Sea can handle maritime shipping. The remainder, also called fluvial Danube, can handle ships and barges up to 2,000 dwt. The whole Romanian section of the Danube is navigable, but transport is hindered by seasonal low water levels and in 2003 traffic volumes declined sharply due to an unusually long low-water period in the summer.

The Danube is part of the TEN-T Priority axis no. 18: Rhine/Meuse/Main-Danube inland waterway axis and it provides Romania and the other countries through which it passes with major new opportunities for the development of water transport.

¹⁷ Website of United Nations Economic Commission for Europe (UNECE), https://www.unece.org/fileadmin/DAM/trans/main/sc3/European_inland_waterways_-_2012.pdf (accessed in October 2017)



Source: National Institute of Statistics, Statistical Yearbook of Romania 2016

Figure II_G_5 Inland waterways transport on harbour, in 2015

Table II_11 Goods transport by inland waterways, 2006 – 2015

UM / Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Thousand tonnes	29,305	29,425	30,295	24,743	32,088	29,396	27,946	26,858	27,834	30,020
Million tonne-kilometre	8,158	8,195	8,687	11,765	14,317	11,409	12,520	12,242	11,760	13,168

Source: National Institute of Statistics, Statistical Yearbook of Romania 2016

In 2007, the year when Romania joined the European Union, cargo traffic on the Romanian inland waterways accounted for 29.4 million tonnes and 8,195 million tonne-km, much higher than the new EU member states achieved in the same year: 1.1 million tonnes in the Czech Republic, 8 million tonnes for Hungary and Slovakia, and 6.4 million tonnes for Poland¹⁸. This suggests that the greater portion of inland waterway traffic in Romania starts and ends within the country.

The Romanian figures are much lower when compared to other EU member states: 134.6 million tonnes in Belgium, 351.6 million tonnes in Holland, and 249 million tonnes in Germany¹⁸. This is a matter of the size and capability of the networks, and the availability of large volumes of appropriate cargo.

Air transport

In terms of air transport, The Aeronautical Information Publication (AIP) lists a total of 21 aerodromes on the territory of Romania. Fifteen of these airports currently carry out scheduled flight operations:

- Bucharest – Henri Coandă – classified as major international airport;
- Constanța/Mihail Kogălniceanu - classified as strategic international airport due to its use by NATO;
- Craiova, Timișoara, Iași, Cluj-Napoca – classified as international hubs;
- Sibiu, Bacău, Târgu Mureș, Suceava, Tulcea, Baia Mare, Oradea - classified as regional airports

¹⁸ EUROSTAT website, <http://ec.europa.eu/eurostat/web/transport/data/main-tables> (accessed in October 2017)

- Satu Mare, Arad - classified as small regional airports

In some cases, these planned services can not be provided throughout the year, but only in certain seasons.

Four airports operate under the authority of the Ministry of Transport (Henri Coandă - the main airport in Bucharest, Baneasa - Bucharest, Traian Vuia from Timisoara and Mihail Kogalniceanu in Constanta), the other airports being subordinated to the local authorities. Of the 21 aerodromes published in AIP Romania, three are privately owned (Tuzla, Sibiu-Măgura and Vatra Dornei).

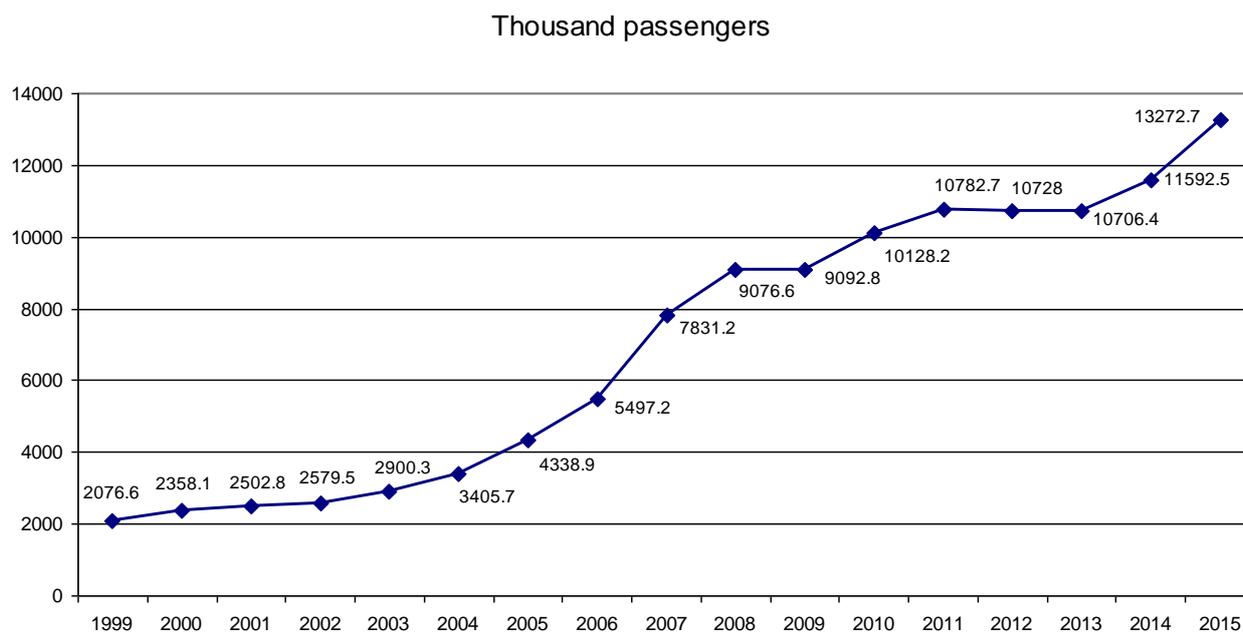
The location of the key Romanian airports is shown on the following map.



Source: <https://intrebari-si-raspunsuri.ro/aeroporturi-romania/>

Figure II_G_6 Operating airports Romania, in 2015

The number of air passengers during 1999 and 2015 is presented in the following figure.



Source: National Institute of Statistics, Statistical Yearbook of Romania 2016

Figure II_G_7 Commercial air transport, 1999-2015

The number of air passengers in Romania increased constantly from 4.3 million to 13.3 million during 2005 ÷ 2015. Of the approximately 13 million passengers, about 7 million transited the Henri Coanda International Airport in Bucharest¹⁹.

The volume of transported goods (freight and mail) increased from 20,226 tonnes to 34,320 tonnes during the same period. Romanian airfreight market is not significant in terms of volume and is largely served by the Henri Coanda Airport gateway that handles around 80% of all air cargo in Romania.

The transport sector is one of the most important sectors both from the point of view of energy consumption and environmental implications. Transport sector development is done in tightly correlation with socio-economic development of Romania.

II. H. Industry

In the period 1990 - 2005 were carried out actions of restructuring and privatization of industrial enterprises. Undertakings that hadn't any market or couldn't handle economic competition had ceased their business. After 2008 due to the global economic crisis, some undertakings had ceased their business because of marketplace lack (metallurgical enterprises, heavy machinery businesses, etc.).

After 1989 year, the Romania economy had experienced a structural adjustment. Thus, in 2000 the industry, agriculture and constructions have contributed by 46.43% to the formation of Gross Value Added against 67.8% which was the contribution thereof in 1990. We remark a relative continuous course of increase of contribution of the services sector as against the other economic branches until the 2005 year. In Table II_12 shows the evolution of the GVA per activities sectors for the period 2000 – 2015. We remark that in the economic-development period of 2000 - 2007 the industry and agriculture sectors reduced their contribution to Gross

¹⁹ EUROSTAT website, <http://ec.europa.eu/eurostat/web/transport/data/main-tables> (accessed in October 2017)

value added as against the construction and services sectors. This direction is not kept in the crisis period. Taking into account the macroeconomic structures of the EU countries, which suffered a long restructuring process, we can conclude that, after the crisis, the direction of decrease of industry and agriculture contribution and GVA formation will be kept, but in lower measure.

Table II_ 12 Contribution of different activities to GDP growth within 2000-2015 [%]

Indicator	2000	2005	2010	2015
TOTAL GVA, out of which:	100	100	100	100
Industry	29.02	28.10	31.85	27.10
Agriculture	12.06	9.52	6.40	4.70
Constructions	5.35	7.39	10.24	6.60
Services	53.57	54.99	51.51	61.60

The main sectors of the Romanian economy are: industry, energy, construction, agriculture, tourism, communications (internet, mobile and landline phone), commerce, trade and public sector.

Romania's main industries are: textiles and footwear, metallurgy, light machinery and assembly of machinery, mining, wood processing, building materials, chemical, food and oil extraction and refining. Pharmaceutical industry, heavy machinery and household appliances have a steady annual growth. Currently, the car industry is very wide and oriented towards the market. Romania's economic power is focused primarily on the production of goods by small and medium enterprises, in industries such as precision machinery, motor vehicles, chemicals, pharmaceuticals, household appliances and clothing.

Romania's economic power is concentrated primarily on the production of goods by small and medium-sized enterprises, in industries such as precision machinery, motor vehicles, chemicals, pharmaceuticals, household appliances and clothing.

The evolution of Romania different industrial branched depends on the economic development of entire country and the area policies adopted within EU, as well as on the socio-economic context at world level. In the Table II_13 the evolution of the industrial contribution to GVA formation during 2000 - 2014 is presented and one should mention that the procession industry has the main share (approx. 80%). Important contributors to the GVA formation are the food industry, the industry of beverages and tobacco products (approx. 22-25%), industry of transportation (approx. 11%), energy industry (approx. 11-13%), and metallurgy industry (approx. 8%).

Table II_ 13 Evolution of the contribution of different industrial branched to GVA formation

Indicator	2000	2005	2008	2009	2010	2014
Total GVA	100	100	100	100	100	100
Mining and quarrying	7.98	5.32	4.38	4.90	5.84	3.08
Manufacturing, out of which:	80.68	86.09	85.41	82.22	76.26	82.76
- Food industry, manufacture of beverage and of tobacco products	24.57	28.52	27.12	26.88	25.44	21.91
- Manufacture of textiles, clothes and leather goods	8.15	10.66	8.55	7.79	9.79	9.41
- Manufacture of wood and of the paper and polygraph goods	9.44	8.22	7.44	7.66	7.16	4.89
- Manufacture of coke and refined of petroleum products	3.78	5.85	4.66	3.49	1.46	15.47
- Manufacture of chemicals and chemical products	6.08	4.06	2.96	2.51	1.48	2.77
- Manufacture of basic pharmaceutical products and pharmaceutical preparations ^{*(included in subcategory above)}	0.00	*	0.98	1.45	0.27	0.88
- Manufacture of rubber and plastic products and of other	0.00	7.70	9.58	8.65	4.50	7.13

Indicator	2000	2005	2008	2009	2010	2014
non-metallic mineral products						
- Manufacture of basic metals and fabricated metal products	7.48	8.69	10.03	7.97	10.56	8.67
- Manufacture of computers, electronic and optical products	12.26	6.54	3.76	4.36	7.54	2.85
- Manufacture of electric equipment ^(included in subcategory above)	0.00	*	4.17	4.16	4.93	4.80
- Manufacture of machinery and equipment n.e.c.	0.00	5.06	3.60	3.72	3.96	4.72
- Transport equipments industry	4.21	9.90	12.37	16.56	14.77	9.23
- Other manufacturing activities n.e.c.,	4.73	4.79	4.78	4.78	8.15	7.25
Electricity, gas, steam and air conditioning production and supply	10.00	8.59	8.21	10.16	12.93	11.17
Waste supply, sewerage, waste management and decontamination activities	1.35	0.00	2.00	2.71	4.98	2.98

Source: National Institute of Statistics, Statistical Yearbook of Romania 2016

II. I. Waste

Waste management is one of Romania's current issues. The integrated approach in waste management concerns waste collection, transport, treatment, capitalization and disposal activities and it includes the construction of waste disposal subsystems, together with measures on the prevention of their generation and recycling, in accordance with the hierarchy of principles: preventing waste generation and the negative impact thereof, waste recovery through recycling, reuse and the safe disposal of waste, when recovery is no longer possible.

The responsibility for the waste management activities shall fall with the generators thereof, in accordance with the "polluter pays" principle, or, as appropriate, with the producers, in accordance with the "producer responsibility" principle.

Each type of waste generated on the country's territory shall be formally classified into one of the following categories:

- Municipal waste;
- Industrial waste;
- Waste generated from medical activities.

Municipal waste represents the totality of waste generated in the urban and rural environment by households, institutions, commercial units, businesses (household waste and similar), street waste collected from public spaces, streets, parks, green areas, building-demolition waste generated in households and collected by sanitation operators and sludge from the purification of municipal wastewater.

The Table II_14 presents the evolution of the amount of municipal waste generated during 2010-2014.

Table II_ 14 The amount of municipal waste generated during 2010-2014

	2010	2011	2012	2013	2014
Total municipal waste generated, out of which:	6,343.144	5,216.162	5,044.121	5,070.805	4,956.075
1. waste generated and uncollected (estimated)	1,250.112	857.650	1,056.687	828.564	687.985
2. municipal waste collected, out of which:	5,093.032	4,358.513	3,987.432	4,242.24	4,268.091
- household waste collected in the mixture and separately	3,367.325	2,955.517	2,654.525	2,817.947	2,900.695
- similar waste collected in the mixture and separately	1,176.870	917.794	852.591	874.591	902.144
- waste from gardens and parks	123.514	100.700	95.223	97.204	70.134
- market waste	81.773	90.024	71.270	61.330	54.170
- street waste	343.550	294.478	313.823	391.168	340.948

Source: Ministry of Environment, National Environmental Protection Agency, National Plan for Waste Management

Municipal waste management entails their collection, transportation, capitalization and disposal, including monitoring the storage facilities after closure.

The responsibility for managing municipal waste belongs to the local public authorities who, directly or by concession of the sanitation service to an authorized service provider must insure the collection, selective collection, transportation, treatment, capitalization and final disposal of the waste.

In Romania, storage represents the main municipal waste disposal option. According to NEPA data, in 2014, the recycling rate was about 5% and the composting rate of about 8%.

In 2016, at national level, 50 waste storage facilities were in operation: 35 waste storage facilities conforming to the directive's storage requirements and 15 non-conforming waste storage facilities that will stop storage activity in 2016 or 2017.

The evolution of the storage facilities' in Romania is presented in the Table II_15.

Table II_ 15 Number of Storage Facilities in Romania during the period 2010-2016

Facilities – year	2010	2011	2012	2013	2014	2015	2016
Conforming facilities	27	30	30	32	34	34	35
Non-conforming depth storage facilities	40	70	49	49	49	49	15
Non-conforming surface storage facilities	35						

Source: National Environmental Protection Agency

Conforming waste storage facilities are built and operated based on the operational and technical requirements and measures for the storage of waste with the purpose of preventing or reducing to as great an extent as possible negative effects on the environment (surface water, groundwater, soil and air) and on population health based on GD no. 349/2005 on waste storage, the Order of the Ministry of the environment and water management no. 757/2004 to approve the Technical norm regarding the storage of waste and GEO no. 78/2000 concerning the status of waste, with subsequent changes and additions.

According to the data reported by NEPA, the quantity of wastes deposited in 2014 in the wastes deposits was of approximately 3,557,627 t.

The waste recycling and reuse trends in Romania during the period 2010-2014 are presented in the following tables.

Table II_ 16 Waste recycling, 2010-2014

Waste type	2010		2011		2012		2013		2014	
	tons	%	tons	%	tons	%	tons	%	tons	%
Glass	91,031	56.8	83,790	60	106,192	66.3	73,67	49.2	89,103	54.2
Plastic	79,391	28,2	112,460	40.3	152,852	51.3	149,940	51.7	149,769	44.5
Paper	177,636	66.8	191,990	65.5	211,698	69.8	232,580	74.6	323,556	83.4
Metal	36,267	65.7	34,410	62.3	32,398	55.5	28,732	52.8	42,147	64.2
Wood	38,451	18.1	73,390	32.5	98,660	41.4	71,902	28.9	77,071	26.6
Other	0	0	0	0	0	0		0	0	0
Total recycling	422,776	43.4	496.040	50	601,800	56.8	556,621	52.8	681,646	54.8

Source: National Environmental Protection Agency, National Plan for Waste Management

Table II_ 17 Waste reuse, 2010-2014

Waste type	2010		2011		2012		2013		2014	
	tons	%								
Glass	91,031	56.8	83,790	60	106,192	66.3	73,467	49.2	89,103	56
Plastic	86,945	30.9	120,370	43.2	154,778	51.9	158,218	54.5	155,353	51.4
Paper	194,751	73.2	199,340	68.0	212,648	70.2	239,745	76.9	325,024	83.8
Metal	36,267	65.7	34,410	62.3	32,398	55.5	28,732	52.8	42,147	55.5
Wood	62,033	29.3	101,950	45.2	102,696	42.8	73,886	29.7	90,680	30.9
Other	0	0	0	0	0	0	0	0	0	0
Total reuse	471,027	48.3	539,860	54.4	608,712	57.4	574,048	54.4	702,307	56.4

Source: National Environmental Protection Agency, National Plan for Waste Management

As concerns the depositing of municipal wastes, in 2016, 15 non-compliant deposits for municipal wastes were operating that will end their activity during period 2016-2017 according to the negotiated calendar (annex to the Government Decision 349/2005 concerning wastes' depositing – transposing the European Directive 99/31/EC concerning wastes' depositing). For the other non-compliant municipal wastes still in their transition period (until 2017), it is currently performed the improvement of operation and monitoring activities.

According to the negotiations for Romania's adherence to the EU provided in the Adhesion Treaty, Romania is obliged to ensure the gradual decrease of wastes deposited in these municipal deposits of non-compliant wastes, by observing certain maximum annual quantities.

Biodegradable waste

Most part of the total amount of municipal waste, is represented by domestic and biodegradable waste (around 72%), and approximately 45% of it is represented by biodegradable waste. These come from both households and from economic agents, commercial areas, offices, public institutions, hospitals, as well as from public areas (parks, public gardens, markets, streets).

Table II_18 presents the data on amounts of municipal waste generated (including amounts of estimated waste generated but uncollected) and amounts of waste collected by means of special services of town halls or sanitation companies in 2014, compared to 2013. The table also shows data on biodegradable waste generated.

Table II_ 18 Amounts of waste generated and collected (including biodegradable waste) in 2014 compared to 2013

Types of waste	Amount of waste - mil. tons/year	
	2013	2014
Total municipal waste generated, out of which:	5.07	4.95
- Biodegradable waste	3.93	3.84

Analysing data presented in the table above one should observe a decrease of the total amount of municipal and biodegradable waste generated on national level in 2014 compared to 2013, of about 17%, as well as a decrease of the amount of biodegradable waste.

In Romania, waste incineration is not a common practice for the treatment/ disposal of the municipal and assimilated waste. So far, in Romania there were not put into operation incineration installations for municipal waste.

The amount generated of medical waste in 2013 is 26,645 t and in 2014 is 22,158 t. According to NAPP, the amount of hazardous industrial waste managed in 2014 is 301,500 t, out of which 228,460 tons are recovered and 73,040 tons eliminated.

During the year 2016, the following plants for the incineration of hazardous industrial waste were in operation:

- 6 incineration / co-incineration plants belonging to 6 private industrial operators, which incinerate / coincide with their own hazardous waste;
- 12 existing installations for the incineration of hazardous waste belonging to private operators incinerating for third parties;
- 7 co-incineration plants in cement kilns - authorized for the treatment of solid and liquid hazardous waste.

Industrial waste

The waste from the processing industry is only a small part eliminated, the majority of the generated non-hazardous waste being recovered. In 2014, weight of non-hazardous waste was about 6% of the waste generated by the manufacturing industry.

Disposal of non-hazardous waste is carried out either in its own landfills or in landfills authorized for landfilling for disposal from third parties as well as in municipal landfills.

According to the NAPM database, currently 13 non-hazardous waste deposits belonging to the economic operators in the manufacturing industry are in operation.

Non-hazardous wastes generated during 2010 – 2014 by the main economic activities excluding waste from mining industry are shown in the following table.

Table II_ 19 Non-hazardous waste generated by main economic activity, with the exception of the mining industry, during 2010 – 2014

Quantity (tons/year)					
	2010	2011	2012	2013	2014
Extractive industry					
Total waste	175,303,735	195,711,915	223,090,321	218,661,298	182,493,266
Non-hazardous waste	175,265,251	195,678,141	222,993,681	218,532,915	182,375,085
Manufacturing industry					
Total waste	3,777,704	4,248,032	3,244,528	3,802,836	4,408,486
Non-hazardous waste	3,657,204	4,162,602	3,195,731	3,734,953	4,344,891
Production and supply of electricity and heat, gas, water and air conditioning					
Total waste	5,813,275	6,502,799	9,013,526	6,894,308	9,871,205
Non-hazardous waste	5,813,236	6,502,798	9,013,526	6,893,986	9,871,205

Quantities of hazardous waste generated by the main industrial activities during 2010 - 2014 are presented in the following table.

Table II_ 20 Hazardous waste generated by main economic activity during 2010 – 2014

Thousand tons

The economic activity	2010	2011	2012	2013	2014
Extractive industry	38.48	33.77	97.03	128.39	118.18
Processing, production and supply of electric and thermal energy	304.72	170.76	229.46	191.65	163.48
Total	343.2	204.53	326.48	320.04	281.67

Medical Waste

Every year, the Ministry of Health, through the National Institute of Public Health Bucharest, issues a National overview called "Monitoring and inspection of the management system for waste generated from medical activities" and updates the national database on waste generated from medical activities. This is part of the National program for monitoring determining factors in life and work environments, i.e. Objective 1 - Protecting health and preventing diseases associated with environmental risk factors.

The amount of hazardous waste resulting from medical activity generated in 2015 is 7.72 ktone / year equal to that recorded in 2014.

II. J. Building stock and urban structure

Constructions were the economic sector that suffered the most during the economic crisis. If in 2008 the construction sector represented 11% of GDP and 52 billion lei current prices, in 2014 it represented 6.3% of GDP and 19 billion lei current prices²⁰. However, in the latest years this sector is showing signs of recovering. Between January and November 2015, the construction sector increased by 9.4% (gross series), marking the best evolution since 2008.

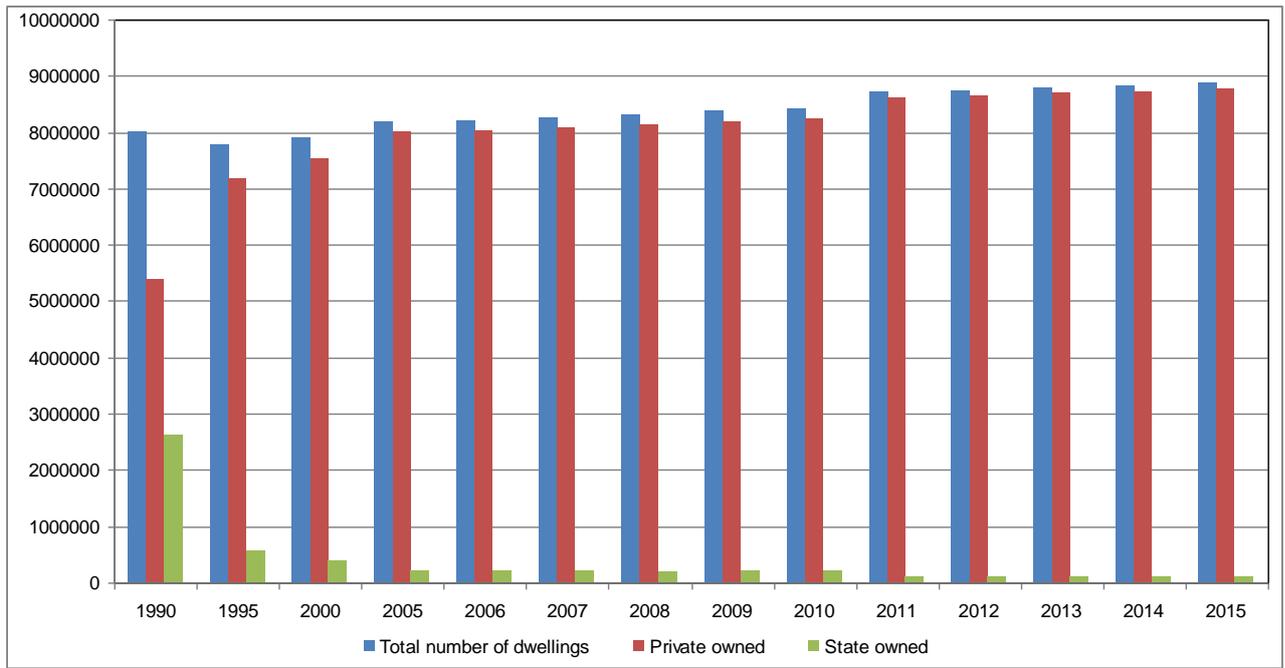
According to the National Institute of Statistics (INS) the following figures have been registered in 2015²⁰:

- Households: 7,470 thousand units;
- Dwellings: 8,882 thousand units;
- Living area 21: 416,870,412 sqm (55.16% in urban area).

In figures II_J_1, II_J_2, II_J_3 the evolution of the number of dwellings, living floor in the dwellings and finished dwellings, by areas, during the period 1990-2015 are presented.

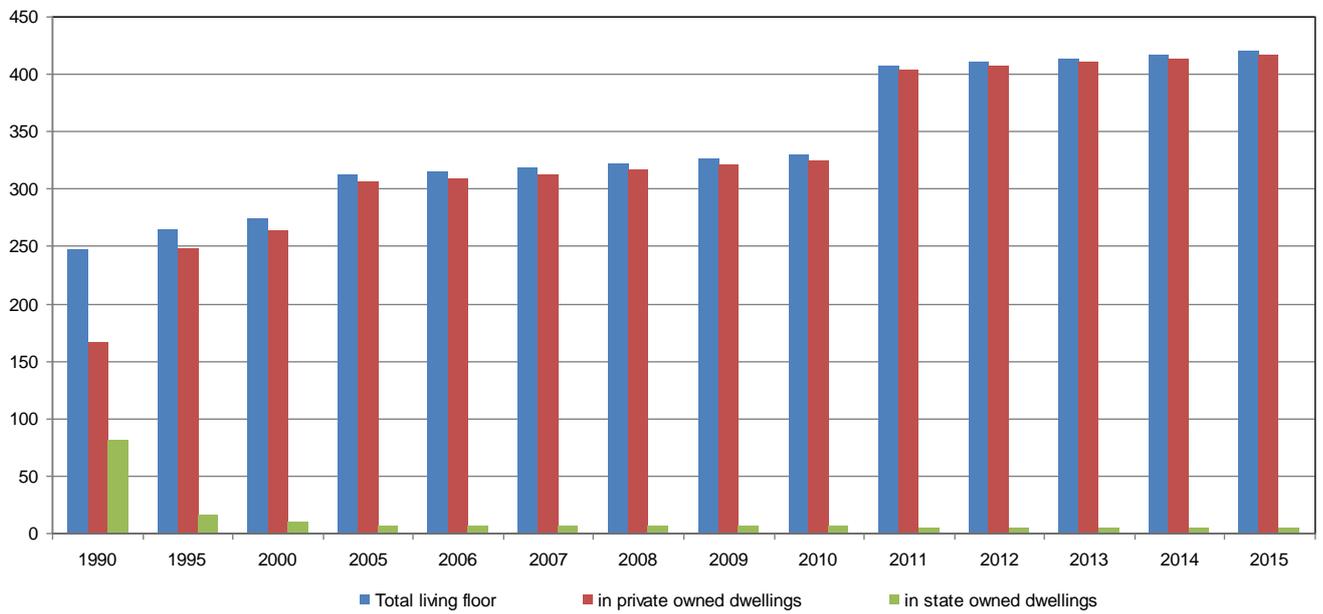
20 National Institute of Statistics, Statistical Yearbook of Romania 2016

21 Living area is the total useful area of rooms for living, i.e. except the area of bathrooms, kitchens/kitchenettes, deposit areas and hallways



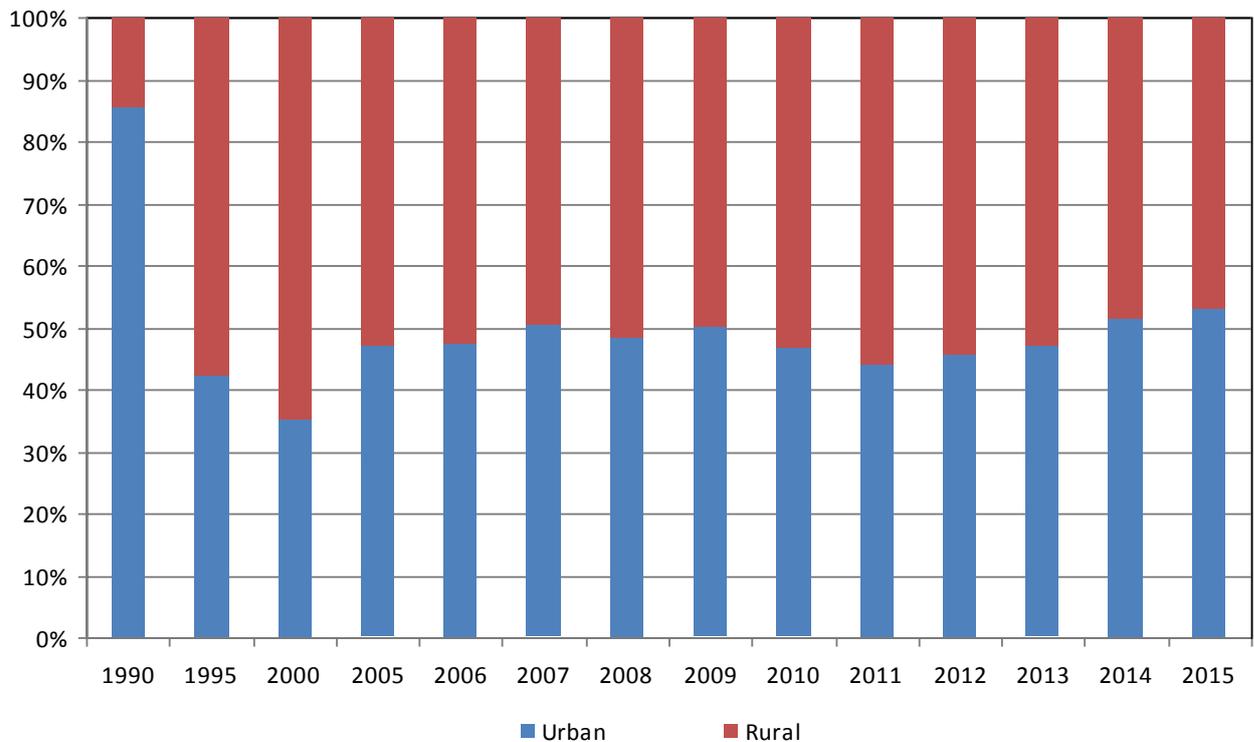
Source: National Institute of Statistics, Statistical Yearbook of Romania 2016

Figure II_J_1 Number of dwellings



Source: National Institute of Statistics, Statistical Yearbook of Romania 2016

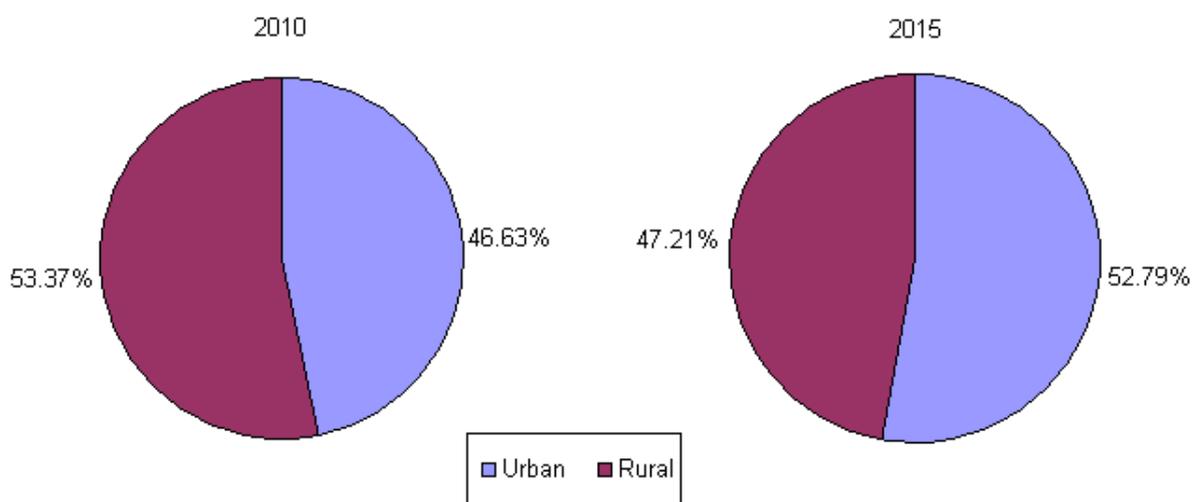
Figure II_J_2 Living floor in dwellings, mill.m²



Source: National Institute of Statistics, Statistical Yearbook of Romania 2016

Figure II_J_3 Finished dwellings by area of residence [%]

New houses were built both in the urban and rural areas with a trend of accelerating this process in the urban areas. The average annual new build rate has shown an increase of about 6% in the urban area (Figure II_J_4) and is characterized by a major share of private funding.



Source: National Institute of Statistics, Statistical Yearbook of Romania 2016

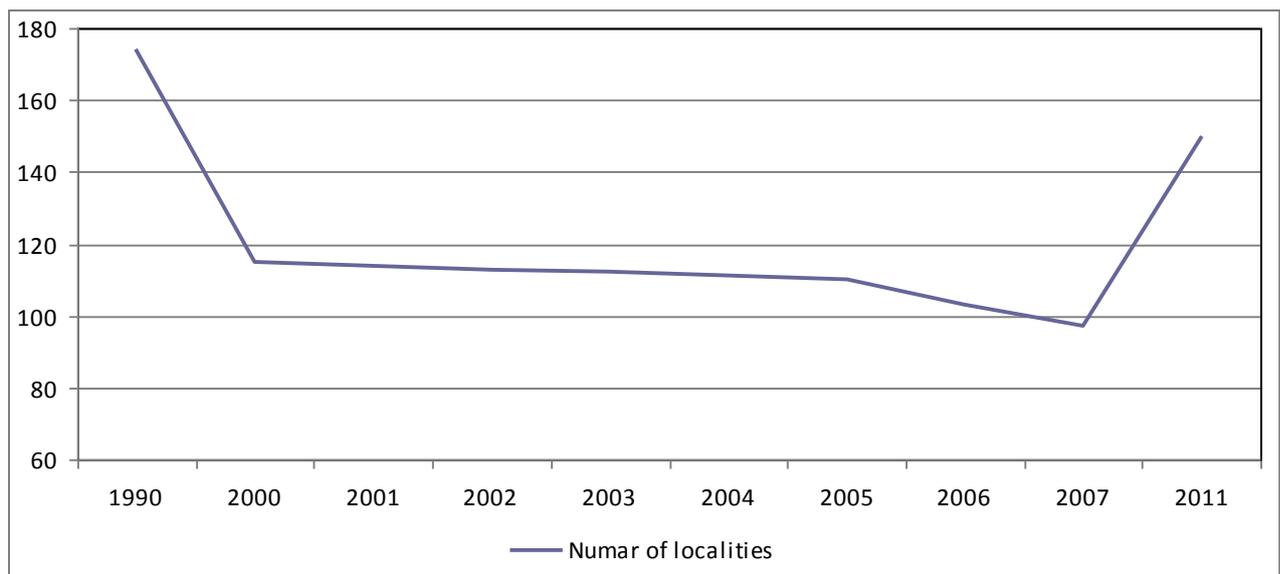
Figure II_J_4 Finished dwellings - year 2010 compared to year 2015 - by area of residence

The insulation level of building envelope for residential building stock (built mainly before 1990) is very low. The modernization of existing building stock is made both by private funding (owners) and public funding (through national rehabilitation programs). For residential buildings two thermal rehabilitation programs are active: one established by Government Emergency

Ordinance (GEO) no. 18/2009 applied for block of flats built in the period 1950-1990 and the other one established by GEO no. 69/2010 for all residential buildings.

In terms of utilities, almost all new houses benefit from all the required utilities. Figures II_J_5, II_J_6, II_J_7, II_J_8 are presenting the evolution of the number of localities with public transport services, drinking water supply installations, public sewerage installations and natural gas distribution network during the period 1990-2015. It can be noticed that the level of investments has increased in these areas leading to the increasing of the living standards.

Local public transport of passengers has steadily declined since 1990. In the period 2000 – 2005, the number stabilized between 115 and 110, but in 2007 it decreased at 97, starting to increase again reaching at 150 in 2011 (in the urban area 101 localities and 49 localities in the rural area). (Figure II_J_5).



Source: National Institute of Statistics, Statistical Yearbook of Romania 2016

Figure II_J_5 Number of localities with public transportation services

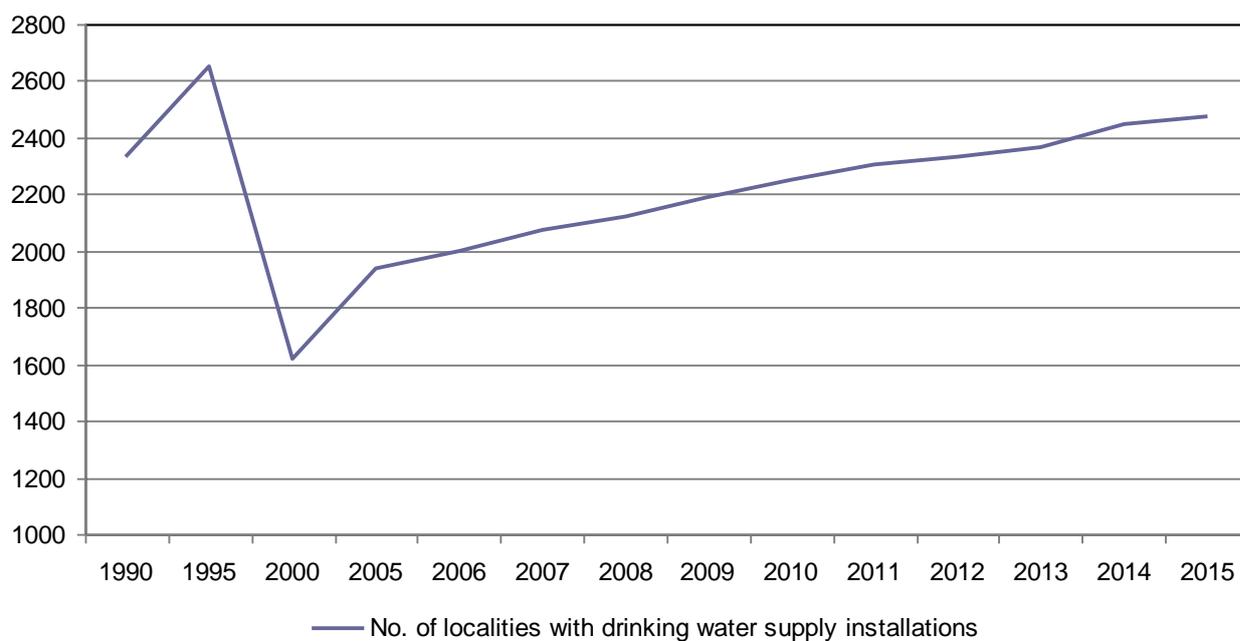
At the same time, the length of the simple line for public transport infrastructure (tram and trolleybus) recorded the same downward trend between years 2000 and 2013, simple line length decreasing by 14% for trams and by 56% for trolleybuses.

The number of vehicles had a different evolution; the number of trams and trolleybuses has been steadily declining (34% decline for trams, respectively 38% for trolleybuses, during 2000-2015), while the number of buses and minibuses increased by about 10% between 2000 and 2009, followed by a decrease of 18% in the next 6 years.

It is expected to have a growth in the GHG emission levels in the cities due to the fact that transport by trams and trolleybuses actioned by electricity has been so much reduced and partially replaced by bus and minibus transport using gasoline.

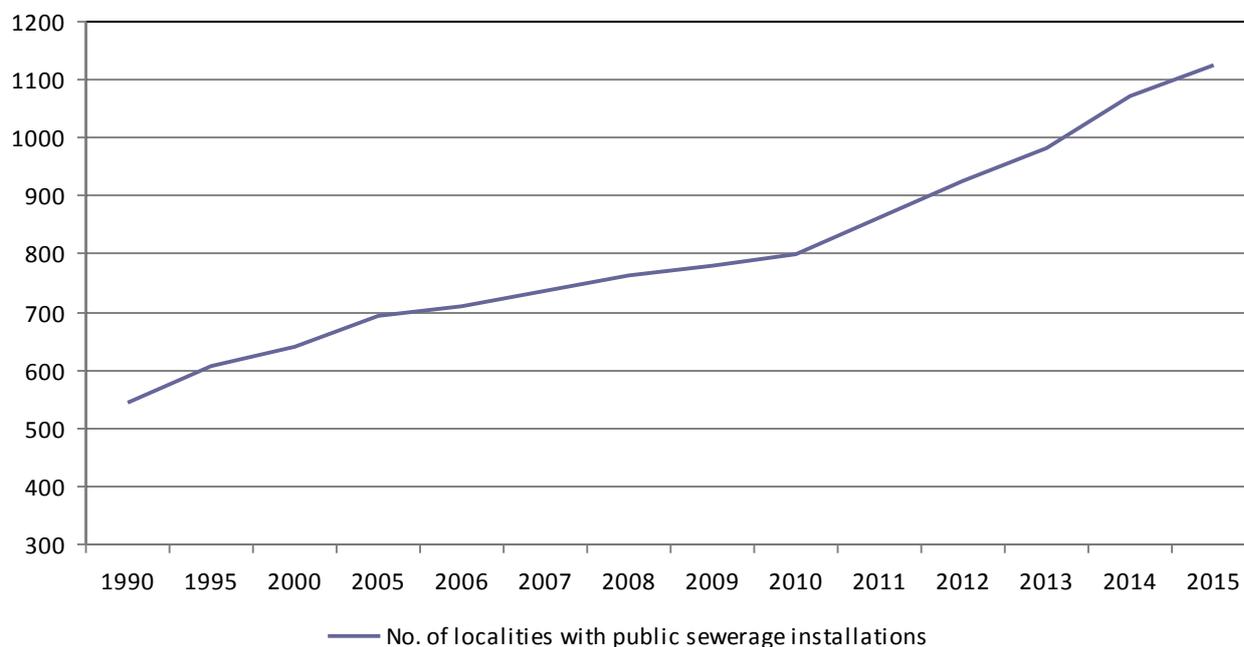
The subway, transport facility specific to Bucharest, the Romanian capital, has registered limited positive evolution during 2000-2015, both in terms of length of railways (about 6%) and vehicles in inventory (about 9%). However, due to the fact that at present there is an increasingly larger numbers of passengers to transport, it is necessary to construct new subway lines for the decongestion of the surface traffic and the development of a sustainable transport.

There are large discrepancies between rural and urban areas in terms of public transportation services that are provided 33% of villages in rural areas, compared to 67% in urban areas.



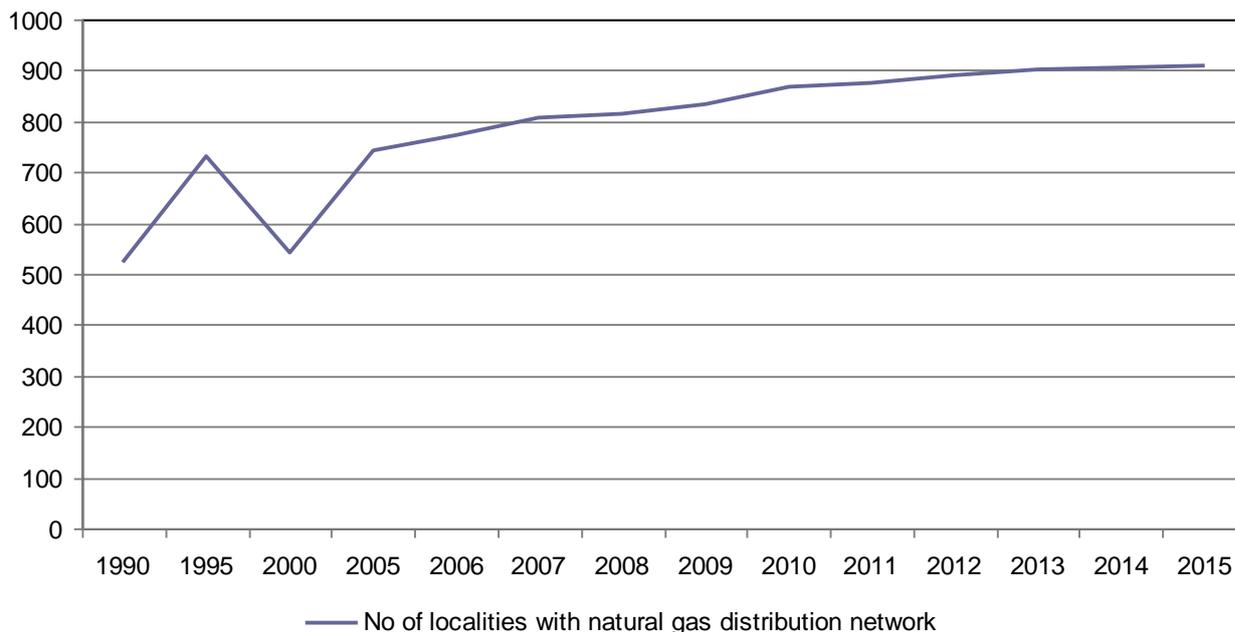
Source: National Institute of Statistics, Statistical Yearbook of Romania 2016

Figure II_J_6 Number of localities with drinking water supply installations



Source: National Institute of Statistics, Statistical Yearbook of Romania 2016

Figure II_J_7 Number of localities with public sewerage installations



Source: National Institute of Statistics, Statistical Yearbook of Romania 2016

Figure II_J_8 Number of localities with natural gas distribution network

II. K. Agriculture

Agriculture is an important sector in the Romanian economy contributing during 2005 - 2014 with 4 – 10 % of GDP, depending on the year and climatic conditions. Although agriculture was collectivized by the government in 1949, a land reform program instituted in 1991 returned more than 80% of the country's agricultural land to nearly 5.5 million small farmers.

In 2014 Romania had a total agricultural surface of 14,630 thousand hectares, of which 64.2% was available for agriculture. Pastures and hayfields had also an important share (22.4%, respectively 10.6%). Vineyards and orchards, including nurseries accounted for the remaining 2.8% of agricultural surface. Table II_21 presents the evolution of the Romanian arable land by the usage type for the period 2000 – 2014.

Table II_21 Agricultural area trend, 2000-2014 (thou. hectares)

	2000	2005	2010	2011	2012	2013	2014
Agricultural land	14,856.8	14,741.2	14,634.4	14,621.4	14,615.1	14,611.9	14,630.1
Arable	9,381.1	9,420.2	9,404.0	9,379.5	9,392.3	9,389.3	9,395.3
Pastures	3,441.7	3,364.0	3,288.7	3,279.3	3,270.6	3,274.0	3,272.2
Meadows	1,507.2	1,514.6	1,529.6	1,554.7	1,545.0	1,541.9	1,556.3
Vineyards and vine nurseries	272.3	224.1	213.6	211.3	210.5	210.3	209.4
Orchards and fruit tree nurseries	254.6	218.2	198.6	196.7	196.8	196.5	196.9

Source: National Institute of Statistics, Statistical Yearbook of Romania 2016

The Romanian agricultural surface decreased slightly from year to year. Transfer of land to forestry and building sector was the main cause of reducing agricultural area in the past 20 years.

The main crops on arable land are:

- Cereals for grains (wheat, rye, barley, maize etc.);
- Dried legumes (peas, dried beans);

- Roots crops (potatoes, sugar beet, fodder roots);
- Industrial crops (fiber crops, oilseed crops, etc.);
- Vegetables (tomatoes, dry onion, dry garlic, cabbage, green peppers, melons);
- Green fodder from arable land.

Their production between 2000 and 2015 is presented in Table II_ 22.

The production of fruit consists of: plums, apples, pears, peaches, cherries, apricots, nuts, strawberries, etc. The fruit production decreased by 35% in the last 10 years.

Table II_ 22 Dynamics of vegetal agricultural production between 2000 and 2015 (thou. tons)

	2000	2005	2010	2011	2012	2013	2014	2015
Cereal grains	10,477.5	19,345.5	16,712.9	20,842.2	12,824.1	20,897.1	22,070.7	19,332.8
Oil plants	868.5	1,803.1	2,377.7	2,686.9	1,667.6	2,966.6	3,460.6	2,975.2
Potatoes	3,469.8	3,738.6	3,283.9	4,076.6	2,465.2	3,289.7	3,519.3	2,699.7
Vegetables	2,527.8	3,624.6	3,863.6	4,176.3	3,535.3	3,961.0	3,802.5	3,673.5
Fruits	1,301.0	1,647.0	1,419.6	1,479.9	1,128.6	1,300.0	1,301.4	1,224.7

Source: National Institute of Statistics, Statistical Yearbook of Romania 2016

Below are presenting the livestock in farms and the animal production during the period 2000-2015.

Table II_ 23 Livestock in farms during the period 2000 - 2015 (thou. heads)

	2000	2005	2010	2011	2012	2013	2014	2015
Cattle	2,870.4	2,861.7	2,001.1	1,988.9	2,009.1	2,022.4	2,068.9	2,092.4
Pigs	4,797.4	6,622.3	5,428.3	5,363.8	5,234.3	5,180.2	5,041.8	4,926.9
Sheep	7,656.8	7,611.0	8,417.4	8,533.4	8,833.8	9,135.7	9,518.2	9,809.5
Goats	538.0	686.8	1,240.8	1,236.1	1,265.7	1,313.0	1,417.2	1,440.2
Horses	864.5	834.0	610.9	596.4	574.6	548.2	524.7	503.5
Poultry	70,075.6	86,552.2	80,844.9	79,841.7	80,135.7	79,440.3	75,446.8	78,648.1

Source: National Institute of Statistics, Statistical Yearbook of Romania 2016

Table II_ 24 Animal production in the period 2000 – 2015

Product	UM	2000	2005	2010	2011	2012	2013	2014	2015
Meat	live weight	1,447	1,508	1,305	1,357	1,332	1,300	1,316	1,431
Milk	thou hl	51,630	60,614	49,129	50,074	48,337	48,728	50,535	49,156
Wool	mill. pcs.	17,997	18,390	20,457	19,026	19,713	20,719	21,817	22,343
Eggs	tonnes	5,711	7,310	6,199	6,327	6,398	6,388	6,636	6,555
Extracted honey	tonnes	11,746	17,704	22,222	24,127	23,062	26,678	18,040	27,893
Fish	tonnes	17,099	13,352	15,184	11,593	13,443	14,861	15,319	19,601

Source: National Institute of Statistics, Statistical Yearbook of Romania 2016

GHG emissions related to agricultural sector are due to:

- Fuel combustion (CO₂);
- Enteric fermentation (CH₄);
- Manure management (CH₄ and N₂O);
- Rice cultivation (CH₄);
- Agricultural soils (N₂O);

- Field burning of agricultural residues (CH₄, N₂O, NO_x and CO);
- Urea application;
- Liming.

Following the enforcement of the restitution laws in 2010 almost all of the total agricultural surface was privatized. In the present public property fields account for only 0.5% of arable land, 0.7% of pastures total area and 0.2% of meadows total area.

In 2013, from the total 3,563,765 farms, 3,475,052 worked arable land areas between 0.1 and 10 ha, resulting that the average area of arable land of farm was about 3 ha, situating Romania below average size of a European farm. In Romania only 13,075 farms had larger areas than 100 ha, 7,263 farms with areas between 50 and 100 ha, and 68,375 farms with areas between 10 and 50 ha.

Privatization process of arable land generated in Romanian agriculture two structural disadvantages: large area of fields and small farms, and large area of fields owned by farmers at retirement age.

Almost half of the total surface and livestock exist in subsistence farms which diminishes the agriculture sector performance. To strengthen the subsistence farms and make them become viable and competitive restructuring measures are required. Associative actions will play an important role.

II. L. Land use and forestry

II.L.1 Land use

Table II_25 presents the evolution of the land in the period 2000 - 2014 according to the National Institute of Statistics. It results that in 2014 arable areas represented 39.41%, forests 28.25%, pastures and hayfields 20.17%, vineyards and orchards 1.71%, buildings, roads and railroads 4.72%, waters and ponds 3.45% and other areas 2.09% of the total land of Romania.

Table II_25 The evolution of the land fund area during 2000 – 2014 (thou. hectares)

	2000	2005	2010	2011	2012	2013	2014
Total area of the land fund	23,839.1						
Agricultural area	14,856.8	14,741.2	14,634.6	14,590.9	14,615.1	14,611.9	14,630.1
Arable	9,381.1	9,420.2	9,404.0	9,352.3	9,392.3	9,389.3	9,395.1
Pasteures	3,441.7	3,364.0	3,288.8	3,277.7	3,270.6	3,273.9	3,272.2
Hayfields	1,507.1	1,514.7	1,529.6	1,553.5	1,544.9	1,541.9	1,536.3
Vineyards and vine nurseries	272.3	224.1	213.6	211.3	210.5	210.3	209.3
Orchards and tree nurseries	254.6	218.2	198.6	196.1	196.8	196.5	196.9
Forests and other forest vegetation lands	6,457.3	6,742.8	6,758.1	6,800.9	6,746.9	6,742.1	6,734.0
Forests	6,223.1	6,233.0	6,354.0	6,362.5	6,373.0	6,381.0	6,387.0
Other areas	234.2	509.8	404.1	438.4	-	-	-
Constructions	632.9	657.1	728.3	737.0	752.4	758.3	758.3
Roads and railways	388.2	391.1	388.9	388.8	388.3	389.9	389.8
Waters and ponds	867.8	841.4	833.6	822.7	836.8	836.0	831.5
Others	636.1	465.5	495.6	498.8	499.6	500.9	495.4

II.L.2 Forestry

Romania's national forestry real estate occupies at the end of 2014, an area of 6734 thousands hectares, representing 28.23% of the country surface. At European level, Romania ranks 13 in terms of percentage of afforestation, which is below the EU average of 43.24%.

With about 0.30 ha/capita in terms of forest area related to the number of inhabitants, Romania ranks 10 European level.

The spread of forest over the country territory is uneven (10.9% at the plains, 37.2% at the hill, 51.9% at the mountain).

In the plains, successive deforestation linked to land improvement sector underfunding has led to more and more frequent and prolonged drought. Cutting forest in hill and mountain areas it correlates with torrential phenomena, of erosion and land degradation.

In accordance with Law 46/2008 of Forest Code there are 15 counties considered poor areas in forest in which the forest area is under 16% of the total. This per cent ranges from 4.0% in Calarași to 15.7% in Ilfov.

The main priority is the implementation of the National Programme of expanding forest areas, to reduce the impact of climate change and the risk of desertification, especially in areas with deficient in forests, to improve the surface leakage and diminish the risk of floods, landslides, erosion, lakes warping.

III. GREENHOUSE GAS INVENTORY INFORMATION, INCLUDING ON NATIONAL SYSTEM AND NATIONAL REGISTRY

This chapter presents information on 2017 (last) submission of Romania's National GHG Inventory (NGHGI) of anthropogenic greenhouse gas emissions, submission to the UNFCCC Secretariat. The national greenhouse gas emissions/removals estimates were calculated for the period 1989-2015. The results are presented for every year of the analysed period and include also information on: trend analysis, data sources, key categories, uncertainties, and quality assurance and quality control (QA/QC) activities. The 2017 submission comprise the CRF Reporter database, CRF Tables and the National Inventory Report (NIR).

As a Party to the Convention, Romania is required to develop and regularly to update the National GHG Inventory. The last NGHGI for the period 1989–2015 was compiled according to the recommendations for GHG inventories set out in the Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of Decision 14/CP. 11 (FCCC/CP/2013/10/Add.3), using IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006) as well as associated support documents (2013 Revised Supplementary Methods and Good practice Guidance Arising from the Kyoto Protocol; 2013 Supplement to the 2006 Guidelines for the National Greenhouse Gas Inventories: Wetlands).

The last NGHGI submission covers the obligation of Romania under the UNFCCC. It also constitutes Romania's voluntary submission under the Kyoto Protocol. The inventories cover all sectors and the majority of the IPCC source categories. The direct GHG (including groups of gases) included in the national inventory are:

- Carbon dioxide (CO₂);
- Methane (CH₄);
- Nitrous oxide (N₂O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs);
- Sulphur hexafluoride (SF₆);
- Nitrogen trifluoride (NF₃).

The report also contains data on calculations of emissions of the indirect GHGs: NO_x, NMVOC, CO and SO₂, which should be included according to the reporting guidelines. GHG emissions inventories have been reported since the 2005 submission using the CRF Reporter software, delivered by the UNFCCC Secretariat. The last NGHGI refers to figures generated using the 6.0.1.1 version of the CRF Reporter.

The GHG inventories submitted annually by Parties are subject to reviews by expert review teams (ERT), coordinated by the UNFCCC Secretariat. Up to now, the GHG inventories of Romania were reviewed as follows:

Table III_1 Information on reviews of the Romanian NGHGIs coordinated by the UNFCCC Secretariat

Year	Submission	Review process
2002	CRF tables and draft NIR submitted (late submission)	No Review
2003	CRF tables and NIR submitted	In - country Review
2004	CRF tables and NIR submitted	Desk Review
2005	CRF Reporter database, CRFs for LULUCF and NIR submitted	Centralized Review
2007	2 nd version of the 2006 submission: CRF Reporter database, CRF Tables and NIR + Initial Report of Romania under the Kyoto Protocol	In - country Review
2008	2007 and 2008 submissions: CRF Reporter database, CRF Tables and NIR	Centralized Review
2009	2009 submission: CRF Reporter database, CRF Tables and NIR	Centralized Review

Year	Submission	Review process
2010	2010 submission: CRF Reporter database, CRF Tables and NIR	Centralized Review
2011	3 rd version of the 2011 submission	In - country Review
2012	2 nd version of the 2012 submission	Centralized Review
2013	1 st version of the 2013 submission	Centralized Review
2014	1 st version of the 2014 submission	Centralized Review
2016	2 st version of the 2015, 2016 submissions	Centralized Review

The ERT's reports following these reviews can be found on the UNFCCC website.

III. A. Summary tables

Summary tables on emission trends by gases and by sectors are presented, using the common reporting format, for 1989-2015, in the Annex 3.1 and 3.2.

III. B. Descriptive Summary

III. B. 1. Overall GHG emissions trends

The total GHG emissions in 2015, excluding removals by sinks, amounted to 116,426.73 Gg CO₂ equivalent.

According to the provisions of the Kyoto Protocol, Romania has committed itself to reduce the GHG emissions by 8% in the period 2008-2012 comparing to the base year 1989. The total GHGs emissions (without considering sinks) decreased with 61.36 % in the period 1989-2015, and the net GHG emissions (taking into account the CO₂ removals) decreased with 65.55 % in the same period (Figure III_B_1). Based on these observations, there is a great probability for Romania to meet the commitments to reduce the GHG emissions in the first commitment period 2008-2012.

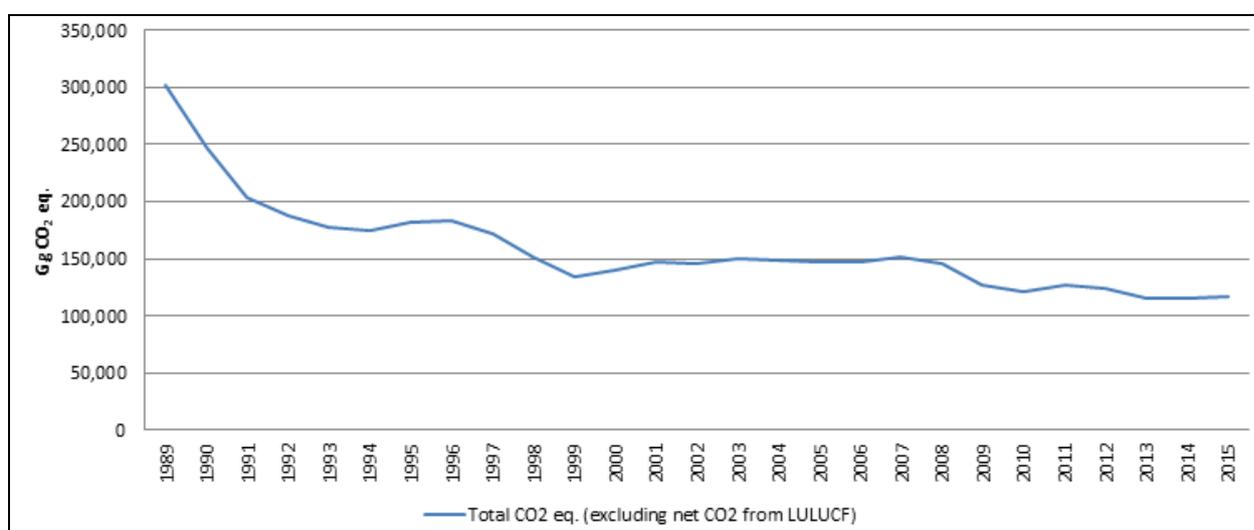


Figure III_B_1 Total GHG emissions in CO₂ equivalent during 1989-2015 period

The emissions trend reflects the changes in this period characterized by a process of transition to a market economy and by financial/economic crisis (Figure III.B.2).

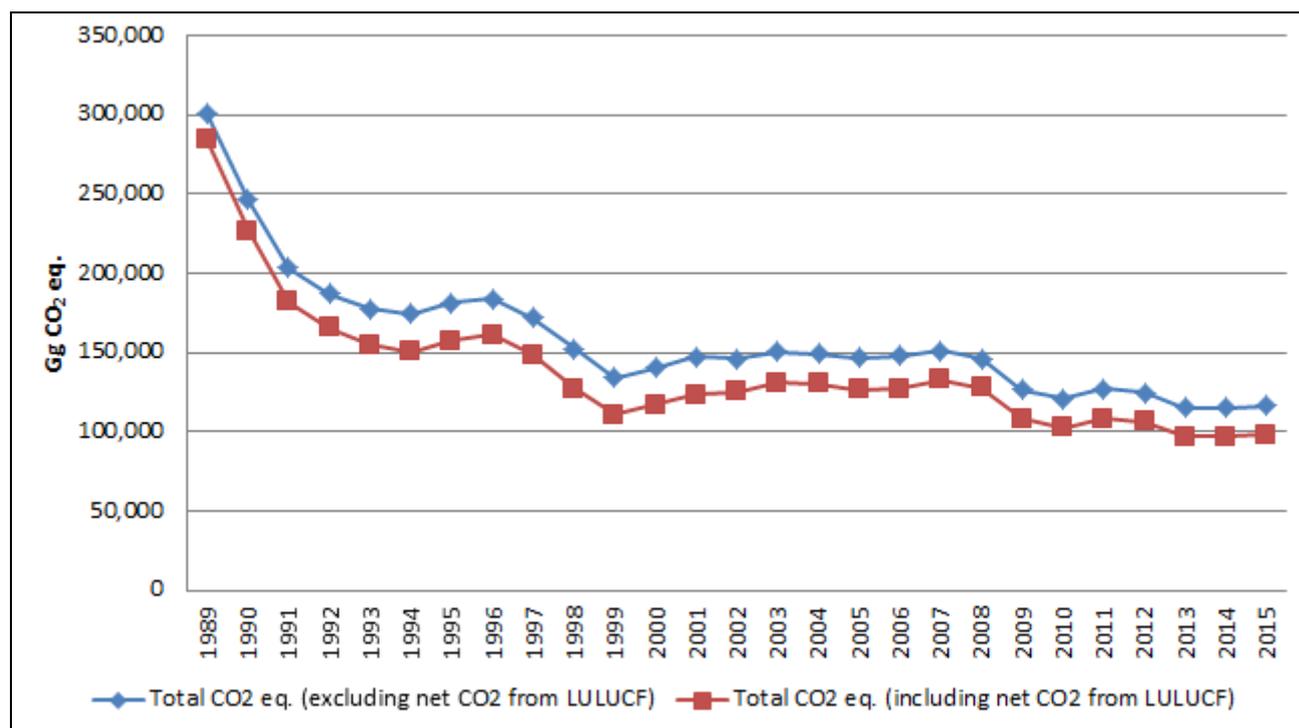


Figure III_B_2 Trends of the aggregated GHG emissions

The emissions trend reflects the changes in this period characterized by a process of transition to a market economy. The emissions trend can be split in three parts: the period 1989-1999, the period 2000-2007 and the period 2008-2015. The decline of economic activities and energy consumption in the period 1989-1992 had directly caused the decrease of the total emissions in that period. With the entire economy in transition, some energy intensive industries reduced their activities and this is reflected in the GHG emissions reduction. Emissions have started to increase until 1996, because of the economy revitalization. Considering the starting of the operation of the first reactor at the Cernavoda nuclear power plant (1996), the emissions decreased again in 1997. The decrease continued until 1999. The increased trend after 1999 reflects the economic development in the period 2000-2007. The limited decrease of GHG emissions in 2005, compared with 2004 and 2006 levels was caused by the record-breaking hydrological year positively influencing the energy produced in hydropower plants. Due to the economic crisis, the emissions have significantly decreased in 2010 comparing with 2008; the trend of GHG emissions during the period 2010-2015 was relative constant.

III. B. 2. Emissions/removals trends by gas

All GHG emissions, except HFCs and SF₆, decreased comparing with the base year. The shares of GHG emissions have not significantly changed during the period. The largest contributor to total GHG emissions is CO₂, followed by CH₄ and N₂O. In the base year, the shares of GHG emissions (excluding LULUCF) were: 69.12 % CO₂, 23.29 % CH₄, 6.11 % N₂O, 1.48 % PFCs; the HFCs and SF₆ are negligible (0.16 Gg CO₂ eq. for HFCs and 0.47 Gg CO₂ eq. for SF₆). In 2015, the shares of GHG emissions (excluding LULUCF) were: 67.00 % CO₂, 25.42% CH₄, 6.12 % N₂O, 1.46 % HFCs, PFCs and SF₆. The F gases started to be used as substitutes for ODS in refrigerating and air conditioning systems since 1995. In 2015, the contribution of these gases to the total GHG emissions was minor: 1.41% HFCs, 0.01 % PFC

and 0.04 % SF₆. Next graphic presents the trend of the aggregated emissions, split by gas (Figure III-B-3 excluding/ including LULUCF).

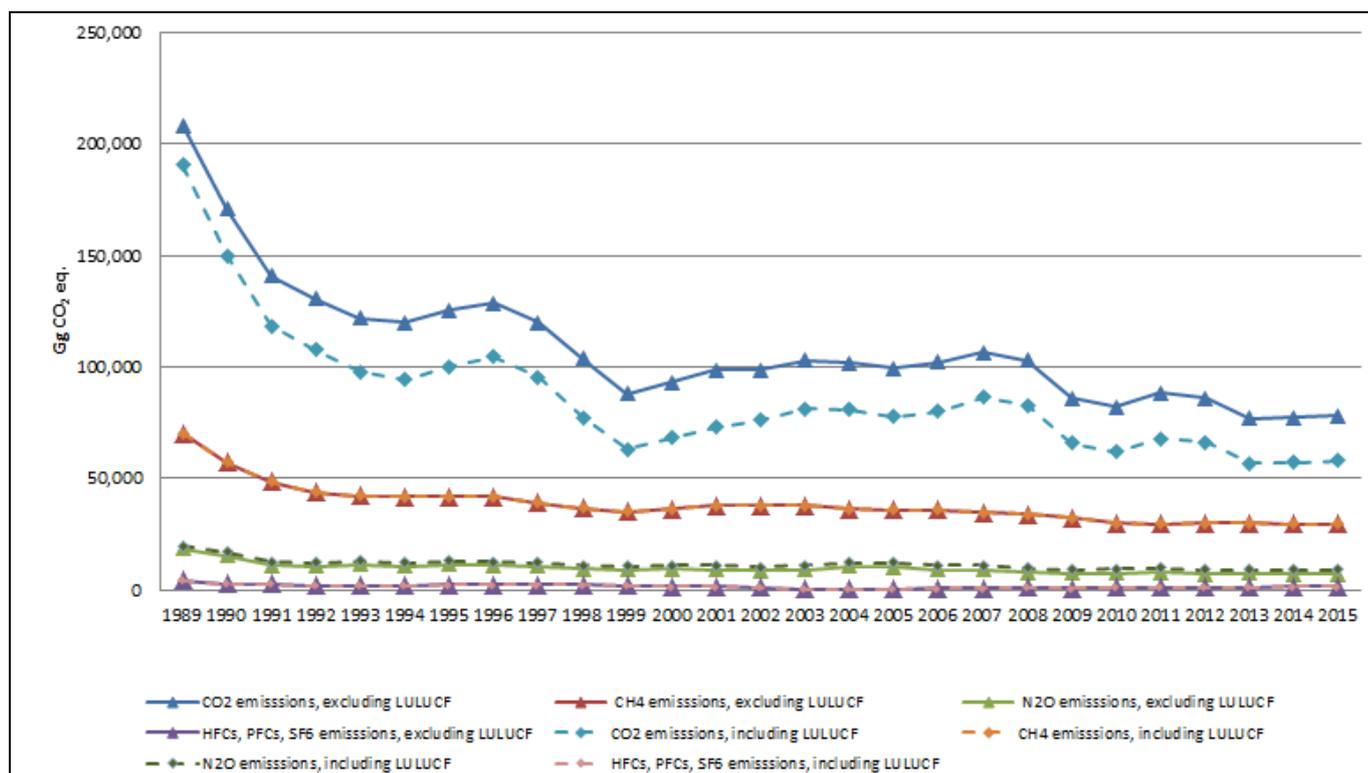


Figure III_B_3 Trends by gas (GHG emissions excluding/ including LULUCF)

Carbon dioxide (CO₂) – the most significant anthropogenic greenhouse gas is the carbon dioxide. The decrease of CO₂ emissions (from 208,314.33 Gg CO₂ eq. in 1989 to 78,013.49 Gg CO₂ eq. in 2015) is caused by the decline of the amount of fossil fuels burnt in the energy sector (especially in the public electricity and heat production, and manufacturing industries and constructions sectors) as a consequence of activity decline.

Methane (CH₄) – the methane emissions, related mainly to the Fugitive emissions from fossil fuels extraction and distribution and to the livestock, decreased in 2015 by 57.84 % compared with the levels in 1989 (from 70,195.76 Gg CO₂ eq. in 1989 to 29,592.00 Gg CO₂ eq. in 2015). The decrease of CH₄ emissions in Agriculture is due to the decrease of the livestock level.

Nitrous oxide (N₂O) – the N₂O emissions are mainly generated within the Agricultural Soils activities in the Agriculture sector and within the Chemical industry activities in the Industrial Processes and Product use sector. The decline of these activities (decline of livestock, decline of N synthetic fertilizer applied on soils amounts, decrease of the crop productions level) is reflected in the N₂O emissions trend. The N₂O emissions in 2015 decreased with 61.28 % in comparison with the level in the base year.

Fluorocarbons and SF₆ (HFCs, PFCs, SF₆) – the F-gases started to be used as substitutes for ODS in refrigerating and air conditioning systems since 1995; therefore the emissions resulted as a consequence of the use of these substances and are estimated beginning with the same year. In 2015, the PFCs emissions generated in the production of the primary aluminium have decreased with 99.85 %.

III. B. 3. Emissions/removals trends by sector

According with Romania's most recent inventory submitted to the UNFCCC in 2017, the evolution of GHG emissions/removals by sectors during 1989 - 2015 period, expressed in Gg CO₂ equivalent are presented in the following figure.

In 2015, in term of GHG emissions, the Energy sector has the biggest share – 81.59 %, followed by the Agriculture sector with 18.96 % and Industrial Processes and Product use with 12.09 %.

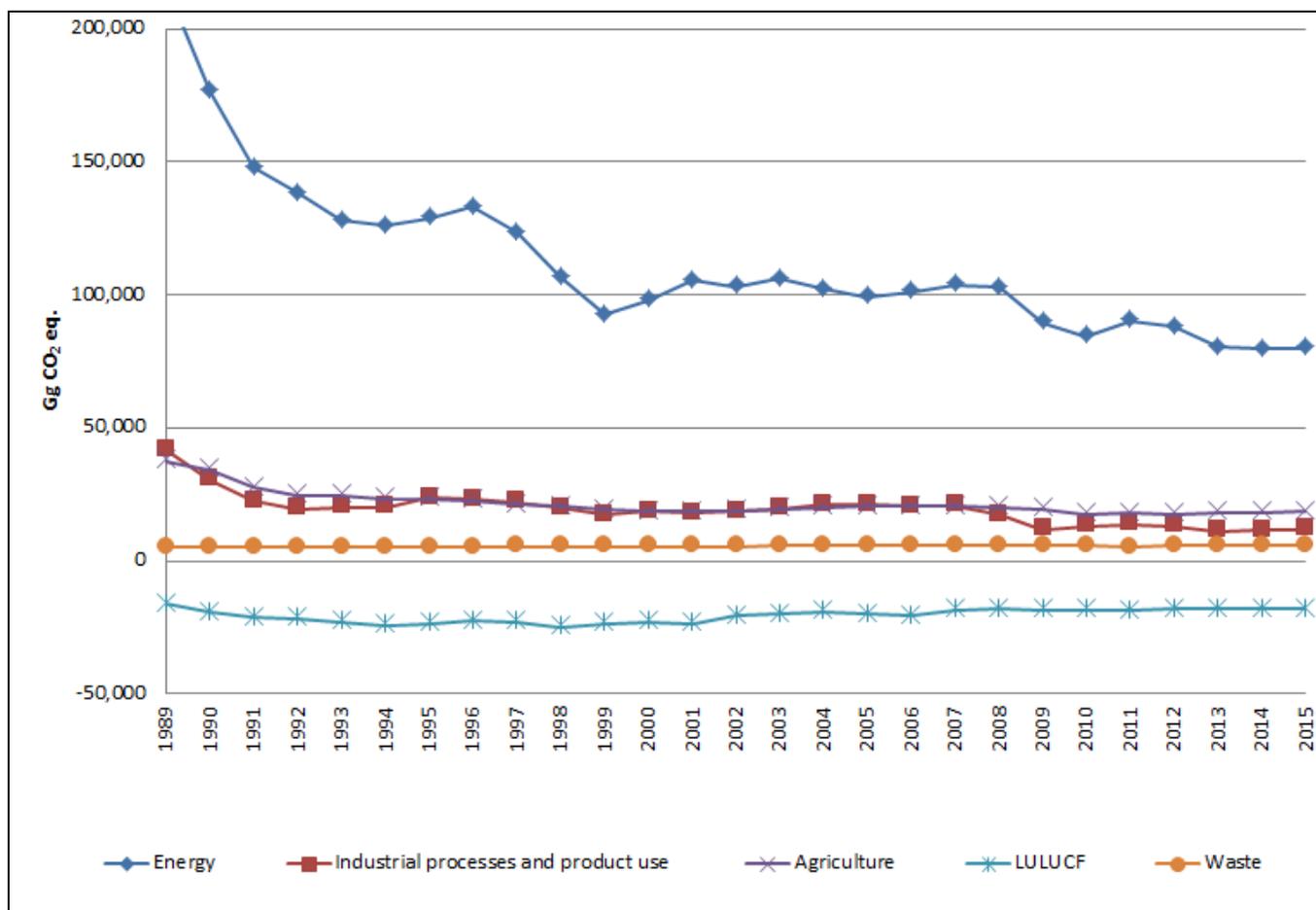


Figure III_B_4 Trends by sector

Energy represents the most important sector in Romania. In 2015, the GHG emissions (excluding LULUCF) from the Energy sector decreased by 63.07 % compared to the base year; the main reason for decreasing the GHG emission trend in Energy sector is the transition to a market-based economy, which led to a sharp drop in electricity production demand from power plants.

Industrial Processes and Product use contributes to total GHG emissions (excluding LULUCF) with 12.09 %. A significant decrease of GHG emissions was registered in this sector (71.61 % decreases in 2015 compared to the level in 1989) due to the decline or the termination of certain production activities.

For the Agriculture, the GHG emissions have also decreased. The GHG emissions (excluding LULUCF) in 2015 are 50.38 % lower in comparison with the 1989 emissions due to:

- the decline of livestock;
- the decrease of rice cultivated area;
- the decrease of crop productions level;
- the decline of N synthetic fertilizer applied amounts.

In 2015, 18.96 % of the total GHG emissions (excluding LULUCF) resulted from the agriculture sector.

For the *LULUCF*, the The net GHG removals/emissions level is 18.6 % higher in 2015 in comparison with the level in the base year. The Romanian land use sector acts as a net sink, at an average uptake of 20,531.11 Gg/year, being relatively stable over the last 27 years.

For the *Waste* sector, the total GHG emissions (excluding LULUCF) have significantly increased in 2015 with 13.78 % in comparison with the level in 1989, due to the increase of population consumption in parallel with the increase of living standards. The contribution of the waste sector to the total GHG emissions (excluding LULUCF) in 2015 is 5.95 %.

The participation of the sectors to GHG emissions (including LULUCF) is presented in the next figure.

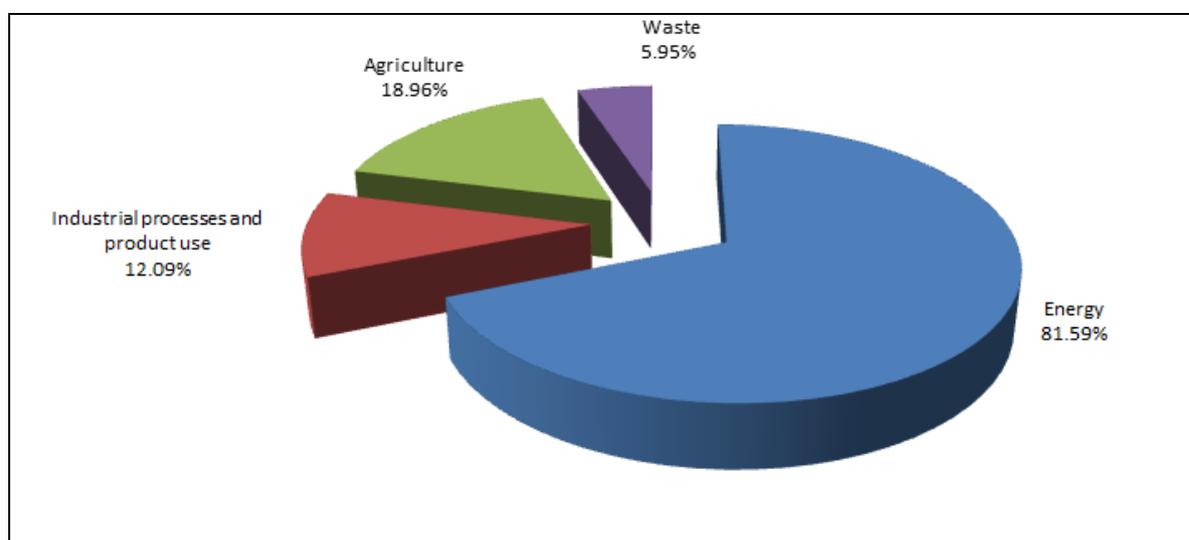


Figure III_B_5 Sectoral GHG emissions in 2015

III. B. 4. Description and interpretation of emissions/ removals trends

Energy

According to IPCC the following categories are included in the Energy Sector:

- 1.A.1. Energy industries;
- 1.A.2. Manufacturing Industries and Construction;
- 1.A.3. Transport;
- 1.A.4. Other sectors (commercial/institutional, residential, agriculture/ forestry/ fisheries);
- 1.A.5. Other (stationary, mobile);
- 1.B. Fugitive Emissions from Fuels.

Compared to the other GHG emissions sectors (Industrial Processes and Product use, Agriculture, LULUCF, Waste), the Energy sector represents the largest source of anthropogenic GHG emissions in Romania. In 2015, the Energy sector was responsible for about 81.59 % of the total GHG emissions 80,098.16 Gg CO₂ eq. (excluding LULUCF) (Figure_III_B_5).

The emissions trend reflects the changes in this period characterized by a process of transition to a market economy (Figure_III_B_6 și Figure_III_B_7).

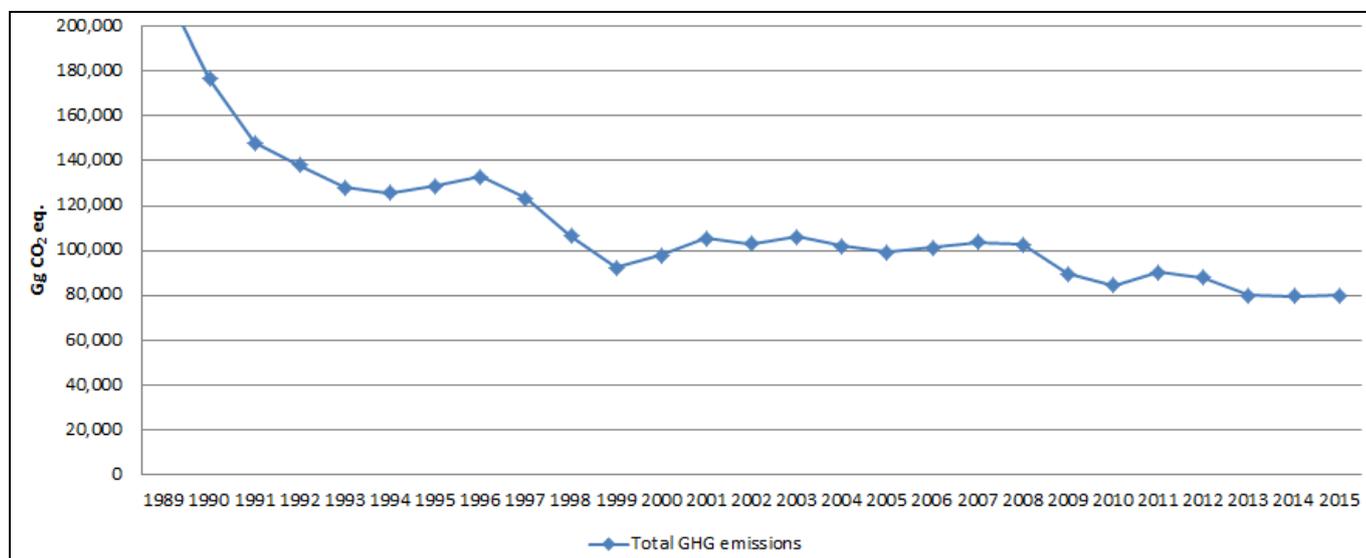


Figure III_B_6 Overall emissions/ removals trend for Energy Sector

The emissions trend can be split in two parts: the period 1989-1996 and the period 1996-2004. The decline of economic activities and energy consumption in the period 1989-1992 had directly caused the decline in total emissions in that period. With the entire economy in transition, some energy intensive industries reduced their activities and this is reflected in the GHG emissions reduction.

Emissions have started to increase until 1994, because of economy revitalization. Considering the starting of the operation at the first reactor at the Cernavoda nuclear power plant (1996), the emissions started to decrease again. The decrease continued until 1999. The increased trend after 1999 reflects the economic development in the period 1999 - 2004.

At the end of 2007, the second unit of the Cernavoda nuclear plant was functioning, therefore the decrease in emission trend is not very noticeable; for 2008-2010 it was noticed a slight tendency of decrease of emissions due to the economic crisis that had affected entire Europe.

In 2015, emissions from the Energy sector have decreased by 63.07 % (80,098.16 Gg CO₂ eq. compared to 216,894.83 Gg CO₂ eq. in 1989, base year).

The trend of GHG emissions between 1989 and 2015, was defined by a substantial decrease of emissions from energy use in Manufacturing Industry and Construction (81.72%) followed by Other (81.39%) and by Fugitive Emissions from Fuels (71.6%), as well as a clear increase of emissions from Transport (41.3%) (Figure III_B_7).

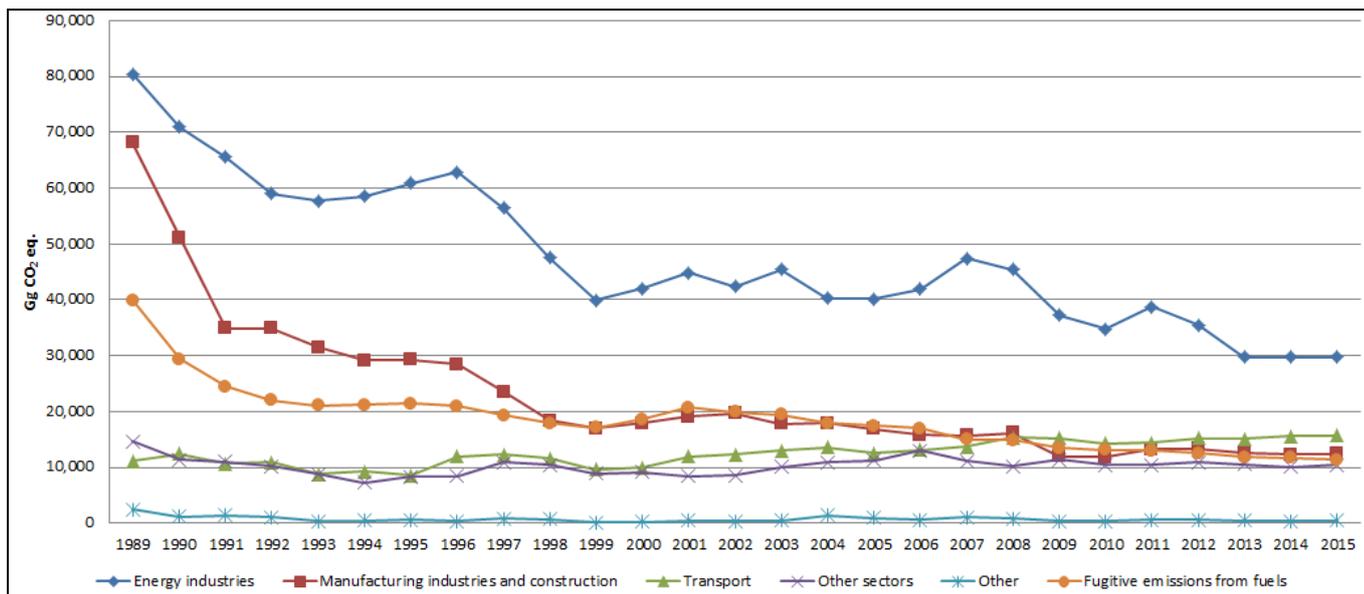


Figure III_B_7 Energy sub-sectors emission/ removals trend for the period 1989-2015

In 2015, GHG emissions from the Energy industries have decreased by 63.08 %, 29,721.92 Gg CO₂ eq. compared to 80,496.44 Gg CO₂ eq. in 1989 (base year) as a result of transition to a market-based economy, which led to a sharp drop in electricity production demand from power plants.

GHG emissions from the Manufacturing Industries and Construction have decreased by 81.72%, from 68,141.68 Gg CO₂ eq. in 1989 (base year) to 12,455.94 Gg CO₂ eq. due to the decrease of several productions levels.

Transport sub-sector have registered an increment of 41.3 % of GHG emissions, 15,730.41 Gg CO₂ eq. compared to 11,132.73 Gg CO₂ eq. in 1989, base year.

GHG emissions from the Other Sectors sub-sector have decreased by 29.30 %, from 14,678.79 Gg CO₂ eq. in 1989, base year to 10,378.38 Gg CO₂ eq. while those from Other sub-sector have decreased by 81.39 %.

GHG emissions from the Fugitive Emissions from Fuels sub-sector have decreased by 71.6 %, 11,350.48 Gg CO₂ eq. compared to 39,967.51 Gg CO₂ eq. in 1989, base year.

Shares of GHG emission categories within the Energy sector, in 2015 are presented in the following figure:

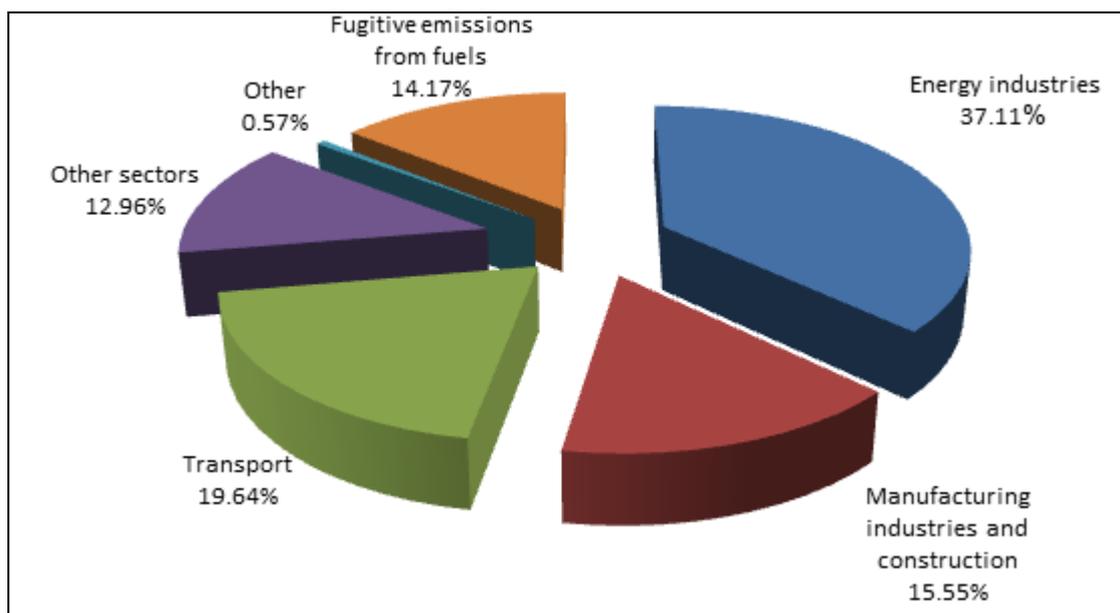


Figure III_B_8 Shares of GHG emission categories within the Energy sector, in 2015

Industrial processes and Product Use

In this sector are considered only the process related emissions. According to IPCC 2006, GHG emissions from Industrial processes and Product use (IPPU) are grouped in the following Sub-sectors:

- 2.A Mineral products;
- 2.B Chemical industry;
- 2.C Metal Industry;
- 2.D Non-energy products from fuels and solvent use;
- 2.E Electronic industry;
- 2.F Product uses as substitutes for ODS (ozone depleting substance);
- 2.G Other product manufacture and use;
- 2.H Other.

The direct GHG emissions reported in this sector are CO₂, CH₄, N₂O, HFCs, PFCs and SF₆.

In 2015 the GHG emissions from IPPU sector contributed with 12.09 % to the total GHG emissions in Romania (Figure_III_B_5).

After 1989, total GHG emissions related to IPPU sector began to decrease due to reduced production levels of minerals and metals products and especially in the chemical industry. The evolution of total GHG emissions for this sector in the period 1989-2015 is shown in the following figure.

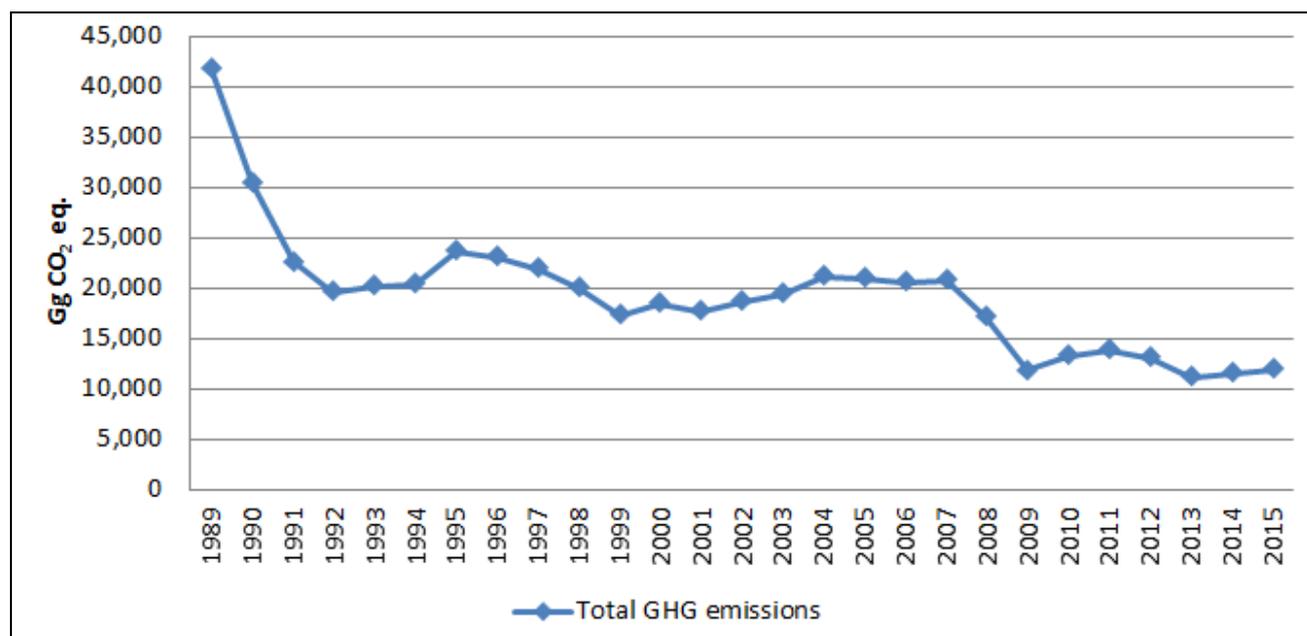


Figure III_B_9 Overall emissions trend for IPPU sector

Total GHG emissions from this sector estimated in 2015 decreased by 71.61 % compared with the estimated values for 1989. The evolution of total GHG emissions between 1989 and 2015 is due to the restructuring and privatization processes carried out in the different industrial sectors.

Starting with 2008, total GHG emissions decreased mainly due to reduction in production levels. In 2009 the emissions had also decreased due to the economic crisis reflected in many activity areas. In 2015, GHG emissions have recorded an increase due to increase of the industrial production levels.

After 1989, there was recorded a decrease within the IPPU sector as a result of decreasing production levels in certain sub-sectors (Chemical Industry, Mineral Industry and Metal Industry):

- After 1989, the production of cement, lime and glass began to decline;
- Starting with 2002, cement production has started to grow slightly; between 2009-2013 production has fallen again due to the economic crisis, followed by a slight increase;
- The lowest level of emissions from ammonia production was recorded in 1998, due to the activity data whose level fell by approximately 50% compared to the previous and next year. This happened as one producing plant has stopped its activity since 1998 and another plant has been closed in 1998 and reopened in the next year;
- Nitric acid production recorded a decrease after 1989, followed by a slight increase since 2010;
- Adipic acid production stopped at the end of 2001 and the activity was permanently suspended since 2002;
- Calcium carbide production recorded a decrease after 1989 and the activity was suspended starting with 2007;
- Iron and steel production recorded a decrease after 1989;
- Ferroalloys production has recorded a decrease after 1989. The lowest level of GHG emissions from this sector was recorded in 1999, as a result of reduced production

levels. Ferroalloys production has stopped in 1999. In the next year (2000) the production was restarted and stopped again during 2013-2015;

- Starting with 2003, the PFC emissions of the aluminium production sector have decreased due to changes in technologies used;
- During 2013-2015, the estimated GHG emissions reflect the decrease in production levels recorded in the Chemical Industry sub-sector.

Between 1989 – 2015, the trend of GHG emissions was defined by a substantial decrease of emissions for the following sectors: Chemical industry (90.52%), Metal industry (79.75 %) followed by Non-energy products from fuels and solvent use (68.96 %) (Figure III_B_10).

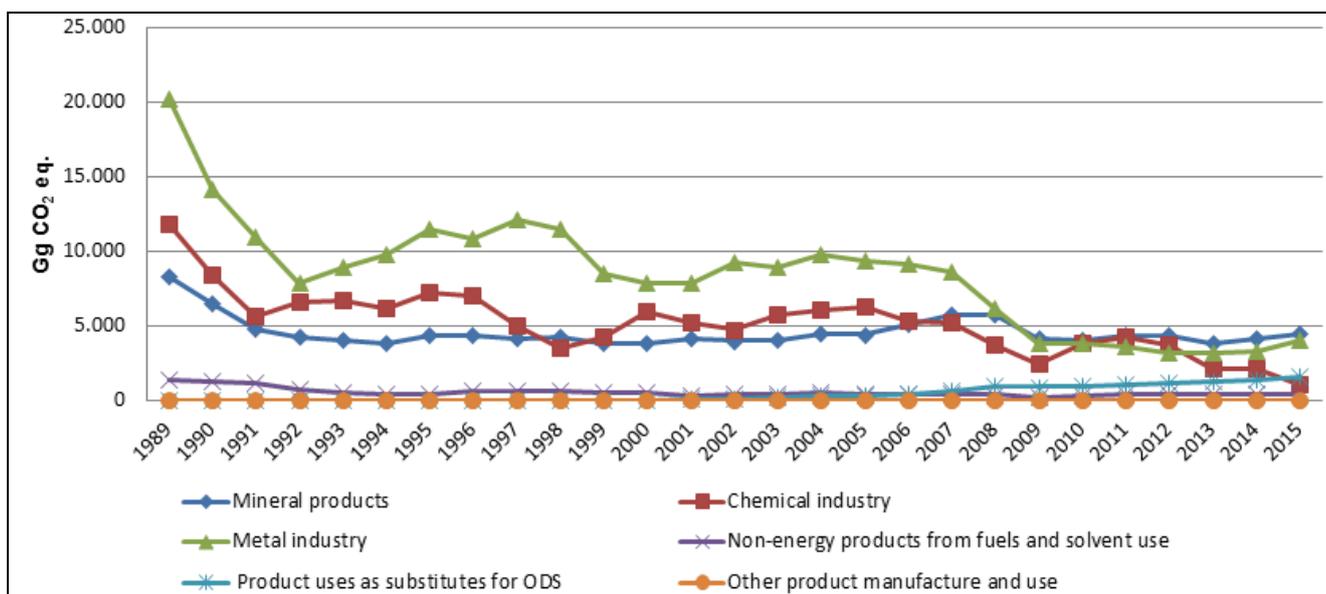


Figure III_B_10 IPPU sub-sectors GHG emission trend for the period 1989-2015

Total GHG emissions of the Mineral Industry sub-sector registered a descending trend during 1989-2011 due to the reduction of the production levels achieved after 1989, namely cement, lime, glass, carbonate consumption; between 1993 and 2007 emissions were relatively constant. Since 2004, cement production has grown slightly. In 2009, GHG emissions decreased significantly as a result of the economic and financial crisis which affected the vast majority of the sectors of activity (cement, lime, glass, carbonate consumption, soda ash use).

In 2015, total GHG emissions from this sub-sector increased due to the rise of production levels for the following categories: Cement Production, Glass Production and use of carbonates in the Ceramic Industry. Mineral Industry sub-sector was responsible for 38.03 % of the IPPU sector related GHG emissions in 2015.

Chemical Industry sub-sector was responsible for 9.45 % of the total GHG emissions from the IPPU sector in 2015. GHG emissions trend in the Chemical Industry sub-sector the changes that occurred between 1989 and 2015, namely:

- Lowest level of emissions from the ammonia production was recorded in 1998 (ammonia production decreased by almost 50% compared to the previous and the next year) due to closing of two producing units in 1998; one of them was reopened the following year (2000);
- Nitric acid production decreased after 1989;

- Adipic acid production had stopped at the end of 2001;
- Carbide production had recorded a decrease after 1989 and it was stopped starting with 2007;
- In 2009 there was a significant decrease in total GHG emissions due to the economic and financial crisis;
- In 2011, total GHG emissions have shown an upward trend, as a result of increasing production levels for certain industrial sectors (ammonia production, nitric acid production, silicon carbide production);
- Between 2012 and 2015, total GHG emissions have shown a downward trend, as a result of decreasing production levels for certain industrial sectors (ammonia production, nitric acid production, silicon carbide production).

The total GHG emissions from *Chemical industry sub-sector* decreased by 90.52 %, from 11,828.92 Gg CO₂ eq. in 1989, base year, to 1,121.87 Gg CO₂ eq. in 2015.

Metal industry sub-sector is responsible for 34.58 % of the total GHG emissions from IPPU sector in 2015. Emissions decreased by 79.75 %, from 20,270.83 Gg CO₂ eq. in 1989, base year, to 4,105.61 Gg CO₂ eq. in 2015.

GHG emissions trend in the Metal industry Sub-sector for 1989–2011 period is due to:

- Iron and steel production recorded decreases after 1989;
- Ferroalloys production has recorded a decrease after 1989. The lowest level of emissions was recorded in 1999 due to the cease of production. In 2000 the production was restarted and stopped again during 2013-2015;
- The reduction of PFC emissions from production of aluminum due to changes in technology starting with 1997 and 2003;
- After 2008, the downward trend in total GHG emissions reflects the reduction of production levels in the sub-sectors: Iron and Steel production and Ferroalloys production;
- In period 2010 - 2014 the emissions trends reflect the decrease in production levels in certain categories (Iron and steel production, Ferroalloys production and Aluminium production sub-sectors);
- In 2015, the total GHG emissions registered an increasing trend that reflects the evolution of various production activities (Iron and steel production, Aluminium production and Zinc production sub-sectors).

Sub-sector *Non-energy products from fuels and use of solvents* is responsible for 3.68% of the total GHG emissions from IPPU sector in 2015.

Total GHG emissions from this sub-sector decreased by 68.96 %, from 1,406,83 Gg CO₂ eq. in 1989, to 436,70 Gg CO₂ eq. in 2015.

The evolution of total GHG emissions in the sub-sector *Non-energy products from fuels and the use of solvents* reflects changes in the structure of the economy between 1989 and 2015.

In the sub-sector *Products used as substitutes for ODS*, during 1989-2015 there is an increasing trend of fluorinated gas emissions from 0.15 kt CO₂eq (1989) to 1,636.76 kt CO₂eq (2015). This trend is maintained for most of the subcategories.

In 2015, emissions from the Air Conditioning and Refrigeration Equipment category (2.F.1.) are responsible for 97.66% of the total 2.F category, the emissions in the Aerosol category (2.F.4)

represent 2.07%, followed by the Foams categories - 2.F.2. (0.25%) and Fire Extinguishing Systems - 2.F.3. (0.02).

The evolution of total GHG emissions from the sub-sector *Products used as ODS substitutes* for the period 1989-2015 are based on PIB growth and legislative changes (the Montreal Protocol, EU Regulation no. 517/2014 on fluorinated greenhouse gases, Directive 2006/40/CE on emissions from air conditioning systems of motor vehicles).

Metal industry contributes with 34.58 % to the total GHG emissions from IPPU sector in 2015 (Figure_III_B_11). Mineral industry and Chemical industry are the two other main contributing sub-sectors with 38.03 % and 9.45 %, respectively, of the total GHG emissions in this sector. The other contributions are: Non-energy products from fuels and solvent use (3.68 %), Product uses as substitutes for ODS (13.79 %) and Other product manufacture and use (0.47 %) (Figure_III_B_11).

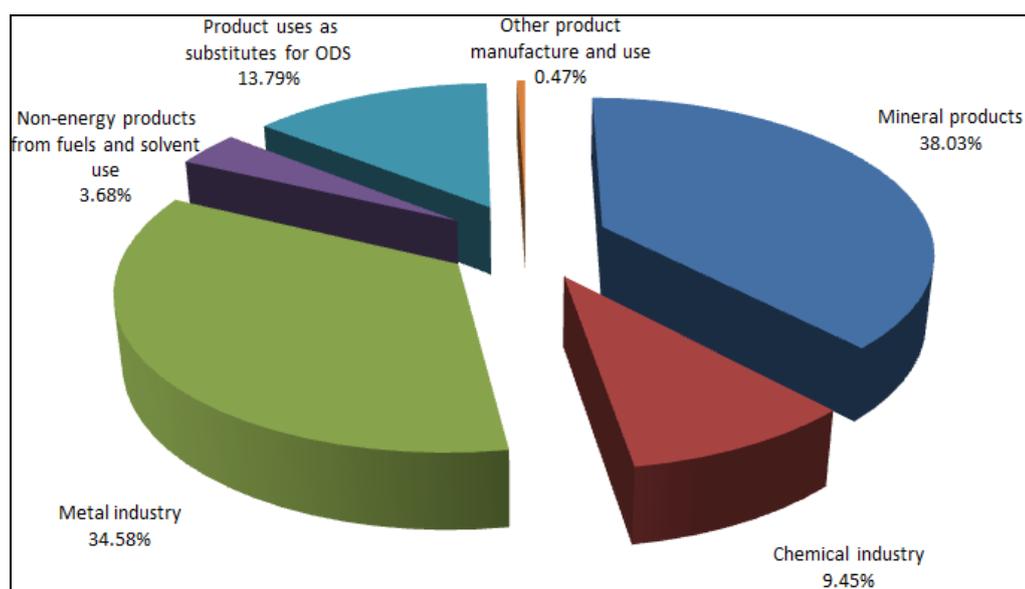


Figure III_B_11 Shares of GHG emission categories within the IPPU sector, in 2015

Agriculture

The Agriculture Sector accounted for 18.96 % of the total GHG emissions in 2015, reaching 18,613.03 Gg CO₂ eq. (Figure III_B_5).

Within the GHG emissions from the agriculture sector, the CH₄ emissions have the largest contribution (in 2015, CH₄ emissions contribution is 68.67 % to the total Agriculture Sector's CO₂ equivalent emissions), followed by the N₂O emissions (30.82 %) and CO₂ (0.51 %).

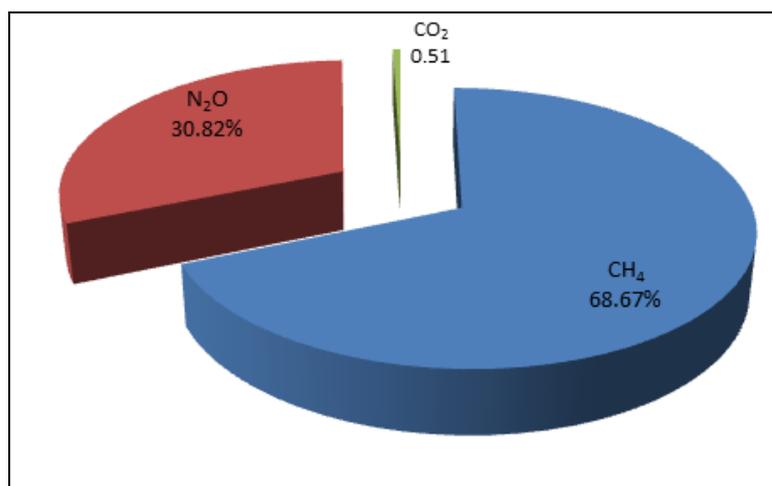


Figure III_B_12 Share of gases within Agriculture Sector in 2015

Over the period 1989 – 2015, the GHG emissions resulted from Agriculture Sector decreased by 50.38 % (Figure III_B_14).

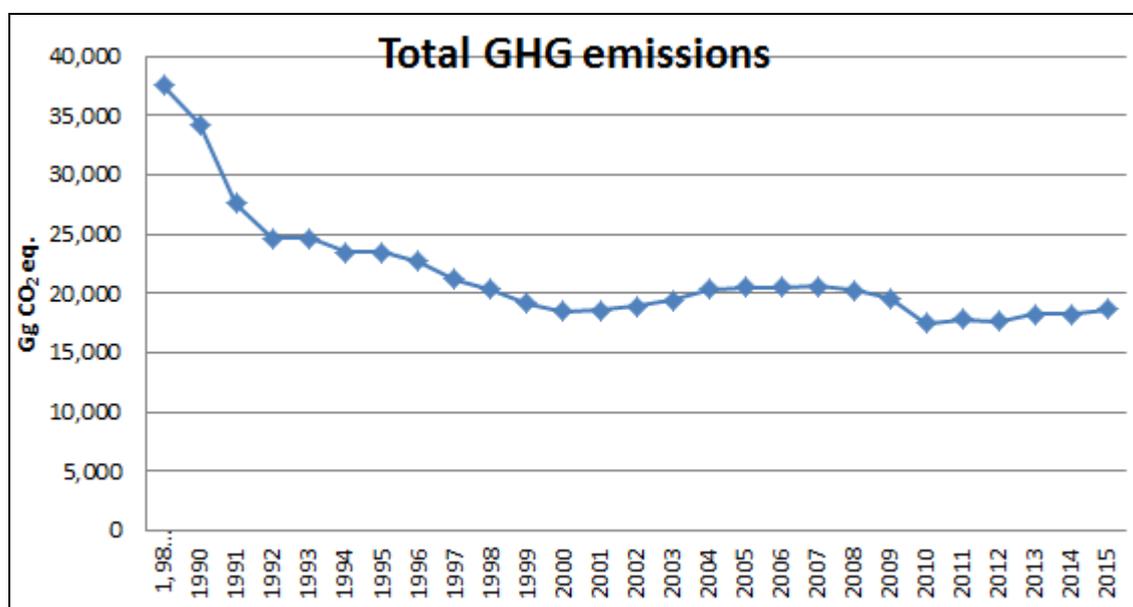


Figure III_B_13 Overall emissions trend for Agriculture Sector

The number of animals decreased in this period whatever of the species and type of operation. After a slight recovery of national livestock situation, another dramatic regression occurred, result of economic situation extremely difficult Romania passed in the period 1997-2000. After the period 2001-2002 and in present, for the livestock species of interest there are recorded fluctuations in the livestock number influenced by the economic context, the emergence of various associative forms that have acquired economic power and by the interest shown by farmers for increasing the genetic value of the animals.

After 1989 the livestock from most Agricultural Production Cooperatives (C.A.P.) were attributed to rural population they being sacrificed in large numbers for meat. On the other hand, in most rural areas, a significant number of farmers have lost the interest in animal husbandry.

In case of emissions resulted from enteric fermentation and manure management, the descending trend reflects the decrease in animal population over the period. The number of all cattle categories decreased in the analysed period, the animals being privately owned both in subsistence farms and individual households. The lack of interest for these species is also due to the lack of associated governmental incentives.

Comparatively with the 2014 year, in 2015 were slowly increased some livestock categories for example: cattle, sheep, goat and poultry.

The rice cultivation generated in 2015 a significantly reduced emission compared to the base year 1989 (72.98 % decrease comparing with the base year).

In case of agricultural soils, the emissions decreased over the period (48.48 % decrease in 2015 comparing with 1989), due to the decrease of the amount of the synthetic fertilizer applied, of the livestock populations and of the crop productions level.

The N₂O emissions from Agricultural Soils decreases (47.78%) comparing with the base year due variation of quantities of synthetic fertilizers, number of animals and of the crop productions.

In the general context of the transition of the economy to a market based approach, the activity data level decreased substantially in the last years of the characterized period in comparison to the base year.

The livestock number decreased in the last years of the characterized period in comparison to 1989 mainly due to:

- The import of animals;
- The draught which affected the crop production levels and the crop production prices;
- State incentives in some periods;
- Closing of the old/opening new facilities due to the restructuration of the economy.

The crop productions level decreased in the late years of the analysed period in comparison to 1989 mainly due to the change in agricultural land property regime and to the transition to the market economy. Reasons for the inter-annual changes in crop production levels include:

- Existence of draught periods;
- Existence if state incentives for some periods;
- Changes in the land property regime, including the disaggregation of large farms before 1990 and crystallization of new large farms in the late years.

The livestock number was decreased in the 2010 year comparative with the 2009 year due to:

- The deficiency precipitation that which led to decreased of production needed for feeding;
- The increases of price per food.

The trend of GHG emissions between 1989 and 2015 was defined by a substantial decrease of emissions from Liming (78.93 %), Rice Cultivation (72.98 %), Manure Management (61.86 %), Enteric Fermentation (49.20), Agricultural soils (48.48 %), Urea application (46.34 %) și Field Burning of Agricultural Residues (12,84 %) (Figura III_B_15).

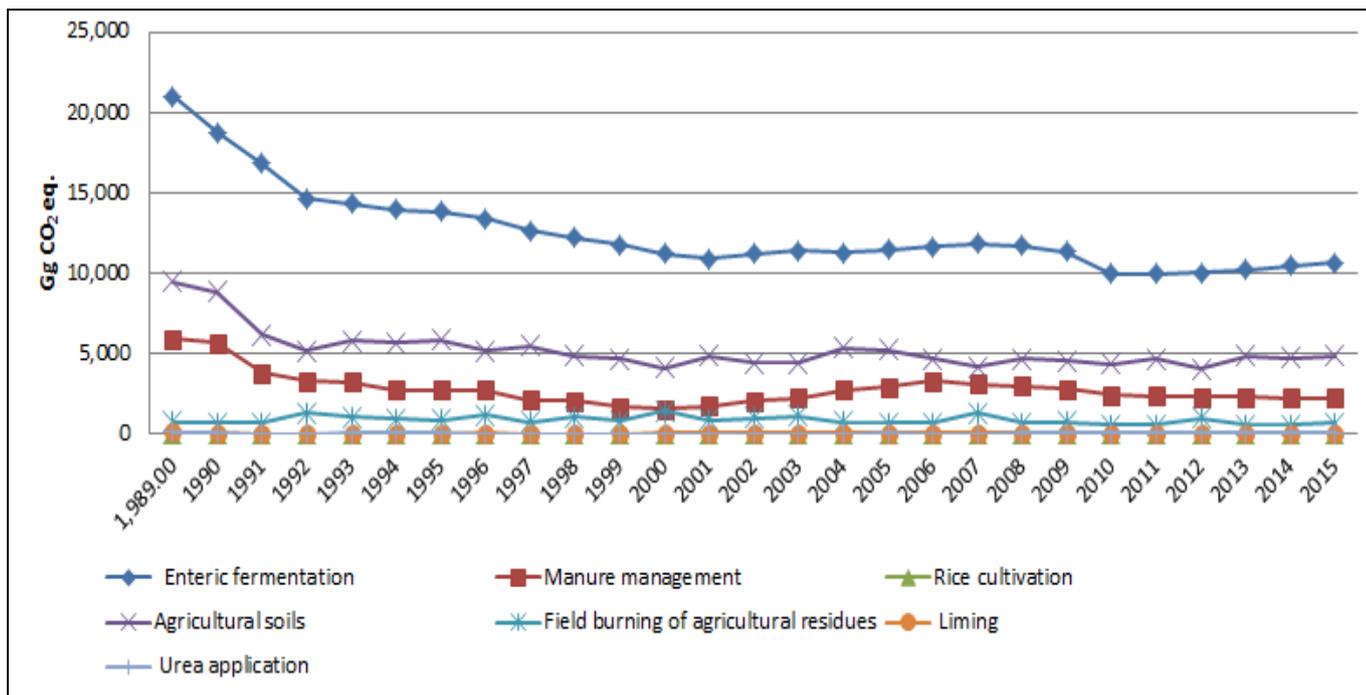


Figure III_B_14 Agriculture sub-sectors emission trend for the period 1989-2015

Compared to 1989, total GHG emissions from *Enteric Fermentation Sub-sector* decreased with 49.2 % in 2015. The decreasing trend is in direct correlation with the dynamics of livestock. The livestock number for all species of economic interest, except goats, due to increased interest in recent years for this species, declined; the interest for goats products is a consequence of the consumers' taste refineries, especially for urban consumers, and of the requirements for milk and goat meat for export.

The administration of goat livestock is based also on valuable genetic biological material import, especially from breeds specialized in milk production.

Manure Management Sub-sector is an important source in the Agriculture sector (in 2015, GHG emissions as CO₂ eq. from Manure Management represented 12.16 % from Total Agriculture emissions).

Emissions from Manure Management Sub-sector are declining since 1989 (by 61.86 %) due to the decrease of the animal population. This diminish is referable to lower number of animal on one hand, and on the other hand to the switchover from traditional systems to economically organized farms, in which is practiced different waste management systems.

The dynamic of emission of GHG from manure management reflect the livestock described situation in Romania.

The years 1997-2000 have been of Romania unfavourable, in economically terms reflecting the number of animals decrease and implicitly the emissions diminish.

After 2000, livestock will return with higher share, steps first taken by farmers of especially hens and the emissions increased to 2006, then again begin to fall.

Rice Cultivation Sub-sector is the smallest source of GHG emissions in the Agriculture sector.

Emissions from rice cultivation are declining since 1989 due to the decrease of rice cultivated area by 72.98 %. The rice cultivated area has decreased from 21.6 thousands ha in 1991 to 100 ha in 2003. The reduction of rice cultivated area is due to areas privatization process and

concession of the land from state patrimony, which ended in 2004. In 2015 the rice cultivated area was 11.1 thousand ha.

Due to natural conditions, Romania benefits of a relatively balanced production of rice while the cultivated area and the emissions from rice continue to fall.

Agricultural soils Sub-sector registered a declining of livestock population and the crop productions, and a diminishment of the synthetic fertilizer amount applied determining a 48.48% decrease of emissions in 2015 comparing to the 1989.

The decrease of crops, for example in 1992 was caused by unfavorable weather conditions, while the situation was completely opposite in 2004. In the 2007 year, the crop was reduced from 2006 due to drought.

Cultivated areas were maintained crop except soybeans which recorded significant decreases.

Emissions from *Field burning of agricultural residues* in 2015 are smaller than emissions in 1989 with 12.84 %, due to the lower agricultural yields. The lowest emissions are found in years 2000, 2007 and 2012.

The GHG emissions from *Liming* are smaller in 2015, with 0.17% comparing with 1989; the emissions decreasing until 1993 then begin to fluctuate in according with the decreasing and increasing of annual amount of calcic limestone CaCO_3 .

The GHG emissions from *Urea application* are smaller in 2015, with 0.34 % comparing with 1989; the emissions were decreased until 1992 then begin to fluctuate in according with the decreasing and increasing of annual amount of urea fertilisation.

Agricultural Soils and Enteric Fermentation are the two main contributing sub-sectors with 57.39% and 26.32 %, respectively, to the total GHG emissions in Agriculture Sector in 2015 (Figure_III_B_16). The Manure Management sub-sector has contributed with 12.16 % to the total GHG emissions. The contributions of Field Burning of Agricultural Residues, Urea application, Liming and Rice Cultivation sub-sectors to the overall sector emissions are very low: 3.63 %, 0.34 %, 0.17 % respectiv 0.0001 %.

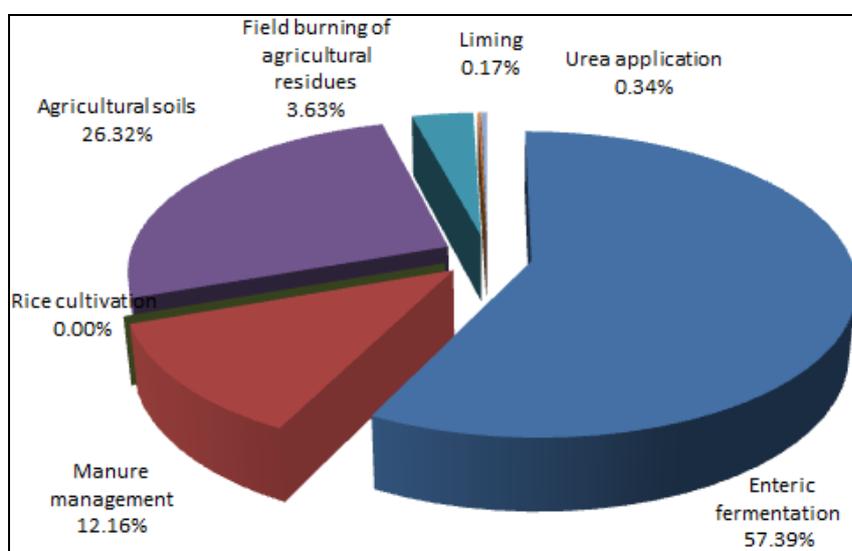


Figure III_B_15 Shares of GHG emission categories within the Agriculture Sector, in 2015

Land Use, Land Use Change and Forestry

Agricultural lands, including arable, orchards, vineyards, pastures and hayfields makes up 61.3% of Romania's total national area. Forests cover 28.3% while constructed areas and road/railways, cover some 4.8%, humid areas, water and lakes some 3.5% and other land 2.1%.

Emissions from LULUCF comprise CO₂, CH₄ and N₂O emissions from biomass burning.

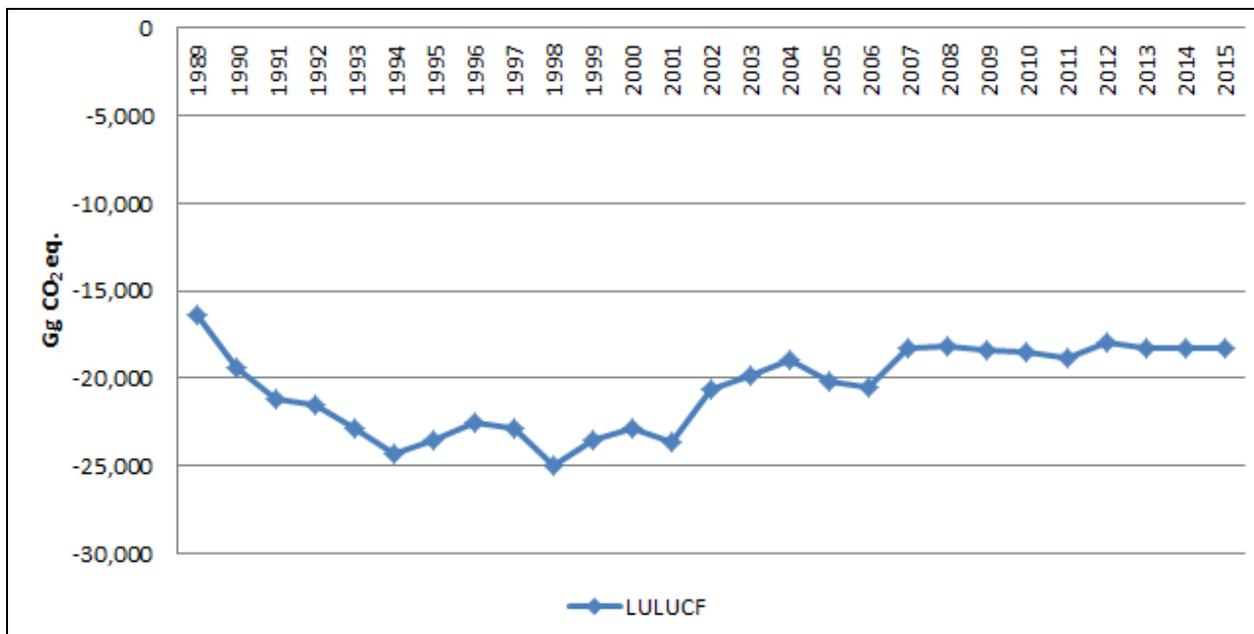


Figure III_B_16 Overall emissions trend for Land-Use, Land-Use Change and Forestry

The net GHG removals/emissions level is 11.83 % higher in 2015 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 20,531.11 Gg CO₂/year, being relatively stable over the last 27 years.

Waste

Over the period 1989 - 2015, GHG emissions resulted from Waste sector increased by 14.91 %, due to population consumption growth, to the increase of waste managed sites number and also to the increase of population connected to sewerage (Figure III_B_18).

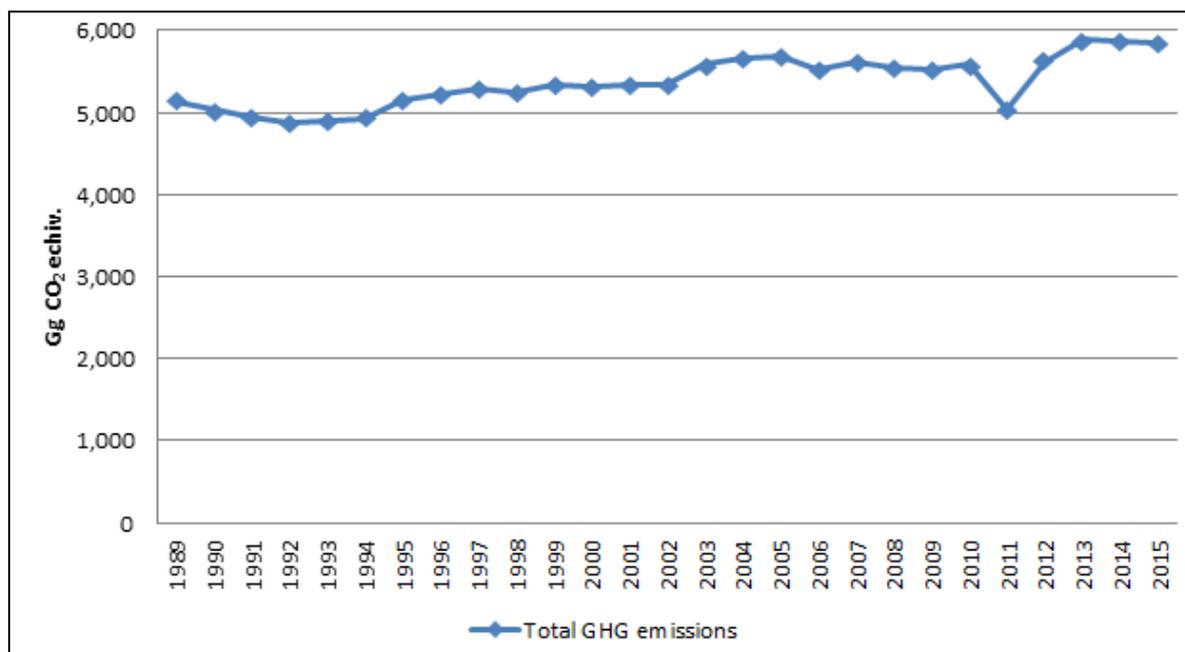


Figure III_B_17 Overall emissions trend for Waste Sector

In 2015 GHG emissions from the Waste Sector accounted for 5,843.31 Gg CO₂ eq., which represent 5.95 % of the total national GHG emissions in this year (Figure III_B_5).

In the base year (1989), the total GHG emissions from the waste sector reached 5,135.66 Gg CO₂ eq., which represented 1.80 % of the total national GHG emissions in that year.

Compared with the other sectors, emissions from the waste sector showed a significant increase from the base year, with 13.78 %, due to increasing of population consumption in parallel with increasing of living standards (Figure III_B_18).

The trend of GHG emissions between 1989 and 2015 was defined by a significant increase of emissions from Solid Waste Disposal on Land (164.47), as well of a decrease of emissions from Waste Water Handling (40.64 %) (Figure III_B_19).

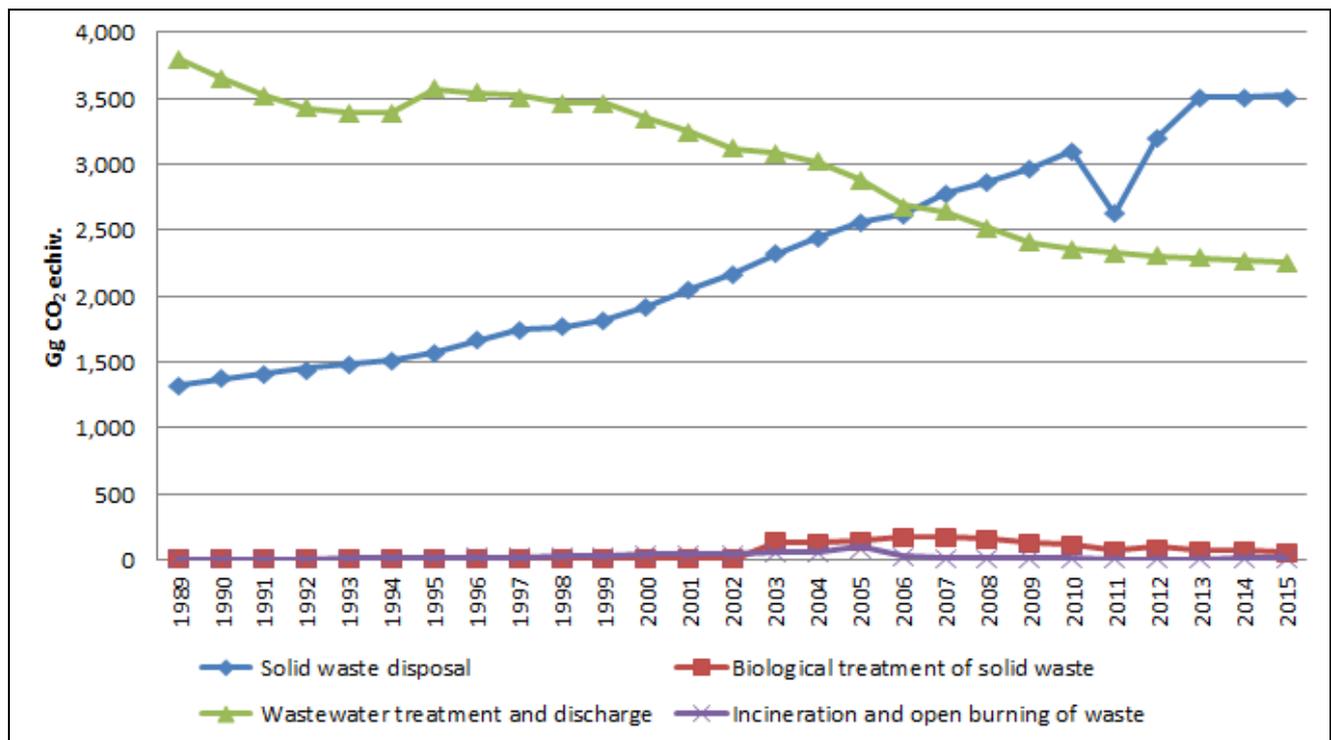


Figure III_B_18 Waste sub-sectors emission trend for the period 1989-2015

After 2000, Romania began to comply with EU standards, implementing European legislation both in waste and wastewater treatment management. However, the GHG emissions trend is different for the three subsectors of Waste Sector due to improvement of living standards which is reflected differently in the evolution of these subsectors.

GHG emissions trend from Solid Waste Disposal on Land category increased significantly in 2015 year comparing with the level in the base year, with a percentage of 164.47 % (Figure III_B_19). This increase is due to the increasing trend of waste generation rate following the increasing trend of population consumption.

Emissions from wastewater handling decreased with 40.64 % in 2015 compared to 1989. This decrease is due to the decreasing number of population and to the increased number of inhabitants connected to sewerage on the one hand and on the other hand to the decreasing level of industrial production.

In Waste Incineration Subsector the emissions trend has remained almost constant because the amount of waste destined for incineration was constantly, except for the period 2004-2006 when there was intensified burning of industrial hazardous waste due to compliance with Directive 2000/76/CE.

The most important contribution to GHG emissions from Waste Sector, in 2015 year, has Solid Waste Disposal on Land Sub-sector (60.24 %), Wastewater Handling Subsector (38.65 %); the other sub-sectors have a smaller contribution: Biological treatment of solid waste (0.99 %) and Waste Incineration (0.12) (Figure III_B_20).

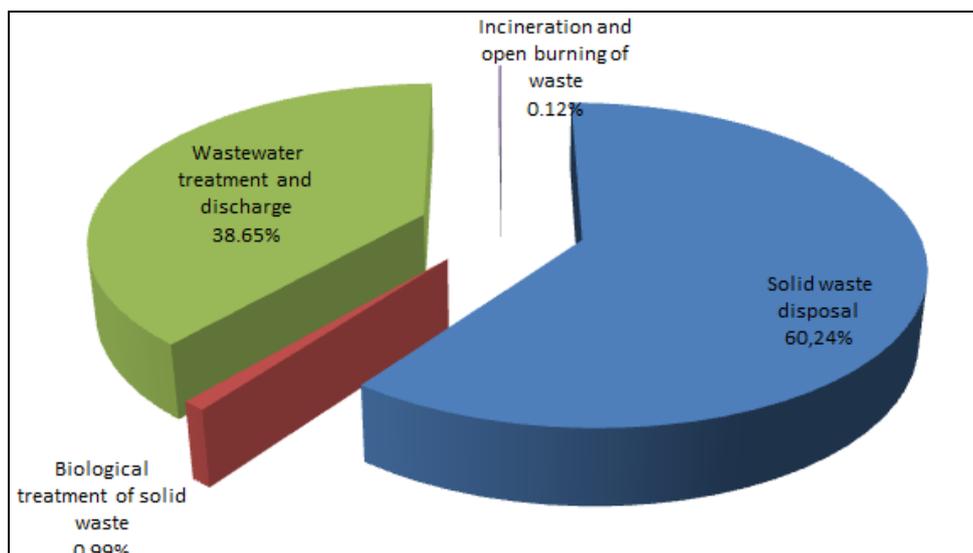


Figure III_B_19 Shares of GHG emission categories within the Waste Sector, in 2015

III. C. National systems in accordance with Article 5, paragraph 1, of the Kyoto Protocol

(a) Name and contact information for the national entity and its designated representative with overall responsibility for the national inventory of the Party

The contact information for the national entity, including its designated representative with overall responsibility for the national inventory are:

- National entity: National Environmental Protection Agency;
Address: Splaiul Independenței no. 294, Sector 6, Bucharest;
Telephone: +40-21-2071101, fax: +40-21-207.11.03.
- Designated representative with overall responsibility:
Name: Sorin Deaconu;
Telephone: +40-21-2071101; fax: +40-21-2071103;
e-mail: sorin.deaconu@anpm.ro.

(b) Roles and responsibilities of various agencies and entities in relation to the inventory development process, as well as the institutional, legal and procedural arrangements made to prepare the inventory

Based on Article 5 of the Kyoto Protocol, Romania established a National System (NS) for estimating the anthropogenic emissions for all greenhouse gases not covered by the Montreal Protocol. The system complies with the provisions of the subsequent decisions of the CMPs of the Kyoto Protocol and with provisions of the Regulation (EU) no 525/2013.

In order to fulfil the obligations under the United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol and European Union legislation, in 2007 the Governmental Decision (GD) no. 1570 for establishing the National System for the estimation of anthropogenic greenhouse gas emissions levels from sources and removals by sinks was adopted, setting all institutional, legal and procedural aspects for supporting the Romanian authorities to estimate the GHG emissions/removals levels, to report and to archive the National

Greenhouse Gas Inventory (NGHGI) information, including supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol.

The GD no. 1570/2007 was modified and completed, by GD no. 668/2012, GD no. 120/2014 and GD no. 1022/2016.

Before 1 April 2013, the competent authority was the National Environmental Protection Agency (NEPA), under the subordination of the Ministry of Environment and Climate Change (MECC).

Based on the GD no. 48/2013, all NEPA climate change related structure, personnel, attributions and responsibilities were taken over by MECC, in order to improve the institutional arrangements and capacity within the climate change domain, thus increasing the efficiency in activities implementation also in respect to the NS/NGHGI administration; starting with 4 July 2016, NEPA is the the competent authority for National System administration, according with GEO no. 9/2016 and GD no. 284/2016.

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);
- 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 implementation the studies ²² performed;

²² "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation", ISPE

"Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N2O emissions estimation", 2013, ISPE

"Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology", 2014, ISPE

"Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)", Denkstat

- 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 Forest Research and Management Planning Institute (ICAS), based on contract (for 2011) or Protocol of collaboration no. 2029/MMP-RP/3.07.2012 between Ministry of Environment and Forests, NEPA and ICAS (for period 2012-2014); also ICAS conducted during period 2011 2014 specific studies for LULUCF sector;²³
- 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 in the Figure III_C_1, were updated during 2011÷ January 2012, based on the study²⁴, performed in 2011, which aimed to improve NS, develop the institutional capacity and establish the programs/measures for determining the emissions factors and other national relevant parameters.

²³“NGHGI LULUCF both under the UNFCCC and KP obligations”, 2011, ICAS;

“Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations” and “Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations”, 2012, ICAS;

“Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2012 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP”, 2013, ICAS;

“Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting”, ICAS, 2013;

“Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP”, 2013, ICAS;

“Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol”, 2014, ICAS.

²⁴ “Support for the implementation of the European Union requirements on the monitoring and reporting of the carbon dioxide (CO₂) and other greenhouse gas emissions”, Institute for Studies and Power Engineering (ISPE)

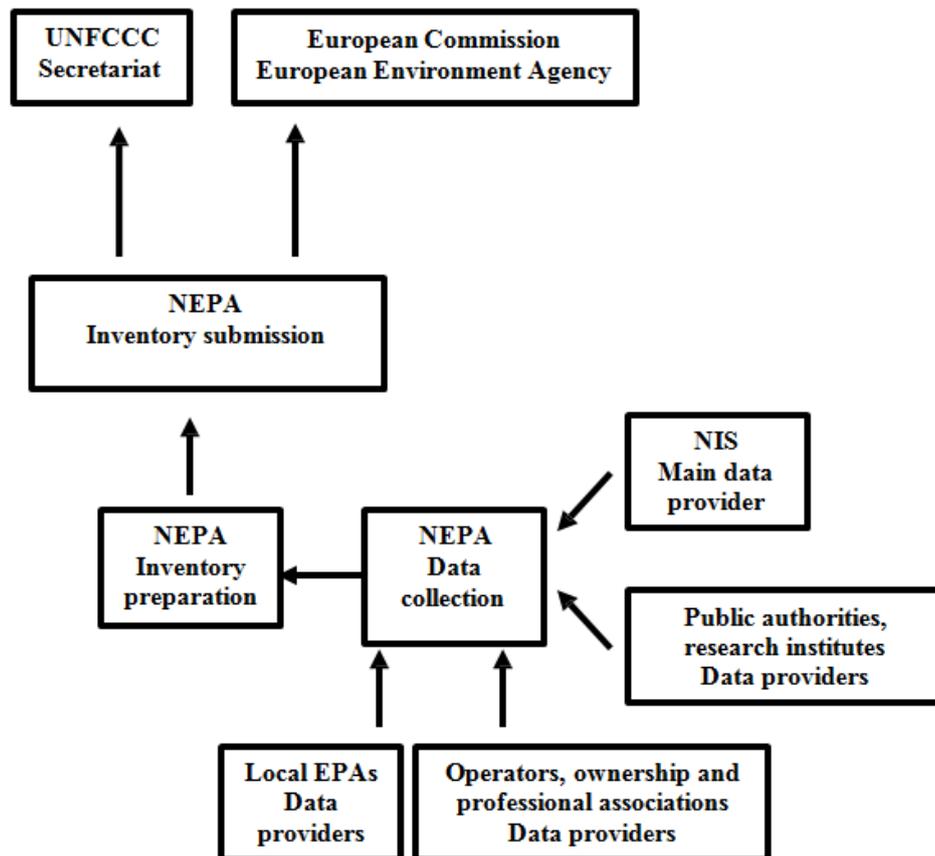


Figure III_C_1 Legal and procedural arrangements

The legal and procedural framework specific to the NS include:

- GD no. 1022/2016 and GD no. 120/2014 for modifying and completing GD no. 1570/2007 for establishing the National System for the estimation of anthropogenic greenhouse gas emissions levels from sources and removals by sinks of all GHGs, regulated through the KP;
- GD no. 1000/2012 on the reorganization and functioning of the National Environmental Protection Agency and of the subordinated public institutions;
- GD no. 38/2015 on the organization and functioning of the Ministry of Environment, Waters and Forests;
- GD no. 668/2012 for modifying and completing the GD no. 1570/2007 for establishing the National System for estimation of anthropogenic greenhouse gas emissions levels from sources and removals of CO₂ by sinks, regulated through the KP;
- GD no. 1570/2007 for establishing the National System for the estimation of anthropogenic greenhouse gas emissions levels from sources and removals of CO₂ by sinks, regulated through the KP;
- Government Urgency Ordinance no. 9/2016 for modifying and completing the Government Urgency Ordinance no. 195/2005 on the environment protection, as well as modifying Article 3 in the Government Urgency Ordinance no. 32/2015 on the establishment of Forestry Guards;
- Government Decision no. 284/2016 for modifying and completing the Government Decision no. 38/2015 on organization and functioning of the Ministry of Environment, Waters and Forests, as well as other normative acts;

- Ministry of Environment Order (MoEO) no. 1376/2008 for approving the Procedure on NGHGI reporting and the modality for answering to the observations and questions raised following the NGHGI review;
- MoEO no. 1474/2008 for approving the Procedure on processing, archiving and storage of data specific to the NGHGI;
- MoEO no. 1442/2014 for approving the Procedure on selection of the estimation methods and of the emission factors for the estimation of the GHG levels;
- MoEO no. 1602/2014 for approving the QA/QC Procedure related to the NGHGI;
- 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, on the preparation of Road transport category estimates based on COPERT 4 model.

(c) Description of the process for collecting activity data, for selecting emission factors and methods, and for the development of emission estimates

According to the GD no. 1570/2007 establishing the National System for the estimation of the GHG emissions levels from sources and removals by sinks, modified and completed, the implementation of the National System ensures the NGHGI quality in three phases:

- Planning;
- Preparation;
- Management of the NGHGI preparation activities.

Data collection process comprises the following steps:

- Identification of data requirements;
- Identification of potential data suppliers;
- Preparation of specific questionnaires;
- Submitting the questionnaires to the potential suppliers of data;
- Data collection;
- Data verification: activity data received are examined (time series discrepancies, large changes in values from the previous to the current inventory year).

Emission factors selection is performed according to the provisions of the MoEO no. 1442/2014 for approving the Procedure on selection of the estimation methods and of the emission factors needed for the estimation of the GHG levels.

Due to NEPA/ MEWF's work, for the implementation of the studies²⁵ performed in period 2011-2014 for several sectors (Energy, Industrial Processes, Agriculture, LULUCF and Waste) and

²⁵ "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation", 2011, ISPE;
 "NGHGI LULUCF both under the UNFCCC and KP obligations", 2011, ICAS;
 "Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations" and "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations", 2012, ICAS;
 "Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2012 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP", 2013, ICAS;
 "Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)", Denkstat;

implementation of Protocol of collaboration (for LULUCF sector and Road transport category), a significant amount of activity data and emission factors have been collected/processed/developed, enabling the development of higher estimates/tier estimates and a significant decrease of the number of categories characterized using the NE notation key.

Also, the informational fluxes for data collection from the operators from the Energy Sector (Energy Industries and Manufacturing Industries and Construction) and from the the Waste Sector (Solid Waste Disposal on Land and Waste Water Handling) were optimized, due to the implementation of an integrated informational system, developed according with the study²⁶ performed SC Asesoft International SA-SC Team Net International SA-SC Star Storage SRL consortium, based on a contract with NEPA.

The main data sources used for activity data are presented in the following table.

Table III_2 Data sources used for activity data

Sector	Data sources
Energy	National Institute for Statistics (Energy Balance) Energy producers Ministry of Economy Romanian Civil Aviation Authority Transgaz SA National Authority on Regulating in Energy National Agency for Mineral Resources
Industrial Processes and product use	National Institute for Statistics (Statistical Yearbook, other data sources) Industrial operators through 42 Local Environmental Protection Agencies Direct information from industrial operators
Agriculture	National Institute for Statistics
LULUCF	National Institute for Statistics (Statistical Yearbook) Ministry of Agriculture, Forests and Rural Development (MADR)-Forests General Directorate (2007-2008); Ministry of Environment and Forests-Forests General Directorate (2009-2011) National Forest Administration (RNP)
Waste	National Institute for Statistics National Environmental Protection Agency Public Health Institute National Administration "Romanian Waters" Food and Agriculture Organization Landfill operators through 42 Local Environmental Protection Agencies

The sources of the emission factors/increment rates used are: national studies, IPCC 2006, national research institutes and plants, in a limited number.

"Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N2O emissions estimation", 2013, ISPE;

"Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting", ICAS, 2013;

"Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP", 2013, ICAS;

"Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology", 2014, ISPE, UPB;

"Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology" 2014, UPB, ISPE;

"Estimation of methane emissions from industrial wastewater according to the IPCC 2006 methodology", 2014, ISPE;

"Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol", 2014, ICAS.

26 "Environmental Integrated Informational System", SC Asesoft International SA, SC Team Net International SA, SC Star Storage SRL

Data processing and emissions calculation

Data processing is performed according to the provisions of the Ministry of Environment Order no. 1474/2008 for approving the Procedure on processing, archiving and storage of data specific to the NGHGI.

Activities were carried out mostly by NEPA/MEWF, ISPE and ICAS, as contractors of studies mentioned above implemented in period 2011 - 2014; specific activities comprise:

- Primary data processing:
- Checking the completeness of all data and information for all years and categories within the analyzed period;
- Completing the datasets, using also default IPCC interpolation/extrapolation and/or alternative techniques;
- Checking the accuracy and consistency of datasets;
- Values transformation, in order to reach the measurement unit adequate within the method used;
- Data aggregation/disaggregation considering the IPCC classification;
- Calculation and/or adjustment of different parameters considering the available data;
- Selection of the emission factors and of the methods;
- Application of methods;
- Emissions/removals estimates, using the most recent data;
- Internal review (errors are rectified);
- Preparation of the national inventory report.

The previous activities were also implemented as part of collaboration between:

- MECC, NEPA, Romanian Automobile Register and Directorate on Driving Licenses and Vehicles Registration in the Ministry of Internal Affairs, in the framework of the Protocol of collaboration no. 3136/MMP/9.07.2012, on preparation of Road transport category estimates based on COPERT 4 model;
- MECC, NEPA and ICAS, in the framework of the Protocol of collaboration no. 3029/MMP-RP/3.07.2012, on administrating by ICAS of the LULUCF Sector, both under UNFCCC and KP.

The emissions from KP Annex A Sectors are estimated following the IPCC 2006.

Data archive

Data archiving is done according to the provisions of the Ministry of Environment Order no. 1474/2008 for approving the Procedure on processing, archiving and storage of data specific to the NGHGI.

NEPA team manages and maintains the NGHGI database and the documentation of specific inventory information. According to the provisions set by IPCC 2006, the NGHGI documentation includes:

- Assumptions and criteria for selection of AD and EF;
- EF used, including references to IPCC documents for default factors or to published references or other documentation for emission factors used in higher tier methods;

- AD or sufficient information to enable activity data to be traced to the referenced source;
- Information on the uncertainty associated with AD and EF;
- Rationale for choice of methods;
- Methods used, including those used to estimate uncertainty;
- Changes in data inputs or methods from previous years;
- Identification of individuals providing expert judgment for uncertainty estimates and their qualifications to do so;
- Details of electronic databases or software used for the inventory, including versions, operating manuals, hardware requirements and any other information required to enable their later use;
- Worksheets and interim calculations for category estimates, aggregated estimates and any recalculations of previous estimates;
- Final inventory report and any analysis of trends from previous years;
- QA/QC plans and outcomes of QA/QC procedures.

All inventory information, as far as needed to reconstruct and interpret inventory data and to describe the national system and its functions, is accessible at a single location – NEPA. While all information officially submitted according to the requirements of the Kyoto Protocol is translated into English, this is not possible for all background information made available during the review process, as the official inventory documentation language is Romanian.

Specific NGHGI data are archived as follows:

- Electronically – all available documents;
- On paper – the documents used for the NGHGI preparation unavailable in electronic format and the correspondence with different organizations.

In order to ensure the security of databases and the confidentiality of the background data, both paper and electronic data are kept under restricted access conditions (NEPA site). Furthermore, electronic data backup activities are undertaken on server with daily frequency during the generation of the official submission and weekly in rest of cases.

(d) Description of the process and the results of key source identification and, where relevant, archiving of test data

The key category analysis (KCA) has been performed according to the provisions in Chapter 4, of IPCC 2006, vol. 1 following the Tier 1 approach.

Separate key category analysis were conducted taking into account both the exclusion and inclusion of the LULUCF sector and also both level and trend criteria; all IPCC sectors and categories, sources and sinks (as recommended in Table 4.1 of IPCC 2006), and gases were analyzed. KCA was conducted for every year of the characterized period.

The results of the KCA, for 2015, are presented in the following table.

Table III_3 Key category analysis for 2015

KCA	Number of key categories
Tier 1 (excluding LULUCF)	36
Tier 1 (including LULUCF)	44

The identification of the KP LULUCF key categories followed the procedure described within the Chapter 2 of the Kyoto Protocol Supplement.

Summary of key categories in 2015, by level and trend (excluding/including LULUCF), are presented in Annex 3.2.

(e) Description of the process for the recalculation of previously submitted inventory data

According to the relevant provisions in IPCC 2006 and the Ministry of Environment Order no. 1376/2008 for approving the Procedure on NGHGI reporting and the modality for answering to the observations and questions raised following the NGHGI review, the recalculations of the emissions/removals estimations are performed and applied in the following cases:

- Available data have changed;
- The previously used method is not consistent with good practice guidance for that source category;
- A category has become a key category;
- The previously used method is insufficient to reflect mitigation activities in a transparent manner;
- New methods become available;
- Inclusion of new source/removal categories;
- Changes in the activity data and emission factors acquisition and use;
- Correction of identified errors;
- Other cases, in accordance with the relevant good practices

Regardless of their magnitude, the recalculations are performed by NEPA for every year of the analyzed period, between the base year and the last reported year. Recalculations are performed using a single method for all years, including, when needed, alternative techniques as interpolation, extrapolation and other relevant techniques.

Based on IPCC 2006, Romania implemented significant recalculations in order to account for better AD and/or EFs, mainly based on NEPA's work, on the studies²⁷ implemented in 2011-

²⁷ "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation", 2011, ISPE;

"NGHGI LULUCF both under the UNFCCC and KP obligations", 2011, ICAS;

Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations" and "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations", 2012, ICAS;

"Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2012 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP", 2013, ICAS;

"Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)", Denkstat;

"Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N2O emissions estimation", 2013, ISPE;

2014 period. The recalculations resulted in significant increase of the accuracy, completeness and consistency of data series.

The information on recalculations, reported within the CRF Tables and within the NIR, contains the information on used procedures, methods applied, emission factors and activity data and information on source/removal categories not previously analyzed.

(f) Description of the quality assurance and quality control plan, its implementation and the quality objectives established, and information on internal and external evaluation and review processes and their results in accordance with the guidelines for national systems

Romania established the QA/QC Procedure based on the UNFCCC and Kyoto Protocol's provisions related to the NGHGI and the NS, the IPCC 2006 provisions, and on the GD no. 1570/2007 establishing the National System for the estimation of the anthropogenic GHG emissions levels from sources and removals by sinks, as modified and completed. QA/QC activities are both described within the QA/QC Programme and within the QA/QC Procedure related to the NGHGI, approved by the Order no. 1602/2014.

The QA/QC Programme and the QA/QC Procedure comprise information on:

- The national authority responsible for the coordination of QA/QC activities;
- The objectives envisaged within the QA/QC framework;
- The QA/QC Plan;
- The QC procedures;
- The QA procedures.

According to GD no. 1570/2007 establishing the national system, as modified and completed, and Order no. 1602/2014, NEPA, as competent authority responsible with the implementation of the QA/QC activities under the NGHGI, is performing the following activities:

- Ensures that specific QA/QC objectives are established;
- Develops and regularly updates a QA/QC plan;
- Implements the QA/QC procedures.

Considering the provisions of relevant regulations, NEPA designated a QA/QC coordinator.

The overall objective of the QA/QC Programme is to develop the NGHGI in line with the requirements of the IPCC 2006 and with the provisions of the Regulation (EU) no 525/2013 on a mechanism for monitoring and reporting greenhouse gas emissions and Regulation (EU) no 749/2014.

Romania QA/QC plan follows the definitions, guidelines and processes presented in Chapter 8 – Quality Assurance and Quality Control of the IPCC 2006. The QA/QC plan, as a main part of

"Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting", ICAS, 2013;

"Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP", 2013, ICAS;

"Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology", 2014, ISPE, UPB;

"Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology" 2014, UPB, ISPE;

"Estimation of methane emissions from industrial wastewater according to the IPCC 2006 methodology", 2014, ISPE;

"Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol", 2014, ICAS.

QA/QC procedures, outlines the current and planned QA/QC activities performed during all stages of the inventory preparation.

The QA/QC plan is reviewed periodically, if needed, and may be modified as appropriate when changes in processes occur or based on the advice from independent reviewers.

The QA/QC plan is intended to ensure the fulfilment of the NGHGI principles in Romania. The objectives of the plan include:

- Applying greater QC effort for key categories and for those categories where data and methodological changes have occurred recently;
- Periodically checking the validity of all information, as changes in reporting, methods of collection or frequency of data collection occur;
- Conducting the general procedures outlined in QC procedures (Tier 1) on all parts of the inventory over a complete exercise;
- Balancing efforts between development and implementation of QA/QC procedures and continuous improvement of inventory estimates;
- Customizing the QC procedures to the resources available and the particular characteristics of Romania's greenhouse gas inventory;
- Confirming that the National Statistical Institute and other agencies/companies supplying activity data have implemented QC procedures.

QC activities

QC activities were implemented by each sectoral expert during all phases of inventory preparation, focusing on key categories.

The following QC activities are conducted annually, before and during the preparation of estimates (15 September ÷ 30 October):

- Checking the specific requirements regarding the reporting deadlines;
- Verification of the data collection against the information needed;
- Checking the correct transcription of input data into the calculation sheets;
- Checking the correctness of conversion factors used in calculation;
- Checking the data structures integrity and the disaggregation of activity data at calculation sheets level;
- Checking the concordance between the data measurement units in the calculation sheets and the equivalent data in the CRF Reporter format;
- Checking the consistency and the data values used in the AD and EF series, at the calculation sheets level;
- Identifying common parameters to multiple source or sink categories and checking the values consistency between source or sink categories;
- Checking the emissions/removals calculation into the calculation sheets, by reproducing a representative sample calculation;
- Checking the correctness of the aggregation of estimated emissions/removals at the calculation sheets level.

The following QC activities are conducted annually, during and after the preparation of estimates (15 October ÷ 10 January ÷ 10 March):

- Checking the emissions/removals estimates for all sources, sinks for the entire time series;
- Checking the explanations, when the emissions/removals estimates are lacking;
- Checking the correctness and consistency of choosing the AD, EF and methods used along the entire time series;
- Checking the trends for identifying the outliers and re-analyze the values;
- Checking the correctness of recalculations and the existence of explanations;
- Checking the recording and archiving of AD, EF and methods used;
- Checking the correctness and the completeness of the data transcription from the calculation sheets level to the CRF Reporter level;
- Checking the correctness and the completeness of the data transcription from the CRF Reporter level to the CRF tables level;
- Checking the data used in the NIR against the CRF tables and calculation sheets;
- Checking the correctness of applied methods descriptions, at the NIR's level;
- Checking the references completeness at the NIR's level;
- Checking the archiving of the CRF tables, NIR, CRF Reporter's specific databases and the calculation sheets;
- Checking the key categories persistency along the time series;
- Checking the adequate qualification of individuals providing expert judgments on the uncertainty estimates and the archiving of documentation regarding the qualification and the expert judgments;
- Checking the uncertainty calculation correctness, by partially replying the Monte Carlo analysis;
- Verification the implementation of ERT recommendations;
- Checking the completeness of archiving the QA/QC documentation (QA/QC programme, checklists, ERT report, improvements lists);
- Checking the performance of QA/QC Programme and propose improvements.

Within the specified deadlines, the previously mentioned activities are performed at sectoral level. Based on specific sectoral responsibilities allocated within the sector, the QC checks are performed for certain category by a sectoral expert not being involved in the administration, including estimating emissions/removals of that category (cross-checking approach).

The results of all checks outlined above are documented in the annual QC checklists for inventory preparation. For this purpose, QC checklists are used consistently throughout the years by all experts involved in the inventory preparation.

Additionally, during 2011- 2014 period, the QC activities were performed by contractors, as part of the studies²⁸ performed for improvement of the NGHGI.

²⁸ "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation", 2011, ISPE;
 "NGHGI LULUCF both under the UNFCCC and KP obligations", 2011, ICAS;
 "Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations" and "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations", 2012, ICAS;
 "Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2012 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP", 2013, ICAS;

QA activities

As part of EU Member State, starting with 1st of January 2007, Romania has the obligation to prepare and submit the NGHGI according to the Regulation (EU) no. 525/2013 and to the Commission Implementing Regulation (EU) no. 749/2014, which provides for a QA activity after the first submission (15th of January) and a final QA for all 28 EU Member States (first half of March for the preparation of the EC inventory). In this respect, starting with 2007, Romania has the possibility to verify the inventory twice before the official submission to the UNFCCC Secretariat.

In order to get an objective assessment of the inventory quality and for identifying areas where improvements can be made, involved third party reviewers at the QA activities level, according to the provisions in IPCC, depending on the availability of resources. In this scope, MEWF developed the specific procedural arrangements. NEPA through its international contacts and bilateral agreements identified the available processes for ensuring the implementation of QA activities.

Until now, NEPA was the beneficiary of technical support provided by the Austrian Environment Agency (as part of the twinning project RO/2006/IB/EN/09). One of the most important activities performed within this framework was the review of different NGHGI sectors. Austrian experts provided specific recommendations consisting in:

- Improvement of transparency at sectoral level, considering the trend and recalculations description;
- Improvement of transparency at sectoral level, by providing a cumulative table on the status of emissions/removals estimation for each sub-sector;
- Improvement on knowledge on practical ways for performing and documenting the QA/QC activities;
- Improvement of the NGHGI archiving structure.

Until first half of 2011, NGHGI team was the beneficiary of a Netherlands Government to Government (G2G) project. One of the main aims of the project was to develop the reporting capacity of the NGHGI team also by assessing the possibility to use higher tier methods. Specific activities comprised:

- Advices on improving the NGHGI sectoral data documentation (through the use of the documentation list);

"Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF6), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)", Denkstat;

"Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N2O emissions estimation", 2013, ISPE;

"Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting", ICAS, 2013;

"Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP", 2013, ICAS;

"Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology", 2014, ISPE, UPB;

"Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology" 2014, UPB, ISPE;

"Estimation of methane emissions from industrial wastewater according to the IPCC 2006 methodology", 2014, ISPE;

"Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol", 2014, ICAS.

- Training courses/presentations related to using of data specific to other reporting mechanisms at the GHG Inventory level (use of ETS data, use of COPERT model);
- Discussions/advices on methodological issues (data collection, emissions estimation) on GHG emissions recovery within the Industrial Processes and Waste activities;
- Advices on moving to higher Tier levels in the Energy Sector:
 - ✓ Calculation of specific emission factors;
 - ✓ Use of COPERT model in estimating the Road Transport emissions.
 - ✓ Advices on using national data for the calculation of natural gas transit fugitive emissions;
 - ✓ Advices on moving on Tier 2 at the Enteric Fermentation, Manure Management and Agricultural Soils levels:
 - ❖ Precise identification of activity data;
 - ❖ Workshop on elaborating the specific requirements for a emission factors/other parameters study development;
 - ❖ Other relevant advices.
- Advices on moving on First Order Decay method at the Solid Waste Disposal Sites level and other relevant advices;
- Other advices relevant to the Waste Sector;
- Identification of the practical ways to complete the estimation of emissions/ removals specific to Kyoto Protocol's Art. 3.3 and 3.4 activities: afforestation/ reforestation/deforestation, forest management and revegetation.

QA activities were also performed in 2011-2014, according to the relevant provisions of IPCC 2006, as part of the studies²⁹ performed for improvement of the NGHGI.

Additionally, in 2012, the NGHGI has been subject to a thorough review within the European Union, review under the 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 2020; also, in 2015, the inventory was reviewed in the context of annual monitoring and compliance cycle.

²⁹ "Elaboration/documentation of national emission factors/other parameters relevant to NGHGI Sectors Energy, Industrial Processes, Agriculture and Waste, values to allow for the higher Tier calculation methods implementation", 2011, ISPE;

"NGHGI LULUCF both under the UNFCCC and KP obligations", 2011, ICAS;

Determination of emission/removal factors for the forest and for conversions from/to forest land associated pools both under UNFCCC and KP obligations" and "Compilation of the 2013 National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector both under the UNFCCC and KP obligations", 2012, ICAS;

"Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2012 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP", 2013, ICAS;

"Elaboration and documentation of the parameters values relevant to the National Greenhouse Gas Inventory Industrial Processes Sector values to allow for the greenhouse gas emissions calculation methods, higher Tier methods, for the categories: Production of halocarbons and sulphur hexafluoride (HFCs, PFCs and SF₆), Consumption of halocarbons and sulphur hexafluoride (actual emissions), Consumption of halocarbons and sulphur hexafluoride (potential emissions)", Denkstat;

"Determination of the biodegradable content industrial wastes amount and of sludge amount from wastewater treatment, deposited in managed landfills (for the period 1989-2012) and in unmanaged landfills (for the period 1950-2012). Determination of incinerated wastes type/amount and of parameters specific to their incineration, for the period 1989-2012. Wastes incineration N₂O emissions estimation", 2013, ISPE;

"Determination of emission-removal factors for the pools in forest areas and in areas in conversion from and to forest according with the obligations assumed as a Party to the UNFCCC and to the KP, for the 2014 year reporting", ICAS, 2013;

"Compilation of the National Greenhouse Gas Inventory Land Use, Land-Use Change and Forestry Sector for the 2014 year associated reporting, according with the obligations assumed as a Party to the UNFCCC and to the KP", 2013, ICAS;

"Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the categories Lime production, Glass production and Ammonia production, according to the IPCC 2006 methodology", 2014, ISPE, UPB;

"Elaboration and documentation of values for the parameters relevant to the National Greenhouse Gas Inventory Sector Industrial Processes and Product Use, values to allow for the implementation of the higher tier greenhouse gas emissions calculation methods for the category Iron and steel production, according to the IPCC 2006 methodology" 2014, UPB, ISPE;

"Estimation of methane emissions from industrial wastewater according to the IPCC 2006 methodology", 2014, ISPE;

"Administration of the NGHGI Land Use, Land-Use Change and Forestry Sector (CRF Sector 4), according to the obligations in the United Nations Framework Convention on Climate Change, including those in the Kyoto Protocol", 2014, ICAS.

National inventory submissions to the UNFCCC Secretariat are subject to the review under Article 8 of the Kyoto Protocol and procedures defined in the relevant COP/MOP decisions.

All recalculations planned and performed (including those following the UNFCCC ERT review) are mentioned in the improvements lists.

The results of QA checks (excepting those of checks performed under Regulation no. 525/2013, Commission Implementing Regulation (EU) no. 749/2014 and 406/2009/EC and, respectively, by ERT) are documented in the annual QA checklists for inventory preparation. For this purpose, QA checklists are used consistently throughout the years by all inventory experts involved in the inventory compilation.

(g) Description of the procedures for the official consideration and approval of the inventory

According with provisions of the GD no. 1570/2007, modified and completed, and of the MoEO no. 1373/2008, the NGHGI verification and evaluation is performed at NEPA level.

NEPA personnel, with attributions/responsibilities of preparing the NGHGI, considers the observations/comments, and as appropriate, updates the NGHGI in order to improve it as soon as possible, considering the relevant reporting guidelines.

III. D. UNIC CONSOLIDATED REGISTRY

(a) The name and contact information of the registry administrator designated by the Party to maintain the national registry

According with provisions of the GD no. 780/2006 (art.24, para. 1), modified and completed, NEPA is the National Administrator of accounts of the European Union GHG Registry.

The Registry Staff, in line with the Decision no. 764/07.07.2017 of NEPA President, is provided bellow:

- Catalin Dulgheru, national administrator of EU GHG Registry, EU GHG Registry Department, Climate Change Division;
- Adriana Cristea, counselor EU GHG Registry Department, Climate Change Division;
- Izabela-Georgiana Franga, counselor EU GHG Registry Department, Climate Change Division;
- Alin-Daniel Șerban, counselor EU GHG Registry Department, Climate Change Division.

b) The names of the other Parties with which the Party cooperates by maintaining their national registries in a consolidated system

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (26) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and Decision 24/CP.8.

(c) A description of the database structure and capacity of the national registry

The consolidated platform which implements the national registries in a consolidated manner (including the registry of the EU) is called the Union registry and was developed together with the new EU registry on the basis the following modalities:

- Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;
- Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;
- Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;
- Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;
- The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL.

In 2016 new tables were added to the database for the implementation of the CP2 functionality. Versions of the Union registry released after 6.1.6 (the production version at the time of the last NC submission) introduced other minor changes in the structure of the database.

These changes were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan.

No change to the capacity of the national registry occurred during the reported period.

(d) A description of how the national registry conforms to the DES between registry systems for the purpose of ensuring the accurate, transparent and efficient exchange of data between national registries, the clean development mechanism registry and the transaction log

All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:

- With regards to the data exchange, each national registry connects to the ITL directly and establishes a secure communication link through a consolidated communication channel (VPN tunnel);
- The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;
- With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;
- The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;
- In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the Union registry, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. Croatia was migrated and consolidated as of 1 March 2013. During the go-live process, all relevant transaction and holdings data were migrated to the Union registry platform and the individual connections to and from the ITL were re-established for each Party.

(e) A description of the procedures employed in the national registry to minimize discrepancies in the issuance, transfer, acquisition, cancellation and retirement of emission reduction units (ERUs), certified emission reductions (CERs), temporary certified emissions reductions (tCERs), long-term certified emission reductions (ICERs), assigned amount units (AAUs) and/or removal units (RMUs), and replacement of tCERs and ICERs, and of the steps taken to terminate transactions where a discrepancy is notified and to correct problems in the event of a failure to terminate the transactions

The consolidated platform which implements the national registries in a consolidated manner (including the registry of the EU) is called the Union registry and was developed together with the new EU registry on the basis the following modalities:

- Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;

- Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;
- Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;
- Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;
- The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL.

(f) An overview of security measures employed in the national registry to prevent unauthorized manipulations and to prevent operator error and of how these measures are kept up to date

The mandatory use of hardware tokens for authentication and signature was introduced for registry administrators.

(g) A list of the information publicly accessible by means of the user interface to the national registry

Publicly available information is provided via the Union registry homepage for each registry e.g. <https://ets-registry.webgate.ec.europa.eu/euregistry/XX/public/reports/publicReports.xhtml>.

According with Regulation no. 389/2013, Annex XIV, the publicly available (except confidential data) are posted on the Romanian Registry's website and are as follows:

- Persons holding accounts (PHA și TA);
- Operators holding accounts – industrial installations and aircraft operators (OHA and AOHA);
- Verifiers holding accounts;
- National accounts administrator contact data;
- Number of units (ERUs, CERs and AAUs) cancelled and retired.

(h) The Internet address of the interface to its national registry

The internet address of the Romanian registry is:

<https://ets-registry.webgate.ec.europa.eu/euregistry/RO/index.xhtml>

(i) A description of measures taken to safeguard, maintain and recover data in order to ensure the integrity of data storage and the recovery of registry services in the event of a disaster Network errors Disaster Recovery Plan – EU Registry Procedure –confidential (SIAR)- Anex II E, 32 (B) -15/CMP 1

The overall change to a consolidated system of EU Registries also triggered changes to data integrity measures, as reflected in the updated disaster recovery plan. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries.

(j) The results of any test procedures that might be available or developed with the aim of testing the performance, procedures and security measures of the national registry undertaken pursuant to the provisions of decision 19/CP.7 relating to the technical standards for data exchange between registry systems.

Each version of the Registry is subject to both regression testing and tests related to the new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to each release of a new version in Production. The test presented in annex (confidential) is performed every year. The tests are carried out by the quality assurance consultants on behalf of and assisted by the European Commission.

IV POLICIES AND MEASURES, INCLUDING THOSE IN ACCORDANCE WITH ARTICLE 2 OF THE KYOTO PROTOCOL AND DOMESTIC AND REGIONAL PROGRAMMES AND/OR LEGISLATIVE ARRANGEMENTS AND ENFORCEMENT AND ADMINISTRATIVE PROCEDURES

IV. A. Policy making process

Decisions related to policies and measures can be taken at different levels: legislative measures at country level, administrative measures at the country, county and municipalities levels.

In accordance with Constitution Act the two chambers of Parliament have legislative power.

The implementation of laws is the domain of the administration, i.e of the ministries and their subordinate administrative units.

Policies and measures with respect to climate change at the municipal level range from land-use planning, public transport and local road construction to public buildings and procurement.

Private business affairs are managed independently.

According to GD no. 19/2017, the Ministry of the Environment functions as a specialized body of the central public administration, with legal personality, subordinated to the Government.

The Ministry of the Environment acts in the following areas: strategic planning, sustainable development, green economy, environmental infrastructure, ecological resilience, meteorology, climate change, protection, conservation and improvement of natural capital, protected natural areas, biodiversity, biosecurity, environment, waste management and management, hazardous and dangerous substances management, air and environmental noise management, industrial pollution control and risk management, atmospheric protection, environmental management and audit system - EMAS, the EU Ecolabel and the national spatial information infrastructure the area of competence, according to the provisions of the GD no. 579/2015.

The Ministry of Environment carries out national policy in the fields of environmental protection, green economy, biodiversity, protected natural areas, climate change on all sectors and subsectors it manages, develops the specific strategy and regulations for the development and harmonization of these activities within the general policy of the Government, ensures and coordinates the implementation of the Government's strategy in its areas of competence, fulfilling the role of state authority, synthesis, coordination, regulation, monitoring, inspection and control in these fields.

The Ministry of Environment ensures the inter-ministerial coordination of the process of drafting, implementing, monitoring and reviewing the national policy on sustainable development in the area of competence.

The Ministry of Environment coordinates the activity of integrating environmental protection requirements into other sectoral policies, in line with European and international requirements and standards.

The Ministry of Environment ensures that ex-ante conditionality and compliance with the plans for measures taken to meet them for the environmental sectors are complied with in line with the commitments made under the *2014-2020 Partnership Agreement* and the *Large Infrastructure Operational Program 2014-2020*.

The Ministry of the Environment is designated as the competent authority for the application of the provisions of Regulation (EU) no. 1293/2013 of the European Parliament and of the Council of 11 December 2013 establishing a Program for the Environment and Climate Policies (LIFE) and repealing Regulation (EC) 614/2007.

Ministry of Environment has the following responsibilities in the field of climate change:

- Ensures the interministerial co-ordination of the process for the elaboration, the revision, the implementation and the monitoring of the National Strategy for Sustainable Development, by creating the institutional framework for monitoring objectives and reporting on sustainable development, in line with relevant European and international initiatives;
- Co-ordinates the activity for the integration of the requirements of climate change in the others sectoral policies in concordance with international and European requirements and standards;
- Elaborates National Strategy and National Action Plan for Climate Change;
- Elaborates National Strategy and National Plan related to the contribution of Romania at the attainment of EU target for reduction of GHG emissions up to 2050;
- Ensures the National Environmental Protection Agency to manage the National System for estimating the level of anthropogenic GHG emissions from sources or sequestration of carbon dioxide, regulated by the Kyoto Protocol;
- Ensure the development of a national greenhouse gas emission projection system, in line with European provisions in the field;
- Ensure the coordination of the implementation of the Emissions Trading Scheme in Romania;
- Administers, through the National Agency for Environmental Protection, the national accounts of the European Union GHG Emission Register, under the jurisdiction of the Romanian State in accordance with the legal provisions of the European Union and the international regulations in force;
- Ensure the adaptation of the national framework in line with the provisions of Decision no. 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce greenhouse gas emissions to meet the Community's emission reduction commitments greenhouse gas emissions by 2020;
- Ensure the coordination of the reporting process according to the requirements of Regulation (EU) no. 525/2013 of the European Parliament and of the Council of 21 May 2013 concerning a mechanism for monitoring and reporting greenhouse gas emissions, and reporting at national and Union level of other relevant information on climate change; and repealing Decision no. 280/2004/EC;
- Develops and updates, according to European principles, the national policy for adaptation to the effects of climate change and ensures the coordination of its implementation at national level, as well as the reporting of results according to European and international requirements;
- Provides the Technical Secretariat of the National Commission on Climate Change, established by the Government Decision no. 1026/2014 for the reorganization of the National Commission on Climate Change.

IV. B. Domestic and regional programmes and/ or legislative arrangements and enforcement and administrative procedures

Romania signed the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. It was ratified by Law no. 24/1994. Thus, Romania has undertaken the commitments stipulated in the respective document.

In Romania there is a legal framework in the field of climate change which allows for a coherent application of the UNFCCC and the Kyoto Protocol. So, there are:

- Primary legislation, including specific acts on climate change;
- General environmental regulations, including climate change aspects;
- Specific legislation related the sectors to energy, transport, agriculture and forestry and waste management.

In 2016 the Government of Romania approved by GD no.739/2016 *the "National Strategy on Climate Change and Economic Growth based on Low Carbon Emissions for the Period 2016-2020"* and the *"National Action Plan for the Implementation of the National Strategy on Climate Change and Economic Growth based on low carbon emissions for the period 2016-2020"*.

The main objective of the "National Strategy for Climate Change and Low Carbon Economy" is to mobilize and enable private and public actors to reduce GHG emissions from economic activities in line with with EU targets and adapt to the impacts of climate change, both current and future. As regards the GHG emission reduction process, this strategy adopts quantifiable targets in line with the EU's 2030 commitments. As far as adaptation to climate change is concerned, the aim is to support and promote the protection of the environment, people and the environment. economic activities to the effects of climate change, especially extreme events. The strategy will guide Romania's climate change and low carbon development actions by 2030, representing an update and extension of the *"National Climate Change Strategy 2013-2020"* made in the light of recent developments.

The Action Plan is intended to implement the *"National Strategy on Climate Change and Growth on the basis of low carbon emissions for the period 2016-2020"*.

The national policies and the action plans to reduce GHG emissions are a key element in limiting the effects of climate change on the environment, the economy and society. To support green growth for carbon reduction, the EU has introduced ambitious climate and energy targets by 2020, being the first region to pass binding legislation to ensure that they are achieved. Romania's obligations as an EU Member State include participation in the EU Restriction and Marketing Mechanism or the EU ETS Emissions Trading Scheme for all energy-intensive installations. Additionally, emissions from economic activities outside the EU ETS are regulated by Decision no. 406/2009 of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020; in line with the target set, greenhouse gas emissions may increase by 19% in 2020 compared to 2005.

For each priority sector, based on the objectives of the sectoral strategy, actions are taken to support each objective. These actions are: political, investment, institutional capacity building, etc. The Action Plan on Climate Change includes the selection of actions for each sector and objective, together with full details of related deadlines, responsible bodies, sources of funding, funding values and result indicators.

IV. C. Policies and measures and their effects

This section provides information on adopted and planned policies and measures, which contribute to achieve the GHG emissions mitigation goals at EU level and of the Convention taking into consideration the Kyoto Protocol.

The adopted and planned policies and measures took into considerations the GHG emissions of the each sector, theirs potentials of the reductions and the national priorities for economic development.

IV.C.1. Energy Sector

The Government of Romania has a strategic objective for the energy sector to meet the energy demand, both now and in the medium and long term at a lower price, appropriate to a modern market economy and a civilized standard of living, food safety, respecting the principles of sustainable development.

Considering the role of energy for the economy and society, the development of this sector is carried out under state supervision, through the development and implementation of a sectoral strategy, and in the short term by implementing a policy related to the strategic field. The Ministry of Energy notified the Ministry of the Environment about the elaboration of the first version of the *"Energy Strategy of Romania 2016 - 2030, with the perspective of 2050"* on 13.02.2017.

Romania has transposed all EU Directives with implications for primary energy consumption at national level.

IV.C.1.1. Electricity and Heat Generation

The primary energy saving measures on the generation of electricity and heating are as follows:

- Withdrawing from service the generating units whose lifespan has been exceeded and which have become obsolete and the replacement thereof with modern units with superior efficiencies;
- Repowering 330 MW units operating on lignite-fired power plants;
- Promoting high efficiency cogeneration; gas turbines with a heat recovery boiler (GT+HRB) and a combined cycle with gas turbines (CC+GT) of approximately 1000 MW and 600 MW biomass-fired units;
- Continuing the upgrade works of district heating supply systems, respectively the units generating heat fluid, the primary heat fluid (hot water) transmission grid, the heating stations and heating modules, the hot water and heat fluid distribution network;
- Generating electricity from renewable energy sources;
- Distributed electricity generating administrated with modern technology of information.

Beginning with 1 April 2011, the state support scheme for promoting high efficiency cogeneration was applied; the support scheme is in force till 2023.

Based on the National Action Plan for Renewable Energy Sources, which indicates the installed powers per types of technologies from renewable energy sources, results the evolution of energies generated, presented in Table IV_1.

Table IV_ 1 Evolution of electricity generated from Renewable Energy Source

	2013	2014	2015	2016	2017	2018	2019	2020
Total generated electricity, of which:	23,558	25,923	27,523	28,845	29,577	30,225	30,866	31,388
Hydropower plants	17,624	18,191	18,679	18,904	19,063	19,214	19,491	19,768
Photovoltaic power stations	100	140	180	220	246	271	295	320
Wind power plants	4,634	5,952	6,614	7,271	7,668	8,020	8,230	8,400
Biomass-fired power plants	1,200	1,640	2,050	2,450	2,600	2,720	2,850	2,900

[GWh]

The main objectives for the utilization of the renewable energy are:

- The integration of renewable energy in the structure of the Romanian Power System;
- The integration of renewable energy in the requirements of the economic efficiency;
- The promotion of the sectoral policy for ensuring the energy security due to the increase share of the renewable energy in final energy consumption, determining lower dependence of imported energy;
- The energy supply for the isolated localities, through utilization of the local energy resources.

IV.C.1.2. Utilization of energy

The energy is used in all economic and social activities. For this reason it is important to use energy in efficient mode with positive impact on the GHG emissions.

The third National Action Plan on Energy Efficiency (NAPEE) for 2014 - 2020 period takes into consideration the sustainable development of Romania and promotes measures that contribute to the efficient use of energy to meet the country's commitment to reducing primary energy consumption by 10 million toe compared to the baseline scenario, so that consumption is 42.99 million toe in 2020.

NAPEE III provides measures to increase energy efficiency in the energy supply system and final energy consumers (in industry, construction, services, agriculture and the residential sector). For this purpose the following programs are promoted:

- Improvement of the thermal performance of the buildings (in service and residential sectors);
- Modernization of the infrastructure for transport and distribution of heat in centralized system ("The National Program heating 2006-2015 - heat and comfort", extended up to 2020);
- The program for the encouragement of the consumers for the acquisition of the electrical goods with high energy efficiency;
- Improving water supply systems to reduce energy and water consumption;
- Improvement of public lighting and buildings by using LED technology;
- Improvement of the freight and passenger transport system;
- Improvement of irrigation systems to increase energy efficiency, etc.

The application of the EU regulations laid down by the Ecodesign Directive leads to a reduction of electricity consumption in the service and residential sectors due to the use of efficient lighting technologies as well as efficient equipment.

In the Agriculture sector, there is a specific objective "Improving Energy Efficiency and Developing the Sector to Generate Energy from Renewable Resources". This objective is achieved by:

- The use of bio - liquid and biomass for obtaining the thermal energy in the farms;
- The implementation of the technologies for collecting and use of the agricultural residues;
- The achievement of the micro installations for obtaining biogas in farms or in groups of farms;
- The introduction of other renewable energies, such us: wind energy, solar energy, geothermal energy;
- The development of the deposits for the agriculture production.

IV.C.1.3. Industry Sector

The Romanian industry, restructured after the crisis of 2008-2011, has important competitive industrial branches, which produce products with high added value, products that are exported, observing the environmental authorizations for operation.

The evolution of the various medium-term industrial sectors depends on:

- Maintain and develop an attractive business environment, enhancing investment flows stimulating technological upgrading, renewal processes and products;
- Consider environmental impacts of products throughout their lifecycle (from design, manufacture, assembly, marketing, sale and use to recycling and disposal);
- Support research, development and innovation in conjunction with the real needs of industry and market demand to achieve competitive advantages and reduce the technological gap from advanced countries in the EU;
- Promoting digital technologies at all stages from design to production, marketing management including the management of companies;
- Encourage direct investment as a source of capital, know-how, modern technology and management skills;
- Supporting the emergence of small and medium enterprises (SMEs) in the manufacturing sector, for achieving high quality products with low cost, in line with market requirements.

Industrial policy seeks to apply the best technologies to increase energy efficiency and ensure quality products at competitive prices while respecting environmental requirements. In industry, the Government of Romania grants state aid under GD no. 495/2014 to large enterprises and SMEs demonstrating the reduction of energy consumption through measures to increase energy efficiency.

Financing investments to increase energy efficiency in industry can also be achieved through the 2014-2020 High-Performance Infrastructure Operational Program (POEM). Thus, in the MAF Priority Axis 6 Promoting Clean Energy and Energy Efficiency to Support a Low Carbon

Economy at the Specific Objective 6.2 Energy Efficiency Reduction for Industrial Consumers is Allotted. The Allocated Budget is € 12,503,129 of which ERDF 10,627,660 Euro.

IV.C.1.4. Transport sector

In accordance with the White Paper on Transport 2050, a 20% reduction of GHG emissions is forecast by 2030, compared to 2008, and by 60% in 2050, compared to the level registered in 1990.

The general objective of the National Strategy for Sustainable Development is to assure that the transport systems satisfy the economic, social and environmental needs of society, with a minimum impact on the economy, society and environment.

In order to improve behaviour in relation with the environment, the global impact of pollutant emissions generated by the transports sector shall gradually be decreased, in order to meet the objectives established for Romania (national emission ceilings). The emissions will be reduced with 5% by 2015 (case of the cities where air quality emissions limit levels are exceeded), and with 15% (case of the cities where the transports are the main source of pollution).

The national objective for the 2020 time horizon is to meet the current EU average level in terms of the economic, social and environmental efficiency of transports and to perform substantial progresses for the development of the transport infrastructure.

The national objective for the 2030 time horizon is to grow closer to the EU average level of that year in terms of all basic parameters of sustainability in the transport operation.

In 2016, the Romanian Government approved the General Transport Master Plan, a strategic document setting out the main directions for the development of transport infrastructure in Romania over the next 15 years, on all modes of transport: road, rail, naval, air and multimodal.

The Romanian Master Plan of Transport will contribute significantly to Romania's long-term sustainable development by increasing intermodal connectivity (links created by combining all modes of transport) between regions, population and business access to the transport network and supporting development regions with potential for economic growth.

The adoption of the Master Plan is also conditionality for Romania's transport financing, through the Operational Program for Large Infrastructure.

The Master Plan for Rail Transport aims to increase the attractiveness of rail transport and to improve the conditions of travel by modernizing the national rail network and developing railway services. This document provides for the following projects:

- Rail modernization projects;
- Modernization of tourist railways projects;
- High-speed rail projects.

For the period 2016 - 2020, these projects accumulate over 2000 km.

The Master Plan in the Shipping field has the mission to increase the volumes of goods and passengers transported on water and to develop the port infrastructures and routes on the Black Sea, the Danube and the waterways.

The Master Plan for Airline aims to increase the number of persons and the volume of air freight and to develop airport infrastructure and to develop new national and international links. The document states that between 2016 and 2018, the airports of Bucharest, Cluj Napoca, Timisoara, Sibiu, Bacau and aerodromes will be modernized. It follows that these upgrades will result in energy savings as a result of the purchase of energy-efficient installations and

equipment and the adoption of constructive solutions that meet the requirements, the energy efficiency norms.

In 2011, the National Action Plan for the reduction of greenhouse gas emissions in the civil aviation sector for the period 2011 - 2020 approved by the Joint Order of the Ministry of Transports and the Ministry of Environment and Climate Change no.169/2011 was drafted. Monitoring on the implementation of the measures under this plan in accordance with Directive 2007/589 / EC resulted in efficiency indicators (fuel quantity reported in tonnes.km) in Table IV_2.

Table IV_2 Efficiency indicators for air transport 2011-2016

Year	Efficiency indicator
2011	0.372=203506000 l kerosen/546088917 tons.km
2012	0.372=182719000 l kerosen/490119064 tons.km
2013	0.347= 168200000 l kerosen/484088685 tons.km
2014	0.359= 180769000 l kerosen/502596946 tons.km
2015	0.345= 210616040 l kerosen/609964746 tons.km
2016	0.329=264615244 l kerosen/804096156 tons km

The data presented in Table IV_2 shows the increase in the air transport activity during the period 2014 - 2016 under the conditions of the efficient use of the fuel.

The Master Plan for Road Transport aims to increase the road connectivity between the economic growth poles of Romania and to improve the conditions of travel between the regions by developing the national road network and ensuring the maintenance of the existing road network. The documents define highway and expressway projects.

Measures to increase energy efficiency and reduce pollutant emissions in the transport sector are as follows:

- Using smart transport systems;
- Reducing road transport;
- The program for the renewal of the National car park, funded by the Environmental Fund budget;
- Measures applied by economic agents, local and central public administrative units, holding over 25 vehicles, for monitoring and management of fuels in order to reduce the fuel consumption;
- Upgrading railway cargo and passenger transport by procuring high energy efficiency rolling stock;
- Implementing a tele-management system of electricity and for the compensation of the power factor in electric traction substations;
- Implementing the level 2 European Railway Traffic Management System (ERTMS);
- Reducing the electricity consumption afferent to the generation of compressed air required for the operation of fixed subsystems testing train brakes by replacing old, Reșița type compressors, with modern and efficient equipment;
- Upgrading underground transport by upgrading the electric train park and the public space lighting systems;
- Using biofuels (meeting the bio-fuel usage share amounting to 10% of the final national consumption by 2020);

- Promoting “clean passenger cars” and stimulating the manufacturing thereof. In order to encourage the procurement of such passenger vehicles, Emergency Ordinance no. 40/2011 on the promotion of non-polluting and energy-efficient road transport vehicles, amended by Emergency Ordinance no. 9/2013 on the environmental stamp for the passenger vehicle, stipulates the granting of a new environmental ticket for each electric passenger vehicle;
- Encouraging forms of alternative transport (cycling, car-pooling, car-sharing, etc.) through urban planning and the development of an adequate infrastructure for cycling (bicycle tracks, bicycle racks, special bicycle wagons/compartments in the subway and on trains, etc.) and expanding the pedestrian areas, particularly in large urban agglomerations;
- Increasing the degree of using public transportation, by optimizing means of public transport (trains, buses, trolley-buses, trams) and the infrastructure required for the proper operation thereof, expanding the underground network.

The National Action Plan for the reduction of GHG emissions in civil aviation has the following scopes:

- Improving the efficiency of fuel used, by at least 2%/year (reducing fuel consumption on average by 1.5% per hour of flight);
- Capping CO₂ emissions from civil aviation sector activities, starting with 2020.

Summarizing the provisions of Regulation no. 443/2009, the average CO₂ emissions for new passenger cars (light vehicles) will be:

- • in 2012 ÷ 2013 of 130 gCO₂ / km;
- • in 2020 of 95 gCO₂ / km.

Council Regulation (EC) no 510/2011 setting emission performance standards for new light commercial vehicles as part of the Community's integrated approach to reduce CO₂ emissions from new light commercial vehicles sets the average CO₂ emissions of new passenger cars at 175 g CO₂ / km, obtained through improved vehicle engine technology. Starting in 2020, the Regulation sets the objective for the fleet of new light commercial vehicles to achieve an average of 147 g CO₂ / km emissions.

Summarizing the provisions of Regulation no. 510/2011, the average CO₂ emissions for new light commercial vehicles will be:

- • in 2014 ÷ 2017 of 175 gCO₂ / km;
- • in 2020 of 147 gCO₂ / km.
-

IV.C.2. Industrial Processes and Product use sector

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 limit 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.

IV.C.3. Agriculture

The National Sustainable Development Strategy of Romania - 2013 – 2020 - 2030 Horizon (GD no. 1460/2008) emphasizes, in the field of agriculture and food production, on ensuring the safety in supply and the safety of food. Agriculture continues to play an important role in ensuring the incomes of a significant part of the active population. It shall promote a sustainable production model, protecting the ecosystems and ensuring the sustainability of food production, the reduction and elimination of imbalances on the agricultural market, generated by the manner of using natural resources, ensuring an improved capitalization of the advantages held by the Romanian agriculture.

The following national aims are considered within the National Sustainable Development Strategy of Romania for agriculture and forestry:

- *2020 horizon.* Consolidating the structures in the agro-food and forestry field, with the economic and social development of rural areas for the continued reduction of gaps and in order to meet the current average performance level of EU member states; Romania's affirmation as an element of stability for food security in South-Eastern Europe;
- *2030 horizon.* The full adoption of community policies and practices on agriculture, forestry and fishing; completing the restructuring and upgrade of such sectors and of the rural space.

The National Rural Development Program 2014-2020 was approved according to the Implementing Decision of the European Commission no. C (2015) 3508 of 26 May 2015, as amended. This program continues the efforts needed to develop the rural area achieved through the previous program (2007-2013) through the strategic approach of the following objectives:

- 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;
- The sustainable management of natural resources and actions against climate change;
- Diversifying economic activities, creating jobs, improving the infrastructure and services to improve life quality in rural areas.

These objectives are in line with the provisions of the Partnership Agreement. and are in line with the Common Agricultural Policy and the Europe 2020 Strategy.

These objectives are met in 2014-2020 through the six EU priorities set out in the Rural Development Regulation (1305/2013):

- Encouraging the knowledge transfer and innovation in agriculture and forestry and in rural areas (P1);
- 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 (P2);
- Promoting the organization of the food chain, including the processing and trading of agricultural products, of animal welfare and the management of agricultural risks (P3);
- The restoration, conservation and consolidation of ecosystems related to agriculture and forestry (P4);
- 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 (P5);
- Promoting social inclusion, the poverty reduction and economic development in rural areas (P6).

All these priorities have been transposed by areas of intervention and facilitating the achievement of objectives related to innovation, environmental protection and mitigation and adaptation to climate change.

By GD no. 226 of April 2, 2015 establishing the general framework for the implementation of the measures of the national rural development program co-financed by the European Agricultural Fund for Rural Development and the state budget has been established in the general

framework regarding the submission, evaluation, selection, contracting, control and monitoring of the projects foreseen in the NRDP 2014-2020.

In 2015, the Order of the Minister of Agriculture and Rural Development, of the Minister of Environment, Water and Forests and of the President of the National Sanitary Veterinary and Food Safety Authority no. 352/636/54/2015 was issued for the approval of the rules on cross-compliance in the schemes and measures support for farmers in Romania with subsequent amendments. The norms annexed to the Order are drafted pursuant to art. 93 and 94 and Annex II respectively of Regulation (EU) No. 1.306 / 2013 of the European Parliament and of the Council of 17 December 2013 on the financing, management and monitoring of the common agricultural policy and repealing Regulations (EEC) 352/78, (EC) No. 165/94, (EC) No. 2.799 / 98, (EC) No. 814/2000, (EC) No. 1.290 / 2005 and (EC) No. No 485/2008.

The Government of Romania, through GD no. 932/2016, approved the "National program for the rehabilitation of the main irrigation infrastructure in Romania". The MADR Order no. 5/2017 for establishing the implementation of the National Irrigation Infrastructure Rehabilitation Program in Romania shows that the program is carried out in three successive phases:

- Stage I, in which a number of 40 irrigation facilities are rehabilitated;
- Stage II, in which a number of 37 irrigation facilities are rehabilitated;
- Stage III, in which a number of 9 irrigation facilities are rehabilitated.

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 strategy for organizing the improvement and exploitation of meadows at national level in the medium and long term, approved by the joint Order no. 226/2003 of the Ministry of Agriculture, Food and Forestry and the Ministry of Public Administration, has the fundamental objective of increasing the total green mass production and its quality, in line with the increase in the economic efficiency of livestock, especially of cattle and sheep.

In December 2013 through GD no. 1081 endorsed the National Strategy and Action Plan for Biodiversity Conservation 2014-2020. According to these documents, the existence of measure 214, agri-environment payments, designed to encourage farmers to serve society as a whole, is introduced by introducing or continuing to apply environmentally compatible agricultural production methods. Payments for this measure are conditional on compliance with minimum conditions as well as specific requirements for extensive land use based on input reduction.

Among the operational objectives of this measure are:

- Protection of approx. 1,450,000 ha of high natural grasslands;
- Apply adequate management on approx. 173,000 ha of important meadows for the protection of bird species *Crex crex*, *Lanius minor* and *Falco vespertinus*;
- encourage the use of green crops on approx. 700,000 ha for the protection of soil and water resources;
- Apply adequate management on approx. 25,000 ha of important butterflies.

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 no. 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 no. 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.

It should be emphasized that Romania has an Integrated national system for soil monitoring, surveillance, control and decisions to reduce the share of pollutants resulting from agricultural and management sources of organic residues resulting from animal husbandry services in vulnerable and potentially vulnerable areas to nitrate pollution, within the structures of the National system on the integrated monitoring of water resources and of protected areas, managed by the National Research and Development Institute for Soil Science, Agro-chemistry and Environment.

IV.C.4. Land Use, Land-Use Change and Forestry Sector (LULUCF)

The development strategy of the forestry sector in Romania has the main goal of increasing its contribution to increase the quality of life level, based on the sustainable management of forests.

The sustainable management of forests is defined by the Romanian legislation to ensure, now and in the future, the capacity to exercise multiple permanent ecologic, economic and social functions at a local, regional, national and global level, without prejudicing other ecosystems. This wording provides a general definition of the climate issue or of the potential contribution to economic development through reductions or compensation of emissions from other economic sectors.

The following are required in order to meet the main aim:

- Updating the institutional framework in order to carry out the unitary and supported implementation of the forestry sector's development strategy;
- Developing the forestry sector regulation framework:
 - ✓ Updating the forestry and rural development legislation according to the requirements set by the sustainable management of the national forestry fund;
 - ✓ Harmonizing the national legislation with the specific EU legislation, the international conventions and agreements under which Romania is a signatory party;
 - ✓ Adapting the regulations on the promotion of market mechanisms and instruments in the sector;

- ✓ Revising and promoting the normative acts on the forestry administration of the national forestry fund through forestry districts, irrespective of the nature of the property;
- ✓ Adapting the regulatory framework specific to wood operation and processing operations, to the environmental protection and conservation requirements and conditions;
- ✓ Improving the legal framework to benefit the association of limited forest area owners;
- ✓ Promoting normative acts (through a participative process) on:
 - ❖ the creation of facilities for forest land owners, in order to ensure stability and the increase of the forestry ecosystems' operational efficiency,
 - ❖ management of protected areas from the forestry fund;
- ✓ Drafting and promoting the financing and compensation – stimulation mechanisms for activities concerning the conservation of biodiversity and the management of protected areas;
- ✓ Promoting norms and regulations specific to the economic agents from the forestry sector, required for the development of efficient activities;
- ✓ Promoting regulations on the granting of facilities to research beneficiaries and those investing in the research-development activity.

The Ministry of Environment and Climate Change has defined the Forestry Development Project with the aim of maintaining and improving the environmentally sustainable management of forests owned by the State and private property, in order to increase the contribution to the national economy and to the rural economies derived from the Romanian forestry resources. The aim of the project shall be met by implementing the following *five components*:

Component 1: *Establishing systems ensuring the sustainable management of forestry funds found under private property by:*

(a) The strengthening of the forestry department, with particular emphasis on forestry inspectorates at the national level and support services, of the MAFE, in order to provide extensive services and advice relating to the needs of new private forest owners as well as overseeing, regulating and monitoring the activities of the sustainable forest management of State-owned land and private property.

(b) *Developing the Association of Private Forest Owners (APPR)* by providing basic staff, logistic support and basic office equipment; and by preparing a five-year business development plan, to define the profile of new members and the recruiting action plan, to identify and develop a range of services required for new members, and to include and analyse the funding of the cash flow ensuring the financial sustainability of the APFO national office and to expand its network of new members. The essential activity of APFO shall concern the facility of the national and local establishment of associations of members - private forest owners and the support thereof for the acquirement of funding within the SAPARD program, with the funds received from the European Union.

(c) *Supporting the establishment of Local Associations of Forest owners (LAFO)* based on the community through development-oriented assistance in areas with high levels of poverty where forest land will be returned to the individual property owners in common ownerships and commons (at the level of village and commune) which currently have limited organizational abilities; and

(d) *The establishment of a national forest monitoring and management system (FMIMS)* required for supervision and control in order to ensure the sustainable management and development of the forestry sector, by providing integrated and updated access to forestry arrangement, cadastre, legislation, inventories of the forest and biodiversity, data concerning the forest product circuit, as well as statistics on wood trade and industry.

Component 2: *Mitigating the consequences of the return on the management of forest lands owned by the State by:*

(a) *Supporting the reform and the strategic development of the NFD* by preparing and supporting the NFD in the implementation of a strategic development plan and funding the role thereof in the management of forests owned by the State. It shall be carried out by: (i) identifying, quantifying and separating the costs and benefits of public goods and economic functions of the NFD, as well as preparing a financial-accounting system ensuring that all activities benefit from adequate resources, (ii) performing and supporting in the implementation of a plan for the reform and consolidation of the institutional capacity, of the improvement of operative and commercial efficiency, this optimizing the generation of incomes from production forests, while safeguarding public interest and ecologic services provided by production and protection forests; (iii) developing a detailed and budgeted action plan, per stages, on the non-fundamental activities of the NFD, both for privatization, and for development, including the supply of management services for the new private sector; (iv) supporting the NFD in defining the requirements for its information management system, in order to support its strategic development, and providing an interactive connection with the national monitoring system and information on the forest management, which shall be established by the project within the Forestry Directorates; (v) defining an objective and process that can be audited to determine the price in wood material auctions; and (vi) supplying the logistic support, materialized in the vehicles and equipment required for the management of the protected forest area network, that is on-going defining, with support from the Biodiversity Conservation Management project on-going development; and

(b) *Restoring and widening the forest road network* so as to reduce environmental impact and to improve the economic reliability of wood operation in production forests owned by the State. Investing in 10 km of new roads and restoring 425 km of old forest roads shall have significant positive impact on the economic performances of the NFD and it shall aid the compensation of high costs occurring as a result of decreasing the share of production forests compared to protection forests. The places where all the road sub-projects shall be carried out were selected through an economic, social and environmentally detailed analysis process and all new roads, as well as all re-engineering projects, shall be based on the Environmental impact study.

The drafting of this work also proposed a wide consultation of all factors involved in the construction and re-engineering of forest roads in our country: non-governmental organisations, National Forest Administration – ROMSILVA, local and central environmental agencies, other agencies responsible for the supervision and authorization of forest road constructions, as well as companies whose scope is forest road constructions and re-engineering.

Component 3: *Support for productivity growth and the competitiveness of the wood industry* by establishing the centre of information for businesses in the forestry sector (ForsBIC), a business development and consulting, which will establish connections and coordination in the wood industry (e.g. forestry, harvesting, transport and processing of primary and secondary wood products), will also provide assistance to the related wood industries, through the analysis and dissemination of information relating to new technologies, markets and prices, hygienic requirements and export, product promotion and registration of trademarks, joint partnerships opportunities and availability of donations and loans etc.

Component 4: *Building public support for sustainable forest management* through the preparation and implementation of the strategy of public awareness campaign focused on the key factors, including the general public, focusing specifically on the communities living in forest areas; private forest owners; the staff of forestry inspectorates; NFD; decision makers in the Government; and other influential groups such as the Church and NGOs. Implementation of the program will be assisted by an inter-ministerial committee comprising of the Ministry of Industry and Commerce, Education, Water and Environmental Protection, Culture, Tourism and Public Administration.

Campaign strategies will include: media education; the provision of public relations for the forestry inspectorates, preparing promotional and educational materials to be used in schools; local educational events; the involvement of NGOs in environmental educational projects, and supporting project implementation units to develop its own public relations capacity and informing key decision-makers on the progress of implementation of the project. Public awareness campaign will involve regular assessments of the factors involved; they will be used in refining the implementation of the campaign in line with the changing needs.

Component 5: *Management and monitoring of the project* will be submitted by the Project Management Unit (PMU), which will be made up of a project director, financial director, two specialists (for forest roads, and public awareness), a specialist in procurement, second specialist in procurement, procurement activities related to construction and rehabilitation of the network of forest roads and an administrative assistant. ECP will oversee and support the implementation of all the activities of the programme in accordance with indicators of which they agreed.

Ecological forestry, reconstruction through afforestation of degraded areas considered unsuitable for agriculture, as well as non-productive land, regardless of their form of ownership, aims to protect the soil, restoring balances and improving environmental conditions.

Land through erosion, pollution or destructive actions of some anthropogenic factors have permanently lost the ability of agricultural production, but can be improved through afforestation of degraded lands are considered. Degraded lands are the following categories of land:

- Land with very strong and excessive surface erosion;
- Land with erosion in ravines, torrents;
- Land affected by landslides, collapses, spillages and mudflows;
- Sandy lands exposed to erosion by wind or water;
- Land with clumps of gravel, cobble, rock, detritus and sediment deposits rains;
- Land with excess moisture at all times; strong acid or salt lands;
- Land polluted with chemicals or oil;
- Land occupied by mining, industrial waste dumps;
- Land with affected or destroyed biocenoze;
- Unproductive land.

Degraded land that can be improved through afforestation, shall be constituted in perimeters of improvement.

Inventorying degraded lands is an obligation, that won't end until after the completion of the improvement actions.

Developed in 2010 it's considering expanding the areas of forests to reduce the impact of climate change and desertification risk, the risk of floods etc.

In the period 2013-2016 afforestation of 75,000 ha will be as such:

- 4000 hectares of degraded land taken by NFD - ROMSILVA from SDA and purchased;
- 4000 hectares of degraded land owned by individuals and local councils;
- 40,000 ha of degraded agricultural land owned by associations of owners, territorial units, administrative units, units of worship;
- 2300 ha of protective forest belts.

In 2017-2020 period afforestation of 60.000 hectares will be as follows:

- 8,000 ha of degraded lands taken by NFD - ROMSILVA from SDA and purchased;
- 8,000 ha of degraded land held by individuals and local councils;
- 40,000 ha of degraded agricultural land owned by associations of owners, territorial units, administrative units, units of worship;
- 4000 hectares of protective forest belts.

In 2021-2030 period there will be afforestation of 158,000 hectares of land.

Increasing the areas occupied by forests during the period 2013-2030 with 293,000 ha requires a financial effort which will be covered from the State budget, from the Fund for the improvement of the Land Fund with the Forestry Department, foreign funds destination referred to in measure 221 of the National Plan for Rural Development, Environmental Fund.

Within the framework of national sustainable development strategy, emphasizes:

- The improvement of the methods of use of agricultural and forest lands of the conservative type
 - a) Promoting technologies for the conservation and enhancement of carbon sequestration in arable soils.
 - b) Planning at the regional level of the results of the use of land resources.
 - c) Implementation of the principles of the green economy.
- Best use of forest resources and private sector
 - d) Support for the private sector regarding the production of biomass and energy-resources integration
- National policies and programmes of the European Union
 - e) To promote integrated land planning
 - f) To promote integrated inter-sectoral policies (energy resources)
 - g) To support interdisciplinary research financed from national programmes and support national policies (or in negotiation at national and international level).

IV.C.5. Waste Sector

Waste management is one of Romania's current issues. The integrated approach in waste management (waste collection, transport, treatment, reuse and disposal activities), includes the construction of waste disposal installations, together with measures for prevention of waste generation and waste recycling, in accordance with the principles hierarchy: preventing waste generation and the negative impact thereof, waste recovery by recycling, reuse and safety disposal of waste, when recovery is no longer possible.

The responsibility for the waste management activities shall fall with the generators thereof, in accordance with the "polluter pays" principle, or, as appropriate, with the producers, in accordance with the "producer responsibility" principle.

Considerable efforts are required for compliance with the EU legislation on waste management in force, as well as of future requirements.

National, regional and county waste management plans were drafted in order to meet the objectives on waste management.

According with Directive 1999/31/EC on the landfill of waste, Member States shall reduce, by 2016, the volume of stored biodegradable waste at approx. 35%, compared to the level registered in 1995, which shall lead to the significant reduction of methane emissions. Furthermore, methane shall be collected in deposits and, if possible, shall be used for energy generation.

The national legislation on the collection, treatment and storage of municipal waste, in line with the EU directives and decisions is presented in Table IV_3.

Table IV_3 Legislation on the generation, collection, transport, treatment and storage of municipal waste

Directives/ Decisions	National Regulations
Directive no. 2008/98/EC on waste	Law no. 211/2011 on the regime of waste, with further modification and completion National Strategy on Waste Management 2014-2020 (HG 870/2013) and the National Waste Management Plan (<i>Official Journal no. 954/18.10.2004</i>) GD 358/2007 amending Annex no. 2 "The National Waste Management Plan" of GD no. 1470/2004 approving the National Waste Management Strategy and the National Waste Management Plan (<i>Official Journal no. 271/24.04.2007</i>) MO (Ministry Order) no. 951/2007 approving the Methodology on drafting regional and county waste management plans. (<i>Official Journal no. 497/25.07.2007</i>)
Directive no. 99/31/EC on the landfill of waste	GD no. 349/2005 on the landfill of waste (<i>Official Journal no.394 as of 10 May 2005</i>) Order of the Ministry of Environment and Sustainable Development no.757/2004 approving the technical regulations on waste storage (<i>Official Journal no.86, din 26.01.2005</i>), supplemented and amended by Order no. 1230/2005 (<i>Official Journal no.1101 as of 7.12.2005</i>)
Directive no. 94/62/EC on packaging and packaging waste, with further amendments	GD no.621/2005 on packaging and packaging waste (<i>Official Journal no.639 of 20/07/2005</i>) GD no.1872 as of 21 December, 2006 and GD no. 247 as of 27 March 2011, amending and supplementing GD no.621/2005 on the management of packaging and packaging waste Law no. 292/2007 (<i>Official Journal no. 758 as of 08.11.2007.</i>), GEO no. 37/2008 (<i>Official Journal no. 336 as of 30.04.2008.</i>), GD no. 25/2008 (<i>Official Journal no. 628/29.08. 2008</i>), Law no. 329/2009 (<i>Official Journal no. 761/9.11.2009</i>) , GEO 15/2010 (<i>Official Journal no. 192/26.03. 2010</i>), Law no. 167/2010 (<i>Official Journal no. 504/20.07. 2010</i>) GEO no. 115/2010 (<i>Official Journal 862/22 December 2010</i>), GEO 71/2011 (<i>Official Journal no. 637/6.09. 2011</i>)

Directives/ Decisions	National Regulations
Resolution no. 2000/532/EC, amended by Resolution no. 2001/119 establishing a list of wastes*	GD no. 856 din 16 august, 2002 on the records of waste management and approving the list of wastes, including hazardous waste (Official Journal no. 659 as of 5 September 2002)

Romania committed to implement the EU legislation concerning waste management till the accession date (01.01.2007), with the following derogations on this chapter, included in "Romania's position document Chapter 22 - Environmental protection":

- Directive no. 94/62/EC on packaging and packaging waste - transition period till 2013;
- Directive no. 99/31/EC on the landfill of waste - transition period till 2017;
- Council Directive no. 2000/76/EC on the incineration of waste - transition period till 2009.

The National Development Plan 2007 – 2013 (NDP) also considered the following aims:

- Improving living standards by ensuring the public utility services at the required quality and quantity standards, in the water and waste sectors, by developing the water and waste water infrastructure systems in the concerned localities and creating/consolidating regional related companies, and by developing integrated waste management systems (waste collection, transport, treatment/disposal in the concerned localities; closure non-compliant landfills).
- Improving the environmental management sectorial systems, focus on: the development of specific water and waste management systems, and of natural resource management systems (conservation of biological diversity, ecological reconstruction of damaged systems, prevention and intervention in case of natural risks – particularly floods), as well as on the improvement of the air protection infrastructure.

According with the National Strategy for the Sustainable Development of Romania (2013 – 2020 – 2030), the strategic directions related to the waste management are:

- The rational correlation of the development objectives, including the investment programs, with the capacity of supporting the natural capital;
- Using the best economic and ecologic available technologies, in public fund investment decisions; the firm introduction of eco-efficiency criteria in all production or service activities;
- Forecasting the climate change effects and drafting both long term adaptation solutions, and inter-sectorial contingency measures, including alternative solution portfolios for crisis situations generated by natural and anthropic processes.

Solid waste storage

The following measures are established at EU and national level in order to reduce waste landfill:

- Prioritization of the efforts in the waste management field in line with the waste hierarchy;
- Increasing the recycling rate and improving the quality of recycled materials, working closely with the business sector and companies with the main activity waste recovery;
- Promoting the recovery of packaging waste.

For the biodegradable waste, the total amount of biodegradable waste deposited shall continuously decrease, by:

- Reducing the amount of biodegradable waste to 35% of the total amount, gravimetrically expressed, produced in 1995, until 2016;
- Reducing the amount of biodegradable waste by recycling and processing (minimizing the waste organic material in order to reduce the amount of levigates and biogas from the storage);
- Reducing the amount of paper waste and cardboard for 60% of the total, gravimetrically expressed, produced in 1995, until 2016.

The most important measure to reduce GHG emissions from non-compliant landfills is foreseen by GD no. 349/2005 regarding the waste disposal, transposing the Directive 99/31/EC regarding the waste disposal, namely: Appendix no. 5 "Calendar of cessation/ termination of service or compliance for the existing landfills – table 5.1 – non-compliant landfills class "b" of the urban area that cease the storage."

According to this calendar, until 2017, 41 non-compliant landfills will have to cease their activity during 2013-2017.

As a member state of the European Union, Romania has to fulfill, by 2020, according to the Directive no. 2008/98/EC of the European Parliament and of the Council of Europe, the following targets: at least 50% reuse and recycling rate of the total mass of the waste (paper, metal, plastic and glass) recycling and other material recovery operations of at least 70% of the mass of non-hazardous waste from construction and demolition activities, 60% recovery of the packaging waste from the total packaging placed on the national market.

The main proposals for revision of the legislative framework included in the Circular Economic Package include among others:

- Preparing for reuse and recycling 65% of municipal waste by 2030 (with an intermediate target of 60% in 2025). In order to achieve this objective, Romania can benefit from an additional period of five years provided that the necessary measures are taken to increase the reuse and municipal waste recycling rate by 2025 and 2030 respectively to at least 50% and 60% by weight;
- Preparing for reuse and recycling 65% of all packaging waste by 2025 and at least 75% by 2030 (with an intermediate target of 65% in 2025). Also, minimum targets for preparation for re-use and recycling of specific materials contained in packaging waste are set for both 2025 and 2030;
- Storage of up to 10% of municipal waste by 2030. Romania can benefit from an additional period of five years provided the necessary measures are taken to reduce by 2030 the amount of municipal waste deposited to 20% of the total amount of waste generated;
- Prohibiting the storage of separately collected waste;
- Promoting economic instruments to discourage depositing;
- Simplified and improved definitions and methods for the calculation of harmonized recycling targets at EU level;
- Promoting reuse and stimulating industrial symbiosis;

- Economic incentives for manufacturers to market more environmentally friendly products and support recycling and recovery schemes (eg packaging, batteries, electrical and electronic equipment, vehicles);
- Reduction of food waste generation in primary production, processing and processing, in wholesale and retail, in restaurants and food services as well as in households.

Directive no. 94/62/EC on the management of packaging and packaging waste, with subsequent amendments, provides for the following objectives for Romania from 2013:

- Recycling at least 55% of the total packaging weight;
- The following minimum recycling targets for the materials contained in the packaging waste must be achieved: (i) 60% by weight for glass; (ii) 60% by weight for paper and board; (iii) 50% by weight for metals; (iv) 22.5% by weight for plastics, taking exclusively into account recycled plastic materials; (v) 15% by weight for wood.

Government Decision no. 870/2013 on the approval of the National Strategy for Waste Management 2014-2020 proposes:

- Prioritize waste management efforts in line with the waste hierarchy (prevention, preparation for reuse, recycling, other recovery operations, eg energy recovery, disposal);
- Developing measures to encourage waste prevention and re-use, promoting the sustainable use of resources;
- Increasing the recycling rate and improving the quality of recycled materials, working close to the business sector and the waste recycling units and enterprises;
- Promoting recycling of packaging waste as well as other categories of waste;
- Reducing the impact of carbon generated by waste;
- Encouraging energy generation from waste for non-recyclable waste;
- Organizing the national database and streamlining the monitoring process;
- Implementation of the concept of "lifecycle analysis" in waste management policy.

The National Waste Management Plan and the National Waste Prevention Plan are being revised, being currently (November 2017) in the environmental approval procedure, the Ministry of Environment informing the public about the organization of the public debate on the proposed plan, including of the environmental report.

Wastewater treatment

The national policy to reduce GHG emissions, in line with EU legislation, implies the adoption of policies and measures at sector level, for assuring the target established at the national level by the Decision no. 406/2009/EC.

In order to prevent the pollution of surface water with the wastewater from anthropogenic sources, the legislation in force shall be follow. This legislation concerns mainly the quality indicators of the wastewater discharged in the environment.

The basis of the EU legislation in the field of the wastewater is the Directive 91/271/ECC concerning the treatment of the urban wastewater, amended and supplemented by the Directive 98/15/EC. The Directive 91/271/ECC was fully transposed into the Romanian legislation by the GD no. 188/2002 approving some rules concerning the conditions for discharge of wastewater into the aquatic environment, amended and supplemented by the GD

no. 352/2005. The GD no. 188/2002 contains the following key annex related to collection, transport, treatment and disposal of wastewater:

- Annex 1. Technical rules for collection, treatment and discharge of urban waste, NTPA – 011;
- Annex 2. Standard on wastewater discharge conditions in the local sewerage networks and direct in treatment plants, NTPA – 002;
- Annex 3. Standard on setting pollutants limits for urban and industrial wastewater discharged into the natural receptors, NTPA – 001.

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

In Romania, the EU legislation in the field of wastewater treatment and discharge into the aquatic environment was implemented during the period 2002-2005, but, further implementation steps are required to fully comply with the requirements of the Directive.

Considering both the location of Romania in the basin of the Danube and the basin of the Black Sea, as well as the necessity to protect the environment in these areas, Romania declared its entire territory as sensitive area. This decision is reflected in the fact that the agglomerations with more than 10.000 equivalent inhabitants should provide an urban wastewater infrastructure to allow the advanced treatment, especially with regards to the nutrients nitrogen and phosphorus. The secondary treatment (biological level) is a general rule for the agglomerations which are smaller than 10.000 equivalent inhabitants.

The terms of implementation of the Directive vary and depend on the size of the agglomeration and its impact on the receiving waters. The final transition period for the implementation of the Directive was set on December 31st 2018, with intermediate deadlines for the collection and treatment of the waste water.

The measures to limit and/or reduce GHG emissions arising from the wastewater treatment are the following:

- Increase the degree of connection to the sewerage and waste water services
- Construction of new wastewater treatment plants;
- Rehabilitation and upgrading of the existing wastewater treatment plants;
- Use of modern technology with lower power consumption;
- Automation of the wastewater treatment plants operation, with beneficial implications for their optimal functioning, i.e. avoiding methane emission.

IV D Cross-cutting Policies and Measures

The policies and measures for all NIR sectors are presented in the subchapters IV.C.1÷5.

An overview of all cross-cutting policies and measures, including the affected sectors is presented in the Table IV_4.

Table IV_4 Cross-sectoral policies and measures

Policies and Measures	Affected sector					
	Energy Supply	Energy Consumption	Industry	Transport	Agriculture and forests	Waste
GD no.739/2016 for the approval of the National Strategy on Climate Change and Economic Growth on the basis of Low Carbon Emissions for the period 2016-2030 and the National Action Plan for the implementation of the National Strategy on Climate Change and Low-Growth Economy (PNASC) for 2016-2020	yes	yes	yes	yes	yes	yes
Law 278/2013 on industrial emissions	yes		yes			
GD no. 780/2006 on establishing the scheme for greenhouse gas emission allowance trading, modified by GD no. 133/2010, GD no. 399/2010, GD no.1300/2010, GEO no.115/2011 and GD no. 204/2013	yes		yes			
Law no. 121/2014 on energy efficiency and Law no. 1607/2016 on amendments and completions to Law 121/2014	yes	yes	yes	yes	yes	
National Energy Efficiency Action Plan 2014-2020	yes	yes	yes	yes	yes	
National Action Plan for Energy in Romania Renewable Sources	yes				yes	
Emissions Trading Scheme	yes	interaction	yes			
Promoting Combined Heat and Power (CHP)	yes	interaction	interaction			
Romanian Energy and Climate Change Fund	yes	yes				
The Eco-Design Directive	yes	yes	interaction			
Biofuels Implementation Directive	interaction			yes	yes	
Green Investment Scheme	yes	interaction		yes	yes	
Waste Framework Directive	yes	yes	interaction			yes

The policies and measures considered in the WEM scenario for reducing the GHG emissions are presented in Table IV_5 ÷ IV_6.

Table IV 5 Policies and measures to reduce GHG emissions, considered in scenario with measures

No.	Policy/ Measure	Objective	GHG	ETS/ non- ETS	Type of policy instrument	Implementa tion Status	Entities responsible for implementing the policy	Estimated effect of the policy and measures on GHG emissions (kt CO ₂ equivalent)			
								2020	2025	2030	2035
ENERGY SECTOR											
1	GD 1069/2007 Romania's Energy Strategy for 2007 – 2020	Evolution of the energy sector, with the main objectives: energy security, sustainable development, competitiveness. This strategy presents the national energy consumption by 2030 and the measures needed to cover this consumption. This strategy was updated in 2013 and 2016 taking into account the effects of the 2008-2011 economic crisis and the economic and social development 2011- 2016.	CO ₂	ETS/ non-ETS	Planning	Implemented	Ministry of Energy	12,668.2	18,092.2	16,375.5	17,394.5
2	Romania's Energy Strategy 2016- 2030 with the Perspective of 2050	Scenarios for the development of the energy sector 2016- 2030, taking into account the EU targets for CO ₂ reduction - under public debate and evaluation at the Ministry of Environment.	CO ₂	ETS/non -ETS	Planificare		Ministry of Energy				
3	GD 1460/2008 National Strategy for Sustainable Development of Romania. 2013 – 2020 - 2030 Horizon	The future evolution of energy sector, of industrial sector, of agriculture and forestry, of rural development of the transport sector. This strategy will be update taking into consideration new social and economic conditions.	GHG	ETS/non -ETS	Planning	Implemented	The Ministry of Energy, Ministry of Economy, Ministry of Environment, Ministry of Agriculture and Rural Development, Ministry of Regional Development, Public Administration and European Funds, Ministry of Transport	43,157.5	50,229.4	51,413.8	53,128.3
4	National Renewable Energy Action Plans	Promotion of energy from renewable sources by types of technologies: hydro, photovoltaic, wind and biomass	CO ₂	non-ETS	Planning	Implemented	Ministry of Energy	3,100.0			

No.	Policy/ Measure	Objective	GHG	ETS/ non- ETS	Type of policy instrument	Implementa tion Status	Entities responsible for implementing the policy	Estimated effect of the policy and measures on GHG emissions (kt CO ₂ equivalent)			
								2020	2025	2030	2035
5	Law no.121/2014 on Energy Efficiency and Law 160/2016 on amending and completing Law no.121 / 2014	Transposes into Romanian legislation the Directive 2012/27/EU Establishes the obligation to purchase products. Services, works., Buildings with high energy efficiency performance, monitoring and reporting on the implementation of the measures of the National Energy Efficiency Action Plan etc.	CO ₂	ETS/non-ETS	Planning	Implemented	Ministry of Economy, Ministry of Regional Development, Internal Affairs and European Funds, Ministry of Transport, Ministry of Agriculture and Rural Development	18,667.3	24,356.8	23,421.6	24,063.5
6	Third National Energy Efficiency Plan for 2014-2020 (NNAP III) approved by Government Decision no.122 / 2015	Primary energy saving measures are put in place (decommissioning of production capacities, new coal capacities, using modern technologies, promotion of high efficiency cogeneration, rehabilitation / modernization of district heating services, reduction of losses in energy transmission and distribution networks Electricity, Heat and Natural Gas Establishment of measures to increase the energy efficiency of the final consumer (industry, construction, agriculture, transport, services, population) Establishment of measures to increase energy efficiency in the public sector (thermal insulation and ventilation in buildings from the public sector, increasing efficiency in public lighting, purchasing equipment and appliances with low energy consumption) The strategy for mobilizing investment in the renovation of the existing residential and commercial residential and commercial buildings nationally.	CO ₂	ETS/non-ETS	Planning	Implemented	Ministry of Energy, Ministry of Economy, Ministry of Regional Development, Internal Affairs and European Funds, Ministry of Transport, Ministry of Agriculture and Rural Development	12,668.2 ¹ 4,055.5 ² 214.5 ³ 301.4 ⁴ 846.0 ⁵	18,092.2 ¹ 4150.0 ² 266.9 ³ 351.3 ⁴ 868.0 ⁵	16,375.5 ¹ 4,223.8 ² 845.6 ³ 400.2 ⁴ 904.2 ⁵	17,394.5 ¹ 4,315.0 ² 533.9 ³ 425.6 ⁴ 1,183.5 ⁵

No.	Policy/ Measure	Objective	GHG	ETS/ non- ETS	Type of policy instrument	Implementa tion Status	Entities responsible for implementing the policy	Estimated effect of the policy and measures on GHG emissions (kt CO ₂ equivalent)			
								2020	2025	2030	2035
7	GD 780/2006 establishing the greenhouse gas emission allowance trading scheme, amended by GD 133/2010, GD 399/2010, GD 1300/2010 and the subsequent legislation	Establishing the greenhouse gas emission allowance trading scheme.	CO ₂	EU ETS	Economic	Implemented	Ministry of Environment; Ministry of Economy, Ministry of Energy	7,000.000	15,000.000	NA	NA
8	The improvement of the handling coal	The decrease of methane emissions	CH ₄	ETS/non -ETS	Planning	Implemented	Mining Companies	2,191.0	2,195.5	2,210.5	2,228.7
9	The improvement for the oil and gas sectors	The decrease of fugitive emissions of CH ₄	CH ₄	ETS/non -ETS	Planning	Implemented	Oil and gas companies	5,275.3	5,393.5	5,471.3	5,513.3
10	The improvement for the oil and gas sectors	The decrease of fugitive emissions of CO ₂	CO ₂	ETS/non -ETS	Planning	Implemented	Oil and gas companies	871.4	913.0	989.5	1056.1
11	Law no. 114/2013 approving GEO no. 64/2011 on the geological storage of carbon dioxide	Reduction of CO ₂ emissions using CCS Technologies	CO ₂	ETS	Regulatory	Implemented	Ministry of Economy, Ministry of Environment	0.000	0.000	0.000	0.000
12	GD 1043/2007 transposition of Directive 2005/32/EC	The establishment a framework for setting of ecodesign requirements for energy-using product	CO ₂	non-ETS	Regulatory	Implemented	Ministry of Economy				
<i>Manufacturing Industries and Construction</i>											
13	The modernization of industrial sector	The reduction of energy intensity	CO ₂	ETS/non -ETS	Planning	Implemented	Ministry of Economy, Industry Enterprises	4,055.0	4,150.0	4,223.8	4,315.0
14	Commitments up to 2020 for non ETS sector	The reduction of GHG emissions for non-ETS sectors	CO ₂	non-ETS	Regulatory	Not implemented	Ministry of Environment; Ministry of Economy; Ministry of Regional Development, Public Administration and European Funds ; Ministry of	8,122 ⁶			

No.	Policy/ Measure	Objective	GHG	ETS/ non-ETS	Type of policy instrument	Implementation Status	Entities responsible for implementing the policy	Estimated effect of the policy and measures on GHG emissions (kt CO ₂ equivalent)			
								2020	2025	2030	2035
							Transport; Ministry of Agriculture and Rural Development				
<i>Transport Sector</i>											
15	GD no. 666/2016 for approving the General Transport Master Plan (GTMP)	Establishes the main directions for the development of transport infrastructure in Romania over the next 15 years, on all modes of transport: road, rail, naval, air and multimodal. In the railway field the aim is to increase the attractiveness of the railway transport and to improve the conditions of travel by modernizing the national railway network and developing the railway services. In the air field, it establishes the modernization of airports and means of transport.	CO ₂	Non-ETS	Planning	Implemented	Ministry of Transport				
16	The modernization of transport sector	The decrease of energy consumption and the emissions with the followings measures: the use of biofuels and bioliquids in accordance with GD no 935/2011, new cars in accordance with EC Regulation no 443/2009, new clean passenger cars in accordance with EO no 40/2001 ammended by EO no 9/2013, encouraging forms of alternative transport (cycling etc), increasing the degree of using public transportation, the use new vehicles with low consumption and emissions, the use of intermodal transport etc.	CO ₂	non-ETS	Planning	Implemented	Ministry of Transport	214.5	266.9	845.6	533.9

No.	Policy/ Measure	Objective	GHG	ETS/ non- ETS	Type of policy instrument	Implementa tion Status	Entities responsible for implementing the policy	Estimated effect of the policy and measures on GHG emissions (kt CO ₂ equivalent)			
								2020	2025	2030	2035
17	GEO 40/2011 transposition of Directive 2009/33/EC	The purpose of this ordinance is to promote and stimulate the market of clean and efficient energy vehicles and improving transport sector's contribution to EU policies on the environment, climate and energy. Stipulate the obligation to take into account the purchase of road transport vehicles of energy and environmental impact throughout their life. Aspects to be considered for the evaluation of operational energy and environmental impacts include at least the following: a) energy b) CO ₂ c) NO _x , NMHC and particulate matter.	CO ₂	non-ETS	Planning	Implemented	Ministry of Transport				
18	GD 928/2012 concerning the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions	Introducing a mechanism to monitor and reduce greenhouse gas emissions	All	non-ETS	Regulatory	Implemented	Ministry of Economy, Ministry of Environment, Ministry of Agriculture and Rural Development				
19	GD no. 935/2011 promoting the use of biofuels and bio liquids, amended and supplemented by GD no. 1121/2013	Establishes the legal framework for the promotion of the use of biofuels and bioliquids in the transport sector. Starting with January 1st 2011, the biofuels share in the energy consumption in transport is at least 5%. In the following years, biofuels share shall increase gradually till 2018 for reaching the standard established by the directive.	CO ₂ , CH ₄ , N ₂ O	non-ETS	Regulatory	Implemented	Ministry of Transport				

No.	Policy/ Measure	Objective	GHG	ETS/ non-ETS	Type of policy instrument	Implementation Status	Entities responsible for implementing the policy	Estimated effect of the policy and measures on GHG emissions (kt CO ₂ equivalent)			
								2020	2025	2030	2035
20	GD no. 90/2011 establishing measure for implementing Regulation (EC) no. 443/2009 setting emission performance standards for new passenger cars	Establishes emission performance standards for new passenger cars; starting in 2020, the vehicle fleet shall have an emission average of 95 g CO ₂ /km, compared to the average emission from 2012-2013, i.e. 130 g CO ₂ /km.	CO ₂	non-ETS	Regulatory	Implemented	Ministry of Transport				
<i>Services Sector</i>											
21	The modernization of services sector (NNAP III)	The decrease of energy consumption with the following measures: the heating upgrade of the buildings, the compulsion to enforce the provisions of EU efficiency standards for new buildings, the efficiency of lighting systems, the use of low energy lamps, new equipments with low energy consumption etc.	CO ₂	ETS/non-ETS	Planning	Implemented	Ministry of Regional Development and Public Administration, Ministry of Economy	301.4	351.3	400.3	425.6
22	Law no. 372/2005 regarding the energy performance of buildings, with modification and completion (2017)	The objective is to increase the energy performance of residential and public buildings. This requires performance requirements for new buildings, renovated buildings and technical building systems. It defines the building whose energy consumption is almost equal to zero.	CO ₂	non-ETS	Regulatory	Implemented	Ministry of Regional Development, Public Administration and European Funds; Ministry of Energy; National Regulatory Authority for Energy				

No.	Policy/ Measure	Objective	GHG	ETS/ non- ETS	Type of policy instrument	Implementa tion Status	Entities responsible for implementing the policy	Estimated effect of the policy and measures on GHG emissions (kt CO ₂ equivalent)			
								2020	2025	2030	2035
<i>Residential Sector</i>											
23	The modernization of residential sector (NNAP III)	The decrease of energy consumption with the following measures: the heating upgrade of the blocks of flats, the compulsion to enforce the provisions of EU efficiency standards for new buildings, the efficiency of lighting systems, the use of low energy lamps, the use of new equipments with low energy consumptions etc.	CO ₂	ETS/non-ETS	Planning	Implemented	Ministry of Regional Development and Public Administration	846.0	868.0	904.2	1,183.5
<i>Agriculture Sector</i>											
24	The modernization of agriculture sector (NNAP III)	The reduction of energy intensity due to concentration of agricultural land and to use of BAT in irrigation installations and new equipments	CO ₂	non-ETS	Planning	Implemented	Ministry of Agriculture and Rural Development	104.7	155.5	180.2	205.2
INDUSTRIAL PROCESSES AND PRODUCT USE SECTOR											
25	Law no. 278/2013 on industrial emissions	Setting permit conditions for IPPC installations, in accordance with BAT Conclusions.	CO ₂ , CH ₄ , N ₂ O	ETS/non-ETS	Regulatory	Implemented	Ministry of Environment	9,609.78	9,537.02	9,219.73	8,790.82
26	Regulation (EU) no. 517/2014 related fluorinated greenhouse gases	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. Annual limit for HCF quantities placed on the market in 2030 represent 21% of 2009-2012 levels.	HFC	Non ETS	Regulatory	Implemented	Ministry of Environment				
27	Directive 40/2006/EC (MAC Directive) on emissions from air conditioning systems of the motor vehicles	Reduction of emissions of fluorinated gases	HFC		Regulatory	Implemented	Ministry of Environment; National Agency for Environmental Protection				

No.	Policy/ Measure	Objective	GHG	ETS/ non- ETS	Type of policy instrument	Implementa tion Status	Entities responsible for implementing the policy	Estimated effect of the policy and measures on GHG emissions (kt CO ₂ equivalent)			
								2020	2025	2030	2035
AGRICULTURE SECTOR											
28	The improvement of quality of nutrition for cattle, sheep and goats	Use the practice of Common Agricultural Policy	CH ₄	ETS/non-ETS	Planning	Implemented	Owners of livestock farms	2,320.0	2,150.0	3,231.3	3,375.0
29	The improvement of manure management	The decrease of methane emissions from livestock	CH ₄	ETS/non-ETS	Planning	Implemented	Owners of livestock farms	695.0	847.5	862.5	980.0
30	Order 1182/2005 of Ministry of Environmental and Sustainable Development and Ministry of Agriculture and Rural Development for approval Agricultural good practice code for the protection of waters against pollution caused by nitrates from agricultural sources	Agricultural good practice code	N ₂ O	ETS/non-ETS	Regulatory/ Planning	Implemented	Ministry of Environment, Ministry of Agriculture and Rural Development				
31	GD 964/2000 transposition of Directive 91/676/EEC concerning the protection water against pollution caused by nitrates from agricultural sources	Approving the Action plan for protection of waters against pollution caused by nitrates from agricultural sources. Romania shall re-examine, revise or supplement at least once every 4 years the list of areas vulnerable to nitrates, appointed to consider the changes and factors resulting from the previous appointment	N ₂ O	non-ETS	Regulatory	Implemented	Ministry of Environment, Ministry of Agriculture and Rural Development				

No.	Policy/ Measure	Objective	GHG	ETS/ non- ETS	Type of policy instrument	Implementa tion Status	Entities responsible for implementing the policy	Estimated effect of the policy and measures on GHG emissions (kt CO ₂ equivalent)			
								2020	2025	2030	2035
32	Order no. 352/636/2015/54/2015 of the Ministry of Agriculture and Rural Development and of the Ministry of Environment, Waters and Forests and of the National Sanitary Veterinary and Food Safety Authority for the approval of cross-compliance rules in the schemes and support measures for farmers in Romania	The Annex to the Order presents Requirements and mandatory standards for farmers for the purpose of environmental protection, namely: protection of resources against pollution with nitrates from agricultural sources etc.	N ₂ O	ETS/non-ETS	Regulation / Planning	Planned	Ministry of Environment, Ministry of Agriculture and Rural Development				
LULUCF											
33	The improvement of land use	The increase of annual harvest wood as of the pre-1989 period. Afforestation of degraded lands 5kha/year(including revegetation and forest belts). Implementation of "no-till" practices for 30% of the area of arable land (in rotation) per year from 2015-2030	CO ₂	ETS/non-ETS	Planning	Implemented	Ministry of Environment and Climate Change, The Autonomous Direction of Forests, Private owners	-3,160.77	-1,093.56	-2,761.19	-2,394.93
WASTE SECTOR											
34	The improvement of the management of the solid waste	The recovering of CH ₄ emissions resulted from the wastes deposits in compliant landfill , the improvement of the degree of the utilization, the achievement of the compliance deposits of the wastes.	CH ₄	ETS/non-ETS	Planning	Implemented	Companies that manage landfill of waste	825.0	1,518.5	2,030.8	2,319.3

No.	Policy/ Measure	Objective	GHG	ETS/ non- ETS	Type of policy instrument	Implementa tion Status	Entities responsible for implementing the policy	Estimated effect of the policy and measures on GHG emissions (kt CO ₂ equivalent)			
								2020	2025	2030	2035
35	Law no. 211/2011 on the regime of waste	Establishes the necessary measures to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and increasing the efficiency of their use.	CH ₄	non-ETS	Planning	Implemented	Ministry of Environment; Ministry of Economy; Ministry of Regional Development, Public Administration and European Funds; Ministry of Agriculture and Rural Development; Public and local authorities				
36	National Waste Management Strategy 2014- 2020 and the National Waste Management Plan (public debate on April 2017)	The Strategy sets Romania's policy and strategic objectives in the field of waste management on short term (2015) and medium term (2020). For Strategy implementation on short-term, the National Waste Management Plan is elaborated detailing the actions to be taken to achieve the objectives of the Strategy, the implementation of these actions, including targets, deadlines and responsibilities for implementation. The provisions of the Strategy apply to all types of waste regulated by Law no. 211/2011 on waste regime.	CH ₄	non-ETS	Planning	Implemented	Ministry of Environment; Ministry of Economy; Ministry of Regional Development, Public Administration and European Funds; Ministry of Agriculture and Rural Development				
37	The Improvement of the wastewater treatment	A more efficient treatment of sewage and commercial water	CH ₄	ETS/non -ETS	Planning	Implemented	Ministry of Regional Development, Public Administration and European Funds; Economic entities	1,688.0	2,209.8	2,816.5	3,515.5

Legend:

1	Reductions in CO ₂ emissions by applying energy efficiency improvement measures (EEAS) in the energy industry
2	Reductions in CO ₂ emissions by applying energy efficiency improvement measures (EEAS) in manufacturing and construction
3	Reductions in CO ₂ emissions by applying energy efficiency improvement measures (EEAS) in the transport industry
4	Reductions in CO ₂ emissions through the implementation of energy efficiency improvement measures (EEAS) in the services sector
5	Reductions in CO ₂ emissions by applying energy efficiency improvement measures (NAPE I) in the residential sector
6	Value represents the difference between GHG emissions from 2005 and those from 2020 A (126331.7- 118209.7)

The policies and measures for reducing GHG emissions in the WAM scenario, presented in Table IV_6, considered all additional measures for complying with Romania target, established by EU.

Table IV_ 6 Policies and measures to reduce GHG emissions, considered in scenario with additional measures

No.	Policy/Measure	Objective	GHG	ETS/ non-ETS	Type of policy instrument	Implementation Status	Entities responsible for implementing the policy	Estimated effect of the policy and measures on GHG emissions (kt CO ₂ equivalent)			
								2020	2025	2030	2035
ENERGY SECTOR											
1	National Renewable Energy Action Plans	Promotion of energy from renewable sources by types of technologies: hydro, photovoltaic, wind and biomass	CO ₂	non-ETS	Planning	Planned	Ministry of Economy	0.0	0.0	2015.0	3,095.0
2	The improvement of the handling coal	The decrease of methane emissions	CH ₄	ETS/ non-ETS	Planning	Planned	Mining Companies	37.0	42.3	37.8	35.3
3	The improvement for the oil and gas sectors	The decrease of fugitive emissions of CH ₄	CH ₄	ETS/ non-ETS	Planning	Planned	Oil and gas companies	154.8	130.8	100.0	66.8
4	The improvement for the oil and gas sectors	The decrease of fugitive emissions of CO ₂	CO ₂	ETS/ non-ETS	Planning	Planned	Oil and gas companies	117.9	120.7	123.3	125.7
5	Romania's Energy Strategy 2016-2030, with the perspective of 2050	The main objectives are energy security (diversify energy resources) sustainable development (increasing energy efficiency, promoting energy production from renewable resources, promoting high efficiency cogeneration plants, rational and efficient use of primary energy resources) competitiveness (developing market for electricity, natural gas, uranium, green certificates, greenhouse gas emission permits)	CO ₂	EU ETS	Regulatory/ Planning	Planned	Ministry of Economy, Ministry of Internal Affairs	876.0	1079.6	120.7	1,886.1
Manufacturing Industries and Construction											
6	The modernization of industrial sector	The reduction of energy intensity	CO ₂	ETS/ non-ETS	Planning	Planned	Ministry of Economy and Industry Enterprises	260.5	282.0	0.0	706.1

No.	Policy/Measure	Objective	GHG	ETS/ non-ETS	Type of policy instrument	Implementation Status	Entities responsible for implementing the policy	Estimated effect of the policy and measures on GHG emissions (kt CO ₂ equivalent)			
								2020	2025	2030	2035
<i>Transport sectors</i>											
7	The modernization of transport sector	The decrease of energy consumption and the emissions with the followings measures: the use of biofuels and bioliquids in accordance with GD no 935/2011, new cars in accordance with EC Regulation no 443/2009, new clean passanger cars inaccordance with EO no 40/2001 amended by EO no 9/2013, encouraging forms of alternative transport (cycling etc), increasing the degree of using public transportation, the use new vehicles with low consumption and emissions, the use of intermodal transport etc.	CO ₂	non-ETS	Planning	Planned	Ministry of Transport	322.0	325.4	395.6	418.0
<i>Services Sector</i>											
8	The modernization of services sector	The decrease of energy consumption with the following measures: the heating upgrade of the buildings, the compulsion to enforce the provisions of EU efficiency standards for new buildings, the efficiency of lighting systems, the use of low energy lamps, new equipments with low energy consumption etc.	CO ₂	ETS/non-ETS	Planning	Planned	Ministry of Regional Development and Public Administration, Ministry of Economy	94.50	172.33	88.0	97.14
<i>Residential Sector</i>											
9	The modernization of residential sector	The decrease of energy consumption with the following measures: the heating upgrade of the blocks of flats, the compulsion to enforce the provisions of EU efficiency standards for new buildings, the efficiency of lighting systems, the use of low energy lamps, the use of new equipments with low energy consumptions etc.	CO ₂	ETS/ non-ETS	Planning	Planned	Ministry of Regional Development and Public Administration	68.55	152.82	483.63	491.92

No.	Policy/Measure	Objective	GHG	ETS/ non-ETS	Type of policy instrument	Implementation Status	Entities responsible for implementing the policy	Estimated effect of the policy and measures on GHG emissions (kt CO ₂ equivalent)			
								2020	2025	2030	2035
<i>Agriculture sector</i>											
10	The modernization of agriculture sector	The reduction of energy intensity due to concentration of agricultural land and to use of BAT in irrigation installations and new equipments	CO ₂	non-ETS	Planning	Planned	Ministry of Agriculture and Rural Development	12.51	26.42	37.23	47.27
AGRICULTURE SECTOR											
11	The improvement of quality of nutrition for cattle, sheep and goats	Use the practice of Common Agricultural Policy	CH ₄	ETS/ non-ETS	Planning	Planned	Owners of livestock farms	467.50	685.00	797.5	1,062.5
12	The improvement of manure management	The decrease of methane emissions from livestock	CH ₄	ETS/ non-ETS	Planning	Planned	Owners of livestock farms	62.50	131.25	200.00	325.00
13	Order 1182/2005 of Ministry of Environmental and Sustainable Development and Ministry of Agriculture and Rural Development for approval Agricultural good practice code for the protection of waters against pollution caused by nitrates from agricultural sources	Agricultural good practice code	N ₂ O	ETS/ non-ETS	Regulatory/ Planning	Planned	Ministry of Environment, Ministry of Agriculture and Rural Development				
LULUCF											
14	The improvement of land use	The increase of annual harvest wood as of the pre-1989 period. Afforestation of degraded lands 5kha/year (including revegetation and forest belts). Implementation of "no-till" practices for 30% of the area of arable land (in rotation) per year from 2015-2030	CO ₂	ETS/ non-ETS	Planning	Planned	Ministry of Environment, Autonomy of Forests, Private Owners	-4,120.22	-6,317.36	-9,305.79	-8,542.55

No.	Policy/Measure	Objective	GHG	ETS/ non-ETS	Type of policy instrument	Implementation Status	Entities responsible for implementing the policy	Estimated effect of the policy and measures on GHG emissions (kt CO ₂ equivalent)			
								2020	2025	2030	2035
WASTE SECTOR											
15	The improvement of the stored solid waste	The recovering of CH ₄ emissions resulted from the wates deposits compliant landfill	CH ₄	ETS/ non-ETS	Planning	Planned	Companies that manage landfill of waste	271.18	670.5	1,168.16	452.96
16	The Improvement of the wastewater treatment	A more efficient treatment of sewage and commercial water	CH ₄	ETS/ non-ETS	Planning	Planned	Ministry of Regional Development, Public Administration and European Funds, Economic Agencies	0.0	0.0	0.0	0.0

IV. D. Policies and measures no longer in place

During the reporting period no policies and measures have expired or were abrogated, which may influence the GHG emissions trends.

In 2016, the National Strategy on Climate Change and Low-carbon Economic Growth for 2016-2020 was approved by GD no. 739/2016 and the National Action Plan for the Implementation of the National Strategy on Climate Change and Economic Growth Based on Low Carbon Emissions for the period 2016-2020.

The main objective of the national strategy on climate change and low carbon growth is to mobilize and enable private and public actors to reduce greenhouse gas emissions, GHGs from economic activities in line with EU targets and adapt to the impacts of climate change, both current and future. As regards the GHG emission reduction process, this strategy adopts quantifiable targets in line with the EU's 2030 commitments. As far as adaptation to climate change is concerned, the aim is to support and promote the protection of the environment, people and the environment. economic activities to the effects of climate change, especially extreme events. The strategy will guide Romania's climate change and low carbon development actions by 2030, representing an update and extension of the National Climate Change Strategy 2013-2020 in the light of current events.

V PROJECTIONS AND THE TOTAL EFFECTS OF POLICIES AND MEASURES, AND SUPPLEMENTARY RELATING TO KYOTO PROTOCOL MECHANISM

V. A. Projections

V.A.1. Background and scenarios

The most recent GHG emission projections were elaborated in April 2017, considering the trends of key macro-economic, technological, demographical and other indicators related to the social-economic development of Romania.

The projections of GHG emissions were considered the following:

- The Sixth National Communication of Romania;
- National Strategy for Climate Change and increase of economy based on reducing the carbon emissions corresponding to 2016-2020 period;
- National Action Plan for implementation the National Strategy for Climate Change and increase of economy based on reducing the carbon emissions for 2016-2020 period;
- National Allocation Plan for participation at EU ETS;
- The data and information related to GHG trend during the 1989 - 2015 period, included in the National inventories submitted by Romania to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC);
- The development and planning strategies at national and sectoral level;
- The forecasts of the macroeconomic indicators elaborated by the National Prognosis Commission in 2017 year.

The GHG projections for 2020, 2025, 2030, 2035 considered different scenarios related to the economic-social, demographic and technological evolution, in order to allow the highlight of the measures undertaken by Romania for implementing the EU Directive on environmental protection, and respecting its commitments as part of Kyoto Protocol.

The GHG emission projections are carried out for 3 scenarios, respectively:

- A "business as usual" (BAU) reference scenario – **the scenario without measures** (WOM), reference year - 2005;
- A mitigation scenario, similar to the reference scenario in terms of the evolution of the economic-social and demographic indicators, containing mitigation policies and programs - **the scenario with measures** (WEM), reference year - 2015;
- A mitigation scenario with additional measures, similar to the mitigation scenario, containing additional emission mitigation measures - **the scenario with additional measures** (WAM), reference year - 2015.

The reference scenario, in terms of the evolution of the economic-social and demographic indicators, considered the impact of current economic crisis on the development of Romania.

The considered scenarios are based on social-economic assumptions, presented in subchapter V.A.3.

Considering that the projection horizon is 2020 - 2035, the reference year is 2015, for which the National Inventory of Greenhouse Gas Emissions is realized and submitted to the UNFCCC, according with Romania's obligations.

The GHG emission projections are based on assumptions related to macroeconomic indicators with high uncertainty on horizon until 2035, because of the economic crisis at nationally and globally level and the lack of updated 2035 strategy on industry, agriculture, transport, etc. Thus, economic development is a dominant factor affecting the results projected.

In order to analyse the sensitivity of projections of GHG emissions in the given assumptions there are developed scenarios on the minimum and maximum economic recovery, compared to baseline scenario for which projections were made.

In the subchapter V.D.8 are presented the sensitivity of underlying assumption and uncertainty made for energy sector and LULUCF sector.

V.A.2. Total GHG emission projections

The total GHG emissions projections are presented in the Table V_1 – V_3 for scenario WOM scenario, WEM scenario and WAM scenario, for each sector (Energy – CRF1, Industrial Processes - CRF2, Agriculture - CRF3, Land Use, Land – Use Change and Forestry LULUCF – CRF4, Waste – CRF5).

In Figure V_A_1 is presented the GHG emissions evolution in the period 1989-2035 for all scenarios (WOM, WEM, WAM). Romania achieved the target established through the Kyoto protocol for the period 2008-2012.

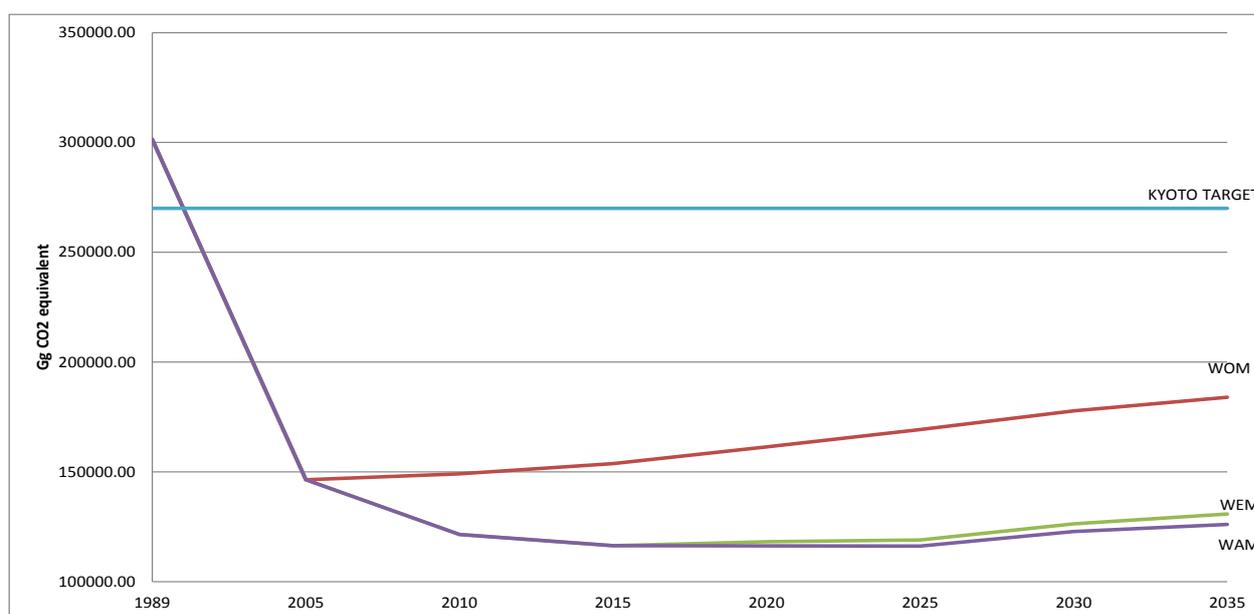


Figure V_A_1 Evolution of the GHG emissions

Table V_1 shows that in the WOM scenario, the GHG emissions increased increase in 2005-2015 from 146,438.74 Gg CO₂ eq. to 155,447.15 Gg CO₂ eq. and are higher by about 33.5% in comparison with the value determined by National Inventory of Greenhouse Gas Emissions for 2015.

Table V_2 shows that in the WEM scenario, GHG emissions are expected to increase between 2015 and 2020 with an average rate of 1.45%. GHG emissions in 2020 will be lower by about 26.75% compared to the emissions from WOM scenario.

Table V_3 shows that in the WAM scenario, GHG emissions are expected to decrease between 2015 and 2020 with an average rate of 0.003%. GHG emissions in 2020 will be lower by 27.95% compared to the emissions from WOM scenario.

Table V_ 1 Evolution of the total GHG emissions for WOM scenario, 2005 – 2035

GREENHOUSE GAS SOURCE	Realised	Forecasted			
	2005	2020	2025	2030	2035
	Gg CO ₂ equiv.				
1. Energy	99239.57	108316.00	113022.62	117654.91	121000.77
A. Fuel combustion	81753.41	89609.22	93970.23	98222.52	101248.99
1. Energy industries	40213.28	41189.98	42338.67	43501.63	44696.75
1.A.1.a. Public electricity and heat production	33505.89	34208.34	35199.30	36173.59	37148.64
1.A.1.b. Petroleum refining	3174.84	3253.12	3325.61	3425.85	3565.87
1.A.1.c. Manufacture of solid fuels and other energy industries	3532.54	3728.52	3813.76	3902.19	3982.24
1.A.2. Manufacturing industries and construction	16811.18	17018.27	17689.46	18227.92	19144.67
1.A.3. Transport	12580.64	18172.62	19741.95	21359.78	21736.27
1.A.3.a. Domestic aviation	189.77	202.69	243.05	260.28	303.93
1.A.3.b. Road transportation	11893.84	17134.41	18635.22	20184.72	20445.82
1.A.3.c. Railways	253.10	571.93	588.54	620.87	678.64
1.A.3.d. Domestic navigation	129.73	142.97	151.17	163.89	171.98
1.A.3.e. Other transportation	114.20	120.63	123.98	130.02	135.91
1.A.4. Other sectors	11245.73	12283.56	13253.23	14185.89	15213.98
1.A.4.a. Commercial/Institutional	2524.96	2561.18	2613.36	3053.71	3394.19
1.A.4.b. Residential	8260.29	8559.96	9200.72	9842.21	10469.11
1.A.4.c. Agriculture/Forestry/Fishing	460.48	1162.42	1239.15	1289.97	1350.69
1.A.5. Other	902.57	944.79	946.92	947.31	947.31
1.B. Fugitive emissions from fuels	17486.17	18706.78	19052.38	19432.38	19751.78
1.B.1. Solid fuels	3141.58	3250.00	3275.00	3325.00	3375.00
1.B.2. Oil and natural gas and other emissions from energy production	14344.59	15456.78	15777.38	16107.38	16376.78
1.C. CO₂ Transport and storage	NO	NO	NO	NO	NO
2. Industrial processes and product use	21005.23	22319.79	23453.68	23999.66	24343.77
2.A. Mineral industry	4435.01	6073.60	6800.00	7080.00	7226.80
2.A. of which cement production	3174.81	3873.60	4300.00	4510.00	4626.80
2.A. of which other non cement production	1260.20	2200.00	2500.00	2570.00	2600.00
2.B. Chemical industry	6312.30	6492.25	6592.50	6495.25	6598.50
2.C. Metal industry	9424.77	7361.76	7477.06	7684.95	7712.39
2.C. of which Iron and steel production	8675.36	7005.65	7105.75	7296.75	7307.33
2.C. of which other non Iron and steel production	749.41	356.11	371.31	388.20	405.06
2.D. Non-energy products from fuels and solvent use	462.12	451.65	465.20	482.88	501.23
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	368.91	1875.62	2043.65	2169.34	2203.71
2.G. Other product manufacture and use	2.12	64.91	75.27	87.24	101.14
2.H. Other	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
3. Agriculture	20505.81	22925.91	24300.56	26815.75	28622.87
3.A. Enteric fermentation	11471.75	12500.00	12750.00	14200.00	14672.50
3.B. Manure management	2948.82	3451.52	3716.00	4123.60	4919.60
3.C. Rice cultivation	0.00	0.00	0.00	0.00	0.00
3.D. Agricultural soils	5226.95	6196.61	7023.86	7643.40	8138.98
3.E. Prescribed burning of savannas	NO	NO	NO	NO	NO
3.F. Field burning of agricultural residues	719.75	681.30	712.29	748.35	789.17
3.G. Liming	85.79	32.03	32.67	33.33	34.00
3.H. Urea application	52.75	64.45	65.74	67.07	68.62
3.I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO
3.J. Other	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	-20122.78	-20159.11	-19148.75	-19222.03	-19175.13
4.A. Forest land	-26540.91	-21982.74	-21571.23	-20803.35	-20802.31
4.B. Cropland	-1671.77	-1270.24	-561.38	-1203.98	-1159.02
4.C. Grassland	232.60	62.75	85.75	86.33	85.91
4.D. Wetlands	1548.66	29.49	29.88	33.00	32.95
4.E. Settlements	3949.39	889.04	924.68	925.81	920.38
4.F. Other land	1859.71	2112.58	1943.55	1740.17	1746.95
4.G. Harvested wood products	499.54	0.00	0.00	0.00	0.00
4.H. Other	NO	NO	NO	NO	NO
5. Waste	5688.13	7805.53	8452.70	9273.50	10018.32
5.A. Solid waste disposal	2565.06	3628.99	3750.00	3950.00	4000.00
5.B. Biological treatment of solid waste	138.78	101.88	107.08	121.93	118.28
5.C. Incineration and open burning of waste	98.22	7.02	7.02	7.02	7.02
5.D. Wastewater treatment and discharge	2886.06	4067.64	4588.60	5194.56	5893.02
5.E. Other	NA	NA	NA	NA	NA
Total CO₂ equivalent emissions without LULUCF	146438.74	161367.24	169229.55	177743.82	183985.73
Total CO₂ equivalent emissions with LULUCF	126315.96	141208.12	150080.80	158521.79	164810.59

Table V_2 Evolution of the total GHG emissions for WEM scenario, 2015– 2035

GREENHOUSE GAS SOURCE	Realised	Forecasted			
	2015	2020	2025	2030	2035
	Gg CO ₂ echiv				
1. Energy	80098.16	81028.26	79875.84	85280.02	87877.15
A. Fuel combustion	68747.68	70659.11	69326.08	74519.53	76923.40
1. Energy industries	29721.92	28471.76	24176.12	27062.54	27233.06
1.A.1.a. Public electricity and heat production	27114.87	24721.43	19705.74	22349.01	22073.37
1.A.1.b. Petroleum refining	1526.12	2065.15	2488.96	2681.04	3059.44
1.A.1.c. Manufacture of solid fuels and other energy industries	1080.93	1685.18	1981.42	2032.49	2100.25
1.A.2. Manufacturing industries and construction	12455.94	12959.76	13537.72	14002.54	14830.36
1.A.3. Transport	15730.41	17762.03	19267.44	20254.96	20924.67
1.A.3.a. Domestic aviation	127.09	119.65	171.56	216.26	280.72
1.A.3.b. Road transportation	15093.54	17054.59	18421.52	19282.65	19799.86
1.A.3.c. Railways	374.21	422.26	461.43	500.59	539.80
1.A.3.d. Domestic navigation	129.53	136.64	172.56	203.61	239.53
1.A.3.e. Other transportation	6.03	28.89	40.37	51.86	64.76
1.A.4. Other sectors	10378.38	11023.81	11899.05	12752.73	13486.56
1.A.4.a. Commercial/Institutional	2014.25	2259.38	2461.17	2651.81	2966.42
1.A.4.b. Residential	7334.14	7702.47	8350.79	8986.96	9367.73
1.A.4.c. Agriculture/Forestry/Fishing	1029.99	1061.95	1087.09	1113.97	1152.41
1.A.5. Other	461.03	441.75	445.75	446.75	448.75
1.B. Fugitive emissions from fuels	11350.48	10369.15	10549.76	10760.49	10953.75
1.B.1. Solid fuels	1004.55	1059.00	1079.50	1114.50	1146.25
1.B.2. Oil and natural gas and other emissions from energy production	10345.93	9310.15	9470.26	9645.99	9807.50
1.C. CO₂ Transport and storage	NO	NO	NO	NO	NO
2. Industrial processes and product use	11872.23	12710.01	13916.66	14779.93	15552.95
2.A. Mineral industry	4515.27	5028.52	5624.32	6074.05	6584.83
2.A. of which cement production	3337.47	3672.00	4029.00	4233.00	4386.00
2.A. of which other non cement production	1177.81	1356.52	1595.32	1841.05	2198.83
2.B. Chemical industry	1121.87	1053.21	1162.91	1283.48	1415.71
2.C. Metal industry	4105.61	4445.96	5107.68	5535.63	5714.62
2.C. of which Iron and steel production	3763.99	4116.85	4764.53	5176.87	5340.28
2.C. of which other non Iron and steel production	341.63	329.11	343.15	358.76	374.34
2.D. Non-energy products from fuels and solvent use	436.70	424.54	414.03	405.62	400.50
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	1636.76	1688.10	1556.39	1448.15	1404.41
2.G. Other product manufacture and use	56.01	69.68	51.33	33.00	32.88
2.H. Other	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
3. Agriculture	18613.03	19249.35	20567.00	21948.93	23350.03
3.A. Enteric fermentation	10682.20	10180.00	10600.00	10968.75	11297.50
3.B. Manure management	2262.51	2470.44	2567.52	2762.19	3033.68
3.C. Rice cultivation	0.01	0.00	0.00	0.00	0.00
3.D. Agricultural soils	4898.87	5793.12	6558.98	7336.76	8090.70
3.E. Prescribed burning of savannas	NO	NO	NO	NO	NO
3.F. Field burning of agricultural residues	675.10	709.31	742.09	780.83	825.53
3.G. Liming	31.40	32.03	32.67	33.33	34.00
3.H. Urea application	62.95	64.45	65.74	67.07	68.62
3.I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO
3.J. Other	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	-18258.18	-16998.33	-18055.19	-16460.83	-16780.21
4.A. Forest land	-25449.91	-22247.45	-21312.47	-19054.68	-19381.60
4.B. Cropland	-1737.29	-1214.29	-817.89	-1331.51	-1312.94
4.C. Grassland	232.60	359.60	137.47	138.05	137.64
4.D. Wetlands	1548.66	29.49	29.88	33.00	32.95
4.E. Settlements	3949.39	1299.94	1319.57	1369.28	1352.00
4.F. Other land	1886.61	4774.37	2588.24	2385.02	2391.75
4.G. Harvested wood products	1311.75	0.00	0.00	0.00	0.00
4.H. Other	NO	NO	NO	NO	NO
5. Waste	5843.25	5222.08	4640.63	4321.18	4077.29
5.A. Solid waste disposal	3519.79	2803.99	2231.50	1919.16	1680.74
5.B. Biological treatment of solid waste	57.81	101.88	112.49	124.20	137.12
5.C. Incineration and open burning of waste	7.02	7.02	7.02	7.02	7.02
5.D. Wastewater treatment and discharge	2258.63	2309.19	2289.62	2270.81	2252.41
5.E. Other	NA	NA	NA	NA	NA
Total CO₂ equivalent emissions without LULUCF	116426.67	118209.70	119000.13	126330.06	130857.42
Total CO₂ equivalent emissions with LULUCF	98168.49	101211.36	100944.94	109869.22	114077.22

Table V_ 3 Evolution of the total GHG emissions for WAM scenario, 2015 – 2035

GREENHOUSE GAS SOURCE	Realised		Forecasted		
	2015	2020	2025	2030	2035
	Gg CO ₂ equiv.				
1. Energy	80098.16	79958.06	78593.53	83934.84	85843.41
A. Fuel combustion	68747.68	69896.12	68325.68	73435.43	75117.33
1. Energy industries	29721.92	28471.76	24176.12	27062.54	27233.06
1.A.1.a. Public electricity and heat production	27114.87	24721.43	19705.74	22349.01	22073.37
1.A.1.b. Petroleum refining	1526.12	2065.15	2488.96	2681.04	3059.44
1.A.1.c. Manufacture of solid fuels and other energy industries	1080.93	1685.18	1981.42	2032.49	2100.25
1.A.2. Manufacturing industries and construction	12455.94	12698.50	13254.63	14000.28	14121.42
1.A.3. Transport	15730.41	17435.50	18937.50	19854.02	20500.56
1.A.3.a. Domestic aviation	127.09	105.23	157.14	201.83	244.81
1.A.3.b. Road transportation	15093.54	16749.52	18120.08	18903.17	19425.75
1.A.3.c. Railways	374.21	422.26	461.43	500.59	539.80
1.A.3.d. Domestic navigation	129.53	129.60	158.48	196.57	225.45
1.A.3.e. Other transportation	6.03	28.89	40.37	51.86	64.76
1.A.4. Other sectors	10378.38	10848.61	11511.68	12071.85	12813.54
1.A.4.a. Commercial/Institutional	2014.25	2164.61	2288.36	2554.37	2868.98
1.A.4.b. Residential	7334.14	7634.61	8162.78	8441.22	8839.68
1.A.4.c. Agriculture/Forestry/Fishing	1029.99	1049.39	1060.54	1076.26	1104.88
1.A.5. Other	461.03	441.75	445.75	446.75	448.75
1.B. Fugitive emissions from fuels	11350.48	10061.94	10267.85	10499.41	10726.08
1.B.1. Solid fuels	1004.55	1022.00	1037.25	1076.75	1111.00
1.B.2. Oil and natural gas and other emissions from energy production	10345.93	9039.94	9230.60	9422.66	9615.08
1.C. CO₂ Transport and storage	NO	NO	NO	NO	NO
2. Industrial processes and product use	11872.23	12710.01	13916.66	14779.93	15552.95
2.A. Mineral industry	4515.27	5028.52	5624.32	6074.05	6584.83
2.A. of which cement production	3337.47	3672.00	4029.00	4233.00	4386.00
2.A. of which other non cement production	1177.81	1356.52	1595.32	1841.05	2198.83
2.B. Chemical industry	1121.87	1053.21	1162.91	1283.48	1415.71
2.C. Metal industry	4105.61	4445.96	5107.68	5535.63	5714.62
2.C. of which Iron and steel production	3763.99	4116.85	4764.53	5176.87	5340.28
2.C. of which other non Iron and steel production	341.63	329.11	343.15	358.76	374.34
2.D. Non-energy products from fuels and solvent use	436.70	424.54	414.03	405.62	400.50
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	1636.76	1688.10	1556.39	1448.15	1404.41
2.G. Other product manufacture and use	56.01	69.68	51.33	33.00	32.88
2.H. Other	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
3. Agriculture	18613.03	18376.65	19080.25	19861.50	20612.59
3.A. Enteric fermentation	10682.20	9712.50	9915.00	10097.50	10235.00
3.B. Manure management	2262.51	2407.94	2436.27	2562.19	2708.68
3.C. Rice cultivation	0.01	0.00	0.00	0.00	0.00
3.D. Agricultural soils	4898.87	5450.42	5888.48	6320.58	6740.76
3.E. Prescribed burning of savannas	NO	NO	NO	NO	NO
3.F. Field burning of agricultural residues	675.10	709.31	742.09	780.83	825.53
3.G. Liming	31.40	32.03	32.67	33.33	34.00
3.H. Urea application	62.95	64.45	65.74	67.07	68.62
3.I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO
3.J. Other	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	-18258.18	-16038.89	-12831.39	-9916.24	-10632.59
4.A. Forest land	-25449.91	-21306.50	-19366.43	-15510.73	-16349.84
4.B. Cropland	-1737.29	-1543.04	-570.39	-1289.43	-1226.57
4.C. Grassland	232.60	359.60	405.87	429.72	423.63
4.D. Wetlands	1548.66	376.74	415.58	33.00	179.31
4.E. Settlements	3949.39	1299.94	1385.60	1436.74	1419.11
4.F. Other land	1886.61	4774.37	4898.37	4984.45	4921.78
4.G. Harvested wood products	1311.75	0.00	0.00	0.00	0.00
4.H. Other	NO	NO	NO	NO	NO
5. Waste	5843.25	5213.71	4594.16	4277.55	4037.17
5.A. Solid waste disposal	3519.79	2781.23	2175.31	1871.29	1642.75
5.B. Biological treatment of solid waste	57.81	116.28	122.21	128.45	135.00
5.C. Incineration and open burning of waste	7.02	7.02	7.02	7.02	7.02
5.D. Wastewater treatment and discharge	2258.63	2309.19	2289.62	2270.81	2252.41
5.E. Other	NA	NA	NA	NA	NA
Total CO₂ equivalent emissions without LULUCF	116426.67	116258.42	116184.60	122853.83	126046.12
Total CO₂ equivalent emissions with LULUCF	98168.49	100219.54	103353.22	112937.58	115413.53

The contribution of different sectors from total GHG emissions, in 2005/2015, 2020 and 2025, for WOM scenario and WEM scenario, are presented in the Figure V_A_2.

In all years and scenario, the contribution of energy sector from total GHG emissions is the highest (about 65÷69%), followed by contribution of agriculture sector (about 13÷18%).

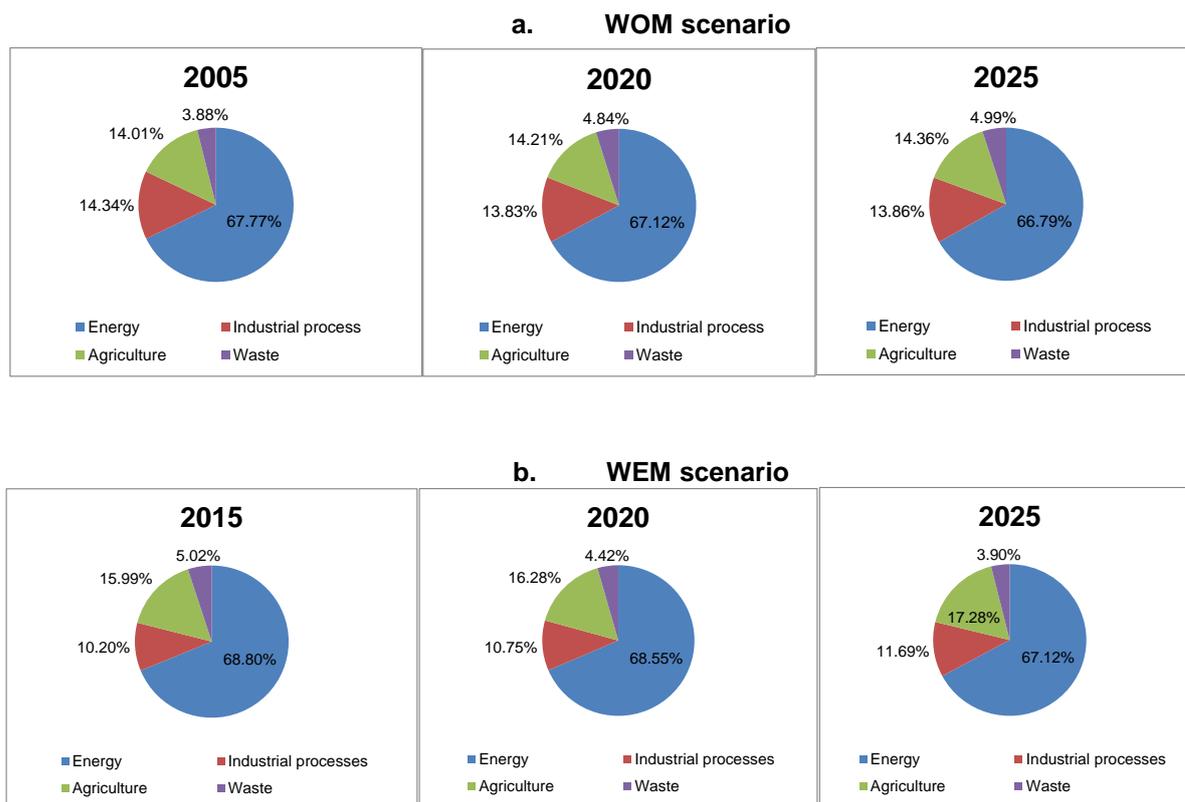
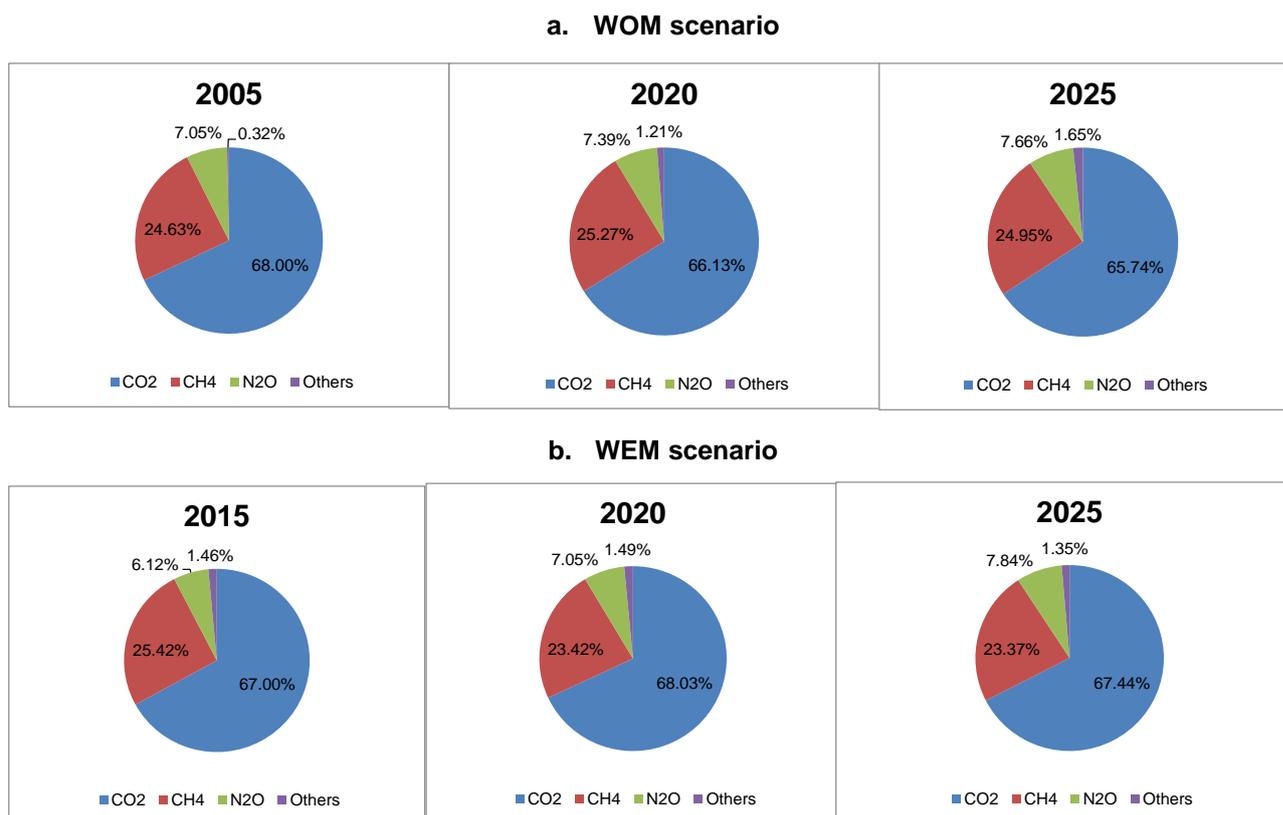


Figure V_A_2 The contribution of the sectors at the GHG emissions

In Figure V_A_3 are presented the contributions of different gases (CO₂, CH₄, N₂O, HFC, PFC, SF₆) to total GHG emissions.

In all period and in all scenarios, the contribution of CO₂ emissions is highest in total GHG emissions (around 66-69%), followed by CH₄ emissions (around 23-26%).



c. WAM scenario

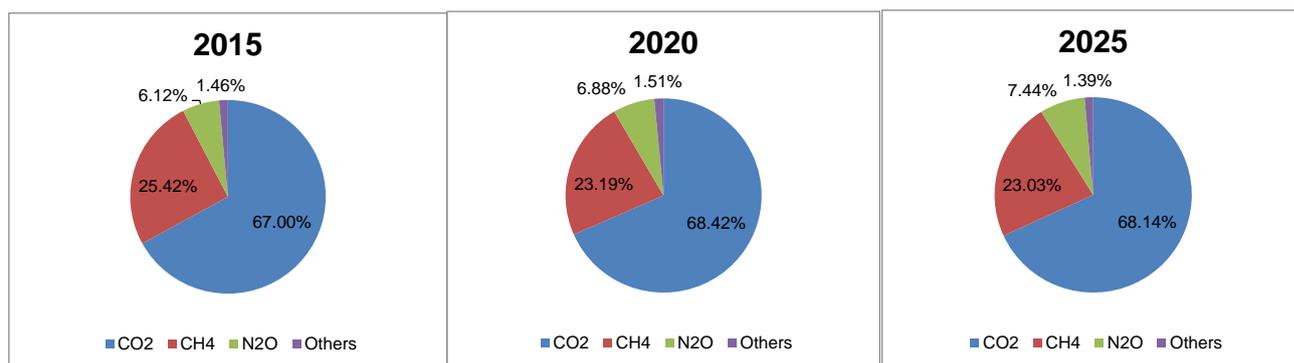


Figure V_A_3 The contribution of various gases at total GHG emissions

In the energy sector, in 2015, the combustion of the fuels (CRF1.A) generated the biggest quantities of GHG emissions, about 90% of total GHG emissions and the fugitive emissions from fuel processing (CRF1.B) generated only about 10% of total GHG emissions. The contribution of the various subsectors at the GHG emissions due to the combustion of the fuels in 2020 and 2025, in WEM scenario, is presented in the Figure V_A_4.

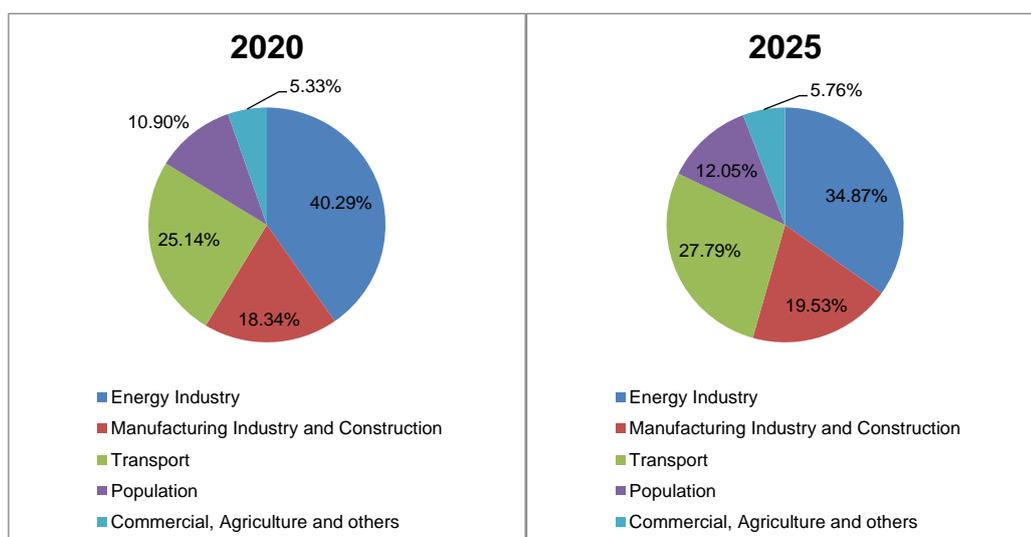


Figure V_A_4 The contribution of different subsectors at GHG emissions due to the combustion of the fuels

The projections of CO₂ emissions for WOM scenario, WEM scenario and WAM scenario, during the period 2005/2015 ÷ 2035, are presented in the Tables V_4 ÷ V_6.

Table V_ 4 Evolution of the CO₂ emissions for WOM scenario, 2005-2035

GREENHOUSE GAS SOURCE	Realised	Forecasted			
	2005	2020	2025	2030	2035
	Gg CO ₂				
Total CO2 emissions without CO2 from LULUCF	99585.25	106708.60	111250.91	116554.18	120167.73
Total CO2 emissions with CO2 from LULUCF	77646.44	84705.51	90258.02	95488.14	99148.59
1. Energy	81882.18	89236.80	93481.40	97705.00	100739.70
A. Fuel combustion	80221.47	87531.80	91731.40	95875.00	98839.70
1. Energy industries	40072.74	41031.90	42175.70	43331.60	44521.50
1.A.1.a. Public electricity and heat production	33378.91	34063.20	35047.70	36015.50	36985.40
1.A.1.b. Petroleum refining	3168.81	3246.30	3320.90	3420.90	3560.90
1.A.1.c. Manufacture of solid fuels and other energy industries	3525.02	3722.40	3807.10	3895.20	3975.20
1.A.2. Manufacturing industries and construction	16742.88	16950.00	17615.60	18150.00	19060.40
1.A.3. Transport	12360.92	17700.00	19235.00	20785.00	21130.00
1.A.3.a. Domestic aviation	188.12	201.50	241.40	258.40	301.20
1.A.3.b. Road transportation	11702.70	16853.60	18323.50	19829.60	20071.10
1.A.3.c. Railways	228.47	383.00	397.10	405.90	453.00
1.A.3.d. Domestic navigation	128.38	141.40	149.20	161.30	169.20
1.A.3.e. Other transportation	113.25	120.50	123.80	129.80	135.50
1.A.4. Other sectors	10213.43	10949.90	11805.10	12688.40	13697.80
1.A.4.a. Commercial/Institutional	2516.54	2554.00	2805.00	3044.00	3383.00
1.A.4.b. Residential	7240.88	7245.90	7774.30	8368.80	8979.50
1.A.4.c. Agriculture/Forestry/Fishing	456.01	1150.00	1225.80	1275.60	1335.30
1.A.5. Other	831.51	900.00	900.00	920.00	430.00
1.B. Fugitive emissions from fuels	1660.71	1705.00	1750.00	1830.00	1900.00
1.B.1. Solid fuels	NA	NA	NA	NA	NA
1.B.2. Oil and natural gas and other emissions from energy product	1660.71	1705.00	1750.00	1830.00	1900.00
1.C. CO2 Transport and storage	NO	NO	NO	NO	NO
2. Industrial processes and product use	17474.66	17369.42	17665.20	18742.88	19319.51
2.A. Mineral industry	4435.01	6073.60	6100.00	6950.00	7226.80
2.A. of which cement production	3174.81	3873.60	4300.00	4510.00	4626.80
2.A. of which other non cement production	1260.20	2200.00	2500.00	2570.00	2600.00
2.B. Chemical industry	3259.59	3500.00	3600.00	3800.00	3900.00
2.C. Metal industry	9317.94	7344.17	7500.00	7510.00	7691.48
2.C. of which Iron and steel production	8663.81	7000.00	7100.00	7290.00	7300.00
2.C. of which other non iron and steel production	654.13	344.17	358.86	375.18	391.48
2.D. Non-energy products from fuels and solvent use	462.12	451.65	465.20	482.88	501.23
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	NO	NO	NO	NO	NO
2.G. Other product manufacture and use	NO	NO	NO	NO	NO
2.H. Other	NE,NO	NO,NE	NO,NE	NO,NE	NO,NE
3. Agriculture	138.54	96.48	98.41	100.40	102.62
3.A. Enteric fermentation					
3.B. Manure management					
3.C. Rice cultivation					
3.D. Agricultural soils					
3.E. Prescribed burning of savannas					
3.F. Field burning of agricultural residues					
3.G. Liming	85.79	32.03	32.67	33.33	34.00
3.H. Urea application	52.75	64.45	65.74	67.07	68.62
3.I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO
3.J. Other	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	-21938.80	-22003.09	-20992.89	-21066.04	-21019.14
4.A. Forest land	-26667.96	-22010.84	-21599.50	-20831.49	-20830.43
4.B. Cropland	-2097.61	-1696.08	-987.22	-1629.82	-1584.86
4.C. Grassland	201.26	31.41	54.41	54.99	54.58
4.D. Wetlands	1515.66	-3.51	-3.12	0.00	-0.05
4.E. Settlements	3699.64	639.28	674.92	676.05	670.63
4.F. Other land	810.67	1036.64	867.61	664.23	671.01
4.G. Harvested wood products	499.54	0.00	0.00	0.00	0.00
4.H. Other	NO	NO	NO	NO	NO
5. Waste	89.87	5.90	5.90	5.90	5.90
5.A. Solid waste disposal	NA	NA	NA	NA	NA
5.B. Biological treatment of solid waste	NA	NA	NA	NA	NA
5.C. Incineration and open burning of waste	89.87	5.90	5.90	5.90	5.90
5.D. Wastewater treatment and discharge					
5.E. Other	NA	NA	NA	NA	NA
Memo items					
M. International bunkers	378.06	867.29	867.29	867.29	867.29
M.IB. Aviation	378.06	619.49	619.49	619.49	619.49
M.IB. Navigation	NO	247.81	247.81	247.81	247.81
M.CO2 emissions from biomass	14972.38	19327.87	21202.64	22603.23	23603.07
M.CO2 captured	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
M. Long-term storage of C in waste disposal sites	NA	NA	NA	NA	NA
M. Indirect N2O					
M. International aviation in the EU-ETS					

Table V_ 5 Evolution of the CO₂ emissions for WEM scenario, 2015 ÷ 2035

SURSA EMISIILOR DE GES	Realised	Forecasted			
	2015	2020	2025	2030	2035
	Gg CO ₂				
Total CO2 emissions without CO2 from LULUCF	78013.49	80415.89	80252.97	86289.41	89394.29
Total CO2 emissions with CO2 from LULUCF	57911.19	61573.54	60353.75	67984.55	70770.06
1. Energy	68092.13	69698.11	68211.54	73293.91	75620.15
A. Fuel combustion	67155.61	68864.49	67374.56	72453.45	74776.18
1. Energy industries	29596.35	28363.70	24083.50	26956.13	27121.07
1.A.1.a. Public electricity and heat production	26992.95	24618.74	19619.43	22249.22	21968.51
1.A.1.b. Petroleum refining	1524.53	2063.01	2486.38	2678.27	3056.27
1.A.1.c. Manufacture of solid fuels and other energy industries	1078.87	1681.95	1977.69	2028.64	2096.28
1.A.2. Manufacturing industries and construction	12394.24	12894.48	13465.61	13926.21	14745.42
1.A.3. Transport	15501.09	17485.54	18968.10	19939.35	20596.14
1.A.3.a. Domestic aviation	125.97	118.60	170.05	214.35	278.25
1.A.3.b. Road transportation	14907.69	16826.97	18176.30	19026.27	19536.10
1.A.3.c. Railways	333.36	376.07	410.89	445.71	480.53
1.A.3.d. Domestic navigation	128.11	135.14	170.67	201.38	236.91
1.A.3.e. Other transportation	5.95	28.76	40.20	51.63	64.36
1.A.4. Other sectors	9242.57	9697.77	10430.35	11203.75	11883.55
1.A.4.a. Commercial/Institutional	2006.24	2252.55	2453.71	2643.76	2957.42
1.A.4.b. Residential	6217.22	6399.89	6906.29	7464.63	7796.00
1.A.4.c. Agriculture/Forestry/Fishing	1019.11	1045.33	1070.35	1095.37	1130.13
1.A.5. Other	421.36	423.00	427.00	428.00	430.00
1.B. Fugitive emissions from fuels	936.52	833.62	836.98	840.46	843.97
1.B.1. Solid fuels	NA	NA	NA	NA	NA
1.B.2. Oil and natural gas and other emissions from energy prod	936.52	833.62	836.98	840.46	843.97
1.C. CO2 Transport and storage	NO	NO	NO	NO	NO
2. Industrial processes and product use	9821.12	10615.40	11937.12	12889.20	13665.62
2.A. Mineral industry	4515.27	5028.52	5624.32	6074.05	6584.83
2.A. of which cement production	3337.47	3672.00	4029.00	4233.00	4386.00
2.A. of which other non cement production	1177.81	1356.52	1595.32	1841.05	2198.83
2.B. Chemical industry	774.75	727.08	802.75	886.31	978.55
2.C. Metal industry	4094.40	4435.26	5096.02	5523.22	5701.74
2.C. of which Iron and steel production	3759.34	4112.40	4759.38	5171.27	5334.50
2.C. of which other non Iron and steel production	335.06	322.86	336.64	351.95	367.24
2.D. Non-energy products from fuels and solvent use	436.70	424.54	414.03	405.62	400.50
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	NO	NO	NO	NO	NO
2.G. Other product manufacture and use	NO	NO	NO	NO	NO
2.H. Other	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
3. Agriculture	94.34	96.48	98.41	100.40	102.62
3.A. Enteric fermentation					
3.B. Manure management					
3.C. Rice cultivation					
3.D. Agricultural soils					
3.E. Prescribed burning of savannas					
3.F. Field burning of agricultural residues					
3.G. Liming	31.40	32.03	32.67	33.33	34.00
3.H. Urea application	62.95	64.45	65.74	67.07	68.62
3.I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO
3.J. Other	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	-20102.31	-18842.36	-19899.22	-18304.86	-18624.23
4.A. Forest land	-25478.15	-22275.59	-21340.62	-19082.82	-19409.74
4.B. Cropland	-2163.13	-1640.13	-1243.73	-1757.35	-1738.78
4.C. Grassland	201.26	328.26	106.14	106.71	106.30
4.D. Wetlands	1515.66	-3.51	-3.12	0.00	-0.05
4.E. Settlements	3699.64	1050.19	1069.82	1119.53	1102.24
4.F. Other land	810.67	3698.43	1512.30	1309.08	1315.81
4.G. Harvested wood products	1311.75	0.00	0.00	0.00	0.00
4.H. Other	NO				
5. Waste	5.90	5.90	5.90	5.90	5.90
5.A. Solid waste disposal	NA	NA	NA	NA	NA
5.B. Biological treatment of solid waste	NA	NA	NA	NA	NA
5.C. Incineration and open burning of waste	5.90	5.90	5.90	5.90	5.90
5.D. Wastewater treatment and discharge					
5.E. Other	NA	NA	NA	NA	NA
Memo items					
M.International bunkers	1508.85	867.29	867.29	867.29	867.29
M.IB.Aviation	1376.43	619.49	619.49	619.49	619.49
M.IB.Navigation	132.42	247.81	247.81	247.81	247.81
M.CO2 emissions from biomass	17052.82	19327.87	21202.64	22603.23	23603.07
M.CO2 captured	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
M. Long-term storage of C in waste disposal sites	NA	NA	NA	NA	NA
M. Indirect N2O					
M.International aviation in the EU-ETS					

Table V_ 6 Evolution of the CO₂ emissions for WAM scenario, 2015 ÷ 2035

GREENHOUSE GAS SOURCE	Realised	Forecasted			
	2015	2020	2025	2030	2035
	Gg CO ₂ equiv.				
Total CO2 emissions without CO2 from LULUCF	78013.49	79539.88	79173.39	85152.25	87508.18
Total CO2 emissions with CO2 from LULUCF	57911.19	61656.97	64497.98	73391.98	75031.57
1. Energy	68092.13	68822.10	67131.95	72156.75	73734.04
A. Fuel combustion	67155.61	68106.44	66415.63	71439.62	73015.74
1. Energy industries	29596.35	28363.70	24083.50	26956.13	27121.07
1.A.1.a. Public electricity and heat production	26992.95	24618.74	19619.43	22249.22	21968.51
1.A.1.b. Petroleum refining	1524.53	2063.01	2486.38	2678.27	3056.27
1.A.1.c. Manufacture of solid fuels and other energy industries	1078.87	1681.95	1977.69	2028.64	2096.28
1.A.2. Manufacturing industries and construction	12394.24	12633.96	13183.61	13926.21	14039.34
1.A.3. Transport	15501.09	17163.57	18642.74	19543.76	20178.11
1.A.3.a. Domestic aviation	125.97	104.30	155.75	200.05	242.65
1.A.3.b. Road transportation	14907.69	16526.26	17879.16	18651.94	19167.59
1.A.3.c. Railways	333.36	376.07	410.89	445.71	480.53
1.A.3.d. Domestic navigation	128.11	128.18	156.75	194.42	222.98
1.A.3.e. Other transportation	5.95	28.76	40.20	51.63	64.36
1.A.4. Other sectors	9242.57	9522.21	10078.78	10585.52	11247.22
1.A.4.a. Commercial/Institutional	2006.24	2158.05	2281.38	2546.62	2860.28
1.A.4.b. Residential	6217.22	6331.34	6753.47	6981.06	7304.08
1.A.4.c. Agriculture/Forestry/Fishing	1019.11	1032.82	1043.93	1057.84	1082.86
1.A.5. Other	421.36	423.00	427.00	428.00	430.00
1.B. Fugitive emissions from fuels	936.52	715.66	716.32	717.13	718.30
1.B.1. Solid fuels	NA	NA	NA	NA	NA
1.B.2. Oil and natural gas and other emissions from energy prod	936.52	715.66	716.32	717.13	718.30
1.C. CO2 Transport and storage	NO	NO	NO	NO	NO
2. Industrial processes and product use	9821.12	10615.40	11937.12	12889.20	13665.62
2.A. Mineral industry	4515.27	5028.52	5624.32	6074.05	6584.83
2.A. of which cement production	3337.47	3672.00	4029.00	4233.00	4386.00
2.A. of which other non cement production	1177.81	1356.52	1595.32	1841.05	2198.83
2.B. Chemical industry	774.75	727.08	802.75	886.31	978.55
2.C. Metal industry	4094.40	4435.26	5096.02	5523.22	5701.74
2.C. of which Iron and steel production	3759.34	4112.40	4759.38	5171.27	5334.50
2.C. of which other non Iron and steel production	335.06	322.86	336.64	351.95	367.24
2.D. Non-energy products from fuels and solvent use	436.70	424.54	414.03	405.62	400.50
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	NO	NO	NO	NO	NO
2.G. Other product manufacture and use	NO	NO	NO	NO	NO
2.H. Other	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
3. Agriculture	94.34	96.48	98.41	100.40	102.62
3.A. Enteric fermentation					
3.B. Manure management					
3.C. Rice cultivation					
3.D. Agricultural soils					
3.E. Prescribed burning of savannas					
3.F. Field burning of agricultural residues					
3.G. Liming	31.40	32.03	32.67	33.33	34.00
3.H. Urea application	62.95	64.45	65.74	67.07	68.62
3.I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO
3.J. Other	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	-20102.31	-17882.91	-14675.41	-11760.27	-12476.61
4.A. Forest land	-25478.15	-21334.65	-19394.57	-15538.88	-16377.99
4.B. Cropland	-2163.13	-1968.88	-996.23	-1715.27	-1652.41
4.C. Grassland	201.26	328.26	374.54	398.38	392.29
4.D. Wetlands	1515.66	343.74	382.58	0.00	146.31
4.E. Settlements	3699.64	1050.19	1135.84	1186.99	1169.35
4.F. Other land	810.67	3698.43	3822.43	3908.51	3845.84
4.G. Harvested wood products	1311.75	0.00	0.00	0.00	0.00
4.H. Other	NO	NO	NO	NO	NO
5. Waste	5.90	5.90	5.90	5.90	5.90
5.A. Solid waste disposal	NA	NA	NA	NA	NA
5.B. Biological treatment of solid waste	NA	NA	NA	NA	NA
5.C. Incineration and open burning of waste	5.90	5.90	5.90	5.90	5.90
5.D. Wastewater treatment and discharge					
5.E. Other	NA	NA	NA	NA	NA
Memo items					
M. International bunkers	1508.85	867.29	867.29	867.29	867.29
M.IB.Aviation	1376.43	619.49	619.49	619.49	619.49
M.IB.Navigation	132.42	247.81	247.81	247.81	247.81
M.CO2 emissions from biomass	17052.82	19327.87	21202.64	22603.23	23603.07
M.CO2 captured	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
M. Long-term storage of C in waste disposal sites	NA	NA	NA	NA	NA
M. Indirect N2O					
M. International aviation in the EU-ETS					

The projections of CH₄ emissions for WOM scenario, WEM scenario and WAM scenario, during the period 2005/2015 ÷ 2035 are presented in the Tables V_7 ÷ V_9.

Table V_ 7 Evolution of the CH₄ emissions for WOM scenario 2005 ÷ 2035

GREENHOUSE GAS SOURCE	Realised	Forecasted			
	2005	2020	2025	2030	2035
Gg CH ₄					
Total CH4 emissions without CH4 from LULUCF	1442.73	1631.12	1689.10	1795.41	1862.47
Total CH4 emissions with CH4 from LULUCF	1442.74	1631.16	1689.14	1795.45	1862.51
1. Energy	675.33	732.88	750.78	764.52	775.07
A. Fuel combustion	42.41	52.88	58.78	60.52	61.07
1. Energy industries	0.70	0.78	0.80	1.01	1.21
1.A.1.a. Public electricity and heat production	0.50	0.610	0.700	0.900	1.100
1.A.1.b. Petroleum refining	0.09	0.13	0.05	0.06	0.06
1.A.1.c. Manufacture of solid fuels and other energy industries	0.10	0.04	0.05	0.05	0.06
1.A.2. Manufacturing industries and construction	1.02	1.02	1.12	1.15	1.34
1.A.3. Transport	2.80	3.74	4.89	6.06	6.07
1.A.3.a. Domestic aviation	0.00	0.00	0.00	0.00	0.00
1.A.3.b. Road transportation	2.75	3.70	4.84	5.98	6.00
1.A.3.c. Railways	0.01	0.02	0.03	0.04	0.04
1.A.3.d. Domestic navigation	0.01	0.01	0.02	0.03	0.03
1.A.3.e. Other transportation	0.02	0.00	0.00	0.00	0.01
1.A.4. Other sectors	35.51	46.00	50.57	51.69	51.82
1.A.4.a. Commercial/Institutional	0.25	0.22	0.25	0.29	0.34
1.A.4.b. Residential	35.13	45.40	49.90	50.95	51.00
1.A.4.c. Agriculture/Forestry/Fishing	0.13	0.38	0.41	0.45	0.48
1.A.5. Other	2.39	1.33	1.40	0.62	0.62
1.B. Fugitive emissions from fuels	632.92	680.00	692.00	704.00	714.00
1.B.1. Solid fuels	125.66	130	131	133	135
1.B.2. Oil and natural gas and other emissions from energy production	507.25	550	561	571	579
1.C. CO2 Transport and storage	NO	NO	NO	NO	NO
2. Industrial processes and product use	3.38	0.72	0.73	0.80	0.95
2.A. Mineral industry	NO	NO	NO	NO	NO
2.A. of which cement production	NO	NO	NO	NO	NO
2.A. of which other non cement production	NO	NO	NO	NO	NO
2.B. Chemical industry	2.92	0.49	0.50	0.53	0.66
2.C. Metal industry	0.46	0.23	0.23	0.27	0.29
2.C. of which iron and steel production	0.46	0.23	0.23	0.27	0.29
2.C. of which other non iron and steel production	NO	0.00	0.00	0.00	0.00
2.D. Non-energy products from fuels and solvent use	NE,NO	NO,NE	NO,NE	NO,NE	NO,NE
2.E. Electronic industry	NE,NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	NE,NO	NO	NO	NO	NO
2.G. Other product manufacture and use	NO	NO	NO	NO	NO
2.H. Other	NE,NO	NO,NE	NO,NE	NO,NE	NO,NE
3. Agriculture	564.99	610.29	624.79	684.79	711.69
3.A. Enteric fermentation	458.87	500	510	568	586.9
3.B. Manure management	85.01	90.5	95	97	105
3.C. Rice cultivation	0.00	0.00	0.00	0.00	0.00
3.D. Agricultural soils	NE	NE	NE	NE	NE
3.E. Prescribed burning of savannas	NO	NO	NO	NO	NO
3.F. Field burning of agricultural residues	21.10	19.79	19.79	19.79	19.79
3.G. Liming					
3.H. Urea application					
3.I. Other carbon-containing fertilizers					
3.J. Other	NO	NA	NA	NA	NA
4. Land use, land-use change and forestry	0.01	0.04	0.04	0.04	0.04
4.A. Forest land	0.01	0.04	0.04	0.04	0.04
4.B. Cropland	NO				
4.C. Grassland	NO				
4.D. Wetlands	NO				
4.E. Settlements	NO				
4.F. Other land	NO				
4.G. Harvested wood products					
4.H. Other					
5. Waste	199.04	287.24	312.80	345.30	374.76
5.A. Solid waste disposal	102.60	145.16	150.00	158.00	160.00
5.B. Biological treatment of solid waste	3.24	2.38	2.50	3.00	2.76
5.C. Incineration and open burning of waste	0.00	NE,NO	NE,NO	NE,NO	NE,NO
5.D. Wastewater treatment and discharge	93.20	139.70	160.30	184.30	212.00
5.E. Other	NA	NA	NA	NA	NA
Memo items					
M. International bunkers	0.02	0.04	0.04	0.04	0.04
M.IB. Aviation	0.02	0.02	0.02	0.02	0.02
M.IB. Navigation	NO	0.02	0.02	0.02	0.02
M.CO2 emissions from biomass					
M.CO2 captured					
M. Long-term storage of C in waste disposal sites					
M. Indirect N2O					
M. International aviation in the EU-ETS					

Table V_ 8 Evolution of the CH₄ emissions for WEM scenario, 2015 ÷ 2035

GREENHOUSE GAS SOURCE	Realised	Forecasted			
	2015	2020	2025	2030	2035
Gg CH ₄					
Total CH₄ emissions without CH₄ from LULUCF	1183.68	1107.97	1112.58	1127.51	1144.36
Total CH₄ emissions with CH₄ from LULUCF	1183.72	1108.01	1112.62	1127.55	1144.40
1. Energy	459.92	430.98	443.24	454.48	464.27
A. Fuel combustion	43.43	49.63	54.80	57.75	59.95
1. Energy industries	0.56	0.57	0.56	0.59	0.74
1.A.1.a. Public electricity and heat production	0.50	0.488	0.463	0.492	0.629
1.A.1.b. Petroleum refining	0.03	0.04	0.05	0.05	0.06
1.A.1.c. Manufacture of solid fuels and other energy industries	0.03	0.04	0.05	0.05	0.06
1.A.2. Manufacturing industries and construction	0.94	0.99	1.09	1.15	1.28
1.A.3. Transport	1.41	1.72	1.87	1.95	2.02
1.A.3.a. Domestic aviation	0.00	0.00	0.00	0.00	0.00
1.A.3.b. Road transportation	1.38	1.68	1.82	1.89	1.95
1.A.3.c. Railways	0.02	0.02	0.03	0.03	0.03
1.A.3.d. Domestic navigation	0.01	0.01	0.02	0.02	0.02
1.A.3.e. Other transportation	0.00	0.00	0.00	0.00	0.01
1.A.4. Other sectors	39.18	45.74	50.66	53.43	55.29
1.A.4.a. Commercial/Institutional	0.26	0.21	0.23	0.25	0.28
1.A.4.b. Residential	38.60	45.00	49.91	52.59	54.30
1.A.4.c. Agriculture/Forestry/Fishing	0.33	0.52	0.53	0.59	0.72
1.A.5. Other	1.33	0.62	0.62	0.62	0.62
1.B. Fugitive emissions from fuels	416.49	381.35	388.44	396.73	404.32
1.B.1. Solid fuels	40.18	42.36	43.18	44.58	45.85
1.B.2. Oil and natural gas and other emissions from energy production	376.31	338.99	345.26	352.15	358.47
1.C. CO ₂ Transport and storage	NO	NO	NO	NO	NO
2. Industrial processes and product use	0.63	0.59	0.67	0.73	0.79
2.A. Mineral industry	NO	NO	NO	NO	NO
2.A. of which cement production	NO	NO	NO	NO	NO
2.A. of which other non cement production	NO	NO	NO	NO	NO
2.B. Chemical industry	0.44	0.41	0.46	0.51	0.56
2.C. Metal industry	0.19	0.18	0.21	0.22	0.23
2.C. of which Iron and steel production	0.19	0.18	0.21	0.22	0.23
2.C. of which other non Iron and steel production	0.00	0.00	0.00	0.00	0.00
2.D. Non-energy products from fuels and solvent use	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	NO	NO	NO	NO	NO
2.G. Other product manufacture and use	NO	NO	NO	NO	NO
2.H. Other	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
3. Agriculture	511.25	489.69	504.89	520.99	537.49
3.A. Enteric fermentation	427.29	407.2	424	438.75	451.9
3.B. Manure management	64.17	62.7	61.1	62.45	65.8
3.C. Rice cultivation	0.00	0.00	0.00	0.00	0.00
3.D. Agricultural soils	NE	NE	NE	NE	NE
3.E. Prescribed burning of savannas	NO	NO	NO	NO	NO
3.F. Field burning of agricultural residues	19.79	19.79	19.79	19.79	19.79
3.G. Liming					
3.H. Urea application					
3.I. Other carbon-containing fertilizers					
3.J. Other	NA	NA	NA	NA	NA
4. Land use, land-use change and forestry	0.04	0.04	0.04	0.04	0.04
4.A. Forest land	0.04	0.04	0.04	0.04	0.04
4.B. Cropland					
4.C. Grassland					
4.D. Wetlands					
4.E. Settlements					
4.F. Other land					
4.G. Harvested wood products					
4.H. Other					
5. Waste	211.88	186.71	163.79	151.30	141.81
5.A. Solid waste disposal	140.79	112.16	89.26	76.77	67.23
5.B. Biological treatment of solid waste	1.35	2.38	2.62	2.90	3.20
5.C. Incineration and open burning of waste	0.00	NE,NO	NE,NO	NE,NO	NE,NO
5.D. Wastewater treatment and discharge	69.74	72.18	71.91	71.64	71.38
5.E. Other	NA	NA	NA	NA	NA
Memo items					
M. International bunkers	0.04	0.04	0.04	0.04	0.04
M.IB. Aviation	0.02	0.02	0.02	0.02	0.02
M.IB. Navigation	0.01	0.02	0.02	0.02	0.02
M.CO ₂ emissions from biomass					
M.CO ₂ captured					
M. Long-term storage of C in waste disposal sites					
M. Indirect N ₂ O					
M. International aviation in the EU-ETS					

Table V_9 Evolution of the CH₄ emissions for WAM scenario, 2015 ÷ 2035

GREENHOUSE GAS SOURCE	Realised	Forecasted			
	2015	2020	2025	2030	2035
Gg CH ₄					
Total CH₄ emissions without CH₄ from LULUCF	1183.68	1078.59	1070.17	1075.10	1081.85
Total CH₄ emissions with CH₄ from LULUCF	1183.72	1078.63	1070.21	1075.14	1081.89
1. Energy	459.92	423.37	435.49	446.73	458.83
A. Fuel combustion	43.43	49.59	53.50	55.51	58.59
1. Energy industries	0.56	0.57	0.56	0.59	0.74
1.A.1.a. Public electricity and heat production	0.503	0.488	0.463	0.492	0.629
1.A.1.b. Petroleum refining	0.03	0.04	0.05	0.05	0.06
1.A.1.c. Manufacture of solid fuels and other energy industries	0.03	0.04	0.05	0.05	0.06
1.A.2. Manufacturing industries and construction	0.94	0.98	1.08	1.12	1.24
1.A.3. Transport	1.41	1.68	1.82	1.91	1.96
1.A.3.a. Domestic aviation	0.00	0.00	0.00	0.00	0.00
1.A.3.b. Road transportation	1.38	1.64	1.77	1.85	1.89
1.A.3.c. Railways	0.02	0.02	0.03	0.03	0.03
1.A.3.d. Domestic navigation	0.01	0.01	0.02	0.02	0.02
1.A.3.e. Other transportation	0.00	0.00	0.00	0.00	0.01
1.A.4. Other sectors	39.18	45.75	49.43	51.28	54.03
1.A.4.a. Commercial/Institutional	0.26	0.20	0.21	0.24	0.27
1.A.4.b. Residential	38.60	45.03	48.69	50.45	53.06
1.A.4.c. Agriculture/Forestry/Fishing	0.33	0.52	0.52	0.59	0.71
1.A.5. Other	1.33	0.62	0.62	0.62	0.62
1.B. Fugitive emissions from fuels	416.49	373.78	381.99	391.22	400.24
1.B.1. Solid fuels	40.182	40.88	41.49	43.07	44.44
1.B.2. Oil and natural gas and other emissions from energy production	376.3055422	332.90	340.50	348.15	355.80
1.C. CO ₂ Transport and storage	NO	NO	NO	NO	NO
2. Industrial processes and product use	0.63	0.59	0.67	0.73	0.79
2.A. Mineral industry	NO	NO	NO	NO	NO
2.A. of which cement production	NO	NO	NO	NO	NO
2.A. of which other non cement production	NO	NO	NO	NO	NO
2.B. Chemical industry	0.44	0.41	0.46	0.51	0.56
2.C. Metal industry	0.19	0.18	0.21	0.22	0.23
2.C. of which Iron and steel production	0.19	0.18	0.21	0.22	0.23
2.C. of which other non Iron and steel production	0.00	0.00	0.00	0.00	0.00
2.D. Non-energy products from fuels and solvent use	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	NO	NO	NO	NO	NO
2.G. Other product manufacture and use	NO	NO	NO	NO	NO
2.H. Other	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
3. Agriculture	511.25	468.49	472.24	478.14	481.99
3.A. Enteric fermentation	427.29	388.5	396.6	403.9	409.4
3.B. Manure management	64.17	60.2	55.85	54.45	52.8
3.C. Rice cultivation	0.00	0.00	0.00	0.00	0.00
3.D. Agricultural soils	NE	NE	NE	NE	NE
3.E. Prescribed burning of savannas	NO	NO	NO	NO	NO
3.F. Field burning of agricultural residues	19.79	19.79	19.79	19.79	19.79
3.G. Liming					
3.H. Urea application					
3.I. Other carbon-containing fertilizers					
3.J. Other	NA	NA	NA	NA	NA
4. Land use, land-use change and forestry	0.04	0.04	0.04	0.04	0.04
4.A. Forest land	0.04	0.04	0.04	0.04	0.04
4.B. Cropland					
4.C. Grassland					
4.D. Wetlands					
4.E. Settlements					
4.F. Other land					
4.G. Harvested wood products					
4.H. Other					
5. Waste	211.88	186.14	161.77	149.49	140.24
5.A. Solid waste disposal	140.79	111.25	87.01	74.85	65.71
5.B. Biological treatment of solid waste	1.35	2.71	2.85	3.00	3.15
5.C. Incineration and open burning of waste	0.00	NE,NO	NE,NO	NE,NO	NE,NO
5.D. Wastewater treatment and discharge	69.74	72.18	71.91	71.64	71.38
5.E. Other	NA	NA	NA	NA	NA
Memo items					
M. International bunkers	0.04	0.04	0.04	0.04	0.04
M.IB. Aviation	0.02	0.02	0.02	0.02	0.02
M.IB. Navigation	0.01	0.02	0.02	0.02	0.02
M.CO ₂ emissions from biomass					
M.CO ₂ captured					
M. Long-term storage of C in waste disposal sites					
M. Indirect N ₂ O					
M. International aviation in the EU-ETS					

The projections of N₂O emissions for WOM scenario, WEM scenario and WAM scenario, for the period 2005/2015 ÷ 2035, are presented in the Tables V_10 ÷ V_12.

Table V_ 10 Evolution of the N₂O emissions for WOM scenario, 2005 ÷ 2035

GREENHOUSE GAS SOURCE	Forecasted	Prognose			
	2005	2020	2025	2030	2035
Gg N ₂ O					
Total N2O emissions without N2O from	34.634	40.044	43.510	46.159	50.152
Total N2O emissions with N2O from LULUCF	40.728	46.229	49.695	52.343	56.336
1. Energy	1.591	2.543	2.590	2.808	2.970
A. Fuel combustion	1.583	2.535	2.582	2.800	2.962
1. Energy industries	0.413	0.465	0.480	0.486	0.487
1.A.1.a. Public electricity and heat production	0.384	0.4359	0.4500	0.4550	0.4555
1.A.1.b. Petroleum refining	0.012	0.012	0.012	0.012	0.012
1.A.1.c. Manufacture of solid fuels and other	0.017	0.017	0.018	0.019	0.019
1.A.2. Manufacturing industries and	0.144	0.144	0.154	0.165	0.170
1.A.3. Transport	0.503	1.272	1.291	1.421	1.525
1.A.3.a. Domestic aviation	0.005	0.004	0.005	0.006	0.009
1.A.3.b. Road transportation	0.411	0.632	0.640	0.690	0.754
1.A.3.c. Railways	0.082	0.632	0.640	0.718	0.754
1.A.3.d. Domestic navigation	0.003	0.004	0.005	0.006	0.007
1.A.3.e. Other transportation	0.002	0.000	0.000	0.000	0.001
1.A.4. Other sectors	0.485	0.616	0.617	0.688	0.740
1.A.4.a. Commercial/Institutional	0.008	0.006	0.007	0.008	0.009
1.A.4.b. Residential	0.473	0.601	0.600	0.670	0.720
1.A.4.c. Agriculture/Forestry/Fishing	0.004	0.010	0.010	0.011	0.011
1.A.5. Other	0.038	0.038	0.040	0.040	0.040
1.B. Fugitive emissions from fuels	0.008	0.008	0.008	0.008	0.008
1.B.1. Solid fuels	NA/NO	NA	NA	NA	NA
1.B.2. Oil and natural gas and other	0.008	0.006	0.008	0.008	0.006
1.C. CO2 Transport and storage	NO	NO	NO	NO	NO
2. Industrial processes and product use	10.006	10.015	10.017	9.020	9.023
2.A. Mineral industry	NO	NO	NO	NO	NO
2.A. of which cement production	NO	NO	NO	NO	NO
2.A. of which other non cement production	NO	NO	NO	NO	NO
2.B. Chemical industry	9.999	10	10	9	9
2.C. Metal industry	NO	NO	NO	NO	NO
2.C. of which Iron and steel production	NO	NO	NO	NO	NO
2.C. of which other non iron and steel production	NO	NO	NO	NO	NO
2.D. Non-energy products from fuels and solvent	NO	NO	NO	NO	NO
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	NO	NO	NO	NO	NO
2.G. Other product manufacture and use	0.007	0.015	0.017	0.020	0.023
2.H. Other	NO/NE	NO/NE	NO/NE	NO/NE	NO/NE
3. Agriculture	20.948	25.410	28.800	32.200	36.000
3.A. Enteric fermentation					
3.B. Manure management	2.764	3.99	4.5	5.7	7.7
3.C. Rice cultivation					
3.D. Agricultural soils	17.540	20.794	23.57	25.649	27.312
3.E. Prescribed burning of savannas	NO	NO	NO	NO	NO
3.F. Field burning of agricultural residues	0.645	0.626	0.73	0.851	0.988
3.G. Liming					
3.H. Urea application					
3.I. Other carbon-containing fertilizers					
3.J. Other	NO	NA	NA	NA	NA
4. Land use, land-use change and forestry	6.093	6.185	6.185	6.185	6.185
4.A. Forest land	0.090	0.091	0.091	0.091	0.091
4.B. Cropland	1.429	1.429	1.429	1.429	1.429
4.C. Grassland	0.105	0.105	0.105	0.105	0.105
4.D. Wetlands	0.111	0.111	0.111	0.111	0.111
4.E. Settlements	0.838	0.838	0.838	0.838	0.838
4.F. Other land	3.520	3.611	3.611	3.611	3.611
4.G. Harvested wood products					
4.H. Other					
5. Waste	2.088	2.076	2.104	2.131	2.159
5.A. Solid waste disposal					
5.B. Biological treatment of solid waste	0.194	0.143	0.150	0.157	0.16551
5.C. Incineration and open burning of waste	0.028	0.004	0.004	0.004	0.00373
5.D. Wastewater treatment and discharge	1.866	1.930	1.950	1.970	1.990
5.E. Other	NA	NA	NA	NA	NA
Memo items					
M. International bunkers	0.012	0.015	0.015	0.015	0.015
M.IB. Aviation	0.012	0.009	0.009	0.009	0.009
M.IB. Navigation	NO	0.007	0.007	0.007	0.007
M.CO2 emissions from biomass					
M.CO2 captured					
M. Long-term storage of C in waste disposal sites					
M. Indirect N2O	5.810	2.506	2.506	2.506	2.506
M. International aviation in the EU-ETS					

Note: * Starting with 2013, N₂O emissions from the chemical industry is under the EU ETS

Table V_ 11 Evolution of the N₂O emissions for WEM scenario, 2015 ÷ 2035

GREENHOUSE GAS SOURCE	Realised		Forecasted		
	2015	2020	2025	2030	2035
	Gg N ₂ O				
Total N2O emissions without N2O from LULUCF	23.912	27.969	31.287	34.802	38.310
Total N2O emissions with N2O from LULUCF	30.096	34.154	37.471	40.986	44.495
1. Energy	1.705	1.864	1.958	2.094	2.182
A. Fuel combustion	1.699	1.858	1.952	2.089	2.176
1. Energy industries	0.374	0.315	0.264	0.307	0.314
1.A.1.a. Public electricity and heat production	0.367	0.3036	0.2508	0.2935	0.2991
1.A.1.b. Petroleum refining	0.003	0.004	0.005	0.005	0.006
1.A.1.c. Manufacture of solid fuels and other energy industries	0.005	0.007	0.008	0.008	0.009
1.A.2. Manufacturing industries and construction	0.128	0.136	0.150	0.159	0.177
1.A.3. Transport	0.651	0.783	0.848	0.895	0.933
1.A.3.a. Domestic aviation	0.004	0.003	0.005	0.006	0.008
1.A.3.b. Road transportation	0.508	0.623	0.671	0.701	0.721
1.A.3.c. Railways	0.135	0.153	0.167	0.182	0.196
1.A.3.d. Domestic navigation	0.004	0.004	0.005	0.006	0.007
1.A.3.e. Other transportation	0.000	0.000	0.000	0.000	0.001
1.A.4. Other sectors	0.524	0.613	0.678	0.715	0.740
1.A.4.a. Commercial/Institutional	0.005	0.005	0.006	0.006	0.007
1.A.4.b. Residential	0.510	0.596	0.661	0.696	0.719
1.A.4.c. Agriculture/Forestry/Fishing	0.009	0.012	0.012	0.013	0.015
1.A.5. Other	0.021	0.011	0.011	0.011	0.011
1.B. Fugitive emissions from fuels	0.006	0.006	0.006	0.006	0.006
1.B.1. Solid fuels	NA	NA	NA	NA	NA
1.B.2. Oil and natural gas and other emissions from energy production	0.006	0.006	0.006	0.006	0.006
1.C. CO ₂ Transport and storage	NO	NO	NO	NO	NO
2. Industrial processes and product use	1.140	1.075	1.187	1.310	1.443
2.A. Mineral industry	NO	NO	NO	NO	NO
2.A. of which cement production	NO	NO	NO	NO	NO
2.A. of which other non cement production	NO	NO	NO	NO	NO
2.B. Chemical industry	1.128	1.06	1.17	1.29	1.42
2.C. Metal industry	NO	NO	NO	NO	NO
2.C. of which iron and steel production	NO	NO	NO	NO	NO
2.C. of which other non iron and steel production	NO	NO	NO	NO	NO
2.D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	NO	NO	NO	NO	NO
2.G. Other product manufacture and use	0.013	0.015	0.017	0.020	0.023
2.H. Other	NO.NE	NO.NE	NO.NE	NO.NE	NO.NE
3. Agriculture	19.253	23.190	26.330	29.610	32.920
3.A. Enteric fermentation					
3.B. Manure management	2.209200849	3.03	3.49	4.03	4.66
3.C. Rice cultivation					
3.D. Agricultural soils	16.43915669	19.44	22.01	24.62	27.15
3.E. Prescribed burning of savannas	NO	NO	NO	NO	NO
3.F. Field burning of agricultural residues	0.604825578	0.72	0.83	0.96	1.11
3.G. Liming					
3.H. Urea application					
3.I. Other carbon-containing fertilizers					
3.J. Other	NO	NA	NA	NA	NA
4. Land use, land-use change and forestry	6.185	6.185	6.185	6.185	6.185
4.A. Forest land	0.091	0.091	0.091	0.091	0.091
4.B. Cropland	1.429	1.429	1.429	1.429	1.429
4.C. Grassland	0.105	0.105	0.105	0.105	0.105
4.D. Wetlands	0.111	0.111	0.111	0.111	0.111
4.E. Settlements	0.838	0.838	0.838	0.838	0.838
4.F. Other land	3.611	3.611	3.611	3.611	3.611
4.G. Harvested wood products					
4.H. Other					
5. Waste	1.813	1.840	1.812	1.788	1.766
5.A. Solid waste disposal					
5.B. Biological treatment of solid waste	0.081	0.143	0.157	0.174	0.192
5.C. Incineration and open burning of waste	0.004	0.004	0.004	0.004	0.004
5.D. Wastewater treatment and discharge	1.728	1.694	1.651	1.610	1.570
5.E. Other	NA	NA	NA	NA	NA
Memo items					
M. International bunkers	0.025	0.015	0.015	0.015	0.015
M.IB. Aviation	0.021	0.009	0.009	0.009	0.009
M.IB. Navigation	0.004	0.007	0.007	0.007	0.007
M.CO ₂ emissions from biomass					
M.CO ₂ captured					
M. Long-term storage of C in waste disposal sites					
M. Indirect N ₂ O	5.258	2.506	2.506	2.506	2.506
M. International aviation in the EU-ETS					

Note: * Starting with 2013, N₂O emissions from the chemical industry is under the EU ETS

Table V_ 12 Evolution of the N₂O emissions for WAM scenario, 2015 ÷ 2035

GREENHOUSE GAS SOURCE	Realised		Forecasted		
	2015	2020	2025	2030	2035
	Gg N ₂ O				
Total N2O emissions without N2O from LULUCF	23.912	26.826	29.019	31.349	33.738
Total N2O emissions with N2O from LULUCF	30.096	33.011	35.204	37.534	39.923
1. Energy	1.705	1.851	1.927	2.046	2.143
A. Fuel combustion	1.699	1.845	1.921	2.040	2.137
1. Energy industries	0.374	0.315	0.264	0.307	0.314
1.A.1.a. Public electricity and heat production	0.367	0.3036	0.2508	0.2935	0.2991
1.A.1.b. Petroleum refining	0.003	0.004	0.005	0.005	0.006
1.A.1.c. Manufacture of solid fuels and other energy industries	0.005	0.007	0.008	0.008	0.009
1.A.2. Manufacturing industries and construction	0.128	0.135	0.148	0.155	0.171
1.A.3. Transport	0.651	0.772	0.836	0.881	0.918
1.A.3.a. Domestic aviation	0.004	0.003	0.004	0.006	0.007
1.A.3.b. Road transportation	0.508	0.612	0.660	0.688	0.708
1.A.3.c. Railways	0.135	0.153	0.167	0.182	0.196
1.A.3.d. Domestic navigation	0.004	0.004	0.005	0.006	0.006
1.A.3.e. Other transportation	0.000	0.000	0.000	0.000	0.001
1.A.4. Other sectors	0.524	0.613	0.661	0.686	0.723
1.A.4.a. Commercial/Institutional	0.005	0.005	0.005	0.006	0.007
1.A.4.b. Residential	0.510	0.596	0.644	0.667	0.702
1.A.4.c. Agriculture/Forestry/Fishing	0.009	0.012	0.012	0.013	0.014
1.A.5. Other	0.021	0.011	0.011	0.011	0.011
1.B. Fugitive emissions from fuels	0.006	0.006	0.006	0.006	0.006
1.B.1. Solid fuels	NA	NA	NA	NA	NA
1.B.2. Oil and natural gas and other emissions from energy production	0.006	0.006	0.006	0.006	0.006
1.C. CO ₂ Transport and storage	NO	NO	NO	NO	NO
2. Industrial processes and product use	1.140	1.075	1.187	1.310	1.443
2.A. Mineral industry	NO	NO	NO	NO	NO
2.A. of which cement production	NO	NO	NO	NO	NO
2.A. of which other non cement production	NO	NO	NO	NO	NO
2.B. Chemical industry	1.128	1.06	1.17	1.29	1.42
2.C. Metal industry	NO	NO	NO	NO	NO
2.C. of which Iron and steel production	NO	NO	NO	NO	NO
2.C. of which other non Iron and steel production	NO	NO	NO	NO	NO
2.D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	NO	NO	NO	NO	NO
2.G. Other product manufacture and use	0.013	0.015	0.017	0.020	0.023
2.H. Other	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
3. Agriculture	19.253	22.040	24.080	26.200	28.390
3.A. Enteric fermentation					
3.B. Manure management	2.209200849	3.03	3.49	4.03	4.66
3.C. Rice cultivation					
3.D. Agricultural soils	16.43915669	18.29	19.76	21.21	22.62
3.E. Prescribed burning of savannas	NO	NO	NO	NO	NO
3.F. Field burning of agricultural residues	0.604825578	0.72	0.83	0.96	1.11
3.G. Liming					
3.H. Urea application					
3.I. Other carbon-containing fertilizers					
3.J. Other	NO	NA	NA	NA	NA
4. Land use, land-use change and forestry	6.185	6.185	6.185	6.185	6.185
4.A. Forest land	0.091	0.091	0.091	0.091	0.091
4.B. Cropland	1.429	1.429	1.429	1.429	1.429
4.C. Grassland	0.105	0.105	0.105	0.105	0.105
4.D. Wetlands	0.111	0.111	0.111	0.111	0.111
4.E. Settlements	0.838	0.838	0.838	0.838	0.838
4.F. Other land	3.611	3.611	3.611	3.611	3.611
4.G. Harvested wood products					
4.H. Other					
5. Waste	1.813	1.860	1.826	1.793	1.763
5.A. Solid waste disposal					
5.B. Biological treatment of solid waste	0.081	0.163	0.171	0.180	0.189
5.C. Incineration and open burning of waste	0.004	0.004	0.004	0.004	0.004
5.D. Wastewater treatment and discharge	1.728	1.694	1.651	1.610	1.570
5.E. Other	NA	NA	NA	NA	NA
Memo items					
M. International bunkers	0.025	0.015	0.015	0.015	0.015
M.IB. Aviation	0.021	0.009	0.009	0.009	0.009
M.IB. Navigation	0.004	0.007	0.007	0.007	0.007
M.CO ₂ emissions from biomass					
M.CO ₂ captured					
M. Long-term storage of C in waste disposal sites					
M. Indirect N ₂ O	5.258	2.506	2.506	2.506	2.506
M. International aviation in the EU-ETS					

Note: * Starting with 2013, N₂O emissions from the chemical industry is under the EU ETS

The projections of HFCs, PFCs and SF₆ emissions for the period 2005/2015 - 2035 are presented in the Table V_13 and V_14.

Table V_13 Evolution of the HFCs, PFCs and SF₆ emissions for WOM scenario, period 2005 ÷ 2035

GREENHOUSE GAS SOURCE	Forecasted		Prognose		
	2005	2020	2025	2030	2035
Emissions of HFCs, PFCs, SF6 and NF3 in kt CO2 equivalent	464.19	1948.14	2126.34	2263.78	2311.69
Emissions of HFCs	368.91	1875.62	2043.65	2169.34	2203.71
2. Industrial processes and product use	368.91	1875.62	2043.65	2169.34	2203.71
2.A. Mineral industry	NO	NO	NO	NO	NO
2.A. of which cement production	NO	NO	NO	NO	NO
2.A. of which other non cement production	NO	NO	NO	NO	NO
2.B. Chemical industry	NO	NO	NO	NO	NO
2.C. Metal industry	NO	NO	NO	NO	NO
2.C. of which Iron and steel production	NO	NO	NO	NO	NO
2.C. of which other non Iron and steel production	NO	NO	NO	NO	NO
2.D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	368.91	1875.62	2043.65	2169.34	2203.71
2.G. Other product manufacture and use	NO	NO	NO	NO	NO
2.H. Other	NO	NO	NO	NO	NO
Emissions of PFCs	95.28	11.94	12.45	13.02	13.58
2. Industrial processes and product use	95.28	11.94	12.45	13.02	13.58
2.A. Mineral industry	NO	NO	NO	NO	NO
2.A. of which cement production	NO	NO	NO	NO	NO
2.A. of which other non cement production	NO	NO	NO	NO	NO
2.B. Chemical industry	NO	NO	NO	NO	NO
2.C. Metal industry	95.28	11.94	12.45	13.02	13.58
2.C. of which Iron and steel production	0.00	0.00	0.00	0.00	0.00
2.C. of which other non Iron and steel production	95.28	11.94	12.45	13.02	13.58
2.D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	NO	NO	NO	NO	NO
2.G. Other product manufacture and use	NO	NO	NO	NO	NO
2.H. Other	NO	NO	NO	NO	NO
Emissions of SF6	0.00	60.58	70.25	81.42	94.39
2. Industrial processes and product use	0.00	60.58	70.25	81.42	94.39
2.A. Mineral industry	NO	NO	NO	NO	NO
2.A. of which cement production	NO	NO	NO	NO	NO
2.A. of which other non cement production	NO	NO	NO	NO	NO
2.B. Chemical industry	NO	NO	NO	NO	NO
2.C. Metal industry	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
2.C. of which Iron and steel production	NO	NO	NO	NO	NO
2.C. of which other non Iron and steel production	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
2.D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	NO	NO	NO	NO	NO
2.G. Other product manufacture and use	0.00	60.58	70.25	81.42	94.39
2.H. Other	NO	NO	NO	NO	NO
Emissions of NF3					
2. Industrial processes and product use	NO	NO	NO	NO	NO
2.A. Mineral industry	NO	NO	NO	NO	NO
2.A. of which cement production	NO	NO	NO	NO	NO
2.A. of which other non cement production	NO	NO	NO	NO	NO
2.B. Chemical industry	NO	NO	NO	NO	NO
2.C. Metal industry	NO	NO	NO	NO	NO
2.C. of which Iron and steel production	NO	NO	NO	NO	NO
2.C. of which other non Iron and steel production	NO	NO	NO	NO	NO
2.D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	NO	NO	NO	NO	NO
2.G. Other product manufacture and use	NO	NO	NO	NO	NO
2.H. Other	NO	NO	NO	NO	NO

Note: * Starting with 2013, PFCs emissions from aluminium production is under the EU ETS

Table V_ 14 Evolution of the HFCs, PFCs and SF₆ emissions for WEM and WAM scenario, period 2015-2035

GREENHOUSE GAS SOURCE	Realised	Forecasted			
	2015	2020	2025	2030	2035
Emissions of HFCs, PFCs, SF6 and NF3 in kt CO2 equivalent	1695.60	1759.69	1609.21	1482.14	1437.65
Emissions of HFCs	1636.76	1688.10	1556.39	1448.15	1404.41
2. Industrial processes and product use	1636.76	1688.10	1556.39	1448.15	1404.41
2.A. Mineral industry	NO	NO	NO	NO	NO
2.A. of which cement production	NO	NO	NO	NO	NO
2.A. of which other non cement production	NO	NO	NO	NO	NO
2.B. Chemical industry	NO	NO	NO	NO	NO
2.C. Metal industry	NO	NO	NO	NO	NO
2.C. of which Iron and steel production	NO	NO	NO	NO	NO
2.C. of which other non Iron and steel production	NO	NO	NO	NO	NO
2.D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	1636.76	1688.10	1556.39	1448.15	1404.41
2.G. Other product manufacture and use	NO	NO	NO	NO	NO
2.H. Other	NO	NO	NO	NO	NO
Emissions of PFCs	6.57	6.25	6.51	6.81	7.10
2. Industrial processes and product use	6.57	6.25	6.51	6.81	7.10
2.A. Mineral industry	NO	NO	NO	NO	NO
2.A. of which cement production	NO	NO	NO	NO	NO
2.A. of which other non cement production	NO	NO	NO	NO	NO
2.B. Chemical industry	NO	NO	NO	NO	NO
2.C. Metal industry	6.57	6.25	6.51	6.81	7.10
2.C. of which Iron and steel production	NO	NO	NO	NO	NO
2.C. of which other non Iron and steel production	6.57	6.25	6.51	6.81	7.10
2.D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	NO	NO	NO	NO	NO
2.G. Other product manufacture and use	NO	NO	NO	NO	NO
2.H. Other	NO	NO	NO	NO	NO
Emissions of SF6	52.27	65.34	46.31	27.18	26.13
2. Industrial processes and product use	52.27	65.34	46.31	27.18	26.13
2.A. Mineral industry	NO	NO	NO	NO	NO
2.A. of which cement production	NO	NO	NO	NO	NO
2.A. of which other non cement production	NO	NO	NO	NO	NO
2.B. Chemical industry	NO	NO	NO	NO	NO
2.C. Metal industry	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
2.C. of which Iron and steel production	NO	NO	NO	NO	NO
2.C. of which other non Iron and steel production	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
2.D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	NO	NO	NO	NO	NO
2.G. Other product manufacture and use	52.27	65.34	46.31	27.18	26.13
2.H. Other	NO	NO	NO	NO	NO
Emissions of NF3					
2. Industrial processes and product use	NO	NO	NO	NO	NO
2.A. Mineral industry	NO	NO	NO	NO	NO
2.A. of which cement production	NO	NO	NO	NO	NO
2.A. of which other non cement production	NO	NO	NO	NO	NO
2.B. Chemical industry	NO	NO	NO	NO	NO
2.C. Metal industry	NO	NO	NO	NO	NO
2.C. of which Iron and steel production	NO	NO	NO	NO	NO
2.C. of which other non Iron and steel production	NO	NO	NO	NO	NO
2.D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO
2.E. Electronic industry	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS (2)	NO	NO	NO	NO	NO
2.G. Other product manufacture and use	NO	NO	NO	NO	NO
2.H. Other	NO	NO	NO	NO	NO

V.A.3. Key Underlying Variables

The GHG emissions projections for the period 2016 ÷ 2035 are based on common assumptions related to the main parameters, such as the population and economic growth. Furthermore, there were also considered the interaction between the sectors concerning the energy demand, transport demand, social demand, etc.

For defining the assumptions regarding the evolution of Romania within the 2016 - 2035 period, a SWOT analysis for the 1989 ÷ 2015 period was performed, according to the following:

- Economic development;
- Demographic development;
- Social development;
- Structural adjustment of the economy;
- Structural adjustment of the industry;
- Technologic upgrade and decrease of the energy intensity in industry, agriculture, constructions;
- Development and upgrade of the transport sector;
- Development and upgrade of the services sector;
- Development and upgrade of the habiting conditions.

The evolution of the main macroeconomic and energetic indicators, used for GHG emissions prognosis, is presented in the Table V_15.

Table V_ 15 Evolution of the macroeconomic and energy indicators within 2005 ÷ 2035

Indicator	M.U	2005	2010	2015	2020	2025	2030	2035
Gross Domestic Product	10 ⁹ Euro ₂₀₁₀	112.34	126.82	142.92	177.35	205.59	226.99	244.54
GDP growth rate	%	4.2	-0.8	3.9	4.6	3,0	2.0	1.5
Population	Thousands persons	21,320	20,247	19,819	19,100	18,350	17,640	17,460
GDP/person	Euro ₂₀₁₀ /persons	5145	6260	7211	9286	11201	12868	14005
Primary energy consumption	10 ⁶ toe	37.87	34.82	31.84	35.72	38.67	40.92	43.01
Primary energy intensity	toe/ Euro ₂₀₁₀	0.345	0.275	0.223	0.201	0.188	0.180	0.176
Final energy consumption	10 ⁶ toe	25.206	22.739	21.896	24.600	26.630	28.180	29.620
Final energy intensity	toe/10 ³ Euro ₂₀₁₀	0.230	0.179	0.153	0.139	0.130	0.124	0.121
Primary energy consumption /person	toe/person	1.776	1.720	1.607	1.870	2.107	2.320	2.463
Gross consumption of electricity	TWh	56.51	59.41	59.57	61.26	66.25	72.79	79.97
Gross consumption of electricity per person	kWh/person	2,651	2,934	3,006	3,208	3,610	4,126	4,580

The assumptions related to Romania macroeconomic development after 2013, considering the continuation of the structural modifications correlated with similar EU directions, are presented in the Table V_16.

Table V_ 16 Evolution of the Gross value added structure up to 2035 , in %

Indicator	2020	2025	2030	2035
TOTAL GVA out of which:	100	100	100	100
Industry	31.5	30.0	29.0	28.5
Agriculture	7.1	6.5	5.8	5.0
Constructions	10.0	10.0	10.0	10.0
Services	51.4	53.5	55.2	56.5

It should be noted that the emissions projections in this report are based on the economic scenario realized taking into account that after the financial and economic crisis from 2009-2011 period, which has a significant impact on the Romanian economy, a period of economic revival followed. Romania will have a GDP growth of about 4.8% in 2016, one of the largest increases in the EU.

The assumptions related to international import prices of coal, natural gas and oil for the period 2020÷2035 are presented in Table V_17.

Table V_ 17 Evolution of international fuel prices in period 2015÷2030

	U.M	2020	2025	2030	2035
International coal import prices	€ (2013)/bpe	14.30	17.10	20.5	21.70
International crude oil import prices	€ (2013)/bpe	75.0	85.1	93.8	97.8
International gas import prices	€ (2013)/bpe	48.3	52.2	56.8	60.6

Differences to the Sixth National Communication

The Romania economic development is strongly linked to the worldwide and EU economic development, and complex international environment affected by the global economic-financial crisis.

It is important to underline that the sixth national communication was made on the basis of economic scenarios that took into consideration the sustained economic development of Romania at rhythms above the European Union average between 2015-2020 and higher than the forecasts for 2015 of the International Energy Agency for the 2020-2030 period.

So, considering the achievements in the period 2010÷2013, the assumptions of macroeconomic and energy indicators used for the GHG emissions projections for the period 2010 ÷ 2020 are optimistic. In these conditions, the GHG projections emissions for the period 2015 ÷ 2020 is expected to be overestimated.

For this reason, in the present report, the economic and technical scenarios, the additional policies and measures considered are revised. For the projection, in order to reduce the uncertainties, the last reported data were considered for the base year (2011), submitted to UNFCCC. The improvement obtained in achievement of the Romanian Inventory Report will ensure an important support in projection activity, in special for non-energy sectors.

V.A.4. Emission projections by sector and by gas

V.A.4.1 Sector Energy (CRF Source Category 1)

The sector energy covers the subsectors 1.A The Fuel Combustion, 1.B Fugitive Emissions, 1.C International bunker.

In the Table V_18 are presented the projected GHG emissions for Energy sector, by gas, for two scenarios (WEM, WAM).

Table V_18 The projections of GHG emissions for Energy sector, by gas

	Emissions, in Gg CO ₂ eq.				
	2015	WOM scenario		WAM scenario	
		2020	2025	2020	2025
CO ₂	68,092.13	69,698.11	68,211.54	68,822.10	67,131.95
CH ₄	11,497.93	10,774.68	11,081.0	8,440.95	9,374.4
N ₂ O	508.10	555.47	583.30	496.0	542.5
TOTAL	80,098.16	81,028.26	79,875.84	79,958.06	78,593.53

In the WEM scenario, the GHG emissions from energy sector will increase by 1.16% in the period 2016÷2020 and will decrease by 1.44% between 2020÷2025. GHG emissions are expected to reach 79,875.84 Tg CO₂ eq., in 2025. The major contribution to the increasing emissions in the period 2020 ÷ 2025 is made by the subsectors manufacturing industries and transport.

In the WAM scenario, the emissions will decrease by 0.2% in the period 2016 ÷ 2020 and by 1.78% in the period 2020 ÷ 2025. GHG emissions are expected to reach 78,593.53 Tg CO₂ eq., in 2025.

In Table V_19 are presented the projected GHG emissions for "Combustion Fuel" subsector (1.A), for different subsectors.

Table V_19 The projections of GHG emissions for subsector "Fuel Combustion"

	Emissions, in Gg CO ₂ eq.				
	2015	WOM scenario		WAM scenario	
		2020	2025	2020	2025
Energy industries (1.A.1)	29,721.92	28,471.70	24,176.12	28,471.76	24,176.12
Manufacturing industries and construction (1.A.2)	12,455.94	12,959.76	13,537.72	12,698.50	13,254.63
Transport (1.A.3)	15,730.41	17,762.03	19,267.44	17,435.50	18,937.50
Commercial (1.A.4.a)	2,006.24	2,259.38	2,461.17	2,164.61	2,288.36
Residential (1.A.4.a)	6,217.22	7,702.47	8,350.79	7,634.61	8,162.78
Agriculture (1.A.4.a)	1,019.11	1,061.95	1,087.09	1,049.39	1,060.54
Other (1.A.5)	421.36	441.75	445.75	441.75	445.75
TOTAL	67,155.61	70,659.11	69,926.08	69,896.12	68,325.68

Differences to the Sixth National Communication

It is important to underline that the GHG emissions forecasts presented in the Sixth Communication are overestimated due to they did not take into account the efforts made to achieve the targets imposed by the EENAP III and to promote new energy sources. Thus, GHG emissions from the fuel combustion are about 80 CO₂ equiv. in the

sixth communication, compared to 70,669 Tg CO₂ eq. in this communication. Due to fuel combustion in the energy industry (1A1) GHG emissions are about 28.4 Tg CO₂ equiv. in 2020 in this communication compared to 31.9 Tg CO₂ equiv. in the sixth communication.

V.A.4.2 Subsector Manufacturing Industries and Construction (CRF Source Category 1.A.2)

In Table V_20 are presented the projected GHG emissions for subsector Manufacturing Industries and Construction, by GHG types, for two scenarios (WEM, WAM).

Table V_ 20 The projections of GHG emissions for Manufacturing Industries and Construction sector, by gas

	Emissions, in Gg CO ₂ eq.				
	2015	WEM scenario		WAM scenario	
		2020	2025	2020	2025
CO ₂	12,394.24	12,894.48	13,465.61	12,633.86	13,183.60
CH ₄	23.6	24.75	27.35	24.4	27.0
N ₂ O	38.1	44.53	44.76	40.24	44.03
TOTAL	12,455.94	12,959.76	13,537.72	12,698.50	13,254.63

In the WEM scenario, the GHG emissions from Manufacturing Industries and Construction subsector will increase by 4.0% in the period 2016÷2020 and will increase by 4.56% between 2020 ÷ 2025. GHG emissions are expected to reach 12.96 Tg CO₂eq. in 2020. Although there is an increase in emissions between 2016-2020, due to the economic revival, it is noticed that measures are being taken to increase energy efficiency and the use of new technologies.

In the WAM scenario, the emissions will increase by 1.94% in the period 2016 ÷ 2020 and will increase by 4.4% in the period 2020 ÷ 2026. GHG emissions are expected to reach 12.69 Tg CO₂ eq. in 2020.

Differences to the Sixth National Communication

It is important to underline that the GHG emissions forecasts presented in the Sixth Communication have been overestimated due to they did not take into account the real effort made to implement the measures foreseen in the EENAP III and the direction development foreseen in the competitiveness strategy.

V.A.4.3 Subsector Transport (CRF Source Category 1.A.3)

The projected GHG emissions for Transport subsector, by gas, for two scenarios (WEM, WAM) are presented in the Table V_21.

Table V_ 21 The projections of GHG emissions for Transport sector, by gas

	Emissions, in Gg CO ₂ eq.				
	2015	WEM scenario		WAM scenario	
		2020	2025	2020	2025
CO ₂	155,01.09	17,485.45	18,968.10	17,163.57	18,642.74
CH ₄	36.22	42.91	46.64	42.0	45.50
N ₂ O	139.1	233.67	252.75	229.93	249.26
TOTAL	15,730.41	17,762.03	19,267.44	17,435.50	18,937.50

In the WEM scenario, the GHG emissions from Transport subsector will increase by 12.9% with the annual average rate of 3.0% in the period 2016 ÷ 2020 and will increase

by 8.5% between 2020 ÷ 2025 with the annual average rate of 2.1%. GHG emissions are expected to reach 17.76 Tg CO₂ eq. in 2020. The major contribution to the increasing emissions in the period 2016÷ 2025 is the beginning of economic growth. The different annual average rates between periods 2016÷ 2020 and 2020 ÷ 2025, reflect the modernization of the transport sector (new vehicles EURO 5, use of biofuels, etc).

In the WAM scenario, the emissions will increase by 10.8% in the period 2016 ÷ 2020 and will increase by 8.9% in the period 2020 ÷ 2025. GHG emissions are expected to reach 18.9 Tg CO₂ eq. in 2025.

Differences to the Sixth National Communication

It is important to underline that the GHG emissions forecasts presented in the previous Communication are close to those made in this Communication.

V.A.4.4 Subsector Others (CRF Source Category 1.A.4)

The projected GHG emissions for subsector Commercial (CRF 1.A.4.a), by gas, for two scenarios (WEM, WAM), are presented in the Table V_22.

Table V_22 *The projections of GHG emissions for Commercial/Institutional subsector, by gas*

	Emissions, in Gg CO ₂ eq.				
	2015	WEM scenario		WAM scenario	
		2020	2025	2020	2025
CO ₂	2,006.24	2,252.55	2,453.71	2,158.05	2,281.38
CH ₄	6.52	5.34	5.75	5.07	5.49
N ₂ O	1.49	1.49	1.71	1.49	1.49
TOTAL	2,014.25	2,259.38	2,461.17	2,164.61	2,288.36

In the WEM scenario, the GHG emissions from Commercial/Institutional subsector will increase by 11.61% in the period 2016 ÷ 2020 and will increase by 8.9% between 2020 ÷ 2025 with the annual average rate of 1.7%. GHG emissions are expected to reach 2.3 Tg CO₂ eq. in 2020. The major contribution to the increasing emissions in the period 2015÷ 2020 will have economic growth.

In the WAM scenario, the emissions will increase by 6.8% in the period 2015 ÷ 2020 and will increase by 5.7% in the period 2020 ÷ 2025. GHG emissions are expected to reach 2.16 Tg CO₂ eq. in 2020.

Differences to the Sixth National Communication

In the Sixth Communication the GHG emissions were overestimated by about 50%. It was for the first time when the projection for this subsector was made taking into consideration the INEGES data.

The projected GHG emissions for subsector Residential (CRF 1.A.4.b), by gas, for two scenarios (WEM, WAM), are presented in the Table V_23.

Table V_23 The projections of GHG emissions for Residential subsector, by gas

	Emissions, in Gg CO ₂ eq.				
	2015	WEM scenario		WAM scenario	
		2020	2025	2020	2025
CO ₂	6,217.22	6,399.89	6,906.29	6,331.34	6,753.47
CH ₄	964.94	1,124.97	1,244.53	1,125.66	1,217.40
N ₂ O	151.98	177.61	196.97	177.61	191.91
TOTAL	7,334.14	7,702.47	8,350.79	7,634.61	8,162.78

In the WEM scenario, the GHG emissions from Residential subsector will increase by 5.0% in the period 2016÷2020 and will increase by 8.4% between 2020 ÷ 2025, with the annual average rate of 1.65%. GHG emissions are expected to reach 8,35 Tg CO₂ eq. in 2020. The major contribution to the increasing emissions in the period 2016÷ 2020 is the beginning of economic growth and the increasing of life level.

In the WAM scenario, the emissions will increase by 4.1% in the period 2016 ÷ 2020 and will increase by 6.9% in the period 2020 ÷ 2025. GHG emissions are expected to reach 7.63 Tg CO₂ eq. in 2020.

Differences to the Sixth National Communication

The forecasts made in this communication are close to the Sixth Communication.

The projected GHG emissions for subsector Agriculture (CRF 1.A.4.c), by gas, for two scenarios (WEM, WAM), are presented in the Table V_24.

Table V_24 The projections of GHG emissions for Agriculture/Forest/Fisheries subsector, by gas

	Emissions, in Gg CO ₂ eq.				
	2015	WEM scenario		WAM scenario	
		2020	2025	2020	2025
CO ₂	1,019.11	1,045.33	1,070.35	1,032.82	1,043.93
CH ₄	8.79	13.04	13.16	13.0	13.05
N ₂ O	2.09	3.58	3.58	3.57	3.56
TOTAL	1,029.99	1,061.95	1,087.09	1,049.39	1,060.54

In the WEM scenario, the GHG emissions for this subsector will increase by 0.31 % in the period 2016 ÷ 2020 and will increase by 2.36% between 2020 ÷ 2025. GHG emissions are expected to reach 1.06 Tg CO₂ eq. in 2020. The major contribution to the increasing of emissions in the period 2016 ÷ 2020 will have the beginning of economic growth.

In the WAM scenario, the emissions will increase by 1.88% in the period 2016 ÷ 2020 and by 1.1% in the period 2020 ÷ 2025. GHG emissions are expected to reach 1.06 Tg CO₂ eq. in 2025.

Differences to the Sixth National Communication

The forecasts are close to these two communications.

In the Table V_25 are presented the projected GHG emissions for Others subsector (CRF 1.A.4) by gas for two scenarios (WEM, WAM).

Table V_ 25 The projections of GHG emissions for subsector Others, by gas

	Emissions, in Gg CO ₂ eq.				
	2015	WEM scenario		WAM scenario	
		2020	2025	2020	2025
CO ₂	9,242.60	9,697.67	10,430.04	9,717.15	10,430.04
CH ₄	979.60	1,143.50	1,267.0	943.41	1,267.0
N ₂ O	156.18	182.64	202.01	188.05	202.01
TOTAL	10,378.38	11,023.81	11,899.05	10,848.61	11,511.68

In the WEM scenario, the GHG emissions from subsector Others will increase by 6.2% in the period 2016 ÷ 2020 and by 7.9% between 2020 ÷ 2025. GHG emissions are expected to reach 11.02 Tg CO₂ eq. in 2020. The major contribution to the increasing emissions in the period 2011÷ 2020 is the beginning of economic growth and the increasing of level of life.

In the WAM scenario, the emissions will increase by 5.8% in the period 2015 ÷ 2010 and by 4.8% in the period 2020 ÷ 2025. GHG emissions are expected to reach 11.51 Tg CO₂ eq. in 2025.

Differences to the Sixth National Communication

It is important to underline that GHG emissions forecasts provided in the sixth communication are close to those in this last communication (8% difference).

V.A.4.5 Sector Industrial Processes (CRF Source Category 2)

The projected GHG emissions for Industrial Processes, by gas, for two scenarios (WEM, WAM) are presented in the Table V_26.

Table V_ 26 The projections of GHG emissions for Industrial Processes, by gas

	Emissions, in Gg CO ₂ eq.				
	2015	WEM scenario		WAM scenario	
		2010	2025	2020	2025
CO ₂	9,821.12	10,615.40	11,937.12	10,615.40	11,937.12
CH ₄	15.77	14.67	16.71	14.67	16.71
N ₂ O	339.74	320.25	353.62	320.25	353.62
HFC	1,636.76	1,688.10	1,556.39	1,688.10	1,556.39
PFC	6.57	6.25	6.51	6.25	6.51
SF ₆	52.27	65.34	46.31	65.34	46.31
TOTAL	11,872.23	12,710.01	13,916.66	12,710.01	13,916.66

In the WEM scenario, the GHG emissions from Industrial Processes will increase by 7.1% in the period 2016 ÷ 2020 and by 9.5% between 2020 ÷ 2025, with the annual average rate of 1.0%. GHG emissions are expected to reach 13.92 Tg CO₂ eq. in 2025. The major contribution to the increasing emissions in the period 2016÷ 2020 is the beginning of economic growth.

The WAM scenario shows the same GHG emissions like scenario WEM.

Differences to the Sixth National Communication

It is important to underline that GHG emissions forecasts provided in the Sixth Communication are overestimated due to the industrial productions have been

overestimated, and it did not take into consideration the orientation of any companies to modern technologies.

V.A.4.6 Sector Agriculture (CRF Source Category 3)

The projected GHG emissions for sector Agriculture, by gas, for two scenarios (WEM, WAM), are presented in the Table V_27.

Table V_ 27 The projections of GHG emissions for Agriculture, by gas

	Emissions, in Gg CO ₂ eq.				
	2015	WEM scenario		WAM scenario	
		2020	2025	2020	2025
CO ₂	94.36	96.48	98.41	96.78	98.41
CH ₄	12,781.28	12,242.25	12,622.25	11,712.25	11,806.0
N ₂ O	5,737.39	6,910.62	7,846.34	6,567.92	7,175.84
TOTAL	16,613.03	19,249.35	20,567.00	18,376.65	1,908.25

In the WEM scenario, the GHG emissions from sector Agriculture will increase by 15.9%, with the annual average rate of 2.95% in the period 2016 ÷ 2020. GHG emissions are expected to reach 19.25 Tg CO₂ eq. in 2020.

In the WAM scenario, the emissions will increase by 10.61% in the period 2016 ÷ 2020. GHG emissions are expected to reach 18.4 Tg CO₂ eq. in 2020.

Differences to the Sixth National Communication

It is important to underline that GHG emissions forecasts provided in the Sixth Communication are close to those of this communication.

It is important to point out that the new methodology used for GHG emissions forecasting by subsector (Enteric Fermentation, Manure Management, etc.) takes into account the impact of the measures taken to modernize and restructure these sub-sectors.

V.D.4.7. Sector Land use, Land-use Change and Forestry (CRF Source Category 4)

The projected GHG emissions for Land use, Land-use Change and Forest, for two scenarios (WEM, WAM), are presented in the Table V_28.

Table V_ 28 The projections of GHG emissions for Land use, Land-use Change and Forest

	Emissions, in Gg CO ₂ eq.				
	2015	WEM scenario		WAM scenario	
		2020	2025	2020	2025
Forest Land	-25.449,91	-22.247,25	-21.312,47	-21306,50	-19364,43
Cropland	-1737,29	-1214,29	-817,89	-1543,04	-570,39
Grassland	232,60	359,60	137,47	359,60	405,87
Wetlands	1548,66	29,49	20,88	376,74	415,58
Settlements	3949,39	1299,94	1319,57	1299,94	1385,60
Other Land	1886,61	4774,37	2588,24	4774,37	4898,37
Wood products harvested	1311,75				
TOTAL	-18258.18	-16998.33	-18055.19	-16038.89	-12831.39

The net quantity of CO₂ absorbed is reduced each year under scenario S3-WAM and highest under scenario S1-WOM. Characteristic is the fact that over time, the annual intake decreases under all scenarios, but the general trend is decreasing even for S1-WOM.

This decrease is related to the reduction of current growth of the forests together with its aging (reinforced by the results of a simulation were provided no wood harvesting but the effect of aging decreases the annual absorption but reaches an annual level equivalent to S2-WEM and S3-WAM much later, around the years 2050÷2070) and that the age structure changes shortly by the appearance of large areas of forest in the youngest age class with very small growths.

In addition, increasing the harvest of wood result shortly in changes of the structure of forests and thus the annual growth is reduced, which explains the reduction of the net amount of CO₂ stored per year. In fact, immediately after the application of a higher annual harvest by about 50%, a reduction in the annual amount of the net average absorbed and stored in forests.

Reducing to zero the amount of annual net quantities would mean cutting the whole current forest growth that year, an unaccepted forestry practice given the exposure to non-sustainability through the structure of the forest fund. However, achieving this threshold by accident is not associated immediately with non-sustainability, but this risk is significant for maintaining yields at very close level or to a higher annual growth of the forest.

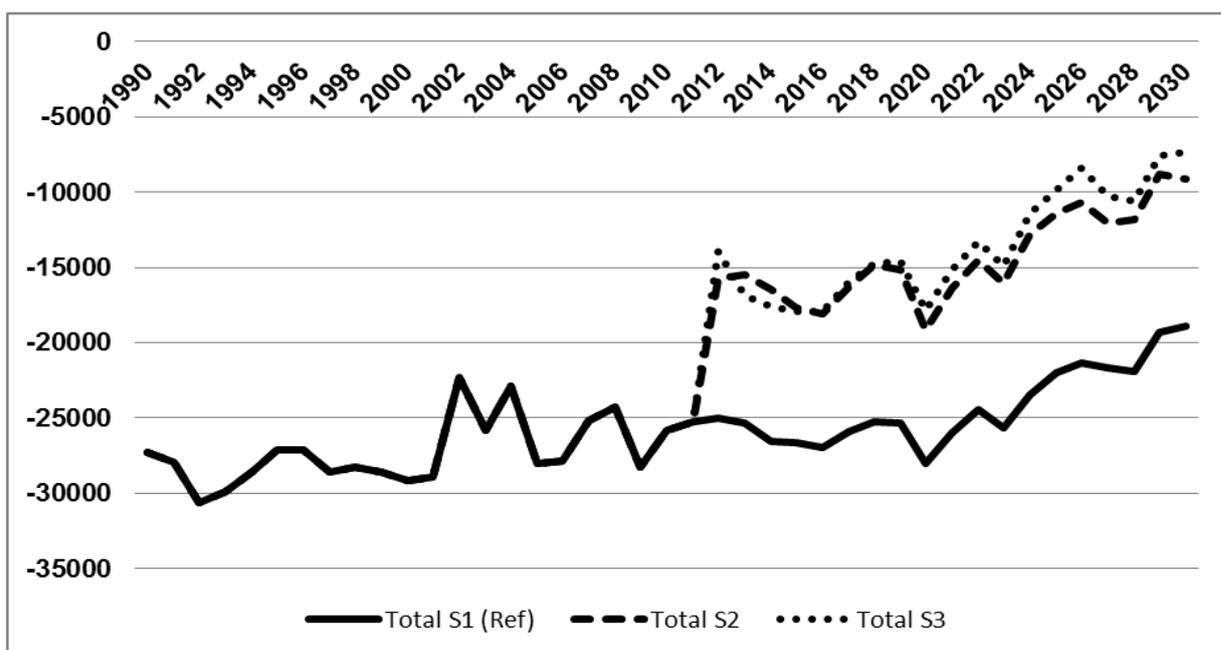


Figure V_A_5 Graphical design of the three scenarios (S1-WOM, S2-WEM, S3-WAM) [Gg CO_{2eq.}]

S-WEM and S-WAM scenarios depend on the increasing harvested wood volume from forests, heavily dependent on actions to strengthen national capacity of harvesting and processing of wood, opening of new forest roads, strengthening the capacity of the forestry regime, to clarify the objectives of production/protection, but also to communicate to the general public and explain the reasons of the need to increase the harvest. Such an option is sustained by the harvests before 1990 when the forests were managed more intensive but absolutely within the limits of sustainability. Deforestation is extremely reduced in the last 20 years, the annual average is about 200 hectares from 1990 till 2011, and as a result it is considered as not having a major contribution to the projections.

Differences to the Sixth National Communication

The GHG emissions projections submitted in the fifth communication are overestimated in comparison with present projections.

V.D.4.9. Sector Waste (CRF Source Category 5)

The projected GHG emissions for sector Waste, by gas, for two scenarios (WEM, WAM), are presented in the Table V_29.

Table V_29 The projections of GHG emissions for Waste sector, by gas

	Emissions, in Gg CO ₂ eq.				
	2015	WEM scenario		WAM scenario	
		2020	2025	2020	2025
CO ₂	5.90	5.90	5.90	5.90	5.90
CH ₄	5,297.08	4,667.75	4,094.75	4,653.52	4,044.10
N ₂ O	540.274	548.43	539.98	554.28	544.16
TOTAL	5,843.25	5,222.08	4,640.63	5,213.71	4,594.16

In the WEM scenario, the GHG emissions from sector Waste will decrease by 11.9%, with the annual average rate of 2.8% in the period 2016 ÷ 2020. GHG emissions are expected to reach 5.22 Tg CO₂ eq. in 2020.

In the WAM scenario, the emissions will decrease by 12.0% in the period 2016 ÷ 2020. GHG emissions are expected to reach 5.21 Tg CO₂ eq. in 2020.

Differences to the Sixth National Communication

It is important to underline that GHG emission forecasts provided in the Sixth Communication are close to those actual communication.

It is important to point out that the new methodology used for GHG emissions forecasting by subsectors (Waste Storage, Wastewater Treatment) takes into account the impact of the measures adopted to modernize and restructure these sub-sectors.

V. B. Assessment of aggregate effects of policies and measures

Chapter 4 presents a comprehensive list of policies and measures included in the Romanian Strategy of Sustainable Development and Climate Change Strategy. Implemented and adopted policies and measures represent an important part of these strategies. It has to be mentioned, however, that the responsibilities for climate change mitigation are performed by different central authorities, which influence the coherent monitoring and evaluation of the effects of policies and measures.

The approach to establish the total effect of planned policies and measures is to take the difference of GHG emissions obtained in scenario WEM and ones obtained in scenario WOM.

The aggregated effect of planned policies and measures, by sectors and by gas, is presented in the Table V_30

Table V_30 Aggregate effect of planned policies and measures

Sector	Gas	Aggregate effect, Gg CO ₂ eq.	
		2020	2025
Energy	CO ₂	19,538.69	25,269.86
	CH ₄	7,547.33	7,688.55
	N ₂ O	202.33	188.36
	GHG	27,288.34	33,146.78
Industrial Processes	CO ₂	6,754.02	5,728.08
	CH ₄	3.20	1.60
	N ₂ O	2,664.12	3,633.03
	GHG	9,609.79	9,537.01
Agriculture	CO ₂	-	-
	CH ₄	3,015.00	2,997.50
	N ₂ O	661.56	736.06
	GHG	3,676.56	3,733.56
Waste	CO ₂	-	-
	CH ₄	2,513.13	3,725.22
	N ₂ O	70.33	86.85
	GHG	2,583.45	3,812.07
TOTAL	GHG	43,158.14	50,229.42

V. C. Supplementary related to mechanism under article 6, 12 and 17 of the Kyoto Protocol

For achieving the target established at international level, countries included in Annex 1 may use the flexible mechanism provided by the Kyoto Protocol.

Romania successfully participates in the development of "Joint Implementation" projects based on the cooperation with different countries, as host country.

In the first commitment period under the Kyoto Protocol, Romania signed 10 Memorandum of Understanding with different Annex I countries (Switzerland, the Netherlands, Norway, Denmark, Austria, Sweden, France, Italy and Finland) as well with the World Bank for the Prototype Carbon Fund (PCF), establishing the legal framework for developing Joint Implementation projects. Under these Memorandums a number of 18 JI projects have received the Letter of Approval, and they are currently in different stages of development (Table V_31).

Table V_31 List of JI projects in Romania

No. crt.	JI projects	Project Type	Agreement
1	"Sawdust 2000" - DHSs on biomass - Int. Buzăului, Vlahita Huedin, Gheorghieni, V.Domei	Fuel switching/ Renewable	Denmark
2	Rehabilitation of CET Timișoara Sud	Energy Efficiency	Sweden
3	Afforestation of degraded agricultural lands	Afforestation	World Bank - PCF
4	Geothermal energy use in DHSs of Oradea-area 2 and Beius	Renewable	Denmark
5	Improving efficiency for stearn boilers in Holboca CHP II Iași	Energy Efficiency	Denmark
6	Efficiency improvement in DHS of Dr. Turnu -Severin	Energy Efficiency	Denmark
7	Municipal Cogeneration at CET Targoviste	Energy Efficiency	Netherlands
8	Upgrading of Alesd and Câmpulung cement plants	Energy Efficiency	Netherlands
9	Modernization of 3 units in Porțile de Fier I Power Plant	Energy Efficiency	Netherlands
10	Modernization of 4 units in Porțile de Fier I Power Plant	Energy Efficiency	Netherlands
11	Emission Reduction of N ₂ O at SC Donau Chem SRL	Chemicals	Netherlands
12	Wind Park Casimcea	Renewable	Austria
13	Wind Park Babadag, Tulcea	Renewable	France
14	Hydropower Development Portofolio, Track 1, Hidroelectrica	Renewable	
15	Wind Park Dorobantu	Renewable	Austria
16	Emission Reduction of N ₂ O at SC Chemgas Holding Corporation SRL	Chemicals	Sweden
17	Emission Reduction of N ₂ O at SC Azomures SA	Chemicals	France
18	Emission Reduction of N ₂ O at SC Nitroporos SRL	Chemicals	Sweden

In respect to the second commitment period under the Kyoto Protocol, Romania did not renew the Memoranda of Understanding presented in the previous paragraph and did not signed Memoranda of Understanding.

Romania does not intend to use the Kyoto Protocol flexible mechanisms to meet the GHG emissions reduction targets till 2020.

V. D. Methodology used for the presented GHG emission projections

V.D.1 Introduction

The methodology for GHG projections relies both on historical data provided by the National GHG Inventory, for the period 1989÷2015 and on macroeconomic indicators forecasts, indicators considered in the Romanian Government's relevant strategies and for the socio-economic policies, considering the adopted EU Directives.

Taking into consideration that the Energy sector is the main GHG source, with approximately 70% from total emissions, according to the National GHG Inventory; therefore, the GHG projections were determined for Energy sector and non-energy sectors.

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

- Forestry - in terms of atmospheric carbon sequestration options;
- Agriculture - to assess CH₄ emissions from livestock digestion and manure fermentation and N₂O emissions from the application of nitrogen fertilizers;
- Industry - to assess emissions from industrial processes;
- Solvents and other products;
- Solid and liquid waste management for assessing the CH₄, N₂O and CO₂ emissions.

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

- A reference scenario "business as usual" (scenario without measures) feasible in the future that does not include special activities to reduce GHG emissions (base year 2005);
- 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, base year 2015);
- 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, base year 2015).

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 analysed, 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.

V.D.2. Methodology for the Energy sector

The GHG forecasts for the Energy sector were established considering the energy demand subsector (industry, transport, agriculture, household and commercial consumption) and the supplying sub-sector (primary energy resources extraction, conversion in refineries, thermo-electric power plants, thermal power plants, transport and distribution of energetic products to consumers).

The projections are based on calculations carried out using the ENPEP (Energy and Power Evaluation Program) programs package, developed by Argonne National laboratory of US Department of Energy (DOE) and distributed to Romania by the International Atomic Energy Agency (IAEA) to perform an integrated energy analysis, economic and environmental.

The software package includes 9 modules, presented in Figure V_D_1. The main modules used in the study are:

- MAED is a simulation model designed for evaluate medium and long-term demand for energy (motor fuel, fossil fuel, district heating, electricity, coke, feedstock) based on the macroeconomic indicators evolution;
- ELECTRIC - determines the electricity power plants development programme considering the Romanian Government's adopted policies on renewable energy resources use, on ensuring the energy security, on technological evolution and on international market fuel prices;
- BALANCE module – determines the balance between energy demand – supply the entire system, including all the demand sectors and the supply sectors (oil, gas, coal, electricity, renewable, etc.) for every year of the study;
- IMPACTS – estimates, for the energetic system determined using the BALANCE module and for the electro-energetic system determined using the ELECTRIC module, the impact on atmosphere, water, soil, the impact of the specific waste, the impact on materials and labour needed for the installations construction and exploitation, the impact on related employees risk and health.

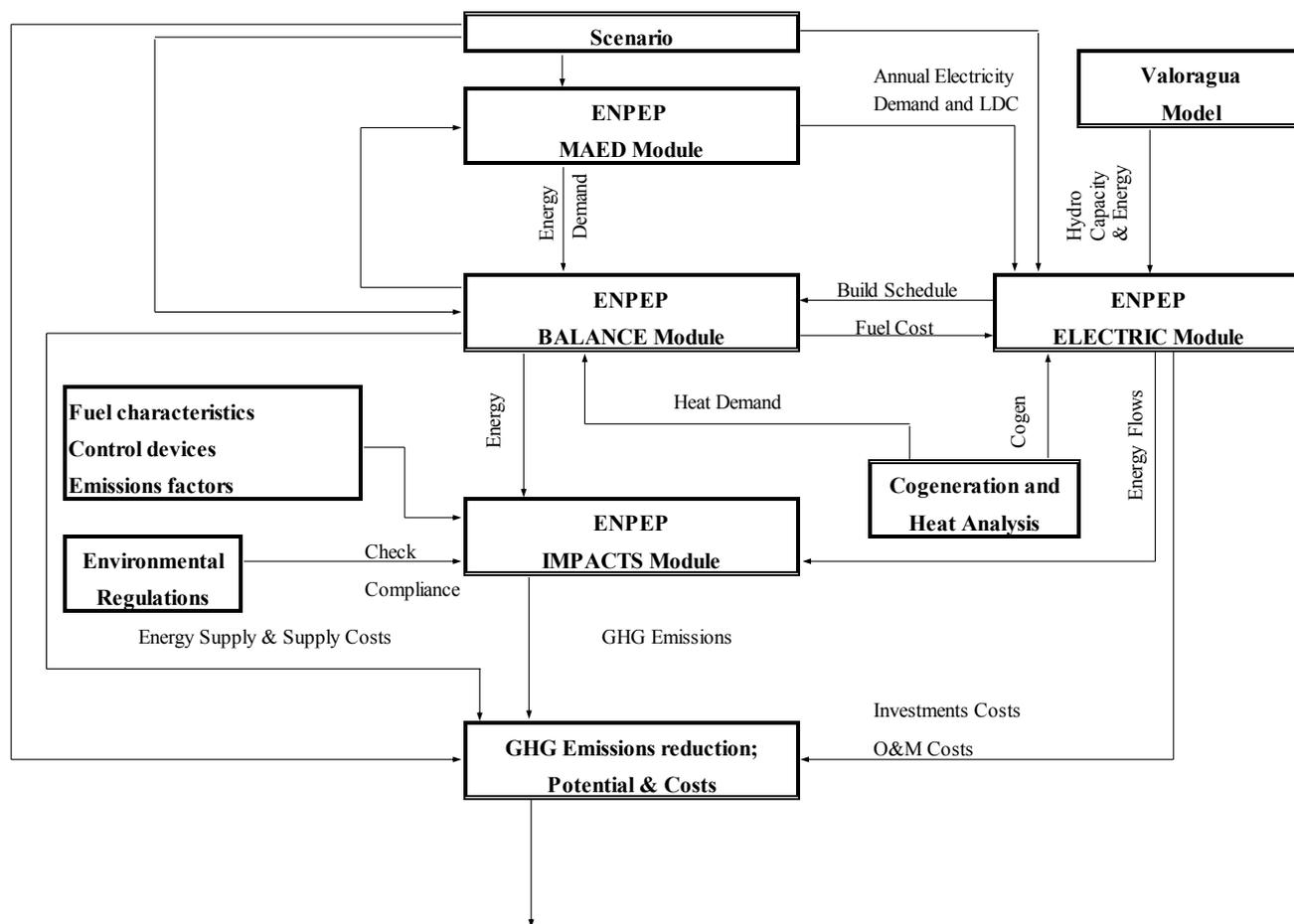


Figure V_D_1 Integrated Modelling Framework for Assessment of GHG emissions and GHG Mitigation Options

In order to allow the use of the modules package, a national energy balance has been prepared, considering the available or imported primary energy resources. Figure V_D_2 shows a simplified energy balance with four major elements:

- Primary energy resources;
- Primary energy resources conversion technologies;
- Transmission and distribution of energy products;
- Energy consumers

Each sector is modelled in detail, considering the technological processes and emission factors according to IPCC. Given this breakdown with the IMPACTS module the resulted GHG emissions are determined.

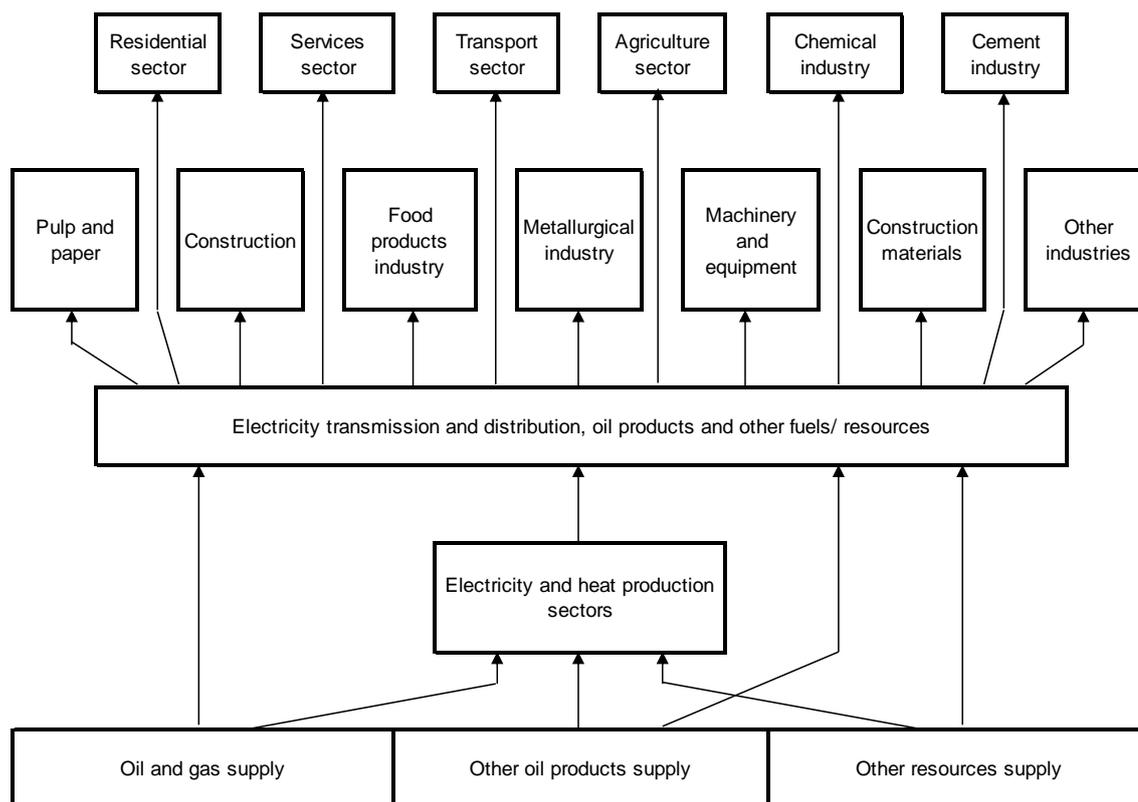


Figure V_D_2 Romania's Energy Balance

The software development ENPEP determine the total energy demand and energy types for the three scenarios (WOM, WEM, WAM) as defined by IPCC sectors: electricity and heat production, refining, transport sector, industry, agriculture, construction, services, residential, etc., which allows the determination of GHG emission projections using emission factors defined by types of fuels.

V.D.2.1 Development of the electricity generation sector

In order to establish the program of development of the power plants for the period 2016 ÷ 2035, one considers the prognosis of the evolution of electric and thermal power consumption in cogeneration, the diversification of the resources of primary power, the reengineering and restoration, the modern technologies of production of electric and thermal power, the environment conditions.

The process of determining the structure of electricity generation during the period 2016 ÷ 2035 is extremely difficult due to the high degree of uncertainty related to:

- The evolution of the electricity demand and of the rates of fuels on international markets;
- Conformity of the existent thermal-energetic groups to the environment conditions;
- The capacity of investors to implement the programs of investments in renewable energy after 2020.

Due to this reason, different scenarios are examined related to the structure of electricity generation during the period 2016 ÷ 2035 with a view to consider different hypotheses related to the variations of key parameters influencing such structure.

The key hypotheses to define the scenarios are related to:

- Prognoses of the consumption of electricity;
- Diversification of the resources of primary energy used;
- Modern technologies of electricity and heating generation in cogeneration;
- Environment conditions;
- Situation of the energetic groups existent in NPS;
- Programs of investment of different companies in the country and abroad.

Table V_32 shows the evolution of electricity production for the reference scenario during the 2005 - 2035 period considered for determining the structure of production capacities within the NPS.

The WOM scenario did not take into account the application of the requirements required to meet the targets set by Directive 2012/27/EU and Directive 2009/28/EC.

Table V_ 32 Evolution of domestic consumption and electricity production during 2005÷2035

Indicator	MU	2005	2010	2015	2020	2025	2030	2035
		Achievment			Forecasted			
Gross domestic electricity consumption	TWh	56.51	58.70	59.57	63.00	66.25	72.79	79.97
Total net electricity production	TWh	55.21	54.88	61.28	64.81	65.85	71.89	78.53
Total gross electricity production	TWh	59.40	60.98	66.50	69.67	71.25	77.79	84.97

The Development Program of power plants in NPS between 2016÷2035 set using the Electric program in the ENPEP software package presented, considers the investments contained in the National Investment Plan, National Renewable Sources Action Plan, new nuclear groups totalling 2,600 MW installed capacity, new hydropower plants totalling 868 MW, lignite-fired thermal power plants totalling 3,000 MW and natural gas-fired thermal power plants totalling 2,050 MW.

The scheduling of the commissioning of the new units was done considering economic and legal conditions, which would allow investments to be promoted in order to put the units into operation between 2016 and 2035.

In the with measures scenario it is expected that the power installed in the wind power plants will be about 4,600 MW between 2016 ÷ 2035. This is beneficial by increasing the share of renewable energy used, thus reducing the use of fossil fuels and therefore GHG emissions.

Table V_33 shows the structure of electricity production during 2016 ÷ 2035 for the WOM, WEM and WAM scenarios.

Table V_ 33 Structure of electricity production within 2005/2015 ÷ 2035 period

Specification / scenario / Year	Scenario	2005	2015	2020	2025	2030	2035
		Realised		Forecasted			
Total electricity production in GWh, from:	No measures	59,400	66,500¹	69,670	71,250	77,790	84,970
- Liquid fuel		105	90	100	150	150	150
- Solid fuel		22,833	25,728	26,395	21,425	23,740	21,720
- Gaseous fuels		10,700	12,000	12,500	13,000	13,500	15,500
- Renewables		20,207	17,006	19,000	19,500	20,000	22,000
- Uranium		5,555	11,676	11,675	17,175	20,400	25,600
Total electricity production in GWh, from:	With measures, with additional measures		66,500	69,670	71,250	77,790	84,970
- Liquid fuel			71	75	0	0	0
- Solid fuel			18,171	18,697	13,150	14,990	14,870
- Gaseous fuels			9,420	10,169	9,000	12,000	13,000
- Renewables			27,162	29,054	28,700	30,400	31,500
- Uranium			11,676	11,675	20,400	20,400	25,600

Note The coverage of electricity production is hypothetical since the measures adopted under Directive 2009/38 / EC and Directive 2012/27 / EU have not been taken into account.

Corresponding to the structure of electricity production, the total demand for energy resources shown in Table V_34 results.

Table V_ 34 Energy demand structure during 2005/2015÷2035

Specification / scenario / Year	Scenario	2005	2015	2020	2025	2030	2035
		Realised		Forecasted			
Total demand for energy resources in PJ, :	WOM	496.64	590.9	651.99	686.15	734.45	795.84
- Liquid fuel		33.1	28.4	30.8	41.7	45.7	46.7
- Solid fuel		232.3	251.7	255.8	200.9	222.1	221.1
- Gaseous fuels		162	179.1	189.7	197.4	207.3	218.0
- Renewables		5.74	4.83	5.39	5.65	5.85	6.04
- Uranium		63.5	126.87	170.30	240.5	253.5	304
Total demand for energy resources in PJ, :	WEM WAM		471.5	456.17	522.9	552	607.8
- Liquid fuel			12.9	15.4	0	0	0
- Solid fuel			220.71	176.2	141.4	169.9	160.9
- Gaseous fuels			106.19	133	121.2	121.8	131.5
- Renewables			4.83	4.7	6.8	6.8	11.4
- Uranium			126.87	126.87	253.5	253.5	304

Tables V_35, V_36, V_37 show the evolution of GHG emissions during 2015 - 2035, for the WOM and WEM scenarios.

Table V_ 35 The evolution of CO₂ emissions over the period 2015 ÷ 2035, for the no measures and the with measures scenarios

Scenario	Total emissions, Gg CO ₂					
	2005	2015	2020	2025	2030	2035
	Realised		Forecasted			
WOM	33,378.91	36,300.00	37,500.00	38,000.00	39,000.00	41,000.00
WEM, WAM		26,992.95	24,618.74	19,619.43	22,249.22	21,968.51

Table V_ 36 . The evolution of CH₄ emissions over the period 2015 ÷ 2035. for the no measures and the with measures scenarios

Scenario	Total emissions. Gg CH ₄					
	2005	2015	2020	2025	2030	2035
	Realised		Forecasted			
WOM	0.50	0.60	0.61	0.70	0.90	1.1
WEM, WAM		0.50	0.49	0.46	0.49	0.63

Table V_ 37 . The evolution of N₂O emissions over the period 2015 ÷ 2035, for the no measures and the with measures scenarios

Scenario	Total emissions, Gg N ₂ O					
	2005	2015	2020	2025	2030	2035
	Realised		Forecasted			
WOM	0.384	0.384	0.436	0.45	0.455	0.455
WEM, WAM		0.35	0.30	0.25	0.29	0.30

V.D.2.2. Evolution of energy consumption in the Industrial sector

In the industry, the following types of energy uses are considered:

- Fuels (gas, diesel);
- Strictly electric uses with no alternative (lighting, electrolysis, electric motors, etc.);
- Heat uses (space heating and domestic hot water, steam, furnace heating and the direct heat generation, etc.);
- Special treatments.

Table V_38 shows alternative energy sources by industry category.

Table V_ 38 . Alternative energy sources by final use category for the industrial sector

Energy source	Extractive industry			Manufacturing industry				
	Electrical use	Engines	Thermal use	Electrical use	Engines	Thermal use		
						heating and water heating	Steam production	furnace/ direct burn
Fossil fuels	X		X			X	X	X
Electricity	X		X	X		X	X	X
Fuels		X			X			
Thermal energy						X	X	
Solar energy			X			X	X	
Traditional fuels (fire wood, agriculture waste)			X			X	X	X
Modern biomass (biofuels, bioliquids)			X			X	X	X

Considering the assumptions regarding the development of different industrial branches, using the MAED program, the evolution of the energy demand for the period 2010 - 2035 in the Industry sector for the three scenarios for which the GHG emissions are forecast (Table V_39) resulted. The no measures scenario did not consider the measures envisaged under Directive 2012/27 / EU and the Ecodesign Directive.

Table V_ 39 Energy demand 2005 ÷ 2035

Energy demand	2005	2015	2020	2025	2030	2035
WOM scenario						
Total, in PJ:	305.6	313.9 ¹	326.6	332.1	345.2	362.9
Electricity	73.5	75.9	80.6	81.6	84.6	88.7
Thermal energy	11.8	13	13.4	13.6	13.9	14.1
Liquid fuel	37.7	40.8	41.6	41.9	42.6	44.6
Solid fuel	47.8	26.3	30.1	32.1	36.1	40.3
Gaseous fuels	122.9	139.8	140.8	141.8	144.8	148.8
Biomass	11.88	18.1	20.1	21.1	23.2	25.4
WEM scenario						
Total in PJ:		296.9	306.7	319.8	330.8	348.5
Electricity		73.96	74.8	79.2	84	88.4
Thermal energy		11.32	13	13	13.2	13.7
Liquid fuel		40.6	38.8	40.2	40.8	42.7
Solid fuel		18.4	24.1	28.1	31.8	36.7
Gaseous fuels		138.68	137.9	139.2	140.1	143.6
Biomass		13.91	18.1	20.1	20.9	23.4
WAM scenario						
Total in PJ:		296.9	302.8	316.0	323.4	338.7
Electricity		73.96	74.8	79.2	83	88.4
Thermal energy		11.32	13	13	13	13.4
Liquid fuel		40.6	37.8	38.9	38.9	40.5
Solid fuel		18.4	23.5	27.0	29.2	33.5
Gaseous fuels		138.68	135.6	137.8	138.4	139.5
Biomass		13.91	18.1	20.1	20.9	23.4

Note 1 The hypothetical value corresponds to the scenario in which the requirements of the 2012/27/EU Directive and Ecodesign Directive.

V.D.2.3. Evolution of energy consumption in the Transport sector

Romania has a national transport system (infrastructure, means of transport, etc.), situated both in terms of functional structure and services provided, at the the average level of standards of conventional transport systems in Europe.

The strategic framework for sustainable transport policy in Romania has aligned itself with the European policy defined in the White Paper on Transport.

In the transport field, Romania has a key position at the eastern border of the EU, as a transit zone in the east-west direction (linking Asia with the Black Sea) and north-south (from the Baltic to the Mediterranean). Three of the TEN-T priority axes cross the territory of Romania.

The development of the Transport sector is closely linked to the economic and social development of Romania.

For a coherent and fair analysis of the Energy Transport sector, two distinct areas are considered: commodities transport and passenger transport.

Considering the economic and social development of Romania after the crisis, the transport sector will need to ensure the efficient transportation of goods and passengers at different distances. Table V_40 shows the evolution assumptions for both urban and interurban passenger transport both on the degree of mobility and on the reduction of the specific consumption of the main categories of means of transport for the three scenarios for which GHG emissions are projected. The number of cars is considered to continue to increase in the case of transport in localities. Thus, the current 42% contribution from 2014 will increase to 48% in 2035 since large cities are already very busy and it is desirable to modernize urban common transport, especially the electric traction one.

Table V_ 40 Assumptions on passenger transport for the period 2010 ÷ 2035

Specification/year	U.M.	2010	2015	2020	2025	2030	2035
No measures scenario							
Average travel distance							
Interurban	Km/year	2,550	2,350	3,250	3,600	4,000	4,400
Urban	Km/day	8.4	8.8	9.2	9.6	10	10.5
Specific consumption reduction indicators							
Cars – inter urban (l/100 km)	%	100	100	100	100	100	100
Cars – urban (l/100 km)	%	100	100	100	100	100	100
Buses – urban (l/100 km)	%	100	100	100	100	100	100
Buses – inter urban (l/100 km)	%	100	100	100	100	100	100
Diesel trains (l/100 km)	%	100	100	100	100	100	100
Electrical trains kWh/100 km)	%	100	100	100	100	100	100
Electrical comun transport (kWh/100 km)	%	100	100	100	100	100	100
With measures scenario							
Specific consumption reduction indicators							
Cars – inter urban (l/100 km)	%	100	97	94	92	90	89
Cars – urban (l/100 km)	%	100	98.5	96.5	94.5	92.5	91.0
Buses – urban (l/100 km)	%	100	97.7	93.8	90	87	86
Buses – inter urban (l/100 km)	%	100	95	90	85	80	80
Diesel trains (l/100 km)	%	100	97	95	92.5	90	89
Electrical trains kWh/100 km)	%	100	95	90	86	82	80
Electrical comun transport (kWh/100 km)	%	100	96	93	91	89	88

With additional measures scenario							
Specific consumption reduction indicators							
Cars – inter urban (l/100 km)	%	100	96	93	91	89	88
Cars – urban (l/100 km)	%	100	98	96	94	92	91
Buses – urban (l/100 km)	%	100	97.4	93.2	89.5	86.6	86
Buses – inter urban (l/100 km)	%	100	94	89	84	79	78
Diesel trains (l/100 km)	%	100	96	94	84	79	78
Electrical trains kWh/100 km)	%	100	94	90	85	81	80
Electrical commun transport (kWh/100 km)	%	100	95	92	90	88	88

The assumptions related to the evolution of goods transport and the reduction of specific vehicles consumption, presented in the Table V_41, considered an increase of the quantity of transported goods, in line with the economic recovery. Also, the modernization of rail and modal transport is expected to regain the goods market.

Table V_41 Assumptions on goods transport for the period 2005 ÷ 2035

Specification/year	U.M.	2005	2015	2020	2025	2030	2035
No measures scenario							
Goods transport	Mld.tkm	53.6	59.7	69.4	78.3	87.2	93.1
Road transport	%	48.3	48.2	48.0	47.5	47.0	46.4
Rail way transport	%	23.1	23.2	23.4	23.9	24.4	25.0
Naval transport	%	26.7	26.7	26.7	26.7	26.7	26.7
Pipeline transport	%	1.9	1.9	1.9	1.9	1.9	1.9
Specific consumption reduction indicators							
Local transport vehicules (kWh/100tkm)	%	100	100	100	100	100	100
Remote vehicles (kWh/100tkm)	%	100	100	100	100	100	100
Diesel trains (kWh/100tkm)	%	100	100	100	100	100	100
Electrical trains (kWh/100tkm)	%	100	100	100	100	100	100
Naval transport (kWh/100tkm)	%	100	100	100	100	100	100
Pipeline transport (kWh/100tkm)	%	100					
With measures scenario							
Goods transport	Mld.tkm		59.7	69.4	78.3	87.2	93.1
Road transport	%		48.0	47.7	47.2	46.8	46.0
Rail way transport	%		23.4	23.7	24.1	24.6	25.4
Naval transport	%		26.7	26.7	26.7	26.7	26.7
Pipeline transport	%		1.9	1.9	1.9	1.9	1.9
Specific consumption reduction indicators							
Local transport vehicules (kWh/100tkm)	%	100	98.7	98.1	97.0	96.0	94.5
Remote vehicles (kWh/100tkm)	%	100	98.5	98.1	97.5	97.0	96.0
Diesel trains (kWh/100tkm)	%	100	95	92	89	86	85.5
Electrical trains (kWh/100tkm)	%	100	96	93	89	85	84.5
Naval transport (kWh/100tkm)	%	100	95	90	85	80	79.0

Specification/year	U.M.	2005	2015	2020	2025	2030	2035
Pipeline transport (kWh/100tkm)	%	100	96.5	95.5	94.9	94.3	94.0
With additional measures scenario							
Goods transport	Mld.tkm		59.7	69.4	78.3	87.2	93.1
Road transport	%		47.6	47.3	46.9	46.5	45.5
Rail way transport	%		23.8	24.0	24.4	24.9	25.9
Naval transport	%		26.7	26.7	26.7	26.7	26.7
Pipeline transport	%		1.9	1.9	1.9	1.9	1.9
Specific consumption reduction indicators							
Local transport vehicles (kWh/100tkm)	%	100	98.0	97.5	97.0	96.0	94.0
Remote vehicles (kWh/100tkm)	%	100	98.0	97.3	96.9	96.2	95.5
Diesel trains (kWh/100tkm)	%	100	95	90	87	84	85.0
Electrical trains (kWh/100tkm)	%	100	95	92	88	84	84.0
Naval transport (kWh/100tkm)	%	100	95	90	85	80	79.0
Pipeline transport (kWh/100tkm)	%	100	96	95	94.4	94	93.7

Taking into consideration the presented assumptions using the MAED program, the evolution of the fuel demand during 2005 ÷ 2035 in the transport sector for the three scenarios for which the GHG emissions are forecasted.

Table V_ 42 Evolution of the fuel demand during 2005-2035, no measures scenario

Fuel demand	2005	2015	2020	2025	2030	2035
Total PJ	168.597	222.513	248.760	270.45	285.82	302.03
Liquid fuel	166.759	219.743	245.600	266.55	281.13	296.63
Solid fuel	0.0	0.0	0.0	0.0	0.0	0.0
Gaseous fuels	1.393	1.5	1.55	1.60	1.65	1.70
Biomass	0.445	1.27	1.61	2.30	3.04	3.700
a. Aerial transport	2.64	4.763	5.870	6.600	7.400	8.300
Gas	0.445	0.044	0.070	0.100	0.200	0.300
Kerosen	2.195	4.719	5.800	6.500	7.200	8.000
b. Road transport	159.205	210.026	233.800	253.300	266.500	280.430
Gas	66.490	56.609	63.800	69.300	71.900	74.400
Diesel fuel	89.987	143.967	159.800	173.200	183.300	193.930
Liquefied petroleum gases	2.310	2.455	3.000	3.600	4.100	4.900
Biomass	0.417	0.950	1.550	2.200	2.900	3.500
c. Railway transport	3.122	4.789	5.560	6.300	6.940	7.600
Liquid fuel	3.094	4.787	5.500	6.200	6.800	7.400
Biomass	0.028	0.032	0.060	0.100	0.140	0.200

d. Naval transport	1.738	2.84	3.030	3.550	4.080	4.600
Diesel fuel	1.696	2.834	3.000	3.500	4.000	4.500
Gas	0.042	0.006	0.03	0.05	0.08	0.100
e. Other transport	1.893	2.45	2.15	2.25	2.35	2.45
Liquid fuel	0.50	0.55	0.60	0.65	0.700	0.75
Gaseous fuels	1.393	1.5	1.55	1.6	1.65	1.7

Table V_ 43 Evolution of the fuel demand during 2015-2035, WEM scenario

Fuel demand	2015	2020	2025	2030	2035
Total PJ	212.418	240.110	260.030	273.430	282.900
Liquid fuel	205.369	232.410	252.110	264.990	273.800
Solid fuel	0	0.0	0.0	0.0	0.00
Gaseous fuels	0.05	0.440	0.620	0.800	0.900
Biomass	6.999	7.260	7.300	7.640	8.200
a. Aerial transport	1.763	1.660	2.380	3.000	3.900
Gas	0.044	0.06	0.08	0.100	0.400
Kerosen	1.719	1.600	2.300	2.900	3.500
b. Road transport	203.931	230.550	248.500	260.100	267.400
Gas	56.609	63.050	68.300	70.900	73.000
Diesel fuel	137.872	157.000	169.300	177.500	182.000
Liquefied petroleum gases	2.455	3.300	3.700	4.200	4.400
Biomass	6.995	7.200	7.200	7.500	8.000
c. Railway transport	4.789	5.460	6.000	6.540	7.100
Liquid fuel	4.787	5.400	5.900	6.400	6.900
Biomass	0.002	0.06	0.100	0.140	0.200
d. Naval transport	1.84	1.940	2.450	2.890	3.400
Diesel fuel	1.834	1.900	2.400	2.800	3.300
Gas	0.006	0.040	0.050	0.090	0.100
e. Other transport	0.095	0.500	0.700	0.900	1.100
Liquid fuel	0.045	0.060	0.080	0.100	0.200
Gaseous fuels	0.05	0.440	0.620	0.800	0.900

Table V_44 Evolution of the fuel demand during 2015-2035, WAM scenario

Fuel demand	2015	2020	2025	2030	2035
Total PJ	212.418	236.760	255.630	268.130	277.200
Liquid fuel	205.369	229.060	247.710	259.690	268.100
Solid fuel	0	0.0	0.0	0.0	0.0
Gaseous fuels	0.05	0.440	0.620	0.800	0.900
Biomass	6.999	7.260	7.300	7.640	8.200
a. Aerial transport	1.763	1.460	2.180	2.800	3.400
Gas	0.044	0.060	0.08	0.100	0.300
Kerosen	1.719	1.400	2.100	2.700	3.100
b. Road transport	203.931	227.500	244.500	255.100	262.400
Gas	56.609	61.00	66.300	68.900	70.000
Diesel fuel	137.872	155.000	167.300	174.500	180.000
Liquefied petroleum gases	2.455	3.300	3.700	4.200	4.400
Biomass	6.995	7.200	7.200	7.500	8.000
c. Railway transport	4.789	5.460	6.000	6.540	7.100
Liquid fuel	4.787	5.400	5.900	6.400	6.900
Biomass	0.002	0.06	0.100	0.140	0.200
d. Naval transport	1.84	1.840	2.250	2.790	3.200
Diesel fuel	1.834	1.800	2.200	2.700	3.100
Gas	0.006	0.040	0.050	0.090	0.100
e. Other transport	0.095	0.500	0.700	0.900	1.100
Liquid fuel	0.045	0.060	0.080	0.100	0.200
Gaseous fuels	0.05	0.440	0.620	0.800	0.900

V.D.2.4. Evolution of energy consumption in the Commercial sector

Energy consumption for the service sector is closely linked to the level of economic activity in the sector characterized by added value and the workforce involved.

There are two broad categories within the service sector: trade and public services.

Within the service sector heating / cooling, hot water and food preparation, lighting, powering electric motors, powering computers, etc. are required.

For this purpose fuel, electricity and thermal energy are used.

Table V_45 shows Assumptions on the evolution of the service sector during 2005 - 2035. In the WOM scenario, the requirements of Directive 2012/27 / EU were not considered.

Table V_ 45 Assumptions regarding service sector in period 2005 ÷ 2035

Assumptions	U.M.	2005	2015	2020	2025	2030	2035
WOM scenario							
Share of employed population in service sector	%	37.9	40.5	42.5	45.0	50.0	55.0
Increase of occupied area	%	100	106	115	130	160	180
Share of air conditioned area	%	5	10	20	30	40	50
Demolition rate	%	0	1	1.3	1.6	2.3	2.5
<i>Specific consumption reduction indicators</i>							
Heating , old buildings (kWh/m ² /year)	%	100	100	100	100	100	100
Heating, new buildings (kWh/m ² /year)	%	100	100	100	100	100	100
Electricity , old buildings (kWh/m ² /year)	%	100	100	100	100	100	100
Electricity , new buildings (kWh/m ² /year)	%	100	100	100	100	100	100
WEM scenario							
Share of employed population in service sector	%	37.9	40.5	42.5	45.0	50.0	55.0
Increase of occupied area	%	100	106	115	130	160	180
Share of air conditioned area	%	5	10	20	30	40	50
Demolition rate	%	0	1	1.3	1.6	2.3	2.5
<i>Specific consumption reduction indicators</i>							
Heating , old buildings (kWh/m ² /year)	%	100	98	97	96	95	93
Heating, new buildings (kWh/m ² /year)	%	100	98	97	96	95	94
Electricity , old buildings (kWh/m ² /year)	%	100	98.5	97.5	96	95.5	92
Electricity , new buildings (kWh/m ² /year)	%	100	98.5	96.5	94.5	92.5	91
WAM scenario							
Share of employed population in service sector	%	37.9	40.5	42.5	45.0	50.0	55.0
Increase of occupied area	%	100	106	115	130	160	180
Share of air conditioned area	%	5	10	20	30	40	40
Demolition rate	%	0	1	1.3	1.6	2.3	2.5
<i>Specific consumption reduction indicators</i>							
Heating , old buildings (kWh/m ² /year)	%	100	97.5	96.5	95.5	94	92
Heating, new buildings (kWh/m ² /year)	%	100	98	97	96	95	93
Electricity , old buildings (kWh/m ² /year)	%	100	98	97	96	95	94
Electricity , new buildings (kWh/m ² /year)	%	100	98	96	94	92	91

Considering the assumptions presented bellow, using the MAED program, the evolution of the energy demand in the services sector during 2005 ÷ 2035 for the three scenarios for which the GHG emissions are forecast (Table V_46) is derived.

Table V_ 46 Energy demand for 2005-2035 period

Energy demand	2005	2015	2020	2025	2030	2035
Total, in PJ:	69.46	80.93	91.85	94.57	101.59	106.4
Electricity	14.42	25.7	31.3	31.9	32.1	33.1
Thermal energy	12.05	8.3	9.3	10.3	10.7	11
Liquid fuel	10.22	7.5	5	6.5	6.0	7.0
Solid fuel	0.015	0.03	0.05	0.07	0.09	0.1
Gaseous fuels	32.73	39.2	45.8	50.2	52.7	55.1
Biomass	0.0	0.2	0.4	0.6	0.8	0.1
Total, in PJ:		74.9	79	84.2	88.7	95.7
Electricity		28.7	29	29.5	30.1	31.1
Thermal energy		9.3	9.3	10.3	10.7	11
Liquid fuel		3.5	4.3	4.8	5.3	5.9
Solid fuel		0	0	0	0	0
Gaseous fuels		33.2	35.2	38.2	41	45.9
Biomass		0.2	1.2	1.4	1.6	1.8
Total, in PJ:		74.9	77.3	81.3	87.4	94.7
Electricity		28.7	29	29.5	30.1	31.1
Thermal energy		9.3	9.3	10.3	10.7	11
Liquid fuel		3.5	4.3	4.8	5.1	5.7
Solid fuel		0	0	0	0	0
Gaseous fuels		33.2	33.5	35.1	39.5	44.4
Biomass		0.2	1.2	1.6	2	2.5

V.D.2.5. Evolution of energy consumption in the Residential sector

Energy consumption of the residential sector is closely linked to the number of households, the well-being of families, the average number of people per household, climatic and cultural conditions.

Household income is an important element for energy consumption. Higher-income people are able to occupy larger dwellings and consume more energy using air conditioning, multiple TV sets and home appliances.

In order to determine the evolution of the energy demand in the residential sector, the evolution of the average surface area of a dwelling is estimated, as well as the evolution of the indices to be used for the calculation of the differentiated energy requirement between the urban and the rural environment.

Table V_47 shows the evolution of the average surface of dwellings during 2050 - 2035, while Table V_48 shows the main indicators considered when determining the energy consumption of households during 2005 - 2035.

Table V_ 47 Average housing surface evolution, in m²

Dwelling type	2005	2015	2020	2025	2030	2035
Apartment	56.3	58.5	60.0	62.0	64.0	66.0
Single-family urban dwelling	69.5	74.0	78.0	82.0	84.0	86.0
Single-family rural dwelling	45.0	48.0	50.0	52.0	54.0	56.0

Table V_ 48 Evolution of main household indices during 2005-2035

Specification/year	U.M.	2005	2015	2020	2025	2030	2035
Specific consumption							
*food preparation	kWh/inhabitant/year	523	523	523	523	523	523
*domestic hot water, per inhabitant	%	40.0	48.0	52.0	56.0	60.0	65
*electricity	kWh/capita/year	550.0	650.0	700.0	800.0	900.0	1000
Electricity (for home appliances)	kWh/inhabitant	800.0	925.0	950.0	1065.0	1099.0	1100
Average household size	pers/household						
Demolition rate	%	0.5	0.7	1.2	1.8	3.0	4.5
Evolution of existing housing stock							
*villa type: with heating of the entire surface	%	5	7	9	11	15	20
*central heating	%	32	33	34	35	37	40
*partial heating	%	63	60	57	54	48	40
Heating Specific consumption reduction indicators – existing housing stock^{*)}							
*villa type: with heating of the entire surface (Wh/m ² /°C/h)	100	100	95	92	89	87	85
*central heating (Wh/m ² /°C/h)	100	99.8	96	93.2	91	88	85
*partial heating (Wh/m ² /°C/h)	100	99.8	99	96	93	91	88
Existing air-conditioned dwellings							
*villa type: with heating of the entire surface	%	5	9	13	17	20	23
*central heating	%	3	6	10	13	16	19
*partial heating	%	0	0	0	0	0	0
Heating Specific consumption reduction indicators – new dwellings^{*)}							
*villa type: with heating of the entire surface (Wh/m ² /°C/h)	100	98	94	91	88	84	81
*central heating (Wh/m ² /°C/h)	100	99	94	92	89	86	83
*partial heating (Wh/m ² /°C/h)	100	99.5	98	94	92	90	87
New air-conditioned dwellings							
*villa type: with heating of the entire surface	%	20	25	35	45	50	55
*central heating	%	15	20	30	40	45	50

Specification/year	U.M.	2005	2015	2020	2025	2030	2035
*partial heating	%	0	0	0	0	9	10
The share of electricity in thermal processes							
Household heating	%	0.7	0.8	0.9	0.95	1	1
Domestic hot water preparation	%	2.4	3.1	4	5	6	7
Penetration rate of centralized electricity distribution	%	49.2	49.5	50.0	51.0	52.0	53.0

Note: * 2005 is considered baseline year for reduction calculation; 2005 = 100.

Considering the presented assumptions and using the MAED program, the evolution of the energy demand in the Residential sector during 2005-2035 for the three scenarios for which GHG emissions are projected (Table V_49) is shown. In the no measures scenario, the requirements of the Directive 2012/27/EU, as well as those on eco-design and labeling were not considered.

Table V_49 Energy demand 2005 ÷ 2035

Energy demand	2005	2015	2020	2025	2030	2035
No measures scenario						
Total, PJ:	327.96	348.8	365.2	387.8	405.8	420.7
Electricity	40.8	43.6	46.6	48.2	49.9	50.9
Thermal energy	47.5	33.6	39.1	43.1	50.6	52
Liquid fuel	28.4	10.7	11.0	12.5	14.3	16.3
Solid fuel	0.55	3.4	3.5	4	4.2	4.4
Gaseous fuels	96.32	103.9	99	109.7	116.7	122.3
Biomass	114.39	130.6	146	160.3	170.1	174.8
With measures scenario						
Total, PJ:		338.6	341.8	372.2	399.7	413.2
Electricity		40.8	46.6	48.2	49.9	50.9
Thermal energy		47.5	39.1	43.1	50.6	52
Liquid fuel		9.9	10.9	11	12.3	13.1
Solid fuel		0.4	3.3	3.6	3.8	4
Gaseous fuels		92.4	97	105.5	113.7	118.4
Biomass		147.6	144.9	160.8	169.4	174.8
With additional measures scenario						
Total, PJ:		338.6	341.7	366.6	385.2	400.5

Electricity		40.8	46.6	48.2	49.9	50.9
Thermal energy		47.5	40.1	44.1	51.6	52
Liquid fuel		9.9	10.7	10.1	11.1	12.2
Solid fuel		0.4	3.3	3.6	3.8	4
Gaseous fuels		92.4	96	103.8	106.4	110.6
Biomass		147.6	145	156.8	162.4	170.8

V.D.2.6. Evolution of energy consumption in the Agriculture and Forestry sector

Following the economical crisis, in agriculture the quantitative and qualitative increase of the agricultural production is envisaged in order to ensure the security of the population's supply and to increase the contribution of this sector to the economic exchanges. An integrated and sustainable development policy for rural areas is promoted.

For the 2015 ÷ 2035 period it is estimated that the energy intensity is reduced. Specific fuel consumption in agriculture will decrease due to the concentration of land and the growth effect generated by the replacement of animals with agricultural machinery. Action will also take place for the modernization of irrigation facilities.

Considering the hypotheses regarding the development of the agricultural sector, using the MAED program, the evolution of the energy demand in the sector during 2005 ÷ 2035 for the three scenarios for which the GHG emissions are forecast (Table V_50) results.

Table V_ 50 The evolution of energy demand during 2005 ÷ 2035

Energy demand	2005	2015	2020	2025	2030	2035
No measures scenario						
Total in PJ out of which:	8.565	19.93	22.60	23.6	24.5	25.6
Electricity	1.191	3.3	3.4	3.5	3.6	3.8
Heat	1.112	0.7	1.2	1.2	1.3	1.4
Liquid fuels	4.482	12.0	13.0	13.5	13.8	14.2
Solid fuels	0.148	0.33	0.4	0.5	0.6	0.7
Gaseous fuels	1.518	2.9	3.4	3.5	3.6	3.7
Biomass	0.114	0.7	1.2	1.4	1.6	1,8
With measures scenario						
Total in PJ out of which:		19.3	21.0	21.6	22.4	23.6
Electricity		3.3	3.3	3.4	3.5	3.6
Heat		0.7	1.2	1.2	1.3	1.4
Liquid fuels		11.9	12.1	12.3	12.5	13
Solid fuels		0.3	0.3	0.3	0.3	0.3
Gaseous fuels		2.8	3.1	3.3	3.5	3.5
Biomass		0.3	1.0	1.0	1.2	1.6

Energy demand	2005	2015	2020	2025	2030	2035
With additional measures scenario						
Total in PJ out of which:		19.3	20.9	21.5	22.3	23.4
Electricity		3.3	3.3	3.4	3.5	3.6
Heat		0.7	1.2	1.5	1.8	1.9
Liquid fuels		11.9	12	12	12.2	12.4
Solid fuels		0.3	0.3	0.3	0.3	0.3
Gaseous fuels		2.8	3.0	3.2	3.2	3.4
Biomass		0.3	1.0	1.0	1.2	1.6

V.D.2.7. Refineries

Romania currently has refineries in two large groups:

- Large refineries that concentrate 85% of the processing capacity: Petrobrazi, Ploiesti, Arpechim Pitesti, Petrotel Pitesti, Petromidia, RAFO Onesti;
- Small refineries, which account for 15% of the processing capacity with a low complexity: Astra Ploiești, Vega Ploiești, Romanian Steaua Campina, Dărmănești refinery, Petrolsub Surplacu de Barcău.

All refineries have a total capacity of 34 million tonnes per year, well above Romania's domestic consumption.

The types of fuels used in combustion processes resulted from the EU-ETS monitoring reports

Table V_51 shows the fuels used in combustion processes in the EU-ETS monitored refineries.

Table V_51 Fuels used in combustion processes in refineries

Name of company	Fuels used
OMV Petrom S.A. Arpechim	Combustible gases (refinery gas + natural gas), fuel oil, natural gas, liquid fuel for outbreaks, recovery energy sources
SC Rompetrol Rafinăria SA VEGA	fuel oil, natural gas
SCOMV Petrobrazi	Combustible gases (refinery gas + natural gas), fuel oil, natural gas, liquid fuel for outbreaks, recovery energy sources
SC Rafo SA	Refinery gases, liquid fuels, natural gas, refinery gases accidentally burnt in the feeler
SC Rompet Petrochemicals	natural gas, residual gases
Astra Română	natural gas, păcură
SC Rompetrol - Petromidia	refinery gas, natural gas
SC Petrotel – Lukoil SA	refinery gas, fuel oil, natural gas
SC Rafinăria Steaua Română SA	fuel oil, natural gas
SC Petrochemicals Trading SRL	natural gas, refinery gas

Using ENPEP, Romania's energy balance forecasts were drafted for 2015 ÷ 2035 period, determining the need for liquid fuel for use in industry, transport, agriculture, services, etc. In order to cover the internal needs of liquid fuels, it was concluded that during 2015 ÷ 2035 for the refineries, the foreseen energy demand in the scenario with no measures, presented in Table V_52 should be ensured.

Table V_52 Energy demand evolution during 2005 ÷ 2035

Energy demand, in PJ	2005	2015	2020	2025	2030	2035
Liquid fuels	20.2	20.2	25.3	30.7	32.0	37.0
Gaseous fuels	6.4	6.4	10.8	12.8	14.9	16.5
Electricity	3.6	3.6	4.4	4.6	4.6	4.6
TOTAL, in PJ	30.2	30.2	40.5	48.1	51.5	58.1

Considering that no information is available on measures taken by economic agents to increase energy efficiency and reduce GHG emissions, the same evolution of GHG emissions in the three scenarios for refineries is considered.

V.D.2.8. Handling of fossil fuels

According to Romania's energy balance, for extraction and handling of fossil fuels (coal, oil and natural gas) are required electricity, solid and gaseous fuels. The evolution of energy demand forecast for the period 2016 ÷ 2035, for the WOM scenario, is presented in Table V_53. This forecast was made by extrapolating the values obtained in the period 2005 ÷ 2015.

Table V_53 Evolution of energy demand during 2014 ÷ 2035

Energy demand, in PJ	2005	2015	2020	2025	2030	2035
Liquid fuels	7.3	8.3	13.1	14.9	15.4	15.9
Gaseous fuels	8.2	9.2	14.1	17.2	17.5	18.1
Solid fuel	0.008	0.008	0.008	0.008	0.008	0.008
Electricity	6.02	6.82	8.3	9.4	10.4	13.1
Heat	0.336	0.136	0.3	0.3	0.3	0.3
TOTAL, in PJ	21.86	24.46	35.81	41.81	43.61	47.41

From handling coal results fugitive emissions of CH₄. These emissions represented about 8.7% of CH₄ emissions from the energy sector in 2015, 3.4% of total CH₄ emissions in Romania. Considering the difficulty of forecasting emission sources as a result of coal extraction during 2015 ÷ 2035, the forecast of these emissions was determined by extrapolating the value for 2005 for the no measures scenario with an average annual rate of about 2% during 2005 ÷ 2015, and 1% during 2015 ÷ 2035.

In the with measures and with additional measures scenarios, the extrapolation of the 2015 value was done with lower annual average rates, considering capturing and using CH₄ emissions for heating and hot water preparation at mining sites.

Oil and natural gas systems take into account the entire chain from extraction of resource (crude oil or natural gas) to the final consumer, including transformation processes to meet consumer requirements. These systems result in fugitive emissions

of CO₂ and CH₄. These emissions were 952.85 Gg of CO₂ and 376.31 Gg of CH₄ in 2015, accounting for about 1.2% of total CO₂ emissions and 8.8% of total GHG emissions in Romania.

Given the difficulty of forecasting the evolution of the oil and natural gas sector by 2035, the fugitive emission forecasts were determined by the method of extrapolating the 2005 figures (scenario with no measures) and 2015 figures (for the scenario with measures and with additional measures). Tables V_54 and V_55 show the projected developments for CO₂ and CH₄ emissions for the three scenarios given the different average annual growth rates.

Table V_ 54 Evolution of CH₄ emissions, in Gg during 2005 ÷ 2035

Scenario	2005	2015	2020	2025	2030	2035
	Achievement		Prognosis			
No measures scenario	1,660.71	1,570.0	1,450.0	1,500.0	1,550.0	988.22
With measures scenario		936.52	833.62	836.98	840.46	843.97
With additional measures scenario		936.52	715.66	716.32	717.13	718.30

Table V_ 55 Evolution of CO₂ emissions, in Gg during 2005 ÷ 2035

Scenario	2005	2015	2020	2025	2030	2035
	Achievement		Prognosis			
No measures scenario	632.92	680.0	680.0	682.0	685.0	690.0
With measures scenario	-	416.49	338.99	345.26	352.15	358.47
With additional measures scenario	-	416.49	332.90	340.50	348.15	355.80

V.D.3. Methodology for GHG emission projections for Industrial Processes sector

According to IPCC 2006, GHG emissions result from non-energy industrial activities.

Table V_56 shows sectors and types of GHG emissions from industrial processes sector.

Table V_ 56. Sectors and types of GHG emissions from the Industrial processes and product use sector

IPCC category	CO ₂	CH ₄	N ₂ O	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 PROCESS USES OF CARBONATES	✓						
2 B CHEMICAL INDUSTRY							
2.B.1. AMMONIA PRODUCTION	✓						
2.B.2. NITRIC ACID PRODUCTION			✓				
2.B.3. ADIPIC ACID PRODUCTION							
2.B.4. CAPROLACTAM, GLYOXAL AND GLYOXYLIC ACID PRODUCTION							
2.B.5. CARBIDE PRODUCTION	✓	✓					
2.B.6. TITANIUM DIOXIDE PRODUCTION							
2.B.7. SODA ASH PRODUCTION	✓						
2.B.8. PETROCHEMICAL AND CARBON BLACK PRODUCTION	✓	✓					
2.B.9. FLUORO-CHEMICAL PRODUCTION							
2.B.10. OTHER							
2 C METAL INDUSTRY							
2.C.1. IRON AND STEEL PRODUCTION	✓	✓					
2.C.2. FERROALLOYS PRODUCTION							
2.C.3. ALUMINIUM 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							

IPCC category	CO ₂	CH ₄	N ₂ O	HFC	PFC	SF ₆	NF ₃
2.E.2. TFT FLAT PANEL DISPLAY							
2.E.3. PHOTOVOLTAICS							
2.E.4. HEAT TRANSFER FLUID							
2.E.5. OTHER							
2 F PRODUCT USES AS SUBSTITUTES FOR ODS							
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 ₂ O FROM PRODUCT USES			✓				
2.G.4. OTHER							
2.H. OTHER							

GHG emissions in non-energy sectors were calculated using models based on spreadsheets, considering the activity data and production structure of sub-sectors. The emission factors used are either specific for the sector (determined by analysing data from previous years) according to the IPCC guidelines. Also, assumptions specific to sub-sectors were considered.

In order to estimate emissions, the following formula was used:

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

where:

$E_g(t)$ - emissions projected for the greenhouse gas g in year t ;

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

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

k - product or material used for whose manufacture or from whose use GHG emissions result;

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

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

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

For 2.D, 2.F and 2.G categories, given the difficulty of long-term prognosis of the conduct of activities that could cause occurrence of these emissions, upon development of forecasts, data extrapolation method is adopted.

V.D.3.1 Assumption for Industrial processes and Product use

In WOM scenario the following legal framework were not considered:

- Regulation (EU) no. 517/2014 related fluorinated greenhouse gases;
- Directive 40/2006/EC (MAC Directive) on emissions from air conditioning systems of the motor vehicles;
- EU - ETS Directive;
- Directive 2010/75/EU on industrial emissions.

Estimation of emissions under this hypothetical scenario for the main industry sectors *Industrial processes and product use* were based on hypothetical outputs and the value of emission factors in 2005.

The assumptions used in the WEM and WAM scenarios are presented in the following chapters.

V.D.3.1.1.1 Mineral industry

V.D.3.1.1.1.1 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 2011÷2015 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 2010, production continued to decline, and in 2011 there was an increase by about 10% compared to 2010, but below 2009. In 2012, clinker production has reached a value of 5,874 kt, with 2% more than in previous year, but the production exceed the production value recorded in the first year of economic crisis (2009). After a decrease in production in 2013, in the years 2014 and 2015 the production increased (with 2015 value of 6203 kt being the highest in the last 7 years).

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.

CO₂ 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.

CO₂ emission factor associated with clinker production is calculated based on the contents of CaO and MgO.

Taking into account the effects of the 2010/75/EU Directive, for the WEM and WAM scenarios we assume that EF will reach a value of 0.51 tonnes CO₂/ tonne of clinker (representing 95% from the average value from the period 2011÷2015) till 2020 and will be constant in the period 2020- 2035.

Considering the evolution of GVA in the construction sector during 2016÷2035, it is estimated that in the year 2020 it will reach a value of 7,200 kt clinker and in 2035 this production will be about 8,600 kt.

V.D.3.1.1.2 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). 2010 marked an increase in lime production to a value of

1,339 kt and in the period 2011-2015 the average lime production was around 1180 kt. Also in 2013 and 2014 the dolomite lime production was ceased, and in 2015 a small quantity (less than 0.5 kt) was recorded.

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 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, the following assumptions are considered:

- On the short-term, no new facilities will close or build;
- Will be considered that dolomite lime will not be further product in Romania, so will be only lime production;

CO₂ emission factor associated with lime production are estimated based on CaO and MgO contents. For CO₂ emissions projections the following assumptions will be used:

- For WEM and WAM scenario the effects of 2010/75/UE Directive will be considered. Thus the EF will decrease in the period 2016-2010, reaching a value of 0.748 tonnes CO₂/ tonne of high calcium lime (95% from EF average value in the period 2011÷2015) and will be have a constant value till 2035.

V.D.3.1.1.3 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.

In Europe the main products are glass containers, representing about 60% of production and flat glass (30%). At national level, the production of flat glass is approx. 65.3%, production of glass containers, approx. 32.3%, and production of mineral wool approx. 2.6% (average for the period 2011÷2015).

Table V_57 shows the shares of glass types produced in Romania between 2011÷2015.

Table V_ 57. Shares of the types of glass produced in Romania

Category	2011 ÷ 2015
Glass for containers	32.1 %
Flat glass	65.3 %
Glass wool	2.6 %

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. 2010 marked a slight increase in the amount of glass produced to a value of 400 kt (but still less than in 2008 production). In 2011 the production of glass had a value close to that of 2010, of 386 kt. In period 2011-2015, glass production had a relativ constant evolution, around 380 kt.

The main weaknesses of this sector are high energy intensity of production process and that production technologies that 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 CO₂ 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, suplimentary emissions reduction will be reached.

Given the current economic situation, the following assumptions are considered:

- On the short-term, no new facilities will close or build;
- Production structure considered will be that in the period 2011÷2015;

For CO₂ emissions projections the following assumptions will be used:

- For WEM and WAM scenario the effects of 2010/75/UE Directive will be considered. Thus the EF will decrease in the period 2016-2010, reaching the values (95% from EF average value in the period 2011÷2015) and will have a constant value till 2035.

Table V_ 58. EF values used in CO₂ projections for category 2.A.3 – Glass Production

Product type	EF, t CO ₂ /t product type	
	WEM	WAM
Glass for containers	0.129	0.129
Flat glass	0.145	0.145
Glass wool	0.186	0.186

V.D.3.1.1.4 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. CO₂ emissions are generated in industrial processes due to exposure to high temperatures.

According with IPCC 2006 GLs, within this category are considered all uses of carbonates in ceramics manufacturing, soda ash use, non-metallurgical magnesia production and other uses.

In the period 2011-2015, the quantities of limestone, dolomite and other raw materials with carbon content used in ceramics manufacture increased from a minimum value of 256 kt in 2012 to a maximum of 1401 kt in 2015.

The quantities of soda ash used in the period 2011-2015 increased from 39 kt in 2011 to 75 kt (in 2015) and 80 kt in 2014.

The same trend is followed by AD in the sub-category 2.A.4. d – *Other* from 96 kt in 2011 to 363 kt in the year 2015.

Taking into account the internal market demand, for the AD projections the following assumption was used:

- an annual growth with 1% since 2015 for the sub-category 2.A.4.a, and 2.A.4.c;
- a increase of limestone use for wet gases desulfuration accounted in the sub-category 2.A.4.d.

In Table V_59 are presented the AD used for projections for each sub-category.

Table V_ 59. AD values projected for each sub-category for the period 2016-2035

Sub-category	Quantities of carbonates / raw materials used, kt				
	2016	2020	2025	2030	2035
2.A.4.a – Ceramics	1415	1473	1548	1627	1710
2.A.4.c – Soda ash use	77	86	91	96	100
2.A.4.d – Other uses	364	383	385	387	389

For CO₂ emissions projections the following assumptions will be used:

- for WEM and WAM scenario for subcategory 2.A.4.a the effects of 2010/75/UE Directive will be considered. Thus the EF will decrease in the period 2016-2020, reaching the values (95% from EF average value in the period 2011÷2015) and will have a constant value till 2035.

Table V_ 60. EF values used in CO₂ projections for category 2.A.4 – Other uses of carbonates

Sub-Category	EF, t CO ₂ /t carbonat or raw materials	
	WEM	WAM
2.A.4.a – Ceramics	0.054	0.054
2.A.4.b – Soda ash use	0.415	0.415
2.A.4.d – Others	0.440	0.440

V.D.3.1.2. Chemical industry

GHG emissions from chemical industry occur due to production processes of ammonia, nitric acid, carbide and other substances (ethylene, methanol, sulphuric acid, etc.).

These emissions in 2010 accounted for 29.16% of the total GHG emissions in this sector. Industrial processes, representing 3.05% of total GHG emissions of 2010 in Romania

GHG emissions produced by the chemical industry fell from about 12,000 Gg CO₂eq. in 1989 to about 3,500 Gg CO₂ eq in 1998 and stabilized around 5,000 Gg CO₂eq during 2000÷2007. In 2015 it was obtained the minimum value of about 1,122 Gg CO₂eq.

These higher fluctuations in emissions occur due to the instability of the economic activities of producers who have stopped and suspended production, depending on the market requirements.

Given the impossibility of long-term projection of the activity carried out by various manufacturers for the forecast of GHG emissions, the extrapolation method was used. Thus, values of CO₂, N₂O and CH₄ of 2015 were extrapolated with an average annual rate of 2% between 2016÷2035, for the scenario without measures.

In the scenario with measures and with additional measures, forecast is realized considered that in 2035 the amount of emissions in these scenarios represent 85% of the scenario without measures.

V.D.3.1.3. 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.

Due that magnesium were not produced in Romania for this sub-category was not estimated emissions and also was not developed emissions projection.

V.D.3.1.3.1 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 in the last years presents exponential increase. In 2001, world liquid steel production was 851,073 kt and in 2015 reached a value of 1,620,408 kt, representing a increase with around 90%.

In what concerns the weight of the steelmaking route, worldwide, in 2015, the BF-BOF steel weight was 74.2 %, the EAF steel represented 25.2 %, and the rest (0.6 %) was OH steel. In the same year in the EU-28 the BF-BOF steel represented 60.6 %, and the EAF steel was 39.4%.

The iron and steel industry in Romania was 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 V_61 shows the main iron and steel producers in Romania and changes in the types of steelmaking processes used.

Table V_ 61. Overview of factories and steelmaking processes in Romania

Factory location	Year of foundation	Steelmaking route	
		Past (in 1989)	Actual
Galati	1961	BF - BOF	BF- BOF
Hunedoara	1882	BF- OH	EAF
Targoviste	1973	EAF	EAF
Campia Turzii	1920	EAF	EAF
Resita	1771	BF-OH	EAF
Otelu Rosu	1796	EAF	EAF
Calarasi	1976	EAF	EAF

EAF = electric Arc Furnace; BF = Blast Furnace; BOF = Basic Oxygen Furnace; OH = Siemens Martin/Open Hearth Furnace

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 CO₂ emissions per tonne 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, national production of EAF steel has decreased and consequently the share of this steel type (38% in 2013). 2015 production structure by types of flows was: 59.7% BOF steel and 40.3% EAF steel.

The economic crisis has seriously affected steel production in Romania, who decreased by about 45% in 2009 compared to 2008 and around 55% compared to 2007. 2010 marked an increase in the amount of steel produced (with 37% higher than previous year) to a value of 3,734 kt (but still with 27% lower than in 2008). In 2011, steel production was maintained at a value close to 2010 production (3,813 kt), and in 2012 dropped to a value of 3,452 kt. In terms of production values in the years 2013 and 2014 they were about 3,200 kt and in 2015 recorded a value of 3,480 kt.

It should also 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 status, we consider the following assumptions for the GHG emissions projection:

- In the short term a reduce capacity using of some EAF steel production units (i.e. Mechel Group);
- In the medium-term a opening of an 800 kt / year production (500 kt in the first stage and another 300 kt in the second stage) facility in Oltenita who will produce EAF steel.

Taking into account the evolution of national and international market request, for GHG emissions estimations will be used the following AD – Table V_62 (with the assumption that in the 2035 will be reached around 80% of the total production capacity).

Table V_ 62. Total steel projection for Romania for the period 2016÷ 2035

Product	Year			
	2020	2025	2030	2035
Total steel production, kt	4000	5000	6000	8000

For CO₂ emissions projections the following assumptions for emission factors are considered:

- for WEM and WAM scenarios will be take into account the effect of the application of Directive 2010/75/EU. Thus the EFs for each type of steel will decrease in the period 2016-2020 up to the values presented in the table below (95% of the average of 2013-2015 EFs for BOF steel and 95% of the average of the 2011-2015 EFs for EAF steel) and will be keep constant until 2035.

Table V_ 63. The EFs values used in CO₂ emissions projections for category 2.C.1. – Iron and Steel Production

Product	EF, t CO ₂ /t steel	
	WEM	WAM
BOF steel	1,517	1,517
EAF steel	0.010	0.010

For CH₄ emissions projections from the sinter production the following assumptions will be considered:

- For WEM and WAM scenarios the effects of the application of Directive 2010/75 /EU will be taken into account. Thus the conversion factor of sinter in BOF steel will decrease in the period 2016-2020 up to a value of 0.943 t sinter / t BOF steel (representing 95% of the lowest value in the period 2011-2015) and will remain constant until 2035.

V.D.3.1.3.2 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 by the background of 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 the years 2011 and 2012, ferro-alloy production fell again and in the last 3 year production 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 that national ferro-alloys production will not resume and will not be realised projections for this sub-category.

V.D.3.1.3.3 Aluminium 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 increased slightly compared to 2010 to a value of 224 kt, followed by a decrease in 2012 to 202.6 kt. The production in 2013 and 2014 was around 195 kt and reached 205 kt in 2015.

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 CO₂ 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 internal and international market demand, it is expected that production will reach 211 kt in 2020, 220 kt in 2025 and 2040 kt in 2035.

For CO₂ emissions projections the following assumptions for emission factors are considered:

- for WEM and WAM scenarios will be take into account the effect of the application of Directive 2010/75/EU. Thus the EFs will decrease in the period 2016-2020 up to 1.525 t CO₂/t primary aluminium (95% from the average of 2011-2015 EFs) and will be keep constant until 2035.

For PFC emissions projections the following assumptions for emission factors are considered:

- for WEM and WAM scenarios will be take into account the effect of the application of Directive 2010/75/EU. Thus the EFs will decrease in the period 2016-2020 up to 0.0296 t CO₂-eq/t primary aluminium (representing 95% from minimum value of the EF from the 2011-2015 period) and will will be keep constant until 2035.

V.D.3.1.3.3 Lead production

Lead are manufactured from two type of raw materials: from lead concentrate (primary lead) and from recycled lead (secondary lead).

The primary lead is obtained from ore containing sulfide and other lead compounds and also 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. The vast majority of this recycled lead comes from scrapped lead acid batteries.

Since 1989, lead production in Romania decreased till 1992. This period is followed by a period of 16 years of continuous growth in production, the maximum recorded being in 2005 (exceeding the 1989 production). On the economic crisis, quantities of lead produced in Romania decreased by about 85% in 2009 compared to 2008. Till 2013 production continue to decrease, with a year (2012) when was stopped. The lead production in 2015 represents 14% from 2011 production level.

Given the current economic situation and the internal and international market demand, the following assumptions are considered:

- On the short-term, no new facilities will close or open;

- The emission factor will be constant over the entire period of projections and is the average value of the last 5 years;
- The production level will reach 1.389 kt in 2020, 1.459 kt in 2025 and 1.599 kt in 2035.

V.D.3.1.3.4 Zinc production

Zinc is 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 sulfide, 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.

Since 1989, zinc production in Romania decrease till 1991 when the production level reached 30% of 1989 production level. This period is followed by a period of 18 years of continuous growth in production, the maximum recorded being in 2008 (double that 1989 production). On the economic crisis, quantities of zinc produced in Romania decreased, being almost zero.

Given the current economic situation and the internal and international market demand, the following assumptions are considered:

- On the short-term, no new facilities will close or open;
- The emission factor will be constant over the entire period of projections and is the default value foreseen in IPCC 2006;
- The production level will reach 0.210 kt in 2020, 0.220 kt in 2025 and 0.240 kt in 2035.

V.D.3.1.4. 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 in the period 2010 - 2015 the emissions due to category 2D Non-energy products from fuels and solvent use contributed only to 0.37% of total GHG emissions in Romania, and the difficulty of long-term prognosis of the conduct of activities that cause occurrence of these emission, upon development of forecasts, data extrapolation method is adopted.

The forecast emissions for the reference scenario is achieved by extrapolating the emission value of 2015 with average annual rate of 1.4% between 2015÷2016 and average annual rates of 2.8%, 3%, 3.8% in the intervals 2016÷2020, 2021÷2025, 2026÷2035.

For scenarios with measures and additional measures technological improvements/ environmental investment are taken into consideration, which contributes to CO₂ emissions reduction. Thus, CO₂ emissions in 2035 will be 80% of the emissions

projected in the reference scenario, for the scenarios with measures and with additional measures

In determining annual growth rates were considered the CO₂ emission trends from 1989÷2015.

V.D.3.1.5. 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 equipments. 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 1989-2015 there is an increasing trend of fluorinated gases emissions, from a value of 0.15 kt CO_{2eq} (1989) to 1,636 kt CO_{2eq} (2015). Emissions from almost all subcategories follow this trend.

Category 2.F.1 accounts for 77.1% of total category 2.F, 2.F.4 for 2.5%, 2.F.2 for 1% and 2.F.3 represent 0.3%. These weights represent the average value over the last 5 years.

For the category 2.F.5 was not recorded emissions and emissions projections will not be achieved.

Under the category 2.F.1. most significant are subcategories: *Stationary air-conditioning* - 2.F.1.f. representing 35% of total category 2.F.1, *Mobile air conditioning* - 2.F.1.e. (31.9%) and *Commercial refrigeration* - 2.F.1.a. (16.7%). These weights represent the average value over the last 5 years.

For the category 2.F.1, in the period 1996-2015 are registred a sharp increase of emissions from 3.76 kt CO_{2eq} to 1598 kt CO_{2eq}. The same trend was followed by 2.F.3 and 2.F.4 category. Emissions from 2.F.3 growth from 0.014 kt CO_{2eq} (1996) to 4.17 kt CO_{2eq} (2015), while emissions from 2.F.4 increased from 0.94 kt CO_{2eq} (1996) to 33.9 kt CO_{2eq} (2015)

For the category 2.F.2 – *Foams blowing agents* in the period 2008-2016 are registred a sharp decline in emissions, from 89.09 kt CO_{2eq}. (2008) to 0.04 kt CO_{2eq}. (2015).

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.

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.³⁰

³⁰ GHG Projection Guidelines, Part B: Sectoral Guidance, Final report, CLIMA.A.3./SER/2010/0004, 2012

V.D.3.1.6. 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 N₂O emissions from the use of products.

Considering that emissions from category 2.G *Other product manufacture and use* represent around 0.05% of the total net GHG emissions (without LULUCF) in the period 2011 ÷ 2015 and and the difficulty to conduct long-term projections of activities that causes these emissions, the extrapolation method for emissions was used.

Thus, the projected emissions for the reference scenario is achieved by extrapolating the of 2015 emission value with annual average rate of 3% for the period 2016 ÷ 2035. In WEM and WAM scenarios for SF₆ emissions were considered the effects of Regulation no. 517/2014 on fluorinated greenhouse gases (F-gases), emissions were extrapolated using the methodology and factors set out in guidelines for achieving sectoral emission projections.

V.D.4 Methodology for GHG emission projections for Agriculture sector

The following direct GHG emissions occur in the Agricultural sector:

- CH₄ from enteric fermentation;
- CH₄ and N₂O from manure management;
- CH₄ from rice cultivation;
- N₂O from use of fertilizers;
- CH₄ and N₂O from agricultural residue burning in the field.

To establish the GHG emission projections, the following equation is used in accordance with NIGHGE 2015:

$$GHG\ Emissions = AD \times EF$$

where: AD is the projected activity date;

EF - forecast emission factor.

In 2015 the agriculture's contribution to GHG emissions was 15.8% and the total GHG emissions in Romania, reaching 18,711,03 Gg CO₂eq.

In 2015 the contribution of the various agricultural sub-sectors to GHG emissions was the following:

- 57.09 % from enteric fermentation;
- 12.61 % from manure management;
- 26.18% from agricultural soils;
- 0.00% from rice cultivation;
- 3.16% from field burning of agricultural residues;
- 0.34% from urea application;
- 0.17% from liming.

Based on data presented we can say that largest contribution to GHG emissions is taken by enteric fermentation, fertilizers usage and the management of manure.

In Table V_64 is presented the evolution of agricultural area in Romania based on way of land using in the period 2005 – 2014. For period 2015 – 2035 is considered the same way of land using as for 2014 year.

Regarding the chemical fertilizers consumption in Romania, we can say that in period 2005 – 2014 were used around 47 kg/ha. An extensive analysis of chemical fertilizers consumption in Romania, shows that in 1989 it were used around 160 kg/ha, while in 1995 were used 52 kg/ha.

Based on this data we can say that, through chemical fertilizing it is not compensate the quantity of nutrients extracted from soil by growth of plants. In order to establish the needed quantities of nutrients, it is taken into consideration the integral use of the manure from agriculture farms. We have to emphasize that even the quantity of natural fertilizers it was considerably reduced between 1989 and 2015, from 41,603 thousands tons to 15,212 thousands tons, mainly due to the negativ evolution of the number of animals.

Having in view that there are no forecasts on long term regarding the evolution of chemical fertilizers quantities which will be used in agriculture sector, it is extrapolated the quantity used in 2014 by around 0.65% per year as average rate.

The chemical fertilizers having GHG emissions, we can mention the chemical fertilizers based on nitroge (N): urea, ammonium nitrate, etc. The N₂O emissions are variable according to the method and period of applying. Therefore, in order to reduce the N₂O emissions, will be considered the improvement of fertilizers using technologies.

Other GHG emissions possible source is rice culture from which is resulting CH₄ emissions from anaerob fermentation during the flood or irrigation period. Rice culture covers quite reduce areas. These areas have continuously declined after 1989 when they accounted 49.3 thousands ha, as following: 0.1 thousands ha in 2003, 1.2 thousands ha in 2004, 3.9 thousands ha in 2005, 12.4 thousands ha in 2010 and 12.7 thousands ha in 2011.

In 2012 the rice culture area decreased at 11.3 thousands ha and at 11.1 thousands ha in 2015. It is considered as hipotezis to maintain 11.1 thousands ha of rice culture for the next period. Having in view that the specific CH₄ emissions from rice culture was around 0.00512 g/m² in 2015, representing 0.000048122% from total estimated value of CH₄ for Romania, there are no propped measures for GHG emissions reduction in rice culture.

In the sector of animal husbandry, the CH₄ emission has two main sources: emission from digestion process of animals and that emissions from anaerob fermentation of organic materials from animal's manure.

In table V_66 it is presented the evolution of animals number between 2005 – 2035. The cancelation of agriculture asociations and farms owned by the State conducted to significant structural modifications. Thus, if in 1989 the livestock of cattle was around 6291 thousands, in 2015 the livestock decreased at 2092 thousands. In 2015 it was registered a number of 9810 thousands sheeps and 4927 thousands pigs.

The increasing price of feed had an important impact on this modifications. It is expected that with the consolidation of private property in agriculture sector to increase the livestock and the production of animal products. It works to improve the animals feed practices at the level of farms and to introduce advanced techniques for zootechnical improvement. In order to reduce methane emissions some actions for animal feed improvement and for methane capture from anaerobic fermentation of manure in order to be used as fuel.

In poultry sector it can be seen a decreasing of the number between 1989 – 1995, from 113,968 thousands to 80,382 thousands heads. An increasing of the poultry number was registered between 2000 – 2005 and again a decreasing at 79,842 thousands in 2011 and at 78,648 thousands in 2015.

The evolution of animals number between 2016 – 2035 should be done considering that the internal consumption is covered and a surplus for export is created. Having in view that this kind of information are missing from Romanian National Strategy for Sustainable Development and there is no other official source of information in this regard, the forecast of animals livestock for 2016 – 2035 was assessed through extrapolating 2015 data with the following annual average rates:

- 1.1% for cattle;
- 1.9% for pigs;
- 1.4% for sheep;
- 1.1% for goats;
- 2.0% for horses;
- 1.1% for birds.

Table V_ 64 Agricultural area trend, 2005-2014

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total aricultural area (thous ha, of which:	14,741.2	14,731.0	14,709.3	14,702.3	14,684.9	14,634.5	14,621.5	14,615.1	14,611.9	14,630.1
- arable	9,420.2	9,434.5	9,423.3	9,415.1	9,422.5	9,404	9,379.5	9,392.3	9,389.3	9,395.3
- pastures	3,364	3,334.4	3,330	3,330	3,313.8	3,288.7	3,279.3	3,270.6	3,273.9	3,272.2
- hayfields	1,514.6	1,524.9	1,531.4	1,532.4	1,528	1,529.6	1,554.7	1,544.9	1,541.9	1,556.3
- vineyards and vine nurseries	224.1	223.7	218	214.5	215.4	213.6	211.3	210.5	210.3	209.4
- orchards and tree nurseries	219.2	213.4	206.6	207.3	205.2	198.6	196.7	196.8	196.5	196.9

Table V_ 65 Chemical and natural fertilizers amounts used in Agriculture trend, 2005 ÷ 2035

Îngrășăminte, în mii tone															
Chemical fertilizers, of which:	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Prognose			
	Realizări														
	461	363	387	398	426	481	487	438	492	452	533	543	554	569	607
- nitrogenous	299	252	265	280	296	306	313	290	344	303	359	363	370	374	400
- phosphatic	138	94	103	102	100	123	126	113	114	119	133	135	138	148	158
- pottasic	24	17	19	16	30	52	48	35	34	30	43	45	46	47	49
Natural fertilizers	16,570	14,900	13,498	11,748	16,748	15,232	14,510	13,293	13,580	16,262	15,212	17,635	18,867	20,185	21,595

Table V_ 66 Livestock evolution, 2005 ÷ 2015

Animal categories (thousands of heads)	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total (excluding bee families and rabbits)	105168	103949	101616	103829	102972	98543	97560	98053	97640	94018	97420
Cattle, of which:	2862	2934	2819	2684	2512	2001	1989	2009	2022	2069	2092
- cows, buffaloes and heifers	1812	1810	1732	1639	1569	1299	1266	1265	1279	1307	1311
- Heifers	154	141	136	133	128	101	96	102	110	119	121
- Cows and buffaloes	1658	1669	1596	1506	1441	1198	1170	1163	1169	1188	1191
Pigs, of which:	6622	6815	6565	6174	5793	5428	5364	5234	5180	5042	4927
- sows for sowing	494	520	442	376	359	356	381	399	384	378	375
Sheep, of which:	7611	7678	8469	8882	9141	8417	8533	8834	9136	9518	9810
- sheep and lambs	6453	6526	7207	7597	7818	7338	7441	7695	7875	8161	8330
Goat types, out of which:	687	727	865	898	917	1241	1236	1266	1313	1417	1440
- goats	581	616	713	741	755	1032	1012	1031	1059	1129	1133
- Horses	834	805	862	820	764	611	596	575	548	525	503
Birds, of which:	86552	84991	82036	84373	83843	80845	79842	80136	79440	75447	78648
- adult laying birds	49725	50278	45208	45529	45046	44504	45464	45402	42541	42739	43663
- Bee families	888	891	982	998	1057	1275	1250	1254	1354	1351	1393
- Rabbits	570	479	495	458	456	268	276	297	290	288	292

Livestock evolution, prognosis 2020-2035

Animal categories (thousands of heads)	2020	2025	2030	2035
Total (excluding bee families and rabbits)	101135	107445	114150	121325
Cattle, of which:	2330	2570	2840	3140
<i>cows, buffaloes and heifers</i>	1475	1593	1759	1942
Heifers	145	160	177	195
Cows and buffaloes	1330	1433	1582	1747
Pigs, of which:	5450	5815	6200	6620
<i>sows for sowing</i>	407	434	462	493
Sheep, of which:	10170	10740	11345	11985
<i>sheep and lambs</i>	8715	9205	9725	10270
Goat types, out of which:	1535	1640	1745	1870
<i>goats</i>	1225	1310	1400	1495
Horses	600	650	700	760
Birds, of which:	81050	86030	91320	96950
<i>adult laying birds</i>	45910	48730	51725	54905
Bee families	1370	1390	1410	1440
Rabbits	305	320	340	350

In order to forecast the CH₄ emissions from agriculture sector within without measures scenario, it were considered the forecasts from Table V_67, as well as the emissions factors (in kg CH₄ per capita and year) used for assessing the inventory for 2015 year. For methane emissions resulted from rice culture and from agriculture scrape burning on the field, it was adopted the hipotesis that these will remain constant over the forecast period. It is considered this hipotesis having in view their low participation within the total methane emissions (0.2% and 1.6% respectively).

For methane emissions reduction from digesting process, were considered the following measures:

- Improving the quality of nutrition by increasing the percentage of protein which leads to an increased supply by 5%. It is estimated that the improvement of breeding technology leads to methane emissions decreasing by 10% at 2020 and by 25% at 2035 in the scenario steps;
- Increased weight gain per kg of fed animal and milk growth per kg of fed animal that will provide increased performance and will ensure a reduction of methane emissions by 5% in 2020 and 10% in 2035 in scenario with supplementary measures.

For methane emissions reduction from animal's manure, anaerobic fermentation of manure will be carried out. The produced methane will be collected and it will be used locally, as fuel within the farms.

The sludge resulted will be used as organic fertilizers, or will be composted for the same purpose, through anaerobic method in order to avoid methane emissions into the atmosphere.

Within scenario without measures, the methane from anaerobic fermentation will not be recovered. In with measures scenario it is considered that at the level of 2020 it will be collected around 10% of the methane resulted from anaerobic fermentation of animal's manure, in 2025 around 15% and in 2035 around 25%. In with supplementary measures scenario the collection rate of methane will increase at 40% in 2035 year.

N₂O emissions result from fertilizers using, from management of manure and from burning the agriculture scrap on field for the period 2015 – 2035.

Having in view that for the period 2005 – 2035 it is quite imposible to predict the volume of activities which ate source of N₂O emissions, in order to realize the forecasts in without measures scenario, the values for N₂O emissions are extrapolated from 2005 using an annual average rate of 2.9%.

Given the high share of emissions from using the chemical fertilizers, in with measures scenario it is considered the improvement of technologies of using nitrate fertilizers. It is considered the utilization of phasing fertilizing technique and the utilization of new machinery for distribution of chemical fertilizers as evenly as possible. In case of with supplimentry measures scenario it is estimated a reduction of emissions due to the use of modern methodes of applying fertilizers, up to 20% in 2035 year.

V.D.6 Methodology for creating carbon storage programs by the use of land, changing the destination of land and forestry

The prognosis is created using a number of models of varying complexity, based on the land's type of use, the most complex being forest prognoses. Simulations cover absorbents and major CO₂ sources, except for the carbon stored in forest wood products, which is taken as neutral (entries in these storage equal exits).

To create *carbon storage prognoses* using forestry-specific measures (*for forested lands*), specialized CBM-CFS3 software is used, which incorporates an empirical model that simulates the dynamics of all carbon stores in forest ecosystem storages according to the Kyoto Protocol (over and underground biomass, litter, deadwood as well as organic carbon deposited in soil). The program was developed in Canada by Dr. Werner Kurz and the Canadian Forestry Service team.

This carbon store dynamic modelling framework conforms to the carbon store estimation and change assessment models of ecosystem stores described in the IPCC 2006.

The software uses the following information: tree species, annual growth and wood production curves for the stands, statistical data on manmade and natural disruptions, harvested wood mass as well as land-use change information (deforestation, forestation). Thus, users are also able to create, simulate and compare various forest management scenarios in order to assess their impact on CO₂ emissions.

To simulate the scenarios, the following data was used:

- a) Forested surfaces from the primary results of the first NFI cycle (2008-2012) * namely 6,641,464 hectares, of which:
 - (i) Forests and other forest vegetation lands where wood harvesting is regulated (5,925,015 hectares);
 - (ii) Forests and other forest vegetation lands where wood harvesting is **not** regulated (716,449 hectares) used to simulate over time the forest vegetation not affected by cutting (protected areas).

** the statistical inventorying of the country's entire vegetation is carried out within NFI. Because the definitions of the forest vegetation categories used in our country only partially correspond with international definitions, NFI uses both forest vegetation classification systems. In this case only the international definitions were used (<http://roifn.ro>).*

- b) Forest surfaces were divided into several categories:
- (i) Seven main species groups (spruce, fir, other conifers, beech, oak, miscellaneous hard and miscellaneous soft);
 - (ii) Eight Romanian development regions (NUTS II) (North-West, Center, North-East, South-East, South, Bucharest and Ilfov, South-West, West);
 - (iii) Twenty-one stand age classes (stands over one year old were also taken into account ~4% of the total surface);
 - (iv) Eight climate units (average annual temperatures and rainfall in forested lands) used in the eight development regions per main species groups (resinous and hardwood), the purpose of this information being to apply the necromass decomposition model (litter, deadwood, soil). The climate units were introduced as per the procedure published by Roberto Pilli (JRC) in „*International Journal of Applied Earth Observation and Geoinformation, Volume 19, p. 59-71*” in the article entitled „*Calibrating CORINE Land Cover 2000 on forest inventories and climatic data: an example for Italy*”.
 - (v) Current annual growth and productivity curves for the seven main species in Giurgiu, V., Decei, I., Armasescu, S., 1972. *Tree and stand biometry in Romania, Dendrometric Tables. Ed. Ceres 1972, Bucharest, 1154p.*
- c) The harvested volume of wood mass used was supplied by the National Institute of Statistics (INS) for the years 1970-2011, per development regions and species groups (age of technical exploitability used was taken from the latest technical norms).
- d) A correction was applied both to annual growth as well as the harvesting of wood mass, which consisted in reducing the two parameters with values appropriate to the size of the biomass expansion factors, in order to avoid the model overestimating by automatically applying these factors.

Emissions projection for forest conversions (deforestation) is carried out based on a national average Carbon store in living wood biomass of 66.8 tC/ha, 7.55 tC/ha in litter (dead organic matter, consisting of deadwood and the litter's corresponding decomposition layers) and a decrease of the Carbon store in the soil of 2.65 tC/ha/year, because Romania was only transitioning towards lands which were strongly modified by man (where 30 cm of topsoil are removed). The calculation is carried out using the nation GHG inventory calculation sheets, the report of 15 of January 2013.

The projection regarding conversions to forest includes all conversions to forest, without differentiating whether they are directly or indirectly anthropogenic. The simulations include assessments of fixed CO₂ V2.1 carried out within the JIFOR project and the common implementation project implemented by Romsilva and the World Bank's Carbon Fund. The data is simulated based on Romanian production and validation tables with data measured under real conditions (within the JI project).

Emissions' projections from non-forested lands: arable land (arable and with wood vegetation that is the subject of reforestation and biomass energy wood cultures,

orchards, vineyards), as well as pastures (pastures and hayfields), are carried out based on extrapolation on NIR estimations during the interval of 1970-2010. The projections are carried out using the GHG inventory's calculation sheets, linearly regressed for the interval 2015-2030. The time series start with the year 1970 in order to capture the effects of the emissions/sequestration generated especially by changes in the organic matter deposits in soils associated with the land-use changes in the 20 year transition period.

Integrating the emission and absorption by changing the stores in various ecosystem deposits on non-forest lands is carried out using the land-use change matrix in use at the national GHG inventory. Data on land surfaces is supplied by NIS, as per the methodologies described in the NIR 2013. Land representation is considered to be an intrinsic component of the time series supplied by NIS, and for forested lands by NFI as well. NFI forest data is larger than that published by NIS, and the calculation takes them into account by decreasing pastures. The annual surface data supplied by NIS are considered as net values at the end of the year (in kha = 1000ha). These surfaces are included in the land-use matrix covering the interval of 1970 - 2010. The yearly decrease in forested surface from one year to the next is considered deforestation (namely change of the use category to non-forest).

As a consequence, the resulting assessments cannot be used to determine the quantifiable amount in order to fulfil the future emission reduction obligations, because they only concern emissions/sequestration resulting from direct anthropic activities and eligible types of activities.

As a simulation basis, each use category is associated a series of activities that may be carried out based on the land category, presented in Table V_67.

Table V_67 Hypotheses taken into account when creating scenarios

IPCC land category (from GHG inventory)	Activity expected due to the plan/policy/program*
Forest lands	Forests in the national forest funds and forest vegetation outside of the national forest fund; Increasing the yearly wood mass harvest.
Conversions to forest lands	Forestation by plating degraded land and; The natural expansion of forest vegetation (inclusion in forest management plans).
Farmlands	Land replanting and creation of forest curtains (including in any type of agro-forest system); Creation of wood biomass cultures; Implementation of „low till” and „no tillage” technologies.
Conversion to farmlands	Decreasing the conversion of land with high carbon stores (ex. from pastures and wetlands).
Pastures (pastures and hayfields) and wetlands	Integral protection of hayfield surfaces; Encouraging forest management for wood vegetation in agro-forest-type systems.
Conversions to pastures and wetlands	Freeing degraded lands for ecological reconstruction (forested or replanted with plant species of the natural fundamental type); Decreasing the conversion to farmland; Conservation of wetlands.
Anthropogenic lands. Other lands & conversions to them.	Conservation of urban green areas.

Such combinations of activities implemented sartorially by 2030 take into account the country's economic capabilities and presume that the economic sectors implement them simultaneously with no technological, financial and capacity restrictions.

Most detailed data entered into the model is identical regardless of scenario (Table V_68 summarizes the scenarios' input data)

Table V_68 The value range of the Carbon store annual change in various stores used in the simulations

Carbon store	Value range of carbon store annual change (tC/year/ha)
Forest lands that remained forest lands	
Biomass (national forest fund)	Average annual growth 1.58 - 2.10 and average annual decrease (by harvesting) 0.24 – 0.38
Biomass (outside of the national forest fund)	Average annual growth 1.8 and average annual decrease 0.3
Lands converted into forest lands.	
Biomass (3)	0.16÷2.61
Dead organic matter	0.15÷0.32
Mineral soils	+1.85 from CL; +1.75 from GL,WL; +2.65 from SL; +2.2 from OL
Forest lands converted to other lands.	
Dead organic matter	-7.42 for litter; -0.75 for deadwood
Mineral soils	-1.85 to CL; -1.75 to GL,WL; -2.65 to SL; -2.2 to OL
Forest lands converted to other lands.	
Biomass	-66.88
Dead organic matter	-7.42 for litter; -0.75 for deadwood
Mineral soils	-1.85 to CL; -1.75 to GL,WL; -2.65 to SL; -2.2 to OL
Farmland	
Non-wood annual culture	Neutral
Biomass (forest species' vegetation) (3)	0.16-2.61
Biomass (wooden, non-forest vegetation)	63
Biomass (net annual change) (1)	2.1
Farmland mineral soils (2)	-0.05
Permanent farmland mineral soils (2)	0.01
Mineral soils from conversion lands to any type of farmland	-0.1 from GL,WL; +0.8 from SL; +0.35 from OL
Wood plantings on farmlands	
Willow– Average annual production of aboveground wood biomass (DM, t/ha/year)	7.0
Poplar – Average annual production of aboveground wood biomass (with m/ha/year)	11.6
Pastures	
Biomass (1)	0.85
Biomass (net annual change) (2)	0.01
Mineral soils from permanent pasture lands (net change) (2)	0.01
Mineral soils from lands converted to pastures	+0.1 from CL; 0 from WL; +0.9 from SL; -0.45 from OL
Wetlands	
Biomass	0.85
Biomass (net annual change) in	0.05
Mineral soils from lands converted to wetlands	+0.1 from CL; 0 from GL; +0.9 from SL; -0.45 from OL
Anthropic lands	
Mineral soils from lands converted to anthropic lands	-0.8 from CL; -0.9 from GL,WL; -0.45 from OL
Net urban area sequestration	0.1
Annual wood harvest	

The positive value (+) indicates an increase in the Carbon stored in the ecosystem store and the negative value (-) indicates its reduction (table V_62). The data is available at the national level, except for (1), which is provided by IPCC (2003) and (2) regular average of the implied net growth of Carbon store changes / decrease reported by SM UE-27 in NIR presented to UNFCCC in 2012 (Mandl et al, 2012). For biomass estimations (3), the values reflect the age dependency of stands of the currently used annual growth.

In Table V_69, is presented the conditions and prerequisites envisaged to achieve GHG emission projections as a result of land use for the three scenarios without measures (S1), with measures to improve land use (S2), with additional financial incentive measures for specific green economy products and services (S3).

Table V_ 69 Scenarios and the methodology for the estimation of GHG's projections for the 2015-2030 period

Terms and conditions description		Input data and detailed methodology of quantitative forecast
Scenario 1 – No measures		
Suppose the current administration practices and resource management for all types of land use		Forest land – with the CBM-CFS3 projection. Non-forest land – the average of 30 random projections of current estimates of NIR. The scenario includes afforestation of 2 kha annually. The estimate assumes the projection of the trend during the 1990s plus annual velocity randomization between the maximum and minimum values of the difference between consecutive years. (with presentation of a number of 30 iterations, until the change in the average has been reduced under $\pm 2\%$ between consecutive years).
Scenario 2 – With measures to improve land use		
(1)	The increase of annual harvest wood as of the pre-1989 period	The projection of removals of the forest vegetation lands with CBM-CFS at the average annual level of 24 million cubic meters. The project involves full conservation of nature protection areas
(2)	Afforestation of degraded lands 5 kha/year (including revegetation and forest belts) for the period 2012-2030	The cumulative annual afforested area for the period 2012-2030 assuming that it derives half from agricultural land (arable land) and half from grassland (including hayfields) according to the simulations of the JIFOR.
(3)	Implementation of "no-till" practices for 30% of the area of arable land (in rotation) per year from 2015-2030	Transition of such areas is assumed to "no till" management. Emission factors considered are: the conversion of the "normal tillage" to "no till" of +0.3 tC/ha and -0.3tC/ha reverse conversion, with respect to the soil C stock ("+" means absorption from the atmosphere). Emission factors will be applied to the stock currently reported by NIR. The data is from the JIFOR project.
Scenario 3 – With additional financial incentive measures for specific products and services in the green economy		
(1)	The increase of annual harvest wood as of the pre-1989 period through the intensification of forest management.	The projection of removals of the forest vegetation lands with CBM-CFS at the average annual level of 24 million cubic meters This involves simulating the increase in the harvest of wood from secondary works (e.g. thinnings) to a level of 60% of the annual harvest. The project involves full conservation of nature protection areas
(2)	Afforestation of degraded lands 10kha annually (including revegetation and forest belts)	It is added to S1 emissions or removals of (1) The cumulated annual afforestation for the period 2012-2030 assuming it derives half from agricultural lands (arable land) and half from grasslands (including hayfields).
(3)	The creation of woody biomass from rapidly increasing crops at 5kha per year.	The assumption of an annual harvest of biomass 15t SU environments/ha and application of 100 kg nitrate/ha/year.
	Implementation of "no-till" practices for 40% of the area of arable land (in rotation) per year from 2015-2030	Transition of such areas is assumed to "no till" management. Emission factors taken into consideration are: the conversion from "normal" to "no tillage till" + 0.2 t C/ha and reverse conversion of tC-0.3/ha. Emission factors will be applied to the C stock by the NGHGI. The data is from the JIFOR project.
(4)	Increasing the protected area of nature conservation and biodiversity protection.	Keeping meadow area in the natural state and implement measures to prevent the over-exploitation and conversion to other uses.

The evolution of the area occupied by forests, afforestation, deforestation and the harvested wood volume, for the 2010 ÷ 2030 period, for the analysed (WOM, WEM, WAM) is presented in the Table V_70.

Table V_70 The evolution of the area occupied by forests (FM), afforestation, deforestation and the harvested wood volume during the 2010 ÷ 2030 period

	2010	2015	2020	2025	2030
Area occupied by forest (thou hectares) of which:	6758.1	6642.1	6642.1	6642.1	6642.1
Forest area	6354.0	6515.7	6515.7	6515.7	6515.7
Other areas	404.1	126.4	126.4	126.4	126.4
Afforested area (thou hectares)	10.1	51.1	101.1	151.1	201.1
Deforested area (thou hectares)	0.11	0.2	0.2	0.2	0.2
Harvested wood volume (S1 - WOM) (thou m³)	16992	13591	12642	16692	16705
Harvested wood volume (S2 - WEM) (thou m³)	16992	22651	21070	27819	27841
Harvested wood volume (S3 - WAM) (thou m³)	16992	22651	21070	27819	27841

V.D.7 Methodology for GHG emissions projection in the Waste sector

Waste elimination by storage has a direct impact on the environment, including by generating GHG emissions.

Waste degradation is a complex process involving chemical and biological reactions, whose results generate biogas with the basic composition: CH₄ and CO₂. The biogas decomposition and elimination process continues for 10 to 30 years, 50 % of degradable organic waste decomposing over 10 years, 12.5 % of the remainder decomposing over 30 years.

The GHG emissions forecasts were performed according to the IPCC 2006.

In 2016, GHG emissions in the Waste sector accounted for 5,415.21 Gg CO₂ equiv., representing 4.39% of the total national GHG emissions.

In regards to the percentage offset of GHG emissions for the Waste sector, the largest contribution in 2011 was due to the waste water sub-sector with a percentage of 53.67%, followed by the stored solid waste sector with a percentage of 46.13% and the waste incineration subsector with a percentage of 0.20%.

V.D.7.1. Forecasting methodology for GHG emissions due to waste storage

➤ Waste deposited

In the elaboration of the *scenario without measures*, the effects of the following legislative regulations were not considered:

- •Law no. 211/2011 on the waste regime (with subsequent modifications and completions)
- Directive no. 2008/98 / EC of the European Parliament and of the Council of Europe
- The legislative framework included in the Circular Economy Package

Estimation of emissions under this hypothetical scenario for the main categories of the Waste sector was based on hypothetical quantities and emission factor values in 2005.

In the scenario without measures, was considered an increase for the quantities deposited in solid landfills, a slight increase in emissions due to the Biological Treatment of Solid Waste and a constant value for Waste Incineration were considered.

For the *scenario with measures*, the projected evolution of the quantities of waste stored in household waste dumps took into account the following general premises:

- Population evolution both in urban and rural areas;
- Evolution of population incomes and evolution of Gross Domestic Product;
- The composition of municipal waste;
- European and national legislation on the characteristics and composition of waste to be deposited in landfills;
- Operation of household waste landfills;
- The economic evolution of the company, especially with regard to packaging waste and their assimilation;
- The investments to be made within the Waste sector, until the European Directives are complied with.
- National implementation of long-term investment plans and integrated waste management systems at county level.

Thus, for the quantities of waste landfilled in household waste, estimated according to the demographic evolution projected in the analyzed period and the necessity to respect the commitments assumed at European level, the following rates of change were considered as compared to the historical year 2015:

- For the quantity of waste per capita, an annual growth rate of 0.8% was considered; of the estimated quantities decreased the quantities of incineration waste and additional quantities from composting;
- For the quantities of waste deposited in non-compliant storage, a 5% annual decrease rate was considered;
- For the quantities of compost waste it was assumed an annual growth rate of 12% by 2020 and an annual growth rate of 2% by 2035 respectively;
- For the quantities of incinerated waste, the historical value recorded in 2015 is considered constant;
- From 2022, a constant quantity of 650000 t / year is considered to be treated by energy recovery in recovery facilities and / or in cement plants.

For the *scenario with additional measures*, the projected evolution of the quantities of waste stored in household waste dumps took into account the following rates of change compared to the historical year 2015:

- For the quantity of waste per capita, an annual growth rate of 0.8% was considered; of the estimated quantities decreased the quantities of incineration waste and additional quantities from composting;
- For the quantities of waste deposited in non-compliant storage, a 5% annual decrease rate was considered;

- For the quantities of compost waste it was assumed an annual growth rate of 15% by 2020 and an annual growth rate of 1% by 2035 respectively;
- For the quantities of incinerated waste, the historical value recorded in 2015 is considered constant;
- From 2022, a constant quantity of 800000 t / year is considered to be treated by energy recovery in recovery facilities and / or in cement plants.

For all forecasting scenarios, with the national implementation of long-term investment plans and integrated waste management systems at the level of the counties, a reduction in the amount of gas from 2016 was considered to be 12% in each year, this quantity being burned at the flares.

➤ **Composting waste**

For *scenario without measures*, it was considered that municipal waste composting facilities would not be built by 2035.

For the *measure scenario*, the annual growth rate of 12% by the year 2005 of the waste treated by composting was assumed to be an annual growth rate of 2% per annum by 2035 respectively.

For the *additional scenario scenario*, an annual growth rate of 15% by the year 2005 of the quantities of waste treated by composting and an annual growth rate of 1% per annum by 2035 respectively was considered.

➤ **Incinerated waste**

In *scenario without measures* it was considered that no municipal waste incineration plants would be built.

In the *scenario with measures*, an incineration capacity of about 400,000 t / year as from 2022 and about 250000 t / year of residual waste from sorting stations or from mechano-biological treatment plants with high PCI, which will be treated in cement plants.

In the *scenario with additional measures*, an incineration capacity of about 500000 t / year as from 2022 and about 300000 t / year of residual waste from sorting stations or from mechanical and biological treatment plants with high PCI , which will be treated in cement plants.

For all scenarios, the value of CO₂ emissions was considered to be constant and equal to the historical value recorded in 2015 and 5,9036 Gg, respectively.

V.D.7.2. Forecasting methodology for GHG resulted from wastewater treatment

Industrial waste water treatment

Taking into account the difficulty of long-term forecast (until 2035) of food, pulp and paper, chemical, etc. developments in the food industry, pulp and paper, etc. within without measures scenario, the evolution of CH₄ emissions was estimated by extrapolating the historical emissions recorded in 2005, with an average annual growth rate of 3%. This rate is taking into account the development of specific industrial

outputs, while maintaining existing waste water treatment technologies at the reference year level.

For WEM scenario and WAM scenario, the evolution of CH₄ emissions was estimated by extrapolating historical emissions in 2015 with an average annual growth rate of 1.5%. This rate is taking into account the development of specific industrial outputs and industrial wastewater treatment technologies modernization.

Municipal and commercial waste water treatment

For WEM scenario, the evolution of CH₄ emissions was estimated by extrapolating historic emissions recorded in 2005, with an average annual decrease of 0.4%, which takes into account the projected population decline.

For WEM and WAM scenario, the evolution of CH₄ emissions was estimated by extrapolating historical emissions recorded in 2015 with an average annual decrease of 0.7%.

For WOM scenario, the estimated evolution of N₂O emissions was performed through extrapolation of historical emissions registered in 2005, taking into consideration an increasing annual average rate of 0.2%. This rate is taking into consideration the increasing of protein consumption per capita.

For WEM scenario and for WAM scenario, the estimated evolution of N₂O emissions for 2015 – 2020, it was performed through extrapolation of historical emissions registered in 2014, taking into consideration an increasing annual average rate of 2%. For 2021 – 2035 the estimation was performed through extrapolation of estimated emissions for 2020, taking into consideration an increasing annual average rate of 2.5%

V.D.8. Sensitivity of underlying Assumption and Uncertainty

Carry out the GHG emissions forecasts are based on the hypotheses regarding macroeconomic indices having a high degree of uncertainty over the analysis period until 2035, due to the economic crisis. Thus, the economic development is a major factor which affects the projections results.

In order to analyze the sensitivity of GHG emissions projections to the changing of some hypotheses, there are carrying out minimum and maximum scenarios regarding economic evolution comparing with the baseline scenario for which the projections were made. The sensitivity analysis refers to the economic development because the effect of other factors is substantially lower.

V.D.8.1 Energy Sector

Taking into account the share of about 70% of the GHG emissions from the fuel combustion in Romania, the sensitivity analysis focuses on the GHG emissions from the energy sector.

Table V_71 presents the main indicators taken into account in the sensitivity analysis for alternative scenarios compared to the baseline scenario. The evolution of the population is considered the same in all three scenarios. The evolution of macroeconomic indicators determines developments in energy and electricity consumption with important influences on GHG emissions.

Table V_ 71 Evolution of the macroeconomic and energy indicators in the 2020 ÷ 2035 period for the analysed scenarios

Scenario	INDICATOR	M.U.	2020	2025	2030	2035
MINIM	Gross domestic product	10 ⁹ Euro ₂₀₁₀	156.63	182.93	196.29	207.73
	Primary energy consumption	10 ⁶ toe	33.40	35.50	38.10	39.50
	Final energy consumption	10 ⁶ toe	23.60	25.50	27.00	28.50
	Electricity gross consumption	TWh	59.70	64.70	70.40	76.55
BASELINE	Gross domestic product	10 ⁹ Euro ₂₀₁₀	177.35	205.59	226.99	244.54
	Primary energy consumption	10 ⁶ toe	35.72	38.67	40.92	43.01
	Final energy consumption	10 ⁶ toe	24.60	26.63	28.18	29.62
	Electricity gross consumption	TWh	61.26	66.25	72.79	79.97
MAXIM	Gross domestic product	10 ⁹ Euro ₂₀₁₀	190.50	229.60	245.80	276.70
	Primary energy consumption	10 ⁶ toe	36.90	39.20	41.90	45.70
	Final energy consumption	10 ⁶ toe	24.70	28.40	29.15	32.10
	Electricity gross consumption	TWh	63.72	68.30	75.30	83.30

The assumptions for macroeconomic restructuring between 2020 and 2035 for the alternative scenarios considered in the sensitivity analyzes are presented in Table V_72.

Table V_ 72 Evolution of Gross Value Added in the 2020÷2035 period

Scenario	INDICATOR	2020	2025	2030	2035
MINIM	Gross Value Added, of which:	100%	100%	100%	100%
	Industry	32.5	32.0	31.8	31.5
	Agriculture	7.4	7.0	6.8	6.0
	Construction	10.0	10.0	10.0	10.0
	Services	50.0	51.0	51.4	52.6

MAXIM	Gross Value Added, of which:	100%	100%	100%	100%
	Industry	31.0	29.2	28.5	27.5
	Agriculture	6.5	6.0	5.5	4.5
	Construction	10.0	10.0	10.0	10.0
	Services	52.5	54.8	56.0	58.0

The evolution of CO₂ emissions due to energy sector, in the baseline and alternative scenarios (minimum and maximum), is presented in the Table V_73.

Table V_73 Evolution of CO₂ emissions in analysed scenario

Scenario	INDICATOR	2020	2025	2030	2035
MINIM	A. Fuels combustion	64321.00	63150.70	67191.20	70244.50
	1. Energy industry	26139.70	22541.32	24641.40	26201.80
	2. Manufacture and construction industry	12170.00	12770.0	13220.70	13999.65
	3. Transport	16945.80	17945.83	18495.80	19061.55
	4. Other sectors	9065.50	9893.55	10743.30	10981.50
BASELINE	A. Fuels combustion	68864.49	67374.56	71437.67	74776.16
	1. Energy industry	28363.70	24083.50	26381.61	27121.07
	2. Manufacture and construction industry	12894.48	13465.61	13834.09	14745.42
	3. Transport	17485.54	18968.10	19745.10	20596.14
	4. Other sectors	9697.77	10430.35	11049.07	11883.55
MAXIM	A. Fuels combustion	71778.5	71973.60	75373.6	78663.9
	1. Energy industry	29246.12	26270.75	27498.63	27878.42
	2. Manufacture and construction industry	13731.45	14598.25	14994.57	15500.58
	3. Transport	18045.30	19618.30	20507.80	21809.20
	4. Other sectors	10755.63	11486.30	12372.60	13475.70

The sensitivity analysis for fuels combustion from the energy industry (energy industry, manufacturing and construction, transport and other sectors) in relation to economic development at national level allows the following conclusions to be drawn:

- CO₂ emissions increase with GDP growth and decrease with GDP decreases. However, emissions increase in the maximum scenario is lower than the decrease in the minimum scenario, given that the higher the GDP, there will be funds available for new technologies;
- In manufacturing and construction industry, it is also noted that emissions are rising with GDP, but growth is lower than the decrease in the minimum scenario, demonstrating the existence of funds for environmental protection and increasing energy efficiency;
- In transport sector in the maximum scenario, there emissions increase with the GDP growth lower than the decrease in the minimum scenario due to the fact that the increase in the living standard of the population leads to an important increase of its mobility, but also the possibility of purchasing means of transport more efficient;

- Power generation structure not differ essentially in the different scenarios. The emission gap in this sector depends mainly on the demand for electricity and heat to be met.

V.D.8.2 LULUCF Sector

Scenario without measures (S1) is the only option that provides an annual net amount of CO₂ absorbed into the conditions for sustained growth of the annual harvest by 20 percent, increasing the risk to harvest more than annual growth, and thus of having emissions from forests, for the other two already after 2020 scenarios. Major risk generated by scenario with additional measures (S3) is multiple: the annual quantity of strong emissions and increasing trend of emissions over time. The possibility of achieving scenario with measures (S2) (with +20%) and scenario with additional measures (S3) (with +20%) is extremely small, but it would mean an annual harvest of about 35 million cubic meters for the 2015-2030 more realistic is a close variant of scenario without measures(S1) (+20%).

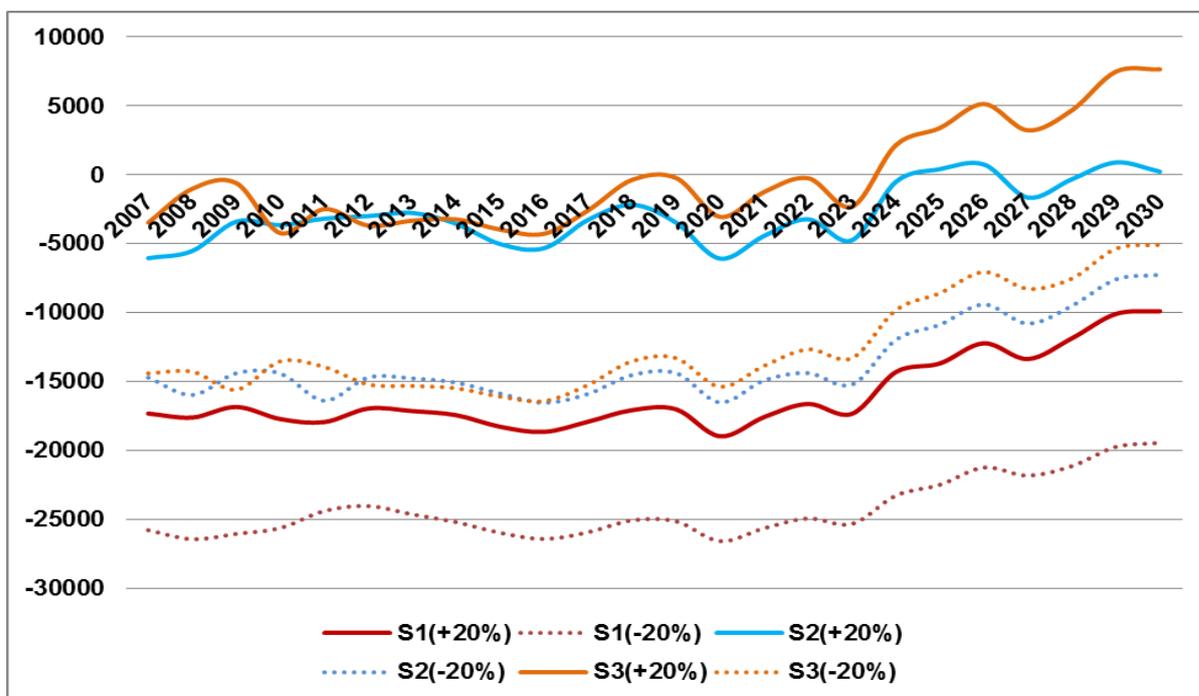


Figure V_D_ 3 The sensitivity analysis of the three scenarios [Gg CO₂ equivalent]

VI. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

VI. A. Expected impacts of climate change

Over the last years, adaptation to climate change impacts has reached an important position on the Romanian political agenda. The National Strategy for Climate Change in Romania, which has an important adaptation section, was approved in July 2013 by the GO 529/2013. This strategy refers to the effects of climate change on water safety, agriculture, energy, transport, industry, insurance, biodiversity, health, tourism, forestry, infrastructure, and recreational activities. The National Strategy for Climate Change in Romania builds technical knowledge upon the background of the Guide on Adaptation to Climate Change issued in 2008. The strategy adds extra guidance on the approaches and institutional cooperation needed to cope with climate change in Romania in an integrative and multi-sectoral providing more information on implementation/application aspects of adaptation relative to the Guide.

This chapter presents updated observed changes in the climate regime and scenarios on the future climate change as well as climate-related vulnerability and adaptation knowledge produced in Romania from the previously issued report.

VI. A. 1 Observed changes in the climate regime in Romania

Air temperature

Analysis performed on data collected from meteorological stations (between 1961 and 2016) highlights significant changes in the temperature field in summer, spring and winter (see figure VI_A_1) and in annual values with the following characteristics:

- Upward trends in seasonal temperature are statistically significant (at 90 % level of confidence) over almost all Romanian territory in spring and summer; in winter, temperatures are increasing in parts of Southern, central and North-Eastern regions of Romania (Marin et al., 2014; Dumitrescu et al., 2014; Birsan et al., 2014);
- We have not found any clear trend pattern (at 90 % level of confidence) in autumn temperature.

Precipitation

There were identified the following features in precipitation data, based on statistics using observations made in the interval 1961-2012 at 104 meteorological stations (see figure VI_A_2):

- Upward trends in the seasonal amount of precipitation are present over large part of Romanian territory in autumn (at a confidence level of 90%);
- Significant downward trends (at 90 % level of confidence) are present in selected locations in winter, spring and summer (Dumitrescu et al., 2014).

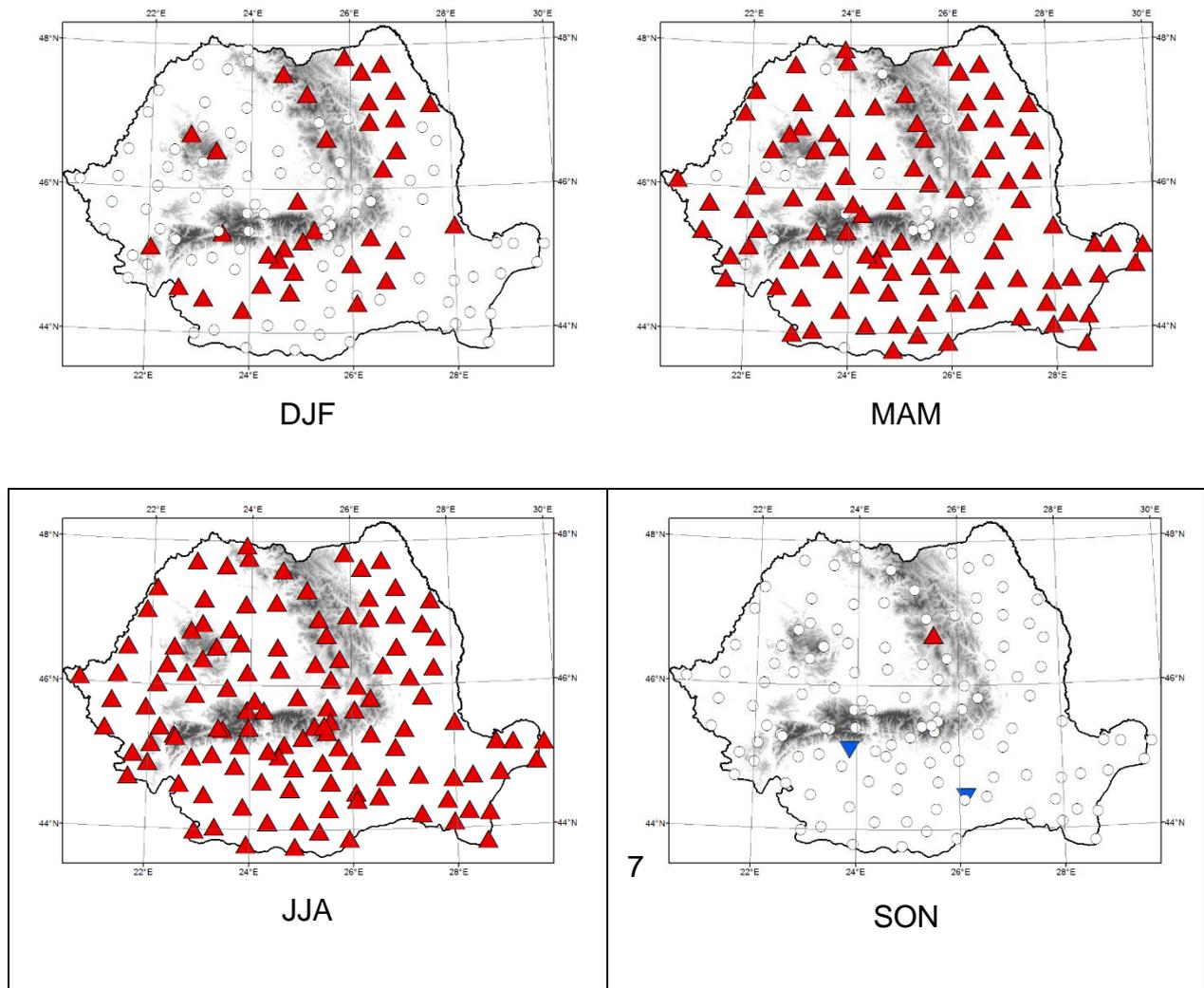


Figure VI_A_1 Seasonal trends of air temperature at 124 meteorological stations for the interval 1961-2016.³¹

Other climate variable trends

Analysis performed on data collected from meteorological stations, in the interval 1961 – 2016, reveals significant changes in other climate indicators, too:

- Snow depth is significantly decreasing over large areas in the central, Western and Northern part of the country; downward trends of snow depth are also present over smaller areas in Southern and Eastern Romanian regions (Dumitrescu and Birsan, 2014);
- Significant decrease of mean wind speed prevails over many areas of the Romanian territory on both annual and seasonal scales (Birsan et al., 2013);
- Maximum length of heat waves is increasing in the southern and western region of Romania; the heat wave is defined in Romanian legislation as intervals with at least two consecutive days having maximum temperature greater than 37 °C (Bojariu et al., 2015).

³¹ Significant trends (at the 90% confidence level) are represented by red triangle for increasing temperatures and blue triangles for decreasing ones. Grey circles illustrate locations without significant trends.

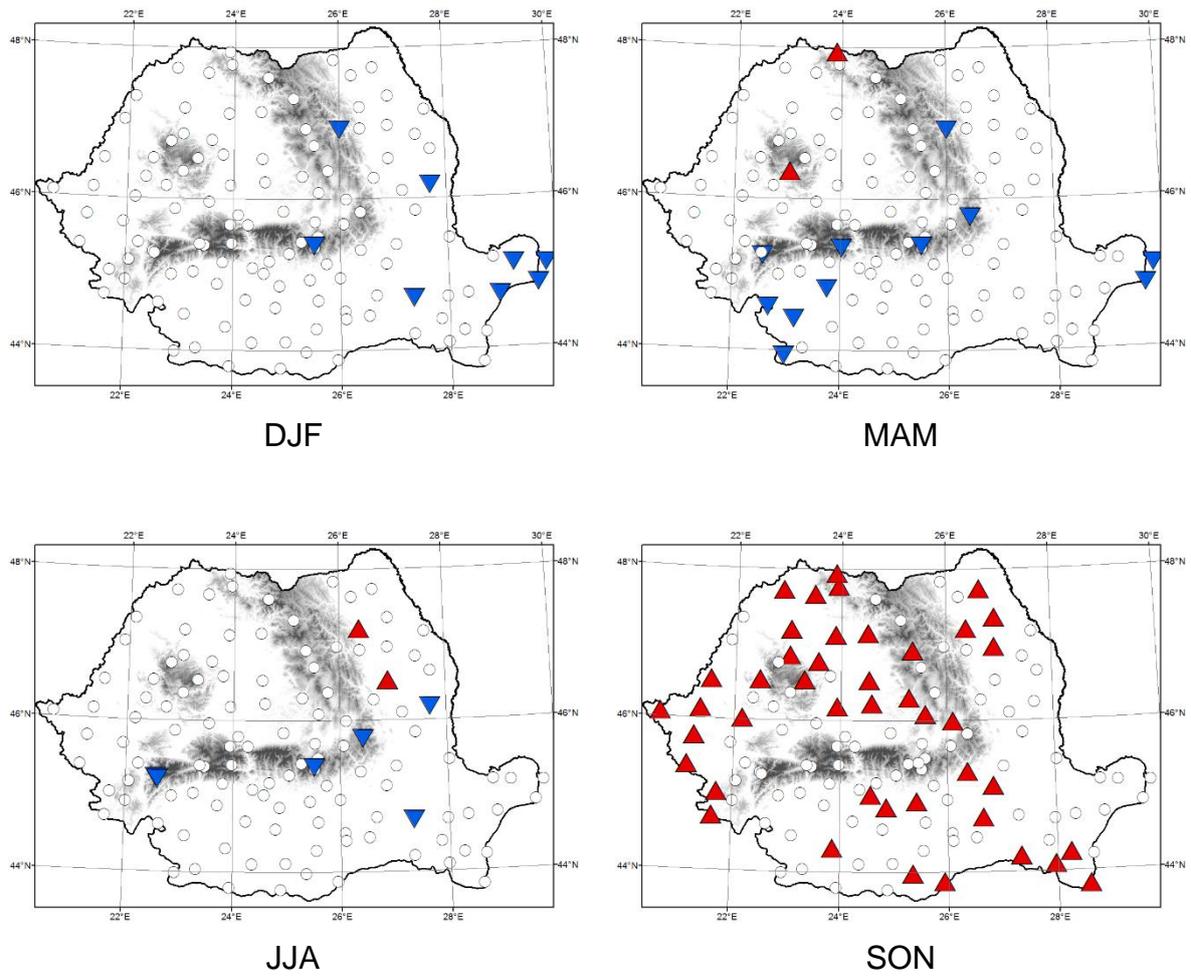


Figure VI_A_2 Seasonal trends of precipitation at 124 meteorological stations for the interval 1961-2016. Red (blue)triangles illustrate upward (downward) trends. Circles illustrate stations with no trend.

Many of these observed trends are expected to continue in the near future and a part of them to amplify on medium and long terms, as global warming is progressing towards the end of this century.

VI. A. 2 Scenarios on the future climate change

Results based on ensembles of numerical experiments with global climate models show over the Romanian territory a progressive increase in air temperature during the 21st century, for all seasons but more pronounced in summer and winter. In near future term (2021-2050), climate model results show mean annual increase of temperature (up to 3 °C in summer) and mean annual reduction in precipitation amount (8% to 9% in summer) over Romania under the worst-case scenario (Figure I_6) (Bojariu et al, 2015).

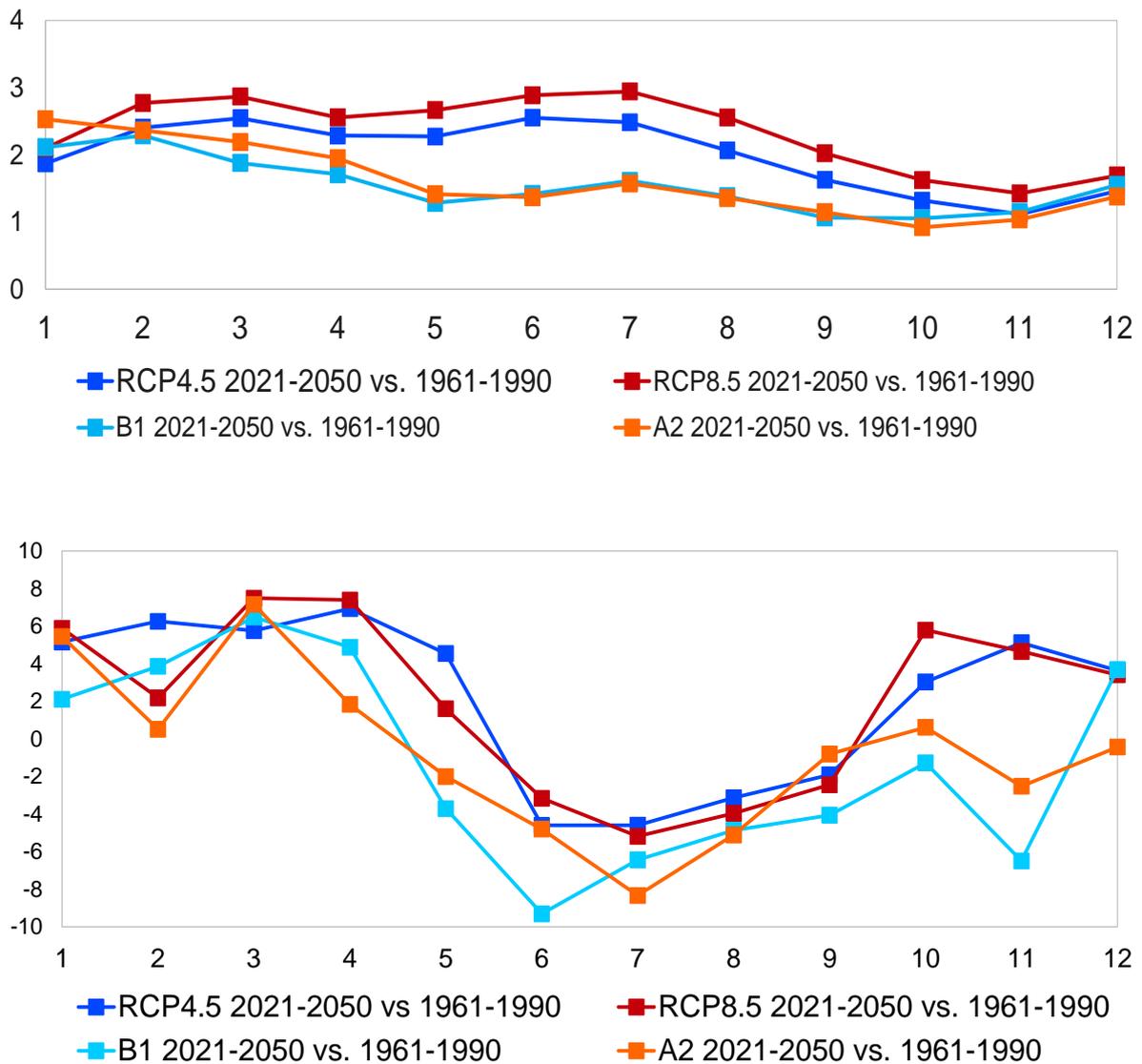


Figure VI_A_3 Seasonal trends of precipitation at 124 meteorological stations for the interval 1961-2016. Red (blue)triangles illustrate upward (downward) trends. Circles illustrate stations with no trend.

The scenario-related differences are relatively small for the first decades of the 21st century. Higher differences in climate are expected towards the end of the 21st century. For the worst-case scenario (RCP 8.5), the mean temperature increase for Romania will reach about 6°C in summer in the interval 2061-2090 compared with the interval 1961-1990 (Bojariu et al, 2015). Also, projections show that changes in mean temperature and precipitation occur along with changes in extreme phenomena statistics (such as increasing in frequency and intensity of heat waves, increasing of precipitation intensity).

In the context of global warming, changes in the climate regime of Romania are modulated by regional conditions. Regional modelling and dynamical downscaling provide supplementary policy-relevant information on detailed spatial feature of climate change (Bojariu et al., 2014).

VI. B. Vulnerability assessment

Romania's climate is expected to undergo significant changes over the next decades. In terms of the near future (2021-2050), the most pressing consequences are those related to the increase in the average monthly temperature (up to 3° C in summer) and the reduction of the amount of precipitation in summer time by 8-9% in Romania (Bojariu et al. (2015), in the case of the most pessimistic scenario, with implications in agriculture and water management, in general (Bojariu et al., 2015, Dascalu et al., 2016). Expansion and the snow quantity have diminished (Birsan and Dumitrescu, 2014) and there will be further reduced in the future (Bojariu et al., 2017), leading to a decrease in the water supply for agriculture and the generation of hydropower.

Projections also show the changes of average temperature and precipitation occur along with changes in the statistics of extreme phenomena. The precipitation intensity has increased (Manea et al., 2014; Busuioc et al., 2016) and will increase even more throughout the country but more pronounced in mountain areas, which will favor rapid floods (Bojariu et al., 2015) . The number of days with heatwaves also increases, especially in the southern, southeast and westernmost parts of the country, with increased vulnerability from this point of view, characterizing large urban agglomerations in the mentioned regions (Dobrinescu et al., 2015; Papathoma -Koehle et al., 2016).

Climate change will not have the same impact for all population categories. Some communities will have to face greater challenges than others. For example, climate impacts will be stronger for those living in climate-sensitive areas, such as large urban agglomerations, floodplains or droughts most commonly affected by drought. Moreover, people with chronic and / or poverty-stricken diseases are more vulnerable due to financial and technological resources and poor infrastructure to cope with climate impacts through resilience and autonomous adaptive capacity (World Bank, 2014, Velea et al. 2017).

Vulnerability to climate change in Romania was analyzed by Xie (2014) for some sectors, such as energy, transport, urban environment, water resources, agriculture and forestry.

From the point of view of resilience and adaptability, Romanian cities need acute planning to cope with the impact of climate change, amplified by the city's heat island and the isolation of urban soil. The impact of climate change will also exacerbate the imbalance between demand and supply of water resources at basin level, which will necessitate either demand reduction measures or the identification of new sources in Romania (Xie, 2014).

VI. B. 1 Biodiversity

Romania includes 28% of mountainous areas (at altitudes over 1,000 meters), 42% of hills and plateaus (altitudes over 1,000 meters) and 30% of plains (under 300 meters altitude) - unique features in Europe and rare even in the world. For this reason, five of the eleven biogeographical regions of Europe are found in Romania: Alpine, Continental, Pannonian, Pontic (including the Black Sea Marine Region) and steppe. Romania is also positioned at the junction of the Mediterranean, Pontic and Eurasian palearctic ecosons.

In Romania there are 54% of the Carpathian Mountains, and 97.8% of the national hydrographic network is collected by the Danube. Natural and semi-natural ecosystems cover 47% of the country's surface. Due to the fact that the population density is low and the surface

of the human settlements is small, the mountain areas have been the least affected by human intervention. These factors also contributed to the designation of 12 of the 13 national parks and 9 of the 14 natural parks in this area. Hill and plateau areas have been more affected by human activities and are more severely damaged as a result of deforestation, erosion, landslides and soil degradation. Hill and mountain areas include a great diversity of protected natural areas and still have significant potential for designation of new protected natural areas in areas that have not been altered or have been insignificantly altered by human activities. The plains are the most populated and most exploited, with only a few places preserved naturally.

Taking into consideration the similarities of the various classification systems, it can be said that in Romania there were established in 2006 approx. 900 types of natural habitat, of which over 500 types are included in the Natura 2000 system. 225,000 ha of virgin forests have been identified. Also in the Retezat-Godeanu-Țarcu mountains is the last Intact Forest Landscape (IFL) estimated at 97,926 ha, of which 18,046 hectares are virgin forests. Special attention should be paid to the Danube Delta, an important member of the UNESCO World Wildlife Reserve Network and the RAMSAR site, the largest wetland in Europe, the world's largest compact reed area, with about 1,700 species of flora and 3,800 of fauna species and over 30 types of ecosystems. The great diversity of habitats / ecosystems in Romania reflects the high level of diversity of species of flora and fauna to be protected.

The increasing the extreme hot temperatures, the changes of the rainfall and seasonal distribution, the decreasing the snow quantity and the number of frost days in winter, the increasing the water temperature associated with the increase of drought frequency and the decrease of groundwater resources are the main abiotic factors affect biodiversity. According to forecasts, if the average temperature will rise with 3⁰C up to 2070 year, more than 30% of the territory will be affected by desertification and about 38% of the territory will be affected by severe aridation, covering all plains, 85% of the hill and plateau area and 20% of the mountain areas low.

The main threats on the biodiversity due to the extreme events characteristic to the climate change are the followings:

- Modification of the species behaviour, as a result of the stress induced on their adaptation capacity (a shorter hibernation period or lack thereof, affecting bears and bats in particular, the modification of the behavioural physiology of the animals as a result of the hydric, thermal stress or the stress determined by the solar radiations; continuing to change the beginning of life cycles, especially spring times for most species; changing migratory patterns, including lack of migration, which particularly affect migratory species of birds and bats; the continuous expansion of species to the north and higher altitudes in response to warm winters and longer vegetation periods);
- Modification in the distribution and composition of native habitats as a result of the changing in the species structure, the most vulnerable habitats being wetlands, high mountain lakes, rivers and streams, marine and freshwater aquatic ecosystems affected by water heating, and sea level rise. Increasing the temperature will decrease the water quality and the eutrophication of the lakes located along the Danube and the Black Sea and the disappearance of the small rivers. The salinity of Danube Delta waters can increase and affect the ecosystems and the conservation status of many species. Extensive disturbance of vegetation in the Carpathian Mountains is expected, by increasing the upper limit of the spruces by 600 m and the gradual disappearance of subalpine (juniper) and alpine areas. The maximum productivity of forests and meadows at 1,000 - 1,200 m altitude will migrate to an altitude of 1,600 to 1,800 m. Special attention should be paid to the Dobrogea area, due to the main threat in this steppe area is desertification, which is only observed in this part of Europe;

- Increased invasion of exotic species at the level of the natural habitats and increasing their potential to become invasive. At present, 449 species are already registered in the DAISIE inventory for Europe (Delivering Alien Invasive Species Inventories for Europe);
- Threats to wild animals, especially to low-moving capacity and / or with low-population species, due to increased forest fire risk in the Carpathian Mountains;
- Increasing the risk of soil erosion in the Carpathian mountains;
- Extinction of the certain species of flora and fauna. Particular, attention should be paid to species with unfavorable conservation status;
- Complex interaction between different pressures on biodiversity.

Due to the fact that ecosystems have the ability to provide a wide range of services, including carbon capture and storage, biodiversity also contributes to fighting climate change.

Conservation of biodiversity and restoration of the damaged ecosystems will reduce vulnerability and increase resilience and should be the support of the adaptation strategy.

VI. B. 2 Agriculture

Agriculture and rural development (ARD) appear to be very vulnerable to the impacts of climate change and the associated risks are not equally distributed. There are regional differences both the likelihood of extreme phenomena, such as drought and episodes with abundant rainfall, and the vulnerability, resilience and adaptive capacity of rural communities to climate change. The differences are further accentuated by the polarization in the size of the agricultural farms, characteristic of Romania country. Probably the most affected category will be farmers farming subsistence farming, especially in southern and south-eastern Romania (Xie, 2014).

The negative meteorological and hydrological events, such as drought and floods are the manifestations with the most significant impact on the agricultural sector and the cause of significant volatility of harvest efficiency from one year to another. Climate risks such as droughts can last for several weeks or months, affecting the results of all annual agricultural production. In Romania, agriculture is the sector contributing year-on-year to GDP by about 6-7%. The 2007 and 2012 agricultural years were considered the driest of Romanian agriculture in the last decade and the production per hectare decreased by 50%, especially in the case of non-irrigated land. According to data centralized by the Ministry of Agriculture and Rural Development (2012), the drought in the agricultural year 2011 -2012 caused damages on an area of 5,883,466 ha at national level. The most affected crops were maize, wheat, barley and rapeseed, potatoes, sunflower and rape. (eg production for rapeseed has fallen by up to 80.2%). Flooding is another recurrent problem in Romanian agriculture. Whether it's snow melting or torrential rains, the number of floods has risen in recent decades as a result of climate change.

The impacts of climate change may be positives or negatives, but the Romanian agriculture sector is currently facing predominantly negative impacts. These include:

- Modifications at the agricultural productivity level

Climate change will affect the quantity and precipitation seasonality, and the increase in evapotranspiration can lead to shorter growing seasons and a greater risk of water shortages at important times in the crop development cycle, such as initial growth and germination and growth and the formation of the rod members. However, for some crops (eg wheat), higher levels of CO₂ in the atmosphere will reduce water intake, while for others (eg corn) the reaction will be minimal. Modeling suggests that wheat productivity may increase significantly (30% or more) in the 2020-2050 period relative to the 1961-1990 climate, but corn productivity is projected to decline. However, these estimates should be treated with caution because the

impact of the CO₂ effect is uncertain; thermal pressures may decrease the productivity; climatic variability is expected to increase, which will lead to frequent disruptions in the crop development cycle and to a lower yield; and competition for water supply can lead to the availability of less water for irrigation in agriculture. In addition, it is estimated that climate change will increase the likelihood of extreme events such as drought or flash floods, which can lead to significant harvest losses.

➤ Intensification of floods

The floods are an important problem of Romanian agriculture. As is known, Romania has a significant surface exposed to flood risk. The floods occur frequently due to snow melt, blocking ice rinks, and / or increasing rainfall, and more and more frequent floods have occurred over the last 20 years as a result of a number of factors additional. These include overexploitation of forests and alteration of local morphological characteristics; the lack of well-maintained flood prevention infrastructure in flood-flood-induced torrential formation.

➤ Increased the frequency and intensity of droughts

In agriculture, one of the worst consequences observed to date is the increasing occurrence of water scarcity and droughts due to the combined effect of low rainfall and rising temperatures, especially in the south and south-east of the country. Thus, estimates based on projected projections also indicate that air temperature increases (eg warmer summers with more frequent and persistent heatwaves) and the reduction in rainfall will be possible in most regions of the country, especially in the season warm. The decline in rainfall appears to be more pronounced in the regions of southern, southeastern and eastern Romania. Given that the future climatic scenarios indicate a decrease in precipitation quantities for the period 2021-2050, it is estimated that the agricultural areas with precipitation deficiencies will be expanded and, implicitly, their intensity will be increased by the increase of the excessively low drought classes (below 350 l / m² / year) and droughts (351-450 l / m² / year), especially in the southern, eastern and eastern agricultural areas of the country. As a result, in the case of corn crops, under the conditions of future climatic scenarios, the areas affected by the strong and extreme pedological drought will be able to expand in the months with maximum plant water requirements (July-August).

➤ Increased risk of soil erosion and desertification

Given the more frequent and intense drought tendency, the probability of increasing soil aridity, combined with warm winds, will increase the risk of wind erosion and soil degradation especially in the southern, eastern and eastern regions of Romania. This phenomenon includes the risk of desertification, marginalization and abandonment of agricultural land in regions where the soils are lighter and more vulnerable to erosion.

➤ Low agricultural productivity per hectare

➤ Intensification of the extreme meteorological phenomena and extension of vulnerable agricultural areas.

Accelerated global warming generates some of weather-climatic phenomena that affect the agricultural sector through extreme temperatures, unbalanced rainfall patterns, disturbance of seasons alternation, increased incidence of dangerous meteorological phenomena. Surface of crops affected by drought, floods, hailstones, late frosts, etc. increases steadily from year to year and generates significant losses both by harvesting crops and by significantly culling crops. Hailstones are particularly detrimental to crops of high economic value - live, orchards, greenhouses, and so on, and damages affect the strategic sectors of the agri-food economy.

➤ Other social and economic costs

The precipitation deficit, which will increase in the summer months, in conjunction with other changes in the hydrological cycle, in the conditions of climate change, will have consequences for the water supply.

Overall, the possible consequences of climate change in Romania will significantly increase the risk of partial / total disaster of agricultural crops depending on the severity and duration of extreme weather phenomena, as well as reducing the financial security of farmers in many regions, especially the south and south- country.

VI. B. 3 Water resources

At the national level, concrete actions were started to increase the ability to act, especially concerning the floods problem, but also generally, on the extreme weather phenomena.

As a result of the catastrophic floods recorded at the end of 2005 year, it was elaborated the National Strategy of Flood Risk Management, in which there are set the duties that fall on each structure involved in the flood risk management, structured on prevention actions and measures, of operational intervention as well as those for the rehabilitation and the return to the state of normality. Also, there are established, at the national, regional and local levels, the procedures needed to manage the emergency situations generated by hydrological drought.

In 2010, the National Strategy for Flood Risk Management on the medium and long term was approved by the Government Decision no. 846/2010. This document takes into consideration the European legislation – the **Directive 2007/60/EC** of the European Parliament and of the Council of 23 October 2007 **on the assessment and management of flood risks**.

It is important to underline that the rivers are complex ecosystems, which depend of the watercourses conditions in which the outflows, the sediments transportation, the temperature of the water and other variables have a well-defined role. In case certain modifications occur within these variables in relation to the values existing naturally, the ecologic balance is affected, fact that leads to the restructuring of the biocenoses, respectively the loss of species, the replacement of certain valuable species with less valuable ones.

As a consequence of this fact, the improvement of the rivers by hydro technical works must have as objective the preservation in time and space of the ecologic balance of the aquatic ecosystems, respectively of the watercourses. Instead of embedding the rivers between dams, solution applied usually up to now, the new concept "more space for the rivers" shows the dominant strategy in EU, by which it is sustained the necessity to recover the floodplains, in order for them to sew properly the floods.

The sustainable quantitative and qualitative administration of the water, the management of the natural disasters generated by the excessive presence or the lack of water, the preservation of the aquatic environment biodiversity by means of master plans performed at the level of the hydrographical basins.

Regarding the climate change impact on the water and sanitation supply systems, two major aspects were identified:

- Warmer and shorter winters lead to the decrease of the seasonal snow volume and to the early and fast snow melting;
- During the summers with extreme and dry temperatures generate the quantitative and qualitative decrease of the water resources and the increase of the water demand.

As a consequence to the climate change, the following vulnerabilities were identified:

- Increase of the evapo-transpiration, especially during the summer months due to the increase of the air temperature leading to the average decrease of the flowing conditions of the rivers with 10-20%;
- Decrease of the snow thickness and duration because of the air temperature increase during the winter, leading to a lower flow of the rivers and to a decrease of the capacity of soil moisture recovery;
- Decrease of the soil humidity leads to the decrease to minimum of the leakage (summer and autumn) contributing to the increase of the pollution frequency and of the water supply restrictions;
- Increase stress on water as needs for irrigations in agriculture grow;
- High temperatures may affect water quality in the rivers and storage lakes (the decrease of the dissolved oxygen and algae flourishing, eutrophication may affect the fish populations);
- Decrease of the river outflows may bring problems on the provision of utilities, the self-cleaning capacity of the rivers, the aquatic ecology and recreation;
- During the dry summers problems may occur related to the supply of the salubrious outflow;
- Modifications on the underground water supply and the water-bearing layers;
- Increase of the diseases associated to water;
- Increase of the damages produced by floods and droughts.

VI. B. 4 Forests

Climate change has and it will have significant impacts on forests in Romania, both on the medium time periods (decades), and on the long periods (centuries). In the medium time, it can expect that the forest productivity to decrease, but the biggest threats come from the increase frequency of disturbing events, such as fires or infestations caused by various pathogens (incidence of forest fires in the actual climatic conditions is low in Romania, excluding the south and southwest of the country). The increase of temperature and the long drought periods can increase the frequency and intensity of forest fires, they can limit the development of regeneration process, and cause the modified of the insect and other harmful behavior. In the south and southeast area of country the desertification process will lead to unfavourable conditions for forest vegetation development. Furthermore, climate change lead to modify the forest structure (especially in the hill areas) and to the forest migration form forest steppe areas to plain areas.

In the mountain areas, forests have been severely affected by the winds are stronger and more frequent and snow, a phenomenon most prevalent in areas with spruce outside the natural range. In Romania, the forests are affected by pests that can adapt to higher temperatures and drought. This will lead to a decline in the structure and stability of forest ecosystems (including biodiversity loss) and lower quality wood.

The climate change affects the health of forests and increases their vulnerability to pests and other biotic factors. Unfavorable climatic conditions associated with biotic pressure could reduce tree growth by about 30%. Reducing growth will diminish the ability of forests to seize carbon and will also have economic consequences (Xie, 2014).

The infestations with pests are a significant concern of the forestry sector. Forest fires are closely related to these infestations - forests infested with dry trees are more susceptible to forest fires, and forest segments affected by fire are more prone to the pest infestation. Pests also affect the overall health of forests, degrading them with rising CO₂ emissions. In view of these signals, improving the adaptability of forests to climate change is a matter of national security.

Another major threat is the forest fires, causing damage and endangering human lives that can be caused by high temperatures and / or extreme weather events (lightning, storms, etc.). Most forest fires are caused by people, especially in spring and autumn when the crop residues are burning on adjacent to national forest lands.

VI. B. 5 Infrastructure, construction and urban planning

According to the statistics, the worldwide urban population doubled during the last 50 years and it is estimated that in 2030 two thirds of world population will be living in cities. The increase of the population density, the development, costs dynamic, the way of life, the specific infrastructure, the ethnic and cultural diversity are elements which can be vulnerable to the climate change effects.

The major impact of the climate change on the urban areas, infrastructure and constructions is related, mainly, to the effects of the extreme weather events, such as the heat waves, abundant snowfalls, storms, floods, and the increase of the slopes instability and the modification of certain geophysical features. Therefore, urban planning and the design of an appropriate infrastructure play an important role in reducing the climate change impact and the decrease of the risk on the anthropic environment.

VI. B. 6 Tourism

The Romanian tourism sector, as in other European countries, is also affected by weather conditions from vulnerable at extreme events (summer heatwaves, intense floods and storms, or decrease of snowfall in the winter time in some regions). This fact will have impact to the choose of tourist destinations.

Using statistical modeling, a recent study shows that extreme temperatures has a negative influence under the number of foreign tourists on the Black Sea coast. The increase of average monthly temperature can favorise the increase of foreign tourist number. (Surugiu et al., 2012).

The mountain tourism is influenced differently by the level of outdoor temperature in comparison with the places near Black Sea; higher temperatures in the mountain area have a negative impact among the occupancy rate of accommodation places (Surugiu et al., 2012). Changes of the precipitation and snow regimes in mountain areas are also important factors which will influence the activities of tourist resorts in the future time. The potential for producing artificial snow will decrease in those areas.

The climate change should be regarded as a catalyst element which can lead at strengthens and accelerates the structural change in the tourism sector. It is useful to be assessed the objectives of the potential impacts to the tourism sector. After this kind of assessment, it is possible to identify, plannify and develop new opportunities to reduce the economic and employment impacts. For example, if in the mountain areas are expected small snow quantities in the winter time, it is an opportunity to planned other diferent tourism activities which promote

the walking and hiking for long warmer time and could be a possibility to develop other spa and wellness centers.

The business owners from tourism sector have to take into consideration the possibility to diversify their investments for avoiding the negative impacts of climate changes, and, in the same time, to answer at different opportunities resulted from them. The tourist accommodation places have to be adapted at the climate change conditions for reducing the negative impacts to the tourism activities. Tourist insurance could be an advantage for tourists and a measure for diminishing the undesirable results of climate change events. The tourist packages have to be diversified, focused on touristique services and sectors which are less vulnerability. Tourists and the tourism employees should be better trained regarding to the dangerous events due to the climate changes and to the measures for adapting at these phenomena. So, they have to succeed to easy adapt at the tourism consumption behaviour. Also, the tourism sector in general should benefit by the monitoring and climate warning systems for reducing the risk of exposure to extreme events and to adapt the offer in real time.

VI. B. 7 Energy

The reducing of electricity demand for heating in winter period, as a result of increase of global average temperature does not compensate for the increase of electricity consumption needed for operation the conditioner and cooling devices on hot days as well as for irrigation in agriculture.

Climate change will change the seasonal electricity demand, which will be lower in winter and higher in summer.

Climate change can also generate a reduction of hydro-electricity due to the decrease of water resources. The decrease of the water resources also affects the operation of the cooling systems of nuclear plants.

The decrease of hydro-electricity production has already been felt in our country when historical minimum values have been reached in 2003, 2007, 2009, 2011 and 2012, 2013 due to a significant precipitation reducing.

In Romania, the electricity generated by hydro plants was by 17.5 TWh in a medium hydrological year, and the electricity produced in dry years was by 12.337 TWh in 2012 or by 15.307 TWh in 2013.

In the dry hydrological years, the electricity shortage in the National Power Grid must be covered by coal-fired power plants with implications for electricity price and environment protection (increased CO₂ emissions).

The energy system infrastructure is affected by extreme weather phenomena. There have been many situations where thousands of residential buildings have been left without electricity. There are breakdowns of electricity transmission and distribution lines, damages at power transformers due to lightning, long-term consumer interruptions due to the extremely fast increase of electricity request needed to operate air-conditioning devices in summer time, for which the electricity distribution network capacity is below the requested capacity.

VI. B. 8 Industry

The impact of climate change on the global economy, in generally, and on the Romanian economy in particular, is an important factor for industry development due to that will have direct consequences on the changes in the world market.

The main risk for the industrial sector, in the context of climate change provides from the infrastructure degradation under the natural phenomena effect (high temperature, precipitation, wind, floods, etc) and those associated with extreme phenomena.

The effects and risks of climate change are:

- •High operational and maintenance costs for several sectors of activity as a result of labor breaks due to the increased frequency of extreme weather conditions (such as heatwaves, high temperatures, heavy rainfall and heavy snowfalls) and the need for increasing investment in prevention and / or health and safety damage at work;
- Uncertainty changes in risk profiles for national disaster insurance and increased insurance premiums for industrial raw materials and production;
- Losses and / or damages caused by water infrastructure degradation due to floods and interruption of water supply in case of drought;
- Accessibility to the industrial locations;
- The supply of fuel and raw material will be affected
- Losses and / or damage caused by drought in agri-food enterprises.
- Torrential rains have caused flooding of surface mining; landslides have compromised access to industrial sites;
- The structure of plant and / or animal feed has changed;
- The operation of large industrial power consumers has been restricted by the effects of heavy rainfall, heavy snowfall and excessive temperatures on electric transformers;
- Infrastructure degradation due to high temperatures;
- The uncertain risk profile change for natural disasters at national level.

In the same time with stressing the climatic excesses, especially in summer, it is possible for some sectors / sub sectors to register:

- Increased costs for industrial water supply;
- Increasing costs for cooling processes;
- Interruption of work during certain periods of the day due to excessive temperatures.

VI. B. 9 Transport

A transport type resistant to the effects of climate change requires a sustainable transport infrastructure. For example, this involves roads covered by materials resistant to the temperature fluctuations and floods, and bridges that take in consideration the flow water records.

The infrastructures of road, air, rail and maritime transport types are vulnerable, specially, to the extreme weather events. The direct impact of the climate change on the maritime transport will be due to the fluctuations of the river flow conditions. Indirectly, the climate change impact will be felt at the road and rail transport level through infrastructure degradation and lack of passenger thermal comfort.

The higher temperatures and the increased frequency of heatwaves is likely to cause problems to the roads and railways. The roads, railways and navigation are the potentially vulnerable to the increase of precipitation intensity and rapid flood frequency. Without providing additional protection, the bridges, roads, and railways are more exposed to extreme phenomena. The

reducing of precipitations, droughts and associated reduction of surface runoff can affect the Danube navigation.

VI. B. 10 Health

The climate change will negatively affect life and health of people in the next decades. Also, they affect the people health through a several mechanisms, such as:

- Some of them are relatively direct effects of extreme events – natural disasters (i.e. floods, storms, very hot wether, droughts)
- Others have a more complex trajectory which have in time as result the changing of pattern infectious diseases or new pathogens (i.e. emerging diseases, disruption of agricultural systems and of other assisted ecosystems, massive urbanisation, population migration, and conflicts caused by overpowered resources, non-fertile land and water resource exhausted).

Today and in the near future, an urgent issue is the impact of heatwaves in the urban areas. Under climate change conditions, the diferent areas from Romanian territory will be affected by the frequent and persistent heatwaves. The negative effects are felt easier in urban environment (Bojariu et all, 2013). The effects of the heatwaves are more severe in the crowded urban areas. Young and old people, and persons affected by certain diseases are vulnerable groups.

In order to identify the measures for adapting in all sectors specified in the Romanian climate chage strategy, it is necessary that Ministry of Health should include the surveillance of events affecting public health from various causes, including climate change starting from the indicators regarding the vulnerability to climate change.

VI. B.11. Insurances

The insurance sector will be affected by the climate change effects. More than this, the insurance sector could play a decisive role in the processes for addapting at this phenomenon. Last years, new financial tools have helped to reduce the sectoral risks, such as Law no. 381/2002 regarding the allowing of indemnities in case of natural calamities in agricultural sector. From 2010, the catastrophic risks, including climate risks (i.e. flood, landslide risk, etc) are covered by the National Housing Insurance Program. This is a program managed by PAID - the Insurance Pool against Natural Disasters.

These two sectoral insurance programs were rarely used because a large part of population has not enough information about them. For example, at the end of June 2015, only 18.5 percents of the residential buildings had insurance policy PAD. PAD is a compulsory insurance policy which covers damage from floods, earthquakes or landslides on dwellings. In the case there are included the optional policies the result would be: 65% of Romanian dwellings are not insured adainst disaster. Now, the optional policies cover natural disasters and other risks for 17% of total Romanian residential buildings. The private insurer companies were reluctant to play on this market or they act in competition with public programes instead of trying to complement them. The actual national programs will need support because they have had a slowly development and they cover a limited application field, and a lot of other insurance produces could be developed for covering the risks generated by the climate changes.

In conclusion, the public authorities and privat insurance sector have limited possibilities for using the insurace as an effective tool for adapting to climate change due to the lack of expertise and less information level of consumer information regarding the consequences of

climate changes. A better collaboration between the public authorities and private insurance sector could lead to creation by insurance policies complementary to the national programmes, not as competitor of them. Moreover, the local administrative units (LAU) will play an important role in national policy deployment regarding the climate insurances and they will require the additional support.

VI. B.12. Recreational activities

Reducing of the colder and precipitation periods, in contrast with the increase of temperatures, creates the favorable conditions for deployment of outdoor activities.

The climate change has a negative impact to the recreational activities only due to the effects generated by extreme events.

VI. C. Adaption measures

The National Strategy for Climate Change in Romania approved in July 2013 by the GO 529/2013 refers to the effects of climate change on water safety, agriculture, energy, transport, industry, insurance, biodiversity, health, tourism, forestry, infrastructure, and recreational activities. The National Strategy for Climate Change in Romania (2013) has been updated by the Ministry of Environment, Water and Forestry with the financial support of the European Union and the technical assistance of the World Bank. The new version was approved by the Romanian Government in October 2016. The updated Strategy aims to develop and operationalize a comprehensive National Climate Change and Low Carbon Green Growth Strategy for 2016-2030 and the associated Action Plan on Climate Change for 2016-2020 (World Bank, 2015).

Complementary to the new Strategy for 2016-2030, the Action Plan aims to assist the government in identifying and programming specific climate change adaptation and mitigation actions during the period 2016-2020 in order to operationalize and implement the Strategy (World Bank, 2015).

The Action Plan includes state-funded adaptation actions mandated by the EU Common Agricultural Policy (CAP) in order to counteract the potentially negative impact that climate change might have for the Agriculture and Rural Development (ARD) sector. The Action Plan promotes actions that support holistic infrastructure and urban planning in order to better integrate climate change considerations in the design and contents of the plans. The Plan also considers actions aimed at increasing the use of insurance against industrial losses due to climate events, include the development of climate change insurance solutions and the creation of climate risk insurance funds in the industry. Adaptation actions aim at assuring that biodiversity will have the capacity to cope with the impacts of climate change (World Bank, 2015).

VI. C. 1 Agriculture and rural development

The Action Plan includes state-funded adaptation actions mandated by the EU Common Agricultural Policy (CAP) in order to counteract the potentially negative impact that climate change might have for the Agriculture and Rural Development (ARD) sector. The Action Plan promotes risk management schemes as essential tools to restore production potential and compensate for the economic losses associated with weather-related events. The "greening" payment for agricultural practices (through the European Agricultural Guarantee Fund) and a

set of NRDP measures also provide an important stimulus for farmers to manage their lands sustainably and thus adapt to climate change (World Bank, 2015).

VI.C.2 Drinking Water and water Resources

Investments aimed at reducing system losses in water distribution networks and in treated wastewater reuse in industrial sectors – especially for large utilities and in shortage-prone areas – are key in order to reduce the risk of water shortages over the short and medium term. In addition to these, the Action Plan also addresses policy measures, including the priorities for establishing requirements for protection of critical water supply sources in water scarce localities and the regulations to limit the use of groundwater in the areas of over-abstraction. A number of short and medium-term research actions are also put forward, as these are important in providing information for effective progress in policy and investment actions for reducing risk of shortages. In terms of reducing flood risks, the upgrade of the existing radar network for measuring precipitation intensity and the assessment of the feasibility of regulation for monitoring and managing construction activities in high flood risk areas are key priorities included in the Action Plan. The key action for enhancing the environmental safety of dams and dykes is the large investment planned for construction, renewal and improvement of the flood management infrastructure (World Bank, 2015).

VI.C.3 Human Environment (Infrastructure and Urban Planning)

The Action Plan promotes actions that support holistic infrastructure and urban planning in order to better integrate climate change constraints in the design and contents of the plans. Policies that enable new development to areas less likely to be at risk are important, as are policies or initiatives aimed at enhancing the physical robustness of vulnerable structures. It is equally important to ensure that local or national building codes affecting new construction represent the state of the art in the field and are subject to relevant modifications based on local flood hazards, seismic maps and other factors. The Action Plan also includes actions that strengthen local capacity in terms of professional training and public education (World Bank, 2015).

VI.C.4 Transport

The starting point for adaptation work in the sector is to conduct sector- or agency-level vulnerability assessments in order to identify the relative vulnerability to the impacts of climate change – of both assets and services – and define short-, medium-, and long-term responses. The review of emergency preparedness planning and vulnerability assessments should be launched as a matter of priority, so as to increase the robustness of responses to disasters and to ascertain where the greatest risks are. Overall, the key challenge is to ensure that the technical assistance outputs translate into changed practice that increases the resilience of Romania's transport infrastructure and services (World Bank, 2015).

VI.C.5 Industry

The Action Plan includes adaptation measures to support the following two strategic objectives: (i) increasing protection from and preparation for climate-related emergency situations in key industries; and (ii) increasing awareness among private owners of industrial enterprises on the need for measures of climate change adaptation. A number of capacity building actions for various sectors of industry are necessary to support these objectives including for the improvement of knowledge and expertise on risk management and knowledge transfer on good

practices for adaptation. The Action Plan also considers actions aimed at increasing the use of insurance against industrial losses due to climate events, include the development of climate change insurance solutions and the creation of climate risk insurance funds in the industry (World Bank, 2015).

VI.C.6 Energy

Both in terms of critical energy infrastructure vulnerabilities to extreme climate events and in terms of potential impacts of climate change on energy demand, the priority for the energy sector is the development of adaptation measures for supply and demand in the energy strategy for the period 2016- 2035. The work in this area would receive a boost by a study identifying the risks to critical energy infrastructure, as well as capacity building and training actions to address the existing knowledge gap (World Bank, 2015).

VI.C.7 Tourism and recreation

Key policy actions in the area of recreation support the protection and expansion of natural recreational areas in urban and peri-urban areas and their access for a diverse public. The pressure to designate these areas as eligible for construction is a major risk and therefore their recreational and protection status should be established and enforced. In addition, a recreation opportunity spectrum policy should be put in place. Key actions in the field of tourism adopt a twofold approach: taking advantage of opportunities and avoiding the risks associated with climate change. Therefore, strategic planning at the national level is a high priority, whereby special attention should be given to competitive and less climate change dependent tourism sectors (e.g., ecotourism and spa tourism). Further priorities include supporting the development of four-season green mountain resorts and adapting coastal tourism to climate change (World Bank, 2015).

VI.C.8 Forestry

Adaptation actions in the area of forestry are built around three key objectives. First, improving the management of forests to support their adaptive capacity to climate change – in practice this includes updating technical guidelines for sustainable forest management, and enhanced economic skills and market information among economic operators. Second, the adaptation of forest regeneration practices to the necessities imposed by climate change – key actions in this respect are the updating of technical guidelines for forest regeneration and related capacity building actions. Third, minimization of climate change risk for forestry – key actions underpinning the attainment of this objective are to maintain and improve the monitoring and observation system for risks such as forest pests, forest fires and invasive species, as well as other capacity building measures and investment in the management of risks from extreme weather events (World Bank, 2015).

VI.C.9 Biodiversity

Adaptation actions aim at assuring that biodiversity will have the capacity to cope with the impacts of climate change. The most important measures are assessing the vulnerability of natural habitats and protected species to climate change and integrating climate change adaptation into strategies and national action plans for species protection, especially to control the alien invasive species. The use of green infrastructure is also a key action needed in order to assure the connectivity of populations or migration corridors (ecological corridors and stepping stones). In addition, the resilience of ecosystems would extensively benefit from improving the conservation status of the bogs, mires and fens and assuring the ecological restoration and/ or recovery of the wetland habitats in the Lower Danube Basin. Other actions in the area of biodiversity include the development of valuation of ecosystem services, the

ecosystems approach and adaptive management in decision making systems, as well as the promotion of scientific research to enhance the knowledge and understanding of the role of biodiversity and its contribution to climate change adaptation. These actions need to be supported by strengthened technical and human resource capacities in order to enhance and to apply the knowledge on the importance of biodiversity for climate change adaptation (World Bank, 2015).

VI.C.10 Public Health and Response Services in Emergency Situations

Impacts of climate change on public health stem both from direct effects of extreme events and more indirect effects that emerge over a longer period of time, for example, from changing patterns of infectious diseases, disruption of agricultural systems, urbanization and population movement. Actions supporting the attainment of two key strategic objectives are outlined in the Action Plan. First, the objective of developing the capacity for surveillance of events with impacts on public health is addressed by key actions for policy and planning for such events. This is in turn supported by capacity building actions in terms of training, research and assessment of the capacity for early detection, and related investments in upgrading technology for surveillance. Second, key priority policy actions for the objective of safeguarding the citizens' health from impacts of disasters by strengthening the Romanian emergency management system are: (a) the completion and harmonization of the regulatory framework for the national emergency management system; and (b) the development of the risk reduction strategy and mitigation measures to reduce natural disaster cases and vulnerability in critical areas of Romania. These actions are supported by a number of priority capacity building measures for establishing risk monitoring capabilities and early warning systems, and priority investments such as in upgrading emergency communications and disaster information management systems (World Bank, 2015).

VI.C.11 Public Education and Awareness Raising

Priority actions that support the objective of improving information and raising awareness among the population on the impact of and adaptation to climate change are two: (a) awareness raising and information campaigns for target groups; and (b) media campaigns to inform the general public. These actions need to be supported by the development of structured partnerships between public authorities and civil society organizations for raising awareness on climate change issues. The second objective of enhancing the education of citizens on climate change is addressed by a number of educational actions at different levels – pre-university education, university and post-university education, as well as lifelong learning programs and occupational training (World Bank, 2015).

VI.C.12 Insurance as an Instrument of Adjustment to climate change

The insurance sector will not only be affected by climate change, but could also play a decisive role in the processes of adaptation to this phenomenon. Existing programs in Romania will require support as their presence and scope remain limited. In addition, new insurance products can be developed targeting specifically the consequences of climate change. The Action Plan therefore lists priority actions that (a) support the increase in the use of and access to insurance products against climate change related extreme events and (b) increase the capacity of the insurance sector in order to increase climate change resilience (World Bank, 2015).

VII. FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

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 offer information on financial resources for the years 2015 and 2016 provided through multilateral and bilateral channels related to the implementation of the Convention.

In 2015, Romania provided 147,018.30 RON (36,702.27USD) through multilateral channel (chapter - "Other multilateral climate change fund"). In 2016, Romania provided 3,296,501 RON (812,106.08 USD) through multilateral channel and 210,000 RON (51734 USD) through bilateral channel (for Georgia).

Detailed information regarding financial support provided for the years 2015 and 2016 are included in the Annexes (tables 7 A, 7 B) of the Third Biennial Report. Information on financial resources for the years 2013 and 2014 are provided in the Second Biennial ([http://unfccc.int/files/national_reports/biennial_reports_and_iar/submitted_biennial_reports/application/pdf/rou_2016_v1_0_formatted_\(2\).pdf](http://unfccc.int/files/national_reports/biennial_reports_and_iar/submitted_biennial_reports/application/pdf/rou_2016_v1_0_formatted_(2).pdf)).

In the years 2015 and 2016 were not developed technology support and transfer (Table 8) and capacity-building (Table 9) activities. Thus, the table 8 and 9 of 3BR were not provisioned for this years.

VIII. RESEARCH AND SYSTEMATIC OBSERVATIONS

According to the requirements of the UNFCCC, research and systematic observations are performed for a better understanding of the effects of the climate change in Romania in such a way that they can be used to propose greenhouse gas (GHG) mitigation and adaptation measures to be adopted. In this context, Romania is synchronized with the international efforts (e.g. contributing to Global Climate Observation System - GCOS activities).

This chapter reports on general policy and funding related to research and systematic observation (section VIII.A), research made on national, European and international levels (section VIII.B) and systematic observation (section VIII.C).

VIII. A. General policy on research and systematic observation

Research activities in Romania consist of themes related to climate system, impact and adaptation for policy support. National research activities are carried out along with participations in international and European programmes such as Horizon 2020, JPI Water, JPI Ocean and JPI Climate. The main coordinator of Romanian research is the Ministry of Research which financially supports research projects selected from national competitions which are organized by the Executive Unit for Scientific Research (UEFISCDI). Also, The Ministry of Research financially supports a part of the contributions to the European and international research area.

The Ministry of Environment coordinates and financially supports applicative research on water management, climate related environmental risks and sustainable adaptation planning. The Ministry of Regional Developing, Public Administration and European Funds is the focal point for the Danube Transnational Programme which partially supports projects on adaptation to climate change and climate-related risk assessment in relation to disaster management.

As for the systematic observation, Romania has actively participated in various fields of climate-related monitoring, both nationally and within European and global programmes (such as GCOS). Romania has internationally exchanged data and contributed to European and global databases.

VIII. B. Research

Cooperation in international research

The Romanian research on climate change is synchronized with three large international scientific programmes in the field of global change research: the International Geosphere Biosphere Programme (IGBP), the World Climate Research Programme (WCRP) and the International Human Dimensions Project (IHDP). The National Meteorological Administration is scientifically involved mainly in activities related to WCRP. The Institute of Geography of the Romanian Academy has activities related to IGBP and IHDP.

Romanian experts on climate change are also contributing to activities carried out by the Intergovernmental Panel on Climate Change (IPCC). National Meteorological Administration coordinates the Romanian expert contributions to the IPCC.

Cooperation in European research

Many of the Romanian institutions have had research projects under the Horizon 2020 Framework Programmes and have participated at COST actions and in other European programmes related to climate (e.g. Danube Transnational Programme). The synergy and cooperation between European and the national research programmes are enhanced by

participation in Joint programme Initiative (JPI). Romania is member in JPI Water, JPI Ocean and associate member in JPI Climate.

National research programmes

The national activities concerning climate change in Romania consist of research projects financially supported by:

- Ministry of Research (e.g. the environment section of National Research Program for Research, Development and Innovation III);
- Ministry of Environment;
- Ministry of Agriculture
- Ministry of Regional Development, Public Administration and European Funds

The physical basis of climate change has been the main area of climate research in Romania in the recent years. Romanian scientists have analyzed climate variability and change at regional level in observed data and in results from global and regional climate models to identify the policy relevant risks related to climate change (e.g., Bojariu et al., 2015).

However, Romania needs more research on mitigation, adaptation and „climate-proofing. Research institutes and socio-economic players have to join efforts in bridging the gaps between physical basis of climate change and impact, adaptation and mitigation research areas.

The most relevant research projects and networks are listed in Annex 3.3.

VIII. C. Systematic observation

Meteorological observations are synchronized and integrated on a European and on a global level. Romania participates in various fields of climate-related monitoring, on national level and in European and global programmes. Romanian experts exploit observing systems for the monitoring of Essential Climate Variables (ECVs) which describe:

- Atmospheric climate (including measurements for some atmospheric constituents such as ozone);
- Black sea climate;
- Terrestrial climate.

Romania complies with the GCOS requirements. The GCOS monitoring principles and best practices are taken into account in the systematic observation activities. In Romania, these activities have been synchronized with the European research area and World Meteorological Organization (WMO) programmes (especially from the Region VI) and with GCOS on global level. Also, Romania has internationally exchanged data and has contributed to European and global databases.

The National Meteorological Administration (NMA) is the main organization which performs systematic observations on atmospheric climate and, to a lesser extent, on parts of sea and terrestrial climate. These observations are gathered, validated and transferred in the National Meteorological Network (NMN). The NMN is organized in 7 Regional Meteorological Centers which consists of 158 operational weather stations, 126 of them being automatic weather stations (MAWS). Observations at 64 rain gauging stations are made on a voluntary basis. From the 158 weather stations, 133 are full-time operational and 26 are part-time operational.

55 weather stations perform an agrometeorological measurement programme. Radiometric measurements are performed at 35 stations.

The programme of meteorological upper-air measurements is carried out at the Aerologic Observatory of Bucharest-Afumați, including two daily radio soundings (at 0000 and 1200 UTC). Daily wind soundings with PILOT balloon are also carried out at the station Bucharest-Afumați at 0600 UTC.

The operational National Meteorological Integrated System (SIMIN) was established in 2003. Within SIMIN the national radar network was upgraded. Now, the national meteorological radar network consists of 8 Doppler weather radar systems. The national radar network integrates three types of equipment produced by several radar systems manufactures (Enterprise Electronic Corporation - EEC, Gematronik and Metstar). The radar information from all equipment is combined into a unique product – the national radar mosaic (available in 3 versions every 10 minutes). The radar information from Romanian network is useful for the neighboring countries, too.

Observations from meteorological satellites refer to receiving and primarily processing in real time digital images and data from geostationary satellites METEOSAT-7 and MASG-1 in 3, and 12 spectral channels, respectively. The operative running of EUMETSAT/SAFNWC model started in February 2005, obtaining 8 of the 12 nowcasting products, every 15 minutes, which are transmitted to the National Forecasting Centre.

In addition to the monitoring activities of the NMA, systematic observations are also recorded by National Institute of Hydrology and Water Management for hydrological-related climate indicators and Black Sea climate. The GeoEcoMar institute performs climate relevant measurements of oceanographic, marine ecosystem and geological indicators in the Black Sea. Institute for Marine Research (Constanta) also performs measurements of climate related indicators of Black Sea climate ecosystems. The GeoEcoMar and Institute for Marine Research contribute to EuroGoos and Black Sea GOOS. National and local agencies for environmental protection gather data related to atmospheric constituents and pollutants.

Romania contributes to free data exchange under national law (Romanian Law of Meteorology) and international regulations (e.g. ECOMET rules). NMA participates in the international meteorological data exchange with a number of 23 stations in RBSN (Regional Basic Synoptic Network) and 14 stations in RBCN (Regional Basic Climatological Network). Also, NMA has submitted and updated climate data to the portal European Climate Assessment & Dataset (ECA & D) (<http://www.ecad.eu/>).

IX. EDUCATION, TRAINING AND PUBLIC AWARENESS

Romania joined the leaders of the 193 UN member states at the September 2015 Development Summit adopting 2030 Sustainable Development Agenda, a global action program in the development field which promotes the balance between the three dimensions of sustainable development - economic, social and environmental. The United Nations declared the period 2005-2014 as the decade of "EDUCATION FOR SUSTAINABLE DEVELOPMENT".

Education and training play a crucial role in the process on the long run of reaching sustainable development in Romania, public outreach, through public engagement and awareness, being very important for a successful implementation of the national strategies and policies in the field of sustainable development. Our national objective, for the 2013-2020 horizon, is to develop human capital and increase competitiveness by linking education and lifelong learning to the labour market and ensuring better opportunities to participate in a modern, inclusive and flexible labour market, environmental friendly oriented.

In the National Sustainable Development Strategy Romania 2013-2020-2030 it is recognized that the Romanian educational and training system is a priority objective of strategic importance and basic preconditions for an effective implementation of the principles of sustainable development in the medium and long run. To this aim, The National Action Plan 2016-2020 on Climate Change, developed in 2015, clear targets were set-up regarding:

- the implementation of measures to adapt the curriculum to climate change, both in the vocational (dual) and the academic environment;
- appropriate public awareness campaigns through information, education and communication campaigns on the possible risks and opportunities resulting from climate change;
- creation of responsible and capable citizens for local innovation actions and climate change adaptation through projects in schools / universities, the community / private sector;
- development of knowledge and skills to increase adaptability to climate change by conceiving an updated and innovative curriculum, providing relevant teachers training and study programs for students and adults.

Improving the education sector has a significant impact on economic growth through employment, relevant skills training and personal development. In this respect, Table IX_1 presents the main education objectives for EU in 2020, for Romania and its progress until 2013/2014.

Table IX_1 Education objectives in EU and Romania, 2020

Europe goals 2020	Romania goals	Romania in 2013/2014
75% of the 20-64 year-old population to be occupied	70%	65.4% (trim. IV 2014)
The percentage of early school leavers to be below 10%	11.3%	18.5% (trim. III 2014)
At least 40% of people between the ages of 30 and 34 to have completed tertiary studies	26.7%	23.8% (trim. III 2014)
At least 15% of people aged between 25 and 64 has to participate in lifelong learning programs	10%	1.8%

Source: European Commission

The educational system in Romania strives to connect with the concept of education for sustainable development, with thematic content integrated into formal, non-formal and informal educational

systems on the three dimensions: socio-cultural, environmental and economic, such as: biodiversity conservation, environmental protection and improvement, environmental quality, environmental regeneration, recycling and reuse of materials.

Between 2007-2013, the Government of Romania has implemented various projects through the Operational Program for Human Resources Development, a program with a capital of about 4 billion euros from the European Social Fund and from the state budget. For the new programming period, the Human Capital Operational Program 2014-2020 (POCU) has a total allocation of € 4.326 billion. One of the three horizontal principles relevant to all ESI funded operations is sustainable development (polluter pays, disaster resilience, resource efficiency, mitigation and adaptation to climate change, biodiversity conservation and protection etc.).

IX. A. Education

In Romania the main responsible authorities for the initial and continuing vocational education and training systems (IVET and CVET) are both Ministry of Education & Scientific Research and Ministry for Labour, Family, Social Protection and Elderly, together with the National Authority for Qualifications (ANC), National Agency for Community Programs in the Field of Education and Vocational Training (ANPCDEFP) and the National Agency for Employment (ANOFM).

IVET is the professional education and training set out within the national education system. Thus, the national pre-university education system comprises the following levels:

- a) Early education, 0-6 years old, consisting of the pre-school level, 0-3 years and 3-6 years, comprising the small group, the middle group and the large group;
- b) primary education, comprising the preparatory class and grades I to IV;
- c) secondary education, which includes: lower secondary education or gymnasium and upper secondary education which can be: high school education and vocational education lasting at least 3 years;
- d) tertiary non-university education, which includes post-secondary education.

High school education is organized in two cycles: the lower cycle of the high school, consisting of the 9th and 10th grades, and the high school cycle of 11th / 12th grade.

Higher education - vocational and technological, professional and post-secondary education are organized for specializations and qualifications established by the Ministry.

High school education comprises the following branches and profiles:

- a) theoretical branch, with the humanist and math profiles;
- b) technological branch, with technical profiles, services, natural resources and environmental protection;
- c) vocational branch with military, theological, sports, artistic and pedagogical profiles.

Higher education includes university education, structured on three levels of study (bachelor, master and doctoral or postgraduate education).

By Labour Code, in Romania there are covered the procedures regarding the CVET, respectively getting new competences and skills, including the assessment of knowledge level and certification according to occupational standards.

The integration of sustainable development principles into initial education and training systems (pre-university, university and post-secondary education) is achieved at the level of the developed

learning instruments and methodologies, by raising the awareness of environmental protection, pollution prevention and control, biodiversity conservation.

One of the fundamentals of the Romanian education is to familiarize the children with the natural environment in order to set up the positive attitude towards the protection of the environment. Environmental protection and climate change issues are present into the curricular activities in gymnasium, technical colleges (dual education system) and the high schools. The focus is also on teachers CVET in order to gain attitudes and active civic behaviour of pupils and students in support of sustainable development, such as raising awareness of environmental issues, developing attitudes and specific skills.

The state and private Universities prepare the future specialists in the fields of environmental protection and climate change.

University "Politehnica" of Bucharest (www.upb.ro) has four faculties which ensure the preparation of the specialists in these fields. These faculties are:

- The Faculty of Power Engineering, which is one of the elite schools of the Romanian higher education, has one undergraduate programme "Industrial Environmental Protection and Engineering" and two in-depth master programmes "Environmental Engineering in Energetics" and "Environmental management and Sustainable Development";
- The Faculty of Biotechnical Systems has various specialties. Those, who are interested in the issues regarding ecology and environmental protection can choose one of the following specialties: "Biotechnical and Ecological System Engineering" and "Sustainable Rural Development Engineering";
- The Faculty of Applied Chemistry and Materials Science has various major fields of study. One of these fields is Environmental protection Engineering in the Chemical and petrochemical Industry;
- The Faculty of Material Science and Engineering offers the programmes of study in Environmental Engineering and Protection in Industry.

At the University of Bucharest the Faculty of Geography has four departments. Two of them are related with climate change. These departments are:

- Department of Regional Geography and Environment which prepares the specialists for the integrated assessment of the environment, for the assessment of the impact of various factor on the environment and the protection of environment;
- Department of Meteorology and Hydrology which prepares the specialists for optimal administration of meteorological, climatological and hydrological risks.

Additional information about the activities of the university can be obtained on the web site: www.unibuc.ro.

The University of Agronomic Sciences and Veterinary Medicine of Bucharest (USAMV) is involved, via Faculty of Land Reclamation & Environmental Engineering, Faculty of Agriculture and Faculty of Horticulture, in programs related to the GHG emissions and climate change impact on agriculture, forests and biodiversity.

The Bucharest Academy of Economic Studies has the Faculty of Agrofood and Environmental Economics which includes in its curricula ecological subjects related to the climate change.

The faculty offers guidelines for the diploma on the following topics: assessment of economic and environmental performance at the microeconomic level, climate change affects natural capital, hazardous waste management, environmental policies etc.

The didactical activity is also dedicated to master or doctoral studies on ecology, such as:

- Carbon capture processes analysis – a new M.Sc. course within the existing Energy Efficiency Master Programme at *UPB – Faculty of Power Engineering*;
- *University “Politehnica” of Timisoara* with two Masters' degrees: “Research regarding the capture of CO₂ released from fossil or unconventional fuels combustion processes” (accomplished) and “Analysis of the flue gas CO₂ absorption processes”;
- The private *Faculty of Environmental Sciences, Bucharest, Politehnica University of Timișoara and Babeș Bolyai University of Cluj-Napoca* (Faculty of Environmental Science) have developed master's degree programs on climate change management and doctoral studies on GHG emissions - impact , prevention, control, reduction and adaptation;
- The *Advanced Studies School of the Romanian Academy* organizes doctoral studies on the topic: Climate Change - Preventive Measures and Economic Impact.

UPB is involved also in national and European research projects for CO₂ Capture, being interested in future development of a Bachelor's Degree on CCUS, closely related to a Master Programme on “Carbon capture, transport and storage processes analysis”.

IX. B. Training

The national education system also includes permanent education (CVET / VET). Romania has the advantage of already having a well-defined legal framework that supports lifelong learning. This regulatory framework, made up of laws on education, apprenticeship, internships (Law No 335/2013 on the conduct of internships for graduates of higher education, as amended and supplemented), volunteering (Law No 78/2014 on regulating the volunteering activity) and adult vocational training, is a very valuable point that can serve as a basis for the further development of the CVET system. Existing regulations need to be implemented, monitored and assessed consistently to expand and improve the CVET system. Thus, in 2015, the Government adopted the National Lifelong Learning Strategy 2015-2020.

Promoting CVET is essential to achieve the key European and national sustainable development goals. This will improve the skills of the population and increase employment and labour productivity, with immediate effects on resource efficiency and competitiveness.

The subject of climate change was also debated in numerous knowledge sharing and best practices events, workshops, conferences and dedicated projects. For example some actions organized by different institutions were selected.

Romanian National Committee of World Energy Council (WEC-RNC) organized:

- FOREN - WEC Central & Eastern European Energy Forum (2014 and 2016 editions) with the topics “The energy for tomorrow: from vision to reality” and „Safe and Sustainable Energy for the Region”.

At the *University “Politehnica” of Bucharest (UPB)* the Faculty of Power Engineering organized the following international conferences related with sustainable development, energy and climate change:

- The six and seven editions of the International Conference Energy and Environment - CIEM 2013 and 2015 with the following themes “Green and Smart Energy” and “Clean and safe power“ debating main issues related to: impact of new technologies on environment, biomass cogeneration system and negative balance of CO₂, passive house, smart grid, renewable energy, clean coal technologies etc.

A number of interesting projects aiming at capacity building, policy influencing, increasing the education level and the public awareness (specific target groups and/or general) have been developed during the last years:

1. Promotion of smart and integrated NZEB renovation measures in the European renovation market (NeZeR)

Project coordinator: VTT Technical Research Centre of Finland - VTT/Finland

Partners: IVL Swedish Environmental Institute – IVL/Sweden; Tecnalia Research and Innovation Foundation – TECNALIA/Spain; W/E Consultants Sustainable Building – W/E / the Netherlands; ISPE, Romania; City of Stockholm, Environment and Health Administration – Stockholm/Sweden; City of Rotterdam – Rotterdam/ the Netherlands; Municipality of Amersfoort – Amersfoort/ the Netherlands; City of Sestao – SES/ Spain; Municipality of Timisoara – MTM/Romania; Partaal – POR/ the Netherlands; Stadshus AB - STA/Sweden; Stockholmshem – STH / Sweden

Project co-funded by: EASME - Executive Agency for Small and Medium – sized Enterprises, IEE 2013 Program

Project duration: 2014-2017

2. Educational and Training System for Clean Coal Technology (CleanCOALtech)

Project coordinator: University Politehnica of Bucharest - Faculty of Power Engineering

Partners: Institute for Studies and Power Engineering (ISPE), Romania; Romanian Association for Technology Transfer and Innovation (ARoTT); The University of Edinburgh (UEDIN), UK; Centre for Renewable Energy Sources and Saving (CRES), Greece

Project co-funded by: EC - LIFELONG LEARNING PROGRAMME / LEONARDO DA VINCI / Transfer of Innovation TOI/2012

Duration: 2012-2014

3. Capacity building of local governments to advance Local Climate and Energy Action – from planning to action to monitoring” (Covenant capaCITY)

Project coordinator: ICLEI Europe

Partners: Centre for Social Innovation (ZSI), Austria; Municipal Energy Efficiency Network EcoEnergy, Bulgaria; City of Burgas, Bulgaria; WWF Danube-Carpathian Program, Bulgaria; City of Koprivnica, Croatia; Estonian Regional and Local Development Agency (ERKAS), Estonia; FCG Finnish Consulting Group (FCG), Finland; Climate Action Network – France (CAN-F); Regional Energy Agency of Crete (REAC), Greece; City of Padova, Italy; Sogesca, Italy; WWF Poland; Agency for Energy Efficiency and Environment Protection (AEEPM), Romania; Association of Municipalities and Towns of Slovenia (SOS), Slovenia; City of Malmö, Sweden; The Climate Municipalities (CM), Sweden; Institute for Housing and Urban Development Studies (IHS), The Netherlands; Act on Energy,

Implementation period: 2011-2014

Project co-funded by: EASME - Intelligent Energy Europe (IEE) programme.

4. Capacity building and lessons to be learned for the institutionalization of sustainable energy policies in the municipalities' operations (Green Twinning)

Project Coordinator: Regional Union of Municipalities of Attica (PEDA).

Partners: 10 partners (municipalities, associations/networks of local authorities, agencies and consulting firms) from Greece, Bulgaria, Poland, Romania, Slovenia and Spain

Project co-funded by: Intelligent Energy Europe (IEE) programme.

Implementation period: 24 months, April 2012-March 2014

Related to training and education projects developed by Romania in European consortiums it must be underlined the important role of the National Agency for EU Programs in the field of Education and Vocational Training responsible for managing several UE dedicated programs. Thus during 2013-2015 several projects were developed in the field of sustainable development, GHG emission reduction and climate change impact mitigation, by Romanian consortium's leaders or partners, as follows:

- 3 Bilateral schools' projects and 47 Multilateral schools' projects in *Comenius Program 2013*, focusing on all levels of school education, from pre-school and primary to secondary schools;
- *ERASMUS+ Program*: 21 projects in 2014 and 18 in 2015 for strategic partnerships (secondary and tertiary non-university education level); 26 projects in 2014 and 26 in 2015 for youth mobility; 2 projects 2014-2015 for adult mobility and 1 project for VET mobility in 2014;
- 4 projects developed in 2013 within *Grundtvig Program* – aiming to help developing the adult education sector programs;
- 4 projects in the field of vocational education and training co-funded by The *Leonardo da Vinci Program* out of which 2 PLM (People in the labour market), 1 VETPRO (Vocational education and training professionals) and 1 ToI (Transfer of innovation) project.

Further climate change mitigation dedicated actions for CVET programs are envisaged considering the financing opportunities given by Horizon 2020 Program, LIFE 2014-2020, RDI National Programs, and the current EEA and Norwegian Financial Mechanism implementation (2009-2014).

IX. C. Public awareness

We should not underestimate the increasing role of the civil society representatives in the public information-education, engagement and awareness process developed through different NGOs projects / public out-reach roll-out with the support of EEA Financial Mechanism 2009-2014. Thus, there were 42 winning projects under the NGO Fund Program in Romania – Sustainable Development component aiming the following fields of interest:

- Climate change
- Biodiversity and landscape protection
- Ecotourism

- Environmental advocacy and watchdog
- Ecological education

The National Administration of the Environmental Fund had a major role in promoting and supporting education and public awareness activities strongly related to climate change mitigation and GHG emissions reduction, such as supporting programs for:

- Promoting non-pollutant and energy efficient vehicles / 2014;
- Public education and awareness in environmental protection and GHG emissions reduction / 2013, 2014, 2015;
- Increasing the use of RES / 2013, 2014;
- Installing heating systems based on renewable energy, including replacement of traditional heating systems for public and private buildings / 2013, 2014, 2015;
- Stimulating the renewal/change of the old and pollutant vehicles at national level / 2013, 2014, 2015;
- Afforestation of degraded land, ecological reconstruction and sustainable forest management / 2013, 2014, 2015;
- Biodiversity conservation and natural protected areas management / 2013, 2014, 2015;
- National program for improving the quality of the environment through the creation of green spaces in urban areas / 2013, 2014, 2015;
- Prevention, removal and / or mitigation of the effects caused by extreme meteorological phenomena / 2014;
- Development and optimization of the National Air Quality Monitoring Network / 2015.

Additionally each local public administration promotes GHG emission reduction and climate change adaptation concepts by encouraging and supporting local NGOs to compete for small education and public awareness projects funded from the local budget.

BIBLIOGRAPHY

- *National Climate Change and Low Carbon Green Growth Strategy for period 2016 – 2020 and the National Action Plan for implementation of the National Climate Change and Low Carbon Green Growth Strategy for period 2016 – 2020 had been developed, approved by the Government of Romania on 05.10.2016, through GD no. 739/2016;*
- *Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC;*
- *Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community;*
- *Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources;*
- *Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide;*
- *Decision no.406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020;*
- *"Romanian Energy Strategy for the period 2007 ÷ 2020" (GD no. 1069/2007);*
- *"Romanian Energy Strategy 2016 ÷ 2030 with perspective 2050;*
- *National Strategy for Sustainable Development - Horizons 2013-2020-2030;*
- *Strategy for renewable energy sources;*
- *Intermodal Transport Strategy in Romania - 2020;*
- *National Strategy for Lifelong Learning 2015-2020*
- *Romania's Education and Training Strategy 2014-2020*
- *National Action Plan for Renewable Energy;*
- *The third National Action Plan for Energy Efficiency for period 2014-2020;*
- *National Action Plan on emissions of greenhouse gases reduction in civil aviation for 2011 ÷ 2020;*
- *National Afforestation Program;*
- *National Rural Development Programme 2014 – 2020;*
- *Romanian Statistical Yearbook - Collections, National Institute of Statistics;*
- *Report on the use of the Environment Fund 2013, 2014, 2015*
- *Interdisciplinary Methodological Guide - Education for Sustainable Development, ISJ Cluj, 2013;*
- *Regulation (EC) No. 715/2007 of the European Parliament and of the Council of 20 June 2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information;*
- *Regulation (EC) No. 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO₂ emissions from light-duty vehicles;*
- *Regulation (EU) No. 510/2011 of the European Parliament and of the Council of 11 May 2011 setting emission performance standards for new light commercial vehicles as part of the Union's integrated approach to reduce CO₂ emissions from light-duty vehicles;*
- *UNFCCC/FCCC/IDR.6/ROU (15 January 2015) „Report of the technical review of the sixth national communication of Romania;*
- *UNFCCC/FCCC/TR.2/ROU (5 October 2016) „Report of the technical review of the second biennial report of Romania;*

- *Birsan MV (2015) Trends in Monthly Natural Streamflow in Romania and Linkages to Atmospheric Circulation in the North Atlantic. Water Resources Management 29(9): 3305–3313. DOI: 10.1007/s11269-015-0999-6;*
- *Birsan MV, Dumitrescu A (2014) Snow variability in Romania in connection to large-scale atmospheric circulation. International Journal of Climatology 34: 134–144. DOI: 10.1002/joc.3671;*
- *Birsan MV, Dumitrescu A, Micu DM, Cheval S (2014) Changes in annual temperature extremes in the Carpathians since AD 1961. Natural Hazards 74(3): 1899–1910. DOI: 10.1007/s11069-014-1290-5;*
- *Birsan MV, Marin L, Dumitrescu A (2013) Seasonal changes in wind speed in Romania. Romanian Reports in Physics 65(4): 1479–1484;*
- *Birsan MV, Zaharia L, Chendes V, Branescu E (2014) Seasonal trends in Romanian streamflow. Hydrological Processes 28(15): 4496–4505. DOI: 10.1002/hyp.9961;*
- *Bojariu R., C. Corbuș, R. Mic, M. Mătreacă, V. Crăciunescu, N. Miliian, A. Dumitrescu, M.-V. Bîrsan, S.-I. Dascălu, M. Gothard, L. Velea, R. Cică, C. L. Grecu, A. A. Pașol (2017) Climate change impact on snow-related processes In: Remote sensing, model and in-situ data fusion for snowpack parameters and related hazards in a climate change perspective, Ed: Gheorghe Stancalie, Editura Printech, pp.63-90;*
- *Bojariu R, Birsan MV, Cică R, Velea L, Burcea S, Dumitrescu A, Dascălu SI, Gothard M, Dobrinescu A, Cărbunaru F, Marin L (2015) Climate Change from physical basis to risks and adaptation (in Romanian with abstract in English) Schimbările climatice – de la bazele fizice la riscuri și adaptare. Printech, București. 200 p;*
- *Bojariu R., M. Papathoma-Köhle, Valéria Wendlová and R.-D. Cica, 2014: Changing risks in changing climate. SEERISK Project Report. DOI: 10.13140/RG.2.1.3710.9287;*
- *Burcea, S., Cică, R. și R. Bojariu, 2016: Hail climatology and trends in Romania: 1961-2014, Monthly Weather Review 144(11):4289-4299, DOI: 10.1175/MWR-D-16-0126.1;*
- *Busuioc A, Birsan MV, Carbutaru D, Baci M, Orzan A (2016) Changes in the large-scale thermodynamic instability and connection with rain shower frequency over Romania. Verification of the Clausius–Clapeyron scaling. International Journal of Climatology 36(4): 2015–2034. DOI: 10.1002/joc.4477;*
- *Cheval S, Busuioc A, Dumitrescu A, Bîrsan MV (2014) Spatiotemporal variability of meteorological drought in Romania using the standardized precipitation index (SPI). Climate Research 60: 235–248. DOI: 10.3354/cr01245;*
- *Cică, R., Burcea, S. and Bojariu, R., 2015: Assessment of severe hailstorms and hail risk using weather radar data. Met. Apps, 22, pp. 746–753. doi: 10.1002/met.1512;*
- *Dascalu SI, Gothard M, Bojariu R, Bîrsan MV, Cică R, Vintilă R, Adler MJ, Chendeș V, Mic RP. 2016. Drought-related variables over the Bârlad basin (Eastern Romania) under climate change scenarios. Catena Journal no: 141 (2016), pp 92–99 doi:10.1016/j.catena.2016.02.018;*
- *Dobrinescu A, Busuioc A, Birsan MV, Dumitrescu A (2015) Changes in thermal discomfort indices in Romania and responsible large-scale mechanisms. Climate Research 64(3): 213–226. DOI: 10.3354/cr01312;*
- *Dumitrescu A, Bojariu R, Birsan MV, Marin L, Manea A (2015) Recent climatic changes in Romania from observational data (1961-2013). Theoretical and Applied Climatology 122(1-2): 111–119. DOI: 10.1007/s00704-014-1290-0;*
- *Manea A, Birsan MV, Tudorache G, Cărbunaru F (2016) Changes in the type of precipitation and associated cloud types in Eastern Romania (1961-2008). Atmospheric Research 169: 357–365. DOI: 10.1016/j.atmosres.2015.10.020;*
- *Marin L, Birsan MV, Bojariu R, Dumitrescu A, Micu DM, Manea A (2014) An overview of annual climatic changes in Romania: trends in air temperature, precipitation, sunshine hours, cloud cover, relative humidity and wind speed during the 1961–2013 period. Carpathian Journal of Earth and Environmental Sciences 9(4): 253–258;*
- *Micu DM, Dumitrescu A, Cheval S, Birsan MV (2015) Climate of the Romanian Carpathians. Variability and trends. Springer International Publishing. DOI: 10.1007/978-3-319-02886-6;*
- *National Strategy on Climate Change and Low-Carbon Economic Growth, Project co-financed from the European Regional Development Fund under the Operational Program Technical Assistance 2007 – 2013*

- *National Action Plan on Climate Change 2016 – 2020* (<http://www.mmediu.gov.ro/categorie/planul-national-de-actiune-privind-schimbarile-climatice-2016-2020/122>) ;
- OPERA-CLIMA - Climate Change and Low Carbon Green Growth Program (<http://www.worldbank.org/en/country/romania/brief/romania-climate-change-and-low-carbon-green-growth-program>) ;
- Papathoma-Koehle M., Promper C, Bojariu R, Cica R, Sik A, Perge K, Laszlo P, Czikora EB, Dumitrescu A, Turcus C, Birsan MV, Velea L, Glade T., 2016: A common methodology for risk assessment and mapping for south-east Europe: an application for heat wave risk in Romania, *Nat Hazards*, 82, pp. 89-109, doi 10.1007/s11069-016-2291-3;
- Velea L., Bojariu R., Cică R., 2014: Occurrence of Extreme Winds Over the Black Sea During January Under Present and Near Future Climate. *Turkish Journal of Fisheries and Aquatic Sciences* 14: 1-2. DOI:10.4194/1303-2712-144_17;
- Velea, L., M.T. Udristioiu, R. Bojariu, S.C. Sararu and L.A. Prunariu, 2017: The influence of Climate Conditions on the Mortality Related to Cardiovascular Diseases in Dolj County (Southern Romania). AIP Conf. Proc., DOI: 10.1063/1.4972381;
- World Bank. 2014. *Romania - A Risk Analysis and Screening Approach for Climate Change Mitigation and Adaptation Options: A Tool for Climate Action Planning*. Washington, DC. © World Bank. <https://www.openknowledge.worldbank.org/handle/10986/21811>;
- World Bank. 2015. *Romania - 2016-2020 National action plan on climate change: summary report. Dissemination note*. Washington, D.C.: World Bank Group. <http://documents.worldbank.org/curated/en/254931468188327164/Romania-2016-2020-National-action-plan-on-climate-change-summary-report>;
- Xie, Jian. 2014. *Romania - Climate change and low carbon green growth program: summary of sector rapid assessments and recommendations for incorporating climate actions in the 2014-2020 sectoral operational programs - component B synthesis report*. Washington, DC; World Bank Group. <http://documents.worldbank.org/curated/en/961771468094456331/Romania-Climate-change-and-low-carbon-green-growth-program-summary-of-sector-rapid-assessments-and-recommendations-for-incorporating-climate-actions-in-the-2014-2020-sectoral-operational-programs-component-B-synthesis-report>.