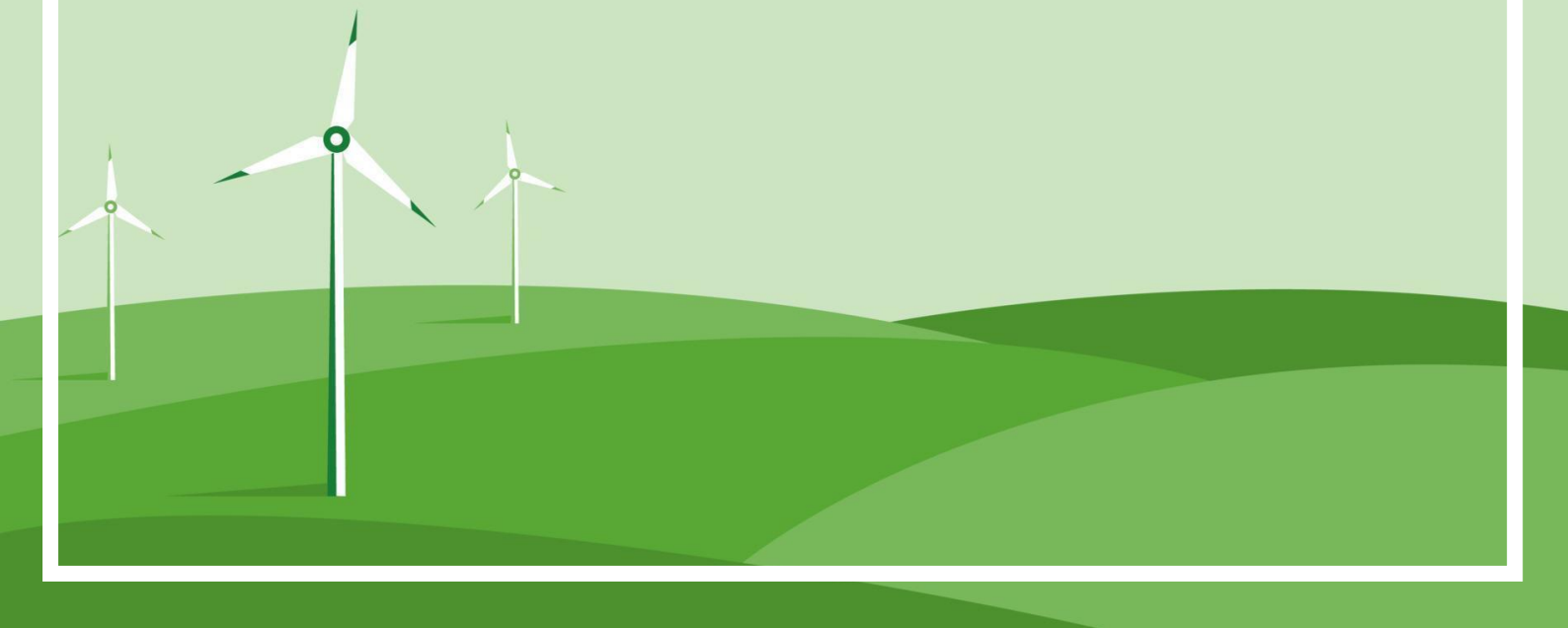
THE THIRD NATIONAL COMMUNICATION OF THE REPUBLIC OF SERBIA TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE



Contents

Summary

The Republic of Serbia has been a party to the United Nations Framework Convention on Climate Change (hereinafter: Convention, UNFCCC) since 2001 and Party to the Paris Agreement since 2017.

The Ministry of Environmental Protection (hereinafter: MEP) is accountable for coordinating the process of drafting and preparing national reports and Biennial Update Reports (BURs). MEP is the accountable institution in terms of fulfilment of obligations under the UN Framework Convention on Climate Change and the Paris Agreement. The Serbian Environmental Protection Agency (hereinafter: SEPA) is accountable for establishing and maintaining the greenhouse gas inventory, as well as preparing greenhouse gas inventory reports.

In June 2015, the Government of the Republic of Serbia submitted its Intended Nationally Determined Contributions, containing a part related to losses and damages caused by extreme weather events and indicates the need for adaptation to impacts of climate change. With it's 2022 updated Nationally Determined Contributions (NDC), in accordance with Articles 3 and 4 of the Paris Agreement and paragraphs 22 and 24 of Decision 1 CP21, the Republic of Serbia is increasing its ambitions to the GHG emission reduction by33.3% by 2030 (without the LULUCF sector) compared to 1990 emission levels. The Law on Climate Change ("Official Gazette of the RS", No 26/21) and the Low Carbon Development Strategy of the Republic of Serbia for the period 2023-2030, with projections until 2050 ("Official Gazette of the RS" No 46/23) were adopted, as well as the Climate Change Adaptation Programme for the period 2023-2030 ("Official Gazette of the RS", No. 119/23) (hereinafter: Adaptation Programme).

The Law on Climate Change provides the basis for the establishment of monitoring, reporting and verification (MRV) system, i.e. implementation of activities on mitigation and adaptation to climate change, including the Low Carbon Development Strategy for the period 2023-2030, with projections until 2050 (hereinafter: the Strategy) and the Climate Change Adaptation Programme for the period 2023-2030, with its Action Plan. At the same time, institutions, their roles and competencies, as well as procedures for the exchange, collection and submission of data, are subject of bylaws.

The Initial National Communication of the Republic of Serbia to the UN Framework Convention on Climate Change was submitted in 2010; the Second National Communication to the UNFCCC was submitted in 2017; the First Biennial Update Report of the Republic of Serbia to the UNFCCC (FBUR) was submitted in 2016, and the Second Biennial Update Report of the Republic of Serbia to the UNFCCC was adopted in November 2023.

The Third National Communication of the Republic of Serbia to the UNFCCC (TNC) was developed in accordance with Articles 4.1 and 12.1 of the United Nations Framework Convention on Climate Change and guidance for preparing the national communications of non-Annex I Parties (Decision 17 / CP.8).

All reports were prepared with the financial support of the Global Environment Facility (GEF), while the United Nations Development Program (UNDP) was the implementing agency, and are available on the national website: www.klimatskepromene.rs.

Although there has been progress in reporting and meeting theobligations under the Convention, there is still a need to enhance the legal, procedural and institutional frameworks for reporting on climate change, including the preparation of BURs and national reports. The integration of climate change aspects in sectoral policies and measures, as well as in the national development goals, remains inadequate, as does the capacity of policy makers at national and local government level to recognize the importance of addressing this issue.

The following bylaws were adopted pursuant to the Law on Climate Change: Regulation on Types of Data, Bodies and Organizations

and Other Natural and Legal Persons that Submit Data for the Preparation of the National Inventory of Greenhouse Gases ("Official Gazette of the RS" No 43/23); and the Rulebook on the Content of the GHG National Inventory and of the National Report on the GHG National Inventory ("Official Gazette of the RS" No 55/23) in June 2023.

International institutions and donors, including the Global Environment Facility (GEF), the Green Climate Fund, the EU and others are providing Serbia with much-needed support for combating climate change. The implementation of further activities also requires GEF support in the field of regular reporting, and the Green Climate Fund for activities to achieve NDC goals.

National Circumstances

The Republic of Serbia is an independent democratic state (since 2006) with a multi-party parliamentary system. It has been an EU candidate country since March 2012.

Serbia is a landlocked continental country. 75% of its territory is on the Balkan Peninsula, and 25% is in Central Europe. The northern part of Serbia consists of plains (Pannonia lowlands), and the southern part of hills and mountains.

The estimated population in 2022 was 6,647,003 of which 51.4% women and 48.6% men. The population in 2022 was lower by 495,975 than in the 2011 Census[1].

Cardiovascular diseases and malignant tumours accounted for over two-thirds of the causes of death in 2019. More than half of all deaths (51.6%) were due to circulatory system diseases, and one in five (21.0%) were due to a malignant tumour.

Serbia's climate is continental in the north, moderate continental in the south and alpine in the high mountains. Winters in Serbia are short, cold and snowy, while summers are warm. With its median air temperature of 11.4ºC, 2021 was the sixteenth warmest year in Serbia between 1951 and the present, and with 13,7 ºC it was the twelfth warmest year in Belgrade since the meteorological station started operation in 1888. Thirteen of the fifteen warmest years in Serbia and fourteen in Belgrade were registered after the year 2000.

Serbia is highly water-stressed country characterized by: very unfavourable spatial availability (those parts that have the greatest need for water also have the most severe scarcity), unfavourable time distribution (among the most unfavourable in Europe) which practically prevents the use of water without accumulation and a small proportion of surface and groundwaters with water resource characteristics. This situation is further compounded by observed and expected climate change effects. A large part of the territory is at risk of flooding, the risk of potential flooding also exists where protective systems have been built. Erosion processes pose a threat to approximately 90% of the national territory.

The economy consists of: banking and insurance; wood industry; energy; construction industry; creative industry; chemistry, pharmacy, rubber and non-metals; IT; utilities; metal and electrical industry; agriculture; metal mines and metallurgy; transportation; textile and leather; trade; tourism and hospitality, and private security.

The energy sector consists of the oil and gas industries, coal mines, electrical power system, the decentralized district heating system and industrial energy. According to the Statistical Office of the Republic of Serbia 2021 Energy Balance, 38.2 billion kWh of electricity were generated in Serbia in 2021, while consumption was at 29.2 billion kWh. Most of the electricity is generated in thermal power plants (62% of electricity), 31% in hydro power plants, 3% in wind power plants, with the rest generated in thermal power plants, heating plants and other electricity generation capacities. Although the annual electricity generation capacity is on average mostly sufficient, the Statistical Office of the

[1] https://publikacije.stat.gov.rs/G2023/pdf/G20232056.pdf

Republic of Serbia 2021 Energy Balance reports that a certain small quantity of electricity was exported in 2021 (net export was 651 GWh, or 1.7% of electricity generated). Household electricity consumption is very high in the Republic of Serbia compared to the EU average (+18.7%), mostly due to the use of electricity for heating and a very low level of energy efficiency.

The share of industry in gross domestic product (GDP) is about ¼ GDP. Food production is one of the most important production sectors and accounts for about 15% of GDP in industry.

The share of transport in the gross domestic product was 3.4% in 2021. Transport includes transport by road, rail, water and air. Air transport recorded the highest increase of services in transport (63.4%), followed by rail (21.7%), road (16.2%) and urban transportation (18.6%). 2,235,794 passenger vehicles were registered in 2021.

The share of agriculture, forestry, and fishery sectors was 6.3% of the GDP in 2021. In 2021, the share of crop production in the total value of agricultural production equalled 68,4% and that of livestock production equalled to 31,6%. According to 2012 data, only 2.9% of the total area of used agricultural land is being irrigated.

Artificial surfaces, forest and seminatural areas, as well as water body surfaces have increased, while there is a decrease in agricultural areas and wetlands in the reference period. The Spatial Plan of the Republic of Serbia (2010-2020) identified the optimum level of forest cover at 41.4%[2]. A total of 2,254,000 ha of land in Serbia are under forests according to the First National Forest Inventory, while, according to the preliminary data of the Second National Forest Inventory, a total of 3,049,502.10 ha of land are under forests. Preliminary data of the Second National Inventory show a change in the structure of ownership of forest land – while state-owned forests dominated over private forests according to the First National Inventory (53% vs. 47%), the Second National Inventory indicates that 57.5% of the forests are now privately owned, while 42.5% of them are state owned. Approximately 143,007 m^3 of wood volume in state forests were damaged in 2020, out of which man-made disasters caused damage to 26,000 m^3. Natural disasters (wind, rain, hail and snow) caused damage around 75,000 m^3 of the wood volume, accounting for approximately 53% of all damages occurring in state-owned forests. In state-owned forests 26 forest fires registered in 2020 and caused damage to 3,525 m^3 of wood volume. In 2020, pest diseases caused damage around 26,000 m^3 of wood volume in state-owned forests. In 2021, 34 fires were registered in state-owned forests, causing damage of 3,360 m^3 to the wood volume. Damage from pest diseases in state-owned forests amounted to approximately 45,000 m^3 in 2021.

The total volume of generated municipal waste was 2,947,496 tonnes in 2020. Of the total amount, 444,274 tons of materials were recycled and 11,183 tonnes of waste were subjected to composting and digestion. 2,819,629 t of total generated waste were disposed of or reused.

Economic activity sectors generated 69.6 million tonnes of waste during 2021 in the Republic of Serbia. A total of 64.5 million tonnes of waste were treated, whereby 16.7% more waste was recycled compared to the previous year.

Wastewater is one of the main polluters of surface and groundwater, which are natural sources of drinking water. This especially holds true for industrial waste and landfill leachate much of which remain untreated. Wastewater mainly comes from households (67%), much less from the industry (19%), while 14% is generated by other users.

Estimates indicate that extreme climate and weather events alone caused a total material damage of EUR 6.8 billion during the period from 2000 to 2020.

[2] Pursuant to the Law on Forests ("Off. Gazette of the RS" No 30/10, 93/12, 89/15 and 95/18 - oth. law).

Greenhouse Gas Inventories

Greenhouse Gas Inventories (hereinafter: GHG inventories) for the 1990 and 2021 period include CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 and NF_3, and have been prepared in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and its 2019 Refinement. Tier (Level) 1 Method and emission factors recommended in the IPCC Guidelines were used for all fossil fuels (solid, liquid and gaseous) except domestic low calorific open-pit lignite.[3] Tier 2 method was applied to the categories: Product uses as substitutes for ODC and Manure management. The Global Warming Potential (GWP) from the IPCC Assessment Report 5 was used. A number of improvements have been made compared to the previously submitted GHG Inventories.

In 2021, total GHG emissions without Land Use, Land-Use Change and Forestry (LULUCF) stood at 62,185 Gg CO_2 eq, and 58,004 Gg CO_2 eq with LULUCF, which represents a decrease of 2.5% compared to 2010 and 24.8% compared to 1990, respectively. 79.1% of total GHG emissions originated from the energy sector, 8.1% from the sector of industrial processes and product use, including production and consumption of mineral raw materials (such as cement, lime, limestone and sodium carbonate, production of chemicals, especially production of ammonia, iron and other metals and other products), 7.6% from the agriculture sector, and 5.1% from the waste management sector; the ratios are similar and absolute values differ slightly in 2010. In 2021, carbon dioxide (CO_2) accounted for 82.3% of total GHG emissions, methane (CH_4) for 14.2% and nitrous oxide (N_2O) for 32%, and hydro-fluorocarbons (HFCs) and sulphur hexafluoride (SF_6) for 0.4%.

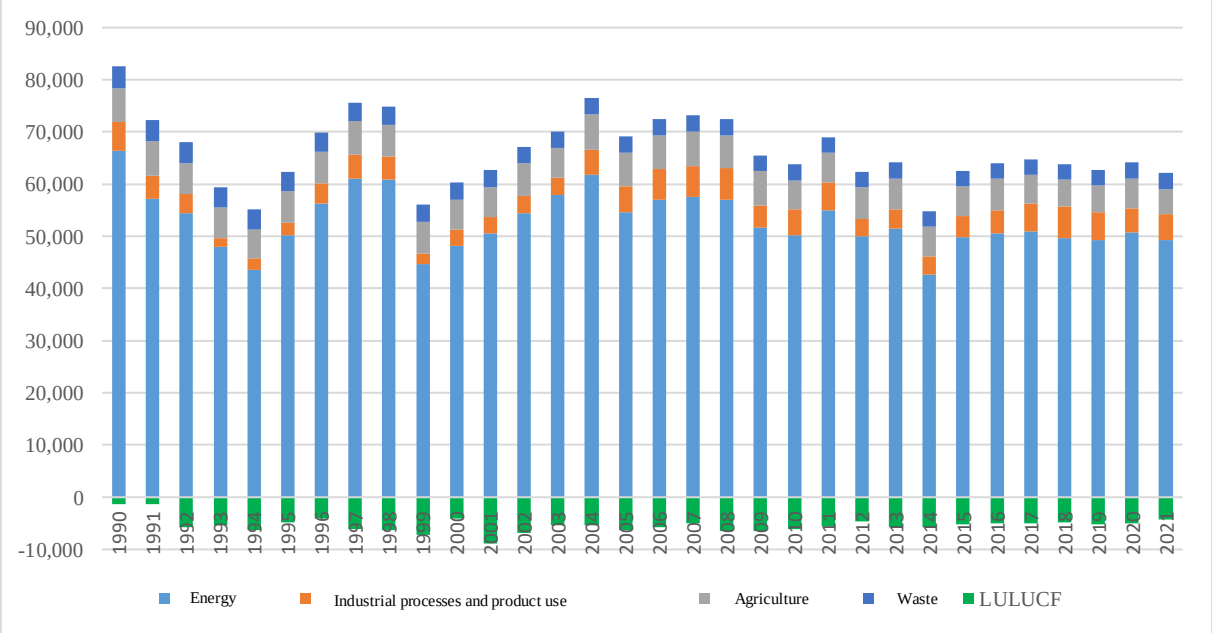


Figure 1: Total GHG emissions and sector contributions in the period 1990-2021 (Gg CO_2 eq)

Emissions from the Energy Sector traditionally contribute the most to GHG emissions. In 2021, emissions were 49,197 Gg CO_2 eq (79.1% of total GHG emissions) and 2.1% less than those in 2010. The Fuel Combustion Activities subsector is the primary contributor in the Energy Sector emissions, with 95.6% of emissions. In 2021, emissions from Industrial Processes and Product Use sector totalled 5,064 Gg CO_2 eq (8.1% of total emissions) and increased by 1.9% compared to 2010 . Emissions from the agriculture sector in 2021 stood at 4,733 CO_2 eq. showing a decline since 2008 (14.8% lower

[3] Annex I of the First National Communication of the Republic of Serbia in accordance with the United Nations Framework Convention on Climate Change: Net Thermal Power Value and Emission Factor for Low-Calorie Lignite from Surface Mining in the Republic of Serbia.

than 2010 emissions). Land Use, Land-Use Change and Forestry (LULUCF) represented a sink of 4,181 CO_2 eq in 2021 and was followed by a 31% decrease compared to 2010, while emissions from the Waste Management sector were 3,192 Gg CO_2 eq (5.1% of total GHG emissions), increased by 5.2% compared to 2010.

For 2021, 18 key categories were identified excluding LULUCF, i.e. 22 key categories including LULUCF, while trend assessment identified a total of 23 key categories excluding LULUCF, i.e. 29 key categories including LULUCF. Category disaggregation was aligned with CRF Table 7.

The estimated uncertainties of the 2021 emissions inventory stood at 9.5%, uncertainty trend stood at 2.0%, and combined GHG inventory uncertainty stood at 8.7% excluding LULUCF, while the uncertainty trend stood at 1.9%.

Priorities in the field of GHG monitoring and reporting include providing financial, technical, and capacity building assistance to improve the quality of activity data, develop national emission factors, supporting methodologies and the establishment of electronic data exchange mechanisms relevant to inventory development and improvement.

GHG Emission Reduction Potentials and Opportunities

GHG Emission Reduction Potentials and Opportunities until 2030 and 2050 were identified in the Strategy, and a detailed approach to implementing measures to achieve its goals and objectives will be outlined in the Action plan. This report presents opportunities for reducing GHG emissions until 2050, identified using three scenarios:

- → **Without measures (WOM)** or Baseline (Business as usual, BaU) - Excludes all policies and measures implemented, adopted, or planned after 2015;
- → **With measures (WEM)** - Considers policies and measures envisaged in the adopted Strategy; and
- → **With Additional Measures (WAM)** - reduction of GHG emissions by 80% compared to 1990.

The implementation of the WAM scenario (additional action compared to WEM) is possible with full financial, technological, and technical assistance of the international community. GHG emission levels by 2070 have also been estimated.

The overall emission reduction potential in 2050, excluding LULUCF, compared to 2010 is 10.7% if applying the WOM scenario; it is 55.0% if applying the WEM scenario, and 69.1%. if applying the WAM scenario. Emissions by gas for all scenarios (BaU, WEM and WAM) are:

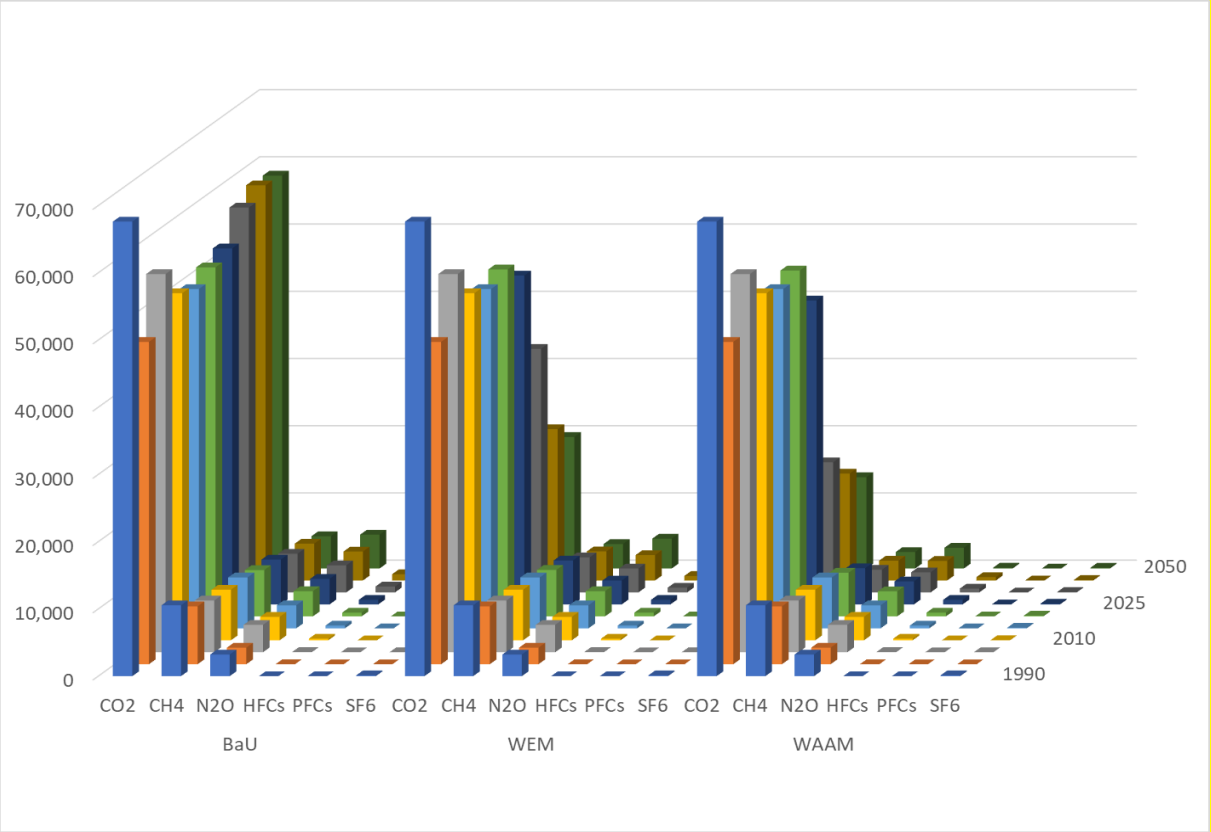


Figure 2: GHG emissions projections by gases and scenarios

The actions, policies and measures to reduce GHG emissions are presented below, followed by those needed to achieve WEM and WAM scenario objectives and are supplementary to those already presented in the Second Biennial Update Report; the costs of their implementation have been split into those for investors, consumers and the state, and are expressed as additional to WOM.

Additional costs compared to WOM /BaU for the period 2020-2030 (million €)	Total	Investors	Consumers	State
WEM	6,511	2,165	4,079	267
WAM	18,854	4,117	10,305	4,432

Additional costs compared to WOM /BaU for the period 2030-2050 (million €)	Total	Investors	Consumers	State
WEM	37,822	9,768	25,596	2,459
WAM	76,792	23,075	48,768	4,949

Climate Change, Impact and Adaptation

The mean temperature increase in the territory of the Republic of Serbia during the period between 2011-2020 was 1.8°C, and during the summer mean maximum temperatures exceeded those recorded between 1961-1990 by as much as 2.6°C. It is expected that by the mid-century (2041-2060), mean

temperatures will rise by approximately 3.1°C. Under the RCP4.5 scenario, climate change is expected to slow down in the latter half of the century, whereas change will be more severe under RCP8.5 scenario, which foresees a rise in mean temperatures by 5.8°C in the period 2081-2100. The most significant increase in extreme weather events was perceived in the rising frequency and intensity of heat waves, extreme rainfall, and droughts. There is a consequential increase in other climate-related hazards such as flooding, landslides, conditions conducive to outbreaks and the spread of fires, etc.

In order to ensure effective planning and implementation of sustainable adaptation measures, adaptation planning considered not only climate conditions but also the interdependencies of processes within the climate system and cross-sectoral dependencies. In addition to climate analyses, water and soil impact analyses were conducted based on available data and revealed significant impacts on soil degradation and the availability of water resources under future climate conditions. Moreover, it was recognised that increasing environmental pollution (air, soil and water) significantly impacts the system sensitivity to climate change, leading to increased vulnerability and climate change-related risks.

The Ministry of Environmental Protection has developed the Climate Change Adaptation Programme for the period 2023-2030, with Action Plan for the period 2024-2026 as an integral part of the Programmethat is aiming to identify climate change impacts on various sectors and systems and to define adaptation measures for those sectors and systems in need for reduction of adverse impacts; that the Government of the Republic of Serbia adopted on 25th December, 2023 and which will be submitted to the Convention Secretariat.

Recommendation for measures that need to be implemented to set up a functioning climate change adaptation process were developed from comprehensive climate analyses, impact assessments and climate change impacts on the population and economic sectors, and were based on science-based methodologies. Within the Programme, the creation of mechanisms to implement a sustainable adaptation process involves measures that systemically provide for the implementation of climate change adaptation across all sectors affected by climate change; measures identifying urgent intervention needs to safeguard against inevitable impacts; measures enabling tailoring of the actual adaptation process to future climate conditions through provision of new data and analyses, and ensuring their rapid deployment in practice.

According to the revised Nationally Determined Contribution, the minimum total sum of material damages caused by extreme climate and weather events between 2000 and 2020 amounts to EUR 6.8 billion, with more than 70% of these damages were caused by drought and high temperatures. Other cause of damage are floodings. However, it was challenging to assess the actual amounts of damages due to the insufficiently developed impact monitoring system, therefore, there is a crucial need to develop a comprehensive monitoring system that incorporates regular information collection on damages and losses and deducing whether these damages are indeed attributed to climate change.

Agriculture, forestry, infrastructure, urban development, health, and biodiversity are identified as the sectors most affected by climate change at the national level. Activities contributing to disaster risk reduction were also planned on top of special measures planned in accordance with a sector's vulnerability and available vulnerability data, prioritising an increase in the safety of citizens. To achieve this goal, a significant upgrade of the notification and warning system is planned, which includes developing advanced weather projections and ensuring efficient dissemination of information and recommendations for timely activities that citizens can undertake to protect themselves, their property, and businesses. The systemic implementation of adaptation efforts involves the so-called multiscalar approach (operating across different spatial levels), or scaling down from national sectoral policies to local sectoral policies.

1. NATIONAL CIRCUMSTANCES

1.1. Fulfilment of obligations under the UN Framework Convention on Climate Change and the Paris Agreement

The Republic of Serbia has been a party to the United Nations Framework Convention on Climate Change since 2001, and ratified the Paris Agreement in 2017.

The Government of the Republic of Serbia submitted its Intended Nationally Determined Contributions in June 2015 and adopted the revised Nationally Determined Contributions in August 2022 by which Republic of Serbia increases its ambitions in terms of reducing greenhouse gas emissions by 13.2% compared to 2010 levels (or 33.3% when compared to 1990) by 2030.

The Law on Climate Change was adopted in 2021, setting up a functional, precise, accurate, and consistent system of monitoring, reporting and verification (MRV).

The Low Carbon Development Strategy of the Republic of Serbia for the period 2023-2030, whith projections until 2050, was adopted in 2023. The Integrated National Energy and Climate Plan is concurrently being developed to define the path to carbon neutrality in accordance with the Strategy, setting energy efficiency and renewable energy source goals by 2040.

The Climate Change Adaptation Programme for the period 2023-2030, with accompanying Action Plan for the period 2024-2026 is being developed within the project: "Advancing medium and long-term adaptation planning in the Republic of Serbia", funded by the Green Climate Fund, aiming to establish systematic, transparent and regular planning, monitoring and reporting on adaptation to climate change, but also to provide capacity building, knowledge enhancement, and research opportunities in the fields of vulnerability and adaptation.

Recognizing the need to adapt to climate change at the local level, the Ministry of Environmental Protection has initiated activities for the preparation of local climate change adaptation plans. Two local climate change adaptation plans were developed, for the Municipality of Bečej and the City of Belgrade. The development process aimed to identify impacts and risks and priority adaptation measures, but also to raise knowledge and strengthen local governments' capacities and more efficiently linking the activities on disaster risk reduction and climate change adaptation. The development of these two local adaptation plans showed that, despite similar changes in climate parameters, the priorities of adaptation are conditioned by a number of factors characteristic for a specific area, i.e. local self-government. Also, there is a lack of knowledge and capacity at the local self-government level, which needs to be approached systematically. In addition, local self-governments are the key to efficient networking and coordinating work and activities to reduce the risk of adverse weather events and natural disasters and for adaptation to the climate change.

The "Strengthening Serbia's capacities for strategic engagement of private sector into climate financing" project was implemented with an awareness of the need to include private investment in reducing GHG emissions and climate change risks. The project was implemented with the financial support of the Green Climate Fund and in cooperation with the Food and Agriculture Organization. In addition to involving the private sector in funding, the project aimed to identify potential national bodies that could be accredited for the implementation of Green Climate Fund projects, as well as the preparation of project documents for applications to this fund.

The GEF/UNDP "Capacity-building Initiative for Transparency - CBIT" project was completed in 2021. The goal of this project was to strengthen national capacities and ensuring the sustainability of climate change reporting.

Although some progress was made in reporting and meeting the obligations under the Convention, the need to improve the legal, procedural and institutional frameworks for reporting on climate

change, including the preparation of biennial reports and of national communication, remains. The inclusion of climate change aspects in sectoral policies and measures, as well as in the national development goals, remains low, as do the capacities of national and local self-government level policy makers on the importance of this issue.

The Republic of Serbia submitted the Initial National Communication (INC) to the United Nations Framework Convention on Climate Change in 2010; the Second National Communication (SNC) to the UN Framework Convention on Climate Change in 2017; the First Biennial Update Report of the Republic of Serbia (FBuR) to the UN Framework Convention on Climate Change in 2016, and the Second Biennial Update Report of the Republic of Serbia to the UNFCCC was adopted in November 2023.

The Third National Communication (TNC) to the United Nations Framework Convention on Climate Change was prepared in accordance with the provisions of Articles 4.1 and 12.1 of the Convention, the Guidelines for the preparation of national communication for non-Annex I Parties to the Convention (Decision 17/CP.8).

All the reports were prepared with the financial support of the Global Environment Facility (GEF), with the United Nations Development Program (UNDP) as the implementing agency.

1.2. Socio-Political Organisation

The Republic of Serbia is an independent democratic state (since 2006) with a multiparty parliamentary system. In March 2012. Serbia was granted the status of a European Union (EU) candidate country.

The political system is based on the principle of division of power into executive, legislative and judicial branches. The National Assembly (250 MPs) is the holder of legislative power, the Government is the holder of executive power, and the Constitutional Court is the holder of judicial power.

Apart from Serbs (80.6%), the most numerous minorities are Hungarian (2.8%), Bosniak (2.3%) and Roma (2%). According to the 2022 Census, the estimated population was 6,647,003, with women accounting for 51.4% and men for 48.6%. The total population decreased by 495,975, or 6.9%, compared to the 2011 Census. The average age of the population according to the 2022 Census is 43.9, which places Serbia among the oldest countries demographically, not only in Europe but globally as well. According to 2021 vital statistics data, the population growth rate stood at -10.9‰. Birth rate is 9.1‰, and the death rate is at 20,0‰.

The largest cities are Belgrade (capital), Novi Sad, Niš and Kragujevac.

1.3. Geographical Characteristics

Serbia is a landlocked continental country. 75% of the territory belongs to the Balkan Peninsula, and 25% to Central Europe, occupying a total area of 88,499 km^2 (including the territory of Kosovo and Metohija* UNSC Resolution 1244 of 1999 refers to). In terms of area, it ranks 111^{th} in the world.

The northern part of Serbia consists of plains (Pannonia lowlands), while the southern part is characterized by hills and mountains. The largest part of the Pannonia Basin is at an altitude below 200 m. Over 30 mountain peaks are over 2,000 m, with the highest peak Đeravica in the Prokletije mountain (2,656 m). The lowest point in Serbia is located on the border with Romania and Bulgaria, at the confluence of the Timok and the Danube rivers (28-36 m).

1.4. Climatological Characteristics

Serbia's climate is continental in the north, moderate continental in the south and alpine in the high mountains. Winters in Serbia are short, cold and snowy, while summers are warm.

The coldest month is January, and the warmest month is July. The mean annual temperature ranges from 10.3ºC in Požega to 13.7ºC in Belgrade, and between 4.3ºC on Kopaonik and 8.7ºC in Zlatibor in the highlands. Annual average rainfall increases with altitude. The annual sum of precipitation varies between 540.5 mm in Kikinda and 901.3 mm in Dimitrovgrad, and between 709.0 mm in Crni Vrh and 1130.5 in Kopaonik in the highlands. Observing the period between 1951-2021, January was identified as the rainiest month. The frequency of years with droughts in the territory of the Republic of Serbia between 2001-2020 was 40%. Over the last few decades, drought has become more frequent, and more precipitation occurs during more intense precipitation events.

The annual duration of solar radiation in Serbia ranges from 1,500 to 2,200 hours per year. During the warmer part of the year, winds from the northwest and west prevail. In the colder part of the year, the east and southeast Košava wind dominates. Winds from the southwest prevail in the mountainous areas of southwestern Serbia.

With a mean air temperature of 11.4ºC, 2021 was ranked as the sixteenth warmest year in Serbia between 1951 and the present, and with 13.7 ºC it was the twelfth warmest year in Belgrade since the meteorological station has been in operation (since 1888). Thirteen of the fifteen warmest years in Serbia and fourteen in Belgrade were registered after the year 2000.

1.5. Hydrology and Water Resources

Serbia is a very water-stressed country, facing several challenges such as: very unfavourable spatial availability (the areas that have the greatest need for water are also experiencing the most scarcity), unfavourable time distribution of water (among the most unfavourable in Europe) which practically prevents the use of water without accumulation and a small share of surface and groundwater resources with water resource characteristics. This situation is further exacerbated by observed and expected climate change.

From the territory of the Republic of Serbia, the waters gravitate towards: the Black Sea (over 92.5%), the Adriatic Sea and the Aegean Sea. The Danube is the longest river and its course through Serbia is 588 km long (of its 2,783 km).

Groundwater is the primary source of water supply for approximately 70% of the population of Serbia, with about 81% connected to public water supply systems. In 2019, 25% of the public water supply in urban settlements was physically and/or chemically contaminated, while 23.8% of public water supply lines indicated microbiological water contamination.

Almost 75% of the population lives in settlements with more than 2,000 inhabitants, where the average level of connection to public sewerage system is about 72%, while approximately 27% have individual sewerage systems (septic tanks). In settlements with less than 2,000 inhabitants, the connection to public sewerage systems is less than 5%. Less than 10% of the population has access to some form of wastewater treatment. Wastewater is primarily generated by households (67%), of which only 14.1% undergoes treatment, and 19% from industry. Approximately 57% of industrial plants lack wastewater treatment, and around 50% of industrial wastewater samples do not meet the required wastewater quality standards.

A large part of the territory is endangered by floods, the risk of potential flooding also exists where protective systems have been built. The most severe situations occur in the basins of smaller watercourses. Erosion processes threaten approximately 90% of the state territory. The most common is very weak erosion (category B) affecting about 48% of the surface. The basins of Pčinja and Dragovištica are the most endangered by erosion, as along with the basin of South Morava, while the

area of Vojvodina is the least threatened. The Republic of Serbia's Water Management Strategy for the period up to 2034 identifies climate change as a significant factor in the field of water management, particularly in terms of maintaining the water regime, especially in the future as an increase in the frequency of flood events and arid periods is expected as a consequences of changing temperature and precipitation regimes.

1.6. Health System and Health Care[4]

Health care is directly carried out through the network of health care institutions, of which there were 350 in 2019.

Cardiovascular diseases and malignant tumours accounted for over two-thirds of the causes of death in 2019. More than half of all deaths (51.6%) were due to circulatory system diseases, and one in five (21.0%) were due to malignant tumours. The structure of morbidity of the adult population in 2019 was dominated by: diseases of the circulatory system with 17%; diseases of the respiratory system with 15% and diseases of the musculoskeletal system and connective tissue with 9%. In the case of the working population, this percentage is the same, except in the case of diseases of the circulatory system (15%). In preschool children, the most commonly registered diseases are: diseases of the respiratory system with 40%; symptoms, signs and pathological clinical and laboratory signs with 8%; and infectious and parasitic diseases with 7%. In school children, respiratory diseases account for 37%; symptoms, signs and pathological clinical and laboratory signs 10%; and infectious and parasitic diseases 8%.

1.7. Economic Characteristics

The economy consists of: banking and insurance; wood industry; energy; construction industry; creative industry; chemistry, pharmacy, rubber and non-metals; IT; utilities; metal and electrical industry; agriculture; metal mines and metallurgy; transportation; textile and leather; trade; tourism and hospitality, and private security.

The Gross domestic product (GDP) was nominally higher by 13.9% compared to the previous year, and in real terms it increased by 7.5%. When observed by economic activity, the most relevant stakeholders in GDP formation in 2021 were the process manufacturing industry sector with 13.0%, wholesale and retail trade and servicing of motor vehicles with 11.8%, the real estate sector with 6.8%, agriculture, forestry and fisheries sector with 6.3%, and the construction sector with 6.0%.

The most significant macroeconomic indicators for the period 2010 - 2021 are shown in Table 1.1.

Table 1.1: Most important macroeconomic indicators

Macroeconomic indicators	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
GDP in mil. EUR	31,546	35,432	33,679	36,427	35,467	35,716	36,723	39,183	42,780	46,005	46,815	53,329
GDP per capita in EUR	4,326	4,896	4,677	5,083	4,974	5,034	5,203	5,581	6,127	6,624	6,786	7,803
% BDP growth	0.70	2.00	-0.70	2.90	-1.60	1.80	3.30	2.00	4.30	4.3	-0.9	7.5
Export of goods and	9,515	11,145	11,469	13,937	14,451	15,728	17,385	19,312	21,238	17,536	17,055	21,404

[4] STATISTICAL YEARBOOK OF HEALTH OF REPUBLIC OF SERBIA 2019; http://www.batut.org.rs/index.php?content=279

services in mil. EUR												
Import of goods and services in mil. EUR	14,244	16,487	16,992	17,782	18,096	18,643	19,597	22,343	25,392	23,875	22,958	28,468
Employment rate (15- 64) %	47.1	45.4	45.3	47.4	50.7	52.0	55.2	57.3	58.8	60.7	61.3	62.2
Unemployment rate (15-64) %	20.0	23.6	24.6	23.0	19.9	18.3	15.9	14.1	13.3	10.9	9.5	11.4
Average net income in RSD	34,142	37,976	41,377	43,932	44,530	44,432	46,097	47,893	49,650	54,919	60,073	65,864
Foreign direct investment in mil. EUR	1,278	3,544	1,009	1,548	1,500	2,114	2,127	2,548	3,464	3,815	3,039	3,886

The risk of poverty rate was 21.2% in 2021, and was lower by 0.5% when compared to 2020. The risk of poverty or social exclusion rate stood at 28.5%, and was lower by 1.3% compared to 2020. Food and non-alcoholic beverages account for the largest share of individual consumption (household expenditure) 34.3%; followed by expenditures for housing, water, electricity, gas and other fuels - 16.4%; as well as transport expenses for 9.1%.

1.8. Energy Sector

The energy sector comprises of the oil and gas industry, coal mines, the electric power system, the decentralized district heating system and industrial energy. “Elektroprivreda Srbije” Public Enterprise (Electric Power Industry of Serbia - EPS) owns most of Serbia’s energy production infrastructure, while the electricity transmission system is operated by the company "Elektromreža Srbije" Public Enterprise (EMS).

In 2021, 38.2 billion kWh of electricity was produced, while 29.2 TWh were consumed. Most of the electricity was produced by thermal power plants (62% of all electricity), 31% by hydro power plants, 3% by wind power plants, with the rest generated by thermal power plants, thermal power stations and other electricity generation capacities. In 2021, natural gas power plants generated 148 GWh of electricity from highly efficient cogeneration, and industrial power plants generated 270 GWh. Transmission and distribution losses amounted to 4,384 GWh in 2021. Primary energy production was 10,176 Mtoe. The primary energy generation structure is presented in Figure 1.1.

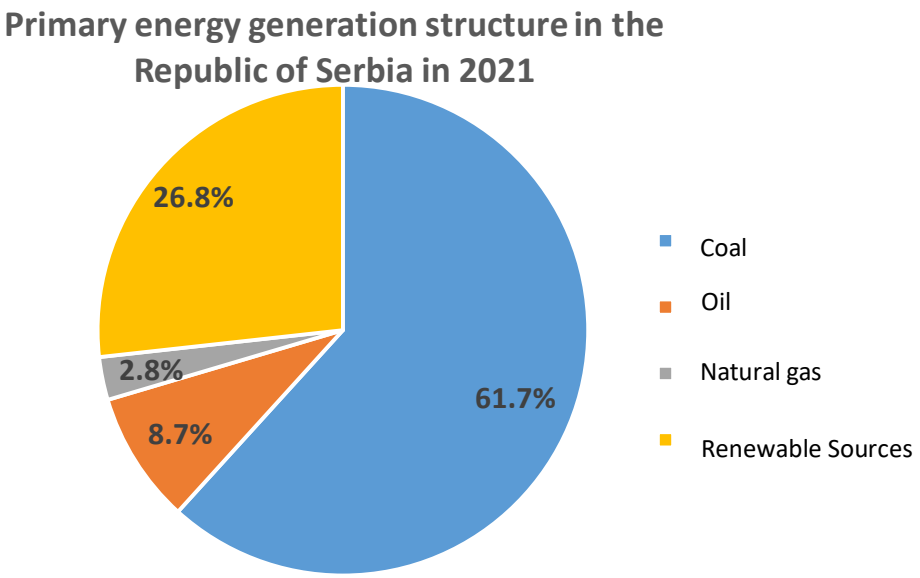


Figure 1.1: Primary energy generation structure in the Republic of Serbia in 2021[5]

In 2021, the total installed RES capacity was 3.524 MW (including large and pumped-storage hydropower plants), of which was approximately 398MW installed net capacity from wind power generation. A total of 550 MW of RES capacities utilized incentives for electricity generation from RES.

Energy available for consumption in 2021 amounted to 9,410 Mtoe (households and other consumers accounting for 46.5%, transportation for 23.4%, industry for 20.9%, non-energy purposes consumption for 7.8% and agriculture for 1.6%). The structure of final energy consumption by energy sources is as follows: petroleum products contribute 29.5%, electricity 27.6%, renewable sources (predominantly biomass) 18.2%, natural gas 9.7%, thermal energy 8.6% and coal 6.2%. Although the annual electricity generation capacity is on average mostly sufficient, a small quantity of electricity was exported in 2021 (net export was 651 GWh, or 1.7% of total electricity generated).). Household electricity consumption in the Republic of Serbia is very high compared to the EU average[6] (+18.7%), mostly due to the use of electricity for heating purposes and a very low level of energy efficiency.

1.9. Industry Sector

The share of industrial production in gross domestic product (GDP) is approximately ¼ GDP. Food production is one of the most important production sectors, contributing to about 15% of GDP within the industry.

In the period 2010-2018, industrial activity increased by 16%, i.e. by 7.3%, 5.2%, 3.9% and 1.3% annually from 2015 onwards. Investments in fixed assets also grew at an average annual rate of 5.5%.

[5] Decision on defining the 2023 energy balance of the Republic of Serbia ("Off. Gazette of the RS" No 144/22)

[6] EU Households consumption of electricity per capita, 2021 (online data codes: nrg cb e, demo pjan)

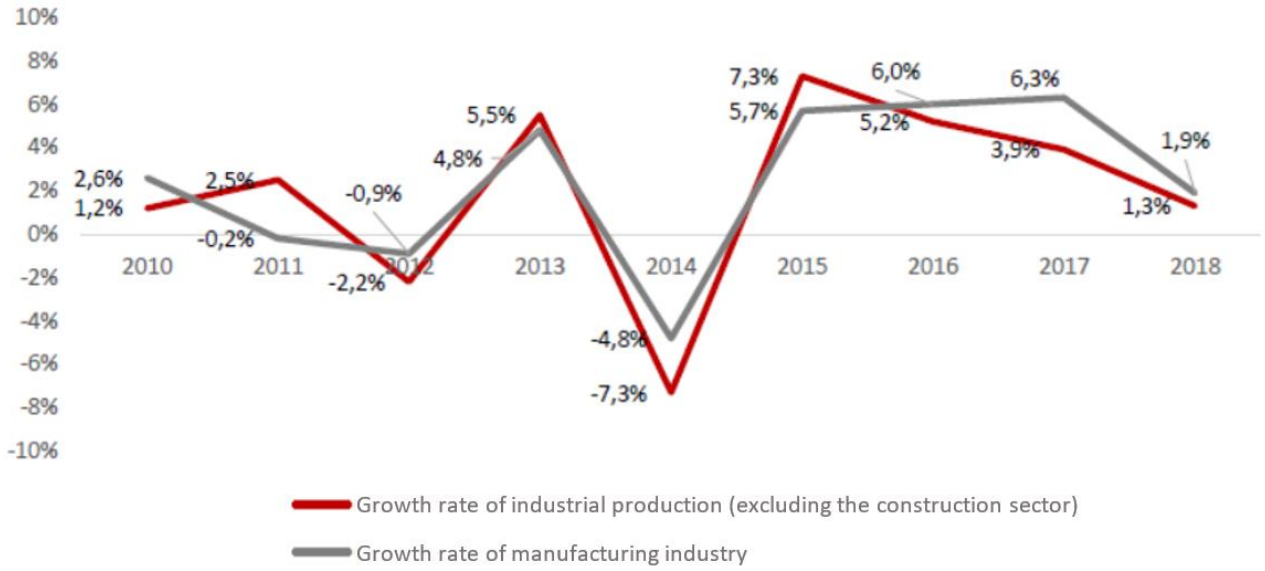


Figure 1.2: Industrial production and manufacturing industry process growth rates between 2010-2018 (excluding the construction sector)

Industrial production in the Republic of Serbia was higher in 2021 by 6.3% when compared to 2020. When compared to 2020, the volume of industrial production in 2021 increased in 22 areas which make up 89% of industrial production, and decreased in 7 areas participating in the industrial production structure with 11%. Observed by sectors and compared to the previous year, the following trends were perceived in 2021: mining sector - 27.6% growth, manufacturing industry - 5.6% growth, electricity, gas, steam and air conditioning supply - 0.7% growth. The data on industrial production by product groups in 2021, compared to 2020, indicate that there was an increase in production of: intermediate goods, except energy (by 13.2%), capital goods (by 11.0%), impermanent consumer goods (by 3.4%) and energy (by 1.6%), while a decline was recorded in the production of consumer durable goods (by 3.0%).

1.10. Transport

The share of transportation in the gross domestic product was 3.4% in 2021. Transport includes transport by road, rail, water and air.

When observed by types of transport, growth was identified in rail 21.7%, road passenger transport 16.2%, air transport 63.4% and urban transport 18.6%.

There was an increase of registered road vehicles across all categories (with the exception of mopeds) in 2021, when compared with 2020.

A total of 2,235,794 passenger vehicles, 10,392 buses, and 268,589 freight vehicles were registered. The transport infrastructure includes 782 km of two lane highway and 3,348 km of railways, of which 1,273 kilometres of railway is electrified.

The most important inland waterway is the Danube (part of Pan-European Corridor VII). Serbia has three airports with certificates and one with an airport license qualified to perform international air transport, as well as 18 airports with an airport license intended for public air traffic or pilot training, and 7 heliports.

1.11. Agriculture

The share of agriculture, forestry, and fishery sector in the GDP stood at 6.3% in 2021. The share of crop production in the total value of agricultural production equalled 68.4%, and that of livestock production equalled 31.6%.

In 2021, arable land and gardens accounted for 75%,, orchards for 5.2%, vineyards for 0.6%, permanent grassland for 9.5% and pastures for 9.5% of all agricultural land. Based on the 2012 Agricultural Census vineyards are present mainly at altitudes below 800 m and are divided into 22 regions, 77 winegrowing areas and a number of vineyard oases. In the structure of sown arable land and gardens, cereals accounted for 67.7%, industrial crops for18.5%, vegetables for 1.8% and fodder crops for 8.7%.

According to data from 2012, only 2.9% of the total area of used agricultural land is irrigated. Mineral fertilizers were used at 66.9% of used agricultural land, and 61.3% of it was treated with plant protection products. Smaller farms (under 5 ha) are predominant. Farm owners are mostly older than 55 (about 63%), and 33% are older than 65. The equipment used by farms is mostly outdated. The share of organic production is still insufficient.

1.12. Land Use Change and Forestry

Land use change between 1990 and 2000[7] is presented in Table 1.2.

Table 1.2: CORINE Level I changes 1990 - 2000 (in hectares)

Class	In class	Decrease (ha)	Increase (ha)
Artificial Surfaces	198	1,974	5,921
Agricultural Areas	19,392	12,819	4,346
Forest and Seminatural Areas	43,369	4,695	6,670
Wetlands	0	103	0
Water Bodies	0	1,333	3,676

Artificial surfaces, forest and seminatural areas, as well as water bodies have increased, while surface areas under agriculture and wetlands have decreased in the reference period.

The Spatial Plan of the Republic of Serbia (2010-2020) has identified the optimal forest cover of 41.4%. A total of 2,254,000 ha of land in Serbia are under forests according to the First National Forest Inventory, while, according to the preliminary data of the Second National Forest Inventory, a total of 3,049,502.10 ha of land are under forests. Preliminary data of the Second National Forest Inventory show a changes in the structure of ownership; while according to the First National Forest Inventory state owned forests dominated over private forests with 53% against 47%, the situation has now reversed and 57.5% of the forests are now privately owned, while 42.5% of them are state owned. Volume of felled timber in forests was higher in 2016 than it was in 2014 and amounted to 3.1 million m^3, while the gross volume of felled wood was smaller in 2020 than in 2019, amounting to 3.18 million m^3. On the other hand, afforestation set up new 11,320 ha of forests between 2011-2016, while a total of 1,481 ha was afforested in 2020. The total afforested area in 2021 amounted to 1,203 ha.

Total damage in state-owned forests of the Republic of Serbia in 2021, expressed in wood volume, was 197,774 m^3, of which 19,000 m^3 was man-made damages. The effect of natural disasters (wind, rain, hail and snow) damaged approximately 120,000 m^3 of the wood volume, accounting for approximately 61% of all damages in state-owned forests. Moreover, 34 forest fires registered in

[7] CORINE method used

state-owned forests in 2021, caused damage to 3,360 m^3 of wood volume. Pest diseases damaged around 45,000 m^3 of wood volume in 2021.

According to the Institute for Nature Conservation of Serbia, there were 677,950 ha of protected areas in 2020, which represented 7.66% of the territory.

1.13. Waste Management

The total amount of generated municipal waste in 2020 was 2,947,496 tonnes. Of the total, 444,274 tonnes of materials were recycled, and 11,183 tonnes of waste were subjected to composting and digestion. Additionally, 2,819,629 t (of total generated) waste were disposed of or reused.

Economic activity sectors generated 69.6 million tonnes of waste during 2021 in the Republic of Serbia. A total of 64.5 million tonnes of waste were treated, whereby 16.7% more waste was recycled compared to the previous year.

According to the Waste Management Programme in the Republic of Serbia for the period 2022-2031, the first stage within municipal waste management infrastructure plans involves planning for household composting (30%), primary separation of green waste and its composting at the local level.

Wastewater is one of the main polluters of surface and groundwater, which are natural sources of drinking water. This especially holds true for industrial waste and landfill leachate much of which remain untreated. Wastewater mainly comes from households (67%), much less from the industry (19%), while 14% is generated by other users.

Serbia processes only 5-10% of its wastewater and needs to build 320 wastewater treatment facilities. Wastewater treatment plants exist in 21 municipalities, but even the largest cities discharge their wastewater into rivers.

The total amount of residential wastewater dropped by 0.7% in 2020 over reference period 2019, while the amount of wastewater discharged into the public sewerage fell by 1.3% compared to the corresponding period in 2019. A 16.5% increase in the wastewater treatment was registered in 2020 when compared to 2019; secondary treatment dominated.

1.14. Disaster Risk Reduction

Since 2000, the Republic of Serbia has experienced several significant extreme climate and weather events that have resulted in serious material and financial losses, as well as loss of human lives. Extreme climate and weather events caused total minimal material damage of EUR 6.8 billion between 2000 and 2020. More than 70% of damages were created due to droughts and high temperatures caused by climate change and extreme weather events.Floods being the second main cause of significant losses.

1.15. Institutional, Legal and Procedural Reporting Framework - MRV

The Ministry of Environmental Protection is responsible for coordinating the process of drafting and preparing national reports and Biennial Update Reports (BURs), as a consequence of its competence for climate change at national level. MEP is the national institution accountable for the implementation of the UNFCCC and consequently for the adaptation and mitigation of climate change.

The Serbian Environmental Protection Agency (SEPA) is responsible for the GHG inventory system (a detailed description is given in Chapter 3).

The Ministry of Agriculture, Forestry and Water Management performs state administration tasks related to three most affected sectors: water resources and hydrology, agriculture, and forestry. This Ministry is also the institution responsible for cooperation with the Green Climate Fund (GCF).

As an institution responsible for systematic meteorological, climatological, agrometeorological and hydrological measurements and observations and monitoring, analysis and projections of conditions and changes in weather, climate and water, the Republic Hydrometeorological Institute has a significant role in impact assessing and climate change adaptation planning .

The Ministry of the Interior is responsible for managing disaster risks and emergencies.

Other institutions of importance, primarily for planning and implementing activities to reduce GHG emissions include the Ministry of Mining and Energy (responsible for developing the Integrated National Energy and Climate Plan), the Ministry of Construction, Transport and Infrastructure, the Ministry of Economy. The role of Ministry of Finance is indisputable.

The MEP conducts a process of consultation with these institutions and other stakeholders; establishes working groups and expert teams involved in the preparation of national reports and other documents and coordinates and implements the formal adoption procedure. For the preparation of this report, the MEP established a Technical Working Group, which includes representatives of government institutions and other stakeholders. The task of the working group was to ensure the availability of data and information from the scope of its competence, to help draft the document and to provide suggestions and comments on the document. Thematic workshops, consultations, seminars and trainings were organized during the development process to ensure a participatory approach.

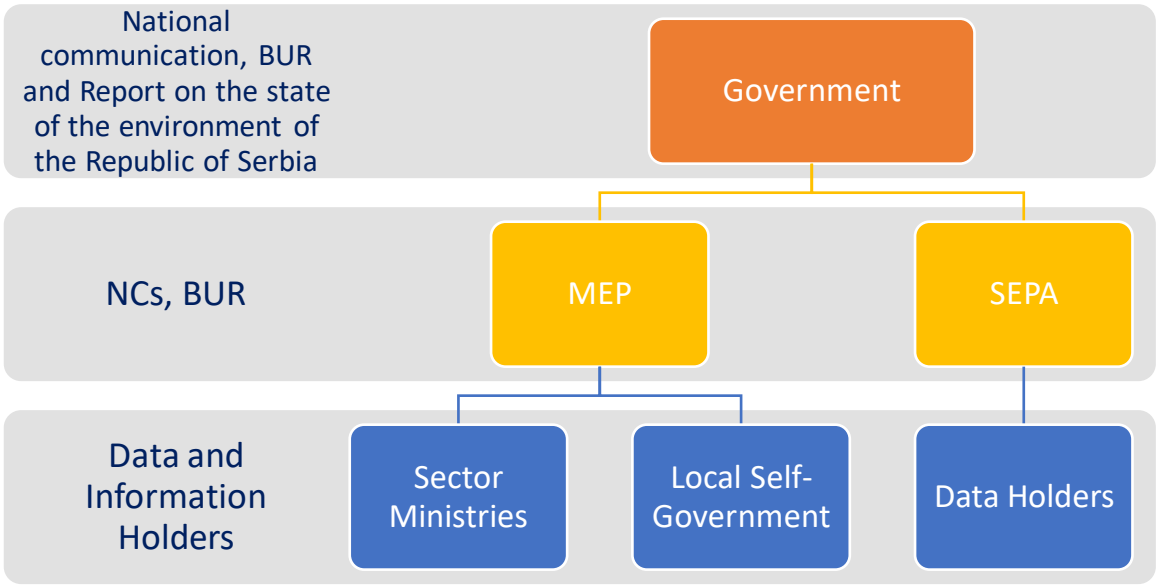
However, due to lack of capacities in national bodies, including MEP and SEPA, technical analyses and assessments are developed by competent national institutions.

National reports, BURs and other documents and information, as well as information about public events in the field or on the nature of climate change, are available on the national website: www.klimatskepromene.rs.

Institutional framework for the preparation of national communications		
Role	**Institution**	**Jurisdiction**
UNFCCC nationally responsible institution	Ministry of Environmental Protection / Climate Change Department	- Overall coordination and process management; - Organization of consultations with interested parties; - Establishment of a working group and teams involved in the preparation; - QA / QC application check; - Preparation of a comprehensive document; - Implementation of the official adoption procedure.
Nationally responsible institution for the GHG inventory system	SEPA	- Overall coordination and management of the GHG inventory preparation process - Preparation and improvement of GHG inventory

The Law on Climate Change sets a foundation for all of the above, as well as for the implementation of activities to mitigate and adapt to climate change, including development of the Strategy and the Climate Change Adaptation Programme. At the same time, institutions, their roles and competencies, as well as procedures for the data exchange, collection and submission, are subject of bylaws. The Law on Climate Change and its implementing by-laws - Regulation on Types of Data, Bodies and Organizations and Other Natural and Legal Persons that Submit Data for the Preparation of the National Inventory of Greenhouse Gases, in May 2023 and the Rulebook on the Content of the GHG National Inventory and of the National Report on the GHG National Inventory adopted in June 2023) - constitute the legal basis for the keeping, continuous publication and constant enhancement of data contained in the National GHG Inventory.

The law mandates the signing of an agreement between the Environment Protection Agency and other relevant stakeholders for the preparation and enhancement of the GHG inventory and outlines the competence of the MEP in preparing reports to the UNFCCC; Strategy and Climate Change Adaptation Programm, as well as reporting on the achievement of these goals, based on reports on the implementation of measures and activities to reduce GHG emissions and adaptation to climate change by sectoral ministries and government institutions, but also local governments.



International institutions and donors are providing significant support to Serbia combating climate change. The Global Environment Facility (GEF), with the United Nations Development Program (UNDP) as the implementing agency, has provided financial and technical support for the preparation of BUR and national communications.

From the aspect of the system of monitoring, reporting and verification (hereinafter: MRV), it is also significant that the GEF played an important role in the establishment of MRV system through the project: "Establishing a Transparency Framework for the Republic of Serbia" (CBIT project).

Moreover, the support provided by the GEF in the climate change field has been of crucial importance over the past decades. In the last few years, EU has invested major resources, including technical support, in the establishment of a legal and institutional framework for climate change monitoring, reporting and verification/evaluation. The financial assistance of the Green Climate Fund is crucial for the implementation of activities important for achieving the NDC, especially in the field of climate change adaptation.

2. GHG INVENTORY

2.1. Institutional and Procedural Arrangements

Under the Law on Climate Change, the Environmental Protection Agency is responsible for monitoring GHG emissions and removals by sinks, and preparation of national GHG inventories in line with reporting requirements of non-Annex I Parties to the Convention[8]. The data collection methodology relevant to the inventory preparation, the relevant institutions and deadlines (until 31 March of the current year for the previous calendar year) were set out in the Regulation on Types of Data, Bodies and Organizations and Other Natural and Legal Persons that Submit Data for the Preparation of the National Inventory of Greenhouse Gases [9]. The Law on Climate Change includes additional provisions regarding GHG monitoring and reporting and establishes a complete and transparent GHG inventory system providing a legal basis for the development and improvement of inventory quality and archiving of data and relevant information.

In the process of the development of the GHG inventory for the period 1990-2018, with the technical assistance of the EU[10], SEPA switched from IPCC software[11] to MS Excel, thus ensuring the preparation of the inventory in CRF format (Common Reporting Format).

The necessary data for the inventory preparation were collected on the official request of the Environmental Protection Agency to the data owners, and also through use of official statistical publications and already collected activity data used for other reporting purposes (CLRTAP, CORINE, FAOSTAT).

2.2. Methodology

GHG inventories include CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 and NF_3 and have been prepared in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, with specific improvements in accordance with the 2019 Refinement to the 2006 IPCC Guidelines.

The Tier 1 Method and emission factors recommended in the IPCC Guidelines were used for all fossil fuels (solid, liquid and gaseous), except for the low calorific domestic open-pit lignite. The Tier 2 method was applied to categories: Product uses as substitutes for ODC and Manure management. Data sources for GHG inventories are shown in Table 2.1. Missing activity data were supplemented by alternative methods (interpolation and extrapolation).

GHG emissions expressed in CO_2 equivalent (CO_2 eq) are calculated using 2006 IPCC global warming potential (GWP) values (Assessment Report 5).

[8] Decision 17/SR.8 Guidelines for the preparation of national communications from States Parties not included in Annex I to the Convention

[9] Regulation on the type of data, bodies and organisations and other natural and legal entities submitting information for the purpose of developing the national GHG inventory ("Off. Gazette of the RS" No 43/23)

[10] Twinning project: "Establishment of a mechanism for implementation of the Monitoring Mechanism Regulation (MMR)"

[11] http://www.ipcc-nggip.iges.or.jp/software/index.html

Table 2.1: Activity data Sources used for GHG Inventory preparation

IPCC sector	Activity data	Source
Energy	National energy balance	Ministry of Mining and Energy
	Registered motor vehicles	Ministry of Interior (database)
	Fuel performance data	Ministry of Mining and Energy, NIS (oil company)
	Processed (purified) natural gas, CO_2 content before purification and CO_2 emissions	NIS (oil company)
Industrial Processes and Product Use	Production and use of raw materials for various industrial processes; product use; population	Statistical Office of the Republic of Serbia (Statistical Yearbook)
	Electrical equipment data	Elektromreža Srbije (EMS)
Agriculture	Number of different categories of livestock	Statistical Office of the Republic of Serbia (Statistical Yearbook)
	Consumption of mineral fertilizers	Statistical Office of the Republic of Serbia (Statistical Yearbook)
	Land areas: annual increment, harvest	Statistical Office of the Republic of Serbia (Statistical Yearbook), Corine Land Cover database
Waste	Amount of landfilled municipal solid waste	Statistical Office of the Republic of Serbia (Statistical Yearbook), SEPA
	Waste composition	University of Novi Sad
	Wastewater treatment	Statistical Office of the Republic of Serbia (Statistical Yearbook)

2.3. GHG Inventory Improvements

The Second Biennial Update Report and the Third National Communication to the UN Framework Convention on Climate Change introduced inventory improvements compared to those previously prepared and presented. Improvements are shown in Table 2.2.

Table 2.2: Inventory improvements compared to previously submitted

Sector	**Improvement**
Cross-sectoral	The value of the global warming potential (GWP) from the 5th IPCC Report was used, so the inventory was recalculated for the entire period 1990-2020. Thus, the total emissions were 1.05% higher in 1990 and 0.83% higher in 2018. The most significant increases, 51% in 1990 and 61% in 2018, occurred in the waste sector.

Energy Sector	A new assessment of the level of uncertainty has been performed regarding the CO_2 emission factors used in the energy industry for solid, liquid and gaseous fuels.
IPPU	
2.B.2 Nitric acid production	The value from the 2019 Refinement to the 2006 IPCC Guidelines replaced the emission factor value for N_2O from the 2006 IPCC Guidelines. From Table 3.3, the emission factor for nitric acid production plants is applied for the period 1990-2015. From 2016 onwards, the emission factor is applied for plants that use emission reduction technology by installing catalytic reduction, thereby reducing the emission of N_2O. After recalculating the total emissions in 2018, they were reduced by 0.33%, while there was no change in 1990.
2.C Metal industry	The 2019 version value replaced the emission factor value for iron and steel making from the 2006 IPCC Guidelines. (Tables 4.1a and 4.1b from the 2019 Refinement to the 2006 IPCC Guidelines), resulting in an increase in GHG emissions by approximately 0.15% over the period 1990-2018.
2.G.1 Electrical equipment	Included are the data on SF_6 emissions collected in cooperation with the transmission network operator of Serbia for the period 1990-2018. The use of SF_6 switches began in 2000. The level of total GHG emissions increased by 0.15% in 2018.
Agriculture sector Category 3A-3B-Livestock: 3A-Enteric fermentation and 3.B-Manure Management	The number of livestock has been recalculated for the period 1990-2018. CLRTAP and GHG inventories have been linked to nitrous losses because they are already calculated in the CLRTAP inventory. This connection also ensures systematic consistency between the CLRTAP inventory and the GHG inventory calculation. Based on data from the Republic Hydro-meteorological Service of Serbia, the average annual temperature has been included in CH_4 emissions from manure management. The value of the emission factor for enteric fermentation [kg CH_4/headage/year] for developing countries (sheep and pigs) has been replaced by the value for developed countries. The emission factor value for enteric fermentation for Tier 1 has been applied from the 2019 Refinement to the 2006 IPCC Guidelines (Tables 10.10 and 10.11); The animal waste management system has been changed from 2019 in the 20019 Refinement to the 2006 IPCC Guidelines; Methane conversion factor (MCFs) has been changed from the 2019 Refinement to the 2006 IPCC Guidelines (Table 10.17); The nitrous excretion rate from 2019 has been changed in the 2019 Refinement to the 2006 IPCC Guidelines (Table 10.19); The emission factor (kg N_2O-N/kg Nex) for direct N_2O emissions from manure management has been changed from the 2019 Refinement to the 2006 IPCC Guidelines (Table 10.21);

	Default values for livestock weight (kg) have been changed (Table 10A.5); Additional improvements have also been made in subsector 3.C - Aggregate sources and non- CO_2 emissions sources on land, such as: The emission factor for the estimation of direct N_2O emissions from treated soils has been changed from the 2019 Refinement to the 2006 IPCC Guidelines (Table 11.1); Default emission factors, as well as volatilization and leaching factors for indirect N_2O emissions from soils, have been changed from the 2019 Refinement to the 2006 IPCC Guidelines (Table 11.3); Inventory recalculations have led to a decrease in total emissions by 0.95% in 1990 and by 0.27% in 2018.
LULUCF sector 3.B Land	The value for above-ground biomass (B t dm/ha) for grassland has been changed (from 6.5 to 13.6 2006 IPCC Guidelines vol. 4. AFOLU, Chapter 6. Grassland, Table 6.4). Previously, the factor was based on IPCC software. The value of carbon stocks (tC/ha) in forests has been changed (from 73.32 to 106.52). The value of carbon stocks (tC/ha) in forests has been changed (from 16 to 16.95 - 2006 IPCC Guidelines Vol. 4. AFOLU, Chapter 2. Generic Methodologies Applicable to Multiple Land Use Categories (Table 2.2)). The amount of mineral-rich soil in a settlement converted into forest land has changed, as 20% has been lost due to paving (2006 IPCC Guidelines, vol. 4. AFOLU, Chapter 8. Settlements, page 8.24). Emission factors for organic soils in forest land, arable land and grassland (2006 IPCC Guidelines, Vol. 4. AFOLU, Chapter 4. Forest Land, Table 4.6, Chapter 5. Cropland, Table 5.6, Chapter Grassland, Table 6.3) have been introduced. The C stocks value in forests (variations in quantities) has been replaced by the value from the 2019 Refinement to the 2006 IPCC Guidelines (Table 2.2., IPCC Cx2), from 16.95 tC/ha to 23.9 tC/ha SOC (stock variations) has been changed from default values presented in 2006 IPCC into national values (from the project for the determination of soil organic carbon in Serbia): A total of 1,311 sites were estimated, and SOC (<30 cm) was calculated using the same methodology. To ensure consistency of time series and resolve the issue of data gaps, a five-year average was used where necessary. A new calculation for harvested wood products (HWP) was presented, with the data and calculation used for FAO reporting. The inventory recalculation led to an increase in sinks by 1.38% in 1990 and 22.45% in 2018.
Conclusion	The net effect of all described cross-sectoral and sectoral improvements represents an increase in emissions by 1.08% in 1990 and 1.23% in 2018.

2.4. Trends and GHG Inventories

2.4.1 Total GHG Inventories

In 2021, total GHG emissions without Land Use, Land-Use Change and Forestry (LULUCF) stood at 62,185 Gg CO_2 eq, and 58,004 Gg CO_2 eq including LULUCF, which represents a decrease of 2.5% compared to 2010 and 24.8% compared to 1990, respectively. The key reason for this trend is the increased use of biomass in the energy sector and, to a lesser extent, the effects of extreme weather conditions on the Remaining Forests category (Table 2.3 and Figure 2.1).

Table 2.3: GHG emissions by sectors and removal by sinks (Gg CO_2 eq)[12]

Source and category of sink	**1990**	**2000**	**2005**	**2010**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Emissions											
Energy	66,313	48,270	54,538	50,242	49,882	50,662	50,907	49,726	49,313	50,740	49,197
Industrial Processes and Product Use	5,516	3,063	4,973	4,972	4,079	4,392	5,283	5,968	5,234	4,624	5,064
Agriculture	6,538	5,662	6,464	5,552	5,551	5,927	5,625	5,115	5,185	5,617	4,733
Waste	4,300	3,381	3,112	3,034	3,012	3,020	2,921	2,994	3,070	3,131	3,192
Land use, land-use change and forestry (LULUCF)	-1,412	-4,051	-6,230	-6,059	-5,267	-4,940	-5,059	-4,819	-5,097	-4,947	-4,181
Total GHG emissions without LULUCF	**82,667**	**60,376**	**69,086**	**63,800**	**62,524**	**64,001**	**64,736**	**63,803**	**62,802**	**64,112**	**62,185**
Total GHG emissions including LULUCF	**81,255**	**56,325**	**62,856**	**57,741**	**57,257**	**59,060**	**59,677**	**58,983**	**57,705**	**59,164**	**58,004**

[12] Due to inventory enhancements explained in table 2.2, emissions in Table 2.3 were partially changed in comparison with emissions used for chapter 3 and preparing the mitigation scenario

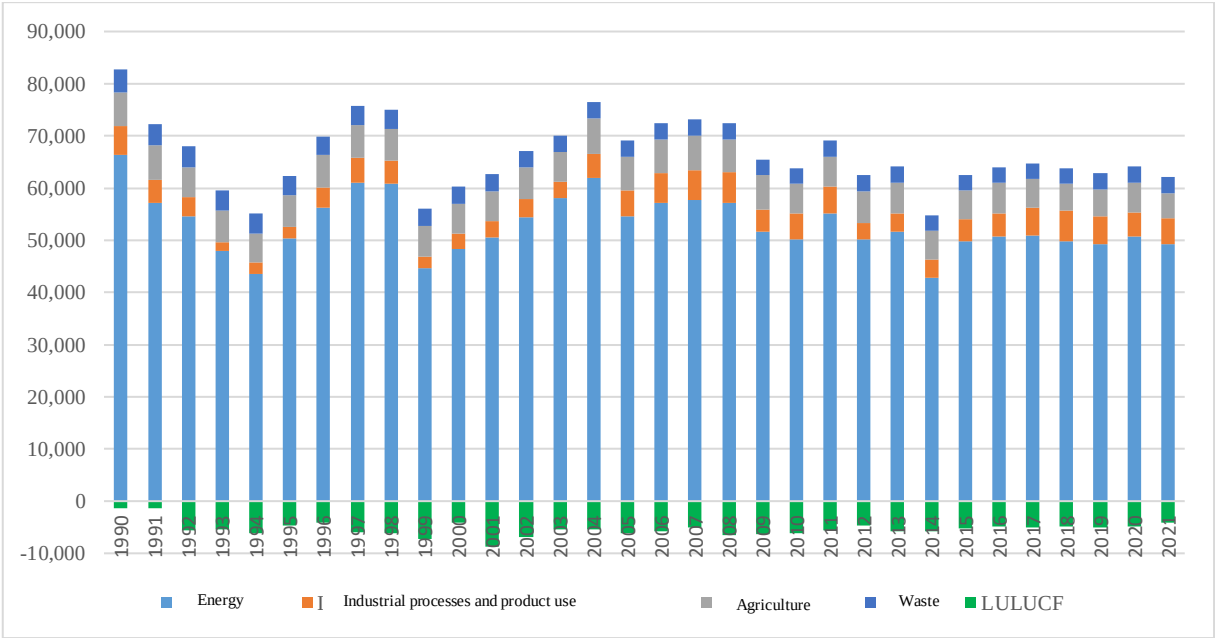


Figure 2.1: Total GHG emissions and sector contributions in the period 1990-2021 (Gg $CO_{2\ eq}$)

During the observed period, the sector's contributions to total emissions remained almost unchanged. Thus, in 2021, 79.1% of total GHG emissions came from the energy sector, 8.1% from the sector of industrial processes and product use, including the production and consumption of mineral raw materials (such as cement, lime, limestone and sodium carbonate, production of chemicals and ammonia, iron and other metals, and other products) and 5.1% came from the waste management sector, ratios remained identical, with only slight difference in absolute values observed in 2010.

The trend of total GHG emissions in the period 2000-2021 is characterized by fluctuations, from highly positive in the period 2000-2004, over negative in the period 2010-2012 due to a decrease in the production of Portland cement, iron and steel, to highly negative in 2014 (15% compared to 2013), as a result of floods that reduced electricity production in plants using lignite from open-pit mines and stabilisation of emissions after 2015 (Table 2.4).

Table 2.4: Trend of GHG emissions and removal by sinks

Source and category of sink	2021/1990	2021/2000	2021/2005	2021/ 2010	2021/2020
Emissions					
Energy	-25.8%	1.9%	-9.8%	-2.1%	-3.0%
Industrial products and product use	-8.2%	65.3%	1.8%	1.9%	9.5%
Agriculture	-27.6%	-16.4%	-26.8%	-14.8%	-15.7%
Waste	-25.8%	-5.6%	2.6%	5.2%	1.9%
Land use, land-use change and forestry (LULUCF)	-24.8%	-3.0%	-10.0%	-2.5%	-3.0%
Total GHG emissions without LULUCF	**-28.6%**	**3.0%**	**-7.7%**	**0.5%**	**-2.0%**
Total GHG emissions including LULUCF	**-25.8%**	**1.9%**	**-9.8%**	**-2.1%**	**-3.0%**

In 2021, carbon dioxide (CO_2) accounted for 82.3% of total GHG emissions, methane (CH_4) for 14.2% and nitrous oxide (N_2O) for 3.2%, and fluorinated hydrocarbons (HFCs) and sulphur hexafluoride (SF_6) for 0.4%. In 2010, CO_2 accounted for 81.1%, CH_4 13.9%, and N_2O 4.5% of total emissions (Table 2.5 and Figure 2.2).

Table 2.5: GHG emissions without LULUCF by gases (Gg $CO_{2\ eq}$)

Greenhouse gas	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Emissions											
CO_2	67,747	48,278	56,548	51,760	50,186	51,702	52,837	52,357	51,435	52,239	51,155
CH_4	12,295	10,205	9,081	8,899	9,012	8,790	8,664	8,652	8,768	8,906	8,801
N_2O	2,489	1,891	3,400	2,885	2,823	3,060	2,832	2,421	2,298	2,731	2,015
HFCs	0	2	43	231	406	348	300	272	224	199	165
SF_6	136	0	13	25	96	101	103	101	76	35	49
Total GHG emissions without LULUCF	**82,667**	**60,376**	**69,086**	**63,800**	**62,524**	**64,001**	**64,736**	**63,803**	**62,802**	**64,112**	**62,185**

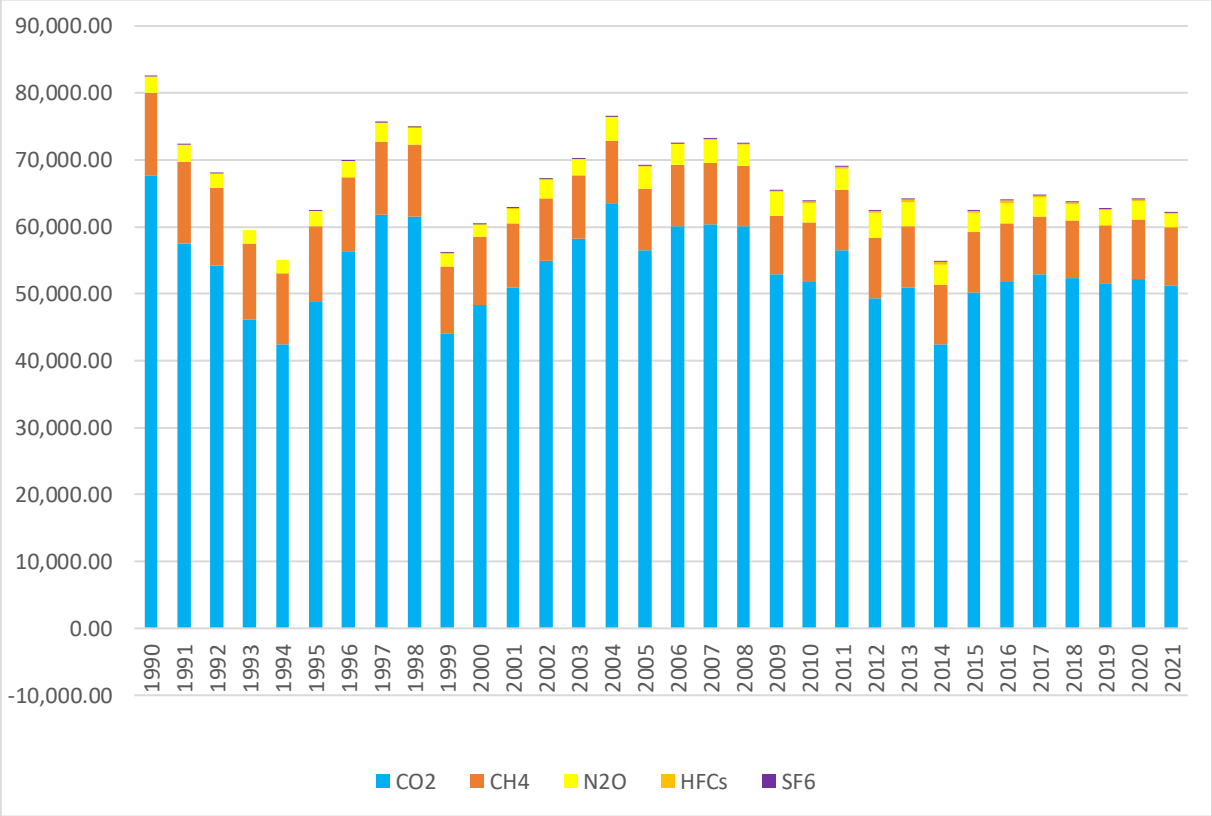


Figure 2.2: Total GHG emissions and gas contribution in the period 1990-2021 (Gg $CO_{2\ eq}$)

2.5. GHG Inventories and Trends by Sectors

2.5.1 Energy

Emissions from the Energy Sector traditionally contribute the most to GHG emissions. In 2021, emissions stood at 49,197 Gg CO_2 eq (79.1% of total GHG emissions) and 2.1% lower than in 2010. GHG emissions reduction resulted from removing emissions from electricity production (reduction of coal consumption), manufacturing and construction industries, other sectors, and increasing emissions from transportation (Table 2.6).

Table 2.6: GHG emissions, by source categories in the energy sector (Gg $CO_{2\ eq}$)

Energy supply (Gg CO2 eq)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
1.A - Fuel Combustion	62,192	45,331	51,353	47,589	47,091	47,986	48,121	47.038	46,969	48,469	47,045

Energy supply (Gg CO2 eq)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Activities											
1.A.1 - Energy industries	42,713	34,122	33,825	31,850	34,115	33,801	34,291	32,300	32,294	33,998	31,936
1.A.2 – Manufacturing industries and construction	7,883	5,407	7,778	5,504	4,238	4,792	4,211	5,232	4,670	4,350	4,325
1.A.3 - Transport	4,560	2,374	6,694	6,728	5,999	6,162	6,415	6,508	7,034	6,701	7,650
1.A.4 - Other sectors	7,086	3,169	3,056	3,506	2,738	3,232	3,204	2,998	2,970	3,419	3,134
1.A.5 - Non-specified	0	259	0	0	0	0	0	0	0	0	0
1.B - Fugitive emissions from fuels	4,121	2,939	3,185	2,654	2,791	2,676	2,786	2,688	2,344	2,271	2,152
1.B.1 - Solid fuels	1,087	1,145	1,070	1,125	1,124	1,131	1.150	1,074	1,130	1,104	1,012
1.B.2 - Oil and natural gas	3,034	1,795	2,114	1,529	1,865	1,667	1,546	1,636	1,613	1,214	1,167
1.B.3 - Other emissions from energy production	0	0	0	0	0	0	0	0	0	0	0
1.C - Carbon dioxide transport and storage	0	0	0	0	0	0	0	0	0	0	0
Total	**66,313**	**48,270**	**54,538**	**50,242**	**49,882**	**50,662**	**50,907**	**49,726**	**49,313**	**50,740**	**49,197**

In 2021, 95.6% of the Energy sector's emissions came from Fuel combustion activities (Table 2.6), of which 67.9% came from the Energy Industries, 9.2% from the Manufacturing Industries and Construction, 16.3% from Transport and 6.7% from Other sectors. Fugitive emissions from fuels accounted for the remaining 4.4%, of which 53.0% from Oil and natural gas and 47.0% from Solid fuels (local coal extraction).

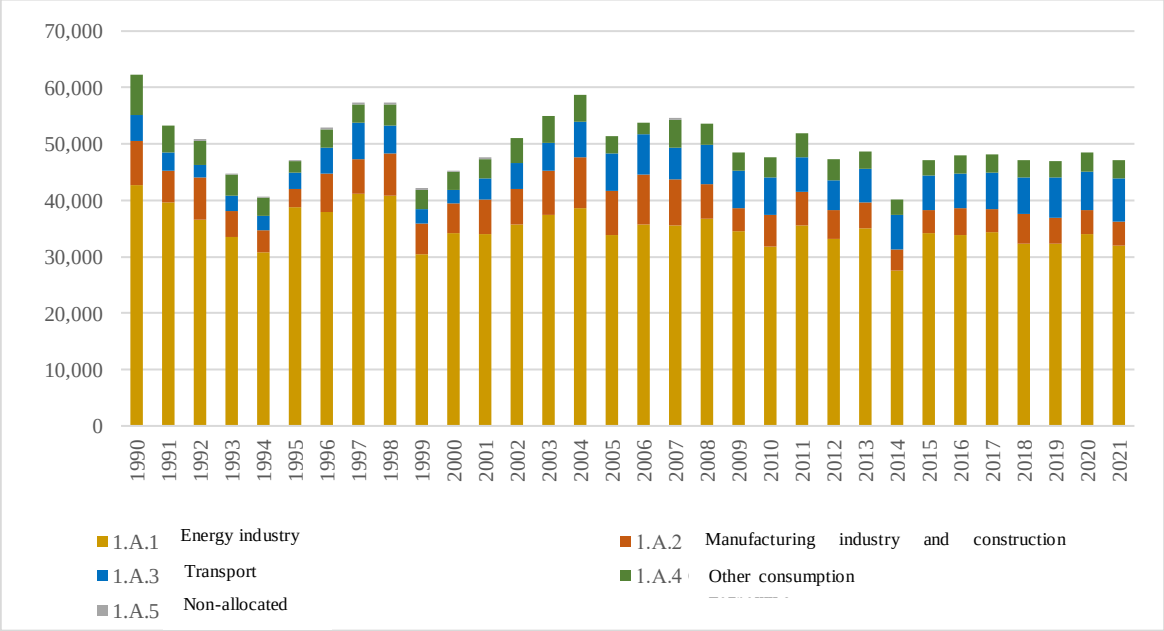


Figure 2.3: GHG emissions from Fuel combustion activities (Gg $CO_{2\ eq}$)

In 2021, GHG emissions from Fuel combustion activities decreased by 1.14% compared to 2010, whereby they increased in the energy industries (+0.3%) and transport (+13.7%), and decreased in manufacturing and construction industries (-21.4%), and other sectors (-10.6%). The 2014 floods caused a reduction in emissions from the Energy industry by 17.2% compared to the 2015-2021 average.

2.5.2 Industrial Processes and Product Use

In 2021, emissions from the sector Industrial processes and product use amounted to 5,064 Gg CO_2 eq (8.1% of total emissions) (Table 2.7 and Figure 2.4).

Table 2.7: GHG emissions by source categories (Gg $CO_{2\ eq}$)

IPPU (Gg CO_2 eq)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
2.A - Mineral industry	2024	1485	1543	1339	1037	1125	1168	1262	1278	1372	1472
2.A.1 - Cement manufacturing	1340	1046	1124	1052	817	890	942	1034	1063	1168	1289
2.A.2 – Lime production	499	287	292	188	149	161	162	165	153	140	107
2.A.3 – Glass production	14	6	5	4	5	4	5	5	6	6	5
2.A.4 – Other process uses of carbonates	170	146	122	95	66	70	59	58	56	58	70
2.A.5 - Other	0	0	0	0	0	0	0	0	0	0	0
2.B – Chemical industry	1371	504	1050	894	611	593	825	576	6	300	290
2.B.1 - Ammonia production	335	131	250	215	171	135	412	203	0	0	0
2.B.2 - Nitric acid production	563	181	408	301	234	54	91	79	0	0	0
2.B.8 - Petrochemical and carbon black production	445	182	372	357	200	397	315	287	0	294	284
2.B.10 – Other chemical industry	28	9	20	22	7	7	7	6	6	6	6
2.C - Metal industry	1863	1009	2253	2413	1925	2205	2888	3764	3628	2660	3041
2.C.1 - Iron and steel production	1653	990	2236	2373	1813	2086	2768	3646	3541	2623	2986
2.C.4 - Magnesium production	166	0	15	27	111	118	120	118	87	37	54
2.C.5 - Lead production	3	5	2	13	0	0	0	0	0	0	0
2.C.6 - Zinc production	41	14	0	0	0	0	0	0	0	0	0
2.C.7 - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0
2.D - Non-energy products from fuels and solvent use	258	63	83	91	95	117	98	89	93	87	92
2.D.1 – Use of lubricants	194	9	30	37	42	63	46	38	43	38	43
2.D.2 – Use of paraffin wax	0	0	0	2	2	2	2	2	2	1	1
2.D.3. - Other solvent use	64	54	53	52	51	52	50	50	49	48	48
2.E - Electronics industry	0	0	0	0	0	0	0	0	0	0	0
2.F - Product uses as substitutes for ozone depleting substances	0	2	43	231	406	348	300	272	224	199	165
2.F.1 - Refrigeration and air conditioning	0	1	39	226	399	340	293	265	217	192	159
2.F.4 – Aerosols	0	1	4	5	8	8	7	7	7	7	6
2.G – Other Product Manufacture and Use	0	0	1	3	4	4	4	4	4	5	5
2.H - Other	0	0	0	0	0	0	0	0	0	0	0
Total	**5516**	**3063**	**4973**	**4972**	**4079**	**4392**	**5283**	**5968**	**5234**	**4624**	**5064**

In 2021, emissions from this sector were higher by 1.9% than in 2010, with an increase in mineral industry emissions (22.5% increase in clinker production and a 42.9% reduction in lime production) for 9,9% and a sizable reduction of chemical industry emissions (production of petrochemicals and nitric acid) by 57.6%, and growth in emissions from the metal industry ("Železara Smederevo") by

26.0% and a reduction of emissions from products used as substitutes for ozone-depleting substances by 28.7%.

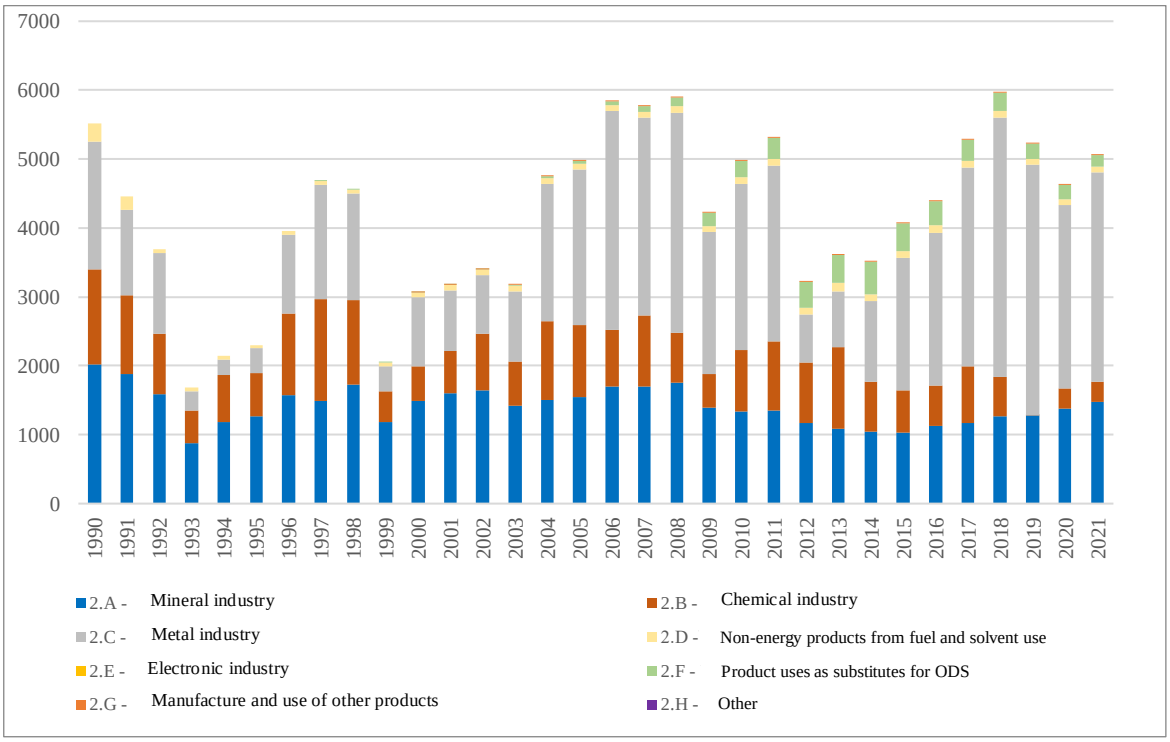


Figure 2.4: GHG emissions by categories in the sector (Gg $CO_{2\ eq}$)

In 2021, 60.0% of emissions from the Industrial processes and product use sector came from the Metal Industry, 98% of which came from Iron and Steel production, 29.1% from the Mineral industry (cement manufacturing 88%, lime production 8%) and 5.7% from the Chemical Industry (petroleum products and carbon black 97.9%, and other chemical products 2.1%). Production of ammonia and nitric acid ceased in 2019 due to plant shutdown. Products used as substitutes for ozone-depleting substances emitted 3.3% (96% from refrigeration and air conditioning), and Use of Non-Energy Products from fuels and solvent accounted for the remaining 1.8% of emissions (52% of which are from the use of solvents, 47% from the use of lubricants and 2% from the use of paraffin wax).

2.5.3 Agriculture

Total emissions in the agriculture sector in 2021 were 4,733 Gg CO_2 eq (7.6% of total emissions in 2021) and were accompanied by a drop of 819 Gg CO_2 eq from 2010, i.e. 14.8%, mostly due to reduction of emissions from agricultural land (Table 2.8 and Figure 2.5).

Table 2.8: GHG emissions by categories in the agriculture sector (Gg $CO_{2\ eq}$)

Agriculture (Gg CO_2 eq)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
3.A - Enteric fermentation	**4090**	**3391**	**2991**	**2593**	**2565**	**2481**	**2496**	**2456**	**2467**	**2466**	**2405**
3.A.1.a Dairy cattle	2068	1831	1616	1255	1120	1109	1117	1101	1100	1086	1062
3.A.1.b Beef cattle	1244	881	746	744	791	760	765	742	772	765	733
3.A.2 Sheep	491	406	397	372	451	420	429	431	414	425	427
3.A.3 Pigs	217	208	181	156	145	134	130	125	126	133	127
3.A.4 - Other livestock (goats and horses)	70	65	51	67	59	58	54	57	55	58	56
3.B - Manure management	**1473**	**1352**	**1128**	**985**	**964**	**884**	**872**	**926**	**925**	**901**	**869**

Agriculture (Gg CO_2 eq)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
3.B.1.1.a Dairy cattle	128	116	100	78	71	69	69	73	73	69	67
3.B.1.1.b Beef cattle	164	127	98	98	114	100	101	125	130	110	106
3.B.1.2 Sheep	14	12	12	11	13	12	13	13	12	12	13
3.B.1.3 Pigs	454	459	372	321	310	271	264	293	291	285	272
3.B.1.4 - Other livestock	62	57	44	46	50	44	43	49	47	44	43
3.B.2.1.a Dairy cattle	213	189	167	129	115	114	115	114	114	112	110
3.B.2.1.b - Beef cattle	79	56	47	47	50	48	48	47	49	48	46
3.B.2.2 Sheep	18	15	14	14	16	15	16	16	15	15	16
3.B.2.3 Pigs	300	286	245	212	194	179	175	168	167	178	170
3.B.2.4 - Other livestock	41	35	29	30	30	29	29	29	27	26	26
3.B.2.5 Indirect N_2O emissions	0	0	0	0	0	0	0	0	0	0	0
3.C - Rice farming	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3.D - Agricultural land	**836**	**803**	**2106**	**1768**	**1793**	**2214**	**1949**	**1569**	**1528**	**1930**	**1229**
3.D.1 - Direct N_2O emissions from managened soils	582	562	1527	1284	1296	1610	1408	1142	1111	1405	892
3.D.2 Indirect N_2O emissions from managened soils	254	241	579	484	497	604	541	427	417	525	337
3.E - Regulated savanna burning	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3.F Burning crop residues in the fields	**107**	**81**	**105**	**109**	**96**	**96**	**94**	**90**	**92**	**95**	**97**
3.G - Land clearing	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3.H - Urea application	**32**	**35**	**133**	**97**	**133**	**252**	**214**	**74**	**172**	**226**	**132**
3.I - Other Carbon Containing Fertilizers	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3.J - Other	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total	**6538**	**5662**	**6464**	**5552**	**5551**	**5927**	**5625**	**5115**	**5185**	**5617**	**4733**

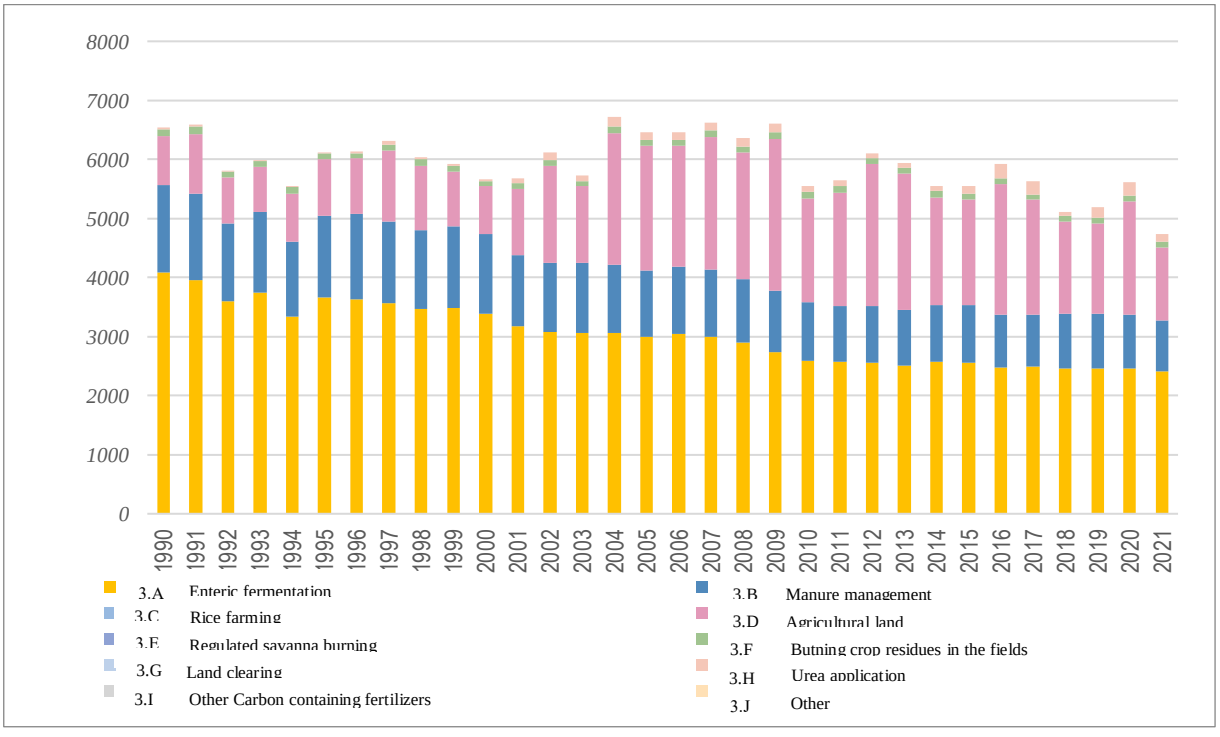


Figure 2.5: GHG Emissions by Categories in the Agriculture Sector (Gg CO_2 eq)

Agriculture emissions in 2021 were 4,733 Gg CO_2 eq, of which 3,274 Gg CO_2 eq (69,2%) came from livestock farming (2,405 Gg CO_2 eq enteric fermentation and 869 Gg CO_2 manure management); 1,229 Gg CO_2 eq from direct and indirect N_2O emissions from managing agricultural land (73.0% direct and 27% indirect N_2O emissions), 2.8% from urea application, and the remaining 2.1% emissions represented the burning of biomass (in the fields). Emissions from agricultural land dropped between 2010 and 2021 by as much as 30% (-538 Gg CO_2 eq), while urea application grew by 35% (+34 Gg CO_2 eq) over the same period, and enteric fermentation emissions from sheep rose by 15% (+56 Gg CO_2 eq).

2.5.4 Land Use, Land-Use Change and Forestry

In 2021, total net sinks from the land use, land-use change and forestry sector amounted to 4,181 Gg CO_2 eq and since 2010 were accompanied by a decrease of 1,878 Gg CO_2 eq (Table 2.9 and Figure 2.6), representing a 31% decrease. The main driver behind this sink was 4.A Forest land, while other categories of land use and land-use change marked a stable emission trend.

Table 2.9: GHG emissions by categories in the land use, land-use change and forestry sector (Gg CO_2 eq)

LULUCF (Gg CO_2 eq)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
4.A Forest land	-2012	-5444	-6313	-6116	-5311	-5018	-5099	-4854	-5101	-5043	-4299
4.B Crops	19	11	84	14	56	56	56	56	56	57	53
4.C Pastures	354	1159	-137	12	35	7	-5	-2	2	5	5
4.D Wetlands	179	164	148	91	93	89	85	82	78	75	73
4.E Settlements	73	71	128	141	148	148	149	149	150	150	150
4.F Other land	25	21	7	77	90	92	93	95	97	99	101
4.G Harvested wood products	-50	-33	-148	-279	-378	-314	-339	-347	-379	-290	-263
Total	**-1412**	**-4051**	**-6230**	**-6059**	**-5267**	**-4940**	**-5059**	**-4819**	**-5097**	**-4947**	**-4181**

Net sinks in the forest land sector amounted to 4,299 Gg CO_2 in 2021, while sinks due to harvested wood products amounted to 263 Gg CO_2. An average annual trend of forest land sink reduction by 1.95% was recorded after 2008. Further reduction of this sink is expected with the rise in the use of biomass for heating and industrial purposes. Substantial rises of emissions from pastures were recorded in 2000 and 2007 due to catastrophic dry pasture fires.

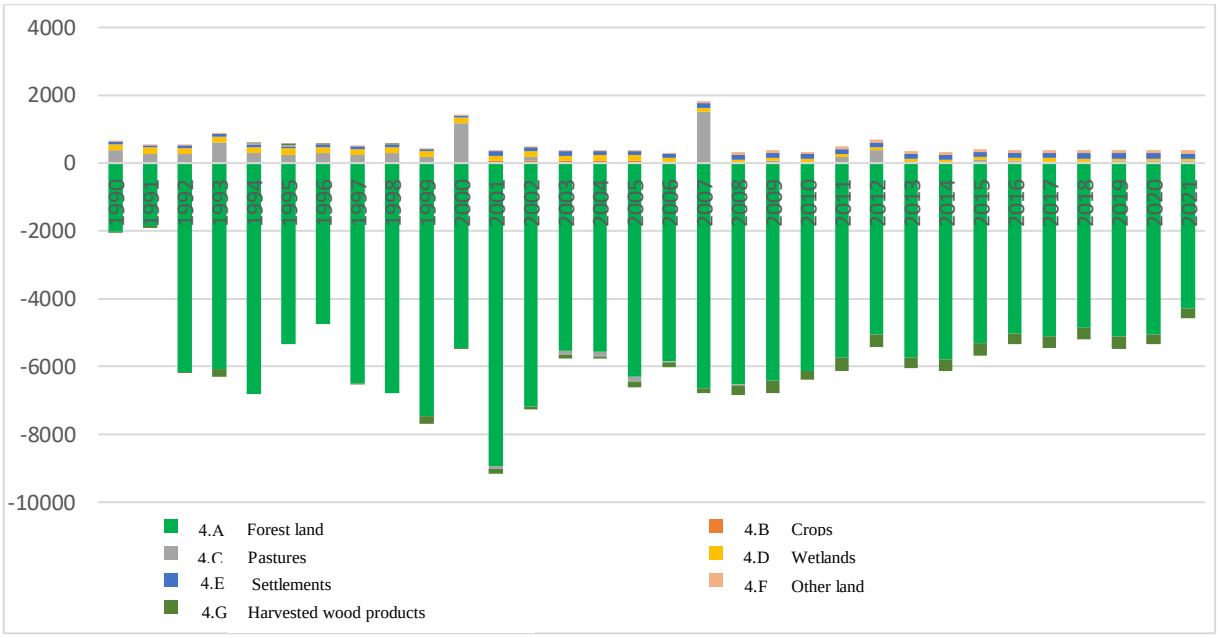


Figure 2.6: LULUCF emissions in Serbia for the period 1990-2021

2.5.5 Waste Management

In 2021, emissions amounted to 3,192 Gg CO_2 eq (5.2% of total GHG emissions) and were higher by 5.2% compared to 2010 (Table 2.10 and Figure 2.7).

Table 2.10: GHG emissions by subsectors of the Waste management sector (Gg CO_2 eq)

Waste (Gg CO_2 eq)	**1990**	**2000**	**2005**	**2010**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
5.A - Solid waste disposal	3,047	2,426	2,171	2,115	2,129	2,102	2,089	2,167	2,252	2,319	2,385
5.B - Biological treatment of solid waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.C - Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.D - Wastewater treatment and discharge	1,253	954	941	919	883	918	832	827	817	812	807
5.E - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	4,300	3,381	3,112	3,034	3,012	3,020	2,921	2,994	3,070	3,131	3,192

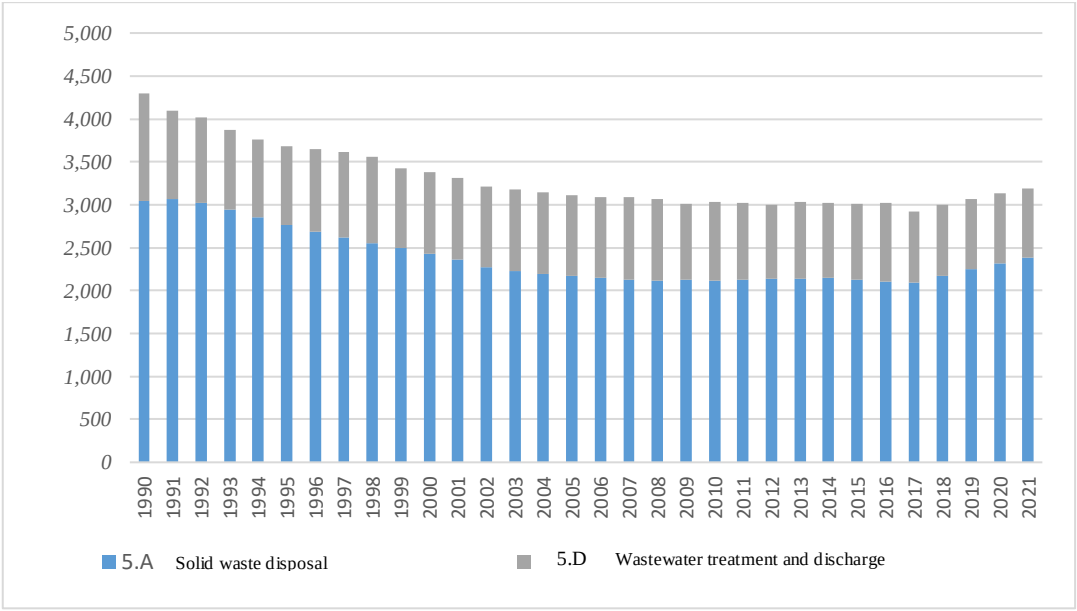


Figure 2.7 GHG emissions by subsectors of the Waste management sector (Gg CO_2 eq)

In 2021, 74.7% of the sector's total emissions were a consequence of solid waste disposal in landfills, and 25.3% was a consequence of wastewater, and this ratio of emission sources remained more or less unchanged during the entire 2010-2021 period. A rising trend in solid waste disposal emissions was recorded between 2017-2021 due to the rising quantities of disposed waste and the lack of adequate solid waste management and treatment.

2.6. GHG Emissions and Removals and Trends by Gas Type

2.6.1 Carbon Dioxide (CO_2)

In 2021, CO_2 emissions amounted to 51,155 Gg and their share in total emissions, without LULUCF, ranged from 81.1% in 2010 to 82.3% in 2021. Most of the CO_2 emissions come from the fuel combustion sector (90.2%) and the rest comes from industrial processes (9.5%), mineral production and metal production (Table 2.11).

Table 2.11: CO_2 emissions by subsectors and categories (Gg)

CO_2(Gg)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
1- Energy	**62,919**	**45,371**	**51,926**	**47,267**	**46,719**	**47,582**	**47,848**	**46,780**	**46,329**	**47,637**	**46,186**
1.A - Fuel combustion	61,420	44,790	50,732	46,899	46,429	47,305	47,455	46,378	46,296	47,606	46,158
1.B - Fugitive emissions from fuels	1,498	581	1,194	368	290	277	393	402	33	30	27
1.C - Carbon dioxide transport and storage	0	0	0	0	0	0	0	0	0	0	0
2 - Industrial processes and product use	**4,797**	**2,872**	**4,489**	**4,395**	**3,335**	**3,867**	**4,776**	**5,503**	**4,935**	**4,377**	**4,837**
2.A - Mineral industry	2,024	1,485	1,543	1,339	1,037	1,125	1,168	1,262	1,278	1,372	1,472
2.B - Chemical industry	788	314	622	574	369	518	721	484	6	288	278
2.C - Metal industry	1,727	1,009	2,241	2,391	1,833	2,108	2,790	3,667	3,557	2,630	2,996
2.D - Non-energy products from fuels and solvent use	258	63	83	91	95	117	98	89	93	87	92
2.E - Electronics industry	0	0	0	0	0	0	0	0	0	0	0
2.F - Product uses as substitutes for ozone depleting substances	0	0	0	0	0	0	0	0	0	0	0

CO_2(Gg)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
2.G - Other product manufacture and use	0	0	0	0	0	0	0	0	0	0	0
2.H - Other	0	0	0	0	0	0	0	0	0	0	0
3 - Agriculture	**32**	**35**	**133**	**97**	**133**	**252**	**214**	**74**	**172**	**226**	**132**
3.A - Enteric fermentation	0	0	0	0	0	0	0	0	0	0	0
3.B - Manure management	0	0	0	0	0	0	0	0	0	0	0
3.C - Rice farming	0	0	0	0	0	0	0	0	0	0	0
3.D - Agricultural land	0	0	0	0	0	0	0	0	0	0	0
3.E - Regulated savanna burning	0	0	0	0	0	0	0	0	0	0	0
3.F Burning crop residues in the fields	0	0	0	0	0	0	0	0	0	0	0
3.G - Land clearing	0	0	0	0	0	0	0	0	0	0	0
3.H - Urea application	32	35	133	97	133	252	214	74	172	226	132
3.I - Other Carbon Containing Fertilizers	0	0	0	0	0	0	0	0	0	0	0
3.J - Other	0	0	0	0	0	0	0	0	0	0	0
4 - LULUCF	**-1,451**	**-4,150**	**-6,244**	**-6,077**	**-5,304**	**-4,966**	**-5,081**	**-4,841**	**-5,119**	**-4,969**	**-4,202**
4.A Forest land	-2,023	-5,462	-6,313	-6,123	-5,330	-5,027	-5,105	-4,861	-5,108	-5,049	-4,306
4.B Crops	19	12	80	14	53	53	53	53	53	53	50
4.C Pastures	339	1,088	-135	10	30	3	-8	-4	0	3	2
4.D Wetlands	170	156	140	86	87	84	81	77	74	70	69
4.E Settlements	71	69	126	139	145	146	146	147	147	147	147
4.F Other land	24	21	7	77	88	90	91	93	95	97	99
4.G Harvested wood products	-50	-33	-148	-279	-378	-314	-339	-347	-379	-290	-263
5 - Waste	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
5.A - Solid waste disposal	0	0	0	0	0	0	0	0	0	0	0
5.B - Biological treatment of solid waste	0	0	0	0	0	0	0	0	0	0	0
5.C - Incineration and open burning of waste	0	0	0	0	0	0	0	0	0	0	0
5.D - Wastewater treatment and discharge	0	0	0	0	0	0	0	0	0	0	0
5.E - Other	0	0	0	0	0	0	0	0	0	0	0
Total CO_2 emissions with LULUCF	**66,297**	**44,128**	**50,304**	**45,683**	**44,882**	**46,736**	**47,756**	**47,515**	**46,317**	**47,270**	**46,953**
Total emissions without LULUCF	**67,747**	**48,278**	**56,548**	**51,760**	**50,186**	**51,702**	**52,837**	**52,357**	**51,435**	**52,239**	**51,155**

2.6.2 Methane (CH_4)

CH_4 emissions stood at 314.5 Gg of CH_4 in 2021 and they were 1.1% lower than in 2010. Main subcategories of methane emissions are: enteric fermentation (27.3%), Solid waste disposal (27.1%), Fugitive emissions from fuels (24.1%), Wastewater treatment and discharge representing 8.2%, and manure management 5.7%, respectively. (Table 2.12).

Table 2.12: CH_4 emissions by subsectors and categories (Gg)

CH_4(Gg)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
1- Energy	**110.64**	**95.90**	**83.63**	**96.55**	**102.84**	**99.34**	**98.44**	**94.69**	**96.07**	**99.53**	**96.33**
1.A - Fuel combustion activities	17.19	11.76	12.72	14.98	13.57	13.69	13.03	13.10	13.51	19.50	20.45
1.B - Fugitive emissions from fuels	93.45	84.14	70.91	81.57	89.27	85.65	85.41	81.59	82.56	80.03	75.88

CH_4(Gg)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
1.C - Carbon dioxide transport and storage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 - Industrial processes and product use	**0.70**	**0.28**	**0.72**	**0.70**	**0.30**	**0.77**	**0.48**	**0.43**	**0.00**	**0.44**	**0.43**
2.A - Mineral industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B - Chemical industry	0.70	0.28	0.72	0.70	0.30	0.77	0.48	0.43	0.00	0.44	0.43
2.C - Metal industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.D - Non-energy products from fuels and solvent use	0.00	0.00	0.00	0.00	96	0.00	0.00	0.00	0.00	0.00	0.00
2.E - Electronics industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F - Product uses as substitutes for ozone depleting substances	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.G - Other product manufacture and use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.H - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 - Agriculture	**178.52**	**151.00**	**132.17**	**115.48**	**114.31**	**109.11**	**109.33**	**110.05**	**110.53**	**109.36**	**106.59**
3.A - Enteric fermentation	146.08	121.12	106.81	92.62	91.62	88.61	89.13	87.73	88.12	88.06	85.91
3.B - Manure management	29.37	27.55	22.34	19.75	19.93	17.75	17.50	19.75	19.76	18.58	17.89
3.C - Rice farming	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.D - Agricultural land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.E - Regulated savanna burning	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.F Burning crop residues in the fields	3.07	2.33	3.02	3.11	2.76	2.76	2.71	2.57	2.64	2.72	2.80
3.G - Land clearing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.H - Urea application	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.I - Other Carbon Containing Fertilizers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.J Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 - LULUCF	**0.47**	**1.74**	**0.01**	**0.20**	**0.54**	**0.28**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**
4.A Forest land	0.27	0.42	0.01	0.16	0.44	0.22	0.16	0.16	0.16	0.16	0.16
4.B Crops	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.C Pastures	0.21	1.32	0.00	0.03	0.11	0.06	0.04	0.04	0.04	0.04	0.04
4.D Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.E Settlements	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.F Other land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.G Harvested wood products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 - Waste	**149.23**	**117.27**	**107.81**	**105.09**	**104.41**	**104.70**	**101.18**	**103.83**	**106.55**	**108.75**	**110.95**
5.A - Solid waste disposal	108.83	86.66	77.54	75.52	76.03	75.08	74.60	77.41	80.45	82.82	85.16
5.B - Biological treatment of solid waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.C - Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.D - Wastewater treatment and discharge	40.40	30.61	30.27	29.57	28.38	29.63	26.58	26.42	26.10	25.93	25.79
5.E - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total CH_4 emissions with LULUCF	**439.56**	**366.20**	**324.34**	**318.02**	**322.41**	**314.21**	**309.64**	**309.21**	**313.35**	**318.28**	**314.51**
Total CH_4 emissions without LULUCF	**439.09**	**364.46**	**324.33**	**317.82**	**321.86**	**313.93**	**309.43**	**309.00**	**313.14**	**318.08**	**314.31**

2.6.3 Nitrous Oxide (N_2O)

In 2021, N_2O emissions stood at 7.66 Gg and decreased by 29.9% compared to 2010, due to a shortfall in the chemical industry (in the production of nitric acid). The share of N_2O emissions in total emissions ranged from 4.5% in 2010 to 3.2% in 2021 (Table 2.13). Main Nitrous emission sources in 2021 were Agricultural land with 60.5%, Manure management 18.1%, Fuel combustion with 15.5% and Wastewater treatment and discharge with 4.2%.

Table 2.13: N_2O emissions by subsectors and categories (Gg)

N_2O(Gg)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
1- Energy	**1.12**	**0.81**	**1.02**	**1.03**	**1.07**	**1.13**	**1.14**	**1.11**	**1.11**	**1.19**	**1.19**
1.A - Fuel combustion activities	1.09	0.80	1.00	1.02	1.06	1.12	1.14	1.11	1.11	1.19	1.19
1.B - Fugitive emissions from fuels	0.02	0.01	0.02	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00
1.C - Carbon dioxide transport and storage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 - Industrial processes and product use	**2.13**	**0.68**	**1.54**	**1.13**	**0.88**	**0.20**	**0.34**	**0.30**	**0.00**	**0.00**	**0.00**
2.A - Mineral industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B - Chemical industry	2.13	0.68	1.54	1.13	0.88	0.20	0.34	0.30	0.00	0.00	0.00
2.C - Metal industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.D - Non-energy products from fuels and solvent use	0.00	0.00	0.00	0.00	96	0.00	0.00	0.00	0.00	0.00	0.00
2.E - Electronics industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F - Product uses as substitutes for ozone depleting substances	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.G - Other product manufacture and use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.H - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 - Agriculture	**5.69**	**5.28**	**9.92**	**8.38**	**8.37**	**9.88**	**8.87**	**7.39**	**7.24**	**8.79**	**6.10**
3.A - Enteric fermentation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B - Manure management	2.45	2.19	1.90	1.63	1.53	1.46	1.44	1.41	1.40	1.44	1.39
3.C - Rice farming	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.D - Agricultural land	3.15	3.03	7.95	6.67	6.77	8.35	7.35	5.92	5.77	7.28	4.64
3.E - Regulated savanna burning	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.F Burning crop residues in the fields	0.08	0.06	0.08	0.08	96	96	0.07	0.07	0.07	0.07	0.07
3.G - Land clearing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.H - Urea application	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.I - Other Carbon Containing Fertilizers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.J - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 - LULUCF	**0.10**	**0.19**	**0.05**	**0.05**	**0.08**	**0.07**	**0.06**	**0.06**	**0.06**	**0.06**	**0.06**
4.A Forest land	0.01	0.02	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
4.B Crops	0.00	0.00	0.02	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4.C Pastures	0.04	0.13	-0.01	0.00	0.01	3	0.00	0.00	0.00	3	0.00
4.D Wetlands	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
4.E Settlements	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4.F Other land	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4.G Harvested wood products	-50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5 - Waste	**0.46**	**0.37**	**0.35**	**0.34**	**0.33**	**0.33**	**0.33**	**0.33**	**0.33**	**0.32**	**0.32**
5.A - Solid waste disposal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

N_2O(Gg)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
5.B - Biological treatment of solid waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.C - Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.D - Wastewater treatment and discharge	0.46	0.37	0.35	0.34	0.33	0.33	0.33	0.33	0.33	0.32	0.32
5.E - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total N_2O emissions with LULUCF	**9.49**	**7.33**	**12.88**	**10.93**	**10.74**	**11.61**	**10.75**	**9.20**	**8.73**	**10.37**	**7.66**
Total N_2O emissions without LULUCF	**9.39**	**7.14**	**12.83**	**10.89**	**10.65**	**11.55**	**10.69**	**9.13**	**8.67**	**10.31**	**7.60**

2.6.4 Hydrofluorocarbons (HFCs)

NFCs consumption has decreased significantly since 2010, mainly due to the substitution of ozone-depleting substances in air conditioning systems, and the emissions - that were 165 $GgCO_2eq$ (Table 2.14) in 2021 – followed suit. The current HFCs emission assessment methodology will be improved in the coming period and additionally aligned with IPCC methodology, which may result in changing trends and partial emission increase.

Table 2.14: HFCs emissions by source categories (Gg CO_2 eq)

HFCs (Gg CO_2 eq)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
2– Industrial processes and product use	0.0	2.0	42.9	231.4	406.4	348.3	299.9	272.1	223.8	199.3	165.1
2.A - Mineral industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.B - Chemical industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.C - Metal industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.D - Non-energy products from fuels and solvent use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.E - Electronics industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.F - Product uses as substitutes for ozone depleting substances	0.0	2.0	42.9	231.4	406.4	348.3	299.9	272.1	223.8	199.3	165.1
2.G - Other product manufacture and use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.H - Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total HFCs Emissions	**0.0**	**2.0**	**42.9**	**231.4**	**406.4**	**348.3**	**299.9**	**272.1**	**223.8**	**199.3**	**165.1**

2.6.5 Sulphur Hexafluoride (SF_6)

In 2021, SF_6 emissions stood at 49.4 Gg CO_2 eq and increased by 97.0% compared to 2010 (mainly due to emissions from the metal industry and magnesium production). Emissions from electrical equipment (first estimate) amounted to 4.8 Gg CO_2 eq and increased by 53.7% compared to 2010 (Table 2.15).

Table 2.15: SF_6 emissions by source categories (Gg CO2 eq)

SF_6 (Gg CO_2 eq)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
2– Industrial processes and product use	136.0	0.0	13.5	25.1	95.8	101.5	103.1	101.3	75.9	35.1	49.4
2.A - Mineral industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.B - Chemical industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.C– Metal industry	136.0	0.0	12.3	21.9	91.5	97.1	98.7	96.9	71.6	30.3	44.5
2.D - Non-energy products from fuels and solvent use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.E - Electronics industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.F - Product uses as substitutes for ozone depleting substances	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SF_6 ($Gg\ CO_2$ eq)	**1990**	**2000**	**2005**	**2010**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
2.G - Other product manufacture and use	0.0	0.0	1.2	3.1	4.3	4.4	4.4	4.4	4.4	4.8	4.8
2.H - Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total SF_6 emissions	**136.0**	**0.0**	**13.5**	**25.1**	**95.8**	**101.5**	**103.1**	**101.3**	**75.9**	**35.1**	**49.4**

2.7. Key Categories and Uncertainties Analysis

Key categories from the national GHG inventory, both sources and sinks, were identified by using the TIER 1 method (2021) and trend assessment (1990-2021) and are presented in Table 2.16 by CRF categories.

Table 2.16: Key categories, level and trend assessment

Key emission and sink categories	**Gas**	**Criteria used to identify key sources**		**Key category excluding LULUCF**	**Key category including LULUCF**
		Level –- L	**Trend - T**		
1.A.1 Fuel combustion –- Energy generating industries –- Liquid fuels	CO_2	X	X	X	X
1.A.1 Fuel combustion –- Energy generating industries –- Solid fuels	CO_2	X	X	X	X
1.A.1 Fuel combustion –- Energy generating industries –- Gaseous fuels	CO_2	X	X	X	X
.A.2 Fuel combustion –- Manufacturing industry and construction –- Liquid fuels	CO_2	X	X	X	X
1.A.2 Fuel combustion –- Manufacturing industry and construction –- Solid fuels	CO_2	X	X	X	X
1.A.2 Fuel combustion –- Manufacturing industry and construction –- Gaseous fuels	CO_2	X	X	X	X
1.A.3.b Road transport	CO_2	X	X	X	X
1.A.4 Other sectors – Liquid fuels	CO_2	X	X	X	X
1.A.4 Other sectors – Solid fuels	CO_2	X	X	X	X
1.A.4 Other sectors – Gaseous fuels	CO_2	X	X	X	X
1.A.4 Other sectors – Biomass	CH_4	X	X	X	X
1.B.1 Fugitive emissions from solid fuels	CH_4	X	X	X	X
1.B.2.a Fugitive emissions from fuels – Oil and natural gas–- Oil	CH_4	X		X	X
1.B.2.c Fugitive emissions from fuels – Flaring and incineration	CO_2		X	X	X
2.A.1 Cement manufacturing	CO_2	X	X	X	X
2.A.2 Lime production	CO_2		X	X	X
2.B.1 Ammonia production	CO_2		X	X	X
2.B.2 Nitric acid production	N_2O		X	X	X
2.C.1 Iron and steel making	CO_2	X	X	X	X
3.A Enteric fermentation	CH_4	X	X	X	X

Key emission and sink categories	Gas	Criteria used to identify key sources		Key category excluding LULUCF	Key category including LULUCF
		Level –- L	Trend - T		
3.B Manure management	CH_4	X		X	X
3.B Manure management	N_2O	X	X	X	X
3.D.1 Direct N_2O emissions from managed lands	N_2O	X	X	X	X
3.D.2 Indirect N_2O emissions from managed lands	N_2O		X	X	X
3.H Urea application	CO_2		X		X
4.A.1 Forest land that remains forest land	CO_2	X	X		X
4.A.2 Land converted into forest land	CO_2		X		X
4.C.2 Land converted into lawns	CO_2		X		X
4.G Harvested wood products	CO_2		X		X
5.A Solid waste disposal	CH_4	X	X	X	X
5.D Wastewater treatment and discharge	CH_4	X		X	X

19 key categories were identified for 2021 at the level of emissions without LULUCF, i.e. 22 key categories with LULUCF, while the trend assessment identified a total of 23 key categories without LULUCF, i.e. 29 key categories with LULUCF. Category disaggregation was aligned with CRF Table 7 (Addendum I).

Uncertainty in the calculation of GHG emissions and trends over time is determined according to the 2006 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and the Good Practice Guidance for Land Use, Land Use Change and Forestry, by applying the TIER 1 method. The total estimated uncertainty is a combination of individual uncertainties of emission factors and activities.

The uncertainty of the emissions inventory including LULUCF 2021 was 9.5%, trends 2.0%, and combined GHG inventory uncertainty, excluding LULUCF, 8.7% and trends 1.9%. Key sectors contributing most to the deviation are shown in Table 2.17.

Table 2.17: Contribution to total GHG emission uncertainties in 2021

CRF category		Gas	Contribution to total insecurities
5.A	Landfilling of solid waste	CH_4	59.7%
1.A.1	Energy industry-solid fuels	CO_2	14.2%
3.D.1	Direct N_2O emissions from treated soils	N_2O	6.0%
1.B.2	Fugitive emissions from fuels – Oil and natural gas	CH_4	4.2%
3.A	Enteric fermentation	CH_4	3.9%
3.D.2	Indirect N_2O emissions from managed lands	N_2O	3.4%
4.A	Forest land	CO_2	2.8%
2.C	Metal industry	CO_2	2.2%
1.A.3	Transport	CO_2	0.9%
1.A.4	Commercial buildings, housing, agriculture - Biomass	CH_4	0.9%

2.8. Financial, Technical and Capacity Building Needs

Priority needs to improve the quality of GHG inventory include:

• Further strengthening of institutional capacities and cooperation for the purpose of:

o implementation of the duties stipulated in the Law on climate change

o more efficient collection of data needed to compile the GHG inventory and their completeness

o Strengthening cooperation between institutions collecting data on activities

o Implementation of control and quality assurance

o Implementation of the inventory improvement plan

• Strengthening the data collection system

• Production of necessary tools for GHG inventory, as an integral part of IT MRV system

• Preparation and improvement of national emission factors and other required parameters

• Improving the consistency and accuracy of time series

• Improving the reporting system in a way that responds to the requirements of Decision 18/CMA.1

• Modalities, procedures and guidelines for the transparency framework ensuring action and support pursuant to Article 13 of the Paris Agreement

• Inclusion of indirect emissions in the GHG inventory

• Preparation of a complete top-down system reference approach for GHG emission estimates for complete time periods.

It is especially important to reduce the uncertainty of emission estimates and provide better national data and emission factors for categories 5A - Landfilling of solid waste and 3A - enteric fermentation and metal industry.

Therefore, the provision of financial, technical and capacity building assistance to improve the quality of activity data, preparation of national emission factors, supporting methodologies and the establishment of electronic data exchange relevant to the development and improvement of inventory are priorities in the field of GHG monitoring and reporting.

These improvements primarily depend on the number of employees working on GHG inventory issues and the capacity of SEPA. Therefore, the key need is to establish a team, in the next 1-2 years, composed of 4 (minimum 3) experts with educational profiles close to the sectors involved in the GHG inventory, one QA / QC expert and general knowledge of inventory. Concurrently, it is crucial to strengthen the capacity of institutions which collect activity data.

3. GHG EMISSION REDUCTION POTENTIALS AND OPPORTUNITIES

3.1. Introduction

The potentials and opportunities for reducing GHG emissions by 2030 and 2050 in the Republic of Serbia have been identified in the Strategy, and the measures to achieve them are described in the Action Plan (both documents were completed in 2018, whereby the Strategy was adopted in 2023). This report presents a long-term strategy to reduce GHG emissions. The possibilities for reducing GHG emissions by 2050 have been identified through the following scenarios:

- → **Without measures (WOM)** or Baseline (Business as usual, BaU) - Excludes all policies and measures implemented, adopted, or planned after 2015;
- → **With measures (WEM)** - Considers policies and measures provided for in the adopted Strategy;
- → **With Additional Measures (WAM)** - GHG emission reduction by 80% compared to 1990.

The implementation of the WAM scenario (additional action in relation to WEM) is possible with full financial, technological and technical assistance of the international community.

The reference year is 2010, and the 2015 is the modelling baseline year . Three models were used:

- → PRIMES - GEM-E3 package: composed of PRIMES energy system model and GEM-E3 model for macroeconomic projections;
- → CAPRI - Common Agricultural Policy Regional Impacts Model, Model for Agriculture and Land Use, Land Use Change and Forestry (LULUCF);
- → IPCC 2006 Waste model for the waste sector (excluding wastewater, which was estimated using a different, simplified approach).

GHG emission levels by 2070 were also estimated based on the results of the model until 2050, and continuing trends influenced by demographic trends after 2050, and with using the CAPRI model for the agricultural sector.

The same projections of GDP, population, and economic parameters that characterise the sectors were used for all scenarios. Complete comparability of scenario results is ensured using the same assumptions related to macroeconomic and demographic parameters and global fuel price projections.

Compared to the second BUR, this report presents a new WAM scenario. Assumptions and data relevant to BaU and WEM until 2030 are presented in the BUR, while those for the long term (until 2050) and the more ambitious WAM scenario are explained here (Chapters 4 and 5 and Addendum II).

3.2. GHG Emission Reduction Scenarios

3.2.1 Scenario Without Measures (WOM/BaU)

Emission levels in WOM for the period 2030 - 2050 (until 2030 in 2BUR) and changes compared to 2010 are shown in Table 3.1 and Figure 3.1. GHG emission will grow until 2050 (from 2020), temporarily stabilising in the period from 2040 to 2045 (replacement of existing lignite power plants with new and more efficient ones). Total possible reduction of emissions in 2050 according to this scenario, without LULUCF, is 10.7% compared to 2010.

Table 3.1 GHG emissions and trends compared to 2010 (kt CO_2eq)

BaU scenario	2010	2020	2025	2030	2050	2020/ 2010	2025/ 2010	2030/ 2010	2050/ 2010
Energy industry	33,050	34,451	34,188	34,590	37,472	4.2%	3.4%	4.7%	13.4%
Manufacturing and construction industries	4,278	3,898	4,062	4,014	3,837	-8.9%	-5.0%	-6.2%	-10.3%
Transport	6,742	7,197	7,822	8,354	9,518	6.7%	16.0%	23.9%	41.2%
Other sectors	3,477	2,627	2,660	2,677	2,532	-24.4%	-23.5%	-23.0%	-27.2%
Fugitive Emissions	2,409	2,406	2,474	2,221	1,750	-0.1%	2.7%	-7.8%	-27.3%
IPPU	4,660	4,736	5,384	5,671	6,608	1.6%	15.5%	21.7%	41.8%
Agriculture	5,305	5,133	5,046	4,752	5,721	-3.3%	-4.9%	-10.4%	7.8%
Waste	2,730	2,755	2,582	2,371	1,936	0.9%	-5.4%	-13.1%	-29.1%
TOTAL BaU (without LULUCF)	62,650	63,204	64,218	64,650	69,374	0.9%	2.5%	3.2%	10.7%

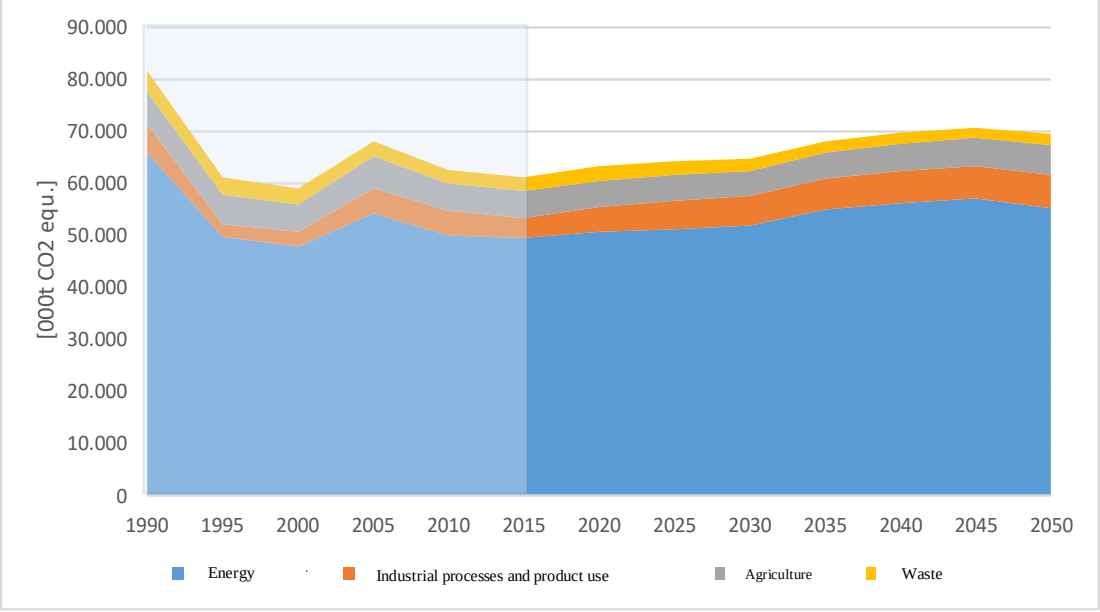


Figure 3.1: GHG emissions in BaU scenario (kt CO_2 eq)

GHG emissions in the energy sector will rise, including the energy industry and transport subsectors (almost 50% of total 2050 emissions), in agriculture and IPPU, while they will decrease in other sectors.

3.2.2 Scenario With Measures (WEM)

According to the WEM scenario, GHG emissions will increase until 2020, after which they will decrease until 2050 and achieve a drop of 55% compared to 2010 (Table 3.2. and Figure 3.2.).

Table 3.2: GHG emissions by sectors (kt CO_{2eq}) and trends (%) according to the WEM scenario

CWEM scenario [kt CO_2eq]	2010	2020	2025	2030	2050	2030/ 2010 (%)	2050/ 2010 (%)
Energy industry	33.050	34.548	31.164	27.426	7.596	-17,0	-77,0
Manufacturing and construction industries	4.278	3.842	4.101	3.651	2.691	-14,7	-37,1
Transport	6.742	7.096	7.406	7.433	4.731	10,2	-29,8
Other sectors	3.477	2.393	2.267	2.089	1.035	-39,9	-70,2
Fugitive Emissions	2.409	2.429	2.279	1.938	220	-19,6	-90,9
IPPU	4.660	4.736	5.178	4.994	4.539	7,2	-2,6
Agriculture	5.305	5.132	4.813	4.493	5.432	-15,3	2,4
Waste	2.730	2.755	2.582	2.371	1.936	-13,1	-29,1
Total WEM (without LULUCF)	62.650	62,931	59,790	54,396	28,180	-13.2	-55.0

The largest emission reductions in 2050 compared to 2010 can be expected in the energy sector, from the following areas:

- → Energy industry (dominated by electricity and heat production) - by 77%; and
- → Fugitive emissions from mining and post-mining activities as a result of market-initiated phase-out of coal - by 90.9;

followed by:

- → Manufacturing industries and construction - by 37.1%;
- → Other sectors - by 70.2%;
- → Waste management - by 29.1% due to the reduction of biodegradable waste; and IPPU - by 2.6%.

GHG emissions from transport and agriculture will grow by 29.8% and 2.4%, respectively.

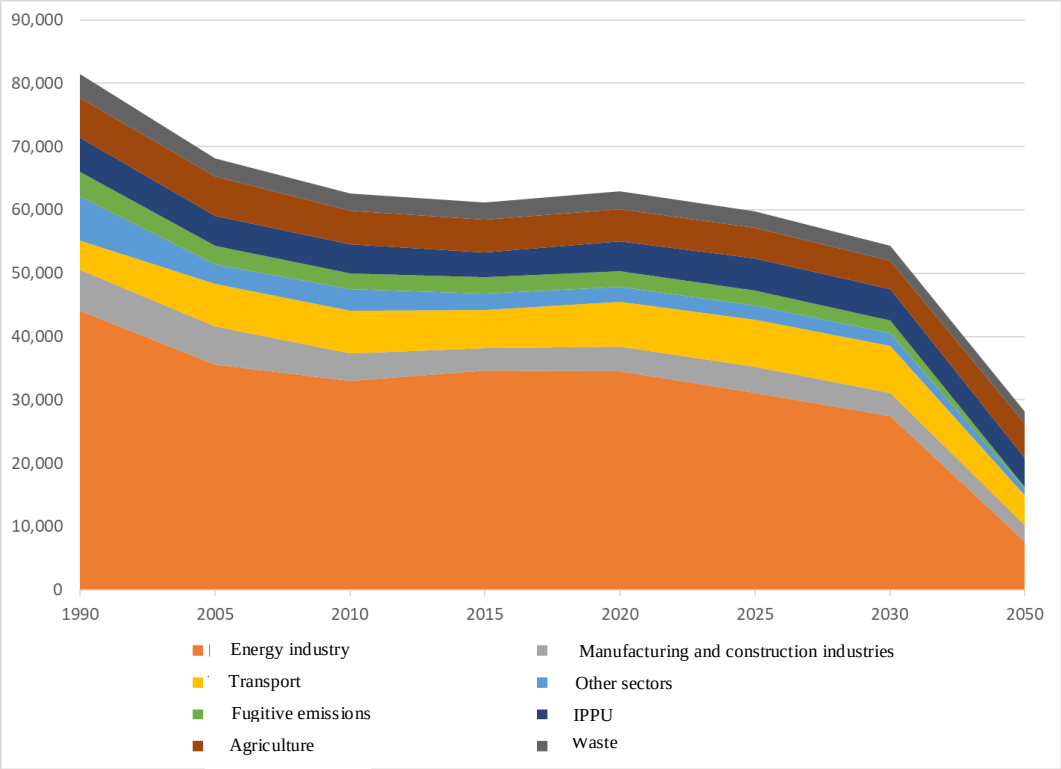


Figure 3.2: GHG emissions by sectors according to the WEM scenario

3.2.3 Scenario With Additional Measures (WAM)

As an EU candidate country, Serbia is aligning its legislation with EU legislation and policies. Thus, the WAM scenario is actually harmonized with the existing EU legislation, without taking the EU Green Deal into account. Therefore, the scenario started from the previously assumed reduction of EU GHG emissions by 80% compared to 1990. Taking into account national circumstances and available technologies, the WAM scenario projects a reduction in GHG emissions in 2050 by 76.2% and 69.1%, respectively, without removal through sinks compared to 2010 (Table 3.3). Determining the potential for achieving carbon neutrality should be the goal of the next modelling for Serbia.

Table 3.3: Total GHG emissions (kt CO_2eq) and trends (%)

Target year	1990	2010	2020	2025	2030	2050
Total GHG emissions (kt CO2eq)	81,526	62,650	62,328	54,804	46,140	19,366
Comparative years	2020/2010	2025/2010	2030/2010	2050/2010	2030/1990	2050/1990
Trend	-0.5%	-12.5%	-26.4%	-69.1%	-43.4%	-76.2%

The largest decline in GHG emissions in 2050 will be achieved by the Fugitive Emissions sector (-92.9%), then Energy industry (88.6%) assuming complete coal phase out, Other sectors (77.8%) and Waste Management (69.1%) (Table 3.4).

Table 3.4: GHG emissions and trends by sector and subsectors according to the WAM scenario

WAM Scenario [kt CO_2e]	2010	2020	2025	2030	2050	2030/ 2010 (%)	2050/ 2010 (%)
Energy industry	33,050	34,537	27,995	22,824	3,767	-30.9	-88.6
Manufacturing and construction industries	4,278	3,851	4,112	3,134	1,917	-26.7	-55.2
Transportation	6,742	6,944	7,006	6,396	3,091	-5.1	-54.1
Other sectors	3,477	2,392	2,115	1,996	772	-42.6	-77.8
Fugitive Emissions	2,409	2,424	2,168	1,709	171	-29.1	-92.9
IPPU	4,660	4,731	5,167	4,625	4,787	-0.7	2.7
Agriculture	5,305	5,132	4,691	4,249	4,015	-19.9	-24.3
Waste	2,730	2,317	1,551	1,207	845	-55.8	-69.1
Total (without LULUCF)	62,650	62,328	54,804	46,140	19,366	-26.4	-69.1

The emission reduction from the Transport Sector may be higher than the expected 54.1% with a significant change in the macroeconomic situation compared to the assumed one in 2050.

3.2.4 GHG Emissions Projections by Gases

Emissions by gases for all scenarios (BaU, WEM and WAM) are shown in Table 3.5 and Figure 3.3.

Table 3.5 GHG emissions projections by gases according to three scenarios

WOM/BaU	1990	2000	2005	2010	2015	2020	2025	2030	2050
CO_2	67,621	47,945	56,261	51,632	50,467	51,913	52,954	54,005	58,445
CH_4	10,550	8,613	7,703	7,525	7,569	6,883	6,659	6,075	4,798
N_2O	3,223	2,460	4,073	3,488	3,425	3,745	3,800	3,656	5,033
HFCs	0	2	45	239	412	552	680	793	976
PFCs	0	0	0	0	0	0	0	0	0
SF_6	132	0	12	21	89	110	124	121	123
WEM	**1990**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2050**
CO_2	67,621	47,945	56,261	51,632	50,467	51,609	48,919	44,395	19,566
CH_4	10,550	8,613	7,703	7,525	7,569	6,916	6,528	5,897	3,641
N_2O	3,223	2,460	4,073	3,488	3,425	3,745	3,548	3,325	4,440
HFCs	0	2	45	239	412	552	680	678	442
PFCs	0	0	0	0	0	0	0	0	0

SF_6	132	0	12	21	89	110	115	100	91
WAM	**1990**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2050**
CO_2	67,621	47,945	56,261	51,632	50,467	51,447	45,204	37,797	13,585
CH_4	10,550	8,613	7,703	7,525	7,569	6,493	5,385	4,496	2,449
N_2O	3,223	2,460	4,073	3,488	3,425	3,727	3,420	3,128	3,087
HFCs	0	2	45	239	412	552	680	638	124
PFCs	0	0	0	0	0	0	0	0	0
SF_6	132	0	12	21	89	110	114	81	120

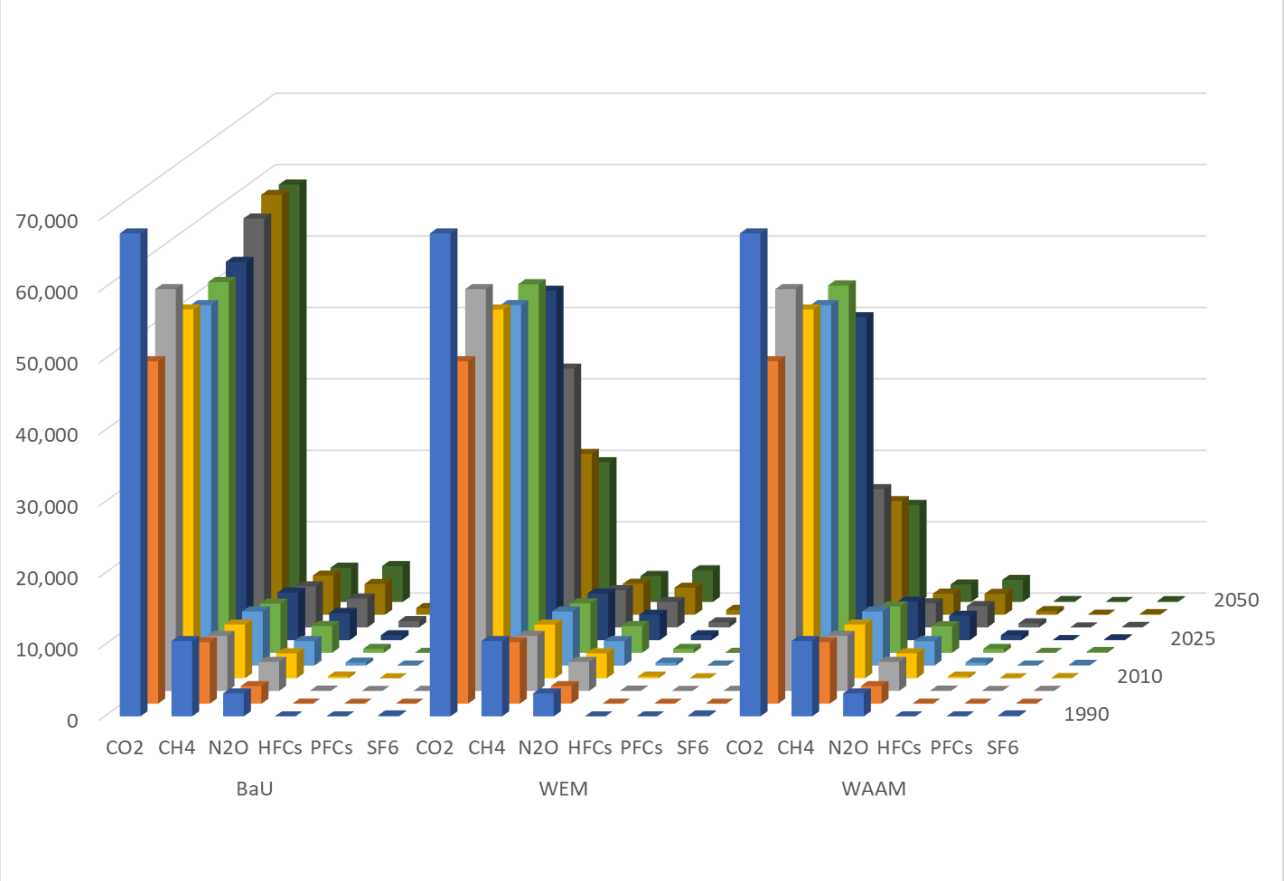


Figure 3.3 GHG emissions projections by gases and scenarios

According to all scenarios, carbon dioxide remains the largest part of total emissions from 2030 to 2050, but there will be three times less of it in 2050 according to the WEM scenario and more than 4 times less in the total amount of emissions according to WAM, when compared to BaU. According to the BaU scenario CO_2 will account for more than 99% of total GHG emissions in the energy industry and 94% in the Energy sector.

Methane emissions by 2030, followed by N_2O emissions, represent the second largest emissions. N_2O emissions are on the rise by 2050 compared to 2010, with the exception of the WAM scenario according to which they are in decline due to assumed significant improvements in wastewater management. HFC emissions are on the rise under all scenarios.

3.3. Actions, Policies and Mitigation Measures

The actions, policies and measures to reduce GHG emissions shown below are those needed to achieve the objectives of the WEM, as well as the WAM scenario, an additional scenario compared to those already shown in SBUR (Table 3.6).

Table 3.6: GHG emission reductions policies and measures and additional implementation costs by 2030 and 2050 against the BaU scenario.

No.	Mitigation action	GHG emission reduction compared to BaU			Implementation costs (M€):		
1	Harmonisation with the EU emissions trading system and/or introducing other instruments for carbon pricing		WEM	WAM		WEM	WAM
		2030	6,942	11,526	2021-2030	279	-89
		2050	29,730	33,556	2031-2050	2,330	3,568
2	Increasing the use of RES in energy production		WEM	WAM		WEM	WAM
		2030	4,397	5,631	2021-2030	635	1,390
		2050	10,113	10,113	2031-2050	5,266	14,063
3	Improving energy efficiency and increasing the use of CHP and RES in district heating systems	Included in Mitigation action 1				WEM	WAM
					2021-2030	i.e.	i.e.
					2031-2050	i.e.	i.e.
4	Increasing the share of RES and energy efficiency in industry		WEM	WAM		WEM	WAM
		2030	715	1,283	2021-2030	694	1,177
		2050	1,483	2,265	2031-2050	-559	-213
5	Improving the thermal insulation of households		WEM	WAM		WEM	WAM
		2030	220	163	2021-2030	1,852	8,126
		2050	737	900	2031-2050	7,438	24,983
6	Energy efficiency, improvemen	Included in Mitigation action 5				WEM	WAM

	t of heating and cooling infrastructur e and promotion of RES use in households		2021-2030	81	-71
			2031-2050	-37	-760
7	Improving energy efficiency and the use of RES in the tertiary sector		WEM	WAM		WEM	WAM
		2030	365	516	2021-2030	94	-30
		2050	754	852	2031-2050	-391	-1,011
8	Improving thermal integrity in the tertiary sector	Included in Mitigation action 7				WEM	WAM
					2021-2030	169	4,112
					2031-2050	2,842	5,714
9	Renewal of the passenger car fleet and promoting sustainable passenger transport		WEM	WAM		WEM	WAM
		2030	752	1,125	2021-2030	2,263	2,406
		2050	3,367	4,256	2031-2050	18,214	24,799
10	Freight transport fleet renewal and promotion of sustainable freight transport		WEM	WAM		WEM	WAM
		2030	156	807	2021-2030	388	1,204
		2050	1,393	2,13	2031-2050	2,086	3,458
11	Raising awareness of the benefits of winter cover crops		WEM	WAM		WEM	WAM
		2030	579.05	581.07	2021-2030	76	76
		2050	622.67	625.58	2031-2050	434	436
12	Increasing the share of legumes in livestock feeding		WEM	WAM		WEM	WAM
		2030	14.60	15.36	2021-2030	4	4
		2050	14.28	14.41	2031-2050	17	18
13	Afforestatio n		WEM	WAM		WEM	WAM
		2030	259.1	2037.8	2021-2030	35	272
		2050	832.3	6982.2	2031-2050	70	544
14	Conversion of coppice		WEM	WAM		WEM	WAM

	forests to high forests	2030	458.4	458.4	2021-2030	34	34
		2050	1,146.1	1,222.5	2031-2050	67	67
15	Formation of short rotation plantations (SRPs) - willows and poplars		WEM	WAM		WEM	WAM
		2030	654.84	n/a	2021-2030	18	18
		2050	1,637.2	n/a	2031-2050	36	36

The implementation of the proposed measures in the field of forestry also provides additional social benefits, as they generate approximately 2,000 to 3,000 new jobs in the primary sector alone. Additional opportunities for new jobs can be expected in the wood industry (at least 1,000). This is important given the loss of jobs in sectors related to coal mining and exploitation. Achieving the goals set by the WAM scenario requires financial, technological and technical support from the international community. In addition to the above, the actions that need to be implemented in the period 2030 - 2050 to achieve the WAM scenario and which completely rely on international support are shown in Table 3.7.

Table 3.7: Policies and measures for the 2030 - 2050 with international support

Measure	Description	Target year	Reductions in CO_2eq (kt) compared to WOM	Implementation costs (M€)
AGRICULTURE				
Raising cows with higher milk yield	Raising cows with higher milk yield can reduce total emissions because their number is reduced for the same milk production. The effects of this measure lead to the reduction in nitrous oxide emissions.	2030	i.e.	4
		2050	i.e.	47
Addition of flaxseed in the feeding of domestic animals	Lipid supplementation in animal feeding increases the energy content of the diet, and thus improves energy utilization and reduces methane emissions produced by ruminants. One of the most effective lipids is flaxseed.	2030	9.00	22
		2050	64.47	422
Precision Farming	Precision Farming (PF) is a management concept based on monitoring, measuring and responding to crop variability. PF can reduce fertilizer and fuel costs, but also contribute to increased yields. It is expected that larger farms will voluntarily apply this technology if its effect has been proven.	2030	20.44	17
		2050	60.02	177
Anaerobic digestion	A by-product of anaerobic digestion (AD) is digestate, a nutrient-rich substance commonly used as a fertilizer. Manure, crop residues and dedicated energy crops from agriculture are used as raw materials for AD, but also organic waste products from the food industry and households and digestion produces energy that can be sold or used for own	2030	9.15	1
		2050	36.23	55

	needs. The application of anaerobic digestion on farms with more than 200 heads is assumed here.			
Anti-methanogenic vaccination	Development of vaccines that will reduce the production of methane in the animal's stomach (rumen) due to enteric fermentation of ruminants.	2030	n/a	0
		2050	44.76	96
Nitrification inhibitors	Nitrification inhibitors are chemical compounds which delay the bacterial oxidation of ammonium ions. Nitrosomonas bacteria lead to the transformation of ammonia through nitrite (NO2) to nitrate (NO3). Depending on the increase in the efficiency of nitrous use and its positive effects on costs, the application of this technology can be expected in the future.	2030	n/a	0
		2050	204.64	292
Nitrates as a dietary supplement	With the help of nitrates bacteria from the stomach of animals (rumen) can lead to the reduction in methane production. The essence of this measure is to add the necessary nitrates to feeding.	2030	n/a	0
		2050	0.46	14
WASTE				
Separation of waste at the source and the construction of the material recovery facility	The establishment and application of a system of separation at the source in all local governments and the construction of at least one facility for the recovery of materials in each region of waste management are assumed. The goal is to increase the recycling of recyclable materials and the removal of biodegradable fractions (i.e. paper and cardboard) from landfills. Only 10% of paper and cardboard waste is planned for landfill disposal.	2030	109.7	30
		2050	220	24
Construction of biological treatment facilities (composting plants)	It is assumed that biodegradable and green waste should be collected separately and that at least one biological treatment facility should be built in each region. The aim is to increase	2030	219.4	69
		2050	280	55

	the removal of biodegradable waste from landfills by introducing defined biological treatment options (e.g. open composting plants and the production of high/quality compost).			
Construction of biological treatment facilities (anaerobic digestion)	By 2050, produce compost from 85% of the generated food waste and garden waste, and treat 15% with anaerobic digestion. Under this scenario, 0% of food waste and garden waste will be disposed of at landfills. The combination of treatment for recycling (paper and cardboard) and composting will divert 90% of waste from landfills (of which 60% goes for recycling, 20% for composting, and 10% for incineration).	2030	164.6	90
		2050	320	72
Enhanced waste prevention initiatives	Increased waste prevention by 28% by 2050, which is about a 2% reduction in waste by preventive measures per year.	2030	86.8	110 88
		2050	324	
LULUCF				
Regeneration of over matured stands	It is assumed that the over matured beech stands on 70,000 hectares will be regenerated in the period until 2035. The annual growth of over matured stands is 3 m^3/ha and the absorption capacity is negligible compared to the growth of young stands of 8 m^3/ha. This means a cutting area of 4,200 ha/year.	2030	654,89	No additional cost
		2050	0	

3.4. Costs and Financial Needs

Certain funds are needed for the implementation of these activities, which distribution in the 2031-2050 period is shown in Table 3.8. In addition to the costs of achieving the GHG emission reduction targets from the scenarios presented in this report, Table 3.8 also shows the costs of the Scenario with additional measures for the period by 2030, presented in SBUR, in order to obtain a complete picture. Costs are shown in relation to the costs of the Scenario without measures or the Baseline Scenario.

Table 3.8 Additional costs and their distribution in the 2030 – 2050 period (in millions of EUR) compared to costs of scenario without measures

Additional costs compared to WOM / BAU	Total	Investors	Consumers	State
WEM				
Energy supply	37,088	9,123	25,514	2,451
IPPU	81.9		81.9	0
Agriculture	468.8	468.8	0.0	0
LULUCF	183.1	183.1	175.58	7.5
Additional costs compared to WOM/BaU	37,822	9,768	25,596	2,459
WAM from SBUR				
Energy supply	39,361	15,664	23,500	196
IPPU	105.6		105.6	0
Agriculture	1,054.3	1,054.3	0.0	0
Waste	78.8			78.8
LULUCF	183.1	183.1	175.6	7.5
Additional costs compared to BaU	40,782	16,894	23,606	4,283
WAM				
Energy total	74,219	20,877	48,639	4,703
IPPU	128.9		128.9	0
Agriculture (total)	468.8	468.8	0.0	0
Waste (total)	238.8			239
LULUCF (total)	621.1	183.1	613.58	7.5
Additional costs compared to BaU	76,792	23,075	48,768	4,949

By 2035, for implementing the activities, it is assumed that 90% of the total costs will be covered through loans, while the loans will cover 70% of the total costs from 2035 onwards. Additional costs in relation to the WOM scenario are also those required for employment in the relevant state bodies (Table 3.9).

Table 3.9: Additional FTE and cost estimates from the national budget according to different scenarios

	Additional FTE		Additional estimated state budget spending (000 euros)	
	WEM	WAM	WEM	WAM
Energy supply	19	28	190	280
Agriculture	3	8	30	80
Forestry	11	15	110	150
Waste	-	10	-	100
Total	33	61	330	610
	Additional FTE	Additional costs from the budget (000 euros)		Additional FTE

3.5. Long-Term Framework for GHG Emission Reduction by 2070

The GHG emission change trends since 1990 to 2070 are shown in Table 3.10.

After 2050, the agricultural sector will fully dominate total national emissions (> 60% of national GHG emissions), which will increase by another 10% in the period 2050-2070. The contribution of the waste management sector to total emissions will decline after 2050 to a symbolic one in 2070.

Table 3.10: GHG emission levels – 2070 outlook

[MiotCO_2e]	2050	2070
WOM	69,374	45,644
WEM	28,180	16,952
2BUR WAM	25,269	10,092
WAM	19,366	7,784

Starting from the assumptions of these scenarios, it is clear that the decarbonisation of the Serbian economy is possible in the long run (2070 or later) and requires, among other things, significant additional afforested areas, which in turn can jeopardize food production and security of food availability.

3.6. The development of new technologies and e-fuels could be an additional alternative, especially in the Energy industry category, as well as the intensive application of carbon capture and storage technologies, the use of hydrogen and the application of circular economy principles. Shortcomings, limitations and needs

Planning sectoral measures and policies in a way that leads to the reduction of GHG emissions, assessing the effects on the level of GHG, which includes making GHG projections and monitoring their implementation are not subject to the legal framework. The Law on Climate Change introduces this basis and makes them binding. Additionally:

- Awareness of the need to include aspects of reducing GHG emissions in sectoral policies and measures is almost non-existent;
- Understanding the models and projections in relevant institutions is low;
- Technology needs assessments and technology transfers have not been conducted;
- There is no systematic and systematically collected information on climate finance, research and capacity building activities.

To overcome these shortcomings, it is necessary to strengthen the capacity of:

- *Sectoral ministries for:*

1) understanding the link between climate change and sectoral policies and development goals, especially among decision makers;
2) understanding the basic principles and functioning of GHG models and projections (a sufficient number of trained sector experts is required);
3) understanding the sensitivity analysis for projections;
4) including GHG projections in sectoral documents;
5) establishing a system for monitoring and reporting on effects and costs, sectoral policies and measures (RAM) and preparing corrective actions;

6) establishing a system for monitoring and reporting on research and capacity building activities in sectors relevant to climate change, as part of or related to the RAM monitoring and reporting system.

It is especially important to strengthen awareness and capacities of:

- the Ministry of Finance and local governments on the need to:

1) define, monitor, and report on climate financing;
2) provide funding for actions and reporting.

As presented in SBUR, the financial costs of establishing an MRV system are equivalent to an increase in human resources of 5.9 to 8.2 FTE[13], while implementation requires between 7.9 to 10.2 FTE (more than 1 expert per year in practice). An additional need for electronic data exchange and reporting is the subject of the CBIT project.

The reduction of GHG emissions, as assumed by the scenarios, implies a significant reduction in the number of jobs in the energy sector and a significant increase in jobs in construction and forestry and the forestry sector. Therefore, financial and capacity building mechanisms and education should be created facilitating the transition of workers from the sector with a reduction in economic activity to those where growth is expected. It is also urgent to develop decarbonisation plans for coal-dependent areas and regions.

4. ADAPTATION TO CLIMATE CHANGE

4.1. An Overview of Approaches in Adaptation Planning and Implementation in the Republic of Serbia

Adaptation to climate change is regulated in the Republic of Serbia with the Climate Change Adaptation Programme for the period 2023-2030, with accompying Action plan for the period 2024-2026 (hereinafter: Adaptation Programme), developed pursuant to the Law on Climate Change adopted in 2021. Analyses of climate change, impacts with vulnerability assessments and risks, and priority adaptation measures were developed for the purpose of developing this Program. The Action plan elaborates activities for the implementation of Adaptation Programme measures over a three-year period, with budget allocation estimates and donor (project-based) funding.

In order for the Republic of Serbia to achieve or increase its climate change resilience by mid-21st century, the primary and **main goal** at national level is: *raising capacities to achieve greater resilience to climate change with a view to enhance the wellbeing of people, nature and the environment*. This goal is to be implemented by 2030 through a group of measures defined within **specific objectives**, specifically related to the following: **(1)** raising the level of awareness and education on climate change and climate hazards – enabling Serbian citizens and stakeholders (entrepreneurs, manufacturers, etc.) to protect themselves, their property, and businesses through risk reduction, as well as to enable the government and the scientific community to further monitor the impacts and expand the knowledge base in this field; **(2)** systemic implementation of adaptation from the national to the local levels – through including climate change issues and risk reduction measures and accelerating recovery from negative impacts through strategic planning, and/or embedding adaptation processes into public policy acts; **(3)** increasing the resilience of critical infrastructure and natural resources – as priority in reduction of loss and damage due to climate change impacts, through changing the modes of

[13] FTE – full time equivalent

planning and construction; **(4)** securing funding for the implementation of adaptation processes – reallocation of budget funds and focusing project activities from various funds with the aim of increasing the adaptation efficacy.

Activities leading to the development and implementation of a sustainable adaptation process are implemented through 25 adaptation measures defined as priorities and feasible to 2030. The allocation of measures by sectors accountable for implementation according to defined objectives are shown in Figure 4.1. The distribution of funding allocated for the implementation of the Action plan, their distribution in groups of measures defined by goals, and their distribution by years, are shown in Figure 4.2. Most of the measures concern the provision of information and further expansion of knowledge, whereas most of the funding was provided for measures implemented with the aim of providing money for urgent investment, in terms of investment within the group of measures under goal 4. Nearly 90% of all necessary investments in developing and implementation of the adaptation processes over the coming three years will be provided from the budget, while approximately 10% is expected from other sources of funding, i.e. projects. Also, in line with broader recommendations on activities that need to be implemented with a view to implement adaptation quickly and effectively, options were opened for additional projects that are at the planning stage and that were not considered in this round of funding allocation due to uncertainty of their implementation. It is expected that information originating in developed risk analyses, recommendations, and identified shortcomings, will focus further potential investment from international funds and thereby ensure additional necessary steps in implementing adaptation to climate change.

Additional information relative to planning and implementation of adaptation measures within the Climate Change Adaptation Programme are shown in section 5 of this chapter.

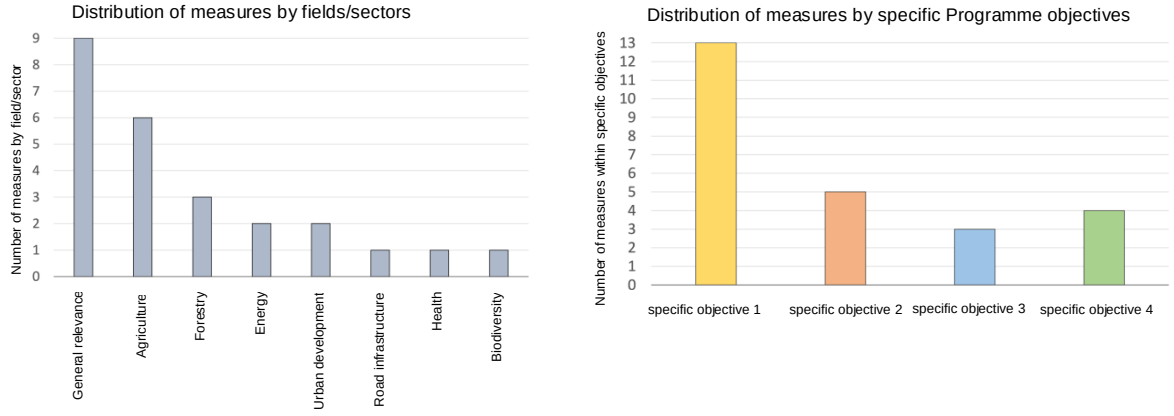
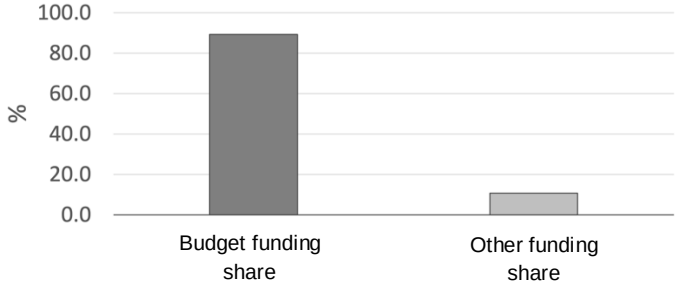


Figure 4.1 Distribution of priority adaptation measures by sectors with direct benefits, i.e. directly accountable for implementation (left) and grouped by types of defined objectives (right).



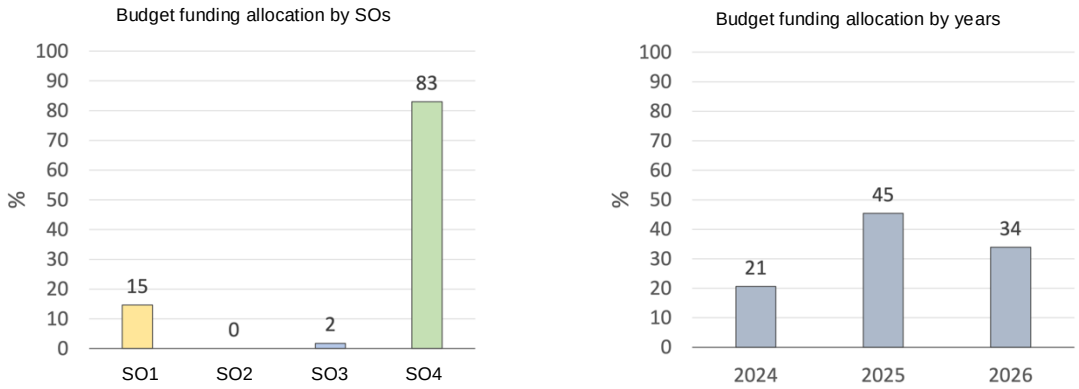


Figure 4.2 Distribution of funding within planned activities across the period 2024-2026: share of budget- and other types of funding (top), distribution by objectives (bottom left), distribution by years (bottom right). Values were deduced according to estimates in the Adaptation Programme for the action plan for the period 2024-2026, with total necessary funding of approximately RSD 1 billion.

4.2. Climate Change Analysis

A climate change analysis was developed for the purpose of planning adaptation to climate change in line with the IPCC Sixth Assessment Report (2021) methodology and terminology and with the understanding of the air-water-land nexus to the extent that current knowledge and data availability make it possible. This defined climate impact-makers and other climate-related hazards and categorised them in groups of threats causing climate change, which are excessively hot conditions, excessively humid, excessively dry conditions and, additionally, a group of threats connected with storms. This is how sector-based adaptation planning is informed about the vulnerabilities of the climate system and it enables the application of the nexus in adjustment planning in order to create a sustainable adaptation process that also implies the conservation of natural resources. Climate hazards also include weather conditions, extremes, and threats that are the consequence of the impact of weather conditions on a territory with certain characteristics (floods, fires, landslides, etc.). Other sector specific climate hazards were also defined, provided there were enough available data. Key results and/or information on changing climate conditions, as well as past and future climate-related hazards, are shown in Table 4.1.

Analyses of perceived climate change were done for the recent past period 2001-2020 (and separately for the decade of 2011-2020 due to the intensification of the change) and contrasted with the reference period between 1961 and 1990. Future climate change analyses were also made for the close future period 2021-2040, mid-century period 2041-2060 and the end of century period 2081-2100, according to greenhouse gas emission scenarios RCP4.5 and RCP8.5, using a multi-model ensemble approach. Future changes were made contrasting the same reference period. Addendum III presents an overview of climate impact-makers for which the analyses were made (Table III1) and sums up the most important results obtained for the territory of Serbia (Table III2) taken from the Adaptation Programme, that also provided the information overview in Table 4.1.

Table 4.1 A short overview[14] of the climate change analysis results with consequences in other components of the climate system (water and land) for the period 2001-2020 (especially highlighted in brackets for 2011-2020 where relevant) and for the future period 2041-2060 (most likely outcome including analysis according to both scenarios). If not indicated otherwise, the presented changes were given in comparison with values during the reference period 1961-1990.

Climate threat group	2001-2020 (2011-2020)	2041-2060
Too hot	Mean temperature +1.4°C (+1.8°C) Mean temperature for JJA +2.0°C (+2.4°C); Mean maximum temp. for JJA +2.2°C (+2.6°C) Number of heat waves per year +2.4 (3) Number of hot days (t. above 35°C) per year +4 to +7 in lowland areas (+10 in individual regions)	Mean temperature +3.1°C Number of heat waves per year +4 to +5 Number of hot days (t. above 35°C) per year more than +20 in lowland areas and ocurrence of these days in higher mountainous areas.
Excessive water/humidity	Moving the average annual maximum precipitation closer to the earlier months (change in annual precipitation distribution), colder period of the year and snowmelt period. The share of precipitation delivered in the form of extreme precipitation (over 30 mm per day) has increased by more than 100%. The share of small and moderate precipitation has decreased. (change in distribution of precipitation by intensity to higher intensity precipitation). Approximately 7% of the territory of Serbia is at high risk (at risk each year) of extreme precipitation.	Extreme precipitation continues increasing. High risk of extreme precipitation in 56% of the territory of Serbia.
	Flows are increasing during the higher flow period and maximum flow levels are increasing as well in local rivers, south of the Sava and the Danube. The risk of flood is rising. The risk of soil degradation due to large precipitation events is also on the rise.	
Insufficient water/humidity	Reduction of average precipitation in JJA in the range of 10-20% (as a consequence of changing yearly distribution of precipitation). On average 4 years with droughts per decade (5 years per decade). On average there was 1 year with drought in the reference period. There was 1 instance of extreme drought (defined according to major damages in 2012) in the period 2011-2020. Average aridity/humidity level value for Serbia is in the category of humid climate (no change compared to the reference period).	Reduction of average precipitation amounts for JJA over 20%. On average, every year is a year with drought on the territory of Serbia. Frequency of extreme droughts: 3-4 per year. Higher level of climate aridity, dry sub-humid climate present on the territory of Serbia on average.

[14] Detailed analyses and results, including the explanation of the applied methodology, sources of data and information, are given inside the adaptation programme, while an overview of climate impact-makers and summaries of results for all periods are in Addendum III (taken from the adaptation programme)..

	Reduction of river flow in period with lower water levels. Extension of periods with low flow levels. Reduction in lowest flow level values. Reduction in the groundwater recharge speed. Increasing risk of soil degradation due to rising aridity levels. Higher frequency of weather conditions conducive to fires breaking out and spreading.
Storms	Increasing in intensity and frequency, including wind and hail impact strength. Larger average hailstone size.

4.3. Digital Climate Atlas of Serbia

The Digital Climate Atlas of Serbia web portal (atlas-klime.eko.gov.rs; Figure 4.3) was created to enable the use of climate data, i.e. the data concerning climate change, in all aspects of policymaking from national to local level, various scientific disciplines, as well as in education and classes in schools and universities. This provides for easy downloading of the data, maps and graphs, containing data for various spatial scales (national, regional, municipal and site levels). It is possible to download daily data for past and future periods, obtained respectively from observation and climate models employing various greenhouse gas emission scenarios, until 2100. Downloading was also enabled for standard climate parameter results (e.g. mean temperatures and precipitation sums) and more 20 various climate indices, as well as values for their changes. The portal can be supplemented with other relevant indices if the need arises. Training on using the Digital Atlas and development of material with instructions and recommendations for the use of data are currently ongoing. The portal was developed in Serbian and English language versions.

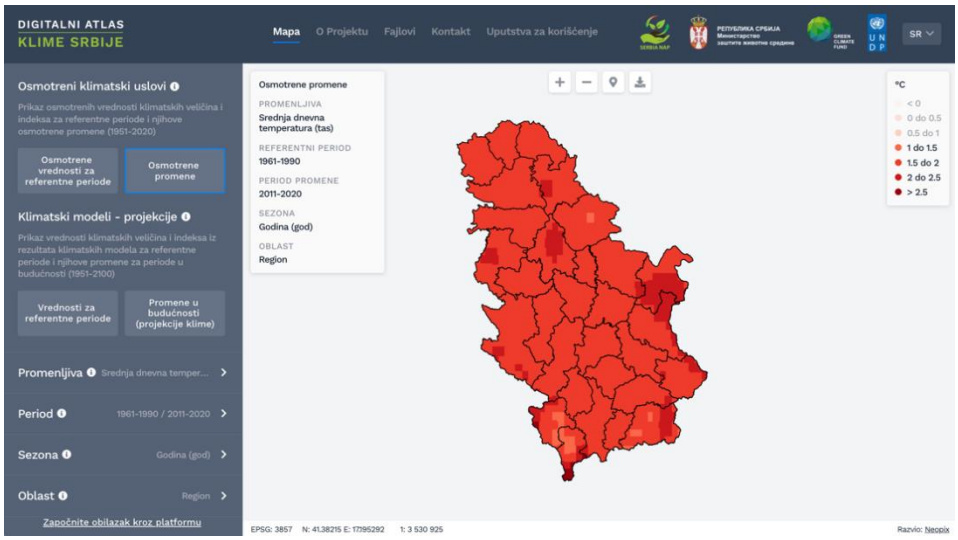


Figure 4.3 Digital Climate Atlas of Serbia (atlas-klime.eko.gov.rs).

4.4. Climate Change Impact and Adaptation Measures

Climate change impact analysis was developed for priority sectors defined in Nationally Determined Contributions (2022). Vulnerability and risk assessments were made for sectors where there was enough knowledge and data for national level assessments; the most relevant impacts for all sectors were defined, as were future activities, for the purpose of developing national level assessments for sectors that were previously unavailable due to insufficient

available data, lack of appropriate methodology and shortcomings in interdisciplinary cooperation. Furthermore, recommendations for adaptation measures were derived from assessments, complete with defined measures with multi-sector contributions, and dubbed measures of general importance (Figure 4.4). Priority sectors for planning and implementing climate change adaptation until 2030 and information on developed assessments are shown in Table 4.2.

Table 4.2 Progress made in climate change vulnerability and risk assessments by sectors and a general overview of defined national priorities in implementing adaptation to climate change

SECTORS	IMPACTS	VULNERABILITY AND RISK ASSESSMENTS	ADAPTATION MEASURES
Health and Safety	Identified impacts of highest importance	Framework vulnerability assessment developed at national level, with defined vulnerable groups. A spatial assessment was not made.	Defining the methodology and spatial vulnerability and risk distribution assessment. Improving notification on dangers with recommendations on further action
Agriculture	Identified impacts of highest importance	Vulnerability and risk assessment made, including spatial distribution of various hazards, by types of production, as well as by types of plant production (18 types). Distribution of water needs and analysis of changes in future climate conditions developed.	Implementing protection measures against emerging risks (hailstorms and frost), implementing short-term adaptation (adjustments) in production and long-term production planning through regionalization. Regulated and regular implementation of agricultural extension service education sessions for the purpose of disseminating new knowledge with the aim of adaptation, including the preservation of soil and water resources. Considering possibilities and securing capacities to increase water consumption share from captured precipitation.
Forestry	Identified impacts of highest importance	Vulnerability and risk assessment made for the most prevalent species, including spatial distribution of hazards.	Systemic implementation of adaptation through amendments to legislation and education with the aim of sustainable forest management in the changing climate.
Road Infrastructure	Identified impacts of highest importance	No vulnerability and risk assessment made at national level.	Development of a methodology for vulnerability and risk assessment and assessment development with recommendations for changing the standards.
Energy	Identified impacts of	No vulnerability and risk assessment	Assessment development of a changing in the distribution of

	highest importance	planned, except for impacts on selected parameters of the climate system that are relevant to energy.	the needs for heating and cooling due to climate change. Development of a climate change impact assessment to relevant hydrological parameters. Operative long-term projections with adapted products and early planning.
Urban Development	Identified impacts of highest importance with direct impact of climate hazards, without considerations of the complexities of urban systems	No vulnerability and risk assessment made or planned due to specificities of urban areas, however work is being done on enabling risk identification at local level.	Systemic implementation of activities with the aim of reducing the urban heat island effect and implementing other solutions based on the concept of Nature-based solutions.
Biodiversity	Existence of impacts recognised from individual case	No vulnerability and risk assessment made. Recommended inclusion of impact on biodiversity in the nexus with relevant sectors.	Defining indicators for climate change impact monitoring.

In addition to measures where competent sectors with most benefits from implemented measures were defined, measures relevant for all sectors, for defining national investment monitoring procedures, and for the general public, both directly and indirectly, were defined. Defined measures of general importance are measures regulating the labelling of activities and investments contributing to adaptation to climate change, setting up systems to monitor climate change, impacts and the progress of adaptation, changes in the national-level disaster risk assessment methodology (implemented from the national to the local level), providing for combating land degradation due to climate change for areas that are unused and exposed (by way of amending legislation), as well as guiding scientific research with contributions to adaptation to climate change. Enhancing the capacities of the Republic Hydrometeorological Institute was highlighted as especially important, with the aim of improving the early announcement and warning system, developing and operatively implementing enhanced long- and short-term projections, with products especially developed for various sectors (health and safety, agriculture, energy, infrastructure), as well as ensuring efficient and effective dissemination of information. Development of adaptation measures is based on publicly available data, scientifically justified methodologies, as well as scientific results from earlier research[15]. Due to major uncertainties in defining and monitoring drought, both at global and national levels, the Republic of Serbia planned the development of methodology for drought monitoring as a multidimensional event with consequences in various sectors.

The planned development of requirements and capacities for implementing adaptation measures identifies participation of state institutions, universities and other scientific organisations, local self-governments, civil society organisations, etc.

[15] The program of adaptation to climate change with the action plan displays methodologies, data sources and references used in the development of adaptation measures and further guidelines for the implementation of adaptation.

Certain information from the Adaptation Programme, highlighting impacts and the need for adaptation due to identified highest climate change hazards, are presented in the Addendum. Other comprehensive results can be found in the Adaptation Programme.

SPOTLIGHT: Select information from the Adaptation Programme regarding sector vulnerability and adaptation

The adaptation process needs to include all individuals, so that they can protect themselves, their jobs/businesses, and their property from rising climate hazards. This is why the basis for the functioning of the adaptation programme is secured during the development stage, i.e. specifically setting up a significantly advanced timely climate hazard warning and announcement system, with high spatial dispersion and multi-purpose products (according to sector-based needs), as well as an efficient notification system with recommendations on required interventions and behaviours in case of adverse weather events.

Health

Between 45 and 55% of the population is at risk of climate change, and 20 to 30% of those are at extremely high risk (certain to suffer climate change consequences). Due to migration of the population into cities, the population ageing rate, and the rise in extremely high temperatures, it can be assumed that the share of the population at high risk will rise significantly in the mid 21.century. 2-3 years per decade will reach values that have been recognised as dangerous for healthy human bodies in the urban heat island areas during the period 2041-2060.

Agriculture

Maize production will be at the highest risk in **crop production** at national level. Maize production has been established on approximately 45% of surfaces with crop production, with the highest shares in areas at the highest risk of water shortages. Nearly 90% of it is owned by family farms that on average have a low adaptation capacity. Crop failure in the driest years compared to the averages during 2011-2020 runs up to 40%. Hailstorms and frost during the vegetation stage are currently the highest risks in **fruit production**, while water shortages have been identified in cultivated crops, which is why securing irrigation is already found in recommendations. Urgent intervention is needed to secure resources to put up anti-hail nets, shading, and frost protection systems (the most urgent crops were identified). **Winegrowers** recognised the urgency and necessity of introducing the practice of putting up anti-hail nets, which was previously not the case. Increasing the need for irrigation water by mid-century will be approximately 18% per hectare (44-48% until the end of the century, according to RCPS8.5). The biggest emerging risk in **livestock farming** is exposure to high temperatures, which is why the need to improve conditions animals are kept in has been identified. It is necessary **for all fields** to endorse new practices that will help ensure higher resilience to climate change and reduce negative impact to land, water, and air.

Forestry

More than half of all afforested areas between 2019 and 2022 funded from Forest Directorate subsidies dried up due to adverse weather conditions (insufficient water/humidity and high temperatures). In the mid-21st-century climate is expected that areas with generally favourable climate conditions for fir, beech, spruce, Scots pine, and European black pine will shrink on average by approximately 30%, and by the end-of-century - in case of the scenario projections a further increase in greenhouse gas emissions (RCPS8.5) - the areas with favourable climate conditions will reduce by 70%, possibly even over 90%. Pedunculate oak and other hygrophilous tree species will be threatened due to diminished groundwater availability. Regulatory frameworks concerning the raising of new forest and maintenance of existing ones, and/or those regulating forest management, urgently need to be amended.

(Road) Transportation Infrastructure

Total material damages caused to critical infrastructure by flooding in 2014 and 2015 have been characterised with the highest level - catastrophic (>5% of the budget). Total material damages caused by climate hazards and climate change risks remain unknown. Vulnerability and risk assessments for all climate hazards and timely communication are necessary with a view to reducing damage to infrastructure, planning future work and increasing safety levels.

Energy Supply

Rising temperatures and increasing extreme heat waves are the largest factors affecting energy availability and consumption, and climate change impacts similarly affect the availability of water resources for energy generation and plant cooling purposes. Since parameters that energy generation and consumption are based on have been significantly altered through climate change, and since they continue to change, it is necessary to undertake impact assessments, obtain information on coming risks and optimise consumption.

Urban Development

Air temperatures in the areas of urban heat islands could be as much as 10 degrees higher compared to measuring points defined by the World Meteorological Organisation standards (set up in such a way to avoid local influences, including the urban heat island effect, and hence measurements are taken on a large open area above grass, in shade). Increasing areas under natural greenery (undergrowth and trees) is the only solution to mitigate the urban heat island effect that is exceptionally detrimental to the health of citizens of urban environments.

4.5. Other relevant information concerning planning and implementation of adaptation in the Republic of Serbia

As mentioned in section 1 of this chapter, development of a functional and sustainable mechanism for continuous implementation of adaptation to climate change in the Republic of Serbia was initiated with the development of the Climate Change Adaptation Program for the period 2023-2030 with its first Action plan for the implementation period 2024-2026. The proposed measures for various sectors, followed by measures that were selected for implementation during the Program and measures with activities defined in the Action plan, are the result of (Figure 4.4):

- applying the adaptation principles from the European Union Adaptation Strategy that indicate the necessity for 'smarter' adaptation (scientifically justified, with efficient communication between science and policymakers), 'more systemic' (regulating its implementation through implementing knowledge on climate change and needs for adaptation through sector-based public policy acts, laws and regulations, from the national to the local level) and 'faster' (adopting and implementing urgent intervention to mitigate damages and losses from emerging climate hazards with the highest current risk levels).
- harmonising the development of the planned adaptation process with the international context and other EU frameworks.
- analysing the legislative and institutional framework of the Republic of Serbia as well as its planning documents, so as to define the prevalence of activities related to adaptation, institutional accountability for certain interventions, as well as ways for a systemic implementation of the adaptation process.
- science-based climate change analyses, impacts, vulnerability and risk assessments and proposed measures for the implementation of adaptation (results developed according to scientifically justified methodologies, IPCC R6 methodology and terminology, data extrapolated from scientific references, official databases, etc).
- the defined expected contribution of implementing measures in the course of the Adaptation Programme to effecting and maintaining climate change resilience, defined through the vision and the goals/objectives[16].

[16] Results indicate that the range of most likely climate change for the period around the middle of the 21st century can be known, while later changes depends on the implementation of global greenhouse gas emission reduction policies. Adaptation measures were shaped to set a basis for the formation of a sustainable adaptation process that should be constantly implemented and evolving in the future. Currently it is expected that the Republic of Serbia will reach a high level of resilience to climate change in case necessary measures are implemented, as defined in the vision set out for the Adaptation Programme. The main goal at national level until 2030 is to set necessary capacities for the implementation of the adaptation process, as defined in the goal of the Program. The rest is listed in section 4.1 of this chapter.

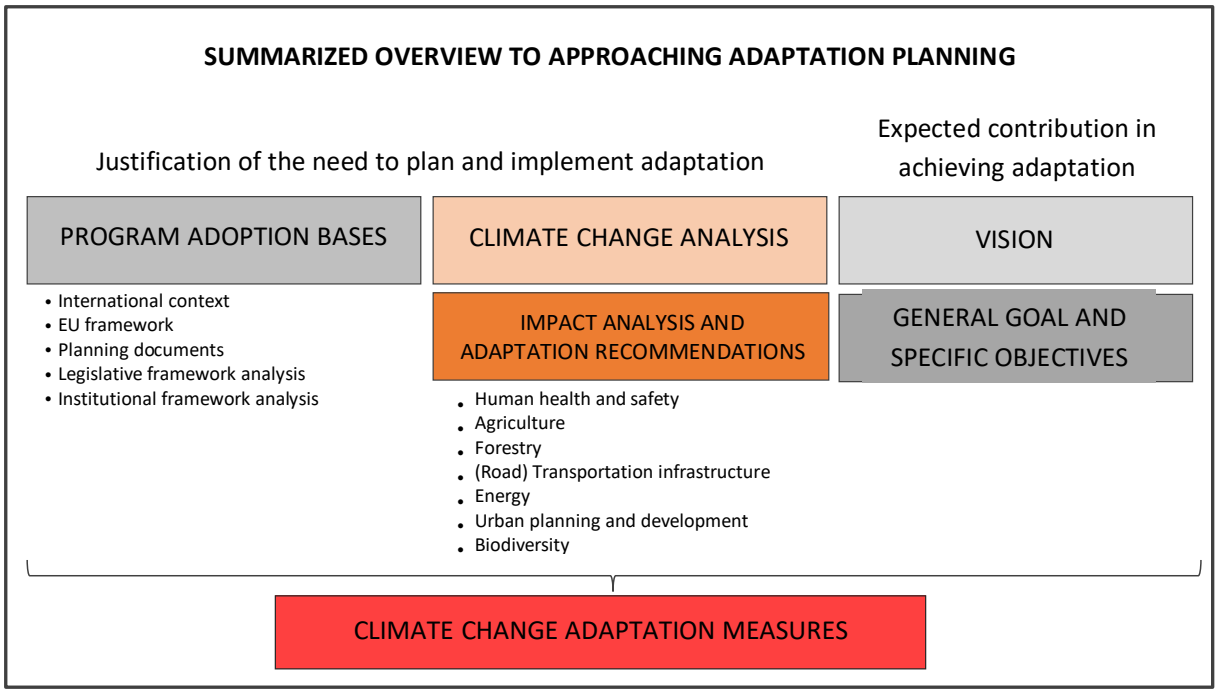


Figure 4.4 Structure of the fundamental components in planning the development of a mechanism for implementing a sustainable process of adaptation to climate change.

4.6. Other activities related to adaptation to climate change in the Republic of Serbia

Previously mentioned activities are included in the Adaptation Programme that has a task of organising a sustainable adaptation process until 2030, functioning from the national to the local levels, through activities of public bodies. Apart from those, there are other activities that are being implemented or have been planned for, and that are expected to contribute to adaptation in the Republic of Serbia. Some of the most interesting individual examples are listed below. A new subject on climate change and adaptation was introduced since 2023/2024 in agriculture and veterinary high schools with a complete set of teaching resources[17]. The development of teaching resources for school education sessions on climate change through various subjects (e.g. adaptation and promotion Climate Box[18] toolkit and other accompanying resources) is also planned. Providing regulated communication on climate change and ways of adaptation is planned within the Environmental Protection Strategy for the period 2024-2033 (under development), specifically within adaptation, through a dedicated portal (toolkit), as a one stop spot with teaching resources disaggregated in fields. During development of analyses made for the purpose of developing the Adaptation Programme, it was perceived that it is necessary to enhance knowledge on vector-borne diseases, whose monitoring and impact projections need additional research capacities and include these in the adaptation process once more specific results are achieved[19]. Moreover, there is special focus on enhancing capacities for local self-government independence in adapting their activities in accordance with climate change. Apart from all of the above, there are many other scientific activities (projects) and education for the interested public on climate change that are being implemented sporadically in individual fields,

[17] Material developed within the "Strengthening Disaster Resilience in Agriculture" project GCP/SRB/006/EC, FAO
[18] Material improved within the UNDP project "Climate education to Advance SDGs and Climate Action (Climate Box)"
[19] Analyses of climate change and impacts by sectors that were behind results shown in the Program were done within the project "Advancing medium and long-term adaptation planning in the Republic of Serbia", Ministry of Agriculture, Forestry and Water Economy and UNDP`

or as needed in various projects. However, the effects (results) of these activities relative to contributions and investments remain unknown (systemic monitoring of events and effects is not in place), which is why they have not been included in reporting thus far. As for the harmonisation of analyses, measures and reporting done by the Republic of Serbia to other United Nations conventions, the need to harmonise analyses, measures and reporting to UNFCCC, UNCCD and CBD has been recognised, as well as adopting the concept of Nature-based Solutions within reaching the goals of these three conventions.

5. FINANCIAL, TECHNOLOGICAL, AND CAPACITY BUILDING NEEDS

Although there has been some progress in reporting and meeting its obligations under the Convention, there is still a need to improve the legal, procedural and institutional frameworks for reporting on climate change, including the preparation of BURs and national reports. The inclusion of climate change aspects in sectoral policies and measures, as well as in the national development goals, remains low, as do the capacities of policy makers at national and local government level on the importance of this issue.

Providing financial, technical and capacity building assistance to improve the quality of activity data, preparation of national emission factors, supporting methodologies and the establishment of electronic data exchange relevant to the development and improvement of inventory are priorities in the field of GHG monitoring and reporting.

Financial needs for the implementation of activities provided for in the Adaptation Programme Action Plan in the period 2024-2030 are presented in subchapter 1 (Figure 2) of the adaptation chapter. As the Adaptation Programme introduces systemic implementation of adaptation, i.e. through planning and strategy papers, through laws and regulations, it is necessary to obtain additional support from donor funds, EU pre-accession assistance, as well as support from UN financial institutions and funds (GEF and GCF). These funds are necessary for the implementation of infrastructure investments, as well as for the capacity building and awareness raising of interested parties and competent institutions.

Moreover, the Green Agenda for the Western Balkans funding mechanism represents a good example since, in addition to donor funds, it also represents a mechanism for attracting green investment from the private sector and industry, The Republic of Serbia necessitates a sustainable mechanism of funding public and private sector investment for adaptation to climate change and/or maintaining the adaptation process in the future, as well as for the green transformation and the decarbonisation of the economy. Such a mechanism would combine budget funding, development funds, donor funds, private sector investments and commercial loans. It is also necessary to develop innovative funding mechanisms, such as green bonds, green guarantee schemes, etc. The capacity building and awareness raising fields need support for timely capacity building for a smarter, more systemic and faster implementation of adaptation at local self-government level.

Measures proposed in the Strategy also require additional investment in various sectors. These additional investment costs are estimated at EUR 6.5 billion for the period 2020-2030 and between EUR 37.8 and 76.8 billion for the period 2030-2050. Additional costs in the field of energy, including energy efficiency, as well as sources of funding for investment, defined on

the assumptions adopted for the Strategy, have been subjected to detailed analyses within the Integrated National Energy and Climate Plan and, in line with this, the total investment cost will be defined with that plan, once it is implemented.

ADDENDUMS

Addendum I

Table I-1. Analysis of the key category for the last reported year (2021) based on emission levels (excluding LULUCF)

CRF	CRF name	Fuel Group	Gas	2021 Emissions [GgCO2eq]	Lx, 2021	Cumulative	Ranking
1.A.1	Energy industry	Solid fuels	CO_2	28366.37	0.460	45.6%	1
1.A.3.b	Road transportation		CO_2	7453.05	0.121	57.6%	2
2.C.1	Iron and steel making		CO_2	2986.45	0.048	62.4%	3
1.A.1	Energy industry	Gaseous fuels	CO_2	2763.48	0.045	66.8%	4
3.A	Enteric fermentation		CH_4	2405.37	0.039	70.7%	5
5.A	Solid waste disposal		CH_4	2384.58	0.039	74.6%	6
1.A.2	Manufacturing industry	Gaseous fuels	CO_2	2051.29	0.033	77.8%	7
1.A.4	Other sectors	Gaseous fuels	CO_2	1396.22	0.023	80.1%	8
2.A.1	Mineral industry / Cement		CO_2	1289.43	0.021	82.2%	9
1.A.2	Manufacturing industry	Liquid fuels	CO_2	1232.18	0.020	84.1%	10
1.B.1	Fugitive emissions from fuel / solid fuel	Solid fuels	CH_4	1011.84	0.016	85.8%	11
1.A.2	Manufacturing industry	Solid fuels	CO_2	1006.97	0.016	87.4%	12
3.D.1	Direct N_2O emissions from managed land		N_2O	892.16	0.014	88.8%	13
1.B.2.a	Fugitive emissions from fuel / oil		CH_4	789.38	0.013	90.1%	14
5.D	Wastewater treatment and discharge		CH_4	722.11	0.012	91.3%	15
1.A.1	Energy industry	Liquid fuels	CO_2	690.26	0.011	92.4%	16

1.A.4	Other sectors	Solid fuels	CO_2	666.55	0.011	93.4%	17
1.A.4	Other sectors	Biomass	CH_4	509.56	0.008	94.3%	18
3.B	Manure management		CH_4	501.02	0.008	95.1%	19

Table I-2: Key category analysis based on the emissions' trend (from the base year to the last reported in 2021 excluding LULUCF)

CRF	CRF name	Fuel Group	Gas	1990 Emissions [Gg CO2eq]	2021 Emissions [Gg CO2eq]	Tx, 2021	Trend contribution	Cumulative
1.A.3.b	Road transportation		CO_2	4469.75	7453.05	0.050	0.211	0.211
1.A.1	Energy industry	Gaseous fuels	CO_2	1303.63	2763.48	0.022	0.092	0.302
1.A.2	Manufacturing industry	Liquid fuels	CO_2	4001.71	1232.18	0.022	0.092	0.394
2.C.1	Iron and steel making		CO_2	1652.68	2986.45	0.021	0.074	0.557
1.A.4	Other sectors	Solid fuels	CO_2	2796.70	666.55	0.018	0.063	0.621
1.A.1	Energy industry	Solid fuels	CO_2	39344.12	28366.37	0.016	0.057	0.677
1.B.2.c	Fugitive emissions from fuels - Flaring and Incineration		CO_2	1495.19	24.95	0.013	0.038	0.716
1.A.1	Energy industry	Liquid fuels	CO_2	1901.60	690.26	0.009	0.035	0.750
3.A	Enteric fermentation		CH_4	4090.37	2405.37	0.008	0.033	0.783
1.A.4	Other sectors	Liquid fuels	CO_2	1463.40	465.17	0.008	0.023	0.806
3.D.1	Direct N_2O emissions from managed land		N_2O	581.79	892.16	0,006	0.022	0.828
2.B.2	Chemical industry / Nitric acid		N_2O	563.44	0.00	0.005	0.018	0.846
1.A.4	Other sectors	Gaseous fuels	CO_2	2328.70	1396.22	0.004	0.017	0.863
1.A.2	Manufacturing industry	Gaseous fuels	CO_2	2284.38	2051.29	0.004	0.014	0.878
2.A.1	Mineral industry / Cement		CO_2	1340.26	1289.43	0.003	0.014	0.892
2.A.2	Mineral industry / Lime		CO_2	499.45	107.34	0.003	0.014	0.905
2.B.1	Chemical industry / Ammonia		CO_2	363.07	5.94	0.003	0.010	0.916
1.A.4	Other sectors	Biomass	CH_4	411.13	509.56	0.002	0.010	0.926

1.B.1	Fugitive emissions from fuel / solid fuel	Solid fuels	CH_4	1086.87	1011.84	0.002	0.008	0.933
3.D.2	Indirect N_2O emissions from managed land		N_2O	253.97	337.09	0,002	0.007	0.940
1.A.2	Manufacturing industry	Solid fuels	CO_2	1525.24	1006.97	0.002	0.007	0.947
5.D	Wastewater treatment and discharge		CH_4	1131.12	722.11	0.002	0.006	0.953
3.B	Manure management		N_2O	650.51	367.73	0.001	0.211	0.211

Addendum II Key Scenario Assumptions

Table II-1: WAM macroeconomic and demographic assumptions

Target year	2020	2025	2030	2035	2040	2045	2050
Population (in millions)	6.977	6.884	6.826	6.796	6.822	6.842	6.858
Household size (population / household)	2.683	2.660	2.638	2.617	2.600	2.589	2.581
GDP (in 000 M€13)	36.722	44.412	52.915	62.106	71.805	81.775	91.730
ETS price (€'13/ t from CO_2)	0.0	23.0	28.0	130.3	250.0	320.0	350.0
Average efficiency value (€'13/toe)	265.2	569.4	1038.8	1451.4	1548.7	1676.8	1855.7
Value of renewable sources (€'13/MWh)	9.10	13.14	57.12	12.13	12.43	45.79	50.86
International fuel prices (in $'13 per boe)							
Oil	59.8	76.0	92.2	100.3	107.0	110.0	113.1
Gas (NCV)	39.4	46.7	55.2	58.9	60.9	62.1	63.1
Coal	16.9	20.8	24.8	26.2	27.1	28.0	28.6
Renewable sources potential (MW)							
Solar	1879	3753	5627	7501	9376	11250	13124
Wind	750	1081	1521	2046	3324	3577	4029
Hydro	2972	3325	3545	3871	4017	4083	4366

Target year	2020	2025	2030	2035	2040	2045	2050
Sectoral value added (in 000 MEuro'13)							
Iron and steel	0.07	0.09	0.10	0.12	0.13	0.15	0.16
Non-metallic minerals	0.22	0.27	0.31	0.35	0.39	0.44	0.50
Paper and cellulose	0.27	0.35	0.44	0.52	0.60	0.68	0.77
Food, beverages and tobacco	1.41	1.69	2.00	2.33	2.67	3.02	3.35
Engineering	1.56	1.97	2.44	2.96	3.56	4.19	4.85
Textile	0.33	0.32	0.32	0.32	0.32	0.32	0.31
Other industries	0.90	1.08	1.29	1.51	1.74	1.99	2.25
CO_2 standards for cars and vans (gCO_2/km)	140	85.2	74.9	50,239	12,296	0.3624	0.3624
Ownership rates (cars per capita)	0.37	0.41	0.45	0.47	0.47	0.49	0.50
Share of biofuels in transport	0.7%	2.0%	8.7%	12.5%	15.3%	16.2%	17.5%

For the **agricultural sector**, the key drivers on the supply side are milk and cereal yields, and on the demand side GDP and population (provided by the GEM3 model).

Table II – 2. Feasibility and share in implementation of WEM

	Feasible	share in implementation
Measures related to CROPS		
Winter cover crops	✓	52%
Increased share of legumes in the surface of animal feed	✓	13%
Precision farming	✓	0%
Nitrification inhibitors	✗	n/a
Livestock measures		
Breeding for higher milk yields	✓	1%
AD (Anaerobic digestion)	✓	0%
Linseed as a food supplement	✓	0%
Antimethanogenic vaccination	✗	n/a
Breeding for the efficiency of ruminant nutrition in non-dairy ruminants	✗	n/a
Nitrates as a food supplement	✗	n/a

Table II – 3. Mitigation actions in agriculture in WAM

	Feasible	share in implementation (2050)
Measures related to CROPS		
Winter cover crops	✓	55%
Increased share of legumes in the surface of animal feed	✓	100%
Precision farming	✓	7%
Nitrification inhibitors	after 2040	56%
Livestock measures		
Breeding for higher milk yields	✓	24%
AD (Anaerobic digestion)	✓	20%
Linseed as a food supplement	✓	21%
Antimethanogenic vaccination	after 2040	75%
Breeding for the efficiency of ruminant nutrition in non-dairy ruminants	after 2040	100%
Nitrates as a food supplement	after 2040	1%

Table II – 4. Options and targets of biodegradable waste treatment assumed for BaU/WAM

Relevant waste fractions for GHG emissions	Treatment option		Targets to be achieved			
			2025	2030	2040	2050
	Treatment option		Targets to be achieved	Relevant waste fractions for GHG emissions	Treatment option	Targets to be achieved
Relevant waste fractions for GHG emissions	Diversion	2025			2025	
	Disposal		85%	Food and garden waste	Disposal	85%
		Composting		Redirecting	Composting	
Food and garden waste	Redirecting	85%	Paper and cardboard	Disposal	85%	Paper and cardboard
Paper and cardboard	Disposal					
	Redirecting	Recycling		Redirecting	Recycling	

Table II – 5. Measures and appropriate schedule included in WOM (BaU) / WEM scenario

Name of the region	Type of measure and expected period until implementation														
	Construction of sanitary landfills			Introduction of separation at the source and construction of a material recovery plant			Construction of biological treatment plants (composting plants)			Construction of heat treatment plants (incineration)				
	2025	2030	2030-2050	2025	2030	2030-2050	2025	2030	2030-2050	2025	2030	2030-2050		
Sremska Mitrovica															
Pančevo															
Inđija															
Užice															
Pirot															
Kikinda															
Lapovo															
Jagodina															
Leskovac															
Subotica															
Valjevo															
Zrenjanin															
Nova Varoš															
Vranje															

Name of the region	Type of measure and expected period until implementation											
	Construction of sanitary landfills			Introduction of separation at the source and construction of a material recovery plant			Construction of biological treatment plants (composting plants)			Construction of heat treatment plants (incineration)		
	2025	2030	2030-2050	2025	2030	2030-2050	2025	2030	2030-2050	2025	2030	2030-2050
Belgrade												
Novi Sad												
Niš												
Sombor												
Vršac												
Zaječar												
Smederevo												
Kragujevac												
Kraljevo												
Kruševac												
Požarevac												
Loznica												

Table II – 6. Options and targets of biodegradable waste treatment assumed for WAAM

Relevant waste fractions for GHG emissions	Treatment option		Targets to be achieved 2025			2025
Food and garden waste	Disposal		85%	Food and garden waste	Disposal	85%
	Redirecting	Composting		Redirecting	Composting	85%
		Anaerobic digestion			Anaerobic digestion	15%
Paper and cardboard	Disposal		85%	Paper and cardboard	Disposal	85%
	Redirecting	Recycling		Redirecting	Recycling	60%
		Composting			Composting	20%
		Incineration			Incineration	10%
Overall improved waste prevention (i.e. waste reduction) of about 2% annually						

Addendum III Addendum to the Climate Change Analysis

Table III-1. Climate impact-makers caused by climate- and weather-related hazards and other hazards they can cause, climate parameters (indices) that can point to the relevant changes in climate impact-makers and climate categories they belong to.

Climate impact-makers	Seen through - and/or Monitored by	Climate indices*	Meaning	Climate hazard category
Increased climate variability	**Higher frequency of changes in weather:** from normal (colder) temperature conditions to warm or hot weather, at annual, seasonal and monthly levels; higher frequency of changes from dry (or drier than normal) to humid (or more humid than normal) conditions, at seasonal and annual levels.	Change in climate values of temperature and precipitation indices and extreme weather event indices during a climate period. Can be perceived from other climate-related hazards, such as the increase of drought periods and strong and extreme weather, increase in number of heat waves, etc.	This change calls for **preparedness against extreme precipitation conditions in both extremes (excess or insufficient precipitation)** and against the increase of hot- and retention of normal temperature conditions (apart from rising temperature the risk of hazard due to snowfall is still possible). This is a consequence of the increase in drier weather conditions and the increase in extreme weather events, and the quicker increase of maximum temperatures compared to their minimum counterparts, and the seasonally uneven warming. This change requires **preparedness against extremely hot and regularly cold weather conditions.**	• **excessive heat** • **excessive water/humidity** • **insufficient water/humidity**
Increasing temperature and heat waves	**Constantly warmer** mean seasonal and annual temperatures **and temporarily much hotter conditions** than normal in individual periods throughout the year.	Number of heat waves (hwfi), heat wave duration (hwfid), number of hot periods (hwdi) and duration (hwdid), number of days with Tx>30 (tropical days, TRD), Tx>35 (hot days, THD), Tn>20 (tropical nights, TRN), increasing mean Tx and Tn values (seasonal anomalies). Other derived/combined indices for impact analyses: mean incidence of critical events characterised by temperature values above/below a certain threshold per year, their frequency (number of years in a climate period with critical events), changes in the incidence dates, etc.	This change requires **general preparedness against warmer climate conditions**, and especially against the **stress caused by extremely hot conditions** and other related hazards. Some of the other related hazards are **disruptions in food production**, conditions conducive for vectors and **vector-borne diseases**, more conducive conditions to **fire breakouts**, etc.	• **excessive heat**
Change in the annual precipitation distribution	**Change in the mean sums of precipitation, seasonal/monthly**, climate shift in periods with higher or lower accumulation of precipitation. Excessive or insufficient water during months/seasons. Possible contribution to emergence of floods and droughts.	Anomalies in mean sums of precipitation during months/seasons, compared to normal (values for the reference climate period).	This change requires **preparedness against changes in availability of water**, e.g.: **extended summer deficit**, while a surplus is possible during spring, with the tendency of moving to earlier periods and overlap with snowmelt season, which can cause **flooding and landslides**. The summer deficit can trigger a higher risk of **droughts**. It also impacts the **prolongation of the periods with low flow in rivers.**	• **excessive water/humidity** • **insufficient water/humidity**

Change in precipitation pattern by intensity	**Temporary excess of water** caused by short-duration events. Decrease in number of events with small and moderate precipitation and increase in number of events and accumulation of precipitation with strong and extreme precipitation. Possible contribution to flooding, large quantities of snow, soaking the soil (beyond the infiltration capacity). Possible hailstorms and other consequences of storms (strong winds).	Number of days with precipitation over 20mm (rr20), over 30mm (rr30), maximum daily precipitation (rx1d), maximum five-day accumulation of precipitation (rx5d). Mean values per year and number of days in a climate period when defined critical precipitation events occur, etc.	This change requires increasing resilience to the short-term excess surface water/humidity, i.e. **large surface runoffs, increase in maximum flows in rivers, and flooding**. It can affect **reduced quality of potable water**, it can also cause **landslides**. It was recognised as a **soil degradation** risk factor. Since these events are caused by intensive weather events that often generate **strong winds and hailstorms** (depending on the part of year and in which region they occur), this climate hazard can also serve as an indicator for an increase in storms with strong winds and hail.	• **excessive water/humidity** • **storms (strong winds, hail)**
Change in droughts	**Temporary water/humidity insufficiency**, including amounts of water in rivers, groundwater, reservoirs, soil, etc.	Anomalies in seasonal accumulated precipitation, SPEI (spei6a), forest aridity index (fai), hydro-thermal coefficient (HTC). Frequency of defined critical events (number of years in a climate period with their occurrence), defined by border values of indices pointing to insufficient water/humidity.	An increase in this climate hazard requires higher resilience to **temporary insufficient water/humidity** that impacts life and in combination with high temperatures creates conditions conducive for **fire breakouts**. It can temporarily affect **reduced water quality and availability**. There is no single definition of drought and its manifestation is different in various environments and sectors, and hence the criteria for defining it can differ.	• **insufficient water/humidity**
Change in aridity/droughtiness	**Constant water/humidity insufficiency** at annual or seasonal level. The aridity level relates to climate characteristics of a region at annual level, while the level of droughtiness relates to climate characteristics of a season.	Change in mean (climate-related) value of the index beyond a certain limit: aridity index, hydro-thermal coefficient (HTC), SPEI.	An increase in this climate hazard requires higher resilience to **constant water insufficiency**, on average at annual level or throughout a certain part of the year (in season). It affects **water quality and availability**. It can cause declining/extinction of living world. It was recognised as a **soil degradation** risk factor.	• **insufficient water/humidity**

* Listed climate indices were used in analysing climate change for the Republic of Serbia and its impacts, and the data for most of the indices are available within the Digital Climate Atlas of Serbia web portal. The choice of indices for the climate change analysis depends on the purpose of their use, i.e. impact analyses they are being used for (depending on the sector that the analysis is done for and the region the analysis is done in).

Table III-2. A summary of the analysis of observed and future climate change in the territory of the Republic of Serbia, shown in groups of climate hazards caused by them, obtained from the results of the analysis of identified climate impact-makers that are of significance in the Republic of Serbia and have identified impacts on sectors. The results are shown from the analysis of observed climate change for the period 2001-2020 and the second decade of this period 2011-2020, compared with climate conditions in the period 1961-1990, and the analysis of future climate change for near-future climate periods 2021-2040, mid-century 2041-2060 and end of century 2081-2100, according to RCP4.5 and RCP8.5 scenarios, and compared with 1961-1990 climate conditions. The difference in results under these two scenarios for 2021-2040 is not significant, while it is especially highlighted if significant for 2041-2060. The difference in climate projection results under these scenarios becomes significant only in the latter half of the 21st century, i.e. in the period 2081-2100.

Group of climate hazards	**Climate impact-makers**	**Climate change and altered climate conditions (observed and future) for the 21st century at the territory of the Republic of Serbia**
Excessive heat	• Increased climate variability • Increasing temperature and heat waves	**Mean temperature** rose by +1.4°C in 2001-2020 (+1.8°C in 2011-2020) compared to 1961-1990. The increase in mean maximum temperature is on average higher than mean minimum temperature. The increase in mean temperature is highest for the JJA season, +2.0°C (+2.4°C). The increase in maximum temperature for JJA is +2.2°C (+2.6°C). The expected increase is +2.2°C in the period 2021-2020, +2.5, and more probably +3.1°C in the period 2041-2060, and approximately +3.1°C in the period 2081-2100, according to RCP4.5 and +5.8°C according to RCP8.5, compared to 1961-1990. **Heat waves** did not occur every year during 1961-1990 (less than 1 annually). Increase in the number of annual occurrences +2.4 in 2001-2020 (+3 in 2011-2020) compared to 1961-1990. Increased climate variability let to the occurrence of more extreme years (there were 4 heat waves in 6 years in 2011-2020). Increase in the average number per year in 2011-2020 is +3.5, in 2041-2060 approximately +4 to +5, in 2081-2100 +5 according to RCP4.5 and +8 to +10 according to RCP8.5, compared to 1961-1990. **Days with high temperatures** (maximum daily temperature over 30°C and over 35°C) are present in the lowlands. On average there were 20-30 **tropical days** (days with maximum daily temperature over 30°C) annually in the lowlands in the period 1961-1990, and their number doubled in 2001-2020. In 2021-2040 there will be 55-40 annually on average, in 2041-2060 approximately 65 and in 2081-2100 approximately 70 according to RCP4.5 and approximately 85-96 according to RCP8.5. There were on average 2-3 **hot days** (over 35°C) annually in the lowlands in 1961-1990, the increase in 2001-2020 was +4 to +7, and in 2011-2020 in some areas as many as +10. In 2021-2041 there will be 13-15 annually on average, in 2041-2060 more than 20 and in 2081-2100 approximately 25 according to RCP4.5 and 35-45 according to RCP8.5. In the future the risk of high temperatures rises with higher altitudes above sea level. The probability of years/periods with higher deviations than expected climate average is increasing because of **higher climate variability**, i.e. the occurrence of extreme heat conditions that did not happen in Serbia before can be expected. The biggest heat extremes are in **urban environments** (urban heat island effect), where temperature deviations compared to the environment are approximately 2°C on average, and as much as 4°C during certain periods.
Excessive water/humidity	• Increased climate variability • Change in the annual precipitation distribution • Change in precipitation distribution by intensity	It was perceived that the **annual maximum accumulation of precipitation is moving to an earlier period within the year (from late MAM and early JJA season to earlier within the MAM season)**. **The number of days with very strong (20mm-30mm daily rainfall) and extreme (over 30mm daily rainfall) precipitation and amounts of precipitation discharged in this form, while events with low and moderate precipitation are decreasing**. The rise in the share of precipitation falling in the form of extreme precipitation increased more than 100% in 2001-2020 compared to 1961-1990. Moderate extreme precipitation risk in 2001-2020 on 45% of the territory of the Republic of Serbia, and high risk on 7% (Central/Western Serbia, partly Vojvodina and Eastern Serbia). Extreme precipitation risks are on the rise in the future and high risk areas become bigger. It is expected that 34% will be under moderate risk and as much as 56% under high and very high extreme precipitation risk in 2041-2060. **Increased climate variability** implies that it was perceived and that it is expected that certain years and/or periods within a year can have much more rainfall than the average climate values, meaning the increase in extreme precipitation conditions is also expected.

		Flow and maximum water levels are expected to increase in rivers during higher water level periods. **The risk of soil degradation due to erosion caused by extreme precipitation is also on the rise.**
Insufficient water/humidity	• Increased climate variability • Change in the annual precipitation distribution • Increase in droughts • Increase in aridity/droughtiness	**Mean annual sum of precipitation** does not have significant changes until the second half of the 21st century, and in 2081-2100 a drop by 8 to 14% compared to 1961-1990 is expected according to RCP8.5. **Decrease in rainfall during JJA** in 2001-2020 is 10 to 20% in the most parts of Serbia; a further decrease is expected in the future, over 20% in 2041-2060 and according to RCP8.5 even more than 40% in 2081-2100, compared to 1961-1990. **The percentage of drought years on average in the analysed period increased by 30% for the territory of the Republic of Serbia in 2001-2020 (+40% in 2011-2020) compared to 1961-1990**. Frequency in the period 1961-1990 was 10%. It is expected that every year between 2041-2060 will be a drought year for the territory of the Republic of Serbia on average. The **frequency of years with strong droughts** (happened once in 2011-2020) is rising; in 2021-2040 there will be 2-3 per decade (over a ten-year period), in 2041-2060 3-4 per decade, and - according to RCPS8.5 - in 2081-2100 we can expect 7-8 years per decade. **The level of climate aridity, i.e. a constant droughty status of average climate conditions, is expected to rise in the Republic of Serbia**. In the future in the period 2001-2020 the average climate class for Serbia is 'humid climate', while in the lowlands (Vojvodina, Central Serbia, Eastern and Southeastern Serbia and locally in other areas) it is 'dry subhumid'. Due to the unfavourable precipitation distribution throughout the year, the JJA season is in most of the territory, except in tall mountains in Western Serbia, where it is 'semi-arid'. Other seasons fall into the 'humid' category. On average, the territory of the Republic of Serbia will have 'dry subhumid' climate in 2041-2060 and 'semi-arid' in 2081-2100, according to RCPS8.5. Increased climate variability also implies a more frequent occurrence of years with more arid conditions, as well as the aforementioned increase in droughts. Rising temperature makes an important impact on more arid conditions. **The low flow period is extended and minimum water levels are reduced. Groundwater recharge speed is reduced. Average soil humidity is decreasing due to increased evapotranspiration.** **The increase in the climate aridity level impacts soil degradation.**
Storms	• Change in the annual precipitation pattern	No change was observed in mean wind speed and spatial distribution of mean wind speed. These changes cannot be quantified at the moment, but an increase in extreme precipitation can be viewed as an indicator of increasing storm events. **The increase in events with very strong and extreme precipitation points to a rising number and intensity of events that are producing such pF and are followed by strong winds with a chance of snow (bigger snowstorms possible but snow retention is decreasing) and hail, depending on the part of year and location they appear in. The surface area at higher risk from is getting bigger.**