THE 2020-2030
CLIMATE CHANGE ADAPTATION AND LOW EMISSION DEVELOPMENT STRATEGY FOR BOSNIA AND HERZEGOVINA

December, 2020

Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina

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Federal Ministry of Environment and Tourism

Department for Spatial Planning and Legal-Property Affairs of Brcko District

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List of Abbreviations

BAU	Business as usual
BD	Brčko District of Bosnia and Herzegovina
BHAS	Agency for Statistics of Bosnia and Herzegovina
BiH	Bosnia and Herzegovina
CDM	Clean Development Mechanism
COP	Conference of Parties
DNA	Designated National Authority
EE	Energy efficiency
EU ETS	EU Emission Trading System
EU	European Union
FBiH	Federation of Bosnia and Herzegovina
FBIH MHS	Meteorological and Hydrological Service of FBiH
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse gases
GMST	Global mean surface temperature
HE	Hydropower plant
INC	Initial National Communication Report under the UNFCCC
INDC	Initial National Determined Contribution
IPCC	The Intergovernmental Panel on Climate Change
MHSC	Meteorological and Hydrological Service of Croatia
MoFTER	Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina
NAMA	Nationally Appropriate Mitigation Actions
NDC	Nationally Determined Contribution
NGO	Non-Governmental Organisation

OSCE	Organisation for Security and Co-operation in Europe
PPP	Public-Private Partnership
RES	Renewable energy sources
RS	Republika Srpska
RS MHS	Meteorological and Hydrological Service of Republika Srpska
SCCF	Special Climate Change Fund
SNC	Second National Communication Report under the UNFCCC
TNC	Third National Communication Report under the UNFCCC
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WA	Watershed Agency
WB	The World Bank
WBIF	Western Balkans Investment Framework

1 INTRODUCTION

Climate change is one of the greatest challenges that the humanity currently faces because it affects all aspects of the environment and the economy and threatens the sustainable development of society. It is increasingly accepted that climate change affects the frequency and intensity of extreme events. Based on previous research, increasing variability of climate in all seasons has been observed. Rapid and intense changes occur in short periods of time - from extremely cold to warm weather or from periods of extremely heavy precipitation to dry periods. The adoption of a series of international resolutions and agreements confirms the scientific and political consensus that climate change is already happening to a significant extent.

According to the 2019 Intergovernmental Panel on Climate Change (IPCC) Report there is a global trend of temperature increase of + 1.1°C and if the concentration of greenhouse gases continues to increase at the current rate, global warming is likely to reach 1.5°C between 2030 and 2052.

The first effects of climate change are already visible in Europe and the world, and these effects are projected to intensify in the coming decades. Thus, climate change is not just a future problem but rather something that is happening today, affecting traditional development patterns and having serious economic impacts. A new pattern is emerging, contributing to eradicating poverty as well as sustained economic growth, enhancing social inclusion, improving human welfare and creating employment opportunities, while maintaining the healthy functioning of the world's ecosystems. At the United Nations Conference on Sustainable Development in Rio de Janeiro, Brazil in June 2012, global leaders recognised these emerging patterns under the term 'green economy'. Within the context of climate change, a 'green economy' is viewed as being based upon the introduction of:

- measure for adaptation to climate change, including preparing for adverse consequences and taking advantage of opportunities brought about by unavoidable changes in climate and climate variability; and
- measure for climate change mitigation, reducing greenhouse emissions through improved energy and material efficiency, and introducing renewable energy sources.

In Bosnia and Herzegovina (BiH), six of the last 10 years have been very dry to extremely dry, and five years have been marked by extreme flooding. During the period 2009-2018 almost all years had the characteristics of extreme weather conditions: floods in 2009, 2010, 2014, 2018, 2019, drought and heat waves in 2011, 2012, 2013, 2015, 2016 and 2017, cold wave in early 2012, strong wind in mid-2012 and late 2017; extremely large number of days with the appearance of the hail in 2018 (the entire anti-hail prevention system was on standby for 78 days, while during 43 days the meteorological situation required the action of anti-hail rockets, which is twice as much as the average).

Climate change is intensifying a range of pre-existing hazards, thus affecting the activities related to subsistence, infrastructure and economic activity. In the wider development context, natural disasters mostly affect the most vulnerable and marginalised groups (children; people with disabilities; elderly poor, national minorities, women). In summer 2012, the intense drought that hit both Bosnia and Herzegovina and the wider Balkans caused a decline in world grain production, resulting in increased

grain prices reaching record levels. In May 2014, catastrophic floods were recorded in Bosnia and Herzegovina. Although the events that led to these disasters and catastrophes could not be prevented in most cases, it is evident that good adaptation to climate change can greatly reduce their impacts. The focus of natural disaster management is on risk reduction and climate change should be incorporated into risk assessment and risk reduction planning processes in Bosnia and Herzegovina, with special emphasis on river management and reservoir construction that could effectively manage floods and droughts.

Climate change increases the need for risk management to be effectively integrated into development strategies. The economic implications, combined with the risk of natural disasters caused by climate change, require the development of an effective strategy to reduce and manage risks. Without such a strategy, climate change will directly affect food production and security, energy supply and household welfare. Climate change in Bosnia and Herzegovina has hit agriculture and water resources the hardest, and adaptation opportunities are intertwined.

The negative consequences of climate change are already visible in Bosnia and Herzegovina, even though the country contributes little to the causes of climate change globally. The per capita emissions amount to about 7.25 tons of carbon dioxide equivalent per capita in 2014, which is about 17% less than the average of the European Union (EU) Member States. But compared to relative wealth, Bosnia and Herzegovina's emissions are almost four times higher than those of the EU. Greenhouse gas emissions per unit of GDP were 1.85 kg CO_2 equivalent per EUR in 2014, while the EU average was 0.39 kg CO_2 equivalent per EUR. These statistics illustrate the economic and social situation of Bosnia and Herzegovina: caught in the poverty trap with rather low GHG emissions but even lower GDP per capita, indicating irrational use of resources, primarily energy.

Unlike many other environmental problems, the impact of climate change is not geographically linked to its causes. Thus, although BiH is among the countries with the lowest per capita GHG emissions in Europe, climate change has already been observed. BiH is particularly vulnerable to climate change due to its geographical position, the economic importance of the agriculture and forestry sectors, as well as its limited capacity to adapt to climate change.

Therefore, it is of priority importance to determine the impact of climate change on Bosnia and Herzegovina, the degree of vulnerability and priority measures of action. In other words, it is necessary to have a strategic approach to the process of adaptation to climate change and to use the opportunities for the application of innovative solutions for sustainable development. At the same time, the transition towards low emission development provides opportunities related to the 'green economy', as well as mobilising and attracting domestic and international investments in energy efficiency and renewable energy sources.

The first Strategy for Climate Change Adaptation and Low Emission Development for Bosnia and Herzegovina was adopted by the Council of Ministers of Bosnia and Herzegovina on 8 October 2013. The Strategy identified measures for climate change mitigation, measures for adaptation to climate change and capacity building needs, with the aim of providing a strategic and programme basis for effective international support.

This document is an updated version of the Strategy, which aims to improve action plans based on monitoring and evaluation, as well as improved knowledge gained during the implementation of the first version of the Strategy.

The new Strategy development process is an upgrade to the activities covered by the Initial, Second and Third National Climate Change Communications of Bosnia and Herzegovina and the ongoing activities covered by the Fourth National Communication (FNC). Consultative work identified six priority sectors for the Climate Change Adaptation Strategy:

- Agriculture
- Water resources/water management
- Forestry and forest resources
- Biodiversity and sensitive ecosystems
- Tourism
- Human health
- Energy.

Water management and agriculture are considered to be the main priorities that, to a greater or lesser extent, affect other sectors.

The priority sectors for the Low Emission Development Strategy are:

- Electricity generation
- Building and housing
- Transport
- Agriculture
- Forestry
- Waste.

Climate change is not sector specific, and demands a cross-cutting approach based upon principles and measures that need to be implemented to ensure effective climate change adaptation and mitigation. These are concerned with:

- Capacity building,
- Governance,
- Finance,
- Education, research and development,
- Early warning system,
- Public sensitisation and knowledge transfer measures,
- Gender equality.

2 CLIMATE CHANGE POLICY

2.1 The international context and the European Union policy

2.1.1 Status of international climate negotiations

The United Nations Framework Convention on Climate Change (Convention or UNFCCC) is the first and fundamental international agreement aimed at addressing climate change. The Convention was adopted on 9 May 1992 and opened for signature at the Rio de Janeiro Earth Summit from 3 to 14 June 1992. Formally, the Convention entered into force on 21 March 1994. The aim of the Convention is to achieve the stabilisation of greenhouse gas concentrations in the atmosphere to a level that will prevent dangerous anthropogenic effects on the climate system.

Based on the UNFCCC Convention, the Kyoto Protocol was adopted, which represents a step towards reversing the global trend of growing greenhouse gas emissions. The Kyoto Protocol was adopted in Kyoto in 1997 and entered into force in 2005. The Protocol set legally binding quantified targets for developed, industrialised countries with the aim of reducing their greenhouse gas emissions. The first commitment period of the Kyoto Protocol lasted from 2008 to 2012. In that period, the target was to reduce greenhouse gas emissions by 5% compared to 1990 emissions. In the second commitment period[1], from 2013 to 2020, the target was to reduce emissions by 20% compared to 1990 but as a joint reduction commitment under the UNFCCC convention. However, the Kyoto Protocol and its Doha Amendment could not ensure a reduction in emissions that would stop the rise in global temperatures.

The Paris Agreement on Climate Change is based on the UNFCCC Convention and is the first common legally binding global climate agreement that unites all nations for the first time in a joint ambitious effort to combat climate change and adapt to climate change. The Agreement was reached at the 21st session of the Conference of the Parties (COP 21) to the United Nations Framework Convention on Climate Change (UNFCCC) in Paris on 12 December 2015, and entered into force on 4 November 2016, 30 days after met the so-called "double threshold" (ratification by 55 countries that account for at least 55% of global emissions). To date, the Agreement has been ratified by 189 of the 197 parties to the Convention.

The Agreement aims to strengthen the global response to the threat of climate change by holding the increase in the global average temperature to 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels. In addition, the Agreement aims to secure food supplies, but also to strengthen states' capacity to combat the effects of climate change, develop new ‘green’ technologies and help weaker, economically less developed members achieve their national emission reduction plans.

At the Sustainable Development Summit, held on 25 September 2015, United Nations Member States adopted the 2030 Agenda for Sustainable Development, which contains 17 Sustainable Development

[1]The second commitment period was agreed in 2012 and is known as the Doha Amendments to the Kyoto Protocol

Goals to eradicate poverty, combat inequality and injustice, and address climate change by 2030. Goal 13: 'Climate Action' calls for urgent action to combat climate change and its impacts.

2.1.2 European Union policy on climate change adaptation and mitigation

In December 2019, the European Commission presented the European Green Deal - a strategy for achieving the sustainability of the EU economy by turning climate and environmental challenges into opportunities in all policy areas and making the transition just and inclusive. The European Green Deal describes how, by 2050, Europe will become the first climate-neutral continent and how to boost the economy, improve health and quality of life, protect nature without neglecting anyone.

The European Green Deal contains a framework plan with measures to improve the efficient use of resources by moving to a clean, circular economy and to halt climate change, restore biodiversity and cut pollution. It lists the necessary investments and available financial tools and explains how to ensure a just and inclusive transition. The Deal covers all economic sectors, especially transport, energy, agriculture, maintenance and construction of buildings and industries such as the production of steel, cement, textiles and chemicals, and information and communication technologies. [2]

The European Green Deal strongly supports the continuation of work on climate change adaptation and mitigation policy at all levels and in the framework of international climate negotiations. The Deal sets out a strategic approach to addressing the impact of climate change through the adoption of a new EU strategy for adaptation to climate change. In doing so, it will be important to ensure that climate change adaptation measures also contribute to reducing greenhouse gas emissions.

The EU's long-term goal in the context of low-carbon development is to reduce GHG emissions by 80-95% by 2050 compared to 1990. This objective is defined and elaborated through 'A Roadmap for moving to a competitive low-carbon economy in 2050'. In line with this objective, the EU has adopted the 2030 Climate and Energy Policy Framework, which sets the following targets:

- 40%[3] cuts in GHG emissions (from 1990 levels),
- At least 32% of final energy consumption should be from RES and
- At least 32.5% improvement in energy efficiency.

This strategy is aimed at creating a European society as a competitive, secure and energy efficient system, ready to achieve the long-term goal of reducing greenhouse gas emissions by 2050. The strategy sends a strong signal to the market, encouraging private investment in new energy infrastructure and low-carbon technologies.

The Climate and Energy Policy Framework sets guidelines for EU action until 2030. The target of reducing GHG emissions by at least 40% compared to 1990 will be implemented by reducing emissions in the ETS by 43% compared to 2005, and in sectors outside the ETS by 30% compared to 2005.

In order to achieve the defined targets, the EU has introduced a number of instruments that encourage the reduction of GHG emissions, the use of RES and the increase of energy efficiency. When it comes

[2] European Commission, available at: https://ec.europa.eu/croatia/news/eu_green_deal_2019_hr

[3] Representatives of EU Member States agreed in November 2020 to raise this target to 55% (the proposal was submitted for adoption by the EU Parliament)

to the GHG emissions target, the approach focuses on reducing emissions but does not exclude other methods, such as carbon capture and storage. Directive 2009/29/EC establishes a scheme for GHG allowance trading with the aim of achieving a reduction in GHG emissions in a cost-effective manner. The Directive provides for the establishment of an Emissions Trading Scheme (ETS) in the EU for GHG. The Directive covers large power plants, refineries and large factories producing steel, cement, glass, ceramics and paper. The Directive obliges operators engaged in these activities to obtain GHG emissions permits from the competent authorities. The conditions for issuing permits are defined by the Directive. The Directive also specifies the total allowable GHG emission allowances for aviation. For each five-year period, it is necessary to prepare a national plan for the distribution of emission permits, stating the total amount of the planned quota for that period and the proposed method of distribution. Furthermore, the Directive prescribes a penalty of EUR 100 for each tonne of carbon dioxide equivalent emitted by that installation for which the operator has not surrendered the emission permit. The public must have access to emission permit allocation, information on project activities in which the Member State participates directly or by authorising private or public entities and emission reports, which are necessary under the GHG emission permit and kept by the competent institution. Operators covered by the Directive have the obligation to submit monitoring reports to the competent authority, which must be verified by independent verifiers. The operator must submit to the competent authority a report on emissions, covering annual emissions in a given period, by 31 March each year for the previous year.

EU Directive 2018/2001 on the promotion of the use of energy from renewable sources is aimed at achieving the target of a share of 32% of RES in the final consumption of energy by 2030. Its goal is to strengthen small energy producers from RES and shorten the procedure for obtaining installation of RES from 50 kW to 1 MW for a maximum of one year, through 'one-stop-shops', and also empower the energy cooperative. The Directive requires Member States to give all citizens, whether living in single family houses or apartments, the right to produce energy from RES. The revised Directive sets a binding EU minimum target of a 14% share of RES in the transport sector, calculated as the share of fuel supply in the EU market. In the heating and cooling sector, a non-binding target of 1.3% annual increase in RES consumption has been set, at least 1.1%, while Member States will have to justify if they do not meet this target.

As of 15 October 2017, Directive 2012/27/EU on energy efficiency became valid, repealing Directive 2006/32/EC. The Directive introduces the concept of cap consumption expressed in primary and final energy, setting a limit at the level of the countries of the Energy Community. Namely, in addition to the expected savings in final energy, according to the Directive, savings on the primary energy in transformation, transmission and distribution are expected, and cogeneration and efficient district heating systems are promoted. This means changing the way of planning, as well as involving the entire energy sector in the phase of preparation, implementation and monitoring of proposed programmes and planned measures.

Directive 2010/31/EC on the energy performance of buildings defines the requirements for energy audits, energy certification, minimum energy performance of buildings, methodology for calculating energy performance, etc.

Regulation 443/2009 sets emission standards for new passenger cars. The aim of this Regulation is to create incentives for the automotive industry to invest in new technologies. The Regulation actively

promotes eco-innovation and takes into account future technological advances. The Regulation sets a value of 130 g CO_2/km as the average emission value for new passenger vehicles, which will be achieved through technological improvement of vehicle engines. From 2020 onwards, this Regulation sets a target of 95 g CO_2/km as average emissions for the new car fleet[4].

Directive 1999/94/EC relating to the availability of consumer information on fuel economy and CO_2 emissions in respect of the marketing of new passenger cars (Consumer Information Directive), as amended by Directive 2003/73/EC, Regulation (EC) 1882/2003 and Regulation (EC) no. 1137/2008, provides information on fuel economy and carbon dioxide emissions for new passenger cars offered for sale or lease in the EU.

Directive 2009/31/EC on the geological storage of carbon dioxide (the CCS Directive) establishes a legal framework for the environmentally safe storage of carbon dioxide as part of the fight against climate change.

In 2013, the European Commission adopted an EU strategy for adaptation to climate change. The Strategy aims to make Europe more resilient to climate change. Applying a coherent approach and improving coordination aims to increase the readiness and ability of all levels of government to respond to the impacts of climate change.

The EU's climate change adaptation strategy focuses on three key objectives:

- Promoting action by Member States: The Commission encourages all Member States to adopt comprehensive adaptation strategies and will provide guidance and funding to help them build up their adaptation capacities and take action. The Commission will also support adaptation in cities based on the Global Covenant of Mayors for Climate & Energy initiative.
- Climate change adaptation measures at EU level by further promoting adaptation in key vulnerable sectors such as agriculture, fisheries and cohesion policy, ensuring that Europe's infrastructure is made more resilient, and encouraging the use of insurance against natural and man-made disasters.
- Better informed decision-making by addressing gaps in knowledge about adaptation and further developing the European Climate Adaptation Platform (Climate-ADAPT).

2.2 Policy of Bosnia and Herzegovina on climate change

Bosnia and Herzegovina became a party to the UNFCCC on 6 December 2000, and ratified the Kyoto Protocol on 22 April 2008. Following the ratification of the Convention, BiH has worked seriously to establish an appropriate political, institutional and legal framework to meet its obligations under the Convention. According to the Convention, BiH has the status of a developing country, which means, among other things, that it is obliged to report on GHG emissions and to participate in international cooperation mechanisms to reduce emissions and adapt to climate change.

[4]Ministry of Foreign Trade and Economic Relations of BiH (2017). Strategy for harmonisation of regulations with the *Acquis Communautaire* in the field of environmental protection of Bosnia and Herzegovina

2.2.1 Existing policies and measures

In terms of international obligations on climate change mitigation and adaptation, BiH supports the principle of common but differentiated responsibilities. Economic and other specifics should be taken into account when determining the transition period for the transition to a low-carbon economy. The goal of the low-carbon strategy is to create synergies with the concept of developing new green businesses and the economy, the concept of a circular economy in which resources are used to the maximum, waste generation is reduced to a minimum.

Under the UNFCCC, Bosnia and Herzegovina is considered a non-Annex I Party, i.e. developing or transitional countries. The non-Annex I parties are not obliged to take greenhouse gas (GHG) emission reduction action but they are encouraged to do so with financial support from developed countries. In this context, BiH participated in the Clean Development Mechanism (CDM) with three registered projects.

In 2013, the Council of Ministers adopted The 2013-2025 Climate Change Adaptation and Low Emission Development Strategy for Bosnia and Herzegovina, whose strategic goal was to increase BiH's resilience to climate variability and climate change, while preventing environmental degradation and gradually reducing greenhouse gas emissions. Integration into all relevant sectors is very slow, mainly due to lack of knowledge and institutional capacity.

BiH has demonstrated its commitment to participate in global efforts aimed at mitigating and adapting to climate change by signing the Paris Agreement. As a contribution to the fulfilment of the Paris Agreement, it adopted the document 'Intended Nationally Determined Contributions (INDCs)' for the period until 2030. The document is based on previously adopted strategic documents, such as the Adaptation to Climate Change and Low Carbon Development Strategy of BiH, and the documents Second National Communication on Climate Change under the UNFCCC and the First Biennial Report on Greenhouse Gas Emissions under the UNFCCC. According to the scenarios developed within the INDC, the highest level of GHG emissions is reached in 2030, when according to the baseline scenario, 20% higher emissions are expected than the 1990 level of emissions. As an unconditional target of reducing GHG emissions, BiH has set a goal of a 2% reduction in 2030 in relation to emissions according to the baseline scenario. The conditional target (with more international assistance) is to reduce emissions by 3% compared to 1990 emissions.

The Council of Ministers also adopted Decision on the Establishment of the Designated Authority for Implementation of the Clean Development Mechanism of the UNFCCC Kyoto Protocol in BiH (Official Gazette of BiH, 102/10) and the Decision on Amendments to the Decision on Establishment of the Designated Authority for Implementation of the Clean Development Mechanism of the Kyoto Protocol, which added the development, reception and approval/rejection of measures for climate change mitigation (NAMA, etc.) to the existing activities of the Designated Authority. Meteorological and hydrological services are responsible for compiling the GHG inventory at the entity level. In the RS, the Law on Air Protection prescribes that RS MHS is responsible for compiling the GHG inventory, which maintains the inventory for the Republika Srpska, publishes data on an annual basis on the official website of the Service, prepares the Annual Report on the GHG emissions inventory for the Republika Srpska and delivers it to the competent authorities. However, appropriate bylaws regulating

inventory management have not yet been adopted. In the FBiH, FBIH MHS is working on the collection of data on air emissions, including GHG, but the competence is not clearly defined.

By signing the Declaration on the Green Agenda for the Western Balkans on 10 November 2020 in Sofia, BiH expressed its commitment to implementing measures in the field of climate change mitigation, energy transition, sustainable mobility and circular economy, as well as biodiversity protection, sustainable agriculture and food production. BiH has committed to a number of concrete actions, including the introduction of a carbon tax and market models to encourage renewable energy sources, as well as the phasing out of coal subsidies with a view to achieving climate neutrality by 2030. In the coming period, the mechanisms of cooperation between the EU and the countries of the Western Balkans in the implementation of the Green Agenda will be defined.

By signing the Treaty establishing the Energy Community, BiH has, among other things, committed itself to transposing the EU acquis, or transposing and implementing the relevant EU directives and regulations in the field of climate change and energy. The most important aspects, whose transposition process has begun almost a decade ago, are encouraging the use of RES, increasing energy efficiency and establishing a system for collecting, reporting and verifying GHG emissions. So far, BiH has produced and submitted three communications on climate change and two biennial reports on GHG emissions. Within these documents, inventories of GHG emissions for the period from 1990 to 2014 were compiled and submitted to the UNFCCC Secretariat. The inventory for 2015 and 2016 is being compiled.

In 2018, BiH adopted the Framework Energy Strategy of BiH until 2035. The strategy contains the basic principles of climate policy that are not sufficiently translated into concrete measures. According to the Strategy, a long-term energy-related vision of BiH is the creation of a competitive and long-term sustainable energy system taking into consideration security of supply. In order to achieve this vision, five key priorities and related focus areas have been defined:

- Efficient use of resources – a long-term development of the energy sector of BiH implies reduction of harmful emissions and generation of electricity from fossil fuels, therefore it is extremely important that the future coal exploitation and production activities are implemented in a more efficient manner, by applying an adequate technology and methods of operation; the future stronger orientation towards clean energy, which is nowadays predominantly based on hydropower potentials, requires good management of natural resources; fulfilling the vision includes digitalisation, new technologies and IT systems that enable cost reduction, better work and new business models.

- Safe and affordable energy – BiH cannot achieve the energy security in all segments on its own, primarily because of non-existence of its own oil and gas production; generation mix of BiH is relatively price competitive, however, in the forthcoming period further price-related pressures may be expected (coal production price, ETS - Emissions Trading System, generation price deregulation, etc.), which could have negative impact on competitiveness; planned intensive construction of (thermal power) plants under the current price conditions and EU policies, increases the risk of fixed costs increase and possible decrease of power plant utilisation, thus putting pressure on future price competitiveness; keeping the average generation costs at the level of current level in the long run is considered a good result considering all types of pressures.

- Energy efficiency - in line with the long-term vision of the EU Member States; energy savings in final consumption, savings in the electricity, gas and heat transformation, transmission and distribution process, creation of conditions for highly efficient cogeneration as well as promotion and expansion of efficient district heating systems; to improve the energy efficiency legal and regulatory framework, define financial measures and institutional implementation framework, and to conduct information campaigns, education and capacity building.

- Energy transition and environmental responsibility - clean energy and reduction of negative impacts on the environment are highly positioned on the agenda; BiH has committed itself, until 2028, to reduce SO_2 by 95%, NO_x by 67% and dust by 88% relative to 2014, with regard to large combustion plants; as for the RES share in the gross final energy consumption until 2020, the set goal implies the 40% target; the next step would be the preparation of Strategic Environmental Assessment (SEA) and the environment and nature protection strategy to adequately follow the energy strategy.

- Development and harmonisation of the regulatory and institutional framework - it implies the comprehensive and essential changes and overall reform of the energy sector; the strategic goal includes accelerated harmonisation of legislation with acquis, or transposition and implementation of the obligations assumed under the Treaty establishing the Energy Community; harmonising the energy sector with the Third Energy Package and future EU Directives.

In order to meet the obligations arising from the Energy Community Treaty, BiH has adopted RES and EE action plans based on the entity action plans. According to preliminary analyses, BiH has met the target related to the share of RES in final energy consumption for 2020 (40% of RES in final energy consumption). The target on the share of RES in transport has not been achieved, the target of energy efficiency has been partially achieved.

At the meeting of the Ministerial Council of the Energy Community at the end of 2017, BiH committed itself to drafting an integrated National Energy and Climate Plan (NECP) in which it should define the goals, policies and activities of the energy sector decarbonisation process for the period 2021-2030.

BiH is working on the project 'Advance the National Adaptation Plan (NAP) process for medium-term investment planning in climate sensitive sectors in Bosnia-Herzegovina'. The project will support BiH to advance the National Adaptation Plan (NAP) process and reach goals outlined in the Paris Agreement and 2030 Agenda for Sustainable Development.

The BiH National Adaptation Plan will build on the country's Climate Change Adaptation and Low Emission Development Strategy of 2013. The project will advance adaptation planning in BiH with a focus on sectoral approaches, upgrading the knowledge base for adaptation, prioritising adaptation interventions for the medium term, building institutional capacities for integrating climate change adaptation, and demonstrating innovative ways of financing adaptation at entity, cantonal and local government levels.

This is an initial step in setting a general policy course for low-emission and climate resilient development, integrating more specific policies, measures and projects into sectoral strategies, and

identifying existing possible adaptation and mitigation actions to attract international support. An NDC implementation plan is currently being prepared, which should be a guide for reducing greenhouse gas emissions in the coming years.

2.2.2 Institutional framework

BiH is a decentralised country comprising two entities (the Federation of Bosnia and Herzegovina and the Republika Srpska) and Brčko District of Bosnia and Herzegovina. Pursuant to Annex IV of the Dayton Peace Agreement, which applies as the Constitution of Bosnia and Herzegovina, issues such as foreign policy, foreign trade policy and customs policy fall under the competence of the institutions of Bosnia and Herzegovina. All functions and powers that are not explicitly assigned by the Constitution to the institutions of Bosnia and Herzegovina belong to the entities. Thus, the Federation of Bosnia and Herzegovina and the Republika Srpska and the Brčko District manage environmental issues by applying laws, regulations and standards.

The Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina is responsible for performing tasks and responsibilities within the competence of BiH related to defining policy, basic principles, coordination of activities and harmonisation of plans of entity authorities and institutions at the international level in agriculture, energy, environment, development and use of natural resources and tourism. The FBiH Ministry of Environment and Tourism, the Ministry of Spatial Planning, Civil Engineering and Ecology of the Republika Srpska and the Department of Spatial Planning and Property Legal Affairs of the Brčko District are the institutions competent for the environment. According to the Decision of the Council of Ministers of Bosnia and Herzegovina on the Establishment of the Designated Authority for Implementation of Projects of the Clean Development Mechanism Protocol of the United Nations Framework Convention on Climate Change in Bosnia and Herzegovina (Official Gazette of BiH, Nos. 102/10 and 45/15) DNA BiH is the competent authority in the country for CDM projects consisting of the Executive Board of DNA BiH (representatives of the Ministry of Foreign Trade and Economic Relations of BiH, the FBiH Ministry of Environment and Tourism, the Ministry of Spatial Planning, Civil Engineering and Ecology of Republika Srpska and the Department of Spatial Planning and Property Legal Affairs of the Brčko District), the Technical Secretariat within the Executive Board of the DNA BiH with its seat in the Ministry of Foreign Trade and Economic Relations of BiH, the Secretariats of the Entities, the Secretariat of the Brčko District and the Expert Council of the Secretariats of the Entities and the Brčko District.

In 2006, the Ministry of Foreign Trade and Economic Relations of BiH appointed the Ministry of Spatial Planning, Civil Engineering and Ecology of the Republika Srpska as a UNFCCC focal point for Bosnia and Herzegovina.

3 SITUATION ANALYSIS

3.1 Impact of climate change on Bosnia and Herzegovina

As a result of historic and current greenhouse gas emissions there are inevitably impacts of climate change already in Bosnia and Herzegovina. The country must prepare itself to respond to climate change – and maximise opportunities where they occur – by understanding vulnerabilities, increasing resilience and building capacity. This section highlights the pressing need to adapt to climate changes and plan for the future to ensure a sustainable economy, environment and communities.

3.1.1 Observed climate change to date

The Initial National Communication (INC) and the Second National Communication (SNC) and the Third National Communication (TNC) on climate change recognise that climate change is affecting Bosnia and Herzegovina, and will accelerate during the remainder of the twenty-first century. The analysis of meteorological data for the period 1961-2014 indicates that the mean annual temperature maintains a continuous increase throughout the territory. A positive linear trend in the mean annual temperature has been observed and particularly pronounced in the last 30 years. Trends in annual temperatures at all analysed stations are statistically significant, while changes are more pronounced in the continental part. The increase in air temperature on an annual basis ranges from 0.4 to 1.0°C, while the increase in temperature during the vegetation period (April - September) goes up to 1.2°C. However, temperature increases over the last fourteen years have been even more pronounced. In the analysed period, all indices of warm temperature extremes have positive trends, while the indices of cold temperature extremes have a negative trend. The most significant change in this period is observed in the number of frost days (FD) and the number of summer days (SU). At all meteorological stations, the number of frost days (FD) has a negative trend. In the central mountainous areas, the number of frost days has been reduced by 4 days to 10 years, while in the south of the country there is somewhat less reduction amounting to 2 days to 10 years. The number of summer days (SU) has a positive trend and is statistically significant.

At all meteorological stations in Bosnia and Herzegovina, the coldest month is January, with an average temperature of -3.8°C in Sokolac to 5.3°C in Mostar. The average temperature in January in the northern part ranges from -0.2°C to 0.2°C. The warmest month is July, with the highest average air temperature in the eastern and southern part of the territory (Bijeljina 21.8°C, Bileća 22.1°C and Mostar 25.4°C). The average temperature in July in Banja Luka is 21.4°C. Mean annual air amplitude temperature in the period 1961-2015 in the north ranges from 20.2°C in Tuzla to 21.7°C in Bijeljina. The highest annual temperature amplitude in the entire study area is present in Semberija, which is the most continental part of the study area. Temperature amplitudes are slightly lower in high Herzegovina (for example, Bileća 18.8°C) and in Sarajevo (19.9°C).

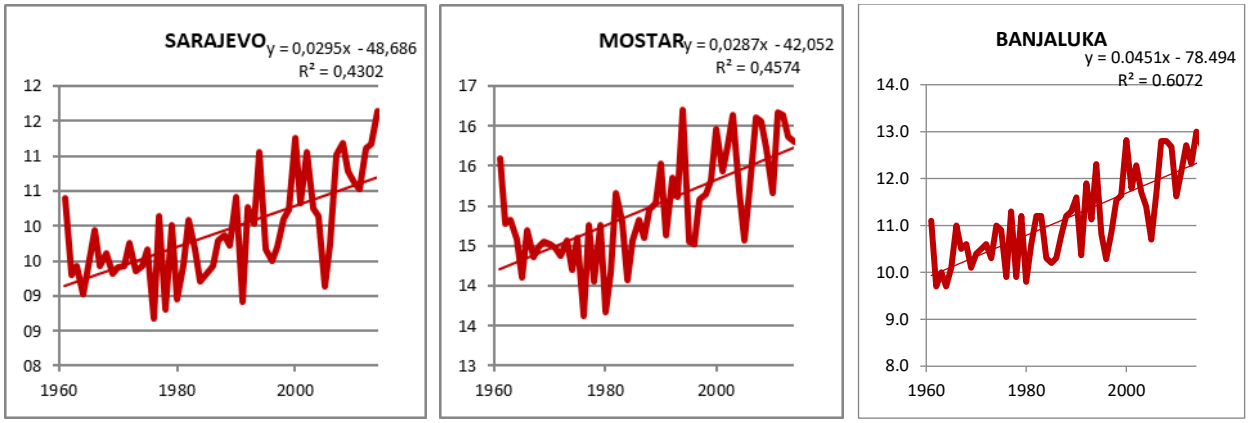

Figure 1: Trends in air temperature changes, 1961-2015 (Sarajevo, Mostar, Banja Luka)

Of the ten warmest years in the observed period 1961-2015, nine years have been recorded since 2000 (only 1994 was among the ten warmest). Among the warmest years in the analysed period were: 2000, 2007, 2008 and 2014. The year 2014 was the warmest year in most of Bosnia and Herzegovina. In Semberija, warmer than 2014 were only the years of 2008 and 2015. In Herzegovina, 2014 was not among the first few warmest years. Mostar was the warmest in 2015, then in 1994, 2011 and 2012 (interestingly, there are very small differences in the average annual temperature in Mostar during the ten warmest years). Since 1990, when the warming trend is more pronounced, only a few years have been colder than the average climatic period (1961-1990) - 1996 (at all stations except Sokolac), 2005 (in Sanski Most, Prijedor, Doboj, Tuzla , etc. Sarajevo and Bileća), and in 1995 in Tuzla and Bileća, in 1997 in Tuzla and in 1991 and 2006 in Bileća. Since 1990, Sokolac has been warmer than the average standard climate period. Among the coldest years in the period 1961-2015 are the years of 1962, 1964, 1976, 1978, and 1980 (all from the period before 1990). In the northwest, the coldest years were recorded at the beginning of the analysed period. The coldest years in Banja Luka and Prijedor were in 1962 and 1964. In the area from Doboj to Bijeljina the coldest year was 1980, and in the area of Sarajevo and Sokolac, as well as in Herzegovina, the year of 1976.

In the observed period 1961-2015. in the entire territory of Bosnia and Herzegovina there is a negative trend in the annual number of frosty days which is statistically significant in almost all areas. Negative trend values range from 2.1 to 6.4 days per decade[5]. The change in trend is most pronounced in the northwestern part of the territory. The year with the least winter days was recorded after 1990. There have been extremely few icy days in the last decade, when global warming was most pronounced.

In the period 1961-2015, most of the territory of Bosnia and Herzegovina was characterised by a slight increase in annual precipitation. Linear trends for the multi-year period 1961-2015 indicate stagnation or a slight increase in precipitation throughout Bosnia and Herzegovina. Changes in precipitation are more pronounced by seasons than on an annual basis. Although no significant changes in precipitation were recorded, the pluviometric regime, or the annual distribution, was greatly disturbed. Due to the increased intensity of precipitation and its greater variability, as well as due to the increased share of heavy rains in the total precipitation, the risk of floods has increased, especially in the northeastern part of Bosnia and Herzegovina where catastrophic floods were recorded in May 2014.

[5]Popov, T., Gnjato, S., & Trbić, G. (2017).Trendovi indeksa ekstremnih temperatura u Bosni i Hercegovini – primjer Mostara /*Extreme temperature index trends in Bosnia and Herzegovina - the example of Mostar*/.Herald, 21, 107–132. doi:10.7251/HER2117107P

3.1.2 Anticipated climate change

As part of the preparation of the Fourth National Communication (FNC) under the UN Framework Convention on Climate Change, a projection of the future climate for Bosnia and Herzegovina was made, based on different scenarios of future concentrations of greenhouse gases. The future concentration scenarios considered are scenarios RCP2.6, RCP4.5, RCP6.0 and RCP8.5[6], which are defined in the Fifth Report of the Intergovernmental Panel on Climate Change (IPCC)[7]. All future changes are shown for the period 2016-2100 in relation to the reference climate period 1986.-2005[8].

According to global climate models[9], for the RCP8.5 climate scenario, which is the most extreme climate scenario, the anticipated change in mean daily temperature is 4.8°C, with a range of 4 to 6°C compared to the 1986-2005 reference period. For the middle of this century, the mean change according to this scenario is slightly higher than 2.5°C, while for the near future (2016-2035) the anticipated change is about 1°C compared to the value from the reference period 1986-2005.

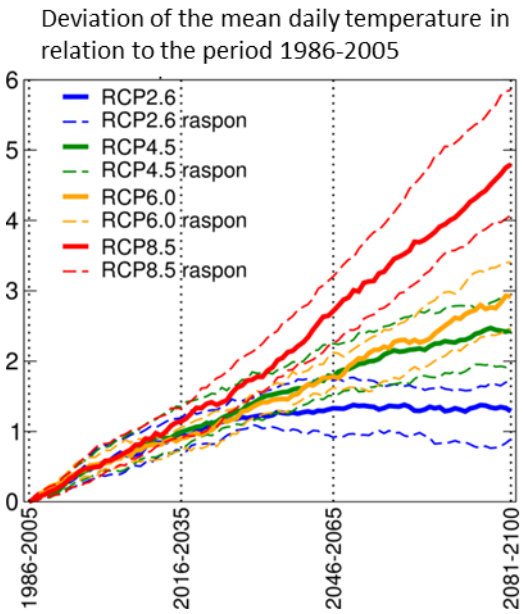

Figure 2: Change in the average annual value (in °C) of the mean daily temperature, shown as the deviation of the 20-year moving average value from the reference period 1986-2005

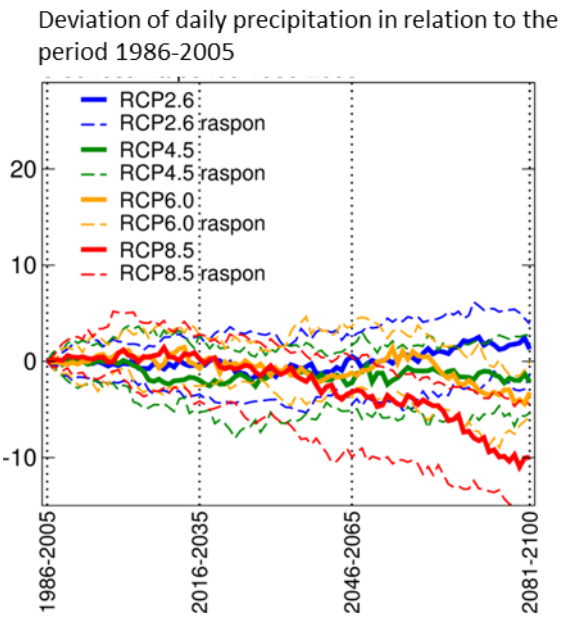

Figure 3: Change in the average annual value (in%) of daily accumulated precipitation, shown as a deviation of the 20-year moving average value compared to the reference period 1986-2005

Unlike temperature changes, precipitation changes show a somewhat more complex structure, with possible both positive and negative changes compared to the reference period, especially for periods in the near future, when all four scenarios show that possible changes range from -5 to + 5% in relation to the values from the reference period. The differences between the scenarios are noticeable only

[6]Scenarios RCP2.6 and RCP4.5 assume that in the future, conditionally speaking, there will be a stabilisation of greenhouse gas concentrations, while according to scenarios RCP6.0 and RCP8.5, their concentration will continue to grow, or follow the trends observed in the past. In this sense, scenario RCP2.6 can be considered 'optimistic', while on the other hand scenario RCP8.5 according to which concentrations rise to approximately 1250 ppm (CO_2 equivalent) can be considered 'pessimistic', or as this scenario is colloquially called 'Business as usual' scenario, given that according to this scenario, the energy policies of individual countries, primarily in terms of the use of fossil fuels, would remain unchanged in the future.

[7]https://www.ipcc.ch/assessment-report/ar5/

[8]This period was used as a reference in the last Fifth Report of the Intergovernmental Panel on Climate Change.

[9]The results of global climate models are taken from CMIP5 database (*Coupled Model Intercomparison Project – phase 5*) (https://cmip.llnl.gov/cmip5/) which was used in the preparation of the Fifth Report of the Intergovernmental Panel on Climate Change.

for the periods at the end of the twenty-first century, with the scenario RCP8.5 standing out, according to which at the end of the century, the anticipated value of change is around -10% with a range from -4 to -15%. According to the presented results, only in the case of this scenario, future changes can be more significant in the second half of the twenty-first century, when according to this scenario we should expect a decrease in total precipitation and climate change in terms of potential annual precipitation loss.

According to regional climate models[10], for the RCP8.5 scenario, the change in mean daily temperature for the first period, the near future (2016-2035), ranges from 0.5 to 1.5°C. For the second analysed period, the middle of the century (2046-2065), the changes range from 1.5 to 3°C. Finally, for the last period (2081-2100) the temperature increase ranges from 2.5 to 5°C where the increase of maximum daily temperatures for the season June-July-August is particularly prominent, when the temperature increase in most parts of the country is higher than 5°C. Changes in temperatures are higher in mountainous areas, which is clearly visible in the case of changes for the last analysed period 2018-2100.

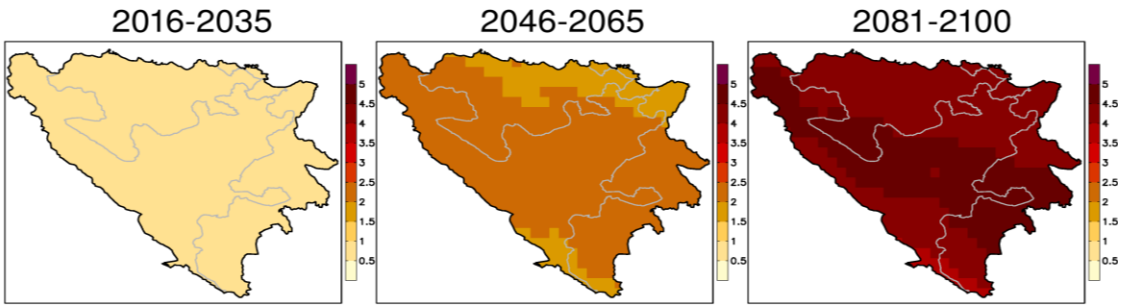

Figure 4: Change in mean daily temperature (in °C) in relation to the reference period 1986-2005 for the RCP8.5 scenario

In the case of the RCP8.5 scenario, the change in daily accumulated precipitation on an annual basis for the first two periods ranges from -5 to 5%, and for the last analysed period (2081-2100) it is negative and in some parts of the country less than - 10%. The season with the highest precipitation loss is June-July-August (JJA), which is especially pronounced for the RCP8.5 scenario for which during the last period, the possible precipitation reduction is less than -30% in the south of the country. This deficit of summer precipitation is obviously the main contribution to the negative change in total precipitation on an annual basis.

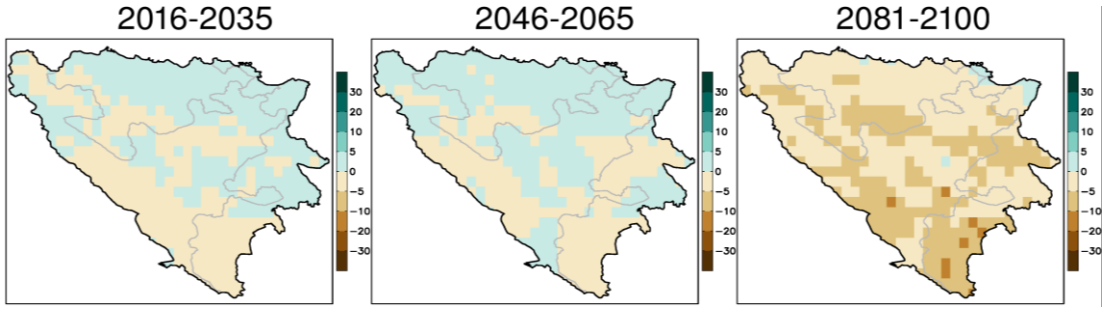

Figure 5: Change in mean daily precipitation (in %) compared to the reference period 1986-2005, for the RCP8.5 scenario

[10]The results of the regional climate models are taken from the EURO-CORDEX database (https://www.euro-cordex.net/) which is the reference base for climate projections for Europe and which in recent years has been the basis for many studies on climate change in Europe. Regional climate models allow using lateral boundary conditions from global climate models, future climate projections to be regionalised to a better horizontal resolution. In this case, regional climate models with a resolution of 11 km were used.

According to climate models, the number of frost and the number of icy days will decrease in all scenarios. For the RCP8.5 scenario, the change in the number of frost days is significantly reduced for further time horizons and for the period 2046-2065 it amounts to -30 days, while for the last period the change is most pronounced in the southern parts of the country and amounts to -60 days. The change in the number of ice days is also significantly reduced for further weather horizons and for the period 2046-2065 it is up to -20 days, while for the last period the change is most pronounced in the mountainous parts of the country and amounts to -30 days (in some smaller areas up to -50 days, while in the northern parts the change is somewhat milder and amounts to -20 days).

By the end of this century, according to all scenarios, the number of summer days will increase. For the RCP8.5 scenario, the change in the number of summer days increases significantly for further weather horizons and for the period 2046-2065 it is up to 40 days more, in some parts up to 50 days more, while for the last period the change is most pronounced and amounts to 60 days, almost throughout the country.

According to all scenarios, the number of days with precipitation greater than 20 mm will generally increase. Changes range from +5 to +20% (in most parts of Bosnia and Herzegovina where changes are positive) and up to -5% (in parts where the change is negative). In the case of the RCP8.5 scenario, for the time period 2081-2100 this change is somewhat more pronounced in most of the territory and amounts to +20%, and in some smaller areas over +30%.

The number of consecutive dry days will generally increase, with the exception of some smaller parts of the territory of Bosnia and Herzegovina. For the period of the near future, the change according to all three scenarios in most parts of the territory is from 0 to 5% more of these days, while only in smaller areas the change is from 0 to -5%. For the RCP8.5 scenario, the change in consecutive dry days increases significantly for further weather horizons and for the period 2046-2065 it is 10 to 20% more of these days, while for the last period the change is most pronounced and is 20 to 30% more of these days, in most of the country.

Finally, a further rise in temperature will lead to a prolongation of the growing season.

3.2 Observed and projected climate change impacts on key sectors in Bosnia and Herzegovina

Temperature increases in Bosnia and Herzegovina are likely to have largely detrimental impacts, particularly as predicted higher temperatures are associated with reduced precipitation and higher evaporation rates for inland areas of the country. A global mean temperature increase greater than 2°C will result in increasingly costly adaptation and considerable impacts that exceed the adaptive capacity of many ecological systems (such as high mountain and lowland oak forest areas), and a high risk of large scale irreversible effects including endemic species extinction.[11]

3.2.1 Agriculture

According to forecasts, climate change in Bosnia and Herzegovina will be reflected in rising air temperatures, droughts during the summer months, as well as extremes in terms of precipitation, its

[11]European Union EG Science Paper, 'The 2°C target: Background on Impacts, Emission Pathways, Mitigation Options and Costs',2008

distribution and intensity. The consequences of climate change in the agricultural sector can be viewed twofold: as positive and as negative consequences. According to research, in the Republic of Croatia by 2050 the yield of the most important agricultural crops could be reduced from 3 to 8%, and a similar situation can be expected in Bosnia and Herzegovina.

Heat stress is one of the biggest problems in agriculture, especially in the sub-Mediterranean part of Bosnia and Herzegovina. This problem has been particularly present in the last two decades, with it being best seen in fruit production, viticulture and, more recently, olive production. In the north of Bosnia and Herzegovina (Republika Srpska), according to some projections, there will be a reduction in corn yield from 10% to 25%, while the central part of the country will have the potential to increase yields. There is an opportunity to reduce soybean yields because soybeans require heavier soils and significant amounts of soil moisture. Drought and high temperatures during the summer of 2012 have been estimated to have cost approximately $ 1 billion in lost agricultural production[12], as well as destroying nearly 70% of vegetables and corn in the inner parts of BiH[13].

Due to the pronounced spatial and temporal unevenness in the distribution of precipitation, especially in the south of the country, during the summer dry periods when water needs are greatest, there will be an increase in the need for irrigation of agricultural crops. Spring crops will be endangered due to high temperatures and water shortages during the summer months. There will be a decrease in yield and quality of grazing, fodder (especially spring crops) and the impoverishment of pastures due to heavy rains and stronger winds. Likewise, accelerated soil erosion processes can be expected mainly through increased soil erodibility after longer drought periods, increased precipitation intensity and changes in land use patterns.

The negative consequences are reflected in the frequent floods that inevitably lead to the destruction of crops, and one of the problems is the stagnation of surface water, which also endangers and destroys crops. Estimates show that the May 2014 floods alone caused damage and losses to agriculture estimated at EUR 187 million. According to the 2015 report[14] of the Ministry of Foreign Trade and Economic Relations of BiH, floods, and later landslides, affected about 70,000 ha of the most productive agricultural land, and on about 55,000 ha crops were either completely destroyed or of varying degrees of damage whose losses are estimated at about BAM 131 million. About 25,000 farms have suffered huge losses due to the floods. In livestock, losses of about 5,000 pieces of large and small cattle, and more than 200,000 pieces of various poultry whose value is estimated at about BAM 31.6 million were recorded.

Climate change is increasing the spatial distribution and intensity of the development and spread of diseases, pests and invasive thermophilic weeds. Weeds and pests are likely to spread northward. Changes in agricultural technologies, especially more intensive irrigation, may increase the incidence of some other phytopathogenic bacteria.

Climate change is expected to have a positive effect on yields and quality of winter (but not spring) crops due to the extended vegetation period. Winter crops can also suffer from excess and lack of autumn soil moisture. Fruit and grape growing areas will expand due to the disappearance of very cold

[12]The Balkan drought brings to light the year of negligence in agriculture, *Reuters*, August 2012.

[13]Association of Agricultural Producers

[14]Agriculture, Food and Rural Development Report for Bosnia and Herzegovina for 2014

winters and late spring frosts, but the question arises as regards the adaptation to long-lasting droughts, high temperatures and stress that plants are exposed to due to such conditions.

The impact of climate change on the livestock sector is reflected not only through the occurrence of heat stress in animals, which significantly affects the production and quality of animal products, but also through the availability and quality of feed whose production is also endangered, and the drying of ponds and watering places. For example, increasing the temperature as well as increasing the humidity reduces food consumption and milk production in cows (1.5-2 litres per cow per day, in some cases as much as 50%).

Climate change, which includes an increase in temperature, as well as a change in the spatial (geographical) and temporal pattern of precipitation, leads to the emergence and spread of new exotic animal diseases. During the last decade, significant changes have been recorded in the occurrence and distribution of some vector-borne diseases, including Lyme disease, Leishmaniasis, Trypanosomiasis, Dengue fever and others.

When it comes to freshwater fishing, the lack of precipitation in the spring-summer period lowers the biological minimum in all watercourses, which accelerates the process of eutrophication, which adversely affects the process of reproduction and sustainability of the fisheries ecosystem. Due to increased air temperatures and sunlight, in cage and pool farming there is a faster heating of water which can have an adverse effect on the appearance of various diseases and pathogens.

All of the above, especially in a negative context, will have a particular impact on the poorer part of the population in rural, marginalised areas and on small producers who still struggle with a number of shortcomings when it comes to implementing adaptation and mitigation measures.

The answer to reduce high vulnerability in the agricultural sector should focus on important issues such as human capacity building to understand this issue, increase soil retention capacity for water, application of conservation tillage measures, cultivation of adequate species and varieties resistant to climate change, introduction of irrigation systems in all agricultural areas of BiH, construction of water reservoirs and ponds for irrigation, application of anti-erosion measures and introduction of forest farming as a measure to mitigate the effects of high temperatures, biodiversity protection and landscaping.

3.2.2 Water resources/water management

Water resources management

Water resources are important throughout BiH and can certainly be an important basis for the overall economic development of the country on the basis of ‘green economy’.

In Bosnia and Herzegovina, the annual precipitation is about 1,250 l/m2 (which makes 64,000 million m3 of water), and 1,155 m3/s flows from its territory, or 57% of the total fallen water (transit interstate waters are not taken into account)[15]. The total annual runoff per capita is 8,045 m3, which puts Bosnia and Herzegovina in the middle category of European countries in terms of water

[15]Framework Water Management Master Plan of Bosnia and Herzegovina, 1994.

availability[16]. The same category, near the lower limit, also includes the value of 5,675 m^3/capita/year for the Sava River Basin (Danube basin), while runoff in the Adriatic basins is in the high category, 26,500 m^3/capita/year.

Quantification of the catchment area balance is a fundamental requirement in the assessment and management of water resources, especially under the influence of water use and climate change. Since 2017, the Agency for Statistics of Bosnia and Herzegovina has been publishing data on renewable water resources of Bosnia and Herzegovina in the form of a Communication (Table 1).

Table 1: Assessment of renewable water resources, 2000 – 2017 (millions of m^3)[17]

Year	Precipitation	Real evapo-transpiration	Internal flow	Inflow of surface and groundwater from neighbouring countries	Renewable water resources	Surface and groundwater runoff to neighbouring countries	Outflow of surface and groundwater towards the sea
2000	1	24.287	19.732	2.000	21.732	28.332	7.168
2001	62.147	26.106	36.042	2.000	38.042	23.798	11.702
2002	56.494	25.715	30.779	2.000	32.779	25.212	10.288
2003	43.584	24.221	19.363	2.000	21.363	28.441	7.059
2004	61.123	26.062	35.061	2.000	37.061	23.539	11.961
2005	63.259	26.187	37.072	2.000	39.072	25.561	9.939
2006	49.908	25.070	24.839	2.000	26.839	26.362	9.138
2007	54.067	25.542	28.525	2.000	30.525	27.734	7.766
2008	49.688	25.074	24.615	2.000	26.615	25.954	9.546
2009	60.447	26.032	34.415	2.000	36.415	24.788	10.712
2010	78.837	26.930	51.907	2.000	53.907	17.724	17.776
2011	35.201	22.587	12.614	2.000	14.614	28.851	6.649
2012	52.792	25.399	27.392	2.000	29.392	28.291	7.209
2013	60.371	26.000	34.370	2.000	36.370	23.128	12.372
2014	75.610	26.883	48.728	2.000	50.728	20.431	15.069
2015	48.982	24.974	24.008	2.000	26.008	27.091	8.409
2016	55.280	25.617	29.663	2.000	31.663	25.516	9.984
2017	51.354	25.247	26.107	2.000	28.107	26.498	9.002

Source: Agency for Statistics of Bosnia and Herzegovina: Press release: Renewable water resources, 2018

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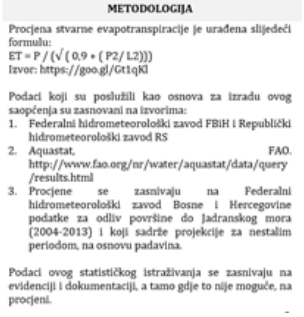
Category Dobris report (1995)	Availability (m^3/apartment/year)
Extremely low	< 1000
Very low	1000 - 2000
Low	2000 - 5000
Medium	5000 – 10 000
Above medium	10 000 – 20 000
High	20 000 – 50 000
Very high	>50 000

[17]Agency for Statistics of Bosnia and Herzegovina: Press release: Renewable water resources, 2018



METODOLOGIJA

Procjena stvarne evapotranspiracije je urađena slijedeći formulu:
ET = P / (√ (0,9 + (P2/ L2)))
Izvor: https://goo.gl/Gt1qKl

Podaci koji su poslužili kao osnova za izradu ovog saopćenja su zasnovani na izvorima:
1. Federalni hidrometeorološki zavod FBiH i Republički hidrometeorološki zavod RS
2. Aquastat, FAO. http://www.fao.org/nr/water/aquastat/data/query/results.html
3. Procjene se zasnivaju na Federalni hidrometeorološki zavod Bosne i Hercegovine podatke za odliv površine do Jadranskog mora (2004-2013) i koji sadrže projekcije za nestalim periodom, na osnovu padavina.

Podaci ovog statističkog istraživanja se zasnivaju na evidenciji i dokumentaciji, a tamo gdje to nije moguće, na procjeni.

Changes in the hydrological regime in recent decades in BiH are evident[18], in relation to the values and dynamics of precipitation, water levels and river flows. Under the influence of climate change, growing urbanisation and other anthropogenic influences, it can be expected that the sectors of agricultural production, hydropower, water supply in urban and rural areas will be particularly affected by the unfavourable consequences of increasing spatial and temporal unevenness of the hydrological regime, while successive droughts can also cause irreparable damage to forestry. Therefore, it is necessary, where possible, to redistribute available water in a socially acceptable way, with treating water as economic good.

The forecasted changes in precipitation and air temperature will negatively affect the current water resources management system in Bosnia and Herzegovina, or both its entities and BD. Changes can be expected in terms of time of occurrence, frequency and intensity of extreme events - floods and droughts. The largest increase in air temperature is predicted in the vegetation period (June, July and August), and a slightly milder increase during March, April and May, which will result in increased evapotranspiration and more pronounced extreme minimums of water levels in watercourses. This will result in a general reduction in the availability of water resources in the vegetation period when the needs are greatest, in terms of water quantity, but also quality, because in low water periods the potential and real danger of significant water quality degradation increases (in which untreated municipal and other wastewaters dominate, such as in the summer in the Miljacka River in Sarajevo). Groundwater resources are also becoming increasingly endangered, which is especially dangerous for the supply of drinking water, which in BiH absolutely predominantly relies on this resource. Excessive exploitation, in addition to quantitative problems, means insufficient renewal of underground reservoirs during the rainy season, leading to problems with the quality of these waters, which (except chlorination) are largely untreated, and increased abstraction can lead to the withdrawal of hazardous pollutants outside protection zones, or the periphery of the original funnel-shaped depressions, or unexpectedly large distances, in the case of karst. A significant increase in air temperature during the winter season (December, January and February) will result in a decrease in snowfall, or a decrease in flow in most watercourses in the spring months. On the other hand, the expected more frequent precipitation of higher intensity will cause greater runoff, often accompanied by floods.

With the increase of uneven distribution of weather, the problems related to the pronounced spatial inequality are exacerbated - the water-scarce areas are the parts with the greatest water needs, valleys with the greatest potentials for intensive agriculture with the necessary irrigation and with the highest population density.

The water sector already suffers significantly from poor and degraded infrastructure as a result of poor maintenance, war destruction, insufficient investment and inadequate management: for example, reductions in water supply have been common in many settlements, towns and cities in BiH for years. An indication of possible long-term stress due to insufficient water supply has been felt in recent years by the residents of Sarajevo, when they faced daily reductions.

[18]Third National Communication and Second Biennial Report on Greenhouse Gas Emissions of Bosnia and Herzegovina under the UN Framework Convention on Climate Change, 2016.

Hydropower

The hydropower potential of Bosnia and Herzegovina is estimated at 8,000 MW, with technical potential of 6,800 MW and economic potential of 5,800 MW, putting the country among the leading nations in southern Europe. Hydropower along with woody biomass, and wind and solar energy, represent key renewable energy sources, with a potential utilisation ratio that is 30% higher than the EU average, and the highest in the Balkans[19].

Hydropower is a mature and, in the long run, very economical and, with other water uses, potentially very complementary technology: affordable, renewable and flexible. However, it must also be coordinated with other users of space and water, including water-dependent ecosystems, and the high concerns of citizens and civil society organisations about the status and threats to the environment. Giving explicit preference to the economic benefits of HPP construction, without an equally important consideration of social and environmental effects is wrong. It is necessary for the competent institutions in BiH to adhere to relevant EU environmental legislation, notwithstanding its transposition status, applicable international conventions, and relevant guidance developed on his basis, as the reference for sustainable hydropower development[20].

Hydropower is in a multiple relationship with climate change. On the one hand, it contributes to the avoidance of greenhouse gas emissions from the burning of fossil fuels, while hydropower reservoirs in principle allow all other water users the necessary temporal and spatial redistribution of available water, of course, depending on the plan and actual implementation of reservoir management. Also, storage and especially pump-reversible hydropower plants provide the necessary stability to the electricity grid, due to the rapid fall in prices and the growth of the installation of intermittent renewable sources - wind and solar power plants. On the other, water availability and hydropower generation are likely to be affected by changing rainfall patterns, which can reduce the mean flow of some rivers.[21]

The development of small hydropower projects (small hydropower plants, SHPPs) and their impact, for example on nature and biodiversity, population, human health, soil, water and landscape, are the subject of growing public opposition in Bosnia and Herzegovina, especially the local population. By the end of 2018, the country registered 159 MW of small hydropower plants.[22]

SHPPs are mostly built in the upper courses of rivers, in localities with pronounced vulnerabilities, often despite opposition from the local community.

Changes in temperature and evaporation, as well as changes in the intensity of precipitation, affect the change in the flow regime of watercourses in Bosnia and Herzegovina, and thus hydropower. The results of the study of the impact of climate change on the availability of water for hydropower

[19]Renewable Energy and Energy Efficiency Partnership [REEEP], 2007

[20]One of the harmonised positions from the joint statement of the ministers on 'MINISTERIAL MEETING ON CLEAN ENERGY TRANSITION IN WESTERN BALKANS - STATEMENT", Regional Hydropower Master Plan, Podgorica, February 2019, https://wbif.eu/news-details/fourth-update-regional-strategy-sustainable-hydropower-western-balkans

[21]UNCC – Article: How Hydropower Can Help Climate Action, 2018. - Distribution of water from the reservoir to various users does not always happen in our country. This is a consequence of often inadequate water permits, or reservoir(s) management plans, and/or the absence of (automatic) inspection by the competent authority for the enforcement of these permits by the hydropower plant or reservoir operator.

[22]Annual Implementation Report 2018/2019, Energy Community Secretariat 1 November 2019

generation in plants across Europe, for climate change of 2 degrees, for the southeastern region (Balkans, Greece and Southern Italy) indicate a decrease in available quantities of about 2% (Figure 6).[23]

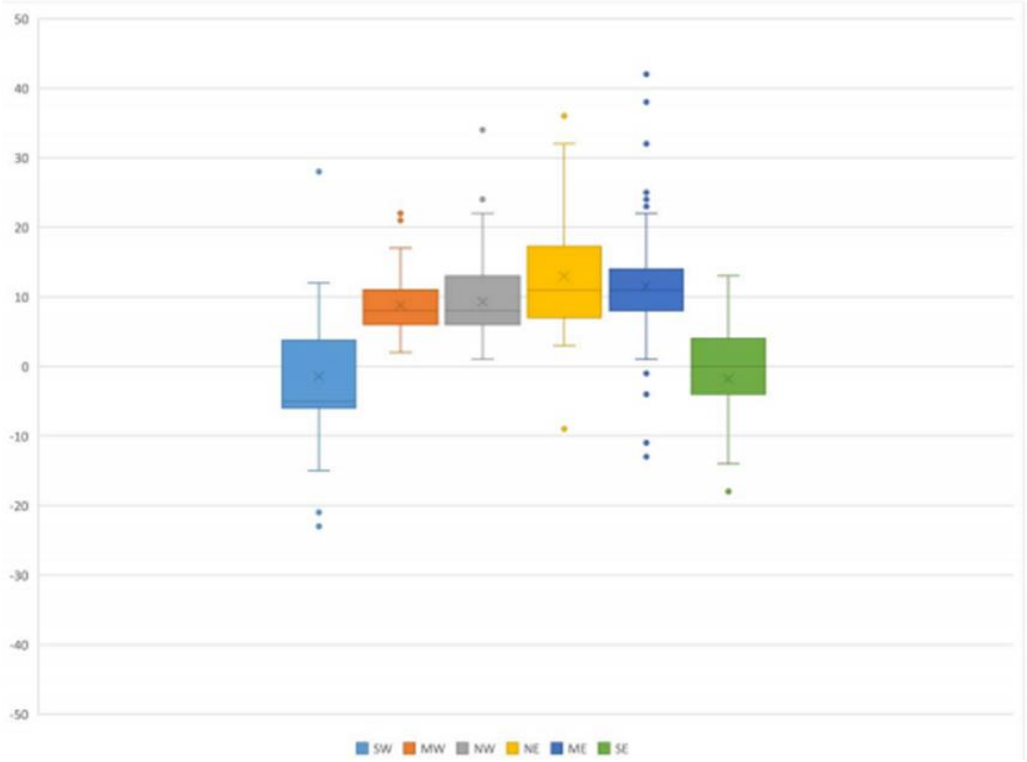


Figure 6: Percentage changes in mean annual inflow (Qsr) to hydropower plants in 6 European regions for climate change of mean temperatures of 2 degrees, compared to the period 1981-2010 (An ensemble of 11 Euro-Cordex model, with the LISFLOOD model)

Countries covered by analysis, by region:

- Southwest region - SW: Spain, Portugal, Southern France, Northern Italy;
- Mid-West - MW: France, Benelux, Germany;
- Northwest - NW: United Kingdom, Ireland, Norway;
- Northeast - NE: Sweden, Finland, Baltic countries;
- Central East - ME: Poland, Czech Republic, Hungary, Austria;
- Southeast - SE: Greece, Southern Italy, Croatia, Serbia, Romania, Bulgaria.

The seasonality of water inflow and the quantities that can be used for the generation of hydropower will be modified, thus affecting the change in the way of reservoir management and requires appropriate management of electric power systems. However, adaptive reservoir management strategies and plans must be multisectoral in design and legally sound and clearly defined.

The development of hydropower, along with other sources, especially wind and solar energy, represents a promising source of renewable energy in Bosnia and Herzegovina. This sector offers significant opportunities for 'green economy' development, with the potential involvement of small- and medium-sized enterprises (SMEs) in their construction and operation. It is especially promising to

[23]EC JRC Technical report "Impact of a changing climate, land use, and water usage on Europe's water resources", 2018.

connect the operation of HPPs with wind and solar power plants, which by their nature work intermittently (depending on the availability of wind and sun), while HPPs even with small reservoirs, especially pump-reversible, can balance, harmonise and stabilise the electricity grid. They are the ones that achieve the highest electricity prices on the market with their work, because they balance the grid, which is actually paid by all other producers (and, finally, consumers), who cannot do it (nuclear and thermal, wind and solar, biomass, etc.).

The risks associated with climate change have not yet been systematically considered in strategies and management plans for hydropower development in Bosnia and Herzegovina. In general, negative impacts are expected in Southeast Europe[24]. Certain studies show that these changes can have both positive and negative effects, depending on the climate scenario[25]. Hydro-reservoirs are crucial, and they must have multi-purpose roles - for agriculture, tourism, ecosystems, flood risk reduction and other roles. In addition to the advantages, multipurpose reservoirs also have environmental risks. It is necessary to regulate the quality of water and the purposes for which water can be used through legal norms.

In Bosnia and Herzegovina, less than 40 percent of the hydropower potential is used, so thermal power plants are predominant (Figure 7).

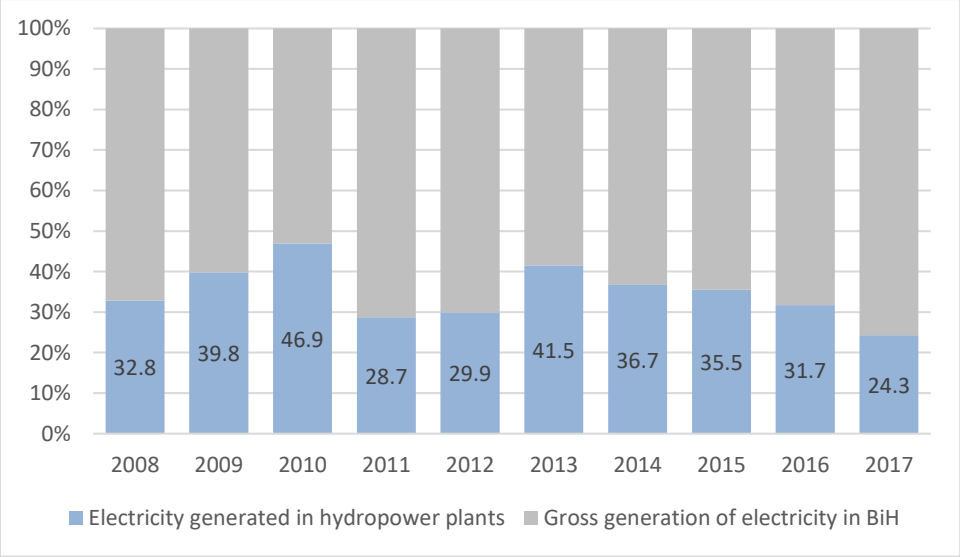


Figure 7: Share of electricity generated in hydropower plants in relation to gross electricity generated in BiH[26]

The total volume of constructed water reservoirs in BiH is 3,851.40 x 106 m3. Most of the reservoirs were built in Herzegovina, with about 90% of the total reservoir volume. As the extremely low level of equalisation of the water regime (9%) has been achieved in Bosnia and Herzegovina, the need to build a larger number of reservoirs was noticed long ago. In Bosnia and Herzegovina, it would be promising to reach a total volume of about 10,000 x 106 m3 of storage space. In the near future, it would be necessary to build about 2,000 x 106 m3 of storage space, especially on watercourses in the Sava River Basin. This would reach the level of total construction of about 5,800 x 106 m3 of storage space, or a

[24]EEA: Projected impacts of climate change on electricity production from different sources in four European regions, 2017.

[25]T. Wagner and All: Impacts of climate change on stream flow and hydro power generation in the Alpine region, *Environmental Earth Sciences*

[26]Agency for Statistics of Bosnia and Herzegovina: Energy Statistics, Publication 2009-2018

ratio of about 14.4% of the volume of the average annual flow[27]. Appropriate feasibility studies are urgently needed as per entity.

There is also the problem of non-conformity of the operation of HPP plants on the same watercourse and the damages that occur or may occur as a consequence thereof, given the fact that the economic interests of different operators of HPP plants are not always compatible. Flood risks are also, or may be, significantly increased. Therefore, it is necessary to improve inter-entity cooperation on these issues, which will force operators on the same watercourse to work closely together.

The Western Balkans Investment Framework (WBIF) provided the principles of sustainability for hydropower in the Western Balkans in the 2018 Report, as follows, in relation to BiH:[28]

- **Hydropower development** should be part of a broader strategy to replace carbon-intensive generation capacity because it helps to achieve the binding renewable energy targets established in the National Renewable Energy Action Plans in wager to overcome the electricity deficit in the region; some new hydropower plants could be developed across the region in line with international best practices and relevant EU acquis. The development of greenfield projects should be limited to large hydropower plants, as the contribution of small hydropower plants (of a capacity 10 MW or less) to the global energy production is extremely limited while their impacts on the environment are disproportionately severe.
- **The rehabilitation of existing structures as a priority**; rehabilitating and increasing the efficiency of existing hydropower plants in combination with ecological restoration measures shall be the first, immediate priority for investments. This is to safeguard the existing capacity and generation that hydropower currently contributes to the region's energy mix.
- **Integrated water resources management**; Hydropower development must take into account of upstream and downstream interactions, which go beyond administrative and political boundaries. The implementation of the EU Water Framework Directive (Directive 2000/60/EC), an essential piece of legislation on the path to EU accession, requires the development of River Basin Management Plans which would account for all water sources and uses. River Basin Management Plans shall contribute to the proper assessment of the region's viable hydropower capacity and to the assessment of the cumulative effect of existing infrastructures and prospective projects. In addition to international best practices, the following will be used in river basin management plan development: European Commission guidelines on Natura 2000 and hydropower and the Common Implementation Strategy (CIS) guidance on article 4(7) of the EU Water Framework Directive, along with other existing CIS guidance; the International Commission for the Protection of the Danube River Guiding Principles: Sustainable Hydropower Development in the Danube Basin
- **The climate challenge for hydropower development**; existing assumptions about hydropower plants' viability will need to be updated to take account of hydrological alterations resulting from climatological change. Climate adaptation scenarios will have to be integrated into the future development of hydropower. The multipurpose use of hydropower infrastructure linked to flood control measures should be considered as part of any flood protection strategy.

[27]Framework Water Management Master Plan of Bosnia and Herzegovina, 1994

[28]WBIF Annual report 2018, Executive Summary

- **Environmental impacts of hydropower development**; the region's unique nature and biodiversity features several pristine river ecosystems. Waterways provide its inhabitants many services that are essential to their livelihoods and this means that hydropower must be developed in compliance with the highest standards of ecological preservation. According to the Water Framework Directive, hydropower development shall not lead to the deterioration of a water body's status as long as the conditions for exemptions are not met; it shall also maintain a favourable conservation of habitats and species. Therefore, relevant EU environmental legislation, notwithstanding its transposition status, and applicable international conventions shall constitute the reference for hydropower development in the region and in BiH[29]. These requirements are interlinked and should therefore be implemented in a coordinated manner. Some areas in the region host particularly high nature and biodiversity value, making them more vulnerable to hydropower developments. Such zones should be identified and preserved and they should preferably be excluded from hydropower development. The on-going process of designating Natura 2000 sites will contribute to the identification and preservation of such areas.
- **Including sustainability principles in hydropower planning**; sound strategic planning and high standards in project design will be achieved with the development of high quality Strategic Environmental Assessments and Environmental Impacts Assessments. The EU Directives shall be the reference for preparing such assessments – not only the Strategic Environmental Assessments and Environmental Impacts Assessments Directives but all relevant Directives, such as the Water Framework Directive and the Habitats Directive. These assessments should cover not only the environmental impacts but also all pertinent aspects, including integrated water resources management, the effects of changes in climate patterns, transboundary considerations as well as social impacts and the need to preserve cultural heritage. For projects that are likely to have significant effects on the environment, the Environmental Impact Assessments must be systematically undertaken and quality-checked, when developing greenfield projects and when rehabilitating existing infrastructures. Environmental mitigation and ecological restoration measures proposed by such assessments will be undertaken as due. The Environmental Impact Assessments should not only consider impacts at the scale of the project site but also at the scale of the river to address potential consequences upstream and downstream, including cumulative impacts with other activities. Projects located in designated protected areas, or in areas of high nature and biodiversity value and vulnerability, shall be assessed with a higher scrutiny. This is to comply with the provisions of the EU Habitats and Birds Directives. Projects that are expected to cause deterioration to water bodies should only go ahead if compliant with the Water Framework Directive's provisions. All assessments must be subject to proper public consultation, engaging with local communities and civil society organisations.

[29]EU Water Framework Directive (2000/60/EC) and the two associated directives: the Environmental Quality Standards Directive (2013/39/EU) and the Groundwater Directive (2006/118/EC); EU Floods Directive (2007/60/EC); EU Birds and Habitats Directives (2009/147/EC and 92/43/EEC); EU Strategic Environmental Impact Assessment and Environmental Impact Assessment Directives (2001/42/EC and 2011/92/EU as amended by Directive 2014/52/ EU); Aarhus Convention (UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters); Espoo Convention (UNECE Convention on Environmental Impact Assessment in a Transboundary Context) and the associated SEA Protocol; Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats); Relevant transboundary water conventions and agreements (e.g. Convention on the Protection and Use of Transboundary Watercourses and International Lakes; the Danube River Protection Convention; Framework Agreement on the Sava River Basin).

3.2.3 Forestry and forest resources

Status of forests and forestry in Bosnia and Herzegovina

Bosnia and Herzegovina is among the countries with the highest forest cover in Southern Europe, with a richness in plant and animal life that makes it one of the most important forest regions in Europe. This unique diversity provides resilience for forest ecosystems to adapt to climate change and flexibility in adaptation but there is a risk that some of the unique and more fragile ecosystems may be endangered. Although small, Bosnia and Herzegovina is a country of high bio-ecological potential at one of the 'hotspots' of world biodiversity. At the same time, forestry is considered one of the most important sectors in terms of climate change mitigation, as well as a more vulnerable sector in terms of adaptation to climate change.

The area of Bosnia and Herzegovina is divided into four ecological vegetation areas - the Peripannonian, Inner Dinarides, Transitional Illyrian-Moesian and Mediterranean area. At lower altitudes and hilly areas there are mostly oak forests. This is followed by a belt with beech forests, beech and fir, beech, fir and spruce, and finally at the highest altitudes ends with a subalpine beech, spruce and mountain pine. There is also a separate belt of spruce forests, as well as forests of distinct floristic diversity marked by numerous endemic and relict species. The largest areas in Bosnia and Herzegovina today are covered by beech forests (30.92%), followed by sessile oak forests in various forms (30.89%) and finally mixed deciduous and coniferous forests (23.61%). This forest composition is the result of habitat conditions and can be characterised as partially favourable from the aspect of climate change.

The general conclusion is that there is no harmonised data on the area under forests in Bosnia and Herzegovina. The second forest inventory (forest survey in the whole of Bosnia and Herzegovina) has not been officially published. Among the first published data of this survey (UNDP, 2014; FAO, 2015), the total area of forests and forest land is 3,231,500 ha or 63.08%, while the area covered by forests is 2,904,600 ha or 56.7% of the total area of Bosnia and Herzegovina. According to the Statistical Yearbooks of the FBiH Statistical Office and the Statistical Office of the Republika Srpska, forests in Bosnia and Herzegovina in 2017 cover 2.88 million hectares, which is 56.33% of the total area of Bosnia and Herzegovina. Inaccurate definition of the state of forests (primarily surface area), entails the question of accuracy in assessing adaptation and/or mitigation as well as the development of all further strategic goals. Along with the trend of increasing the volume of felling, there is a trend of decreasing the volume of afforestation in the last 10 years. The volume of afforestation in the Republika Srpska has been almost three times smaller in the last three years, while in the Federation of BiH it is almost twice as small.

According to data from statistical yearbooks, fire damage is almost identical in both entities. One can clearly single out the 'critical years' as it was in 2012 when the fire affected almost 80,000 ha of forest and forest land in Bosnia and Herzegovina. In contrast, during 2014 (known for unprecedented floods in Bosnia and Herzegovina), fires were found on just over 1,000 ha. Here we cannot talk about trends, but about the strong connection between climatic characteristics during the summer months (primarily the amount of precipitation) and fire damage. However, the risk of fire increases significantly due to the increase in average and extreme air temperatures during the summer months,

which can have the greatest consequences in mountainous areas at higher altitudes and certainly in the Mediterranean and sub-Mediterranean area.

Existing traditional management systems are based on the natural regeneration of forests, which have been applied in practice for decades and which have contributed to the creation of significant diversity in forests, as well as the application of today's increasingly recognisable management practices of 'management in harmony with nature'.

Impact of climate change on forests in Bosnia and Herzegovina

According to the most extreme scenario (RCP8.5), by 2035 the average temperature in Bosnia and Herzegovina will be higher by +0.5 to + 1.5^{0}C. For the period 2046-2065 changes range from 1.5 to 3^{o}C while for the period 2081-2100 the temperature rise ranges from 2.5 to 5^{o}C. Temperatures projected in this way (from +5 to -20% of precipitation) indicate that drastic changes in forest ecosystems would occur. Generally speaking, the projected scenario would have unforeseeable consequences for forest ecosystems in Bosnia and Herzegovina. According to the available models, an increase in average annual temperatures can lead to and require fundamental changes in forestry, as well as in general land use and management. This is accompanied with the burden of socio-economic and environmental consequences.

The anticipated climate change will not have the same impact on all forest ecosystems in Bosnia and Herzegovina. This claim is supported by the fact that the survival of forest communities is related not only (or exclusively) to the average annual temperature in the area where a given community appears, which means that an increase in average annual temperature will not be the only factor affecting the change. A special impact that can occur as a result of climate change is 'multiple stress', which at the same time causes changes in soil moisture, changes in average and extreme temperatures, as well as changes in the amount and distribution of precipitation (snow-rain, drought-flood), and in that regard the number of pests and pathogens. All together it contributes to the high mortality rate of trees.

Based on available research worldwide, each region for which changes are anticipated should be analysed individually. Not all communities will react in the same way (some are at higher altitudes, deeper pedological profile, with more species and individuals, some are less sensitive, or formed from more tolerant species…), which means that the reaction of each community should be analysed separately. Species that are at the centre of their natural distribution will be more tolerant of climate change, while those near the edges (marginal populations) will be very vulnerable. Finally, all changes and movements of forest communities must take into account a number of other factors that affect changes in forest ecosystems (changes in soil structure, changes in genetic resources and diversity, adaptability of species, etc.). In this scenario, thermophilic sessile oak forests with hornbeam, downy oak and holm oak can be expected to predominate. Some endemic species currently found in forest ecosystems are also expected to disappear.

At present, it is not possible to accurately predict the success of adaptation to life in new habitats caused by climate change. Significant changes are expected in the genera that inhabit the mountainous areas of Bosnia and Herzegovina, especially the migration of some woody species in the direction of the Dinarides to the northwest, with possible local depletion of flora. One can expect a decrease in the number of herbaceous species of narrow ecological niche of the highest mountain areas that will not be able to adapt their distribution range quickly enough.

Therefore, in the territory of Bosnia and Herzegovina, it is not possible to determine exactly which change is more likely in terms of: yield, mortality, changes in stocks or prospects for economically important species. Dendrochronological research on fir, spruce and Serbian spruce in BiH is underway, which should show whether there is a tendency to change growth in correlation with specific climatic parameters. An assessment of the impact and vulnerability in the future should be modelled for the most important species (common beech, sessile oak, spruce, common fir, etc.). Furthermore, individual species may have different ecological valences (degree of adaptation of a living organism to changes in its environment) which means that they can tolerate larger ranges of changes in climatic parameters. The response of individual species to climate change depends on their adaptive capacity. In the future, work should be done on such research that could better assess the impact of climate change on forest ecosystems.

The biggest threat will be to fir forests that are predisposed to be severely affected by climate change. These forests cover a very narrow ecological niche due to their growth in mixed stands with beech. Beech forests have the potential to displace fir in stands due to changes in humidity and temperature. Species with narrow niches are likely to face decline or loss and may, in the case of Bosnia and Herzegovina, begin to move to the edges of their habitats, indicating a shift in vegetation due to climate change, making other species more dominant (this may again reduce the economic value of these forests).

Species that are at the centre of their natural distribution will be more tolerant of climate change, while those near the edges (marginal populations) will be very vulnerable. Also, species with a small distribution range and 'barriers' in migratory flows are more endangered. In addition, it can be considered that high mountain areas in BiH at altitudes of more than 1,500 m will be affected, which corresponds to the border of the subalpine zone. In the canyon parts of relict-refugial landscapes, shallow soils are most often formed, subject to wind and water erosion. Drying of trees in canyons can cause soils to be exposed to even greater erosion, which would lead to stronger temperature extremes of the substrate. This can cause even greater drying of trees, and prevent the recovery of refugial forest communities.

Taking into account the latest world research, the results of climate change and possible scenarios, it is very likely that the dynamics of growth and production of stumpage in the forests of Bosnia and Herzegovina in the coming period will decline and that it will be among the first and most disturbed parameters.

In some parts of Bosnia and Herzegovina, an increased risk of forest fires caused by rising temperatures and changes in precipitation is expected, which calls for an expansion of fire protection capacity. All these aspects (weather, pests, pathogens, fires) can, over a long period of time, lead to reduced productivity and deteriorated forest health in Bosnia and Herzegovina.

Only in rare cases can climate change have some positive effects on forests and forestry: the productivity of certain species may increase in areas with sufficient precipitation (spruce forest belt), resulting in faster growth rates and migrations of more productive species to these habitats.

In a sum, due to the multiple stresses to which forest habitats and trees are exposed, climate change is likely to affect some more sensitive ecosystems. The ecological and economic importance of forests in Bosnia and Herzegovina means that these impacts could have serious consequences for the whole

country. Approaches to adaptation to climate change will require better information in the forest management process, with the aim of ensuring support in adaptation processes.

Charru et al. (2017)[30] analysed the reaction of 8 tree species in a wide range of their adaptability to drought (fir (*Abies alba Mill*), spruce (*Picea abies Karst*), white pine (*Pinus sylvestris* L,), common beech (*Fagus sylvatica* L), sessile oak (*Quercus petraea* Liebl), pedunculate oak (*Quercus robur* L), downy oak (*Quercus pubescens* Willd,) Aleppo pine (*Pinus halepensis* Mill.,) in the wider area of Europe. The reaction of these species was observed through increments in the cross section of the basal area increment (BAI) during 1980-2007. Changes were found in the interval -17% for 'Mediterranean species' to + 42% for 'mountain species'. The changes were significantly larger in colder/wetter conditions than in warmer/drier conditions, where decline was observed.

The following is a summary of key impacts in the forestry sector by 2030 in line with projected climate change:

- Shifting the boundaries of certain types of forests in relation to latitude and altitude, or withdrawal of certain communities under pressure from others;
- Changes in the areas of certain species (ecotypes) of flora and fauna (e.g. silver fir as economically important species);
- Extinction or drastic reduction of the distribution range of certain species (e.g. Serbian spruce as a protected and rare species);
- Changes in the qualitative and quantitative composition of biocenoses;
- Habitat fragmentation;
- Changes in the functioning of ecosystems;
- Soil erosion as a result of a lower degree of 'cover' or fire;
- Decreased productivity of some forest ecosystems (e.g. oak forests);
- Reduction of biodiversity - ecosystem, species and genetic (taking into account the key messages of the European Environment Agency's report), and thus more difficult preservation of biological and genetic diversity;
- Increasing number of pests and pathogens (e.g. bark beetles and gypsy moths), and their migration, including invasive species;
- Shifting of phenological phases of forest tree species (earlier leafing and flowering, longer vegetation season);
- Damage to forest ecosystems as a result of the frequency of extreme weather events (e.g. windfall, icebreaks, floods);
- Reduced value of public forest functions (due to negative impacts such as fires, windfall, ice-break, floods);
- Poorer quality of timber, which is an indirect impact on the economy of Bosnia and Herzegovina;
- Risk of forest ecosystem transformation that would result in large-scale drying of trees;
- Difficult execution of works (measures of cultivation, protection and use) due to frequent extreme disasters (high temperatures, insect infestations, floods, landslides ...)
- Increased frequency and intensity of forest fires.

[30]Charru M, Seynave I, Hervé JC, Bertrand R, Bontemps JD (2017): Recent growth changes in Western European forests are driven. Annals of Forest Science, 74: 33-77. DOI 10.1007/s13595-017-0626-1.

Adaptation to climate change in the field of forestry is a coordinated approach that ensures sustainable forest management in BiH, respecting and adapting to climate change. In that context, the following is necessary:

1. Detailed mapping of forest ecosystem composition
   a. Key research needs on changes in the most significant forest ecosystems through field research, remote reading and GIS mapping project
   b. Established monitoring areas in vulnerable ecosystems to assess changes therein
2. Facilitate the adaptation of individual communities by the transfer of certain species and the establishment of new forests in places where they do not exist today
   a. Extend or renew native species that are expected to adapt to future conditions
   b. Establish or encourage mixed communities with indigenous species
   c. Direct changes in species composition in the early stages of stand development
   d. Protect future-adjusted seedlings
   e. 'Prevent' species that are extremely maladapted
   f. Manage species and genotypes with a wide degree of tolerance to moisture and temperature
   g. Enter the species that are expected to be adapted to future conditions
3. Promote a system of 'adaptive management' in natural forests adapted to climate change
   a. Transforming low/coppice/forests and shrubs into a higher cultivation form
   b. Specific habitat management in different places and conditions
   c. Promote the diverse structure of forests
   d. Maintain and restore the diversity of indigenous species
4. Improvement of forest fire protection system
   a. Modify the structure or composition of forests to reduce the risk or severity of fires
   b. Establish 'corridors' to slow the spread of the catastrophic fire
   c. Maintain and strive for a 'fire-adaptive' ecosystem
   d. Provide adequate fire-fighting equipment
   e. Real-time observation and monitoring of endangered forest ecosystems
5. Reduce risk and long-term effects as a result of natural disasters
   a. Modify the forest structure to reduce the severity of damage caused by wind and ice
6. Reduce the impact of biological stressors
   a. Research on pests and plant diseases due to climate change
   b. Maintain or improve the capacity of forests regarding tolerance to pests and pathogens
   c. Prevent the introduction of invasive plant species and remove existing invasive species
   d. Control the number of harmful organisms to help regenerate the desired species
7. Expansion of the network of protected areas and improvement of the management system of existing protected areas
   a. Expand the boundaries of the reservation in order to increase diversity
   b. Prioritise and maintain unique and sensitive species or communities
   c. Establish 'artificial' reserves for displaced species at-risk
   d. Preserve biological heritage
   e. Establish reservations to maintain ecosystem diversity
8. Maintain and improve genetic diversity
   a. Use reproductive material from a larger geographical area
   b. Give preference to existing genotypes that are better adapted to future conditions
   c. Implement programmes for the conservation of forest genetic resources as a basis for genetic variability with the aim of adaptation and evolution of woody species
   d. Move endangered species to locations where they are expected to be protected (*ex situ* conservation)
9. Promote landscape diversity

a. Reduce the fragmentation of forest ecosystems
b. Maintain and create habitat corridors through afforestation or restoration

10. Support to plantation forestry in the function of intensive biomass production
    a. Selection of adequate habitats for plantation forestry
    b. Selection of the best clones for biomass, as well as technical wood
    c. Consider the potential of phytoremediation in contaminated habitats
11. 'Balance' forest ecosystems after disturbances
    a. Proceed to reforestation in the area immediately after the disaster
    b. Enable testing of species adapted to the future through natural renewal
    c. 'Rearrange' disturbed forest ecosystems so that they can meet the expected future conditions
12. Maintenance of basic ecological functions in all forest ecosystems
    a. Reduce the impact on soil and nutrient circulation
    b. Maintain or restore favourable hydrological conditions
    c. Reduce competition in the use of moisture, nutrients and light

3.2.4 Biodiversity and sensitive ecosystems

Bosnia and Herzegovina has a particularly rich biodiversity, with a high level of biotope diversity and a large number of endemic flora (5,000 species of vascular flora and 30% of the total endemic flora of the Balkans). The strategy on biodiversity defines those areas of Bosnia and Herzegovina that are most vulnerable to climate change: high mountainous systems (above 1,600m); mountain ecosystems (900-1,600m); sub-Mediterranean ecosystems (300-800m); highlands (600-900m), ecosystems of the Peripannonian area (200-600m) and Pannonian ecosystems (up to 200m). The available data suggests that climate change threatens all three macro regions in Bosnia and Herzegovina (Pannonian, mountainous and Mediterranean). Dinarides, one of the Balkan's richest areas in endemic species, will be particularly threatened by climate change. This mountain range is of particular biological and geomorphologic significance.

Climate change models predict that there will be significant changes in precipitation levels caused by the rise in temperatures. This will have a strong effect on the distribution of plant species. Those species that have lived at high latitudes or higher altitudes will be replaced by species whose range shifts from the south or from lower altitudes, which may lead to the extinction of certain species, especially those associated with high mountains, such as species from habitat types: *4070 - Bushes with Pinus mugo and Rhododendron hirsutum, 95A0 - High oro-Mediterranean pine forests, 6150 - Siliceous alpine and boreal grasslands, and 8210 - Calcareous rocky slopes with chasmophytic vegetation. Vegetation models predict further movements of ecosystems to higher altitudes, which means that the upper limit of forest ecosystems will shift to the detriment of subalpine grassland communities. Increasing the concentration of CO_2 in the atmosphere will allow more efficient use of water by plants because they will be able to absorb the same amount of CO_2 with less opening of the stoma. In this way, plant species will be able to grow in areas that were once too arid for them. Climate change poses a particular threat to specific habitat types such as peatlands, ponds and swamps. High (elevated) peatlands are very rare and poorly explored in BiH, and often have a transitional character. They are located in the mountain belt of the inner Dinarides, such as Jahorina, Ravna planina, Romanija (Han Kram), Zvijezda and others. These habitats are inhabited by a large number of highly endangered and vulnerable plant species whose survival will be endangered due to climate change. Swamp habitats, especially in the Mediterranean macro-region, will be particularly exposed to the negative impact of climate change. This primarily includes the area of the Hutovo blato and Bardača nature

parks, which are swamp areas of international importance in BiH (Ramsar site) and inhabited and visited by a large number of bird species and declared an important bird area (IBA), as well as Livanjsko polje and the Bardača swamp complex, which are also Ramsar sites. These three areas, of international importance, are exposed to significant anthropogenic pressures, which are manifested by the degradation of ecosystems. Reduction or complete extinction of these habitats will inevitably lead to a reduction in the distribution range or extinction of certain plant and animal species, especially the endemic ones. In the context of swamp habitats, it is important to mention that swamps represent significant CO_2 stores, thus having a positive impact in terms of carbon sequestration, so it is very important to manage water in a way that preserves existing swamps and revitalises former swamp complexes.

Adaptation measures should be centred on expanding the network of existing protected areas in Bosnia and Herzegovina, and improving management of existing protected areas measures should be aimed at expanding the network of existing protected areas.

In order to preserve a high degree of biodiversity in BiH, it is necessary to take specific measures that will enable, above all, long-term preservation and protection of our rich natural heritage for the benefit of future generations. Climate change will have a number of negative consequences for ecosystems and their services, which represent a significant economic resource. The extent and economic value of these damages is much more difficult to define compared to conventional goods. Adaptation should include the protection and management of natural resources that are changing or threatened by climate change. These changes should therefore be seen as economic impacts that need to be adapted, which includes a wide range of measures and actions aimed at managing, restoring and conserving biodiversity and ecosystem services that provide diverse benefits to human society and represent significant natural capital. All these activities should be based on an ecosystem approach that is key to conserving biodiversity as a whole.

3.2.5 Tourism

In recent years, Bosnia and Herzegovina has recorded a significant increase in the number of tourists, and thus the tourism sector is generating increasing revenues and providing new jobs. Given the fact that BiH is a predominantly hilly and mountainous country, winter mountain tourist destinations have a particularly important place in the tourism sector. In addition to mountain tourism, which is dominated by the winter tourist season, a significant part of the tourist offer consists of destinations of urban and religious tourism, as well as tourist activities related to rivers and lakes in summer, and tourism in protected natural areas.

In 2018, 1,550,796 tourists visited Bosnia and Herzegovina, which is 18.6% more than in 2017. A total of 3,206,336 overnight stays were recorded this year, which is 19.7% more than in 2017. In 2018, foreign tourists had 1,101,317 arrivals, or 2,266,037 overnight stays. Although, according to statistical data, BiH has been recording a continuous trend of increasing the number of tourists and their overnight stays since 2014, due to the presence of the grey economy, poor legislation, insufficient state coordination and investments, BiH tourism has not yet developed its full potential, lagging behind the countries of the region. Also, according to the World Economic Forum's Travel & Tourism

Competitiveness Report[31], out of 136 countries, our country ranked 113th, and was the worst positioned in relation to the countries of Southeast Europe.

Globally, tourism is one of the fastest growing economic sectors. According to the annual report of the World Travel and Tourism Council (WTTC), in 2018, about 319 million people were employed in this sector, and it accounted for 10.4% of world GDP.

In this report, in the part for BiH, it is stated that in 2018, 93,500 workers or 11.7% of total employees were employed in tourism and related activities. It is anticipated that the tourism sector in BiH will directly and/or indirectly employ around 113,900 people by 2028, and the direct contribution of tourism to GDP will amount to BAM 1.41 billion or 3.4% of GDP.

Consumption of foreign tourists who visited BiH for rest and recreation in 2018 amounted to 71% of the total direct contribution of tourism to GDP, while the rest falls on business visits. Also, foreign tourists spend much more than domestic tourists (63% of total consumption).

Based on financial reports and estimates of economic analysts, the annual increase in contributions from tourism and the entire travel industry in the period from 2018 to 2028 will amount to 5.3%, and tourism-related earnings in BiH should be more than 12.6% GDP. In the same period, investments in the field of tourism are expected to increase to more than BAM 575 million.

However, similarly to other economic sectors, climate change is becoming one of the key issues affecting the development and management of the tourism sector in BiH. In this regard, winter mountain tourism is directly exposed to the consequences of climate change, given the relatively low altitudes at which domestic ski centres are located, and the pronounced dominance of the winter tourist season.

The reduction of snowfall and milder winters cause a decrease in the number of tourists during the winter tourist season, which results in poor financial operations of our mountain centres. In addition to the negative implications for the winter tourist season in mountain resorts, due to higher daily temperatures on the Mediterranean coast, mountain centres can be asserted as new destinations during the summer tourist season. An increase in summer temperatures in cities will adversely affect the trends of urban tourism. An important climatic impact on the tourism sector is reflected in the destruction of hydrographic tourist resources (reduction of water levels of rivers and lakes, drinking water quality), which directly reflects on the beauty of the landscape, and affects tourist demand.

In the tourist offer of Bosnia and Herzegovina, the climate is a significant factor of development, especially considering that most tourist activities are done outdoors, tourists count on clear and sunny weather during the holidays, and enough snowfall during the winter season in the mountains. Attractive destinations are also protected natural areas, which are also associated with outdoor tourist activities. In this regard, climate change will potentially lead to the development of ecotourism, or the development of tourism in preserved natural areas.

The impact of climate change in the tourism sector may have wider implications for the entire BiH economy. The reduced number of tourists in mountain centres due to insufficient snowfall during the winter tourist season will initially have the biggest impact on hotels, restaurants, owners of private

[31]The Travel & Tourism Competitiveness Report 2017, available at: http://www3.weforum.org/docs/WEF_TTCR_2017_web_0401.pdf

vacation facilities, which will negatively affect the local and then the domestic economy. The negative impact of climate change in other sectors also has consequences for tourism. Thus, for example, lower yields and losses in the agricultural sector and higher food prices have a negative impact on the price of tourist services, as well as on the development of agricultural and culinary tourism. However, some impacts of climate change, such as the extension of the tourist season and the development of new tourist products, can be considered positive.

Due to insufficient research in this area, recommendations and adaptation measures in tourism are quite limited. Nevertheless, it is possible to take certain steps in order to overcome climate change in the tourism sector of Bosnia and Herzegovina. Adaptation approaches should primarily relate to reducing seasonality, or extending the tourist season, and improving tourist infrastructure and capacity. Extending the tourist season through the enrichment and diversification of the tourist product is a popular trend in already established tourist destinations. New forms of tourist products (activities and tours) can enrich the tourist offer, and encourage tourists to extend their stay in the destination. The development of tourism through the enrichment of the tourist offer of Bosnia and Herzegovina as a unique destination should be defined through strategic goals and programme guidelines, while respecting the principles of sustainability, or taking into account the protection of natural resources and cultural and historical heritage. Also, at the destination level, it is necessary to work on the energy efficiency of hotel facilities, which would lead to a reduction in emissions.

In order to solve the problem of vulnerability of the tourism sector, it is necessary to invest in scientific research and develop a system of informing all participants in tourism about climate change and its impact. The efforts and cooperation of the entity authorities in formulating strategies and measures to facilitate adaptation to climate change in the tourism sector are of key importance. Problems and changes in the tourism sector caused by climate change should therefore be considered at all levels of government. Authorities at the state and entity levels should define a strategy and policy for the development of sustainable tourism, for the implementation of which lower levels of government will be in charge through specific proposals and projects. However, climate change requires concrete solutions, which need to be implemented by local authorities, as they are best acquainted with the specific requirements of the local community. On the other hand, the management structures of individual destinations, primarily mountainous, should work on the reconstruction of accommodation facilities in accordance with environmentally friendly technologies and develop additional tourism amenities, which would attract visitors during the summer tourist season.

Sustainable development of tourism in Bosnia and Herzegovina should include the balanced development of three essential components of sustainability - environmental, social and economic. A prerequisite for even and balanced development is the existence of a unique destination management that will consider all aspects of the impact of climate change on the tourism sector, and interested stakeholders who are willing to cooperate. Therefore, it is necessary to define short-term and long-term goals of tourism at the level of destinations, based on the available tourist attraction basis.

During the period of its intensive growth in the last few decades, the tourism sector has been facing various types of crises. The most recent crisis that has negatively affected tourism globally is certainly the COVID-19 pandemic. The complete cessation of social and economic activities, and temporary lockdown have affected the collective consciousness of society, and the creation of new patterns of behaviour and values.

The experience with the COVID-19 pandemic will bring significant changes in tourism as well, primarily in terms of the development of new, alternative forms of sustainable tourism. The effects of the suspension of economic activities and the reduced volume of transport have had an impact on the decline in CO_2 emissions and the reduction of air pollution in the world's urban centres[32]. The corona virus pandemic will have major financial consequences for the tourism sector and affect its further growth. However, tourism as an activity that depends on the natural environment the most, and at the same time changes it the most, in the post-pandemic period should turn to sustainable principles of development, and develop green (environmentally responsible) destinations.

3.2.6 Human health

Cardiovascular, cerebrovascular diseases and malignant neoplasms account for almost three quarters of all causes of death in Bosnia and Herzegovina. Among the five leading causes of death are diseases of the respiratory system.[33] Although there is a society's concern for the general health of the population, a system for monitoring the movement of diseases that can be linked to climate change has not yet been established in Bosnia and Herzegovina. There are no data from health statistics on the impact of climate change on the health of the population, nor are there results based on scientific research. Therefore, it is not possible to more precisely determine the connection between weather conditions, or biometeorological phases and the incidence of chronic non-communicable diseases, primarily diseases of the circulatory and respiratory systems, as well as individual infectious diseases. However, although there is no data based on scientific research, climate change certainly affects the health of the population in Bosnia and Herzegovina.

Human health depends on weather conditions, whereas diseases in which the most pronounced impact of climate change is anticipated are: diseases of the circulatory system (stroke, acute myocardial infarction), respiratory allergies and other diseases of the respiratory system (chronic obstructive pulmonary diseases), malignant neoplasms, mental health disorders and stress disorders, neurological disorders, vector diseases and zoonoses, diseases transmitted by contaminated water and food, etc. Climate change will have the greatest impact on vector (transmissible) diseases, the causes of which are transmitted by mosquitoes, ticks and other types of insects.

Climate change indirectly affects water availability, crop yields, food production and quality, and thus the higher incidence of population diseases due to deteriorating water supply and unhealthy food. The impact on food and water, as well as on diseases related to them, is not only reflected in the reduction of their availability but also in the reduction of quality and increase of contamination (presence of microbiological and chemical pollutants in water and food). Due to the increase of organic matter in the contaminated water, the consumption of chlorine and chlorine preparations during disinfection has increased, which may lead to increased exposure to trihalomethanes (carcinogenic disinfection by-products). Due to the anticipated, more frequent floods and other natural disasters

[32]Telišman-Košuta, N. (2020): Turizam nakon doba korone: Što će biti drugačije? Što može biti bolje? Dostupno na: /*Tourism after the Corona Age: What will be different? What could be better? Available at*/: http://www.iztzg.hr/files/file/RADOVI/2020/COVID-19/Teli%C5%A1man-Ko%C5%A1uta-N_2020.pdf

[33]Public Health Institute of the Federation of Bosnia and Herzegovina, Reports on the health status of the population of the Federation of Bosnia and Herzegovina, 2013-2017

Public Health Institute of the Republika Srpska, Reports on the health status of the population of the Republika Srpska, 2013-2017

(e.g. extreme heat and drought), more frequent and extensive occurrences of water and alimentary epidemics can be expected.

Of all the extreme meteorological events, heat waves are most associated with the morbidity of the population but also with a high mortality rate, and represent an important and global public health problem. Climate change, and excessive heat as its result, mostly affect vulnerable population groups - small children and the elderly, pregnant women, the chronically ill, especially those suffering from cardiovascular and respiratory diseases, and people who work outdoors such as construction and agricultural workers. In contrast, projected milder winters are likely to lead to a reduction in morbidity and mortality from cold-induced diseases.

The legislation in Bosnia and Herzegovina and other relevant documents related to the health sector contain sufficient comprehensive information on the impact and adaptation of the sector to climate change. The Laws on Health Care[34] and the Laws on Protection of the Population from Infectious Diseases[35] in the Federation of Bosnia and Herzegovina and the Republika Srpska oblige public health institutions to implement preventive measures that improve the general health condition, and reduce morbidity and mortality. These preventive measures relate, *inter alia*, to the protection of public health from risk factors arising from the environment (contaminated water, food, air, soil, vectors of infectious diseases, etc.), including meteorological and climatological factors (extreme heat, cold, changes in barometric pressure, etc.). The Law on Health Care[36] is in force in the Brčko District, and in 2017, Guidelines for drafting a law on protection of the population from infectious diseases were adopted. It is necessary to enact legislation, aligned with EU legislation, which regulates working hours and work obligations in days of climate extremes, in other words to update the existing regulations in the field of health protection of workers in the Federation of BiH, Republika Srpska and Brčko District in order to align with EU legislation on this issue. In this way, the health of workers working outdoors would be protected from climatic extremes (heat waves, low temperatures, etc.) and improved.

In order to protect the health of the population from the effects of climate change, the health sector should adopt an 'Action Plan to protect the health of the population of Bosnia and Herzegovina from the effects of climate change'. Existing documents in the field of health that could be updated to include climate change are: Order on the Programme of health protection measures against harmful environmental factors (Official Gazette of FBiH, 27/14), Law on Protection of the Population from Infectious Diseases (Official Gazette of FBiH, 29/05), Strategic Health Development Plan of the Federation of BiH 2008-2018 , Law on Protection of the Population from Infectious Diseases (Official Gazette of the RS, 14/10), Policy for improvement of health of the population of the Republika Srpska by 2020, Action Plan for prevention and control of non-communicable diseases in the Republika Srpska from 2019 to 2026, Programme of measures for prevention and control, elimination and eradication of infectious diseases for the territory of the Republika Srpska for 2020, The Youth and Health Strategy of Bosnia and Herzegovina, etc.

Public health is highly exposed to climate change, and the consequences can cause serious disruptions to the functioning of society as a whole. The main expected impacts of climate change that cause high vulnerability in the health sector are: increasing mortality and changes in the epidemiology of chronic

[34]Official Gazette of FBiH, 46/10 and 75/13, Official Gazette of RS, 106/09 and 44/15

[35]Official Gazette of FBiH, 29/05, Official Gazette of RS, 90/17

[36]Official Gazette of, 38/11

non-communicable diseases and acute infectious diseases, and the impact on the epidemiology of diseases related to climatological factors. Diseases caused by environmental, as well as meteorological and climatological factors, significantly contribute to the burden on the health of the population and the health system itself because they lead to high health care costs and overexploitation of key potentials, prevent optimal health and well-being, and undermine social and economic development.

The projected rise in temperatures is likely to lead to an increase in morbidity and mortality from cardiovascular and cerebrovascular diseases. Continuation of existing global warming trends is expected to increase air pollution by inorganic and organic pollutants, which may cause an increase in morbidity and mortality from respiratory and malignant diseases. At the same time, combustion of fossil fuels affects population health and results in climate change. Reducing the use of coal through the gradual closure of coal-fired power plants, or replacing black coal with sustainable renewable energy sources, as a measure of protection against climate change, would also have a positive impact on the health of the population.

At the global level, major changes are expected in the dynamics and prevalence of infectious diseases for which there is a possibility that their epidemiological characteristics may change due to the effects of climate change. Expanding the habitat of ticks and Asian tiger mosquitoes, as well as other vectors, increases the risk of Lyme borreliosis, tick-borne meningoencephalitis, West Nile virus, dengue fever, chikungunya fever and leishmaniasis[37]. Diseases transmitted by vectors - primarily insects - spread because warming expands the space in which they can live. Warm and humid weather is ideal for the development of mosquitoes and ticks, which are the most common carriers of transmissible diseases.

In the context of future climate change, the supply of safe drinking water, which is difficult in extreme droughts, especially in rural areas, and in conditions of major floods, could have a great impact on the health of the population. Microbiological and chemical contamination of drinking water may result in epidemics of intestinal infectious diseases and diseases caused by toxic substances (heavy metals, pesticides, etc.), which requires directing the investment in the construction of water treatment plants. The importance of the sustainability of spring water and the deterioration of water quality due to climate change, requires a review of technological processes for the preparation of drinking water and the inclusion of a greater degree of resistance in the preparation of water for human consumption in public water supply.

In the publications of the World Health Organisation (WHO) there are estimates of the impact of climate change on human health obtained on the basis of health statistics on morbidity and mortality from non-communicable diseases (primarily respiratory, cardiovascular and cerebrovascular diseases) and infectious diseases (malaria, borreliosis, dengue, haemorrhagic fevers and other vector-borne diseases transmitted by mosquitoes, ticks, rodents, etc.), as well as data on the movement of morbidity and mortality rates from diseases of the gastrointestinal system caused by consumption of contaminated food and water. According to WHO, public health is directly or indirectly affected by impacts due to climate change.[38] Estimates of the impact of climate change on health are based on the quantification of risk factors that contribute to the growth of mortality and morbidity rates of diseases sensitive to climate change and on the analysis of existing trends in these diseases. They are presented a projection of the expected impact on the health of the population for the period up to

[37] Tatem AJ, Hay SI, Rogers DJ. Global traffic and disease vector dispersal. PNAS 2006 ; 103: 6242 – 7

[38] https://proveg.com/blog/destruction-of-ecosystems-loss-of-biodiversity-risk-of-zoonotic-pandemics/

2030 and 2050. According to these estimates, many deaths from climate change (especially in children) can be prevented by specific targeted prevention activities in countries within the European region and beyond (e.g. implementing good hygiene practices, improving access to sanitation and safe drinking water, implementing measures for improving air quality, etc.). The Public Health Institute of the Federation of Bosnia and Herzegovina, cantonal public health institutes, the Public Health Institute of the Republika Srpska and its 5 regional centres in Doboj, Istočno Novo Sarajevo, Foča, Zvornik and Trebinje, have experts who can educate the population on the application of hygiene principles and measures to protect health from diseases caused by climate change (pollution of water, food, air, soil, ultraviolet radiation, heat waves, low temperatures, etc.) through awareness campaigns and the distribution of promotional materials (e.g. brochures, posters, leaflets),

In order to protect the health of the population, research related to the movement of diseases caused by climate change will be of great importance. In the long run, preventing increased morbidity and mortality from diseases caused by extreme temperatures, pollution of the atmosphere, water and soil, increased natural disasters, and reduced arable land - is the only way to preserve global health. Public participation is crucial in defining effective responses to climate change adaptation. Therefore, it is necessary to continuously inform the public about the possible impact of climate change on human health. Informed population, by implementing appropriate protection measures, can significantly reduce their vulnerability to the impact of extreme weather and climatic conditions.

3.2.7 Energy sector

The European Environment Agency's (EEA) report on the challenges of adapting to climate change emphasises that extreme weather events are increasingly affecting all parts of the European energy system. The most important changes include rising of medium and extreme air and water temperatures, changes in available water quantities, flood hazards and other hazards related to the consequences of climate change. Such changes will affect the availability of primary energy sources, in particular renewable energy sources, as well as the production, transmission or transport, distribution and storage of energy and energy needs. Several studies show that, without appropriate measures to adapt to the effects of climate change, direct damage to the European energy system from extreme weather events could amount to billions of EUR a year by the end of the century, with much higher indirect costs[39].

According to the EEA analysis, Northern Europe will feel both the beneficial and harmful effects of climate change on the energy system, while Southern Europe will feel mostly negative consequences. The availability of water in Northern Europe is expected to increase and decrease but with pronounced seasonal differences.

The energy sector is directly related to the impact of climate parameters and climate change. Climate parameters directly affect the energy sector in the following way:

- Reducing the availability of cooling water for thermal power plants; an increase in the mean ambient temperature reduces the efficiency of all thermal power plants;
- Climate extremes and natural disasters can disrupt and damage energy supply infrastructure;
- Flooding of parts of open-pit mine and increased risk of soil erosion (tailing dumps);

[39]https://prilagodba-klimi.hr/utjecaj-posljedica-klimatskih-promjena-na-energetiku/

- Disruption of fuel transport on rivers (due to low water level or water freezing);
- Increasing energy consumption for water supply.

Climate changes that Bosnia and Herzegovina is already facing and that are expected in the coming period are:

- change in the amount of precipitation (more precipitation in winter with a decrease in the share of snowfall - less precipitation in summer)
- higher amount and intensity of extreme events (ice-breaks, windfall, droughts, floods, thunderstorms)
- more frequent winds of higher intensity
- global temperature rise in all seasons.

Throughout Bosnia and Herzegovina, linear trends for the multi-year period 1961-2015 indicate stagnation or a slight increase in annual precipitation. Changes in precipitation are more pronounced by seasons than on an annual basis. Although no significant changes in precipitation were recorded, the pluviometric regime, or the annual distribution, was greatly disturbed. Due to the increased intensity of precipitation and its greater variability, as well as due to the increased share of heavy rains in the total precipitation, the risk of floods increased, especially in the northeastern part of Bosnia and Herzegovina where catastrophic floods were recorded in May 2014. Droughts in the summer months are responsible for reducing available water resources which causes a reduction in energy production, agricultural yields, etc., while floods in the winter and spring months cause the destruction of infrastructure and livelihoods.

Some of the effects of climate change on energy can be economically beneficial, such as reduced heating needs but many of the consequences are negative for energy as well as for society. For example, higher temperatures reduce heating energy consumption but at the same time can increase cooling energy demand.

Electricity is a vital component of the BiH economy, as it enables work in the manufacturing, industrial and service sectors, and is the third most important export commodity. Bosnia and Herzegovina produces electricity, mainly from coal-fired and hydropower plants, and much less from solar and wind power plants. After 1995, the production of electricity from hydropower remained stable in terms of estimates of participation in total electricity production, while the use of coal increased significantly. In 1996, only about 20.9% (2,148 GWh) of electricity was produced from coal, while hydropower sources produced about 70.5% (5,156 GWh). However, by 2017, the production mix had changed significantly to the extent that coal-fired power plants produced about 75% (12,339 GWh) and hydropower sources only 24% (3,977 GWh) of electricity (all other sources produced less than 1%).[40]

It is estimated that a 5-10% reduction in water flow could cause financial losses of US $ 60 million for all three power companies with a majority public capital holding[41]. Any disruption to hydropower generation is offset by the use of coal-based energy. In the long run, this is problematic because it

[40]Amar Čausević et al. (2020): Bosna i Hercegovina: Utjecaj i rizici klimatskih promjena */Bosnia and Herzegovina: Impact and Risks of Climate Change/*, El.knjiga.-Tuzla:Udruženje građana Multi, available at: https://www.researchgate.net/publication/344562602_Bosna_i_Hercegovina_-_Utjecaji_i_rizici_klimatskih_promjena/link/5f80548c299bf1b53e188fa1/download

[41]Second National Communication of Bosnia and Herzegovina on Climate Change, 2013

increases GHG emissions and negatively affects the health of the population. In 2012, Bosnia and Herzegovina experienced a prolonged drought period, causing a loss of BAM 1.65 billion in agricultural production and a 25% reduction of energy production.[42]

The following examples show some of the climate parameters and some of the manifestations of climate change and how they directly affect the production, transmission and distribution of energy[43]:

- Global temperature rise causes an increase in energy consumption for cooling in summer and a decrease in energy required for heating in winter with an extension of the period when heating or cooling is required. The consequence is less heating power but a longer period of heating need, which means that heating systems will have to be ready for possible operation over a longer period (increased costs of operation and maintenance and storage of fuel). Cooling systems will have to have more power, which, with a high simultaneity factor, requires greater production and infrastructure capacities for electricity supply;
- Reduction of precipitation in the summer period causes less production of electricity from hydropower plants while increasing the need for electricity in the summer months. Reducing the amount of precipitation also causes the problem of thermal power plants with once-through cooling by reducing the amount of water available for the cooling system. In the case of air-cooled plants, the temperature rise will reduce the efficiency of the plant;
- Increased precipitation in winter (especially in the form of rain instead of snow) and transitional periods causes the possibility of floods which can then cause damage to energy production, transmission and distribution;
- Sudden melting of snow caused by climate change can lead to soil erosion in open-pit mines and flooding of parts of mines (similar to floods) which can cause downtime and/or increased pumping costs (equipment, manpower and energy); this requires a change to managed generation from hydropower;
- The impact of increased wind intensity, in wind farms, leads to an increase in the average wind speed, which has a positive effect on electricity production but only to certain values of wind speed, after which it is necessary to stop work. Increased wind intensity as a consequence may have a negative impact due to the possibility of damage to overhead lines;
- Extreme climate events affect energy production but also transmission and distribution. Extreme climate events can cause physical damage due to storms or floods;
- High temperatures have a physical impact on the cables, which leads to a reduction in the transmission efficiency of the conductors, and ice-breakers cause damage and interruptions in transmission and distribution. Significant difficulties or complete interruptions in the supply of fossil fuels are possible, regardless of whether it is further processing/production or direct consumption.
- Global temperature rise can positively affect energy production from solar systems due to reduced losses and due to reduced clouds.

Measures to adapt the energy sector:

[42] Source 'Drought Conditions and Management Strategies in Bosnia and Herzegovina - Concise Country Report', 2013.https://www.researchgate.net/publication/270816670_Drought_Conditions_and_Management_Strategies_in_Bosnia_and_Herzegovina_-_Concise_Country_Report

[43] Based on https://prilagodba-klimi.hr/utjecaj-posljedica-klimatskih-promjena-na-energetiku/

- Capacity building for impact assessments of extreme weather events, risk reduction, preparedness measures and responses to emergencies,
- Increasing the resilience and flexibility of the grid energy system (electricity system and natural gas system) to the effects of extreme weather events and expected climate change,
- Increase of security of electricity supply in the summer period through diversification of sources and increase of decentralised electricity production, construction of centralised heat supply system for preparation of hot sanitary water and district cooling system,
- Improving the capacity for modelling and forecasting weather conditions and extreme weather events for the purpose of adaptation of the energy sector to climate change with the adaptation of electricity production from storage hydropower plants,
- Greening of degraded areas such as tailing dumps, slag dumps, abandoned quarries, etc. leads to the mitigation of effects of heat stroke and improving of the visual effect.

It should be emphasised that these measures for the energy sector are an integral part of measures to adapt the whole economy. Measures such as decentralisation and diversification of electricity generation are included and analysed in the part related to climate change mitigation.

3.2.8 Summary of key impacts of climate change

Table 2 below shows the key impacts expected across the most affected sectors by 2030.

Table 2: Summary of key climate change impacts by sector

Sector	Negative impacts	Positive impacts
Agriculture	• Reduced crop yields and yields of pastures and meadows, as a result of reduced precipitation and increased potential evapotranspiration due to rising temperatures; development and spread of diseases, pests and invasive thermophilic weeds • Increased need for irrigation of agricultural crops • Frequent floods and stagnation of surface water leading to crop destruction • Due to more intensive irrigation, there is a possibility of potential incidence of some other phytopathogenic bacteria • The appearance of late spring frosts during the extension of the vegetation period has a negative effect on fruit growing • Increasing the number of days with the occurrence of hail • Decrease in productivity of domestic animals and poultry, and in general the quality and quantity of animal products and aquaculture • Incidence and spread of communicable diseases in animals; Generally increased insecurity of food supply as a consequence of the above	• More favourable conditions for growing winter crops that make better use of spring moisture, and which can be sown later in the autumn • Extended vegetation period for certain crops, earlier sowing and planting • Shifting some production of warmer areas to higher altitudes
Water resources/ Water management	<u>Water management</u> • Temperature rise, changes in rain and snow cover, and increase in the frequency of floods and droughts. • Changes in the hydrological regime, especially drought, may have serious consequences for other sectors as well. <u>Hydropower</u> • Plants with water reservoirs are more resistant to changes in flow and can provide protection against	None expected Not researched in BiH

Sector	Negative impacts	Positive impacts
	floods, while run-of-river HPPs are directly affected by changes in flow. • There is a negative impact of increasing sediment transport. Temperature rise results in increased evaporation from the reservoir.	
Forestry and forest resources	• Increased frequency and extent of forest fires; • increased risk for rare and endangered forest communities; • Greater damage as a result of calamities of diseases and pests • Physiologically weakened ecosystems as a result of drought • Risk of transformation of the forest ecosystem resulting in large-scale tree mortality • Change of latitude and altitude of forest communities or withdrawal of certain communities under pressure from others • Impaired preservation of biological and genetic diversity; extinction of endangered and rare species	• Faster growth rates; • Potential new economic species
Biodiversity and sensitive ecosystems	• Loss of existing habitats • Habitat fragmentation • Species extinction • Loss of swamps • Rapid temperature and/or precipitation changes, affecting ecosystem function	Emergence of new habitats
Tourism	• Reducing the snow cover (an increase in winter air temperatures may reduce mountain snow cover necessary for the development of ski tourism, and pressures on drinking water sources due to the production of artificial snow) • Changing weather conditions (bad and unpredictable weather has a negative impact on the choice of destinations for tourists and excursionists) • High summer temperatures in cities (high temperatures in urban centres adversely affect the development of urban tourism) • Changes in the water level of rivers and lakes due to reduced rainfall and rising temperatures (destruction of aquatic ecosystems, which are part of the tourist offer, and reduced appeal of these hydrographic resources for the development of sports and recreational tourism) • Changes in ecosystems and the extinction of rare plant species due to climate change have a negative impact on tourism in protected areas and the beauty of the landscape, which is a common motive for tourist visits	• The rise of summer air temperatures on the Mediterranean coast has a favourable effect on the development of summer tourist offer in BiH mountain centres • Diversification of the tourist product and extension of the tourist season
Human health	Climate change may lead to: • Increased mortality from cardiovascular, cerebrovascular and other diseases associated with the appearance of 'heat waves' • Increasing the frequency of epidemics of diseases transmitted by contaminated water and food and zoonoses • Increase in morbidity and mortality from diseases of the respiratory system and malignant neoplasms • Neurological disorders and mental health disorders • The possible spread of the Asian tiger mosquito (Aedes albopictus) and the increase in the incidence of West Nile fever • Increase in the number of tick-borne diseases (Lyme disease and tick-borne encephalitis)	Fewer cold-related deaths

Sector	Negative impacts	Positive impacts
Energy sector	• Less precipitation causes less electricity production from hydropower plants while increasing the need for electricity, especially in the summer months • Increased precipitation in winter (especially in the form of rain instead of snow) and in transitional periods causes the possible occurrence of floods which can then cause damage to energy production, transmission and distribution • Sudden melting of snow caused by climate change can lead to soil erosion in open-pit mines and flooding of parts of mines (similar to floods) which can cause downtime and/or increased water pumping costs. • Extreme climate events affect energy production but also its transmission and distribution • High temperatures have a physical impact on the cables leading to a decrease in the transmission efficiency of the conductors, while ice-breakers cause damage and interruptions in transmission and distribution	• Global temperature rise can positively affect energy production from solar systems due to reduced losses and due to reduced clouds • The temperature rise reduces the need for heating and allows the use of low-temperature heating systems

3.2.9 Consequences – including extreme events and disaster management

Climate change is affecting all regions of the world. Increase in global mean surface temperature (GMST), which reached 0.87°C in the period 2006-2015 compared to 1850–1900, lead to the increased frequency and magnitude of the impact. Based on this, conclusions are drawn about the effects of increasing GMST of 1.5°C or more on natural and human systems. Estimated global warming is currently rising by 0.2°C per decade due to past and current greenhouse gas (GHG) emissions[44]. The 2 degree global temperature increase limit may be reached already around 2040 when there would be limited mitigation (RCP8.5 scenario), or much later this century – or never - when there would be substantial mitigation and thus reduced emissions.[45]

For a 2°C GMST change, projections of changes in average annual precipitation and changes in daily precipitation in winter and summer, at the end of the century (2071–2100) compared to the current climate, are shown in Figure 8 and Figure 9, respectively.

[44]IPCC, Chapter 3, 2018: Impacts of 1.5°C of Global Warming on Natural and Human Systems

[45]JRC: Impact of a changing climate, land use, and water usage on Europe's water resources, 2018.

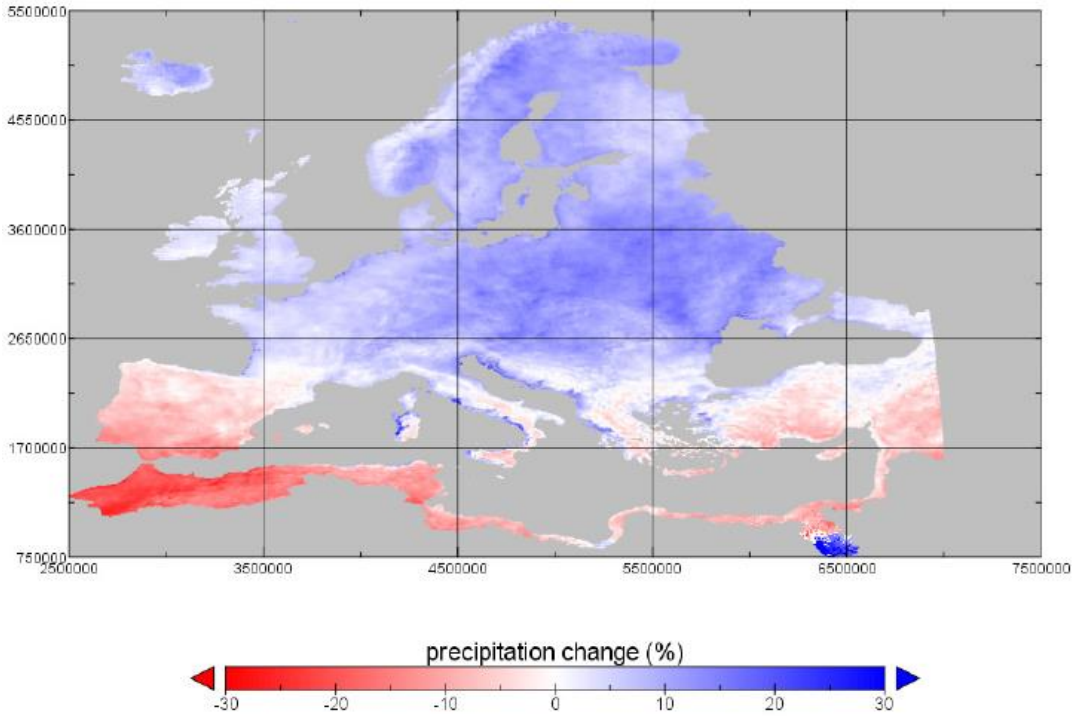


Figure 8: Projected changes in mean precipitation in Europe for the change of GMST of 2°C (averaged results of 11 Euro-Cordex model)[46]

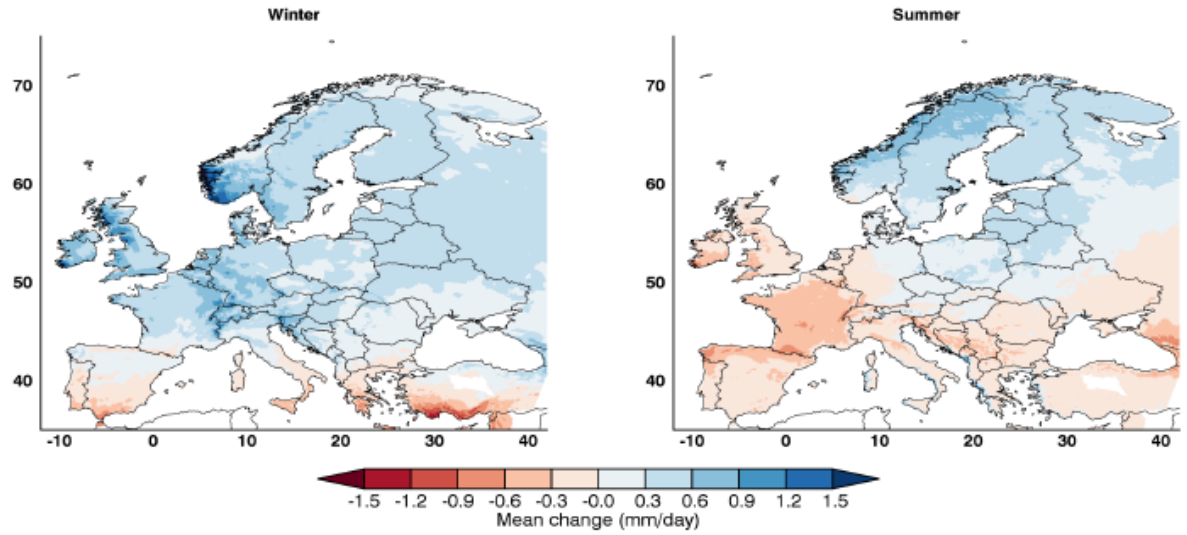


Figure 9: Projected change in daily precipitation in winter and summer, at the end of the century (2071-2100) compared to the current climate (1981-2010), RCP8.5 scenario (source: Dosio, 2018)[47]

Heavy rains and other extreme weather events are becoming more frequent, as are floods. Southern and Central Europe are facing more frequent heatwaves, forest fires and droughts. The Mediterranean area is becoming increasingly dry, making it even more vulnerable to droughts and fires. A large number of the mentioned changes have already been noticed in BiH.

[46] IPCC, Chapter 3, 2018: Impacts of 1.5°C of Global Warming on Natural and Human Systems

[47] IPCC, Chapter 3, 2018: Impacts of 1.5°C of Global Warming on Natural and Human Systems

In the analysis of river flows in BiH at the level of mean values, no significant changes in the value of water quantity can be observed[48], however, the frequent occurrence of extreme values is evident, as well as the increase between the minimum and maximum value in the analysed series. This is particularly unfavourable given that the runoff regimes of even larger rivers in Bosnia and Herzegovina are of a torrential nature, with a very fast concentration of flows.

Climate change scenarios show a significant reduction in precipitation in the region during the summer season, which may lead to an increase in the frequency and intensity of drought, and thus to an increase in the impact of the phenomenon. In the last two decades, Bosnia and Herzegovina has been affected by several extreme floods (2004, 2010, 2014). Also, extreme droughts are becoming more frequent in Bosnia and Herzegovina (2000, 2003, 2007, 2012, 2015, 2017). These events are discussed in more detail in the Adaptations section, with a review of the damage caused.

The time period after the drafting and publication of the Strategy in 2013[49] until today (mid-2019) was marked by catastrophic floods in 2014, which affected the wider Sava River Basin in Bosnia and Herzegovina, the Republic of Croatia and the Republic of Serbia. The floods were preceded by precipitation that exceeded the hitherto recorded phenomena, from 14 to 19 May 2014. In BiH, they caused the loss of 23 human lives and enormous material damage. A total of 70 administrative units (municipalities/cities) in BiH were affected by the floods and suffered losses with detrimental consequences for the population, economic activities and the environment. The document entitled 'Recovery and Reconstruction Needs Assessment in Bosnia and Herzegovina', prepared with the assistance of the EU, UN and WB, estimated that the total consequences of this natural disaster in Bosnia and Herzegovina amounted to € 2,037 million or € 1,040 million in the Federation of Bosnia and Herzegovina, € 968.30 million in Republika Srpska and € 29.6 million in Brčko District.

On its webpage, the NASA published images (Figure 10) made by 'Aqua' satellite from the space, using the so-called Moderate Resolution Imaging Spectroradiometer (MODIS).

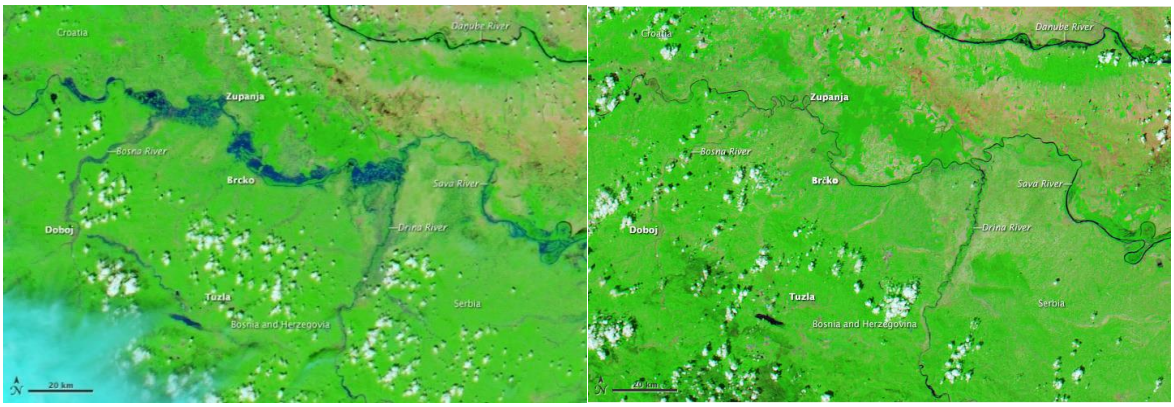


Figure 10: Left - Satellite image of the Balkans, 19 May 2014, after the precipitation. Right - Snapshot of the same area, 18 May 2013, taken for comparison.
The area affected by the floods in May 2014 was as much as 22,900 km².

[48]The Third National Communication (TNC) and Second Biennial Update Report on Greenhouse Gas Emissions (SBUR) of Bosnia and Herzegovina under the United Nations Framework Convention on Climate Change (UNFCCC), 2016.
[49]Climate Change Adaptation and Low-Emission Development Strategy for Bosnia And Herzegovina, 2013.

The May floods were accompanied by a large number of landslides, some of which completely reshaped the environment. In July, August and September 2014, precipitation caused new flooding problems in areas devastated by the May floods.

These climate changes and the extremes that have taken place in the last ten years[50] have caused enormous damage to the agricultural sector and agriculture can certainly be considered one of the most vulnerable sectors in Bosnia and Herzegovina. Estimates show that the May 2014 floods alone caused damage and losses to agriculture estimated at EUR 187 million[51].

It can be concluded that in the period since 2013, BiH has experienced increased impact due to climate change. This is certainly a very important indicator that climate projections are realistic and that the dramatic consequences of climate change in the coming period are very likely to intensify in BiH. Although events that lead to disasters cannot necessarily be prevented, adaptation strategies can greatly reduce their impact. The focus of disaster management is to reduce risk. Climate change needs to be incorporated into risk assessment and risk reduction planning processes in Bosnia and Herzegovina, with particular emphasis on floods, and forest fires. Climate change is both a protracted and a complex hazard, and being multifaceted (e.g. drought, flood, temperature changes, etc) and multi-dimensional (local, entity level, state and global), it has both short and long-term aspects. This has major implications for disaster management in terms of operating at different scales and across different sectors.

In a wider development context, disasters impact most on the vulnerable and marginalised. The extreme drought of 2012 had a major impact on grain prices, which reached extremely high levels. The floods in 2014 primarily affected cereals and fodder crops (over 80% of the total estimated damage), while the livestock sector and other infrastructure had damage of about 20%. Damage in floodplains on arable and fodder crops was huge due to the phenophase of plant development which was most sensitive in that period. This has a potential impact on the vulnerable and poor population. Similarly, reductions in power generation result in increased energy prices. Climate change increases the need to effectively integrate risk management into development strategies.

Climate change has a significant impact on ecosystems and biodiversity, and thus on their capacity to provide ecosystem services[52]. Ecosystems are able to cope to some extent with the changes. However, climate change is taking place much faster than in the past, which calls into question the ability of ecosystems to adapt. Climate change is leading to an increase in extreme events such as forest fires. Hot and dry summers and strong winds increase the risk of fires that can spread quickly and cover large areas. Five fire zones have been identified in Bosnia and Herzegovina: Low Herzegovina, High Herzegovina, Centre, West and North.

Climate change and invasive species pose the greatest threats to biodiversity. Invasive species respond much better to increasing CO_2 concentrations than other species. Also, these species have a shorter generation time, well-developed abilities for rapid spread and a wide ecological valence, which allows them to cope well with rapid changes in the environment. Furthermore, increasing the frequency of extreme weather conditions, such as storms, will allow the spread of invasive plant and insect species

[50]Seven dry years, of which three extremely dry (2008, 2010 and 2012) and floods (2009, 2010 and, especially, 2014)

[51]Council of Ministers of Bosnia and Herzegovina: Action Plan for Flood Protection and River Management in BiH 2014-2017, 2014.

[52]The term ecosystem services refers to those types of services provided by nature free of charge, and man uses them.

through air or water over greater distances. Extreme weather conditions will lead to disturbances, and invasive species generally survive successfully in disturbed environmental conditions characterised by high light levels and fragmented native communities. Climate change is fostering the spread and establishment of numerous alien species and creating opportunities for them to become invasive. These species can significantly reduce the natural resilience of natural habitats, agricultural systems and urban areas to climate change.

Extreme climate events, such as heat and cold waves, droughts, floods and the occurrence of absolute temperature maximums and minimums have a negative impact on the development of tourism. In the future, the tourism sector in Bosnia and Herzegovina will be particularly vulnerable to extreme events and natural disasters, and the consequences in this sector will be reflected in the reduction of tourists (due to destination uncertainty) and disruption of traffic connections (road, air and rail). The increasing frequency and intensity of extreme events and natural disasters have forced the authorities to adopt various strategies and plans for managing the risks of natural disasters.[53] Strategic documents related to risk assessment and protection against natural disasters in Bosnia and Herzegovina do not analyse the negative consequences in the tourism sector, which are reflected in the damage to tourism infrastructure and in the perception of the destination as unsafe by tourists due to floods, fires, heat waves etc. Also, in the tourism sector, frequent extreme events and natural disasters cause an increase in insurance policy premiums due to damage, but when the level of risk becomes too high, insurance companies withdraw, leaving tourism service providers at high risk.

In the context of future climate change, the supply of safe drinking water, which is hampered by extreme droughts, especially in rural areas and in the event of major floods, could have a major impact on the health of the population.

Thus, economic implications, coupled with the risk of significant climate change-related disasters, require an effective strategy to reduce and manage risks. Without such a strategy, climate change will have direct impact on food production and food security, energy supplies, and household welfare. The Ministry of Security of BiH, in cooperation with the OSCE, during 2019, in broad consultation, prepared 'Updating the assessment of the threat to BiH from natural or other disasters.' Hydrometeorological hazards are also included in the assessment.

3.3 Greenhouse gas emissions

3.3.1 Current emissions

As a member of the UNFCCC, BiH is required to report on greenhouse gas emissions. Through the preparation of the first three communications and two biennial reports on emissions, inventories of emissions from 1990 to 2014 were made. The inventories were made using the IPCC 1996 methodology. The inventories for 2015 and 2016 according to the IPCC 2006 methodology are being prepared. With this in mind, information on greenhouse gas emissions is much more reliable compared to the period when the previous Strategy was made, and domestic capacities for their

[53]Although The 2010-2022 Water Management Strategy of the Federation of Bosnia and Herzegovina and The 2015-2024 Integrated Water Management Strategy of the Republika Srpska provide for flood protection measures, little has been applied in practice, and done in the field. After the May 2014 floods, in November of the same year, the 2014-2017 Action Plan for flood protection and river management in BiH was made, which all levels of government were obliged to implement by the end of 2017. However, in March 2018, it was stated that this plan has not been fully implemented and the deadline for its implementation has been extended to 2021.

monitoring have been improved. In this way, it is possible to more reliably forecast emissions and in this regard to define the objectives arising from international agreements. Figure 11 indicates GHG emission trend from 1990 to 2014.

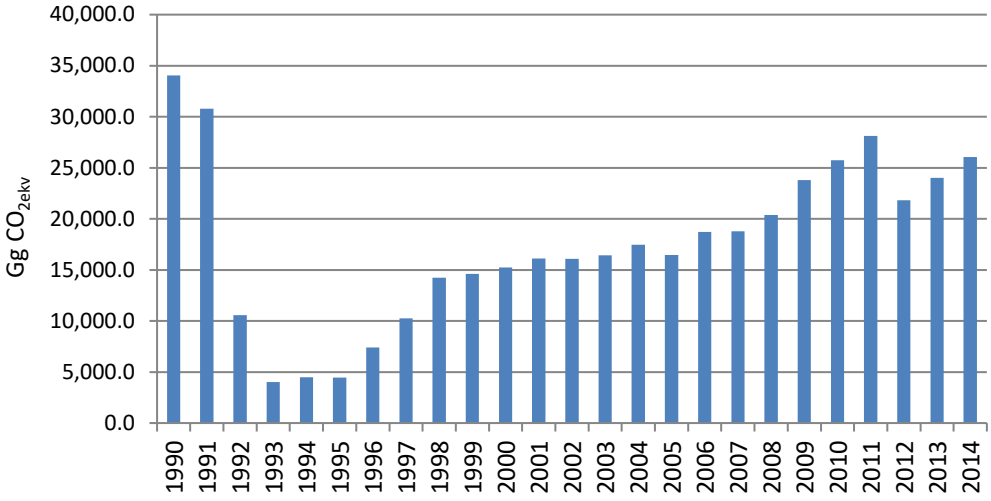


Figure 11: Annual GHG emissions in Bosnia and Herzegovina

The highest emissions were in 1990 amounting to 34,040Gg CO_{2eq}. Emissions were significantly reduced during the 1992-1995 war, whereupon they increased. In 2001, they were less than half compared to 1990. After that, primarily due to the growth of emissions in the energy sector, total emissions exceeded 20,000 Gg CO_{2eq} (in 2008). Emissions from other sectors were more than halved between 1990 and 2001, due to a reduction of more than 80% in industrial emissions and 50% in the agricultural sector. The highest emissions after 1995 were in 2011 (counting the period until 2014) and amounted to 28,107 Gg CO_{2eq}, which is about 83% of 1990 emissions. In 2012, a significant drop in emissions was observed as a result of a smaller share of thermal power plants in electricity production. Emissions in 2014, the last year for which an inventory has been made so far, amounted to 26,062 Gg CO_{2eq}, which is almost 25% less than in 1990.

Analysing emissions per capita, emissions in 2011 reached the 1990 levels per capita emissions (although emissions are lower, but the number of inhabitants decreased), but they are still among the lowest values in Europe. In 2014, per capita emissions amounted to about 7.38 tons of CO_{2eq} per capita, which is about 15% less than the EU average. However, if the comparison is made in relation to the gross domestic product, the emissions in BiH are almost five times higher than those in the EU. GHG emissions per unit of GDP for BiH amounted to 1.87 kg CO_{2eq} per euro in 2014, while the EU average was 0.39 kg CO_{2eq} per euro. These indicators illustrate the economic and social situation of BiH, caught in the poverty trap with relatively low values of GHG emissions, but even lower gross domestic product per capita, which indicates the irrational use of resources, primarily energy.

The graphs below (Figure 12) indicate the share of individual sectors in the total GHG emissions in 1990 and 2014.

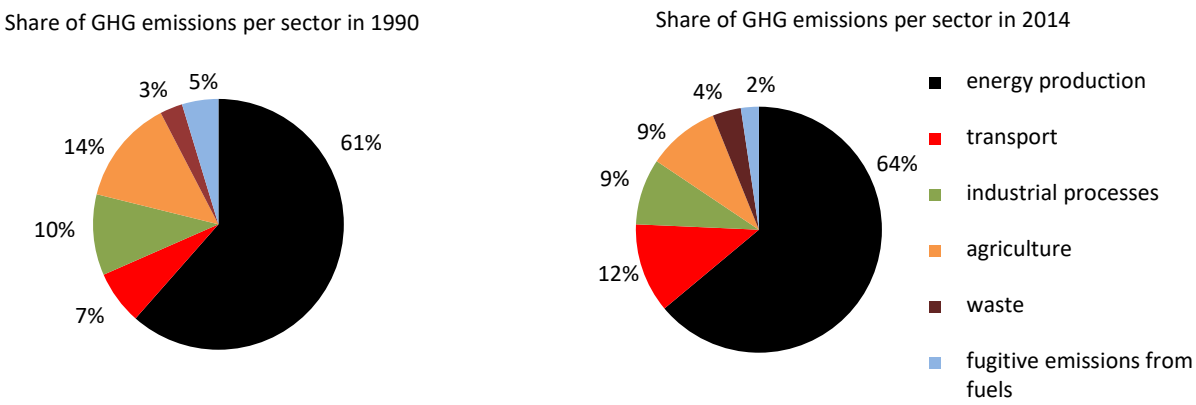


Figure 12: Share of GHG emissions per sector

The charts show the increase of the share of energy production in total GHG emissions from 61% (in 1990) to 64% (in 2014), although emissions (in absolute terms) in this sector are lower in 2014. There is a significant increase in the share of transport, from 7% to 12%. The share of agriculture decreased significantly, while the share of industrial processes remained approximately the same. The share of fugitive emissions from fuels fell from 5% in 1990 to 2% in 2014, indicating an improvement in the way fuel is handled. It is important to point out that this is the share of emissions of all greenhouse gases, not just carbon dioxide emissions.

The level of data reliability has been raised by creating an inventory of GHG emissions. Budget verification was performed, which refers to the procedures that need to be followed during data collection and inventory preparation. In accordance with the RS Law on Air Protection, RS MHS is responsible for the development of GHG inventory for RS. The same powers are provided by the draft Law on Air Protection of FBiH for FBIH MHS. It is necessary to legally define how to consolidate data between entities for the level of BiH with the addition of emissions from the Brčko District.

The amount of 1990 emissions has not yet been reached. It is evident that the amounts of emissions have a growth trend, primarily due to the increase in the share of thermal power plants in electricity production.

According to the draft inventory for 2015 and 2016, which is done according to the IPCC 2006 methodology, there is a further trend of emission increase. In 2016, a new coal-fired thermal power plant was put into operation. Taking into account the production of electricity in thermal power plants in 2017 and 2018, it can be said with confidence that even in those years, emissions are also higher compared to 2014 by almost 2,000 Gg CO_{2eq} or about 7%. However, it should be emphasised that this is not an emission trend due to a relatively short period but the impact of the variability of the share of thermal power plants in electricity production, which primarily depends on the amount of precipitation in the observed year.

3.3.2 Emission projections

As elaborated in Chapter 3.1.1, GHG emissions in BiH depend primarily on the volume of production in thermal power plants, given that their share in GHG emissions is generally over 50%. Therefore, future emissions largely depend on the intensity of operation of existing thermal power plants and their replacement with new thermal power plants. An additional unfavourable factor from the aspect

of GHG emissions is the obligation to build a desulphurisation system at some existing thermal power plants, which will reduce net efficiency and consequently increase specific GHG emissions. Factors influencing the volume of thermal power plant production are, first of all, the situation on the regional electricity market and the readiness of mines to produce sufficient quantities of coal. On the other hand, the construction of RES plants, or the growth of the share of RES in total electricity production, has no direct impact on reducing GHG emissions as long as electricity from thermal power plants can be placed either on the domestic or international market. Thus, it is fair to say that future GHG emissions will primarily depend on the implementation of plans in the electricity sector.

The INDC BiH has set indicative targets for GHG emissions in 2030 compared to 1990. The INDC states that according to the business-as-usual (BAU) scenario, the maximum emissions are expected in 2030, when the expected emissions are 20% higher than the level of emissions in 1990. The unconditional goal of BiH according to the INDC is to reduce emissions by 2% by 2030 in relation to BAU, or 18% higher emissions compared to the base year 1990. A more significant reduction is projected in a scenario that implies more intensive international support to reduce emissions. Under this scenario, the goal is to reduce emissions in 2030 by 3% compared to 1990 emissions, which would mean a reduction of 23% compared to BAU. Figure 13 shows previous emissions and their projections from the INDC for different scenarios.

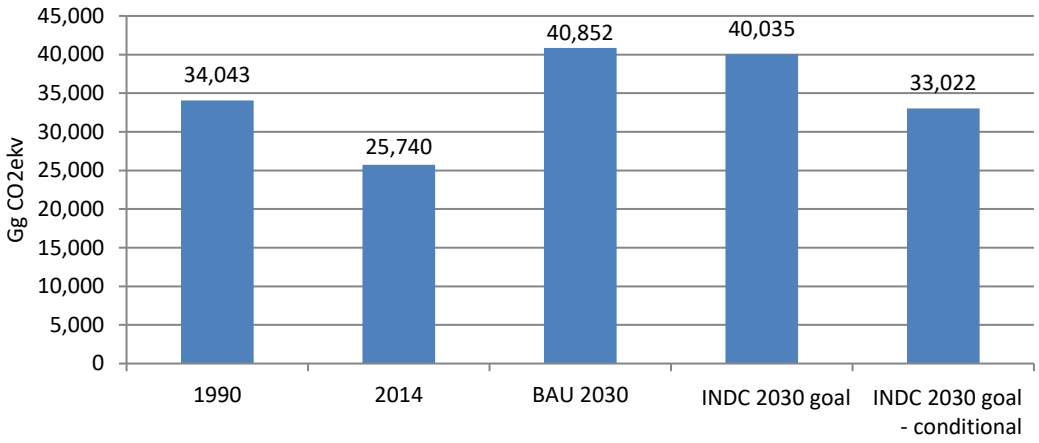


Figure 13: Previous GHG emissions and their projections from the INDC for different scenarios

Looking from 2020, and taking into account the feasibility of current plans in the electricity sector related to the closure of existing and construction of replacement/new coal-fired power plants, it is clear that GHG emissions by 2030 will not grow even to the level of the INDC conditional goal. On the other hand, there are clear requirements arising from the Energy Community membership to define emission reduction targets compared to 2014. This means that none of the scenarios given in the INDC meet this requirement.

The Framework Energy Strategy of BiH until 2035 has not specifically determined the future directions of electricity development. Multiple scenarios have been developed, without selecting a specific one. Of the four scenarios developed, only one leads to some emission reductions (called moderate renewable scenario). Other scenarios are based, among other things, on a significant increase in the capacity of thermal power plants and their production. The main disadvantage of these scenarios is that they predict an unrealistic increase in electricity production, by as much as 80% by 2035. The

moderate renewable scenario envisages a slight increase in production, but from RES, while the role of thermal power plants would be focused on security of supply. A major contribution to reducing electricity emissions will be made after 2035, when most of the existing coal-fired power plants are expected to close. In other sectors covered by the mentioned Strategy, significant reductions in GHG emissions are envisaged. This primarily refers to the building sector where a reduction in the energy required for heating and a reduction in the use of coal and heating oil is expected. In district heating, the trend of reducing the consumption of fossil fuels is expected to continue but at the same time the increase in district heating capacity (expansion of existing and construction of new systems) is predicted, so that the expected reduction by 2030 is negligible. The impact of this on reducing GHG emissions will be reflected mainly in the building sector. After that, a significant drop in emissions is expected by 2050 due to the increase in the share of RES and the cessation of the use of coal and liquid fuels.

The experience of other developed countries shows that it is the most difficult to reduce emissions from transport. BiH had a target of 10% of energy in transport coming from RES by 2020. It is clear that this target has not been met, and the actual share is below 1%. The share of transport in GHG emissions in 2014 was 12% and has a growth trend. Given that emission reductions are expected in other sectors, the share of transport will continue to grow in the coming period. No significant electrification of road transport is expected by 2030. It will only mitigate the increase in emissions that will result from the increase in transport volumes.

In agriculture, the trend of reducing emissions can be expected to continue. Emissions from agriculture decreased by almost 50% in the period 1990-2014. With the application of new technologies (production and use of biogas, dietary changes, etc.) a significant contribution can be expected.

The waste management sector is characterised by the fact that the effects of measures aimed at reducing GHG emissions are seen only after some time (5-10 years), so the period until 2030 is too short to record more significant results. However, in the long run, or by 2050, the effects of the measures will be very visible.

3.3.3 Reduction potential

Given that over 50% of GHG emissions come from the electricity sector and that about 70% of electricity (varies depending on the annual distribution and precipitation) is produced in coal-fired power plants that have a high specific emission (about 1.3 tCO_2/MWh) one may conclude that the greatest potential for reducing GHG emissions is in the electricity sector. The exploitation of this potential goes in three directions:

- Gradual closure of existing inefficient thermal power plants and replacement of a part of the existing ones with new, more efficient thermal power plants, taking into account to reduce total emissions at the target rate,
- Construction of RES plants, especially those that can play a role in security of supply and development of other sectors of the economy in BiH (woody biomass power plants, biogas plants and storage hydropower plants, which will enable the integration of larger wind and solar power plants),
- Reduction and management of electricity needs while reducing transmission and distribution losses.

Replacing existing thermal power plants without production restrictions alone does not mean much for absolute emission reductions. No significant increase in domestic electricity needs is expected. With increasing production from RES, if the market restricts exports, there will necessarily be a reduction in electricity production from thermal power plants. This process should be managed in order to avoid a sharp drop in coal demand and consequently a sudden loss of jobs in the mines. New thermal power plants have an efficiency of about 42%, and existing ones are on average just over 30%. Proportional to the increase in the degree of efficiency, replacement/new thermal power plants have a lower specific carbon dioxide emission (below 1 tCO_2/MWh). The amount of emission reduction in absolute amount from new thermal power plants depends on the volume of production. Figure 14 shows the potentials to reduce GHG emissions by building replacement thermal power plants depending on electricity production with the gradual closure of existing thermal power plants by 2035. It is emphasised that this is only a simulation of the potential for reducing emissions, and not planning the production of electricity from coal-fired power plants.

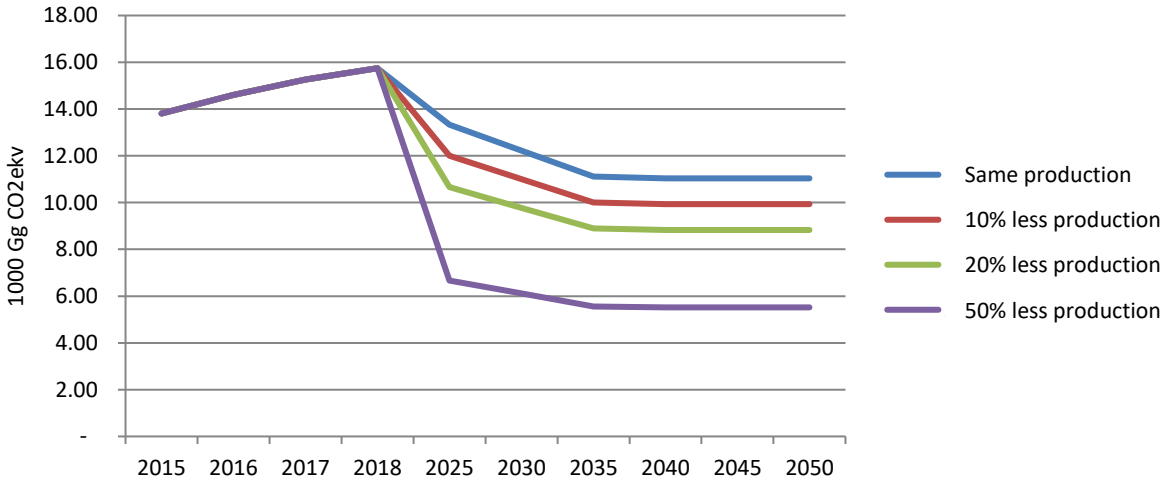


Figure 14: Potential to reduce GHG emissions by replacement thermal power plants in BiH by 2050

If we assume the production from thermal power plants by 2050 in the amount of the average production in the period 2015 - 2018 (about 11,110 GWh/year, which is slightly more than in 2014), emission in the electricity sector in 2030 is about 800 Gg CO_{2eq} or 6% lower than that in 2014. The emission reduction in 2050 is about 2,000 Gg CO_{2eq} or about 15% compared to the 2014 emission. This shows how important it is to gradually close the existing thermal power plants and replace them with new ones. As mentioned earlier, production from thermal power plants will necessarily decline. Therefore, Figure 4 shows the emission reduction potential if production decreases by 10% (red line), 20% (green line) and 50% (purple line). Of course, depending on the circumstances, primarily production from other sources, production from thermal power plants can drop significantly more than the stated estimates. A significant reduction of 25% is achieved as early as in 2030 with a production reduction of 20%, and for the same scenario the reduction in 2050 is 32%. A 20% reduction in production is about 2,200 GWh/year. In order to compensate for this reduction from RES, it is necessary to install about 750 MW of wind farms. Given that the largest share of emission reductions is expected from the electric power industry, the reduction of production from thermal power plants by 50% was also analysed, or for about 5,500 GWh/year. In that case, the emission reduction in 2030 is about 7,000 Gg CO_{2eq} or by 53% compared to 2014. In that case, the emission in 2050 is 58% lower than the emission in 2014. It needs to be emphasised that this is only a simulation of the reduction

potential. In line with the goal of the Green Agenda for the Western Balkans, BiH has committed itself to working to make Europe a climate-neutral continent by 2050. The Action Plan for the implementation of the Green Agenda will also define the work of thermal power plants in that context, but it is certain that their work after 2050 will be reduced to a minimum or completely shut down.

An additional potential in electricity is the decentralisation of production, energy consumers will also become energy producers, the use of advanced grids, smart systems and energy storage will enable flexible consumption and greater integration of RES. In this part, there is a great potential of civic energy projects primarily through the construction of solar power plants and, later, wind farms. In order to enable such projects, a reform of the existing entity incentive systems is needed.

In the context of exploiting the potential of biomass, it is necessary to emphasise the need to regulate the biomass market by introducing the principle of cascading use of wood. This would result in the use of the lowest quality biomass for energy production, without cases of using biomass for these purposes, although it is biomass that can be used for some other purposes that give greater added value. In addition, it is necessary to regulate the market of biomass, especially pellets, by prescribing mandatory certification of the quality of biomass that is placed on the market.

In second place in terms of emission reduction potential is the building sector. In 2014, emissions in the residential building sector amounted to about 1,500 Gg CO_{2eq}. Given the current situation characterised by high energy needs for heating (on average about 200 kWh/m^2 per year) and low efficiency of heating systems, it is reasonable to say that there is great potential in building (the largest is in residential buildings), and that systemic measures can reduce emissions by about 20% by 2030 (with an annual renovation rate of 1%). The exploitation of this potential may be achieved by implementing the following measures related to:

- Reduction of heating needs for existing buildings and construction of new highly efficient buildings (in accordance with EU standards),
- Replacement of energy sources for heating using certified and efficient equipment for production of heat (condensing boilers, heat pumps, regulation, etc.) and
- Connection of buildings to district heating with zero or low GHG emissions.

Additional potential for reducing (indirect) emissions lies in the decarbonisation of the preparation of domestic hot water that is today heated predominantly by electricity from the grid. Centralised heat supply for domestic hot water heating (via district or block heating) reduces the load on the electricity grid, reduces the need to build new generation capacity and allows greater integration of intermittent RES (wind and solar energy).

There is significant potential for reducing emissions in industry through increased energy efficiency and the use of RES, especially through on-site electricity generation to cover part of its own needs. The market will encourage industry as decarbonisation because it is a matter of competitiveness. In addition, there must be a system of incentives by the state (e.g. net metering or net billing, energy efficiency education, financing of measures, etc.). However, until 2030, no significant reduction of emissions from industry is expected because energy efficiency measures and the application of RES will compensate for the increase in industrial production, which means that emissions will be reduced compared to the baseline scenario (without measures).

In transport, the greatest potential for reducing emissions lies in electrifying transport through electrification of public transport, switching (one part) of road freight and passenger transport to rail and increasing the share of electric and/or hybrid as well as plug-in passenger vehicles. The development of public electrified transport would reduce the share of individual road transport and thus improve air quality in many cities (while reducing GHG emissions). By encouraging the procurement of electric and/or hybrid as well as plug-in passenger vehicles, emissions may be reduced, especially having in mind the reduction of the emission factor of the electricity grid. There is a significant potential in the development of non-motorised modes of transport (cycling and walking) in urban areas, which should be set at a high level of priority in spatial planning. None of the above measures has so far been sufficiently recognised in the sectoral strategic documents. Due to the planned increase in transport volumes, possible measures can only mitigate the continuation of the trend of increasing emissions (Table 4).

In agriculture, there is significant potential for reducing emissions through multiple benefit measures such as biogas production and its use for electricity and heat production. Such plants (biogas plants) eliminate methane emissions, converting it into useful forms of energy. In doing so, they can play a significant role in balancing the grid, and above all provide an additional source of income to farmers and contribute to the sustainability of agricultural production.

In the field of waste management, the potential for reducing emissions is, above all, in waste prevention (resource efficiency, cleaner production), separate collection, recycling and reuse of waste, production of biogas and compost from organic waste to reduce the amount of waste for disposal to a minimum. In addition to reducing direct methane emissions, these measures also indirectly reduce emissions because they reduce the energy required to produce new materials and replace the use of fossil fuels. Landfills have significant potential through the installation of landfill gas collection and utilisation systems.

3.3.4 Choices

Having received the results of the 2013 census, it was realised that BiH does not have such a low per capita GHG emission. In 2014, per capita emissions amounted to about 7.38 tons of CO_{2eq} per capita, which is about 15% less than the EU average. In 2008, the amount was 5.18 tons of CO_{2eq} per capita. This increase is primarily the result of a significant decrease in the number of inhabitants according to the census with a simultaneous increase in emissions by about 25%. Undoubtedly, such increase of emissions must be reduced in the following period. An additional disadvantage is that BiH has a GDP value in relation to GHG emissions.

BiH is in the process of opting for significant quantitative emission reductions. By signing the Green Agenda for the Western Balkans, BiH has committed itself to contributing to Europe's climate neutrality. With the uncertainty of future projections of GHG emissions due to insufficiently clear commitment in some sectors (primarily in electricity), it is difficult to set meaningful targets for climate change mitigation. If active measures are not applied immediately, GHG emissions could be at a maximum in the period from 2025 to 2030. Exactly for 2030, BiH has an obligation to define a target for reducing emissions. Therefore, it is concluded that time is an important factor because it is lacking. The period of 5-10 years is relatively short in order to significantly reverse the trend of GHG emissions.

The key challenge is to use the transition to a low carbon economy to achieve the objectives of rapidly improving the economic situation and social cohesion. In this process, there is potential for economic growth and new workplaces as a result of investment in emission reductions for the electricity, buildings, transport and waste sectors, and especially for the sustainability of agriculture and forestry.

Based on the analysis of the existing situation there are two main axes along which the possible development scenarios could be defined. The first is related to the level of energy efficiency and sustainability, and the second to the distribution of investment in new electricity generation between coal and renewables. The possible scenarios are presented in Figure 15 below.

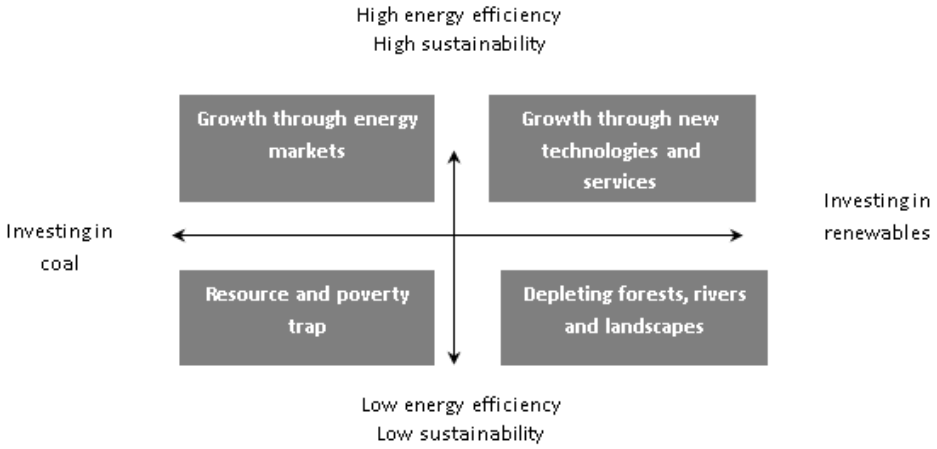


Figure 15: Choices affecting future developments and GHG emission scenarios

The description of these possible scenarios is as follows:

- Resource and poverty trap: Bosnia and Herzegovina continues to depend heavily on coal for its electricity production, industry and heating of buildings. Modern thermal power plants are built with higher efficiency and lower emissions but energy demand and energy prices grow. Households and industry, which cannot afford investments in energy efficiency, pay rising costs for energy, especially after the energy sector enters EU ETS and has to pay emission permits.
- Depleting forests, rivers and landscapes: BiH attracts major investment in hydropower, biomass and wind energy, accounting for a significant share of energy supply. At the same time, coalmining areas are in decline and require additional government support for restructuring. Due to low energy efficiency, energy demand grows faster than supply, leading to overexploitation of natural resources, such as forests, rivers, and landscape and biodiversity in general. This causes additional problems for adaptation to climate change, and reduces quality of life and tourism potential of the country.
- Growth through energy markets: BiH attracts investment in its coal power sector with imported technology, significantly improving its efficiency and reducing specific emissions. The lifespan of coalmines is extended for another generation, making it possible to gradually restructure their economy at low cost. At the same time energy efficiency measures in households and industry keep energy demand below supply, and energy costs within reason. In this case, the cost of emission permits would increase the already high subsidies needed for coal production and use.

- Growth through new technologies and services: An energy sector transformation is achieved combining investment into renewable energy and energy efficiency. This generates new business opportunities and workplaces replacing the lost workplaces in the coalmining regions. High technology manufacturing, service and financing businesses emerge that increase the exports of industrial products and services. Energy demand and energy prices are stable; households and industry are not exposed to increasing prices of emission permits or the volatility of global energy markets.

The first two scenarios (Figure 15 - lower half) should be avoided if possible: through investment on the energy demand side, in energy efficiency of buildings, district heating, and sustainable transport. In these sectors the abatement costs are negative and co-benefits – in terms of poverty reduction and generating economic growth – are significant.

In addition to the choice in favour of energy efficiency, is that regarding future investment in electricity generation (along the horizontal axis). This choice between coal and RES most significantly affects the future emissions of BiH. There is interest to invest in the next generation of coal-fired power plants before BiH enters the EU (construction of a coal-fired power plant is underway). However, one should be aware that their work after 2050 is uncertain, and until then they will be exposed to additional market pressures (carbon dioxide emission permits, abolition of subsidies for coal production and use, etc.). BiH also attracts foreign investment in its RES potential, where hydropower, wind energy and photovoltaic energy are already commercially viable sources (without public subsidies). In this context, it is important to encourage new business models in the field of RES and energy services such as civic energy, energy service companies, energy cooperatives and general encouragement of the prosumer concept.

BiH should focus on building new capacities in RES, taking into account the security of energy supply with a gradual reduction of coal production and active work on the fair transition of mining areas with the use of international funds for this purpose. In the current economic situation, Bosnia and Herzegovina does not have sufficient resources to restructure coalmining regions. The Strategy aims to mobilise international investment in RES and a fair transition of mining areas, as well as energy efficiency of buildings and sustainable transport.

4 STRATEGY VISION AND GOALS

The vision statement for the Climate Change Adaptation and Low-Emission Development Strategy

By 2025 Bosnia and Herzegovina will be a sustainable and prosperous green economy.

Bosnia and Herzegovina's commitment is to join the EU as a member state with low emissions, high quality of life for everyone, preserved natural ecosystems, sustainable natural resources management and a high level of climate resilience. Increasing levels of energy efficiency, greater renewable energy use, and improved energy and transport infrastructure and services will lead to international investment, job creation and business enterprise in a resource-efficient economy. Negative impacts of climate change will be minimised by reducing vulnerability and taking advantage of opportunities brought about by climate change. The transition to a 'green economy' will particularly benefit the vulnerable and disadvantaged by being socially inclusive and contributing positively to gender equity.

The adaptation goal of the strategy

Increase Bosnia and Herzegovina's resilience to climate variability and climate change, and in doing so, secure development gains.

The emission reduction goal of the strategy

Reverse trend of increasing greenhouse gas emissions, significantly reduce emissions by 2030 with the simultaneous growth of the economy through measures and programmes that will result in a reduction of greenhouse gas emissions by 50% by 2050 compared to 2014 and reduce net greenhouse gas emissions by 80% by 2050 compared to 1990.

5 THE ADAPTATION STRATEGY AND ACTION PLAN

5.1 Review of the implementation of the 2013 Climate Change Adaptation Strategy

The 2014 floods, as well as the droughts of 2012, 2015 and 2017, showed how serious the consequences of climate change can be, and that BiH is no exception. This influenced the intensification of activities related to adaptation to climate change in BiH.

After the catastrophic floods in 2014, the EU Delegation asked Bosnia and Herzegovina to develop an Action Plan for Flood Protection and River Management in BiH, which will create a framework in which flood protection and water management issues will be treated in a harmonised and coordinated manner, both in BiH and at the regional level. In January 2015, the Council of Ministers of Bosnia and Herzegovina adopted The 2014-2017 Action Plan for Flood Protection and River Management in BiH, with 6 key measures and 22 sub-measures defined. In March 2018, the deadline for its implementation was extended until 2021.

Several projects were implemented, the objectives of which were related to the development of hydrological models and the establishment of flood forecasting systems, mainly for the Sava River Basin, in BiH and regionally[54]. Although most projects are still ongoing, certain products have already been implemented and are in use, such as the joint flood forecasting and warning platform in the Sava River Basin (Sava Commission is the project coordinator), the forecast model for the Vrbas and Una River Basins, and the procurement of equipment for strengthening the capacity of institutions in charge of hydrological and meteorological monitoring. Upon completion of the project, BiH will have domestic models for flood forecasting in the Sava River Basin, and in addition to access to a joint

[54]In January 2015, the Action Plan for Flood Protection and River Management in BiH was adopted. Following the adoption of the Action Plan, the European Commission approved funds for the implementation of the project: 'Support to flood protection and river management', worth EUR 25,000,000.
Through component 1: Hydrological forecasting system for the Sava River in BiH (Phase 1: Bosna River), the procurement of equipment for the hydrological forecasting system of the Bosna River Basin and the Ukrina, Tinja and Brka River Basins is planned. Funds in the amount of EUR 2,000,000 were used to purchase a software package for the collection, processing and management of meteorological and hydrological data, hydrological and hydraulic models for the Bosna River Basin, appropriate IT equipment and support servers, automatic hydrological stations, precipitation and meteorological stations, stations to measure levels. The project is ongoing (July 2019). Component 2 refers to the reconstruction of flood protection facilities in the Sava River Basin. Funds in the amount of EUR 13,000,000 from the IPA 2014 national component and EUR 10,000,000 from the IPA 2014 regional component are earmarked for investment works, or for rehabilitation, reconstruction and construction of water protection facilities at 22 different locations in BiH.
The WBIF/GEF/SCCF project for the Drina River Basin 'West Balkans Drina River Basin Management' will last until 2021, 20 automatic stations and measuring equipment were procured through the project, and the development of a hydrological model for the Drina River is planned.
Through the JICA project - assistance of the Government of Japan to Bosnia and Herzegovina in meteorological equipment, 12 automatic weather stations (AWS) were assigned, with the aim of establishing agrometeorological monitoring at 10 localities in FBiH and RS.
UNDP: 'Integrating climate changes into management of flood risk reduction in the Vrbas River Basin', a network of 28 hydrological and meteorological stations has been established, and a hydrological forecasting model is being developed. Completion of the project is planned for the second quarter of 2020.
WBIF project 'Improvement of Joint Actions in Flood Management in the Sava River Basin-FFWS' has been completed and its outputs are being implemented.
Assistance from the Government of Finland: Procurement of 10 automatic meteorological and hydrological stations in the Una River Basin.

platform through which it has access to meteorological and hydrological forecasting models in the Sava River Basin region, BiH has had access to European Early Warning System since 2017.

Management plans for river basins/regional basins in BiH[55] have been developed and adopted, whereas the 2022-2027 Management Plans are being developed. Activities have also been initiated on the development of flood risk management plans. These plans are key documents for the implementation of this water strategy.

Following the need for reporting on climate change, the Agency for Statistics of Bosnia and Herzegovina (BHAS), within the Environmental Statistics, began publishing a climate change communication in 2015, in cooperation with the two entity meteorological and hydrological services, and recommended by Eurostat's Directorate-General for Climate Action. The importance of using reliable methods used to assess the availability of water resources generally increases with the increase of fresh water needs. Improving indicator estimates is possible with a review of the applied methodology and with sufficiently reliable data.

Comparing the recommended measures with the implementation, it can be concluded that the results related to water management in some segments exceed the strategic planned results from the 2013 Strategy (e.g. number of established new hydrological and meteorological monitoring stations, number of developed hydrological models, etc.). This can be explained by the successful development and adoption of the Action Plan and a significant number of projects with specific, similar objectives that followed in response to the catastrophic floods of 2014. Similar explanation is valid for the implementation of equipping meteorological and hydrological services in the Federation of BiH and Republika Srpska, respectively, with modern software for data management, and equipment for field measurements. On the other hand, some results were lacking (e.g. preparation of Feasibility Study of dam reservoirs and reservoirs for better water management, development of Water Quality Monitoring Program for rural areas, etc.).[56]

Not many measures recommended by the 2013 Strategy have been implemented in other sectors (e.g. in the forestry sector almost no activity has been started).

5.2 Specific objectives and priorities

The Adaptation Strategy represents a co-ordinated approach to ensure that Bosnia and Herzegovina is well-placed to adapt to climate change in a sustainable way.

The specific objective of the Strategy is to reduce the consequences of climate change that will have the greatest impact on vulnerable groups. It is necessary to partially reduce the negative impacts, increase resilience and at the same time take advantage of the opportunities brought about by climate change. This will be achieved through the establishment of an enabling environment, adaptable to all relevant sectors, levels of government, civil society and the private sector. The Strategy will ensure

[55]Sava River Basin Agency: Sava River Basin Management Plan (2016-2021); Adriatic Sea Basin Agency: Adriatic Sea Basin Management Plan; Public Institution 'Vode Srpske': Sava River Basin District Management Plan in the Republika Srpska (2017-2021), Trebišnjica Regional River Basin Management Plan (2017-2021).

[56]For existing reservoirs, new reservoir management plans are to be developed, in line with anticipated climate change, in order to improve their role in water management, not just hydropower production; For new reservoirs - a complete feasibility study is required, by river basins.

that climate change adaptation measures are gender responsive and will incorporate specific measures to ensure that the most vulnerable groups of the population receive adequate support.

This Strategy has four interlinked priority areas, each with its own outcome (Figure 16).

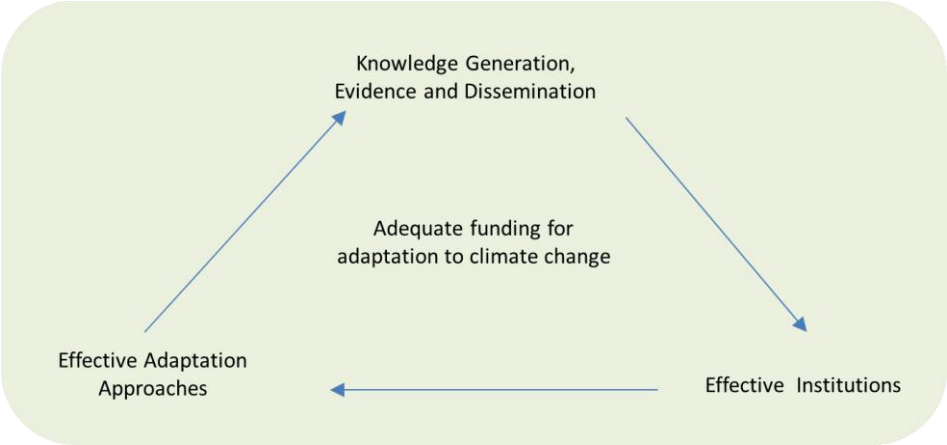


Figure 16: Priority areas of the Adaptation Strategy

The priority areas of action logically link with each other, providing a clear conceptual model for the Strategy. The outcomes and measures, when combined, should effectively deliver the overall goal. The overall goals of the Climate Change Adaptation Strategy and the Low Emission Development Strategy are mutually supportive and integrated.

5.2.1 Knowledge Generation, Evidence and Dissemination

Outcome 1: Climate change risks, vulnerabilities and opportunities are reliably identified, quantified and effectively communicated, supporting evidence-based policy development

Bosnia and Herzegovina needs reliable information to enable the assessment of climate change and subsequent impacts. Although there have been significant improvements in current data monitoring, analysis and modelling in terms of equipping meteorological and hydrological services with modern data management software and equipment for field measurements, it should be emphasised that in the forthcoming period it is very important to ensure the sustainability upon their completion through maintenance of purchased equipment and renewal of software licenses. It is especially important to have appropriate staff, especially in meteorological and hydrological services where it is necessary to strengthen the staff capacities with appropriate engineers of hydraulic engineering, IT and meteorology. In addition, future research needs to be more systematic, comprehensive and better focused on supporting policy and decision-makers. The findings and results need to be accessible and communicated clearly and effectively to policy makers. Adequate research tools, models and reliable data will be available to ensure that predictive knowledge of climate change and associated risk is strengthened, providing a solid foundation for evidence-based policy development.

5.2.2 Effective institutions and regulatory frameworks

Output 2: An effective institutional and regulatory framework supporting adaptation, coupled with delivery capacity, is addressing climate change risks and opportunities across sectors

Bosnia and Herzegovina needs a strong institutional and legislative framework in line with the Constitution and competencies for climate risk management and adaptation, thus providing support for sectoral and horizontal activities, capacity building and innovation. The state does not have a centralised institution that can act with the aim of unified action. There are currently a large number of government bodies managing environmental issues with insufficient coordination. Therefore, the regulation of climate issues in the country requires more efforts in international cooperation and coordination. All levels of government should support sectoral interventions focused on the implementation of climate resilience measures, together with the goal of increasing overall production and social protection. An adequate first step in implementing the recommendations may include seeking financial and technical support from leading development partners. The framework must link environmental protection institutions and institutions in sectors related to climate change adaptation, strengthen their capacities in terms of performing the assigned tasks. The legislative framework needs to be reviewed at all levels, to ensure there is clarity, focus and an ability to mitigate the risks arising from the consequences and take advantage of the opportunities provided by climate change. High-level strategies need to be both localised and developed into sectoral adaptation plans.

5.2.3 Effective adaptation approaches

Outcome 3: Adaptation approaches are mainstreamed into decision-making, implemented and their objectives and planned delivery are understood by an informed society

Although the adaptation priorities and possibilities have been identified and addressed in the Initial, Second and Third National Communications, they have not been sufficiently converted into specific objectives at a central or sectoral level. These objectives need to be strategically embedded in planning, and climate change adaptation issues incorporated into mainstream decision-making. Mechanisms for implementing adaptation approaches also need to be identified, with clarity as to what will be implemented by or with direct support from government and the public sector. Private sector funded or supported, community-based and autonomous measures need to be identified, along with support and co-financing/funding modalities. A key part of the adaptation approach is awareness raising and education. The education system in Bosnia and Herzegovina pays little attention to climate change or associated environmental matters: there is a need to strengthen curriculum and educational programmes at all levels. There is limited awareness of climate change issues and the need for adaptive measures among the public and interested parties. There is also a need for greater involvement of civil society and enhanced advocacy. This requires active communication to raise the profile of climate change issues.

The strategy identifies mechanisms to support adaptation measures and actions at national and local levels. Much of the measures and actions supporting this outcome is focused on the six priority sectors, addressing information generation, modelling, pilot activities and specific technical activities.

Climate change and the associated risks and vulnerabilities need to be embedded in capacity building and awareness-raising programmes, leading to more informed and engaged citizens and improved climate change governance. Knowledge and technology transfer will be encouraged through collaborative work between researchers and the private sector for demonstration and research and development (R&D) work, which may be funded by EC Framework for research and technological development and similar collaborative mechanisms.

5.2.4 Adequate funding for adaptation

Outcome 4: A well-resourced Adaptation Strategy being implemented on time, effectively, and delivering the expected outcomes

The Adaptation Strategy requires funds for implementation, over and above those currently available within Bosnia and Herzegovina. Additional funds will need to be secured to enable this strategy, and associated programmes and plans, to be effectively rolled out. Potential funding sources – in addition to financial institutions – include the private sector, in terms of infrastructure and other investments and to benefit from business opportunities offered by some of the adaptation measures. Opportunities for co-financing, public-private partnerships, and social enterprise-led economic activities[57] need to be highlighted. Innovative partnerships should be developed with multilateral funding agencies (currently reviewing their development assistance in the context of climate-resilient development). The measures contained within the adaptation offer a business opportunity for Bosnia and Herzegovina; not just a requirement for donor assistance and loans. Co-financing may be requested from major donors and, for example, the 'Green Climate Fund' (GCF)[58].

Adequate resources need to be secured to ensure that the Adaptation Strategy and associated programmes and plans are effectively delivered in a timely manner and with sufficient monitoring, evaluation and refinement to ensure the overall goal and specific objectives are achieved.

5.3 Adaptation measures by sector

The following tables detail the planned outputs and measures for delivering the Strategy, together with indicators and indicative budget and timeframe. Based on the audit of the implementation of measures from the previous strategy, a proposal of measures for the forthcoming period was given. Implementation indicators, estimated costs, implementation period and responsible institutions are given for each of the proposed measures.

Adaptation measures are marked by type as follows:

- I - infrastructure measures

[57]The sector of social entrepreneurship consists of various production and business organisations that were not established for the purpose of making a profit but to address a certain social problem or to encourage sustainable local development. They appear in various forms: as citizens' associations, social cooperatives, business incubators, but also as typical limited liability companies. Social enterprises differ from traditional civil society organisations in more pronounced economic activities and willingness to take economic risk in their business. On the other hand, socially-owned enterprises also differ from for-profit enterprises and traditional cooperatives in their stronger orientation towards broader social goals and community interests.

[58]The Green Climate Fund (GCF) is a mechanism to assist developing countries in adaptation and mitigation practices to counter climate change.

- EI - educational and informative measures
- S - structural measures
- IO - institutional-organisational measures
- R - regulatory measures
- R&D - research and development measures.

Table 3: Planned outputs and measures for delivering the Adaptation Strategy

No.	Measure	Indicators	Estimated costs (BAM)	Implementation timeframe	Responsible institution	Type of measure
Outcome 1: Climate change risks, vulnerabilities and opportunities are reliably identified, quantified and effectively communicated, supporting evidence-based policy development						
1.1	Functional monitoring of climate change and modelling through different scenarios[59]	Number and scope of observations Number of reports and disseminated data Number of comparative analyses of different scenarios	500,000	2020-2030	Entity ministries competent for the environment Entity meteorological and hydrological services Universities/faculties	R&D
1.2	Preparation of detailed climatological and meteorological studies for urban areas affected by air pollution (Sarajevo, Zenica, Tuzla, etc.)	Number of studies	1,000,000	2020-2030	Entity meteorological and hydrological services Universities/faculties	
1.3	Strengthen the professional and technical capacity to implement research, applied and operational activities in important disciplines dealing with climate change, which include the field of climate modelling and predictive technologies for forecasting weather and environmental conditions, and promote and adopt a more associated approach to multi- and interdisciplinary economic, environmental and social research to assess sensitivity to climate change (new institutions, new institutional links, interdisciplinary research, public awareness and publications)	3 climate change organisations are functional and provide public information (e.g. at two public universities - one in the RS and the other in the FBiH and 1 in the Brčko District), with adequate funding provided.	500,000	2020-2025	Entity ministries competent for the environment, universities, entity meteorological and hydrological services, water agencies, scientific research institutes, services and other professional bodies	IO
Outcome 2: An effective institutional and regulatory framework supporting adaptation, coupled with delivery capacity, is addressing climate change risks and opportunities across sectors						
2.1	Climate change adaptation strategies (or programmes and plans) developed for each sector that is at high risk and vulnerable to climate impacts, and/or climate change adaptation is integrated into the sectoral development policies, strategies, programmes and plans	Integrated sectoral strategies	700,000	2022-2025	Competent ministries	IO

[59]FBiH MHS and RS MHS were given the opportunity to access (via a link) an interactive software for modelling different climate change scenarios (UNEP Climaproof). It is necessary to insert available data for BiH (July 2019). The MHSs currently do not have the appropriate hardware.

No.	Measure	Indicators	Estimated costs (BAM)	Implementation timeframe	Responsible institution	Type of measure
	(technical assistance, mentoring and support for each key sector identified). Sectors: agriculture, water resources/water management, tourism, forestry, human health, biodiversity and sensitive ecosystems, energy					
2.2	Improved cross-government and sectoral coordination, through building the capacity of the Inter-entity body, as the coordinating body for the implementation of the Strategy. (capacity building and support for meetings, workshops)	1 Inter-entity body mandated and resources provided.	50,000	2021-2022	Competent ministries	IO
2.3	Improved understanding and awareness of climate change, risks, vulnerability and adaptation approaches in key institutions through capacity building (a programme of training events for staff from government, research and civil society organisations on thematic topics)	500 person days training	250,000	2021-2025	Competent ministries, research institutions, civil society organisations	EI
2.4	Processes for climate risk/vulnerability screening and incorporation for development policies and plans developed and implemented (climate change risk-related education and awareness rising through consultancy and training workshops).	1 generic process/system for screening	15,000	2022-2023	Competent ministries, universities and environmental funds	S
Outcome 3: Adaptation approaches are mainstreamed, implemented and their objectives and planned delivery are understood by an informed society						
Agriculture[60]						
3.1	Increase the awareness of the general public, especially those engaged in the agricultural sector, about the impacts of climate change through the interface between the academic community and	Number of lectures Number of broadcasting shows, articles and media campaigns Review of the state of the public through public opinion polls on a scientific basis	150,000	2020-2030 Every 3 years	Universities, entity and cantonal line ministries in charge of agriculture, and the department in the Brčko District of BiH in charge of agriculture, in cooperation with the entity and cantonal line ministries in charge of the	EI

[60]Note: Planned funds for achieving the above results in the agricultural sector may be related to rural development strategies by entities and BD BiH and potential EU funds or donors' funds.

No.	Measure	Indicators	Estimated costs (BAM)	Implementation timeframe	Responsible institution	Type of measure
	the general public through the media and lectures				environment, the Ministry of Foreign Trade and Economic Relations of BiH	
3.2	Educate farmers and official representatives of agricultural institutions on mitigation and adaptation measures with a focus on floods and droughts	Number of trainings Number of participants	150,000	2020-2030	Entity and cantonal line ministries in charge of agriculture, and the department in the Brčko District of BiH in charge of agriculture, extension services	IO R
3.3	Educate farmers and official representatives of agricultural institutions on mitigation and adaptation measures in livestock and poultry production	Number of trainings Number of participants	150,000	2020-2030	Entity and cantonal line ministries in charge of agriculture, and the department in the Brčko District of BiH in charge of agriculture, extension services	IO R
3.4	Improve the knowledge of advisors on climate change - causes and consequences, and mitigation and adaptation measures in agriculture	Number of trainings Number of participants	300,000	2020-2030	Entity and cantonal line ministries in charge of agriculture, and the department in the Brčko District of BiH in charge of agriculture, extension services	IO
3.5	Program and design land management measures at the local and broader level (flood protection of agricultural land, drainage of own water from the plot and landscaping, establishment of irrigation systems (provision of water sources to supply irrigation systems), selection of irrigation systems according to climate, soil conditions and cultivated crop for the purpose of rational water consumption with the highest yield and quality)	Number of landscaping programmes Land area (ha) Economic effects of applied measures (yield, profit)	2,000,000	2020-2030	Entity and cantonal line ministries in charge of agriculture, and the department in the Brčko District of BiH in charge of agriculture, water agencies	I
3.6	Establish communication-linked hail protection systems in the entities and the Brčko District of BiH	Number of established and connected systems	1,500,000	2020-2025	Entity and cantonal line ministries in charge of agriculture, and the department in the Brčko District of BiH in charge of agriculture, PE 'Anti-hail prevention of the Republika Srpska'	I
3.7	Introduce new agricultural practices adapted to climate change from the point of view of choosing the species and variety in order to strengthen the resilience of the farm to climate extremes	Number of pilot studies Number of farmers applying new agricultural practices Number of newly introduced practices	5,000,000	2020-2030	Entity and cantonal line ministries in charge of agriculture, and the department in the Brčko District of BiH in charge of agriculture, with the coordination of the Ministry of Foreign Trade and Economic Relations of BiH, the	R&D S

No.	Measure	Indicators	Estimated costs (BAM)	Implementation timeframe	Responsible institution	Type of measure
		Number of mixed farms where practices are applied in order to strengthen the resilience of farms to climate extremes			Plant Health Administration of Bosnia and Herzegovina and the Veterinary Office of Bosnia and Herzegovina	
3.8	Energy production from biogas on poultry and livestock farms	Total amount of energy produced Number of farms producing energy from biogas	35,000,000	2020-2030	Entity and cantonal line ministries in charge of agriculture, and the department in the Brčko District of BiH in charge of agriculture, in cooperation with the entity and cantonal line ministries in charge of energy and environment, entity environmental funds, all coordinated by the Ministry of Foreign Trade and Economic Relations BiH	S I
3.9	Application of conservation measures of land cultivation and proper use of fertilisers in order to increase soil fertility and moisture conservation in order to increase the resistance of cultivated plants to climate change	Number of measures applied Number of farmers applying the new measures Area of land whose fertility is increased (ha)	2,500,000	2020-2030	Entity and cantonal line ministries in charge of agriculture, and the department in the Brčko District of BiH in charge of agriculture, extension services	S
3.10	Introduction of new species, varieties, breeds and strains in agricultural production (livestock and arable farming) adaptable to the new climate changes	Number of surveys Number of researched and introduced breeds and strains in animal husbandry and farming	25,000,000	2020-2030	Entity and cantonal line ministries in charge of agriculture, and the department in the Brčko District of BiH in charge of agriculture, extension services	S
3.11	Prepare plans and projections for the construction of micro-reservoirs in hilly and mountainous areas that have a dual role: as recipients during excess water and irrigation reservoirs during the dry season	Number of prepared plans and projections Territorial coverage Potential number of beneficiaries of this benefit Degree of ecosystem improvement	200.000	2020.-2030.	Entity and cantonal line ministries in charge of water management, and the department in the Brčko District of BiH in charge of water management, in cooperation with the Ministry of Foreign Trade and Economic Relations of BiH and river basin agencies	S
3.12	Construction of hydrotechnical facilities and application of natural measures EbA (EbA-*Ecosystem-based Approaches*) for protection against natural disasters (hydrotechnical facilities for protection against natural disasters should serve, above all, for flood protection, and	Number of constructed hydrotechnical facilities	50,000,000	2020-2030	Entity and cantonal line ministries in charge of water management, and the department in the Brčko District of BiH in charge of water management, in cooperation with the Ministry of Foreign Trade and Economic Relations of BiH and river basin agencies	S

No.	Measure	Indicators	Estimated costs (BAM)	Implementation timeframe	Responsible institution	Type of measure
	construction of reservoirs to reduce the impact of droughts)					
Water resources/water management						
3.13	Strengthening the capacity of institutions responsible for water management in BiH, ensuring an appropriate level of coordination and cooperation with other institutions in BiH and ensuring adequate participation in the work of international bodies[61]	Benchmarking - comparison with the capacities of counterpart institutions in 5 comparative countries (Croatia, Serbia, Montenegro, Slovenia and Austria), with recommendations; The comparison is carried out by an independent consultant, who will also establish an indicator - a comparison with the best and the EU average.	100,000 + 2 x 50,000 = 200,000	At the beginning, middle and end of the planning period (2021, 2025 and 2029)	The Ministry of Foreign Trade and Economic Relations of BiH, the competent entity ministries and the department of the Government of BD	IO
3.14	Assessment of the degree of implementation of plans[62]	Percentage of implementation of measures from Water Management Plans and Flood Risk Reduction Plans, by river basins and entities (0-100%)	Expressed in the planning documents of the competent institutions	Every calendar year	Competent water agencies, coordinated by the Ministry of Foreign Trade and Economic Relations of BiH Competent entity ministries and BD Government department	IO
3.15	Develop and adopt Flood Risk Management Plans	Number of completed plans (1-10) (It is necessary to make 5 plans (two entities and BD, for two river basin districts), first and second cycle, in 10 years)	Expressed in the planning documents of the competent institutions	2021-2022. and 2027-2028.	Competent water agencies, coordinated by the Ministry of Foreign Trade and Economic Relations of BiH Competent entity ministries and BD Government department	IO
3.16	Establishment of a hydrological forecasting system in BiH	Strengthening meteorological and hydrological monitoring - procurement, installation and	3,000,000	2020-2025	Competent water agencies and entity ministries, FBiH MHS, RS MHS	

[61]Climate change leads to increased intensity and frequency of water regime extremes (floods and droughts) both locally (e.g. torrents and landslides, and smaller watercourses) and regionally (larger and transboundary watercourses). Increase the capacity of BiH water management institutions to deal with and address these phenomena through coordination and cooperation with other relevant sectors, especially spatial planning and urbanism, utilities, industry, energy, tourism and agriculture. The basic intention is to promote the sustainable development of water use, both for people and the economy, and for water-dependent ecosystems, due to the services that these ecosystems provide to people.
Improving cooperation with neighbouring and other countries in the region, or their counterpart institutions, and regional and other relevant international bodies, enables equal and competent fulfilment of obligations of institutions in BiH and towards their citizens, as well as at the regional and international level.

[62]This is one of the elements of the Terms of Reference for the development of the Environmental Strategy of Bosnia and Herzegovina, the FBiH Environmental Strategy, the Environmental Strategy of the Republika Srpska and the Environmental Strategy of the Brčko District, for the period 2020-2030, which has just begun, with guidance and assistance of the Stockholm Environment Institute (SEI), in order to prepare and assist BiH for the implementation of the EU environmental acquis.
In previous or existing water management plans, which expire this year (2020) anyhow, climate change has not been sufficiently addressed nor integrated.

No.	Measure	Indicators	Estimated costs (BAM)	Implementation timeframe	Responsible institution	Type of measure
		connection to the system of automatic HM stations				
		Benchmarking - comparison with the capacities of counterpart institutions in 5 comparative countries (Croatia, Serbia, Montenegro, Slovenia and Austria), with recommendations; The comparison is carried out by an independent consultant, who will also establish an indicator - a comparison with the best and the EU average.	100,000 + 2 x 50,000 = 200,000	At the beginning, middle and end of the planning period (2021, 2025 and 2029)	The Ministry of Foreign Trade and Economic Relations of BiH, the competent entity ministries and the department of the Government of BD	IO
3.17	Make a study on the impact of climate change in the Adriatic Sea Basin in BiH	Studies made for two entities in the Adriatic Sea Basin, twice in the period 2020-2030	2x200,000 = 400,000	2021 and 2027	Ministry of Foreign Trade and Economic Relations of BiH with the competent water agencies (from Mostar and Bijeljina)	IO
3.18	Make a study on the impact of climate change in the Sava River Basin in BiH	Studies made for two entities in the Sava River Basin, twice in the period 2020-2030	2x200,000 = 400,000	2021 and 2027	Ministry of Foreign Trade and Economic Relations of BiH with the competent water agencies (from Sarajevo and Bijeljina)	IO
3.19	Construction/reconstruction of flood, erosion and torrent protection facilities in endangered areas/settlements and roads, including rainwater drainage	Percentage of execution according to the annual plans of the competent agencies, as well as regional and local self-government bodies	Locality-specific	2020-2030	Ministry of Foreign Trade and Economic Relations of BiH, competent entity ministries and department of the Government of BD, cantons, cities and municipalities	I
3.20	Reduce water losses in water supply systems to an optimal level, by increasing the efficiency of water supply companies	Percentage of physical losses and percentage of non-revenue water, by water supply companies	Locality-specific[63]	2020-2030	Competent entity ministries and BD Government departments, cantons, cities and municipalities	I
3.21	In cities where local floods occur regularly in places with low drainage capacity - solve problems with engineering works and / or EbA measures	Number of resolved localities in relation to the total number in BiH	Locality-specific	2020-2030	Cities and municipalities, with the help of cantons and entity environmental funds	S

[63]EAS BIH (May 2017), Drinking Water; The investment costs, Capex, are estimated at a total of EUR 415 million by 2025. The goals to be achieved are coverage of 96% of the population by service and water supply fully compliant with the standards in this segment.

No.	Measure	Indicators	Estimated costs (BAM)	Implementation timeframe	Responsible institution	Type of measure
3.22	Implement measures of a non-investment nature, for example, through more consistent application of regulations for stopping illegal construction in the flood zone, agro-forestry, etc.	Number of new illegal buildings, in relation to the total number of existing buildings in each flood zone	Expressed in planning documents of competent institutions / authorities	2020-2030	Cities, municipalities and cantons, with the assistance of the competent water agencies	EI
3.23	Drought vulnerability assessment in BiH with identification of the risk of increasing the frequency of drought periods on water supply of the population, industry, deterioration of water quality, irrigation, etc.	An assessment made for all parts of BiH, by climate areas	500,000	2021	The Ministry of Foreign Trade and Economic Relations of BiH with the competent entity ministries and environmental funds.	R&D
3.24	Amendments to standards, regulations and related engineering design laws that strengthen the sustainability and resilience of infrastructure at high risk from the effects of climate change on water resources	An assessment of the relevant regulations has been made. The indicator is the number of changes, in relation to the total number of required changes.	50,000 (for professional services, otherwise everything is part of the regular activities of the competent authorities)	2021 and beyond	Ministry of Foreign Trade and Economic Relations of BiH with the competent entity ministries and environmental funds.	IO
3.25	Establish groundwater monitoring by volume and parameters adequate to the importance of groundwater in water supply in BiH	Number of groundwater bodies with established monitoring, in relation to their total number	4,000,000	2021 and beyond (although monitoring activities have already started)	Competent water agencies and entity ministries	IO
3.26	Water protection, especially in areas at higher risk of floods and droughts; especially address the problem of salinisation in the riverbank area and the lower reaches of the Neretva	New Water and Flood Risk Management Plans developed	Expressed in the planning documents of the competent water agencies	2021-2022 and 2027-2028	Competent water agencies and entity ministries	IO
3.27	Study the possible impacts of the concept of 'living with floods' in BiH; open a discussion on this topic among stakeholders from different sectors and from different levels of government	Number of inhabitants who will 'live with floods', in relation to the total number of inhabitants, by main river basins, water areas and entities, and in total in BiH	300,000 (within the development of Flood Risk	2021-2022 and 2027-2028	Competent water agencies and entity ministries	IO

No.	Measure	Indicators	Estimated costs (BAM)	Implementation timeframe	Responsible institution	Type of measure
			Management Plans)			
3.28	Inform the population through campaigns focusing on climate change and floods, so that the public and economic operators are well informed about the consequences of their actions before and during floods	Number of campaigns conducted (plan is 5 in 10 years)	5 x 100,000 = 500,000	Every other year, for 10 years	Competent water agencies, entity ministries and environmental funds	EI
3.29	Develop a feasibility study of retentions and reservoirs in BiH in order to improve water management[64]	Studies done, by entities	2 x 250,000 = 500,000	2020-2021	Ministry of Foreign Trade and Economic Relations of BiH, entity ministries and competent water agencies	R&D
3.30	Strengthen water quality monitoring systems in rural areas; technical assistance for monitoring water quality in rural areas; education in rural areas on the topic of water quality in wells and local water supply systems	Benchmarking - comparison with the capacities of counterpart institutions in 5 comparative countries (Croatia, Serbia, Montenegro, Slovenia and Austria), with recommendations; The comparison is carried out by an independent consultant, who will also establish an indicator - a comparison with the best and the EU average.	200,000	2020-2030	Ministry of Civil Affairs of BiH, with the competent entity ministries and health institutions	EI
3.31	Construction of reservoirs for multipurpose use, redistribution of large and small waters - flood protection, irrigation, hydropower as a renewable energy source, water protection in low water periods	Volume of constructed reservoirs in relation to the annual volume of torrential waters, by main river basins and water areas	Unable to estimate currently	2022-2030	Council of Ministers, entity governments, regional cooperation	S
3.32	Hydrotechnical and horticultural (agroforestry) regulation of existing and potential torrent watercourses that cause damage to urban space and agricultural land	Number of regulated torrents in relation to the total number, by municipalities	An average of 10,000 per torrent	2020-2030	Municipalities with Environmental Funds and competent water agencies	S

[64]Construction of reservoirs and retentions in BiH need to be urgently started in a planned manner, for multi-purpose use, including enabling the regulation of the water regime for adaptation to climate change. To begin with, update and adapt to the new conditions and requirements of some of the many previously developed studies and projects, so that their goals and planned results are generally useful and clear to the general public, and to allow prioritisation in mainstream decision-making and encourage potential investors. Synchronise everything with the development of a new cycle of development of Water Management Plans and Flood Risk Management Plans, which are currently being developed within the development of BiH and entity environmental strategies, with the guidance and assistance of the Stockholm Environment Institute (SEI), in order to prepare and assist BiH for the implementation of the EU environmental acquis.

No.	Measure	Indicators	Estimated costs (BAM)	Implementation timeframe	Responsible institution	Type of measure
3.33	Provide conditions for sustainable use of groundwater; estimation of available quantities based on the results of established monitoring and additional investigative works	Current use in relation to sustainable use, by water bodies, and collectively by entities, BD and water areas.	4,000,000	2021-2022 and 2027-2028	Competent water agencies	IO
Forestry and forest resources						
3.34	Detailed mapping of forest species composition (field survey, remote sensing and GIS mapping project) (forest inventory)	Unique forest inventory in the entire territory of BiH (by entities and BD)	2,000,000	2020-2025	RS Ministry of Agriculture, Forestry and Water Management, FBiH Ministry of Agriculture, Water Management and Forestry, scientific research institutions	R&D
3.35	Research into species selection based on modelled climate change	1 research programme with 10 species trials	500,000	2020-2030	RS Ministry of Agriculture, Forestry and Water Management, FBiH Ministry of Agriculture, Water Management and Forestry, scientific research institutions	R&D
3.36	Monitoring plots established in vulnerable eco-types to assess changes, disease, mortality and succession; (budget includes monitoring over entire period).	Installation of 2 towers with all measuring instruments plus 20 monitoring plots	5,000,000 with 50,000 BAM/annual maintenance	2020-2030	RS Ministry of Agriculture, Forestry and Water Management, FBiH Ministry of Agriculture, Water Management and Forestry, scientific research institutions	R&D
3.37	Education of forestry employees, raising public awareness of the importance of forests and sensitivity to climate change	30 seminars, 10 promotional videos, 50 TV reports	1,000,000 for 10 years	2020-2030	RS Ministry of Agriculture, Forestry and Water Management, FBiH Ministry of Agriculture, Water Management and Forestry, scientific research institutions, public and private TV and radio broadcasting services	EI
3.38	Laws and bylaws adjusted to the effect of climate change in order to synchronise habitat capacity, felling volume and wood processing capacity	Adoption of new and amendments to existing laws and bylaws related to forests and climate change in order to define management systems adapted to climate change	-	2020-2023	RS Ministry of Agriculture, Forestry and Water Management, FBiH Ministry of Agriculture, Water Management and Forestry	R
3.39	Improve forest fire protection system; on the ground forest management (firebreaks, re-structuring, fire-fighting equipment, observation and real-time monitoring).	1 forest fire protection system, formation of bioindication points, formation of a network of observation posts for monitoring fire hazards	4,000,000 (3,000,000 BAM initially for the formation of a network of bioindication points, the formation of a	2020-2030	RS Ministry of Agriculture, Forestry and Water Management, FBiH Ministry of Agriculture, Water Management and Forestry, public and private forest management companies	I

No.	Measure	Indicators	Estimated costs (BAM)	Implementation timeframe	Responsible institution	Type of measure
			network of observation posts, with 100,000 BAM/year for monitoring)			
3.40	Legislation and bylaws adapted to the effects of climate change in order to improve 'adaptive forest growing and planning systems'	Law on Forests and related bylaws amended in order to align with EU practices	-	2020-2023	RS Ministry of Agriculture, Forestry and Water Management, FBiH Ministry of Agriculture, Water Management and Forestry	R
3.41	Identification of protected areas for a larger area of 'adaptive forest ecosystems'	100 ha/year on average new protected areas or a total of 1,000 ha	100,000 BAM/year or total 1,000,000	2020-2030	RS Ministry of Spatial Planning, Construction and Ecology, FBiH Ministry of Environment and Tourism	I
Biodiversity and sensitive ecosystems:						
3.42	Monitoring and data collection systems installed, operating, and used to develop management regimes (monitoring programme established by research organisations, data collection systems installed, information transfer mechanism developed for researchers to managers).	1 monitoring programme	300,000	2020-2022	Scientific research institutions and competent public institutions	I
3.43	Typology development and habitat mapping	Lists of habitat types in BiH and maps of habitat types with special reference to habitats of importance for the EU	400,000	2020-2022	Scientific research institutions and competent public institutions	R&D
3.44	Development of Red Lists for BiH	Distribution area maps, defined degree of endangerment and proposal of measures for effective protection of each of the species from the Red List	800,000	2020-2022	Scientific research institutions and competent public institutions	R&D
3.45	Development of action plans for the control of invasive species of plants and animals	Plans and actions with defined mechanisms for control and spread of invasive species. Legal frameworks and needs in line with EU needs.	200,000	2020-2022	Scientific research institutions and competent public institutions	IO

No.	Measure	Indicators	Estimated costs (BAM)	Implementation timeframe	Responsible institution	Type of measure
		Control of invasive species and reduction of their impact on indigenous species and entire ecosystems.				
3.46	Establishing new and strengthening the capacity of existing protected areas	Increasing the network of protected areas at the level of BiH in order to effectively protect all significant and sensitive types of habitats and ecosystems	500,000	2020-2022	Competent entity ministries, scientific research institutions and competent public institutions	I
3.47	Improve protected areas management system; provide capacity building and resources to enhance protected areas management with regards to adaptation.	Management plans for protected areas developed	50,000	2020-2025	Competent entity ministries, scientific research institutions and competent public institutions	I
3.48	Establish seed banks for native species covering variety of origins to encompass genetic variability and distinct populations.	3 seed banks established	250,000	2020-2025	Competent entity ministries, scientific research institutions and competent public institutions	I
Tourism						
3.49	Education and raising awareness of the importance of sustainable tourism and adaptation to climate change (media campaign, organisation of workshops, panels, scientific and professional conferences)	Produced and distributed information and propaganda materials on the adaptation of the tourism sector to climate change; Defined short-term and long-term strategic goals of tourism development	300,000	2021-2026	Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina, entity governments and competent entity ministries, scientific research institutions, competent public institutions and media	EI
3.50	Development of a sustainable tourism strategy	Developed strategy for the development of sustainable tourism with short-term and long-term development goals	100,000	2021-2023	Competent entity ministries, scientific research institutions	EI R&D
3.51	Research of the tourist market with the aim of obtaining data on the attitudes of tourists about climate change and the optimal temperature as a factor for choosing a holiday destination	Collected and processed data on the state of the tourist market that should be available to the public and private sector; Defined adaptive measures based on the obtained data	200,000	2021-2023	FBiH Ministry of Environment and Tourism, RS Ministry of Trade and Tourism, FBiH Tourist Board, RS Tourist Organisation, scientific research institutions and competent public institutions	R&D

No.	Measure	Indicators	Estimated costs (BAM)	Implementation timeframe	Responsible institution	Type of measure
3.52	Development and promotion of new tourism products and selective forms of tourism; Expansion and development of the tourist market	A four-year marketing campaign; Participation in regional and world tourism fairs; Increasing the number and changing the structure of tourists by country of origin; Extended tourist season	500,000	2023-2027	FBiH Ministry of Environment and Tourism, RS Ministry of Trade and Tourism, FBiH Tourist Board, RS Tourist Organisation	R&D EI
3.53	Establishment of more efficient legislative and legal regulations in the field of tourism and hotel management	Strengthened capacities of competent institutions; Increased efficiency of the tourism sector; Better inter-entity cooperation in the tourism sector	50,000	2020-2021	The Parliamentary Assembly of BiH, the Council of Ministers of BiH, the entity governments and the competent entity ministries	IO
3.54	Development of unique forms for keeping tourism statistics at the entity level	A unique mechanism for collecting and processing tourism statistics has been established; Systematically processed and valid data	100,000	2020-2021	BiH Agency for Statistics (BHAS), FBiH Statistical Office (FSO) and RS Statistical Office (RSSO)	IO
3.55	Alignment of legislation in the field of providing tourist services with European standards	An effective legislative and legal framework defined and established Legislation in line with EU regulations adopted	Harmonisation and alignment of regulations with the EU acquis is an ongoing process carried out as part of the regular activities of the competent institutions, and as such, in this case should not require additional costs	2021-2026	Directorate for European Integration of the Council of Ministers of BiH, Office of the Government of FBiH for Legislation and Compliance with EU Regulations, Ministry of Economic Relations and Regional Cooperation of RS, Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina, FBiH Ministry of Environment and Tourism, RS Ministry of Trade and Tourism	IO
3.56	Diversification of tourist products and development of selective forms of tourism on the basis of developed	Scientific-research framework of valorisation of tourist resource base defined Tourism product improved;	300,000	2022-2025	FBiH Ministry of Environment and Tourism, RS Ministry of Trade and Tourism, FBiH Tourist Board, RS Tourist Organisation	S

No.	Measure	Indicators	Estimated costs (BAM)	Implementation timeframe	Responsible institution	Type of measure
	scientific-research methodology of valorisation of tourist resource base	Tourist season extended				
3.57	Education, financing and promotion of projects in the field of circular economy in the field of tourism (2 in each entity (FBiH and RS) and 1 in the Brčko District)	Programme of education of participants designed and implemented; Implemented projects whose results are measurable and implemented New forms of tourism developed; Number of tourists and new jobs in tourism increased	350,000	2022-2027	The FBiH Ministry of Environment and Tourism, the RS Ministry of Trade and Tourism and the Brčko District Government	S EI
3.58	Alignment, marking and arranging existing and new hiking and biking trails through the financing of public calls for project proposals	Capacities of mountain tourist centres for the development of summer tourist offer increased Tourist offer enriched Number of tourists and new jobs in tourism increased	500,000	2024-2028	Ministry of Foreign Trade and Economic Relations of BiH, Ministry of Environment and Tourism of FBiH, Ministry of Trade and Tourism of RS, competent cantonal ministries	I R&D
3.59	Procurement and installation of new snow guns and construction of artificial reservoirs on existing ski slopes (priorities: Bjelašnica and Jahorina) and improvement of the existing system of ski slopes through regular maintenance and cleaning	Longer winter ski season Number of tourists increased	9,000,000	2024-2030	Entity governments and competent entity/cantonal ministries (Ministry of Economy of Canton Sarajevo, Ministry of Spatial Planning, Construction and Environmental Protection of Canton Sarajevo; Ministry of Spatial Planning, Construction and Ecology of RS, Ministry of Trade and Tourism of RS), Cantonal Public Utility Company ZOI 84 and OC Jahorina	I
Human health						
3.60	Improved technical regulations for thermal requirements, heating, ventilations and air-conditioning of buildings	Technical regulations improved	50,000	2020-2025	FBiH Ministry of Energy, Mining and Industry, FBiH Ministry of Spatial Planning, Ministry of Spatial Planning, Construction and Ecology of the Republika Srpska, Ministry of Energy and Mining of the Republika Srpska, Department for Spatial Planning and Property-Legal Affairs of the Brčko District	R

No.	Measure	Indicators	Estimated costs (BAM)	Implementation timeframe	Responsible institution	Type of measure
3.61	Water purification to maintain the quality of potable water; water purification plants updated and/or installed in vulnerable locations	2 water purification systems modified and updated; 2 water purification plants installed	1,200,000	2020-2026	FBiH Ministry of Agriculture, Water Management and Forestry, Ministry of Agriculture, Forestry and Water Management of the Republika Srpska, Department of Agriculture, Forestry and Water Management of the Brčko District, scientific research institutions	I
3.62	Public awareness campaign on climate change and public health issues, e.g. 'heatwaves' (major media campaign – TV, Internet, Posters).	Annual media campaigns (3)	200,000	2020-2025	Institute of Public Health of the Federation of BiH, Public Health Institute of the Republika Srpska, Public Health Institute of Brčko District, FBiH Ministry of Health, Ministry of Health and Social Welfare of the Republika Srpska, Ministry of Civil Affairs of BiH, scientific research institutions and media companies	EI
3.63	Disaster management plans improved for extreme heat events (capacity building, workshops, planning, and implementation)	Disaster management plans (gender responsive)	300,000	2020-2025	FBiH Administration of Civil Protection, RS Administration of Civil Protection, Department of Public Safety of Brčko District, Public Health Institute of the Federation of BiH, Public Health Institute of the Republika Srpska, Public Health Institute of Brčko District, FBiH Ministry of Health, Ministry of Health and Social Welfare of the Republika Srpska, Ministry of Civil Affairs of BiH, scientific research institutions	IO
3.64	Strengthened capacity of the Institutes of Public Health (training of staff on ongoing climate change).	Training programme designed and delivered	200,000	2020-2025	Institute of Public Health of the Federation of BiH, Institute of Public Health of Republika Srpska, Institute of Public Health of Brčko District, FBiH Ministry of Health, Ministry of Health and Social Welfare of the Republika Srpska, Institutes for Emergency Medical Service, Ministry of Civil Affairs of BiH	EI
3.65	Establishment of effective statistical monitoring of climate change-related pathology; capacity building research programme designed and implemented;	1 research programme with accessible publications	400,000	2020-2030	Ministry of Civil Affairs of BiH, FBiH Ministry of Health, Ministry of Health and Social Welfare of the Republika Srpska, Public Health Institute of the	R&D

No.	Measure	Indicators	Estimated costs (BAM)	Implementation timeframe	Responsible institution	Type of measure
	and statistics made available				Federation of BiH, Public Health Institute of the Republika Srpska, Public Health Institute of Brčko District, Agency for Statistics of BiH, entity statistical offices	
3.66	Adopted legislation aligned with EU legislation, which regulates working hours and work obligations in days of climate extremes, or revised existing laws in the field of occupational health in the Federation of BiH, Republika Srpska and Brčko District in order to comply with EU legislation prescribing working hours and work obligations in days of climate extremes.	Functional legal frameworks for work in extreme climatic conditions developed	100,000	2020-2025	FbiH Ministry of Health, the Ministry of Health and Social Welfare of the Republika Srpska and the Brčko District Public Security Department in cooperation with the BiH Ministry of Civil Affairs, Public Health Institute of the Federation of BiH, Public Health Institute of the Republika Srpska, Public Health Institute of Brčko District, and the FBiH Civil Protection Administration and the RS Administration of Civil Protection, the Agency for Statistics of BiH, entity statistical offices	R
Outcome 4: A well-resourced Adaptation Strategy being implemented on time, effectively, and delivering the expected outcomes						
4.1	Develop detailed budget requirements at an output level (working groups, workshops, technical assistance).	1 budget per institution	20,000	2021	BiH Ministry of Foreign Trade and Economic Relations, Entity Ministries and the Brčko District Government Department responsible for the environment	IO
4.2	Identify potential sources of funding, including EU IPA, Adaptation Fund, international financial institutions, the Global Environment Facility (GEF), the Green Climate Fund (GCF) - (technical assistance, consultant and workshops)	3 major proposals	120,000	2021-2022	BiH Ministry of Foreign Trade and Economic Relations, Entity Ministries and the Brčko District Government Department responsible for the environment	IO
4.3	Raise awareness among the private sector of the economic opportunities in Adaptation Strategy implementation and on costs and benefits of adaptation (develop communication materials, outreach workshops, trial pilots projects with companies to provide examples).	6 pilot projects developed, delivered and publicised	120,000	2021-2023	BiH Ministry of Foreign Trade and Economic Relations, Entity Ministries and the Brčko District Government Department responsible for the environment	IO
4.4	Enhance capacity and institutional strength for funding proposal	1000 participant days of training; 100 proposals developed	140,000	2021-2026	BiH Ministry of Foreign Trade and Economic Relations, Entity Ministries and	IO

No.	Measure	Indicators	Estimated costs (BAM)	Implementation timeframe	Responsible institution	Type of measure
	development among stakeholders (capacity building/training for developing effective proposals, mentoring for proposal writing, technical assistance for developing proposals).				the Brčko District Government Department responsible for the environment	
4.5	Develop effective finance plan for securing adequate funds from a range of sources (technical assistance in developing a finance plan).	Finance plan	50,000	2021-2022	BiH Ministry of Foreign Trade and Economic Relations, Entity Ministries and the Brčko District Government Department responsible for the environment	IO
4.6	Establish and maintain effective monitoring and evaluation system for the Adaptation Strategy implementation, used to monitor whether the strategy is effective in reducing climate change impacts on populations and sectors.	1 monitoring and evaluation system (M&E)	250,000	2021-2023	BiH Ministry of Foreign Trade and Economic Relations, Entity Ministries and the Brčko District Government Department responsible for the environment	IO
4.7	Evaluate costs and benefits of adaptation measures in BiH, and communicate results (annual evaluation of the Adaptation Strategy, with advice for continual improvement).	Evaluation reports (1 per year)	150,000	2021-2023	BiH Ministry of Foreign Trade and Economic Relations, Entity Ministries and the Brčko District Government Department responsible for the environment	IO

6 THE EMISSION REDUCTION STRATEGY AND ACTION PLAN

6.1 Specific objectives and priorities

The GHG emission reduction strategy is a coordinated approach that achieves development goals through the implementation of measures for low-carbon development and at the same time contributes to global efforts to mitigate climate change. The Strategy also aims to prepare certain sectors for EU accession, in other words to the changes in the business environment that will occur after BiH's accession to the EU. Adequately set goals such as increasing the energy efficiency, increasing the use of renewable energy sources and improving infrastructure and services in the energy and transport sectors will lead to attracting international investment, creating new jobs and enterprises in a resource-efficient economy.

The specific objective of the Strategy is to reduce carbon intensity from production to energy use in BiH through energy efficiency (on the side of production and consumption) and greater use of renewable energy sources, taking into account the security of energy supply. This will be achieved through the establishment of an investment-friendly environment for sustainable energy projects through existing and new business models (especially through civic energy, public-private partnerships, ESCOs, etc.). The Strategy will ensure that decarbonisation measures are implemented gradually to allow time for transition without a sudden loss of jobs in traditional energy. The phasing out of carbon energy subsidies will create a fairer market. In doing so, specific measures will be implemented to ensure that the most vulnerable groups in the population do not feel the effects of the abolition of subsidies.

The Low-Emission Development Strategy has three interrelated priority areas for action:

- Increasing energy efficiency,
- Increasing the share of RES and
- Reduction of GHG emissions.

It should be noted that meeting these targets will significantly reduce emissions of pollutants into the air (sulphur dioxide, particulate matter, nitrogen oxides, etc.). The sections below describe the goals in the field of energy based on the goals from the Framework Energy Strategy of BiH until 2035.

6.1.1 Efficient use of resources

A long-term development of the energy sector of Bosnia and Herzegovina implies reduction of harmful emissions and generation of electricity from fossil fuels, and therefore it is extremely important that the future coal exploitation and production activities are implemented in a more efficient manner, by applying an adequate technology and methods of operation with a clear plan to reduce coal production. Particular focus should be placed on increasing the efficiency of biomass utilisation given its rather large share in the energy balance and the current low efficiency of utilisation. In this sector,

it is necessary to introduce cascading use of biomass, which would lead to the use of solely waste biomass for energy production, which would improve the development of other sectors based on the use of biomass. Efficient use of resources in agriculture will contribute primarily to competitiveness (through additional revenues), and also to the reduction of GHG emissions and adaptation to climate change through the diversification of agricultural production risks. Building district heating on local resources will lead to better resource efficiency, energy accessibility for citizens and solving many problems in urban areas (air pollution, occupation of green areas, noise, ash disposal, fires, etc.). The future stronger orientation towards low-carbon energy, which today is based predominantly on hydropower potentials and woody biomass, requires good management of natural potentials. Meeting this goal includes digitalisation, new technologies and IT systems that enable cost reduction, quality work and new business models.

6.1.2 Secure and affordable energy

BiH cannot achieve the energy security in all segments on its own, primarily because of non-existence of its own oil and gas production. Generation mix of BiH is relatively price competitive. However, in the forthcoming period further price-related pressures may be expected (coal production price, ETS - Emissions Trading System, generation price deregulation, etc.), which could have negative impact on competitiveness. Furthermore, planned intensive construction of (thermal power) plants, under the current price conditions and EU policies, increases the risk of fixed costs increase and possible decrease of power plant utilisation, thus putting pressure on future price competitiveness. Keeping the average generation price at the current level price in the long run is considered a good result considering all types of pressures. Low-carbon development and redirection of subsidies must take into account the affordability of energy for users. Therefore, in order to achieve this goal, it is necessary to develop a plan for the prevention of energy poverty, especially among the socially vulnerable population. Reform of the incentive system in terms of encouraging civic energy projects is necessary in order to make a fair distribution of subsidies.

6.1.3 Energy efficiency

The energy efficiency proposed in line with the long-term vision of the EU member states is the basis for the low-carbon development. This implies savings in final consumption, savings in the electricity, gas and heat transformation, transmission and distribution process, creation of conditions for highly efficient cogeneration as well as promotion and expansion of efficient district heating systems. It is essential to improve the energy efficiency legal and regulatory framework in industry and building, define financial measures and institutional implementation framework, and to conduct information campaigns, education and capacity building.

6.1.4 Energy transition and environmental responsibility

Energy transition and environmental responsibility - clean energy and reduction of negative impacts on the environment are highly positioned on the agenda; BiH has committed itself, until 2028, to reduce SO2 by 95%, NOx by 62% and dust by 88% relative to 2014, with regard to large combustion plants; as for the RES share in the gross final energy consumption until 2020, the set goal implies the 40% target.

6.1.5 Development and harmonisation of regulatory and institutional framework and capacity building

Development and harmonisation of regulatory and institutional framework implies the comprehensive and essential changes and overall reform of the energy sector; the strategic goal includes accelerated harmonisation of legislation with EU acquis, or transposition and implementation of the obligations assumed under the Treaty establishing the Energy Community, leading to harmonising the energy sector with the Third Energy Package and future EU Directives. This goal implies introducing a transparent and non-discriminatory incentive system for energy from renewable sources and energy efficiency projects. Such a system should enable investment in sustainable energy projects through new business models (civic energy, public-private partnership, net billing or net metering of energy, ESCO, etc.). The capacity building process will be motivated by the EU accession process and the process of planning, implementing, monitoring and verifying internationally supported nationally appropriate mitigation actions (NAMAs) in priority sectors (electricity generation, buildings, district heating and transport).

6.2 Nationally Appropriate Mitigation Actions (NAMAs)

The tables below provide a detailed overview of the actions planned by individual sectors with indicators, indicative budget, time frame and expected results. A proposal of actions for the next period was given based on the review of the implementation of actions from the previous strategy. When defining actions, sectoral priorities, or the current situation in certain sectors and the obligations that BiH has committed itself to through international agreements, were taken into account

For each action, a short description is given with an emphasis on the main activities with a time frame for their implementation. The specific objectives that are achieved by implementing a specific action are also listed. With specific objectives, the emphasis is on the positive impacts on the domestic economy and the reduction of GHG emissions. A link is given between individual actions and sectoral directives, or which obligations BiH fulfils by implementing a certain action. The effects of the action sought to quantify the impact of the actions on employment and reduction of GHG emissions, and an assessment of other effects was given, such as the impact on air quality, competitiveness and sustainability of the sector in general. Finally, the approximate costs of preparation and implementation of each of the actions are given. Costs are estimated based on the current unit costs of specific actions. Some technologies show a declining trend in specific investment costs (e.g. solar power plants, biomass power plants, wind farms, heat consumption meters, etc.) which is taken into account.

Table 4: Overview of mitigation actions – low-emission development of BiH

Electricity					
Action	**Description (type of activity)**	**Specific objective**	**Sector-specific EU directive**	**Effects of action**	**Costs (BAM, until 2030)**
Improving the efficiency of coal-fired power plants (construction of replacement/new thermal power plants)	• Replacement of one part of existing thermal power plants with an average net efficiency of 30% with new ones that will have an efficiency of over 40%. • Replacement/new coal-fired thermal capacities with a total capacity of 1050 MW (or 750 MW in the option of more intensive international assistance in the fair transition of mining areas), replacement for existing ones that will cease to operate by 2030 (including TPP Tuzla 7 of 450 MW which is under construction)	• reduction of electricity production costs, • increasing resource efficiency, • reduction of emissions of pollutants into the air, • reduction of carbon dioxide emissions • security of supply	• meeting the requirements from LCP BAT • compliance with the emission limit values for air pollutants from the Industrial Emissions Directive, Chapter III	• 500 jobs in thermal power plants, • mitigating the decline in the number of jobs in mining and thermal energy, • improving air quality • reduction of cross-border transmission of acid gases • specific coal consumption and specific CO_2 emissions will reduce by about 40% • emission reduction: 4,800 Gg/year	• preparation 100 million • implementation 3.7 billion (The stated amounts include about BAM 1.5 billion provided for the preparation and construction of TPP Tuzla 7)
Construction of wind farms	• installation of 550 MW wind farms (excluding those commissioned by the end of 2020)	• increasing the share of RES in total production, • reduction of specific CO_2 emissions	Directive 2009/28/EC on the promotion of the use of energy from renewable sources	• CO_2 emission reduction estimate: 950 Gg/year • development of rural parts (infrastructure), technology transfer	• preparation 100 million • implementation 1.4 billion
Construction of solar power plants	• installation of 400 MW solar power plants (excluding those commissioned by the end of 2020)	• increasing the share of RES in total production, • reduction of specific CO_2 emissions • income of local communities from the sale of electricity	Directive 2009/28/EC on the promotion of the use of energy from renewable sources	• CO_2 emission reduction estimate: 280 Gg/year, • technology transfer	• preparation 50 million • implementation 550 million
Construction of biomass cogeneration plants	• construction of cogeneration plants on wood chips from forest wood residues and wood waste from the wood processing industry and biogas from agriculture, individual power of several MWe, and total capacity of 60 MWe	• income of local communities from the sale of electricity • increase in the share of RES in the total mix, • reduction of specific CO_2 emissions	Directive 2009/28/EC on the promotion of the use of energy from renewable sources	• CO_2 emission reduction estimate: 300 Gg/year due to electricity production and 100 Gg/year due to heat production • creation of 2,500 permanent jobs, • improving air quality, • development of the industry that needs thermal energy, sustainability of forest management companies, sustainability of agriculture	• preparation 15 million • implementation 290 million
Construction of small hydropower plants	• installation of small hydropower plants with a capacity of up to 10 MW, with a total capacity of 50 MW (excluding those commissioned by the end of 2020)	• increasing the share of RES in total production, • income of local communities from the sale of electricity	Directive 2009/28/EC on the promotion of the use of energy from renewable sources	• CO_2 emission reduction estimate: 75 Gg/year • development of rural parts (infrastructure), • technology transfer, potential for tourism development	• preparation 10 million • implementation 140 million
Construction of large hydropower plants	• installation of a new 500 MW	• competitiveness of the sector • adaptation to climate change • network balancing		• reduction of CO_2 network factors; CO_2 emission reduction estimate: 1,200 Gg/year	• preparation 50 million • implementation 1.65 billion

Electricity					
Action	**Description (type of activity)**	**Specific objective**	**Sector-specific EU directive**	**Effects of action**	**Costs (BAM, until 2030)**
Investment in transmission and distribution network	• reduction of losses in the transmission and distribution of electricity	• less electricity production required • RES integration	Directive 2019/944 on the internal market for electricity	• better integration of RES	• 500 million BAM

District heating									
Action	**Current status of implementation of activity (planned/being implemented/ implemented)**	**Specific objective of the implementati-on of action**	**Description of activity (type of activity, time frame of implementation)**	**Management and coordination**	**Estimated potential of emission reduction Gg CO_2**		**Effects of action**	**Other effects**	**Implementation costs until 2030 BAM**
					in 2030	In 2050			
Installation of cumulative and individual thermal energy meters in all facilities connected to SDG	Partially implemented on the territory of BiH (new facilities that are connected to the district heating network mostly have built-in cumulative meters, some also individual meters for apartments. A measure envisaged by the entity energy development strategies.	Reduction of thermal energy consumption, lower costs for users and reduction of carbon dioxide emissions	Cumulative and individual thermal energy meters should be installed in all facilities connected to the district heating system. This measure should be implemented in the period 2020-2030.	In FBiH - Ministry of Energy, Mining and Industry, in the Republika Srpska - Ministry of Spatial Planning, Construction and Ecology of Republika Srpska, Energy and Mining, cantonal and municipal authorities, district heating companies	33.8	39.4	Reduction of pollutant emissions and lower bills for consumed thermal energy	Improving the business of district heating companies, reducing BiH's energy dependence on imported fuels, reducing heat needs	125 million
Introduction of RES in existing DHs; construction of new DHs on RES / including central DHW preparation	Partially implemented on the territory of BiH. For now, of the larger projects, only the project in Gradiška, Prijedor and Banja Luka has been implemented (this activity is foreseen by the entity energy development strategies, i.e. SEAP plans of municipalities and cities).	Reducing CO_2 emissions, new recruitments, reducing the price of thermal energy	Introduction of biomass in DHs that used fossil fuels; construction of new DHs on biomass, use of geothermal and solar energy, preparation of DHW in DH. These projects should be implemented continuously until 2050.	In the Federation of BiH - Ministry of Energy, Mining and Industry, in the Republika Srpska - Ministry of Industry, Energy and Mining, cantonal and municipal authorities, district heating companies	70.0	224.4	Reducing CO_2 emissions, new recruitments, reducing the price of thermal energy	Reducing BiH's energy dependence on imported fuels	200 million
Reconstruction and modernisation of the district	Partially implemented (only parts of the networks where frequent accidents occurred have been	Increasing the overall efficiency of the system	Reconstruction and modernisation of networks and thermal substations. The	Cantonal and municipal authorities, district heating companies	8.5	39.4	Reduction of CO_2 emissions, lower bills for	Improving the business of district heating companies	450 million

District heating									
Action	**Current status of implementation of activity (planned/being implemented/ implemented)**	**Specific objective of the implementati-on of action**	**Description of activity (type of activity, time frame of implementation)**	**Management and coordination**	**Estimated potential of emission reduction Gg CO_2**		**Effects of action**	**Other effects**	**Implementation costs until 2030 BAM**
					in 2030	In 2050			
heating network and thermal substations	replaced. This activity is foreseen by the entity energy development strategies).		measure should be implemented continuously until 2050				consumed thermal energy		

Transport						
Action	**Description (type of activity)**	**Specific objective**	**Sector-specific EU directive**	**Effects of action**	**Costs (BAM, until 2030)**	**Action**
Increasing the share of rail transport	Investment in the reconstruction of railways, bridges, tunnels, retaining and lining walls, signals, level crossings, computerisation, etc. which will result in better service (speed, safety, comfort).	• increase in passenger kilometres by 50% by 2030 compared to 2015 • increase of tonne-kilometres by 20% by 2030 compared to 2015	Directive 2008/57/EC on the interoperability of the rail system within the Community (Recast)	• increasing the quality of railway service • better connectivity and travel comfort • capacity increase • increase in the share of RES in transport (less fuel imports) • emission reduction by 50 Gg CO_{2eq}/year • reduction of road transport - reduction of air pollution	Ministry of Transport and Communications of BiH, FBiH Ministry of Transport and Communications, RS Ministry of Transport and Communications, Government of BD, PE Željeznice FBiH */Railway company/*, PE Željeznice RS */Railway company/*	630 million*
Increasing the share and modernising public transport	Investment in strengthening public transport in terms of volume and quality of services based on modern means of transport (electric and efficient buses), investment in infrastructure (charging stations, services, disposal of used parts, etc.)	• increase of passenger kilometres in public transport by 20% by 2030 compared to 2015 • share of passenger kilometres achieved by electric means of transport 20% in 2030	Directive (EU) 2019/1161 on the promotion of clean and energy-efficient road transport vehicles	• increasing the quality of service • reduction of air pollution • noise reduction in cities • increase in the share of RES in transport (less fuel imports) • emission reduction by 20 Gg CO_{2eq}/year	FBiH Ministry of Transport and Communications, RS Ministry of Transport and Communications, Government of BD Cantonal competent ministries, cities and municipalities, public transport companies (public and private)	250 million
Increasing the share of environmentally-friendly vehicles	Encouraging the purchase and use of hybrid, electric and plug-in passenger vehicles (procurement subsidies, the right to enter 'green' urban areas, cheaper parking, etc.); infrastructure construction (charging stations, disposal of used parts, etc.)	• share of environmentally-friendly passenger vehicles 3% in 2030 (about 30,000 vehicles)	Directive (EU) 2019/1161 on the promotion of clean and energy-efficient road transport vehicles	• reduction of air pollution • noise reduction in cities • increase in the share of RES in transport (less fuel imports) • emission reduction by 90 Gg CO_{2eq}/year	FBiH Ministry of Transport and Communications, RS Ministry of Transport and Communications, Government of BD, Cantonal competent ministries, cities and municipalities, entrepreneurs	1.5 billion

* data taken from the Framework Strategy of Transport of BiH where data are given only for FBiH

Buildings						
Action	**Description (type of activity)**	**Specific objective**	**Sector-specific EU directive**	**Effects of action**	**Costs (BAM, until 2030)**	**Action**
Completion of construction of residential buildings	Support for the completion of unfinished residential buildings (initially for refugees and internally displaced persons) - only family residential buildings, implemented by 2030. The draft Strategy for the renovation of buildings states that as much as 30% of buildings were built in the period from 1992-2014 without a finished facade	It is estimated to have 6 million m^2 of living space. The goal is to complete all houses and reduce their needs to a maximum of 95 kWh/m^2 per year	Directive 2010/31/EU on the energy performance of buildings, Directive 2012/27/EU on energy efficiency	employment of domestic labour (about 9,000 jobs over a period of 10 years), better living comfort of users, lower heating costs, which is especially important because they are mostly socially disadvantaged people, better air quality, reduction of GHG emissions 230 Gg CO_2/year	entity ministries of spatial planning and BD department, competent ministries for refugees and displaced persons, and social protection, entity funds for environmental protection and energy efficiency	1.8 billion
Renovation of residential buildings	The draft Building Renovation Strategy envisages energy rehabilitation of 1% of residential buildings per year by 2030.	Renovation of 604,037 m^2 per year, in the period until 2030, renovation of 10% of the existing residential buildings, i.e. 6,040,370 m^2	Directive 2010/31/EU on the energy performance of buildings, Directive 2012/27/EU on energy efficiency	employment of domestic labour (about 20,000 jobs over a period of 10 years), better living comfort of users, lower heating costs, better air quality, reduction of emissions 550 Gg CO_2/year	entity ministries of spatial planning and BD department, entity funds for environmental protection and energy efficiency	1.8 billion
Renovation of public and commercial buildings, installation of 'green roofs'	The draft Strategy for the renovation of buildings envisages the energy rehabilitation of 1% of public buildings per year by 2030.	Renovation of public and commercial buildings, 90,754 m^2 per year, in the period until 2030 907,540 m^2.	Directive 2010/31/EU on the energy performance of buildings, Directive 2012/27/EU on energy efficiency	employment of domestic labour (about 20,000 jobs over a period of 10 years), better living comfort of users, lower heating costs, better air quality, reduction of emissions 80 Gg CO_2/year	entity ministries of spatial planning and BD department, entity funds for environmental protection and energy efficiency	270 million
Application of solar thermal systems	Installation of solar DHW heating systems for detached houses	Share of solar energy for DHW heating by 2030 3%, installation of about 50,000 solar systems	Directive 2009/28/EC on the promotion of the use of energy from renewable sources	employment of domestic labour (about 1,000 jobs over a period of 10 years), lower heating costs, increase in the share of RES, reduction of emissions 1.2 Gg CO_2/year	Cities, municipalities, funds for environmental protection and energy efficiency, entrepreneurs	150 million
Application of heat pumps	Use of highly efficient heat pumps for heating and cooling	Installation of 10,000 heat pumps for heating and cooling of residential and non-residential buildings	Directive 2009/28/EC on the promotion of the use of energy from renewable sources	employment of domestic labour (about 1,000 jobs over a period of 10 years), lower heating costs, increase in the share of RES, reduction of emissions 1.2 Gg CO_2/year	Cities, municipalities, funds for environmental protection and energy efficiency, entrepreneurs	150 million

Forestry					
Action	**Description (type of activity)**	**Specific objective**	**EU policy**	**Effects of action**	**Costs (BAM, until 2030)**
Afforestation of barren land, coppice and degraded forests	Increasing the area on barren lands and clearings (areas where there has been no forest in the last 50 years; afforestation of shrubs, neglected areas (greening of degraded areas such as tailings dumps, slag dumps, abandoned quarries), degraded forests, etc. (areas where forest vegetation has been present for the last 50 years)	2,500 ha/year (total of 25,000 ha by 2030) biomass production from 20 to 40 m^3/ha per year	New EU Forestry Strategy (2013): ensure that European forests are managed sustainably Strengthening the EU's contribution to promoting sustainable forest management and preventing deforestation worldwide	• reduction of erosion process and regulation of water regime, • increased carbon storage: 45 Gg CO_2 by 2030, 130 Gg CO_2 by 2050 • strengthening seed and nursery production in the forestry sector and growing planting material	100 million
Establishment of plantations of fast-growing species	Farming fast-growing species on degraded and neglected lands	100 ha/year (total of 1,000 ha by 2030)	Directive 2009/28/EC on the promotion of the use of energy from renewable sources New EU Forestry Strategy	• use of degraded and neglected lands • production of biomass for energy production - higher share of RES • increase of carbon storage (3 Gg CO_2 by 2030, 10 Gg CO_2 by 2050 • reduction of fossil fuel consumption - reduction of GHG emissions	3 million
Afforestation and application of other EbA (*Ecosystem-based Approaches*) measures by erosion of affected areas	Implementation of anti-erosion afforestation system (combination of selected species and the system of technical and technological solutions)	50 ha/year (500 ha in total until 2030)	Adaptation to climate change	• reduced damage to agricultural land by washing away fertile land, as well as direct damage as a consequence of landslides, • reduction of damage to material goods • Increased carbon storage: 45 Gg CO_2 by 2030, 130 Gg CO_2 by 2050.	2.5 million

*Measures related to the improvement of forest protection measures and the improvement of 'adaptive forest farming and planning systems' are listed in the chapter on climate change adaptation actions (**Error! Reference source not found.**).

Agriculture						
Action	**Description (type of activity)**	**Specific objective**	**Sector-specific EU directive**	**Effects of action**	**Management and coordination**	**Costs (BAM, until 2030)**
Changes in livestock nutrition	Changing the way and diet of ruminants directly affects the reduction of methane production in the rumen (intake of up to 3% of one type of algae reduces methane emissions in cattle by up to 80%, intake of fats and oils shows a reduction of emissions of 15-20%)	Reduce GHG emissions from agriculture by 12% by 2030	Regulation (EC) No 767/2009 on the placing on the market and use of feed	• increasing the productivity and sustainability of livestock production • positive impact on soil • reduction of GHG emissions 19 Gg CO_{2eq}/year	Entity and cantonal line ministries in charge of agriculture, and the department in the DB that is responsible for agriculture	25 million

Agriculture						
Action	**Description (type of activity)**	**Specific objective**	**Sector-specific EU directive**	**Effects of action**	**Management and coordination**	**Costs (BAM, until 2030)**
Improving the manure storage system	Manure should be stored in watertight pools (e.g. concrete) which must be large enough for the fertiliser to be stored for a period of six months.	Reducing the process of volatile GHG gases into the atmosphere, preserving useful nutrients such as nitrogen	Directive 91/676/EEC on the protection of waters against pollution caused by nitrates from agricultural sources	• reduction of runoff of liquid manure into soil and water • preventing the spread of unpleasant odours • reduction of soil load with nitrates • reduction of GHG emissions 2.7 Gg CO_{2eq}/year	Entity and cantonal line ministries in charge of agriculture, and the department in the DB that is responsible for agriculture	35 million
Use of fertilisers and biomass waste in anaerobic digestion and biogas production	Agricultural residues that cannot be used for consumption by humans and animals can be used for biogas production, and in particular solid and liquid manure represents a significant source for biogas production.	Reduction of easily degradable carbon sources in fertiliser Potential reduction of N_2O emissions generated in the nitrification process Construction of a total of about 7 MWe of biogas plants	Directive 2009/28/EC on the promotion of the use of energy from renewable sources	• farm sustainability • preventing the spread of unpleasant odours • better fertiliser quality • increase in the share of RES • reduction of GHG emissions 2.7 Gg CO_{2eq}/year	Entity, cantonal line ministries in charge of agriculture, and the department in the DB in cooperation with the entity and cantonal line ministries in charge of energy, entity funds for environmental protection	35 million
Application of mineral fertilisers coated with polymers	Polymer-coated fertilisers reduce the consumption of fertiliser per hectare (due to lower nitrogen losses and its prolonged action) with unchanged or increased income	Reduction of losses by washing, denitrification and volatilisation, reduction of phytotoxicity	Regulation (EU) 2019/1009. laying down rules on the making available on the market of EU fertilising products	• fertiliser consumption per hectare decreases with unchanged or increased income • reduction of GHG emissions 0.76 Gg CO_{2eq}/year	Entity, cantonal line ministries in charge of agriculture, and the department in the BD in cooperation with the BiH Plant Health Administration	15 million
Use of natural potentials of microorganisms in sustainable agricultural production	The application of bacteria that enhance the growth of plants reduces the possibility of soil and groundwater toxicity, increases the content of soil organic matter and protection against pathogens. These microorganisms can partially or completely replace mineral fertilisers and pesticides.	Reduction of gas emissions and environmental pollution	Regulation (EU) 2019/1009 of the European Parliament and of the Council of 5 June 2019 laying down rules on the making available on the market of EU fertilising products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009 and repealing Regulation (EC) No 2003/2003	• fertiliser consumption per hectare is reduced, and thus greenhouse gas emissions with the economic effect of saving pure nitrogen in the amount of 30-60 kg/ha, a positive impact on soil and environment	Entity and cantonal line ministries in charge of agriculture, and the department in the BD that is responsible for agriculture	10 million
Improving animal health and welfare	In BiH, it can be expected that productivity in livestock production will decline due to poor quality and availability of feed, due to	Improving the sustainability of farms,	Directive 2010/63/EU on the protection of animals	• increase farm productivity	Entity and cantonal line ministries in charge of agriculture, and the department	20 million

Agriculture						
Action	**Description (type of activity)**	**Specific objective**	**Sector-specific EU directive**	**Effects of action**	**Management and coordination**	**Costs (BAM, until 2030)**
	diseases, and due to pests that may occur as a result of climate change. Improved biosecurity, breeding conditions, nutrition and general welfare in animal husbandry will certainly contribute to reducing emissions, especially methane in dairy cows.	reducing greenhouse gas emissions		• Increased biosecurity on farms protects against the onset and spread of disease • reduction of greenhouse gas emissions	in the BD that is responsible for agriculture	

Waste						
Action	**Description (type of activity)**	**Specific objective**	**Sector-specific EU directive**	**Effects of action**	**Management and coordination**	**Costs (BAM, until 2030)**
Prevention of waste generation and reduction of the amount of generated solid waste	Minimise the generation of waste that includes municipal waste, production waste that is similar in composition and characteristics to municipal waste and sludge from wastewater treatment plants. Application of cleaner production, improvement of education, introduction of economic instruments, application of regulations and investment in modern technologies.	The amount of waste disposed of in sanitary landfills is 34% of the generated waste Establish a waste sludge management system from wastewater treatment plants 100% Waste management education introduced 100%	Directive 2018/850 EC on landfills Council Directive 91/271/EEC on urban waste water treatment	Efficient use of waste, active introduction of circular economy in the system of economy of BiH, raised awareness of citizens about the benefits, reduction of emissions by 200 Gg CO_{2eq}/year.	Entity ministries of spatial planning and environmental protection, Department of environmental protection of BD, entity environmental funds, municipal utility companies, local self-government units	110 million
Increasing the amount of separately collected / sorted solid waste and recycling for reuse	Develop, adopt and implement legislation that will allow for a significant increase in the amount of separately collected and recycled waste Create conditions for improving sustainable waste management Take the necessary measures for the reuse and recycling of municipal waste.	Reuse and recycling of municipal waste in a minimum share of 60% of the waste mass by 2050, the amount of biowaste in relation to the total amount of municipal waste must not exceed 6%	EC Directive 2018/851 on preparing for re-use and waste recycling	Waste volume reduction, employment, lower disposal costs, space savings, resource efficiency emission reduction by 50 Gg CO_{2eq}/year	Entity ministries of spatial planning and environmental protection, Department of environmental protection of BD, entity environmental funds, municipal utility companies, local self-government units	36 million
Providing a waste treatment system with the collection and use of landfill gas	Separation of biowaste at the point of waste generation will increase the amount of landfill gas by 40%, which will be used in a controlled manner for energy production (electricity and thermal energy).	Disposal of landfill gas through a degassing system 100% at all landfills that have a waste disposal permit (sanitary/regulated)	Directive on the promotion of the use of energy from renewable sources	Reducing the risk of explosion, increase of RES share in energy production, emission reduction by 120 Gg CO_{2eq}/year	Entity ministries of spatial planning and environmental protection, Department of environmental protection of BD, entity environmental funds and municipal utility companies	80 million
Reduction of the amount of disposed	Reducing the amount of disposed biodegradable waste and the share of biodegradable waste that will be treated	Amount of used biodegradable waste 30% by 2050.	Directive 2018/850 on landfills	Reduction of the amount of disposed biowaste, employment, compost	Entity ministries of spatial planning and environmental protection, Department of	100 million

Waste						
Action	**Description (type of activity)**	**Specific objective**	**Sector-specific EU directive**	**Effects of action**	**Management and coordination**	**Costs (BAM, until 2030)**
biodegradable waste, production of biogas and compost	will lead to an increase in the amount of waste that will be composted. Encouraging the transfer of knowledge and technology with an emphasis on low-carbon technologies.		Directive 2010/75/EU on industrial emissions	production, energy production from biogas, emission reduction by 120 Gg CO_{2eq}/year	environmental protection of BD, entity environmental funds and municipal utility companies ministry of energy, but also the ministry responsible for issuing permits for the operation of bio-waste plants, permits for composting-environmental permits.	

Cross-cutting sector				
Action	**Specific objective**	**Management, coordination**	**Costs (BAM, until 2030)**	**Source of funding**
Development of a Plan for gradual reduction of HFC use in Bosnia and Herzegovina	Gradual reduction of HFC use, according to the following time frame[65]: • 10% reduction by 2029 • 30% reduction by 2035 • 50% reduction by 2040 • 80% reduction by 2045	Ministry of Foreign Trade and Economic Relations of BiH in cooperation with the FBiH Ministry of Environment and Tourism and the RS Ministry of Spatial Planning, Construction and Ecology	900,000 (approx. USD 500,000)	Multilateral Fund for the Implementation of the Montreal Protocol
Control of consumption of HFC substances and implementation of the procedure of gradual reduction of consumption of HFC substances with the use of international grants and donor funds		Ministry of Foreign Trade and Economic Relations of BiH in cooperation with the FBiH Ministry of Environment and Tourism and the RS Ministry of Spatial Planning, Construction and Ecology and the competent department in the Government of BD	3,000,000	Multilateral Fund for the Implementation of the Montreal Protocol
Inventory and record keeping of HFC substances		Ministry of Foreign Trade and Economic Relations of BiH in cooperation with the FBiH Ministry of Environment and Tourism and the RS Ministry of Spatial Planning, Construction and Ecology and the competent department in the Government of BD	1,500,000	Green Climate Fund (GCF), Kigali Cooling Efficiency Programme (K-CEP), bilateral programmes in the field of climate change (SIDA, GIZ, etc.)
Energy efficiency in the cooling sector (buildings and industry)		Ministry of Foreign Trade and Economic Relations of BiH in cooperation with the FBiH Ministry of Environment and Tourism and the RS Ministry of Spatial Planning, Construction and Ecology and the competent department in the Government of BD	4,000,000	Green Climate Fund (GCF), Kigali Cooling Efficiency Programme (K-CEP), bilateral programmes in the field of climate change (SIDA, GIZ, etc.)

6.3 Emission reduction plans by sector

The implementation of the actions presented in Table 4 results in a targeted reduction of GHG emissions by 12.8% until 2030 compared to 2014 emissions. Reduction of GHG emissions at the end of the observed period, i.e. 2050, is 50% compared to the 2014 emissions. It should be noted that the stated amount of emission reductions did not take into account the increase in carbon sinks, ie. forestry-related action. In addition, the evolution of emissions of HFC compounds covered through the multidisciplinary[66] (cross-cutting) sector was taken into account. A description of the actions by sector is provided below.

For each sector, different development scenarios until 2050 with an overview until 2030 were analysed. As can be seen from Table 4, actions have been selected that have positive effects on

[65] Defined by the Kigali Amendment to the Montreal Protocol for countries referred to in Article 5, Group 1.

[66] Applies to all sectors that use refrigeration and air conditioning.

sustainability in individual sectors, and which also reduce GHG emissions. Given that this concerns the period until 2050, the Strategy must be broad enough to include possible changes in circumstances that BiH cannot influence. In this context, the COVID-19 virus pandemic will surely affect the implementation of actions for greenhouse gas emissions reduction.

6.3.1 Electricity production sector

Overview of the situation in the electricity production sector

Total gross electricity production in 2018 was 19,160 GWh, while final consumption was approximately 11,456 GWh. Net electricity exports amounted to 4,606 GWh[67]. At the same time, per capita electricity consumption is relatively low (compared to European countries). Electricity consumption per capita in 2000 was 1,915 kWh, and in 2013 it reached 2,840 kWh, while in 2018 it amounted to 3,240 kWh, which exceeds the world average. Electricity consumption increased in the period 2002-2018 from 9,150 GWh to 11,456 GWh, which is an increase of about 25%.

In 2018, 12,079 GWh or 63% of gross electricity was produced in thermal power plants, which use domestic coal and have fairly high specific emissions of carbon dioxide (about 1.3 tCO_2/MWh). The rest of the electricity is produced in large hydropower plants, 6,519 GWh or 34%, and 562 GWh or 2.9% is produced in industrial power plants and renewable energy sources (solar power plants, wind farms and biomass power plants). Coal consumption in the energy sector (thermal power plants and industrial power plants) amounted to about 13.4 million tons. Due to the relatively large share of thermal power plants in the production, the carbon dioxide grid emission factor in 2018 was about 820 kg/MWh (in 2013 it was about 720 kg/MWh).

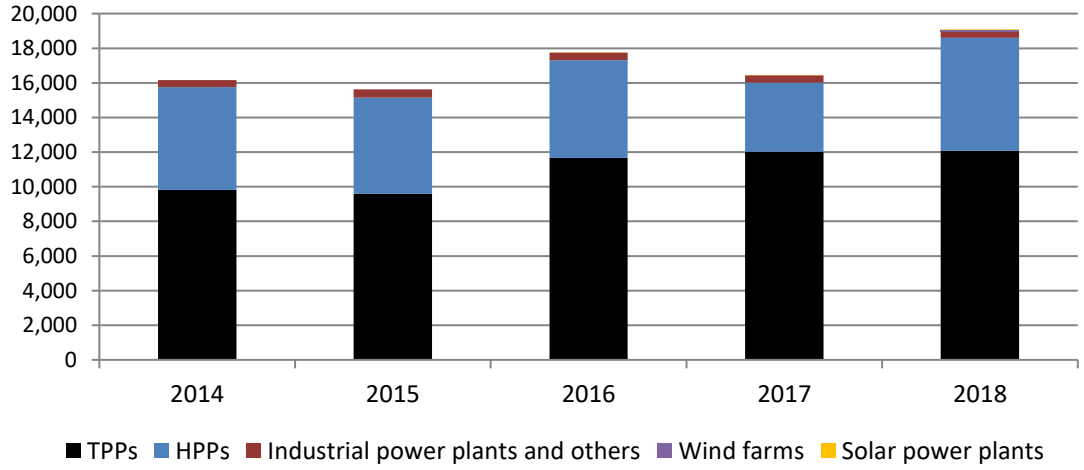


Figure 17: Structure of electricity production in BiH in the period 2014-2018 (GWh)

In 2018, BiH adopted the Framework Energy Strategy until 2035. In the electricity sector, four scenarios were analysed. According to three scenarios, domestic coal will continue to be the main source in electricity production, and production capacity could more than double. There are significant coal reserves and it is a sector that employs a large number of people. However, the competitiveness of existing and new coal-fired power plants in BiH, on the open market, is very questionable, which is emphasised in the Strategy. Therefore, in parallel with the construction of new and closure of existing

[67]Agency for Statistics of Bosnia and Herzegovina (2019). Energy statistics - electricity and heat 2018, December 2019

units in thermal power plants, it is necessary to intensify the construction of capacities that use renewable energy sources. The fourth scenario envisages the largest share of renewable energy sources, and this refers primarily to hydropower plants, biomass power plants, followed by wind farms and solar power plants. In 2018, the first wind farm in BiH was put into operation. Several more wind farms are under development. As a direct consequence of the introduction of guaranteed incentive tariffs and a guaranteed period of purchase of electricity from renewable energy sources (RES) at the entity level, the production of electricity from RES in BiH is growing.

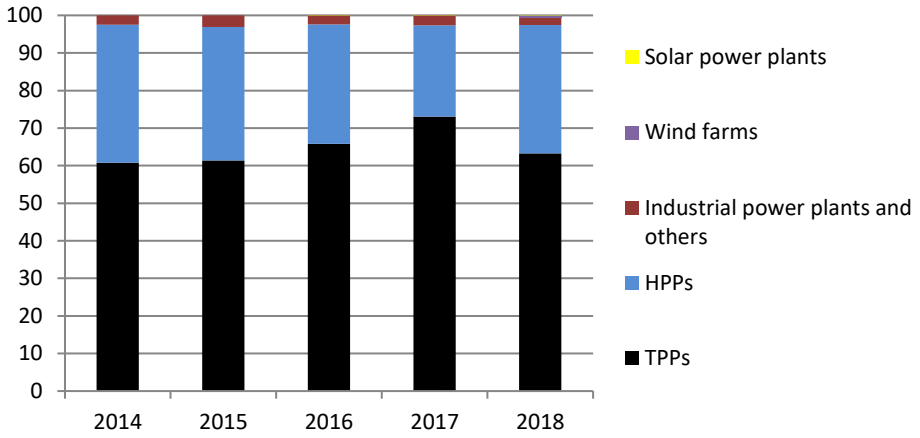


Figure 18: The share of individual sources in total electricity production (%) in BiH

In the last few years, there has been a trend of increasing capacity using renewable energy sources. Among other things, three biomass plants and two wind farms were put into operation. Small hydro power plants and wind farms have the largest share, followed by solar and biomass power plants. The share of individual RES in the installed capacity at the end of 2018 in BiH is shown in Figure 19.

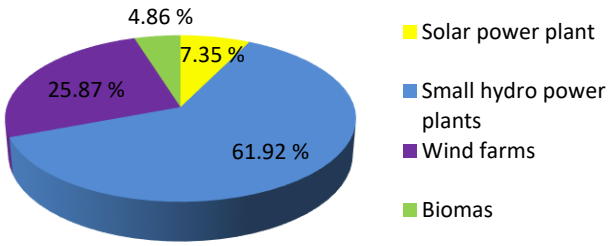


Figure 19: The share of individual RES in the installed capacity for electricity production at the end of 2018 in BiH

Current quotas for encouraging renewable energy sources in both entities are valid until the end of 2020. The adoption of a new incentive system is expected. According to available information, the introduction of a system of auctions, net billing, and encouragement of civic energy projects is also expected.

Measures to reduce greenhouse gas emissions from the electricity sector

Measures to reduce GHG emissions in the electricity sector that are analysed in the BiH Framework Energy Strategy can be divided into:

1. Replacement of existing thermal power units with new ones with significantly higher energy efficiency, which would reduce the specific emission of GHG (tCO_2/MWh),
2. Construction of new capacities using renewable energy sources,
3. Construction of gas-fired thermal power plants.

In addition to these measures, there were also analysed measures related to the use of electricity. Within the preparation of the IV National Communication on Climate Change in BiH, three scenarios for reducing GHG emissions in the electricity sector were analysed. These scenarios are based on the scenarios for the development of the electricity sector of BiH from the Framework Energy Strategy of BiH until 2035. The first two scenarios are called the reference scenario (S1) and the moderate mitigation scenario (S2), and the third the mitigation scenario. The analysis of GHG emissions for these scenarios concluded that only in the mitigation scenario do emissions decrease.

S1 is based on the scenario from the Strategy called Indicative Plan (IP) 2017–2026, with a projection until 2035. It predicts an increase in total installed capacity, as well as an increase in the share of renewable energy sources. In this scenario, the emphasis is on replacing the old thermal power units with new ones – coal-fired and gas-fired ones. Carbon dioxide emissions will increase significantly until 2025, when it will begin to decline due to the closure of part of the existing thermal power plants. In the period 2025 - 2035, the new coal-fired power plants will take over most of the production. Although production will grow significantly, emissions will decline slightly due to the higher efficiency of new thermal power plants compared to existing ones that are gradually closing down.

The characteristics of this scenario are:

- it is planned to install 2,283 MW of new capacity,
- coal-fired power plants keep their dominance, their share 70%, RES power plants 30%,
- after 2025, the commissioning of an additional 600 MW from renewable energy sources is expected,
- in 2035, the amount of installed capacity would be higher by about 56% compared to 2016,
- reduction of the relative share of large hydropower plants,
- the share of power plants using other renewable energy sources will increase, to about 15%,
- in 2035, the amount of electricity produced is 29.5 TWh, which is an increase of about 54% compared to 2018.

The moderate mitigation scenario (S2) is based on the scenario from the Strategy called the cost-optimised (CO) scenario. Carbon dioxide emissions will decline slightly by 2025, primarily due to reduced production from existing thermal power plants as a result of environmental constraints and market conditions. The characteristics of this scenario are:

- construction of coal-fired thermal power plants, after 2025, and there are no plans to build gas-fired facilities,
- by 2025, 1,385 MW of new coal-fired capacity will be commissioned, while 370 MW will be decommissioned,
- in the period 2025–2035, coal-fired thermal power plants with a total capacity of 800 MW and 316 MW of capacity from HPPs and RES in the incentive system will be commissioned,
- the total installed capacity in this scenario would amount to 5,440 MW by 2025, and compared to 2016 there will be a net increase in capacity of 34%,
- in 2035, the amount of electricity produced will be 25.2 TWh, which is about 32% more than in 2018.

The mitigation scenario is based on the scenario from the Strategy called the moderate renewable energy efficiency scenario (MREES). MREES encourages a higher share of renewable energy sources, encouraging energy efficiency measures as an alternative to other scenarios traditionally based on higher participation of thermal power plants. Although this scenario represents the most intense turnover in generation mix planning, it still highly relies on coal (especially until 2035). Emphasis is placed more strongly on the growth and promotion of RES, but the thermal energy sector is still not neglected. During the consultations with the representatives of the competent ministries, it has been concluded that it is necessary to envisage a slightly higher installed capacity of the new coal-fired power plants. Therefore, the development of the electricity sector in BiH is analysed here, which includes the construction of replacement/new coal-fired power plants in the amount of 1,050 MW (350 MW more than MREES). In the case of obtaining adequate international assistance for the fair transition of mining areas, the low-carbon scenario would involve 750 MW of replacement/new coal-fired power plants. Both of these options include the 450 MW power of TPP Tuzla 7, which is under construction. Given the indications of receiving assistance for the fair transition of mining areas, the option of a low-carbon scenario with 750 MW of replacement/new coal-fired power plants is analysed below. It is expected that the installed capacity in RES will increase (new capacity):

- 550 MW of wind farms, 400 MW of solar power plants, 50 MW of small hydro power plants and 60 MW of biomass power plants MW,
- 500 MW capacity of large hydropower plants.

This will increase the share of renewable energy sources (including large hydropower plants) in production to about 55%. In addition to the above measures, it is necessary to invest in the transmission and distribution network in order to reduce losses and integrate RES. The estimated costs for the preparation and implementation of all measures (in the option with 1,050 MW of replacement/new coal-fired power plants) is BAM 8.625 billion. In the 750 MW option, part of this amount (equivalent to the amount for the construction of a 300 MW coal-fired power plant) is directed to the transition of mining areas. So, that means investing in the electricity sector of about BAM 860 million per year in the period until 2030.

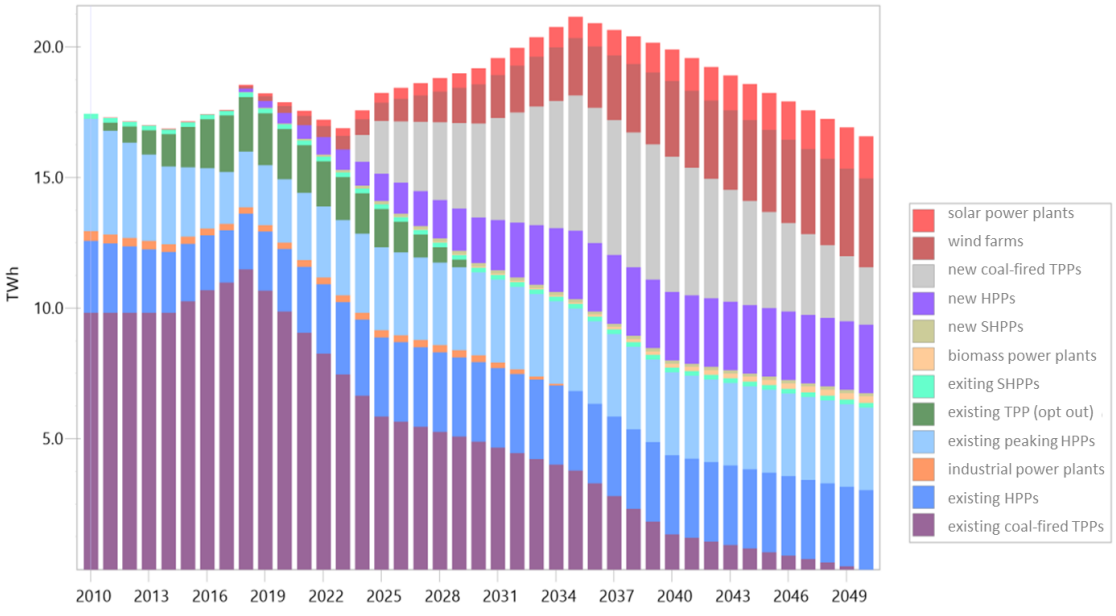


Figure 20: Electricity production in BiH according to the low-carbon development scenario

Net production in 2030 will increase by about 1.32 TWh compared to 2018, and will amount to 19.19 TWh. The share of production from thermal power plants should be reduced to about 45%, which still represents a relatively high share of thermal power plants. The trend of development of the generation mix would develop with similar dynamics as the expected growth of consumption, and the scenario would satisfy the high security of supply of domestic consumption at similar levels as today.

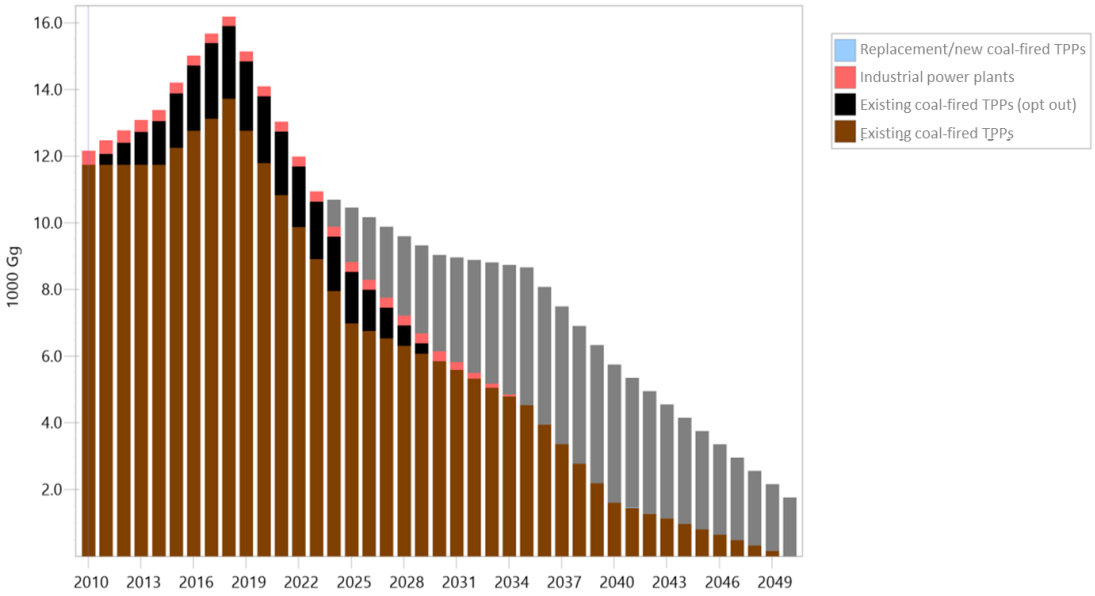


Figure 21: Greenhouse gas emissions from the electricity sector in BiH according to the low-carbon development scenario

Carbon dioxide emissions will fall sharply until 2025, primarily due to reduced production from existing thermal power plants as a result of environmental constraints (in line with the NERP) and market conditions. After that, emissions will decline slightly until 2035. During this period, most of the existing coal-fired power plants will be closed. The intensive decline in emissions begins in 2035 and continues until 2050, when all existing thermal power plants will be closed and replacement/new ones will achieve lower production than projected values. Emissions in 2030 (about 9 million tons) are 30% lower than in 2014 (13.01 million tons), and the reduction in emissions in 2050 (1.76 million tons) compared to 2014, would be around 86.5%.

6.3.2 District heating sector

Overview of the situation in the district heating sector

According to available data, in 2017, there were 29 large companies in BiH (11 in the RS and 18 in the FBiH) that deal with the supply of consumers with thermal energy, or about 32 large district heating systems. The total heated area of all district heating systems at the level of BiH in 2018 was about 10 million m^2, with the largest systems located in Sarajevo (about 3,000,000 m^2 of heated space), Banja Luka (about 1,350,000 m^2 of heated space) and Tuzla (about 1,000,000 m^2 of heated space). According to the balance of thermal energy for 2015, losses in the distribution of thermal energy amounted to 6.53%[68]. In BiH, in the period 2011-2015, there was a trend of decreasing heat production by an average of 3.0% per year. In 2015, the produced thermal energy amounted to 88.45% of the produced

[68]Ministry of Foreign Trade and Economic Relations of BiH (2018). BiH Framework Energy Strategy of BiH until 2035

thermal energy in 2011[69]. According to the IEA, the total heat consumption for heating in BiH in 2015 was 71 PJ, while in the same year the share of heat from district heating was about 8%[70].

In the Republika Srpska, in district heating systems, thermal energy is mostly produced in heating plants, about 94%, and the rest in TPP 'Ugljevik'[71]. Heating plants use fuel oil (Istočno Sarajevo, and to a lesser extent Banja Luka and Prijedor), coal (Doboj, Bijeljina, Čelinac, part of Pale), biomass (heating plants in Pale, Sokolac, Gradiška, Prijedor and Banja Luka). In Zvornik, natural gas is used as an energy source, and heat obtained from the Ugljevik thermal power plant is used to heat the town of Ugljevik. According to 2018 data, the installed capacity of heating plants in the Republika Srpska is 513.51 MW (excluding the capacity of heating plants in Brod and Derventa)[72], and according to the energy balance plan for 2016[73], district heating covered 40 thousand apartments with about 2.3 million m^2 of living space, as well as 460 thousand m^2 of business space. In generally, in the period 2011-2015, in the RS there is a trend of decreasing heat production by an average of 3.8% per year (in 2015, heat produced amounted to 85.66% of heat produced in 2011)[74].

In the FBiH, in district heating systems, thermal energy is largely provided from local thermal power plants (Tuzla, Lukavac, Kakanj) and industrial facilities (Zenica). The two most efficient and largest systems in the FBiH are in the Sarajevo Canton, where natural gas is used as an energy source, and in the City of Tuzla, where heat from TPP Tuzla is used. According to the balance of thermal energy for FBiH, in 2015, losses in the distribution of thermal energy amounted to 7.3%. In the Federation of Bosnia and Herzegovina in the period 2011-2015, there was a trend of decreasing heat production by an average of 2.8% per year (in 2015, the produced thermal energy amounted to 89.3% of the thermal energy produced in 2011) ((Framework Energy Strategy of the Federation of Bosnia and Herzegovina - Draft, 2018), According to the available data from the companies for the production of thermal energy in FBiH, about 97 thousand housing units are heated[75].

Public facilities that are not connected to the district heating network such as health centres (hospitals and clinics), some state institutions (courts, police), hospitality industry and other similar institutions generally have their own plants for heat production that use fuel oil, heating oil, coal, biomass or natural gas, where available, as energy source.

In general, in most district heating companies, heating plants and related equipment are over 30 years old. These systems work with low efficiency, whereas heat losses in some cases reach a value of up to 60%. In the last 25 years, significant reconstructions have been carried out in the district heating system of the city of Sarajevo and Tuzla, in which the area of heated space from the district heating system has almost doubled. The district heating companies in Banja Luka, Prijedor and Gradiška carried out reconstructions and update of the system for the production of thermal energy, while they invested very little in the system of distribution of thermal energy. In most other systems, only the most necessary reconstructions have been carried out in order to ensure the minimum functioning of

[69]Ministry of Foreign Trade and Economic Relations of BiH (2018). BiH Framework Energy Strategy of BiH until 2035

[70]GIZ (2018). Assessment of the potential for the application of highly efficient cogeneration and cooling and heating in BiH

[71]RS Ministry of Energy and Mining (2018): Energy Strategy of the Republika Srpska until 2035

[72]GIZ (2018). Assessment of the potential for the application of highly efficient cogeneration and cooling and heating in BiH

[73]RS Ministry of Energy and Mining (2018). Republika Srpska Energy Balance Plan for 2018

[74]RS Ministry of Energy and Mining (2018): Energy Strategy of the Republika Srpska until 2035

[75]FBiH Ministry of Energy, Mining and Industry (2018). Framework Energy Strategy of the Federation of Bosnia and Herzegovina until 2035

the district heating system. Recently, the number of private heat suppliers increases (Gračanica, Livno, Gradiška, Banja Luka, etc.).

The biggest obstacle to the modernisation of the district heating system in BiH is the difficult economic situation, which causes that the business of all district heating companies takes place in difficult circumstances.

In most district heating systems, the price of heat supplied from the district heating system is determined in agreement with the local government and is not based on the actual costs of production and delivery of heat, whereby the operations of these companies are subsidised by local authorities. In such circumstances, no significant allocations are possible for the modernisation of district heating systems, but only emergency intervention measures are carried out, such as replacement of dilapidated distribution network, mainly in the most critical places of the network where frequent accidents occur during the heating season. All other investments in district heating systems have been largely halted.

In a number of cases, the payment of the delivered thermal energy to consumers is still based on the area of the heated space, and not on the basis of consumption. This is in contradiction with the Consumer Protection Law of 2006, which obliges heat producers to charge the delivered thermal energy to customers according to consumption, and not according to the area of heated space. The application of this law is completely reduced and only to individual cases. According to available data, currently only two companies charge for consumption (in Gračanica and Livno), and in six companies it is done exclusively on the basis of the area of heated space (3 in RS and 3 in FBiH). In other companies, a combined billing is made[76]. From 2020, the billing of delivered thermal energy exclusively according to consumption is planned also in the heating plants in the Sarajevo Canton.

One of the more significant obstacles to more intensive heating is the insufficiently legally regulated area of district heating. At the entity level, laws on the production, distribution and supply of thermal energy have not yet been adopted, although the adoption of this law is envisaged in a number of strategic documents. The law should regulate the conditions for production, distribution and supply of thermal energy, the rights and obligations of producers and consumers of thermal energy.

Measures to reduce greenhouse gas emissions

In order to overcome the existing situation, it is necessary to take a number of measures that would lead to an increase in the overall efficiency of production and distribution of thermal energy, and thus the competitiveness of companies for the production and distribution of thermal energy. The applicability and representation of these measures will be different for each of the district heating systems but in general these measures would lead to a significant improvement in the functioning of the entire district heating system. In general, these measures can be divided into production and distribution measures as well as consumption measures.

Within the measures on the side of production and distribution of thermal energy, it is necessary to implement the following:

[76]GIZ (2018). Assessment of the potential for the application of highly efficient cogeneration and cooling and heating in BiH

- reconstruction and modernisation of existing district heating networks, boiler rooms and heating substations, increase of utilisation of existing capacities, expansion of existing district heating networks and introduction of cogeneration where possible,
- additional encouragement of the introduction of renewable energy sources (biomass, geothermal energy) in district heating systems, both existing and new ones.

Within the measures on the side of thermal energy consumption, it is necessary to implement the following:

- installation of cumulative (buildings) and individual (apartments) thermal energy meters in all facilities connected to the district heating system,
- switching to billing according to the consumption of thermal energy instead of the area of the heated space.

The greatest potential for low-carbon development of district heating in BiH is the relatively large potential of biomass and the potential of energy efficiency measures in existing systems as well as in the very facilities that use the district heating service. Having in mind the potentials of biomass in the period until 2030, the trend of increasing the share of biomass in district heating is expected to continue. The untapped potential of biomass in 2018 is 2 million tons of dry mass. According to GIZ data[77], in 2015, the consumption of energy based on wood residues amounted to about 220,000 tons, and the same source estimates that in 2020 the consumption will amount to 420,000 tons. Thus, in 2020, the utilisation of the natural potential of wood residues is expected to be slightly over 11%. This speaks to the growth potential of the share of biomass in district heating. This increase in the share will be largely due to the reduction of coal consumption in heating plants. However, an increase in the use of heat from industry is expected, which is conditioned by the continuation of the operation of existing and/or the construction of new thermal power plants and other industrial plants. It is realistic to expect the beginning of the use of geothermal energy. The use of solar energy may be expected in new district heating systems that will also supply heat for domestic hot water.

Having in mind the potentials of RES and the problems caused by the individual way of heating in urban areas (air pollution, occupation of green areas, noise, waste generation, endangering safety, etc.), intensive heating is envisaged in the coming period. The strategic goal is that by 2050, the share of district heating in the total heat needs will be about three times higher than the existing one (in 2016), or about 25%. This means that BiH will approach the EU target for 2030 (the share of district heating in total heat needs is 30%). The specific consumption of thermal energy is declining in accordance with the application of existing regulations but their significant improvement is planned for the next period. Renewable energy sources, primarily biomass (mainly in cogeneration plants) and geothermal energy, are intensively introduced into district heating systems in a higher percentage, where part of the thermal energy would be used for central preparation of domestic hot water (DHW). These measures, along with appropriate legal solutions (e.g. a ban on the use of coal in individual furnaces in some cities), would significantly contribute to improving air quality in those cities, increasing housing comfort, and improving the business conditions of district heating companies. The construction of several cogeneration plants for thermal treatment of waste is also planned, as well as the cessation of the use of coal and fuel oil in district heating systems from 2035, and an increase in efficiency in the production and distribution of thermal energy.

[77]Conduction of a biomass market survey in Bosnia and Herzegovina, GIZ, 2018.

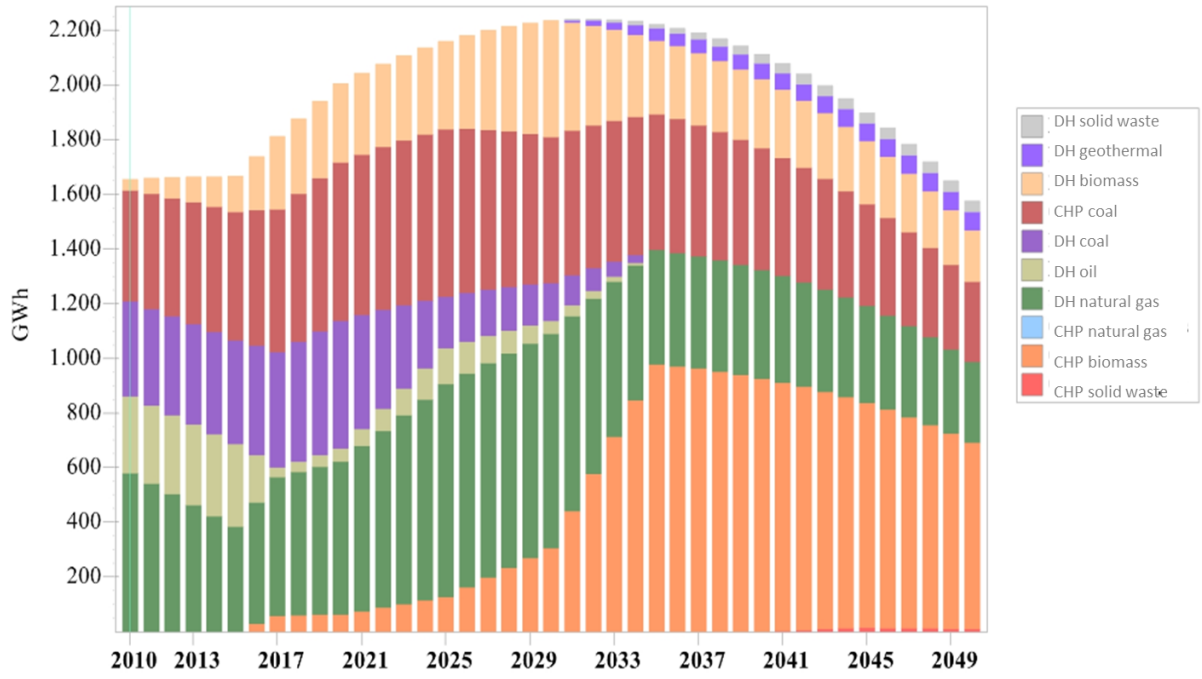


Figure 22: Trend of heat production in district heating by energy sources until 2050

The maximum heat production of about 2,200 GWh will be reached in 2030, and after that there will be a decline in production, so in 2050 the production is slightly lower than the production in 2010. Despite intensive heating, production is declining due to increased energy efficiency of users. The use of liquid fuels and coal in district heating will cease by 2035. The use of heat from thermal power plants and production from natural gas will reduce due to the energy efficiency of users (there is no construction of new systems on these two heat sources). The largest share in 2050 has heat obtained from biomass either through cogeneration plants or plants that produce only heat.

The maximum GHG emissions are expected by 2020. After that, emissions will fall sharply in the period up to 2035, when they are about twice less than the emissions in 2010. This is the result of the cessation of the use of liquid fuels and coal as well as the application of energy efficiency measures by end users. By 2050, the trend of declining emissions continues but at a much lower intensity. Sources of GHG emissions in the period after 2035 are natural gas and coal cogeneration systems. The slight reduction in emissions will be caused by an increase in energy efficiency from production to energy use. Emissions in 2050 are about 350,000 tCO_2, or almost 3.5 times, less than emissions in 2010. Emissions in 2050 will amount to only 30% of emissions in 2010.

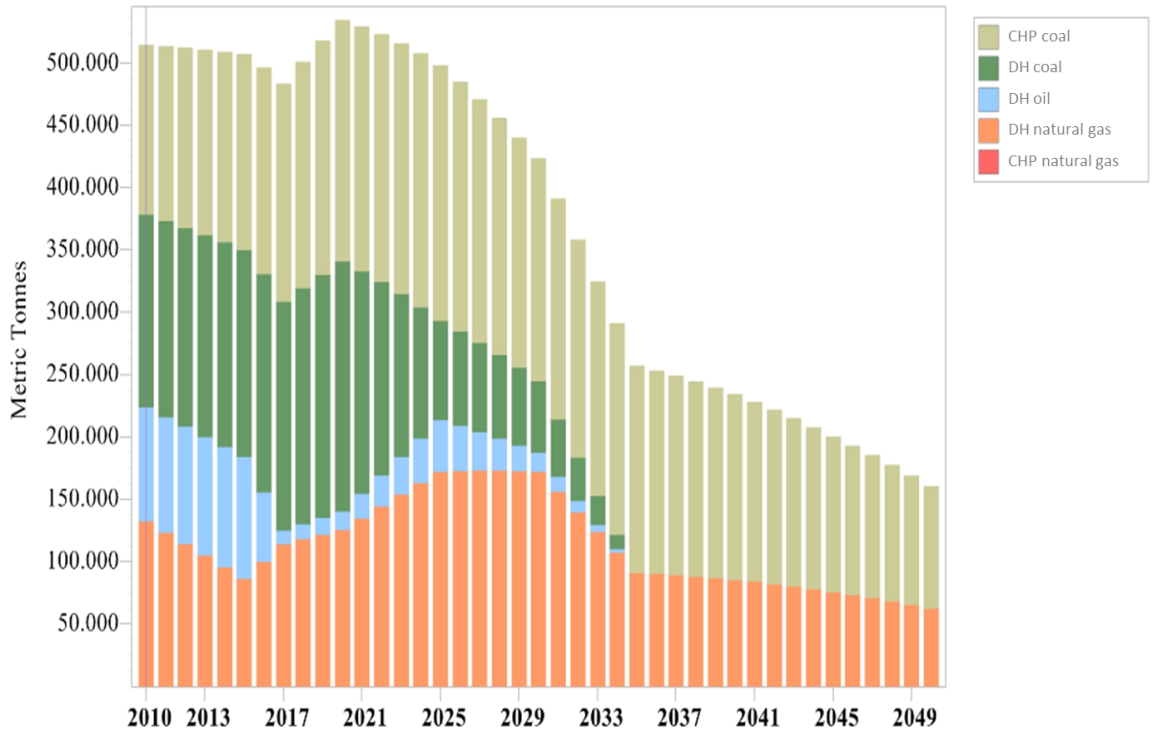


Figure 23: Carbon dioxide emission trend in district heating according to the low-carbon development scenario

In order to achieve the previously described low-carbon development of the district heating sector in BiH by 2050, it is necessary to implement the following measures:

1. *Installation of cumulative (at the level of the building) and individual (at the level of the apartment) heat meters in all buildings connected to the district heating system*

Currently, in most district heating systems in BiH, the billing of thermal energy is carried out on the basis of the area of the heated space, and not on the basis of measured consumption. This is in contradiction with the Consumer Protection Law of 2006 (Article 35, Official Gazette of BiH, No. 25/2006 and 88/2015), which obliges heat producers to charge the delivered thermal energy to customers according to consumption, and not according to the area of heated space. The application of this law is completely reduced and only to individual cases. According to available data, currently only two companies charge for consumption (in Gračanica and Livno), and in six companies it is done exclusively on the basis of the area of heated space (3 in RS and 3 in FBiH). In other companies, a combined billing is made. From 2020, the billing of delivered thermal energy exclusively according to consumption is planned also in the district heating companies in Sarajevo. Almost all new buildings that are connected to the district heating network have built-in cumulative meters of thermal energy consumption, and some are individual for single apartments. The implementation of this activity is envisaged by the entity strategies of energy development (Framework Energy Strategy of the Federation of Bosnia and Herzegovina until 2035, Energy Development Strategy of the Republika Srpska until 2030).

Charging for thermal energy based only on the area of the heated space does not motivate users to use thermal energy efficiently. The implementation of this measure reduces heating costs, improves air quality due to the reduction of emissions from combustion gases in heating plants/industrial power plants, reduces the import of fossil fuels (natural gas and fuel oil).

The Law on Energy Efficiency was adopted in FBiH in 2017. This law stipulates, among other things, that energy suppliers should install individual devices for measuring energy consumption at an appropriate pace (8% per year for the first 5 years and then 12% per year) at the final energy consumers. Installation costs are covered by the users. The Law on Energy Efficiency in the Republika Srpska was adopted in 2013, and it also requires energy suppliers and distributors to install individual devices for measuring energy consumption but does not prescribe a time period in which this must be done. Cumulative and individual heat meters should be installed in all facilities connected to the district heating system. The implementation of this measure should be implemented in the period 2020-2030.

The implementation of this measure is the responsibility of the following: in FBiH - the Ministry of Energy, Mining and Industry, in RS - the Ministry of Industry, Energy and Mining, cantonal and municipal authorities, district heating companies. Given that the relevant laws in both entities have created a legal basis for the implementation of this measure, the role of the competent ministries in FBiH and RS is to monitor the implementation of this measure, as well as the adoption of appropriate rulebooks (decrees) defining the methodology for determining the price (i.e. the method of distribution and calculation of costs for the delivered thermal energy). The implementation of this measure is in line with the Energy Efficiency Directive (2012/27/EU).

The price of thermal energy should consist of a fixed and variable part and should enable the smooth functioning of district heating companies but also motivate users to use thermal energy efficiently. The fixed part should be as low as possible and should motivate producers to increase the overall efficiency in the production and distribution of thermal energy (if the distribution network is owned by the producer of thermal energy). In case the fixed part is too high, consumers will not be motivated to use thermal energy efficiently, and producers will not be motivated to invest in increasing the efficiency of thermal energy production.

The implementation of this measure should be accompanied by the adoption of the Law on Production, Distribution and Supply of Thermal Energy. The law should regulate the conditions for the production, distribution and supply of thermal energy, the rights and obligations of producers and consumers of thermal energy, the conditions for obtaining a concession for the distribution of thermal energy, or a concession for the construction of a distribution network. The mentioned law should be followed by an appropriate rulebook on the methodology for determining the price of supplying the final customer with thermal energy.

It is estimated that the implementation of this measure could reduce carbon dioxide emissions by about 33,804 tCO_2 in 2030, or about 39,400 tCO_2 in 2050 compared to the value of emissions without implementing this measure. This estimate was made on the basis of emission calculations according to the IPCC methodology.

The estimated costs of the implementation of this measure, for buildings that currently do not have built-in thermal energy meters, amount to BAM 125 million in the period until 2030. In the period from 2030 to 2050, all new buildings will have built-in thermal energy meters, so there will be no need to provide new financial resources.

The implementation of this measure will lead to additional employment in the installation of thermal energy meters and their maintenance. The implementation of this measure would also encourage work on increasing the overall efficiency of district heating systems in order to keep the fixed part of

the price of thermal energy as low as possible, and the share of variable depending on thermal energy consumption as high as possible to motivate consumers to use thermal energy efficiently.

Reducing the consumption of thermal energy will cause a reduction in its production, the tendency to minimise losses in production and distribution, and thus reduce carbon dioxide emissions.

2. *Introduction of renewable energy sources in existing district heating systems, construction of new capacities for renewable energy sources/biomass, geothermal energy, solar energy/including central DHW preparation, as well as the use of waste heat from industrial plants for heating purposes*

In the following period, even more significant introduction of RES into existing district heating systems is envisaged. For now, major projects with biomass have been implemented in Gradiška, Prijedor and Banja Luka, and biomass is also used as fuel in heating plants in Pale, Sokolac, Gračanica, Livno and Nemila. There are several smaller centralised biomass systems (several facilities).

In the following period, it is necessary to introduce a higher percentage of RES in district heating systems, primarily biomass (preferably in cogeneration plants), geothermal energy, heat energy from heat pumps, solar systems and heat energy obtained from cogeneration plants for thermal treatment of waste or waste heat from industrial plants in zones where its use is justified. Part of the heat energy should be used for the central preparation of domestic hot water (DHW), which would further increase the revenues of district heating companies, reduce costs for households and reduce GHG emissions. These projects should be implemented continuously until 2050 with investments in improving the energy efficiency by users, which is a prerequisite for the sustainability of district heating, regardless of the energy source in use.

These measures, together with appropriate legal solutions (e.g. a ban on the use of coal in individual furnaces in some cities), would significantly contribute to improving air quality due to reducing emissions of pollutants from fossil fuels in heating plants and industrial plants, increasing housing comfort, reducing heat production costs for heating purposes and DHW as well as reducing the import of fossil fuels (natural gas and fuel oil), and the business conditions of district heating companies would be improved.

The main stakeholders for the adoption and implementation of this measure are:

- in FBiH: Ministry of Energy, Mining and Industry, Ministry of Spatial Planning, competent cantonal ministries, cities and municipalities and district heating companies,
- in the RS: Ministry of Energy and Mining, Ministry of Spatial Planning, Construction and Ecology, city and municipal authorities and district heating companies.

Ministries, within their competencies, should conceptualise legal solutions that would financially encourage the application of RES, e.g. by introducing additional financial obligations to district heating companies that use fossil fuels (carbon dioxide emission taxes), whereby the obtained funds would be used to finance projects in district heating systems that use renewable energy sources (e.g. free connection of users to these systems).

The implementation of this measure is in line with the Energy Efficiency Directive (2012/27/EU) as well as with the Directive on the promotion of the use of energy from renewable sources (2009/28/EU).

The use of waste heat from industrial plants for heating purposes, and especially the introduction of renewable energy sources in existing district heating systems will require significant material investments that cannot be financed entirely from the own funds of district heating companies. Therefore, the implementation of this measure will require appropriate support (institutional - providing guarantees for the necessary credit funds, creating an appropriate legal environment and financial - favourable loans for the implementation of this measure, or providing grants for the implementation of this measure, e.g. in the amount of 20-30% depending on the complexity, innovation and results of the project solution).

The implementation of this measure should be accompanied by the adoption of the law on production, distribution and supply of thermal energy. The law should regulate the conditions for the production, distribution and supply of thermal energy, the rights and obligations of producers and consumers of thermal energy, the conditions for obtaining a concession for the distribution of thermal energy, or a concession for the construction of a distribution network. This would regulate the area of district heating because the existing legislation does not encourage private investors to get more involved in the field of district heating.

It is estimated that the implementation of this measure could reduce GHG emissions by about 70,000 tCO_2 in 2030, or about 224,400 tCO_2 in 2050, compared to the emission values without the implementation of this measure. The estimate was performed based on the emission reduction calculation according to the IPCC methodology.

Assuming that the cost of investment in new capacities for renewable energy sources/biomass, geothermal energy, solar energy/amounts to around 0.8 million BAM/MW (CETEOR, FBS, GAUSS, 2018), the estimated costs of implementing this measure by 2030 would be around BAM 200,000,000, and in the period from 2030 to 2050 an additional BAM 450,000,000 (i.e. a total of BAM 650,000,000 by 2050). In this way, about 800 MW of new RES-fired plants would be additionally provided (about 80% on biomass, and the rest on other renewable energy sources). This measure would be implemented continuously until 2050.

The implementation of these measures will lead to additional employment (in new heating plants, in the collection of biomass, production and installation of solar systems, the use of geothermal energy, etc.).

The introduction of renewable energy sources in district heating systems as well as the use of waste heat from large industrial plants will lead to a reduction in emissions of carbon dioxide and pollutants.

3. Reconstruction and modernisation of the district heating network and thermal substations

The distribution network in most district heating systems is for the most part at the end of its technical lifecycle (over 30 years old) and is in a very poor condition, as are the thermal substations in which thermal energy is regulated and delivered to consumers. In these systems, only the parts of the distribution network where frequent breakdowns occurred were replaced, while the thermal substations in most district heating systems were not significantly modernised. The implementation of this activity is envisaged by the entity energy development strategies as well as numerous other strategic documents.

Implementing this measure would improve housing comfort (all users would have the same quality of heating service), reduce distribution losses, increase the overall efficiency of the heating system,

which should result in lower thermal energy prices, reduced carbon dioxide emissions, reduced fuel consumption, and air quality would be improved due to the reduction of pollutant emissions in heating plants/industrial power plants. In many district heating systems this is a necessary measure for further expansion of the network. These projects should be implemented continuously until 2050.

Cantonal and municipal authorities and district heating companies would be in charge of implementing this measure. The implementation of this measure is in line with the Energy Efficiency Directive (2012/27/EU).

Reconstruction and modernisation of the district heating network and thermal substations will require significant material investments that will not be possible to be fully financed from the own funds of the owners of the thermal energy distribution network. Therefore, the implementation of this measure will require appropriate support (institutional - providing guarantees for the necessary credit funds, creating an appropriate legal environment and financial - favourable loans for the implementation of this measure, or providing part of the grant (20-30%) for the implementation of this measure, encouraging private investments).

The implementation of this measure should be accompanied by the adoption of the law on production, distribution and supply of thermal energy. The law should regulate the conditions for the production, distribution and supply of thermal energy, the rights and obligations of producers and consumers of thermal energy, the conditions for obtaining a concession for the distribution of thermal energy, or a concession for the construction of a distribution network. This would regulate the area of district heating because the existing legislation does not encourage private investors to get more involved in the field of district heating.

It is estimated that the implementation of this measure could reduce emissions by about 8,500 tCO_2 in 2030, or about 40,000 tCO_2 in 2050, compared to the emission values without the implementation of this measure. The estimate was performed based on the emission reduction calculation according to the IPCC methodology.

The estimated costs of implementation of this measure by 2030 would amount to BAM 175,000,000, and in the period from 2030 to 2050 an additional BAM 525,000,000 (i.e. a total of BAM 700,000,000 by 2050). These costs can be significantly reduced by combining works on the network with other infrastructure works (water supply, IT infrastructure, etc.).

Domestic companies that specialise in these activities should be hired to replace the dilapidated distribution network, which will lead to additional employment.

Implementing this measure would reduce distribution losses (from the current 7.9% to about 5%) and increase the overall efficiency of the heating system, thus reducing both fuel consumption and emissions of GHG and pollutants. However, it should be emphasised that this measure is necessary primarily for the sustainability of district heating because many networks are at the end of their lifecycle.

6.3.3 Buildings and housing

Overview of situation in the building sector

The building sector in BiH which includes households and buildings where public and commercial services are provided consumes around 58.44% of total energy. This consumption amounts to about 40% in developed countries, but due to the relatively high energy needs (primarily heating) of the existing building stock on the one hand and underdeveloped industry on the other, the share of the building sector is significantly higher than in developed countries. Considering this, one of the priority goals should be to find ways to reduce energy consumption in both existing and new housing facilities.

Wood biomass and coal constitute the main source of heating energy in BiH. Around 88% of the residential sector use individual boilers and furnaces for heating. A relatively low efficiency level, below 60%, is the main characteristic of these energy conversion technologies both for coal and biomass. The market of boilers and furnaces is not regulated and some manufacturers on the market do not have adequate certificates of efficiency of their products.

On the other hand, imported boilers and furnaces are used that are not designed for domestic coals, which causes low efficiency of conversion of primary into useful energy and higher air pollution. According to the data from the Household Energy Consumption Survey conducted by the Agency for Statistics of BiH in 2015[78], the dominant method of heating is with indoor furnaces with a share of 72.90%, 7.9% of households are heated by district heating, and about 19% households have their own central heating systems.

According to TNC data, the following fuels are used for indoor furnaces: firewood 77%, electricity 12%, natural gas 2% and coal 9%. These data indicate that the share of coal in individual heating systems is very small. This is because official statistics do not consider the black market of coal (private pits and coal theft).

The building sector considered in this section includes primarily residential and public buildings, and only some data are provided for commercial buildings. Below are the basic data on residential and public buildings in BiH, which are taken from the Typology of Residential Buildings (GIZ, 2016) and the Typology of Public Buildings in BiH (UNDP, 2017).

Residential building stock in BiH comprises 861,965 buildings that include 1,619,865 housing units – apartments, of the total gross size of 162,928,630 m^2. An extremely dominant type of residential buildings are single-family houses with 93.91% share in the total number. Their total size amounts to 120,100,130 m^2 (73.71% to total residential stock). They include the largest number of housing units (63.49%), while high-rise buildings account for the smallest number of housing units (0.79%). Distribution of housing units by types of residential buildings and construction periods is shown in Table 5.

[78] Preliminary results of household energy consumption survey, BiH Agency for Statistics, 2015, http://www.bhas.ba/tematskibilteni/PotrosnjaEnergijeFinalSR.pdf.

Table 5: Number of housing units in BiH by types and year of construction

Period	Individual housing		Collective housing					
	SH	TH	MH	AB1	AB2	H	Total	%
Until 1945	12.066	1.608	2.264	3.285	-	52	19.275	1,19
1946-1960	30.576	2.180	27.894	9.667	16.653	605	87.575	5,41
1961-1970	110,371	10,472	50,541	17,648	46,061	5,224	240,318	14.84
1971-1980	244,536	14,904	52,872	20,315	99,245	5,738	437,609	27.03
1981-1991	306,898	8,858	12,053	1,976	39,797	706	370,287	22.87
1992-2014	323,595	10,179	58,588	13,447	57,918	396	464,122	28.66
Total	**1,028,040**	**48,200**	**204,212**	**66,339**	**259,673**	**12,721**	**1,619,185**	**100**
%	**63.49**	**2.98**	**12.61**	**4.10**	**16.04**	**0.79**	**100**	

SH – single-family house; TH – terraced houses; MH – multi-family houses; AB1 - apartment blocks; AB2 – apartment buildings in urban blocks; H - high-rise buildings

Specific energy need for heating of buildings is generally very high, but it differs depending on the residential building type and the construction period (Table 6).

Table 6: Average specific energy need for intermitted heating in kWh/m² per year

	Individual housing			Collective housing		
	SH	TH	MH	AB1	AB2	H
Until 1945	452.34	183.16	230.73	176.08	-	-
1945-1960	473.96	321.27	216.19	158.75	176.71	-
1961-1970	464.90	196.42	188.44	153.05	170.10	193.37
1971-1981	381.59	199.04	146.79	-	129.85	125.64
1981-1991	135.93	219.20	189.20	93.62	110.87	-
1992-2014	127.61	-	65.22	68.06	54.81	-

Electricity is used to run appliances in the household, for lighting and cooling the space, most often for heating hot water and food preparation, and to a lesser extent for heating of apartments. Electricity production in households according to 2015 Survey is shown in Table 7.

Table 7: Overview of electricity production in households[79]

	Annual electricity consumption per household kWh	Annual electricity consumption per unit of heated area kWh/m²
BiH	4,568.2	89.22
FBiH	4,483.8	80.35
RS	4,700.4	91.80
BD	4,906.0	97.53

Total size of public and commercial buildings in BiH is approximately 19,950,000 m^2. The territorial distribution of commercial buildings (shops, department stores, shopping malls, hotels, restaurants,

[79] Preliminary results of household energy consumption survey, BiH Agency for Statistics, 2015, http://www.bhas.ba/tematskibilteni/PotrosnjaEnergijeFinalSR.pdf,
Preliminary results of household energy consumption survey, BiH Agency for Statistics, 2015, http://www.bhas.ba/tematskibilteni/PotrosnjaEnergijeFinalSR.pdf,

etc.) and public buildings (administration, all-day stay, culture, upbringing, education, sports, health) is shown in Table 8.

Table 8: Territorial distribution of public and commercial buildings in BiH

Area	Total size m^2	Public buildings m^2	Commercial buildings m^2
BiH	19,950,000	9,075,439	10,874,561
FBiH	13,396,500	5,191,287	8,205,213
RS	6,214,500	3,644,839	2,569,661
BD	339,000	239,313	99,687

Public buildings intended for administration and education are the most numerous, followed by buildings intended for sports 770 and health 765, and the smallest part accounts for buildings intended for education - kindergartens (Table 9).

Table 9: Overview of total number of public buildings in BiH by purpose

Purpose	Number of buildings	Share in %
Administration	2,755	36.3
All-day stay	327	4.30
Culture	379	5.0
Upbringing (Kindergartens)	170	2.2
Education	2,434	32.0
Sports	770	10.1
Health	765	10.1
Total	**7,600**	**100**

According to age, the majority of public buildings were constructed from 1974 to 1987, while the fewest were built after 2010 and before 1945 (Table 10).

Table 10: Overview of total number of public buildings in BiH by construction periods

Construction period	Number of buildings	Share in %
Until 1945	536	7.1
From 1946 to 1965	1,905	25.1
From 1966 to 1973	1,215	16.0
From 1974 to 1987	2,233	29.4
From 1988 to 2009	1,380	18.1
After 2010	331	4.3
Total	**7,600**	**100**

The stock of public buildings is different according to purpose and age, and the climate region, and their energy performance differs significantly, which is reflected in the average values of annual energy need for their heating (Table 11).

Table 11: Average values of specific energy need for heating of typical buildings in kWh/m² per year

		I	II	III	IV	V	VI	VII
		Kindergartens	**Education**	**Health**	**Sports**	**Culture**	**Office buildings**	**All-day stay**
Region North								
A	until 1945	-	173.19	191.12	-	249.60	176.65	-
B	from 1946 until 1965	278.70	199.91	206.29	382.44	271.05	195.34	191.41
C	from 1966 until 1974	240.43	197.25	198.71	343.88	263.92	178.83	175.80
D	from 1974 until 1988	270.50	197.32	212.35	299.74	264.85	187.29	200.07
E	from 1988 until 2009	1776.81	148.09	181.20	281.36	156.26	136.18	137.04
F	after 2010	155.61	101.86	-	291.73	0.00	124.86	-
Region South								
A	until 1945	-	97.26	82.03	-	142.07	100.24	-
B	from 1946 until 1965	146.21	105.20	104.48	235.70	155.51	109.05	103.07
C	from 1966 until 1974	121.91	104.37	107.38	196.70	142.44	104.40	87.07
D	from 1974 until 1988	149.14	101.43	115.94	174.26	159.38	104.12	122.00
E	from 1988 until 2009	96.37	70.32	89.54	147.11	91.32	72.62	73.03
F	after 2010	87.15	52.13	-	159.31	-	64	-

Measures of low-carbon development in the building sector

The building sector has a great potential for energy saving, and thereby for emission reduction as well (pollutants and GHG), primarily through:

- energy renovation of residential and non-residential buildings, including thermal insulation, heating and hot water consumption preparation systems, cooling systems, household appliances, office equipment and lighting,
- use of RES which includes installation of solar heating systems for domestic hot water preparation installation of heat pumps, installation of photovoltaic systems,
- construction of new low-energy buildings, and
- replacement of energy products

Energy renovation of buildings is the priority measure in the sector of residential and public buildings. The building sector is expected to continue the good practice of energy renovation of envelopes of the existing stock of residential and non-residential buildings, replacement of heating, cooling, air conditioning systems, preparation of domestic hot water, lighting and replacement of household appliances for more efficient ones. To achieve the goals in the building sector, a strong use of financial mechanisms is envisaged, including both grants and financial instruments that will enable the mobilisation of private capital.

Modernisation of thermo-technical systems includes the application of solar thermal systems, systems for the use of modern forms of biomass (pellets, briquettes, agro-pellets, wood chips), heat pumps. Energy renovation of the building envelope reduces the need for heating per m^2 of usable space and

increases the possibility of using heat pumps for heating. Therefore, heat pumps are recognised as technologies with great potential for development and use following the energy renovation of building envelopes.

In order to reduce emissions, an appropriate measure is to expand district heating systems to RES and natural gas and connect them to existing and new buildings. The potential primarily lies in large, but also smaller cities that are suitable for the development of district heating networks and cogeneration plants.

According to its characteristics, the existing building stock in BiH requires the implementation of energy renovation measures. The draft BiH Strategy for the Renovation of Buildings, as well as the entity-level and BD draft renovation strategies envisage different scenarios for the renovation of buildings, as well as the levels of their renovation. The development of the Building Renovation Strategy is an obligation arising from the amendments to the Directive on the energy performance of buildings (EU) 218/844. These amendments set the framework for long-term strategies for building renovation into energy-efficient and decarbonised buildings.

Given that the Reconstruction Strategy has not yet been adopted at the level of BiH, nor at the level of the entities and BD, it cannot be binding at this point. Obligations that will arise from the Strategy will depend on the adopted renovation scenarios. The strategy assumes four scenarios that represent different levels of ambition for future renovation, based on two drivers - renovation rates expressed as a percentage of usable area of annually renovated buildings, and depth of renovation that the reduction of energy consumption per unit of building area depends on. Four renovation scenarios are envisaged, according to the area to be renovated annually, as follows: light scenario with 1% annual renovation of the existing building stock, ambitious scenario with an annual renovation rate of 2.23%, delayed ambitious scenario with an annual renovation rate of 1% by 2030 and 2% from 2030 to 2050, and highly ambitious scenario with an annual renovation rate of 2.8%. The planned works on the energy renovation of private houses will reduce energy consumption per area unit but will also increase the useful heated area.

Measures from 2020 to 2030

- Introduction of ‘green’ procurement system through amendments to the Law on Public Procurement. This measure would give priority in public procurement to goods and services with smaller carbon footprint.
- Adoption of new laws on maintenance of buildings at the entity and cantonal levels in order to create opportunities for major works on residential buildings in order to improve their energy efficiency and rational energy consumption, and reduce GHG emissions. These legal solutions would facilitate the decision-making on the performance of works on buildings, and funds collected by the communities of apartment owners would be used more rationally through pooling.
- More active introduction of various models for co-financing of energy efficiency projects through the entity-level funds for environmental protection and energy efficiency because the current ones are insufficient.
- Providing a separate line for financing of energy efficiency projects for socially vulnerable population as a support to completing unfinished residential buildings (initially refugees and internally displaced persons) – multi-family houses only.

- Continuous work on raising awareness of the general public, primarily young people - from kindergartens, primary and secondary schools. This is a long-term process that does not require extremely large resources, and in the long run, it can significantly contribute to the reduction of GHG emissions, i.e. energy consumption through change of habits.
- Preparation and implementation of action plans for energy renovation of buildings (at the levels of BiH, entities, BD, cantons and municipalities) - after the adoption of building renovation strategies. The building renovation strategy aims at reducing energy consumption and carbon footprint caused by energy consumption in buildings.
- Preparation for encouragement of activities on the implementation of measures from the Building Renovation Strategy (assumed scenario is a light scenario with 1% of renovated building areas per year).
- Preparation of integrated urban renovation on the level of city districts, in order to facilitate the development of district heating systems.
- Plans for measures to encourage investments in energy renovation of buildings (at different levels of government).
- Plans for measures to encourage the use of RES - photovoltaic solar systems and geothermal pumps that would enable greater use thereof.
- Development of a proposed solution for heating systems in cities with major air pollution problems - connection of all buildings to district heating systems where possible, and change of fuels in district heating plants (transition to RES that do not pollute the air).
- Tightening of regulations on the construction of new buildings - reducing the allowed energy at least to the standard of low-energy buildings until 2030, and then the transition to almost zero energy buildings by 2050.

Measures from 2030 to 2050

- Continuation of energy renovation of buildings (if a delayed ambitious scenario is adopted) - a total of 50% of buildings will be renovated by the end of this period
- Encouraging the increased use of RES for the preparation of hot water but also for the production of electricity and heat.

By combining these measures, the scenario of low-carbon development of the building sector through the trend of GHG emissions was analysed. Main characteristics of this scenario are:

- Residential buildings: expected annual increase of heated residential areas is 1%. This percentage includes an increase in newly built residential areas, but also an increase in heated areas, especially in family houses; intense implementation of the provisions of EU directives and regulations. It is envisaged that, altogether, this will lead to energy need of 70 kWh/m^2 for heating of residential buildings in 2050. The share of district heating also increases. In accordance with the adopted strategies, a change of energy products can be expected, as well as the cessation of the use of fuel oil by 2030, and coal by 2050. Greater use of RES is also envisaged, primarily through the use of solar collectors for DHW heating as well as heat pumps for heating of buildings. Due to the increase of the living standard of citizens, annual increase by 1.5% in energy consumption for the preparation of DHW is expected.
- Public and commercial buildings: the public and commercial buildings sector is expected to grow at an annual rate of 2%. Implementation of measures to improve EE in accordance with EU directives is expected, as well as the decrease of energy consumption for heating of

buildings, and utilisation of RES only, especially solar and geothermal energy. New buildings will be constructed as energy efficient with the application of the so-called 'smart' technologies that will reduce energy consumption to a minimum, without negatively affecting the users' comfort and the performance of necessary functions. In addition to RES, natural gas will be increasingly used as energy product, and discontinuation of the use of high-emission energy products such as coal and fuel oil is also envisaged. The average heat demand for heating of buildings is reduced to 50 kWh/m^{2}a by 2050, due to the renovation of about 50% of existing buildings and the construction of new ones with maximum consumption of 40 kWh/m^{2}a. Discontinuation of coal use is expected in 2030. Utilisation of fuel oil ceases in 2025. Biomass is used instead of the aforementioned energy products (mainly by 2030), and geothermal energy is predominant through heat pumps as well as solar energy in the time period from 2030 to 2050.

Trend of emissions from the building sector according to the low-carbon scenario is shown in Figure 24 and Figure 25.

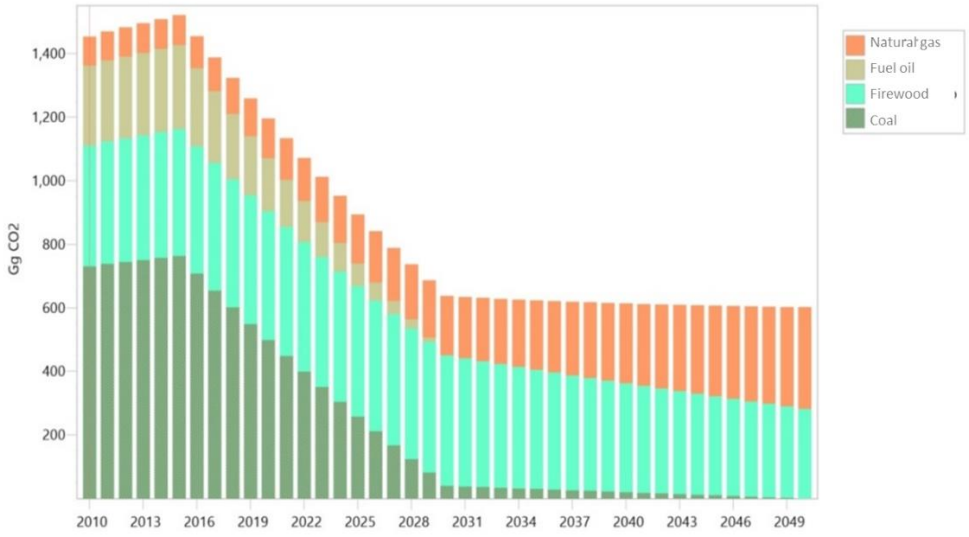


Figure 24: Trend of GHG emissions from residential buildings according to low-carbon scenario

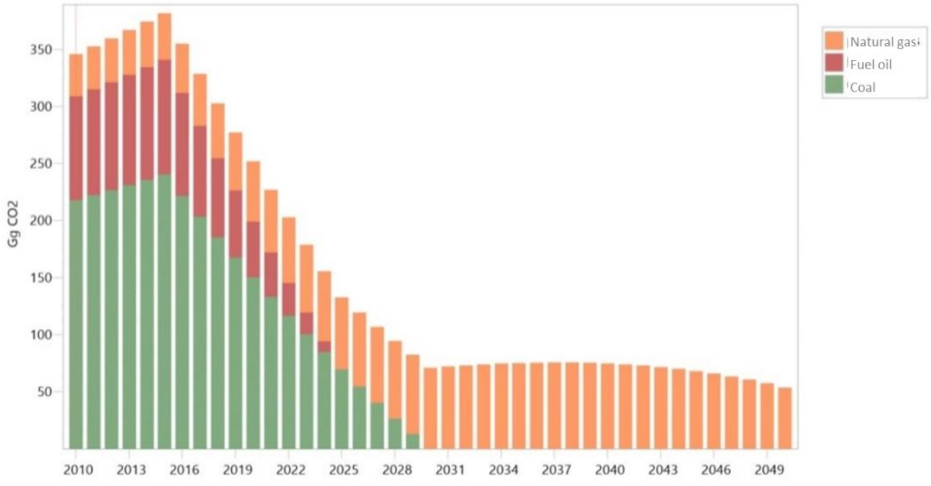


Figure 25: Trend of GHG emissions from public and commercial buildings according to low-carbon scenario

6.3.4 Transport

Overview of situation in the transport sector

Total length of road network in BiH is 22,976 km. Observed according to the categorisation, motorways account for 172 km, main roads for 3,870 km, regional roads for 4,734 km, and other/local roads for 14,200 km [80].

Table 12: Length of road network in BiH

	Length of roads in km			
Road category	**FBiH**	**RS**	**Brčko District**	**TOTAL**
Motorway	92	80	-	172
Main road	2,068	1,765	37 *	3,870
Regional road	2,546	2,151	37 *	4,734
Local road				14,200[81]
TOTAL	**4,706**	**3,996**	**74**	**22,976**

**Data obtained based on total length of roads in BiH*

The total of 1,080,873 motor vehicles were registered in 2018. The total of 89,292 were registered for the first time. Number of registered motor vehicles increases every year. Observed by structure, as much as 85.19% accounts for passenger vehicles. Percentage shares of other vehicle categories in 2018 are shown in Table 13.

Table 13: Structure of registered vehicles in BiH in 2018 (Agency for Statistics of BiH)

Vehicle category	Number of registered vehicles	%
Mopeds	4,787	0.44
Motorcycles	10,552	0.98
Passenger vehicles	920,841	85.19
Buses	5,212	0.48
Cargo vehicles	98,593	9.12
Trailers	33,588	3.11
Other	7,300	0.68
TOTAL	**1,080,873**	**100**

According to the available data on registered motor vehicles by type of energy used (data available for the following vehicle categories: passenger vehicles, buses, cargo vehicles), 22.61% of vehicles use petrol, 72.3% of vehicles use diesel, while the remaining 5.09% use some of the alternative energy sources. Detailed overview of these data is provided in Table 14.

Table 14: Fuel for registered vehicles in BiH in 2018 (Agency for Statistics of BiH)

Fuel	Vehicle category			Total	%
	Passenger vehicles	Buses	Cargo vehicles		
Petrol	228,739	1	2,966	**231,706**	22.61%
Diesel	652,001	4,330	84,488	**740,819**	72.3%
Alternative energy	40,101	881	11,139	**52,121**	5.09%

[80] Framework Transport Strategy of Bosnia and Herzegovina http://www.mkt.gov.ba/aktivnosti/default.aspx?id=5029&langTag=bs-BA

[81] Framework Transport Strategy of Bosnia and Herzegovina http://www.mkt.gov.ba/aktivnosti/default.aspx?id=5029&langTag=bs-BA

The volume of road transport in BiH is shown through two indicators: (i) goods transport, and (ii) passenger transport. Comparing the data from previous Climate Change Communications and based on available data for 2015, 2016 and 2017, it can be concluded that the volume of transport in BiH follows an upward trend. Observed in public road transport, 10,123,000 tonnes of goods were transported in 2017, and the number of tonne-kilometres amounted to 4,280,222,000. As for public passenger transport, 15,906,000 passengers were transported, number of passenger kilometres was 1,661,840,000, and vehicles passed 586,216 kilometres. If we look at the volume of passenger transport in urban and suburban transport separately, the data indicate that 130,502,000 passengers were transported, and that vehicles passed 63,572 kilometres. Table 15 provides a more detailed presentation by year with a percentage decrease or increase in transport volume indicators from one year compared to another.

Table 15: Transport volume in BiH (Agency for Statistics of BiH)

Transport	Type of transport	Year			Increase/ decrease in 2016 compared to 2015	Increase/ decrease in 2016 compared to 2015
PUBLIC ROAD TRANSPORT	**Transport of goods**	**2015**	**2016**	**2017**		
	Mileage of vehicles (in km)	458,147	507,985	586,216	+10.88%	+15.4%
	Tonnes of goods transported	8,288,000	9,377,000	10,123,000	+13.14%	+7.96%
	Tonne-kilometres	3,405,231,000	4,015,177,000	4,280,222,000	+17.91%	+6.60%
	Passenger transport	**2015**	**2016**	**2017**		
	Mileage of vehicles (in km)	87,254,000	85,475,000	93,982,000	-2.04%	+9.95%
	Transported passengers	20,471,000	16,505,000	15,906,000	-19.37%	-3.63%
	Passenger kilometres	1,690,393,000	1,706,372,000	1,661,840,000	+0.95%	-2.61%
URBAN AND SUBURBAN TRANSPORT		**2015**	**2016**	**2017**		
	Mileage of vehicles (in km)	60,592,000	62,937,000	63,572,000	+3.87%	+1.01%
	Transported passengers	138,705,000	131,776,000	130,502,000	-5.00%	-0.97%

Considering the rising number of registered passenger vehicles, the growth of passenger kilometres in this segment is also estimated. Number of passenger kilometres in 2017 was by approximately 12% higher compared to 2010.

According to the 2017 data, the railroad network in BiH consists of 1,018 km of railways, of which 601 km are located in the Federation of BiH, and 417 km in the RS. The amount of transport of goods and passengers per railway kilometre is far below the European average. The current state of the railroad infrastructure is such that the increase in the volume of transport is impossible without major

investments, and the existing amount of transport is insufficient to generate sufficient income to cover costs. Observed through goods transport and passenger transport, the volume of railroad transport in BiH is shown in Table 16.

Table 16: Railroad transport volume in BiH (Agency for Statistics of BiH)

Transport of goods	**2015**	**2016**	**2017**
Tonnes of goods transported	13,819,000	13,156,000	13,254,000
Tonne-kilometres	1,286,480,000	1,142,639,000	1,116,731,000
Passenger transport	**2015**	**2016**	**2017**
Transported passengers	518,000	409,000	472,000
Passenger kilometres	34,305,000	23,701,000	29,518,000

There is a noticeable decrease in both the number of passengers and the tonnes of goods transported in 2016 compared to 2015, and an increase in 2017. A similar decline followed by an increase is noticeable in the number of passenger kilometres, while the situation is slightly different when it comes to tonne-kilometres. The number of tonne-kilometres is on a slight decline from year to year.

Data on air transport indicate that 27 airports are officially registered in BiH. However, only 4 airports are registered for international transport: Sarajevo, Banja Luka, Mostar and Tuzla. Data on transport volume apply to these 4 airports. Sarajevo Airport has the largest volume of transport in terms of the number of transported passengers, with 957,969 out of the total of 1,556,896 transported passengers in 2017. Other airports have a smaller number of passengers, but observing the 2012-2017 period, the total number of passengers in air transport is increasing. The number of airport operations in 2017 amounted to 19,018, which is an increase by as much as 13.79%, given that the number of airport operations in 2016 amounted to 16,713.

BiH has a very short sea coast in Neum and does not have regulated or adequate access to international waters, nor a regulated seaport. The most important international port for the economy of BiH is Ploče Port in Croatia, with a capacity of 5 million tonnes per year. The Sava River is the main navigable river in BiH, 333 km long. Also, Brčko Port is a very important trans-shipment and transport-distribution centre, with an annual turnover of 125,461 tonnes in 2017. Water transport along the Sava River is connected to the Danube, which is considered the Trans-European Transport Corridor VII. The main features of river transport situation in BiH are: neglected waterways, lack of technologically modern fleet (towing instead of thrust), technical and technological obsolescence, as well as the devastation of ports and the lack of shipyards with slipways. As a positive fact, it should be noted that river navigation has the same institutional status as other modes of transport.

Measures for reduction of greenhouse gas emissions from transport

According to data from the International Transport Forum, BiH has low emissions of carbon dioxide from transport (25% below the global average and 77% below the Organisation for Economic Cooperation and Development [OECD] average). Also, the share of GHG emissions from transport is lower than in EU Member States. In 2014, this share for BiH stood at approximately 12%, and in the EU it amounted to around 20%. GHG emissions from transport come mainly from road transport (around 88% of total emissions in 2014).

Some of the targets of the BiH Framework Transport Strategy related to emission reduction are:

- alignment of existing legislation with the EU directives and legislation governing emissions from vehicles,
- incentivising imports of environmentally friendly vehicles, and
- reconstruction and electrification of railway sections.

Living standards will not allow technical measures (newer vehicles, faster growth of hybrid and electric vehicles etc.) to become a high priority in dealing with GHG emission reduction. If the dominance of road transport continues, GHG emissions would continue to grow, and would be approximately 50% higher by 2030 than today (around 5 million tonnes of CO_{2eq}). Thus, there is potential for mitigation measures in avoiding future emissions in the road transport sector. Most studies conducted on the transport sector recommend the improvement and increased use of other modes of transport instead of road transport, whenever possible. Nevertheless, given the current situation and the required investments, no significant contribution of the transport sector to reduction of GHG emissions is expected by 2030.

The movement of GHG emissions from transport is modelled for three scenarios until 2050, with reference to 2030.

Reference scenario (S1) - based on the trends of increasing number of road motor vehicles at an average annual rate of about 3% (growth rates in 2012-2017), and the average age of the fleet between 12 and 15 years with an average annual rate of increase in diesel and petrol consumption of 2%. S1 assumes that GHG emissions produced by road motor vehicles will grow somewhat slower than the number of vehicles (due to the increase in vehicle energy efficiency). As for the age of the vehicle fleet in BiH, it is estimated that the average carbon dioxide emission from road motor vehicles is about 185 g CO_2/km (with an average consumption of 6.5 l/100 km for diesel and about 7.0 l/100 km for petrol vehicles). S1 also envisages an increase in the volume of freight transport while maintaining the existing ratio of road and rail transport in total tonne-kilometres. The share of public transport remains the same i.e. relatively low in this scenario.

Moderate mitigation scenario (S2) - based on a higher share of vehicles with improved engine efficiency and reduced fuel consumption. According to this scenario, the growth rate of the number of road motor vehicles is identical to that in S1, but the quality of the fuel used as well as the road infrastructure are expected to improve (shorten the distances between cities). Reduction of the average age of road vehicles to 12 years by 2025 is a significant element of this scenario. The main characteristic of this scenario is the reduction of emission coefficient from 185 gCO_2/km in the base year to 150 gCO_2/km in 2025, then to 120 gCO_2/km by 2040, and to 100 gCO_2/km by 2050. This trend is, among other things, the result of the growing share of hybrid, electric and plug-in vehicles as well as compressed natural gas vehicles). In addition, the introduction, implementation and enforcement of EU directives in the field of transport is envisaged from 2025. Like S1, it also envisages an increase in the volume of freight transport with continuous growth of the share of rail transport in total number of tonne-kilometres. The share of public transport remains the same as in S1.

Mitigation scenario (S3) - based on more significant mitigation, i.e. reduction of emissions from transport, compared to the reference scenario, through the implementation of EU directives in BiH by 2030 (better quality fuel, more efficient motor vehicles, better tires, introduction of new regulations on imports of road motor vehicles, compliance with EU Regulation 443/2009 on limiting carbon dioxide emissions from new passenger vehicles to 95 gCO_2/km from 2021 and subsidising purchase of

hybrid, electric and plug-in vehicles), building more efficient road infrastructure and flow of vehicles, introduction of measures in urban/city transport that results in reduced emissions, increased public transport (with electrification of public transport), and a significant increase in railroad transport (50% by 2030, and 75% by 2050 participation in freight transport). The outcome of all measures is the emission factor reduction by 2030 to 100 gCO_2/km, and to 70 gCO_2/km in 2050. Like previous scenarios, this one includes the same trend of increasing number of vehicles. According to this scenario, the share of vehicle using alternative fuels in 2050 is 40%.

The results of modelling GHG emissions indicate that S1 causes a continuous emission increase, and thus emissions in 2030 are by 30.5% higher than in 2014. This is a consequence of the constant growth in the volume of both passenger and freight transport without active policy measures aimed at reducing emissions. At the end of the analysed period (2050), the emission is by 86% higher than in 2014. Unlike S1, S2 keeps emissions at existing level with the application of win-win measures (efficiency, growth of the share of railway traffic, etc.) and relatively small incentives for alternative fuel vehicles. Emissions in 2030 are by 4.7% higher than in 2014, which means that these measures are not sufficient to compensate for transport volume growth. At the end of the period, the emission is by 10.5 % higher than in 2014. Despite a slight emission increase in S2, this scenario has lower emissions by about 900 Gg CO_{2eq} or approximately 20% compared to S1 in 2030. S3 results in emission decrease by about 162 Gg CO_{2eq} or 4.8% in 2030, compared to 2014. By 2050, this scenario leads to a decrease by about 400 Gg CO_{2eq} or 12% compared to 2014. This analysis clearly indicates that only S3 leads to a reduction in GHG emissions, contributing to the overall reduction of BiH emissions. Therefore, only S3 can be considered a low-carbon emission scenario for the development of transport sector in BiH. The emission trend according to S3 until 2050 is shown below, divided to passenger and freight transport. Concrete measures are shown in Table 4, chapter 6.2.

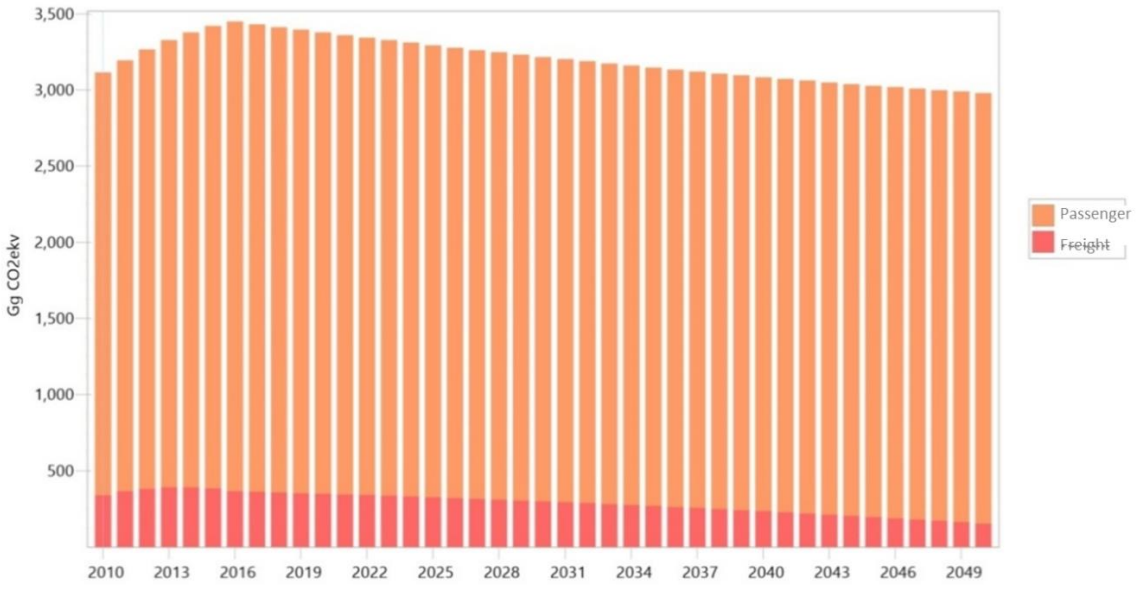


Figure 26: Trend of carbon dioxide emissions in transport until 2050 according to the low-carbon scenario

It should be emphasised that the low-carbon transport scenario has a number of other benefits such as air pollution reduction (especially in urban areas), a reduction in liquid fuel consumption which means a reduction in imports, combined with a higher share of RES in the electricity sector that also means an increase of RES share in transport, noise reduction, etc.

6.3.5 Agriculture

Overview of situation in agriculture

Agriculture, as an important economic activity, accounts for 9% of total GHG emission in BiH. The application of mineral fertilisers is the main source of nitric oxide N_2O emissions (5.8% of total sector-specific emissions in 2018), with methane CH_4 emissions resulting from livestock farming (94.2% of total sector-specific emissions in 2018).

BiH agriculture is characterised by small agricultural holdings, production for own needs, while good agricultural practices are poorly applied. Farms are mostly mixed, with an underdeveloped management and administration methods. Taking into account the importance of agriculture in food production, development and preservation of rural areas, and in the socio-economic development of the country in general, the implementation of measures to reduce emissions in the agricultural sector should proceed according to plan and gradually. Trainings and financial support systems for farmers will be important factors in the implementation of measures.

It is well known that agriculture is one of the most vulnerable sectors to climate change in BiH. The regional market integration and introduction of duty-free access to BiH market for Member States within the EU accession process creates competitive pressure, which will have a wide range of implications for agricultural production and rural economy in BiH.[82]. With all the pressures associated with proper functioning of this sector, one of the challenges is to reduce greenhouse gas emissions.

The vision of agricultural development in BiH is mostly related to BiH's EU accession, when agricultural policy will be developed in accordance with the principles of the EU Common Agricultural Policy. Significant development of agriculture, increase of economic sustainability and competitiveness of farms, and increase of total agricultural and livestock production is expected, supported by the use of European funds. There are realistic chances to start the development of rural areas while retaining the local population, and increasing the education and awareness of farmers. A significant number of producers will apply the Code of Good Agricultural Practice. Climate resilient crops will be grown, and organic production will play a significant role in overall production. The farms will have modern equipment and apply high technical and technological measures, agri-environmental indicators and standards. Livestock feeding methods will be applied that will lead to increased food digestibility and reduced emissions. Use of fertilisers and biomass waste in anaerobic digestion and biogas production will follow an upward trend. All measures that will be taken will be in accordance with natural potentials of an area, socially acceptable and economically efficient.

The implementation of mitigation measures in agriculture should contribute to overall reduction of greenhouse gas emissions in the agricultural sector, and in particular to the reduction of methane and nitrous oxide. According to scenarios, proposed mitigation measures are as follows:

1. Livestock feeding change, especially in ruminants as the largest emitters of greenhouse gases
2. Improvement of manure storage system
3. Use of fertilisers and biomass waste in anaerobic digestion and biogas production
4. Use of polymer-coated mineral fertilisers

[82]Strategic Rural Development Plan of Bosnia and Herzegovina (2018-2021) – Framework document

5. Construction of hydrotechnical facilities
6. Development and encouragement of knowledge and new technologies in this field in the entire production chain
7. Agroforestry as a measure of mitigation that can be incorporated into the organic and agroecological principles of production.

One of the possibilities for reducing the carbon dioxide concentration in the atmosphere is its binding through photosynthesis, and after the death of plants through decomposition by accumulation of organic carbon compounds in the soil (humus). Agrotechnical measures, which increase the organic carbon reserves in the soil, include the application of conservation and reduced tillage, the use of mulch, an increase in the content of organic matter in degraded soils, and measures to increase soil fertility in general. Measures implemented in agricultural production, such as reduced land cultivation, possess significant potential to reduce greenhouse gas emissions at minimal cost, often generating profit. However, such measures have not been widely used in BiH due to various obstacles and the lack of incentives for their implementation.

It is believed that greenhouse emission reduction might be achieved by changing dietary habits of the society. However, it is difficult to discuss the importance of this measure in BiH at the moment, firstly due to the traditionally high consumption of livestock products, and secondly due to the lack of countrywide surveys on dietary habits of the population.

Biomass, as a renewable energy source, is still relatively negligible in BiH. When it comes to agriculture, two categories can be considered: livestock and plant biomass. Agricultural residues such as straw or animal waste still remain unused, and they could significantly contribute to meeting of the biomass demand for energy purposes[83]. Promotion and support are needed in the development of projects for biogas production and organised biomass collection. In that regard, cultivation of fast-growing trees is also proposed which, in addition to economic benefits, contribute to reducing of carbon dioxide emissions, flood protection and phytoremediation.

Emission reduction measures in agriculture

By 2030

Considering that BiH has no common development vision or policy for agriculture sector, and that there is a lack of data on investments, efficiency of measures etc. in one place, it is difficult to give any realistic estimates for this sector without special analyses. It should be emphasised here that the entity-level agriculture/rural development strategies are defined until 2020/21, which further complicates defining of measures and investments in them by 2030.

The Sustainable Development Goals (SDG) from the 2015 Paris Protocol should serve as the motive for achievement of low-carbon development and implementation of these measures. The issue of the Paris Protocol is still not taken seriously, and public education and awareness raising of this global issue would be of great importance.

[83]Pfeiffer, A.; Krause, T.; Horschig, T.; Avdibegović, M.; Čustović, H.; Ljuša, M.; Čomić, D.; Mrkobrada, A.; Mitschke, T.; Mutabdžija Bećirović, S.; Ponjavić, M.; Karabegović, A.; Brosowski, A.: Izvještaj o praćenju potencijala biomase u Bosni i Hercegovini, 2019 /*Report on biomass potential monitoring in Bosnia and Herzegovina, 2019/*

By 2050

Low-carbon agriculture development predicts emission reduction of 377 $GgCO_2$ eq. BiH as a full member of the EU is the starting point of the scenario. Mitigation measures will be improved significantly, which should contribute to the decrease of total GHG emissions from agriculture. Efficient use of European funds and available funding for incentives and development of the sector (Pillar 1 and Pillar 2), as well as the so-called 'green payment' for three measures: crop diversification, ecologically focused areas and permanent grasslands will be crucial. Climate change is fully integrated into sectoral policies and incentive programs. Strategic documents are implemented fully in accordance with action plans. Farms have been modernised, high technical-technological measures and standards are applied, as well as Codes of Good Agricultural Practice. The level of climate change awareness is high. It is realistic to expect these measures to help achieving the given reduction, but the intensity of the implementation of the proposed measures would be stronger at the beginning, and would decrease over time. Working conditions, standards, EU membership, commitment to global targets, and especially awareness of the importance of low-carbon development will be at such a level to allow a realistic expectation that the set target will be reached.

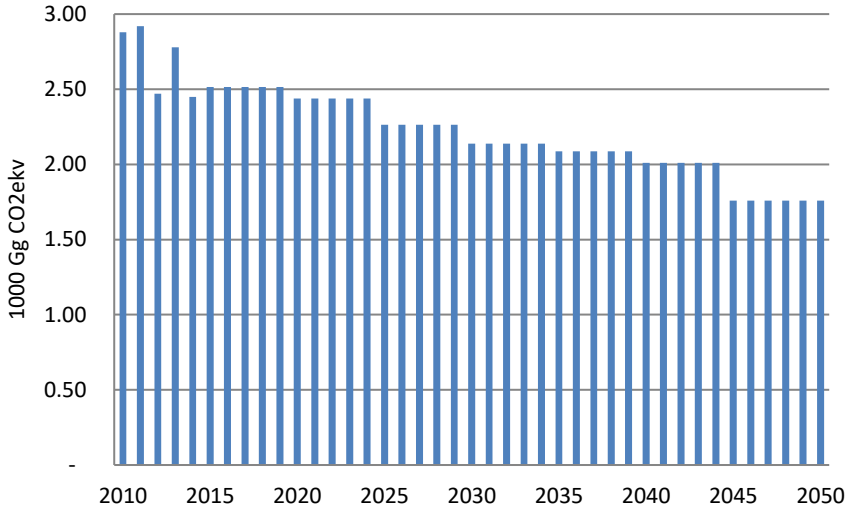


Figure 27: Trend of GHG emissions from agriculture according to low-carbon development

GHG emission decreases from 2,450 Gg CO_{2eq} in 2014 to 2,140 Gg CO_{2eq} in 2030, i.e. by approximately 13%. GHG emission drops to 1,760 Gg CO_{2eq} by the end of the observed period, which is by around 28% less compared to 2014.

6.3.6 Forestry

Overview of situation in forestry

The interaction between biological and geological diversity and human influence on them over a long history resulted in an extremely high degree of landscape, species and genetic diversity in BiH. In addition, the influence of specific orography, geological and pedological structure, hydrology and climate are also significant. Therefore, the landscape and biological diversity of BiH varies from mountainous in the central part, through arable land in the north, all the way to the typical karst - the

Mediterranean area in the south. Urban areas are mainly located in the valleys of large rivers, while most of the area can be characterised as rural.

The wealth of diversity is reflected in the large number of plant and animal species. According to Brujić (2011), there are around 4,500 higher plants, 600 mosses and around 80 ferns, and approximately 250 species of forest trees and bushes in BiH. This is why BiH ranks high on the list of European countries with a high level of biodiversity. It is this diversity that provides forest ecosystems with a better starting position in adaptation to climate change, but at the same time puts them at risk of losing rare and unique species. The main woody species are: fir, spruce, white and black pine, beech, different oak species and a large number of species of deciduous trees (such as maple, elm, ash), along with fruit trees (cherry, apple, pear). Species diversity in BiH is characterised by the highest degree of endemicity in Europe. It is believed that there are many more endemic species in the Balkan mountains than in those that are geographically close to the Mediterranean area but there is less phylogeographic research compared to other mountains. (Hewit, 2011). According to preliminary findings, 10% of all plant species are endangered (Red List of Protected Flora and Fauna of the Republika Srpska 2012, Red List of Flora of the Federation of BiH, 2013). Due to the intense change of habitat conditions, it is necessary to constantly monitor the extent to which the natural genetic pool has declined.

The basis for adaptation to climate change lies in the variability of each species and its distribution range, i.e. survival of tolerant populations and individuals that are able to adapt to new habitat conditions or migrate rapidly to favourable ones. A detailed analysis requires research work on genetic variability in order to assume the adaptivity level of species. The area of the Dinarides (the central and largest part of BiH) is very specific in terms of climate, edaphic and orographic conditions that occur in a relatively small area, directly affecting the differentiation of various ecotypes. Numerous domestic and foreign authors believe that forest trees of the Dinarides display great variability when compared to the same species in the north.

The area of Bosnia and Herzegovina is divided into four ecological vegetation areas - the Peripannonian, Inner Dinarides, Transitional Illyrian-Moesian and Mediterranean areas.[84]. Mostly oak forests are present in lower altitudes and highlands. Then there is a belt with beech forests, beech and fir, beech, fir and spruce, and finally, at the highest altitudes, subalpine beech, spruce and mountain pine (Figure 28 to the left). There is also a special belt of spruce forests, as well as forests of extreme floristic diversity marked by numerous endemic and relict species. Although small, BiH is a country of high bio-ecological potential located at one of the global biodiversity hotspots[85]. The results of the CORINE Land Cover project (or CLC2000) contributed to the research activities of forest ecosystems, taking into account the fact that the project itself plays a significant role in activities related to ecosystem protection, biodiversity prevention and climate change impact monitoring. (Figure 28 to the right).

[84] Stefanović, V., Beus, V., Burlica, Č., Dizdarević, H., Vukorep, I. 1983. Ecological and vegetational delineation of Bosnia and Herzegovina. Special edition No 18. Faculty of Forestry Sarajevo: 1-49.

[85] Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G. & Kent, J. (1999). Biodiversity hotspots for conservation priorities. Nature 403, 853-858.

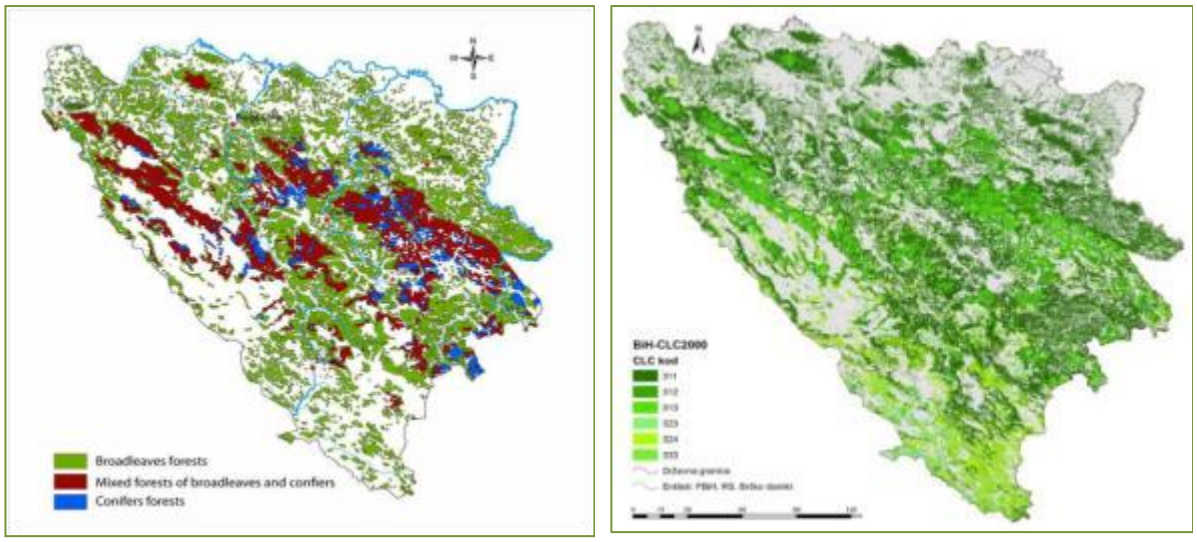


Figure 28: Areas covered by forests in Bosnia and Herzegovina
(Source: CLC 2006)

The forestry sector contributes significantly more to total employment (6.5% in the RS and 4.6% in the FBiH in 2008) than directly through GDP (only 0.83%). However, forestry is an economic branch of strategic importance in BiH due to its export activities and job creation. State-owned forests are managed by public enterprises, while at the entity level they are under the control of line ministries and entity parliaments. The legal and institutional framework relevant to the forestry sector is structured in two entities.

Today, wood processing capacities in BiH exceed habitat potentials of our forests (Musić et al., 2013), which to some extent leads to misunderstanding or 'conflict' between representatives of forestry and wood processing (Marić et al., 2012).

Forestry faces various problems: lack of long-term strategy and development of protected areas (Stupar, 2011) and forest policy, overestimated economic and social functions jeopardise ecological function, inefficient organisation, as well as practices that are not in line with EU practice. All these factors have put the forestry sector in a difficult position as it reflects inadequate cultivation and protection activities, biotic and abiotic vulnerability, degradation of forest land, loss of biodiversity and poor access to forests (FAO, 2015). This synergic effect makes forests and forest systems of Bosnia and Herzegovina vulnerable.

The large land-mined area of forests and forest land is still a significant problem in forest management in BiH. According to the official BHMAC data, 965 km^2 or 1.97% of the total area of BiH is land-mined (July, 2020)[86]. Through systematic reconnaissance operations, 8,638 landmine-suspicious micro-locations have been defined, with estimated 80,000 landmines/ERW left behind. Currently, 20,220 records of minefields are registered in the database (BHMAIS).

Forest certification, which has been implemented in BiH in the last 10 years, is of great importance for managing the quality of the forest stock. According to the Forest Stewardship Council (FSC) data from July 2020, there are 336 companies with a valid FSC standard in BiH, and the majority are engaged in wood processing and trade. Public forest management companies with FSC standards include: Public

[86]Available at: http://www.bhmac.org/?page_id=629&lang=bs

Forestry Enterprise 'Šume Republike Srpske', a. d. Sokolac; Forestry Company 'Unsko-Sanske šume', d.o.o., Bosanska Krupa; Forestry Company 'Hercegbosanske šume', d.o.o., Kupres; Public Enterprise Šume Tuzlanskog kantona, dd Kladanj; Cantonal Forest Management Enterprise 'Sarajevo-šume' d.o.o.; Forestry Company ˝Srednjobosanske šume˝, Donji Vakuf, and Public Enterprise 'Bosansko Podrinjske šume' d.o.o. Goražde. The implementation of this system significantly contributes to better management and administration of state forests and increases contribution to the protection and improvement of all forest functions, from economic sustainability, social responsibility to environmental development.

The general conclusion is that we do not have harmonised data on the size of area covered by forests in BiH. The second forest inventory (forest survey in the entire territory of BiH) has not been officially published. Inaccurate definition of the condition of forests (primarily the size) entails the question of accuracy in assessing adaptation and/or mitigation as well as the development of all further strategic goals. At the same time, forestry is considered as one of the daring sectors in terms of mitigation, and one of the vulnerable sectors in terms of adaptation. Compared to all previous reports, the common information is that the area covered by forest is increasing, the volume of felling is increasing, and that the volume of afforestation is decreasing.

Measures to increase GHG sink in forestry

The strategy of low-carbon development for forestry covers the period until 2030. In order to increase the GHG sink i.e. the contribution of forestry to climate change mitigation, the sector development scenario was analysed, which is based on the assumption that BiH will become a full member of the EU by 2025, and thereby accept all obligations and directives concerning forestry. This primarily refers to the full certification of the entire forest stock in BiH in order to improve the sustainable management of forest complexes. One of the special measures taken into account in this scenario is the continuous afforestation of degraded forest cover and afforestation and rehabilitation of barren land in order to maintain and preserve existing and surface increase of forests in the coming period. According to this scenario, a very important activity for this purpose is complete landmine clearance of existing land-mined forest areas (about 10% of all forest areas), which further opens the possibility to increase the carbon storage potential of forests in BiH. The area of 5,500 ha is afforested per year, with complete success. In the next 20 years, additional 100 ha of energy plantations of fast-growing species are established every year. Activities and investments in fire protection are introduced from the first year of the observed period and they are constant. These activities contribute to estimated annual decrease of fire-affected area by 1,000 ha. Protected areas are isolated with intensity of 100 ha per year. If all the activities envisaged in this scenario were realised, the sink in 2025 would be higher by 285 Gg CO_{2ekv} compared to 2014.

Measures for achievement of the described scenario in the forestry sector are:

1. Detailed mapping of forest species composition (field survey, remote sensing and GIS mapping project),
2. Research into species selection based on modelled climate change; technical assistance, research programme, species trials,
3. Monitoring plots established in vulnerable eco-types to assess changes, disease, mortality and succession (budget includes monitoring over entire period)

4. Trials of new species, provenance and origin underway; field trails established (budget includes monitoring over entire period).
5. Silvicultural improvement of low forests and shrubs, mainly in small private holdings, technical assistance and co-financing for bio-energy production and carbon storage,
6. Improve forest fire protection system; on the ground forest management (firebreaks, re-structuring, fire-fighting equipment, observation and real-time monitoring),
7. Research into pest and plant diseases due to increased temperature; four PhD students and associated research support,
8. Capacity of forestry staff to implement integrated forest management approaches enhanced (technical assistance, training, study tours).

Forestry development vision serving low-emission development in BiH is defined as:

I. Forestry will continue the tradition of sustainable forest management in BiH, emphasising the foundational ecological functions.
II. Reduced impact of biological stressors (greater tolerance to harmful biotic and abiotic factors).
III. In the existing areas, the increment will increase, the unforested land will be used for new forests, areas of lower cultivation form (coppice and degraded forests) will be managed to increase carbon dioxide uptake, forest areas will be cleared from landmines and included in regular management system, and ecological use of wood products in traditional and new products will be encouraged.
IV. The forest is managed in such a way as to maintain all its general useful functions, protect biodiversity and increase the resilience of forests to climate change. Carbon stocks in forest biomass (wood biomass, soil, organic matter and dead wood) have been increased to make the land use and forestry sector a permanent sink for greenhouse gases.
V. More agro-forestry and environmentally friendly management systems, integrated business and development projects, high level of information about condition of forests, inventory, vulnerability and trend projections.

Five main measures to increase GHG sink in forestry (presented in details in chapter 6.2) are:

1. Afforestation of barren land, coppice and degraded forests
2. Establishment of plantations of fast-growing species and Afforestation of erosion-affected areas
3. Application of ‘adaptive forest management systems’
4. More efficient measures to protect forests from fire, disease and pests
5. Larger area of special purpose forests (protected areas, high protection value forests, etc.)

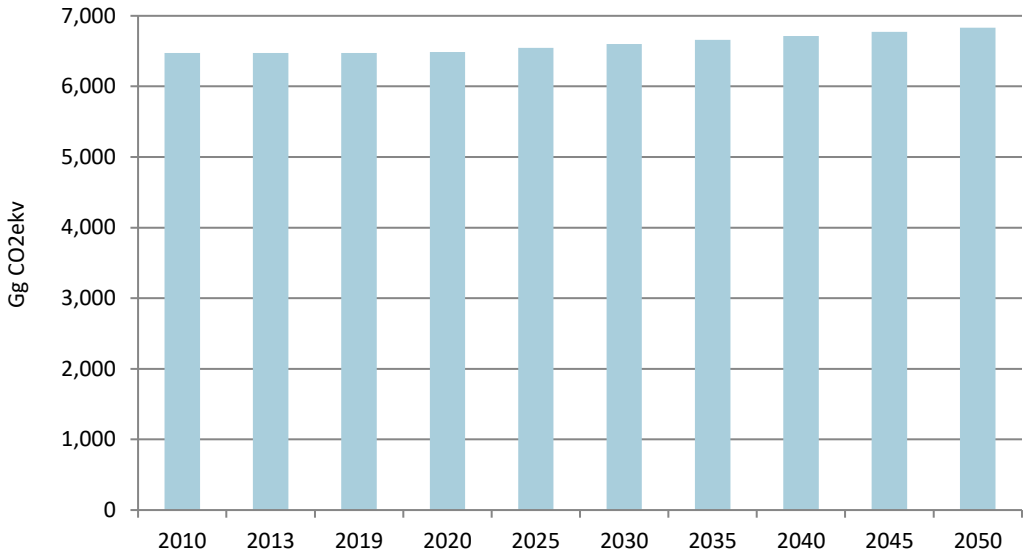


Figure 29: GHG sink trend in forestry

By 2030, the sink amount stagnates; in 2030, it is by about 130 Gg CO_{2eq} higher compared to 2014. The analysed measures have a visible effect only after 2030, and GHG sink is about 360 Gg CO_{2eq} higher in 2050 than in 2014, which is about 1.4 of total GHG emissions in BiH in 2014.

6.3.7 Waste

Overview of situation in waste sector

The amounts of generated waste in BiH in 2015 and 2016 were 1,245,653 t and 1,243,889 t, which indicates a slight decrease. According to the data from previous reports[87], the amount of waste in 2014 was 1,327,130 t. The amount of waste in 2014 is higher than in 2015, although the amount of waste generated per capita is higher in 2015. The amount of waste per capita was 0.95 kg/capita/day in 2014, while in 2015 it was 0.97 kg/capita/day. Namely, the number of inhabitants in 2015 was by 309,045 lower compared to 2014.

Table 17: Overview of waste amounts and daily waste projection per capita in BiH

Year	Population number	Amount of waste kg/capita/day	Total amount of waste t
2014	3,827,343	0.95	1,332.42
2015	3,518,298	0.97	1,245,653

From 2001, which is the final year for the inventory in the Second Climate Change Communication, until 2010, crucial things happened in waste management, which have already significantly affected the situation in waste management. These are presented below. These changes affected the process of obtaining reliable data on generated and treated waste amounts. Coverage of collection and disposal services was about 72% and 75% (2010 and 2011), and 74% and 70% (2014 and 2015), which points to variations, without exclusively arithmetic progression of increase or decrease. For the given

[87] Second Biennial Report of Bosnia and Herzegovina on Greenhouse Gas Emission

amounts of generated waste, calculated methane emissions are 44.70 Gg CH_4 and 40.84 Gg CH_4 (2014 and 2015).

Regarding regional sanitary landfills in the FBiH, 4 landfills were built (Smiljevići-Sarajevo, Mošćanica-Zenica, Uborak-Mostar and Korićina-Livno). The following landfills operate in the RS: Brijesnica-Bijeljina, Ramići-Banja Luka and sanitary landfill Crni vrh-Zvornik. Therefore, it can be said that the quantitative target - 4 regional landfills by 2021 - may be achieved in the RS soon. In addition, this analysis takes into account the new EU Directive[88] encouraging an increase in recycling, with the following municipal waste recycling targets: 60% by 2030; 65% by 2035; 70% by 2040, and 80% by 2050.

From 2012 to 2018, operators of the packaging waste and electrical and electronic waste management system were registered (a total of 4 operators). The operators aim at collecting as much packaging waste and electrical and electronic waste as possible, and disposing them in the prescribed manner. Table 18 shows amounts of generated waste, methane emissions and disposed waste amounts in BiH.

Table 18: Data on waste amounts and methane emissions in BiH[89]

Year	Amount of generated waste t	Amount of registered disposed waste t	Population number	Amount of waste kg/capita/day	Annual net emissions Gg CH_4
2014	1,332.42	985,990	3,827.343	0.95	44.70
2015	1,245,653	924,050	3,518.298	0.97	38.33

In the period after 2002, laws and regulations were adopted, as well as strategic documents regulating waste management, and the National Environmental Action Plan of BiH was adopted. (NEAP[90]). In addition to official acts of the institutions in BiH (*laws and regulations of the Republika Srpska, the Federation of BiH and the Brčko District*), the World Bank, the Czech Development Agency and SIDA implemented a series of significant projects aimed at establishing an integrated waste management system, mainly related to the development of waste management programmes. Also, the implementation of the EU Project for Strengthening Environmental Institutions in BiH and preparations for pre-accession funds have been finalised, which contributes to the progress of the environmental protection sector in the EU accession process. The project ended in December 2014. The Directive Specific Implementation Plan (DSIP)[91] and Action Plans for the implementation of the EU Landfill Directive in the Federation of BiH, Republika Srpska and Brčko District of BiH were developed within the project. The project recommendations for this area are that the Directive Specific Implementation Plans (DSIPs) for each of these horizontal directives should be prepared under coordination of the Ministry of Foreign Trade and Economic Relations, in cooperation with the Directorate for European Integration.

[88] DIRECTIVE (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste

[89] Data source: Agency for Statistics of BiH, available at: http://www.bhas.ba/saopstenja/2016/KOM_2015_001_01_BA.pdf, http://www.bhas.ba/saopstenja/2017/ENV_01_2016_Y1_0_BS.pdf

[90] National Environmental Action Plan BiH/NEAP BiH World Bank/WB, IDF Grant National Environmental Plan BIH – NEAP, Sarajevo/Banja Luka, March 2003)

[91] Landfill Directive (1999/31/EC)

Low-carbon development measures in waste management sector

The EU Circular Economy Action Plan aims at improving the conditions for more sustainable growth through more efficient use of resources and establishment of consistency with other policy areas. The Action Plan covers many topics and measures, from product design through consumption to waste management and recognising the greater value of resources. The plan is to change the legislative framework for circular economy development, set long-term waste management targets, and implement further concrete measures. In the Republika Srpska, the 2017-2026 Waste Management Strategy is the main document that assesses the state of waste management, determines long-term waste management targets, and provides conditions for rational and sustainable waste management. Moreover, the Action Plan should support companies, the society and Member States during the implementation, both on regional and local levels. The Action Plan explicitly emphasises the global dimension of this issue and refers to the set goals of the UN's 2030 Agenda for Sustainable Development.

The establishment of a waste management system, which includes the appropriate collection, transport and treatment/disposal of different types of waste, should be planned and focused towards conservation of natural resources and the basic principles contained in EU legislation:

a) principle of selecting the most environmentally friendly option,
b) principle of proximity and joint waste management approach,
v) principle of waste management hierarchy,
g) responsibility principle, and
d) the 'polluter pays' principle.

As early as in 2001 and until 2010/2011, significant progress was made in the legislation in BiH. An amendment to the Law on Waste Management was adopted in the FBiH. More precisely, the 'Law on Amendments to the Law on Waste Management' was adopted in November 2017, while 2 amendments to the Law on Waste Management were adopted in 2015 and 2018 in the RS.

The Rulebook on packaging and packaging waste management was adopted in the FBiH in December 2011, as well as the Rulebook on management of waste from electrical and electronic products in October 2012. In the RS, the Decree on packaging and packaging waste management was adopted in 2015, and the first operator was registered in 2016.

As for secondary legislation, it is important to emphasise that changes were made several times in the field of packaging and packaging waste management as well as electrical and electronic waste management from 2012 to 2018.

Implementation of the aforementioned legislation and the implementation level contributed to the change of situation in waste management sphere. Unfortunately, the legislation is still not harmonised in the entities (the level of transposition of directives is not the same), nor have the same legal acts been adopted (e.g. rulebooks on specific waste streams), which makes it difficult to predict scenarios for the whole of BiH. In the period between the development of the Third and Fourth National Communications on Climate Change, the 2017-2026 Waste Management Strategy was adopted in the RS in November 2017. Development of the RS Waste Management Plan started in April 2018. The RS Government adopted Decision no. 04/1-012-2-1178/20 on 23 April 2020, adopting the RS 2019-2029 Waste Management Plan. The FBiH's Waste Management Strategy was valid until 2018, and Cantonal

waste management plans have been developed in most cantons (e.g. Sarajevo Canton, Zenica-Doboj Canton; Una-Sana Canton, etc.).

As a precondition for successful implementation of waste management based on environmental protection principles, it is necessary to establish an information system for collection of data on waste amounts (through the Environmental Protection Fund), and develop a sustainable waste management system based on environmental protection principles, along with constant education at all levels of society and economy.

Greenhouse gas emission is reduced indirectly through sustainable waste management, as follows:

- establishment of a waste management system
- remediation of illegal dumpsites
- complete waste reuse (recycling; composting, recovery).

Projections of greenhouse gas emissions from the waste sector are based on the implementation of measures prescribed by sectoral and entity-level legislation, which is harmonised with EU legislation.

Low-carbon scenario also includes the implementation of measures for reduction of greenhouse gas emissions from solid waste disposal. The EU Directive 2008/98/EC on waste sets the main concepts and definitions related to waste management, and lays down main waste management principles. The Directive lays down environmental protection and human health protection measures preventing or reducing the effects of generation and management of waste and decrease overall impact of resource use, thereby improving the efficiency and utilisation. The Directive sets the waste management hierarchy, as follows:

- waste generation prevention,
- preparing for recovery of waste,
- recycling,
- other types of waste treatment, e.g. energy recovery,
- waste disposal.

Low-carbon waste management includes:

- Prevention of generation and decreasing the amount of waste
- Increasing the amount of separately collected and recycled waste
- Providing the system of landfill gas treatment and use
- Reduction of biodegradable waste going to landfills
- Use of landfill gas for electricity and heat production.

Directive 2018/850 of 30 May 2018 on the landfill of waste defines gradual reduction of disposed amount of biodegradable waste in landfills. The Directive on landfills provides guidelines for changing the waste disposal methods and sets targets for reducing the amount of biodegradable municipal waste disposed in landfills. The Directive was amended on 19 December 2002 by the Council Decision (2003/33/EC) establishing criteria and procedures for the acceptance of waste at landfills. The target for Member States is to have all biowaste separated and recycled at the source or to have it collected separately from other waste types by 31 December 2023.

The analysis also included the EU's Strategy for Circular Economy setting the task to fulfil ambitious municipal waste management targets by 2030 related to the reduction of waste amount disposed in

landfills to a maximum of 10% that can be disposed, with simultaneous reuse or recycling of at least 65 -75% of municipal waste.

Given that the EU Directive on landfills imposes restrictions on the disposal of biodegradable waste in landfills, composting is certainly gaining importance as one of potential options for biodegradable waste management.

Increasing the amount of biodegradable waste sent to biological treatment processes, such as composting and anaerobic digestion in biogas plants, results in reduction of methane emissions because it ends up in the biogas plant (methane is burned and only carbon dioxide remains). However, the overall effect of reducing the amount of disposed biodegradable waste is positive, because the reduction of methane emissions will also occur due to the reduction of the amount of disposed biodegradable waste in landfills.

The decomposition of organic waste components in the upper layers of the landfill body takes 15 to 20 years, and even much longer in the lower parts. The aerobic processes of decomposition of organic matter mostly produce carbon dioxide. In the final, the so-called 'anaerobic stable methane stage', biogas contains mainly methane (about 55%) and carbon dioxide (about 45%), generating additional amounts of greenhouse gases (carbon dioxide and methane)

In BiH, waste treated with a biological or other method started with only 0.5% (2018), and should reach 16% by 2050. In case of EU accession, BiH can extend deadlines for implementation of directives by a few years only, and not indefinitely. Thus, the deadline until 2023 for separate collection of biowaste can possibly be extended until 2030.

Therefore, a scenario should be planned in which municipalities would build a system for separating organic components from waste and composting in municipal waste management centres as well as encouraging households, where possible, to compost in the garden by purchasing composters, and providing incentives through amount-based waste tariff system. GHG emission reduction potentials that can be realised through the application of measures are also balanced in the energy sector.

The waste management hierarchy, under the EU Framework Directive, provides clear waste management guidelines to Member States, as well as to countries aspiring to join the EU. Waste disposal is at the very bottom as the least preferrable option. In order to achieve a low-carbon waste management scenario, the following guidelines should be implemented:

By 2030:

- Saving raw materials by applying waste generation prevention and recycling measures;
- Introduction of a system for separate waste collection, in accordance with the targets set in local legislation;
- Full remediation and closure of existing illegal dumpsites;
- Establishment of a waste management system implemented in accordance with the objectives of EU directives - establishment of waste management centres;
- Improvement of electricity production from renewable sources - biogas power plants;
- Solving the issue of waste sludge (from wastewater treatment plants), with the potential for use in agriculture, planting of fast-growing crops for energy purposes (Miscanthus; Paulownia etc.);
- Efficient waste use - recycling centres with sorting plants - circular economy;

- Transfer of knowledge and experience of EU countries in the application of best waste treatment techniques available;
- Awareness raising of the need for waste management - circular economy, encouraging cross-sectoral cooperation (food industry, agriculture, forestry, ...);
- Provide training for the preparation of investment projects - use of funds from EU structural and investment funds;
- Providing a positive environment for attracting of investments.

By 2050:

- Full functioning of the integrated waste management system at the entity and BD levels;
- Development of new waste treatment technologies - investments in research and development;
- Implementation of programmes for investment in efficient waste treatment measures, ensuring reduction of GHG emissions.

By combining these measures, the scenario of low-carbon development of the waste sector through the trend of GHG emissions was analysed. Main characteristics of this scenario are:

An increased level of recycling is introduced at the waste generation site and at the landfills themselves. New rulebooks on the disposal of batteries and accumulators, tires, glass and other waste from specific streams that have not been adopted yet will greatly contribute to this. The rulebooks will also affect the change of the way of charging for services based on generated waste amount. This scenario did not take into account the construction of incinerators for incineration of mixed municipal waste (i.e. treatment after recycling), RDF production, etc. Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) is transposed and implemented.

Principles for prevention of waste generation and reducing the amount of generated solid waste are implemented. The amount of separately collected/sorted solid waste and recycling for further reuse of waste is increased in a minimum share of 60% of waste mass by 2050. Waste treatment systems are installed and maintained at the landfills with the collection and utilisation of landfill gas at all sanitary landfills. Amounts of disposed biodegradable waste are reduced, and biogas and compost are produced from it. Amount of utilised biodegradable waste stands at 30% by 2050. Figure 30 shows GHG emission trends expressed in Gg CO_{2eq} from the waste sector according to low-carbon development.

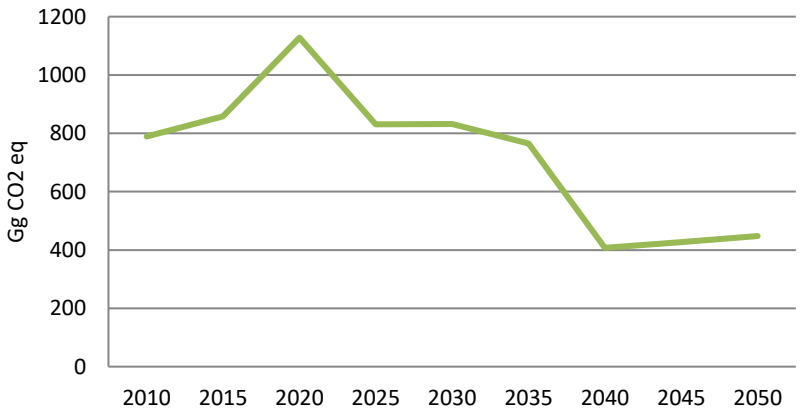


Figure 30: Total GHG emissions from waste sector in BiH according to low-carbon scenario

The figure shows that GHG emission in the waste sector is around two times lower in 2050 than in 2014. However, there is no emission reduction by 2030 due to the time needed to implement the measures. The emission reduction in the energy sector resulting from the production of energy from biogas has been taken into account in the energy sector.

7 IMPLEMENTATION OF THE STRATEGY

7.1 Capacity building

7.1.1 Institutional capacity building

For the purpose of climate change adaptation and mitigation, institutional capacity building is necessary, i.e., strengthening of capacities of institutions and of experts for the implementation of the Climate Change Adaptation and Low Emission Development Strategy for Bosnia and Herzegovina. Capacity building is particularly important in the context of the necessary transformation of economy and society for them to become sustainable. Climate change adaptation is a new concept and a long-term process, which must be carried out in a continuous and planned manner.

BiH is facing significant institutional, financial and human resource limitations in addressing climate change problems. Adapting to and mitigating climate change, as well as building a more resilient society, is complex work. It requires access to diverse types of knowledge, such as climate projections and their impact on natural hazards. It also requires a deep understanding of the situation as well as the willingness to cooperate towards common goals. The institutions in BiH are facing significant challenges that lead to a reduction of capacities for adaptation and capabilities to implement and further develop climate change adaptation strategies, plans and programmes. The RS Ministry for Spatial Planning, Civil Engineering and Ecology represents BiH in the implementation of UNFCCC activities and coordinates all other bodies, at all levels, in the implementation of requirements under the Convention, in cooperation with the BiH Ministry of Foreign Trade and Economic Relation.

Institutional strengthening is needed at all administrative levels: from the state level (e.g. the authorised body for international cooperation in the field of climate change mitigation projects and measures, statistics agencies) to the entity level (e.g. ministries responsible for various aspects of climate change policy, energy efficiency funds, funding mechanisms to support climate change mitigation measures) and the regional and local level, together with the business sector and civil society. The level of knowledge on adaptation is somewhat satisfactory in some institutions (those directly related to vulnerable sectors covered by the Adaptation Strategy). Further capacity building is needed in terms of:

- Ensuring more material and financial resources for the implementation of future planned adaptation measures;
- Recruiting more experts for such topics – there already exists a lack of adequate experts, but this will be even more pronounced in the implementation of action plans adopted for the implementation of the Adaptation Strategy;
- Providing further training for experts in the public sector on climate change and adaptation within their respective fields, especially for those segments of the public sector that are directly involved in the implementation of action plans;

- Participation of BiH representatives in international climate change conferences and forums. In this regard, the institutions need to be open to support their representatives and enable their attendance at conferences and professional gatherings (e.g. COP UNFCCC requires more numerous delegations of representatives of all stakeholder institutions, academia and the NGO sector to represent BiH as well as possible at the international level).

It is necessary to strengthen training for experts working outside the public sector on climate change and adaptation, especially in segments of the economy where the activities are directly linked to climate-related or natural characteristics. It is also necessary to work on further targeted training for experts within NGOs who would then further train broader groups of citizens.

The capacities of institutions competent for the implementation of the Strategy should be strengthened in terms of human resources development, and of the improvement of administrative practices and processes that will result in higher efficiency of institutional work. BiH's priority in the field of climate change mitigation, as well as adaptation, is to strengthen its institutional and professional capacities for development and implementation of climate policy, greenhouse gas monitoring, as well as planning, implementation, monitoring, reporting and verification of mitigation and adaptation measures. The capacity building process, combined with the implementation of mitigation and adaptation measures, will facilitate BiH's eligibility for EU membership, in terms of legal transposition/harmonisation of legislation, administrative capacities and policy implementation.

- *Institutional and organisational measures – agriculture*

The response to high vulnerability in agriculture should focus on important issues such as human capacity building towards better understanding of the issues, increase of soil water retention capacity, conservation tillage measures, growth of adequate species and varieties resilient to climate change, introduction of irrigation systems in all BiH agricultural areas, construction of water reservoirs and ponds for irrigation, application of anti-erosion measures and introduction of agroforestry as a measure to mitigate the effects of high temperatures, biodiversity protection and landscaping. Continuous training and capacity building of agricultural producers is necessary. Extension services should play a key role in promoting agricultural practices and disseminating knowledge and skills regarding adaptation measures. In this regard, it is necessary to strengthen the capacities of the extension services.

- *Institutional and organisational measures – water*

Institutional and organisational measures improve society's readiness to reduce disaster risks and impacts by developing prevention and preparedness, through the provision of climate information, establishment of meteorological and hydrological forecasting and monitoring systems, awareness raising and establishment of mechanisms for effective societal responses to extreme events, multifunctional use of watercourses (water accumulation, energy production and tourism). These measures generally affect their participants, including strengthening of administrative and technical capacities of relevant public institutions. They also include the preparation of technical studies and development of legislative acts that are, on the one hand, in line with actual needs of adaptation to climate change and, on the other, respond to the requirements that BiH should meet in the EU accession process.

- *Institutional and organisational measures – forestry*

The development of human resources and the strengthening of research organisations, which focus on impact/vulnerability assessment of climate change on the forestry sector, could lead to the inclusion of these aspects in policy making. The ecological, social and economic impact of climate change on forest ecosystems and the possible contribution to their mitigation need to be assessed in more detail.

- *Institutional and organisational measures – biodiversity*

To protect species and habitats as efficiently as possible, it is necessary to work on capacity building of institutions responsible for the management of existing protected areas. Institutional and organisational adaptation measures in the field of biodiversity are typology and habitat mapping, establishment of new and capacity building of existing protected areas, revision of red lists and action plans for control of invasive plant and animal species.

- *Institutional and organisational measures – tourism*

Climate change, as a global phenomenon, affects the changing environment in the entire economy, including tourism. Institutional and organisational measures in the tourism sector relate to institutional capacity building and enacting legislation, which are the basis for more effective implementation of adaptation measures, especially through structural measures that give the most concrete effects and results. One of the measures is to introduce more efficient legislation in tourism and hospitality and develop uniform tourism statistics templates at the entity level. Capacity building in the field of energy and construction also puts tourism in the function of mitigation and adaptation (e.g. energy production at tourist facilities, construction of tourist facilities resilient to extreme climatic conditions).

- *Institutional and organisational measures – health*

Institutional and organisational measures of adaptation to climate change for the health sector constitute complex research of the impact of climate change on certain diseases of importance for modern medicine, development of an action plan, establishment of a database of health statistics in public health institutes, enactment of legislation to regulate working hours and work obligations in days of climate extremes, strengthening the capacity of Emergency Services and capacity building of public health institutes.

The above sectors have the greatest need for institutional capacity building, which does not diminish the importance of capacity building in other sectors.

- *Institutional and organisational measures – electricity, district heating, transport and buildings*

Institutional and organisational measures for adaptation to climate change for the electricity sector, renewable energy sources, district heating, transport and buildings relate to institutional capacity building and enacting legislation – the bases for more effective implementation of mitigation and adaptation measures, especially through structural measures that give the most concrete effects and results. In the aforementioned sectors, it is necessary to ensure continuous capacity building for competent institutions, to ensure mutual aligning of different sectors and to increase the efficiency of all these sectors. It is necessary to strengthen the capacity for the transfer of low-carbon technologies and the practices of building infrastructure resilient to expected climate change.

- *Institutional and organisational measures – waste*

Institutional and organisational measures for adaptation to climate change for the waste sector refer to the adoption of laws and regulations, which should be harmonised with the EU legislation, to establish a functional waste management system. Developing and strengthening institutional capacities modelled on EU Member States also means adequately distributing responsibilities and functions among waste management stakeholders. It is necessary to develop and strengthen information and technical services, as well as to set up adequate software for waste flow monitoring in order to establish the only possible functional waste management system.

7.1.2 Capacity building for EU policies on climate change, energy efficiency and environment protection

Stakeholders in Bosnia and Herzegovina, including local leaders, city and municipal mayors, are aware of the need to respond to climate change and take important steps. According to the official website of the Covenant of Mayors, a total of 19 SEAPs have been drafted and adopted in BiH.[92] SECAP is being developed in BiH[93] within the project 'Catalysing Environmental Finance for Low-Carbon Urban Development', implemented by the United Nations Development Programme (UNDP) for 37 municipalities and cities, where action plans were developed in 2019 and 2020 in accordance with the Covenant of Mayors for Climate and Energy. SECAP is based on a baseline emission inventory and risk and vulnerability assessments that include an analysis of the current situation. For a smooth implementation of activities during the implementation of SECAP, it is necessary to adjust the structures of local authorities and ensure sufficient human resources.

To date, capacity building has been ensured by UNDP, GIZ and the EU at the local level. It is possible to continue working using these models and get linked with them, as well as with the approaches taken in the EU and in individual member states, such as the Covenant of Mayors and various other cities, local communities and business networks. The activities should primarily focus on documenting, developing and disseminating good practice examples from the political and practical levels. All major EU-funded projects are required to demonstrate that adaptation and mitigation measures have been envisaged to reduce risk, and that the project contributes to reducing GHG emissions (so-called climate proofing).

To improve the existing capacities for transposition and implementation of the EU *acquis*, the need to improve the system for continuous monitoring of the effectiveness of the implementation of regulations at the level of BiH was especially recognised. It is especially important to improve the knowledge of relevant EU regulations and the manner in which they are transposed into BiH legislation, integrated approach to strengthening the environmental management system, as well as the technical capacity building of relevant services and competent institutions.

The responsibilities of the competent ministries, both at the level of BiH and at the entity level, should be clear and should involve regional and local authorities in the implementation. Therefore, it is necessary to plan investments in training and adaptation capacity and expertise building, especially for local units that are most vulnerable to climate change.

[92] Sustainable Energy Action Plan

[93] Sustainable Energy and Climate Action Plan

Decarbonisation, energy transition and climate change mitigation or adaptation will affect all areas of human activity and life. Spatial and urban planning as a multidisciplinary activity unites all sectors only through planning solutions, therefore, spatial plans are the main instruments for implementing climate policies having the force and legal nature of secondary legislation. Thus, the strengthening of continuous professional development programme for spatial and urban planners related to climate change adaptation measures should be one of the key measures in climate change adaptation and mitigation.

7.1.3 Education, research and development

The analysis of curricula in BiH has shown that scientific knowledge about the theory of climate change and its impact on natural and social processes is almost imperceptible in the curricula of higher education institutions. There is a need for better coverage of these topics in curricula at all levels (primary, secondary and higher education). The importance of climate change and its impact on infrastructure, social processes and human health are increasingly recognised as a significant modern aspect of life, therefore, climate change is gradually being introduced into the higher education curricula in technical, social, and medical and health study courses. Given the above and the importance of climate change and the scientific results in this field and as seen in the three communications on climate change in BiH, there is a strong scientific and economic interest to include contents in higher education curricula that relate to all aspects of climate change studies with special emphasis on climate change adaptation and mitigation scenarios.

The interactions of science and policy are crucial in the development and implementation of GHG emission reduction measures and programmes. Climate change strategies need to be based on sound scientific evidence. The overwhelming scientific evidence gathered in recent decades has put climate change in a high-ranking position, to better understand the vulnerability of sectors, regions and individuals.

Research in the field of climate change has intensified in the last few years but sporadically and only at some faculties (faculties of natural sciences and mathematics, faculties of agriculture and food sciences, faculties of forestry and some technical faculties). The results of these studies have been partially incorporated into climate change communications and published in prestigious international and national journals. It is important to note that allocations for research and development in BiH are still at a very low level, and that the opportunities offered by international research programmes (e.g. Horizon Europe[94]) are insufficiently used.

The Strategy focuses on information collection, modelling and pursuit of knowledge about climate change for the purpose of reducing the uncertainty of future trends projections. There is also an application of the precautionary principle within the Strategy: precautionary measures are being taken to anticipate, prevent or minimise the adverse effects of climate change.

Key research needs

There are important research needs in order to develop a better understanding of adaptation and adaptation approaches. A key requirement in understanding and managing climate is meteorological

[94] Horizon Europe is an ambitious € 100 billion research and innovation programme that will succeed Horizon 2020. The European Parliament and the Council of the EU reached a provisional agreement on Horizon Europe in March and April 2019, respectively.

monitoring. In the past few years in BiH, dozens of automatic hydrological and meteorological stations were procured through projects (EU IPA, WBIF/GEF/SCCF Drina River Basin, assistance from the Government of Finland, WB, UNDP) that followed in response to the catastrophic 2014 floods and which focused on developing flood forecasting system in the Sava River Basin and strengthening the capacity of hydrometeorological services. Thirteen agrometeorological stations were also procured - FBiH and RS Meteorological and Hydrological Services received 6 stations each as assistance from the Government of Japan (equipment arrived in June 2019), and one station was installed in FBiH Service through the GEF SCCF Drina River Basin project. The response to 2014 floods also explains the equipping of meteorological and hydrological services with modern data management software and equipment for field measurements. What is very important in the coming period is to ensure their sustainability, through the maintenance of purchased equipment and the renewal of software licenses.

In tandem with the process described, capacity building of the FBiH and RS Meteorological and Hydrological Services must take place. It is especially important to ensure appropriate staff, i.e., to strengthen the staff by recruiting relevant engineers of hydraulics, informatics and meteorology, and to work on capacity building of the MHSs in terms of making GHG inventory.

In the area of climate change mitigation, the first priority should be the involvement of national researchers in ongoing international research on GHG emissions and methods of their reduction. More research is required on:

- Emissions from various sectors in BiH;
- Mitigation potential of these sectors;
- Costs and benefits of mitigation actions;
- Energy efficiency approaches and technologies;
- Social and consumptions patterns affecting emissions and mitigation measures;
- Role and impact of gender equality;
- Socio-economic modelling.

There are also opportunities for research and development in energy efficiency and RES technologies that could be produced and implemented in BiH. Producing these technologies in the country instead of importing them would have a positive impact on the economy. The industrial tradition in BiH, as well as its strong raw material base (wood, metals and minerals), provides a good foundation for such development. The most promising areas of technology development are those concerned with energy efficient buildings, including using domestic wood as construction material, and more efficient use of wood for energy, components and equipment for hydro, wind, solar and geothermal power.

7.1.4 Awareness raising and knowledge transfer measures (media and information)

There is a need for a greater level of awareness and knowledge about the impact of climate change among decision-makers and the general public, in order to enable a systemic response and build resilience. In this regard, it is necessary to improve the implementation of the Aarhus Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters in Bosnia and Herzegovina, through all three pillars.

The focus of the activities will be on supporting organisations and communities across BiH to respond to the impacts of climate change, rather than merely raising their awareness of climate change and its impacts. Communication should support and result in individual, community and organisation-led responses to climate change, and the implementation of adaptation measures.

The role of individual citizens in contributing to the climate change mitigation and adaptation should not be underestimated. Environmental education must be improved, enabling children and adults to understand more about climate change and its potential consequences. The topic should be incorporated to a greater extent into the primary, secondary and higher education curricula.

In order to engage communities in the climate change discourse, a broad public-focused, awareness-raising campaign should be conducted in print and electronic media, suitably adjusted for different target groups. A series of media events, television programmes, workshops and other relevant awareness-raising events should also be organised. In relation to communication activities, community members, including vulnerable groups (children, persons with disabilities, the elderly, the poor, minorities, women) must also have the opportunity to provide input and participate in their implementation.

In all areas, there is a need for a higher level of awareness raising and dissemination of knowledge regarding the possibilities of reducing the impact on climate change, both among decision makers and the general public. The aim is to establish synergy of all participants, both active and passive, through communication that will result in individual and collective responses related to the implementation of mitigation measures.

The role of the general public should be to contribute to the implementation of measures that will result in a reduction in impact in general, and it should not be underestimated. Education in this regard should be improved and intensified, to enable both children and adults to learn about climate change and ways they can contribute. This topic should be included at a higher level in the curricula in primary, secondary and higher education.

In order to engage communities in the climate change discourse, a broad public-focused, awareness-raising campaign should be conducted in print and electronic media, suitably adjusted for different target groups, which has not been done in BiH so far. A series of media events, television programmes, workshops and other relevant awareness-raising events should also be organised. Community members, including vulnerable groups, must also have the opportunity to provide input and participate in their implementation.

7.1.5 Gender equality

The 2018-2022 Gender Action Plan of Bosnia and Herzegovina and the Law on Gender Equality of 2010[95] were used in the development and implementation of the Strategy. The Strategy recognises the fundamental goal of having equal representation of both sexes in the processes of planning, decision-making and implementation of programmes related to a sustainable environment and strengthening capacities of government institutions dealing with the environment, so that a gender

[95] Law on Gender Equality in BiH, Official Gazette of BiH, 16/03, 102/09, consolidated text 32/10.

perspective is systematically introduced into the creation of policy on integrated protection of the environment.

Risks associated with climate change threaten to reinforce gender inequalities and have the potential to erode progress that has been made towards gender equality. In addition to the general lack of data on climate change, apart from certain areas (health, education and living standards), data are mostly not gender-disaggregated in BiH (e.g. transport, waste, energy, agriculture, etc.), which makes it difficult to formulate and monitor policies and plans. Without an adequate gender approach, BiH will not be able to build and strengthen capacities for climate change adaptation and mitigation.

There are still strong traditional gender roles in Bosnia and Herzegovina, including women's limited access to resources and rights, as well as a lack of women's participation in decision-making. However, when it comes to households, research by reputable and relevant organisations shows that it is mostly women who go shopping and take care of hygiene, sorting and waste disposal. Changing the waste management system could also affect the level of household consumption.

It is important that both sexes are represented during local community dialogue and in the monitoring and evaluation of the implementation of climate change adaptation measures (with gender-disaggregated indicators wherever possible). Gender mainstreaming will help identify vulnerabilities and capacities to adapt to and mitigate climate change, as it provides a clearer and more complete picture of the relationships that people have built with ecosystems.[96] Such an approach will help reduce consumption, waste and greenhouse gas emissions.

7.2 Governance

Climate change should not be addressed by governments in isolation. The success of the 2020-2030 Climate Change Adaptation and Low Emission Development Strategy for Bosnia and Herzegovina will depend on organisations, local communities and businesses preparing for a changing climate, and implementing appropriate responses. Governments in Bosnia and Herzegovina must move this agenda forward, and provide leadership, support and an enabling environment, but ultimately, they must work collaboratively with a range of local, national and international partners.

International experience has shown that developing and implementing adaptation strategies is often constrained by a range of institutional complexities and horizontal issues. Governance institutions were established when climate change issues were of low importance. Due to its multi-faceted nature, climate change adaptation does not always fit into convenient sectoral, departmental or ministerial areas. To date, climate change issues have been peripheral to most institutions in Bosnia and Herzegovina.

Institutions in Bosnia and Herzegovina (and elsewhere) face significant challenges that reduce adaptive capacity and the ability to implement and further develop adaptation strategies. Key among these are conflicting and overlapping mandates, and weak coordination and a lack of effective arrangements. This Strategy will be implemented at all administrative levels of Bosnia and Herzegovina by the institutions presented in Table 19.

[96]Gender Equality and Climate Change, UN Women:
https://www.undp.org/content/dam/unct/serbia/docs/Publications/UNWomen_GCC_srp_F.PDF [accessed: 27 June 2019]

Table 19: Institutions responsible for the implementation of the Strategy

Administrative level/responsibility	Institutions
State level	
Participation in the United Nations Framework Convention on Climate Change	Republika Srpska Ministry for Spatial Planning, Civil Engineering and Ecology (UNFCCC focal point)
Overall coordination of adaptation actions and climate change mitigation actions with potential donors and investors	Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina
Submission of climate change mitigation actions (NAMAs) to registry, reporting on adaptation actions and NAMAs	Republika Srpska Ministry for Spatial Planning, Civil Engineering and Ecology (UNFCCC focal point)
Greenhouse gas statistics	Agency for Statistics of Bosnia and Herzegovina
Reporting to the UNFCCC, European Energy Efficiency Agency and EEA	Republika Srpska Ministry for Spatial Planning, Civil Engineering and Ecology, Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina
Review of progress of the Strategy and its updates	Republika Srpska Ministry for Spatial Planning, Civil Engineering and Ecology (UNFCCC focal point) Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina
Entity level	
Integration of adaptation and mitigation objectives into other development policies	Government of the Republika Srpska, Government of the Federation of Bosnia and Herzegovina and Government of Brčko District
Transposition of EU legislation and standards	Republika Srpska Ministry for Spatial Planning, Civil Engineering and Ecology FBiH Ministry of Environment and Tourism Republika Srpska Ministry of Industry, Energy and Mining FBiH Ministry of Energy, Mining and Industry
Preparation of greenhouse gas inventory for FBiH and RS	RS Meteorological and Hydrological Service FBiH Meteorological and Hydrological Service
Promotion of energy efficiency through EEAs	Republika Srpska Ministry of Industry, Energy and Mining FBiH Ministry of Energy, Mining and Industry Government of Brčko District
Submission and coordination of adaptation actions and NAMAs with potential donors and investors	Republika Srpska Ministry for Spatial Planning, Civil Engineering and Ecology FBiH Ministry of Environment and Tourism FBiH Ministry of Spatial Planning Republika Srpska Ministry of Industry, Energy and Mining FBiH Ministry of Energy, Mining and Industry Republika Srpska Ministry of Agriculture, Forestry and Water Management FBiH Ministry of Agriculture, Water Management and Forestry Government of Brčko District Other relevant ministries
Monitoring, reporting and verification of results of adaptation actions and NAMAs	Republika Srpska Ministry for Spatial Planning, Civil Engineering and Ecology FBiH Ministry of Environment and Tourism
Managing the implementation of adaptation actions and NAMAs through appropriate institutes/services and organisations	Relevant entity ministries and departments in the Government of Brčko District Relevant entity agencies Eco-funds

Administrative level/responsibility	Institutions
Regional, local, business level	
Development and implementation of adaptation actions and NAMAs	Cantons, municipalities, agencies, public enterprises, businesses, NGOs
Integration of mitigation objectives into other action/development plans (local development strategies, LEAP, SEAP, etc.)	Cantons, municipalities
Promotion of energy efficiency	Cantons, municipalities, EEAs, public enterprises, businesses, NGOs

There have been limited opportunities for civil society engagement in Bosnia and Herzegovina to date (particularly for NGOs and community-based organisation), due to financial, human resource and political constraints. International NGOs have dominated climate change agendas in Bosnia and Herzegovina. This needs to be ratified by increased civil society engagement and ownership, demonstrated by on-the-ground adaptation activities at the local level.

Adaptation and mitigation should be integrated into the planning frameworks of local government and governance structures, and adaptive capacity built at that level. The success of climate change adaptation and low-emission development across Bosnia and Herzegovina will largely depend on the extent to which it is acknowledged and acted upon at the local level.

There will be an increasing need for adaptation and mitigation funding at local and entity levels. Priority must be given to the adaptation needs of the most vulnerable in society (e.g. women and small-scale farmers). Capacities to attract funding and improve accountability must be built at all levels of governance.

7.3 Financing

The 2020-2030 Climate Change Adaptation and Low Emission Development Strategy for Bosnia and Herzegovina requires financial resources in the total amount of about BAM 16.701 billion (for a period of 10 years) that are necessary for its successful implementation.

Table 20: Overview of investments required by 2030 to reduce GHG emissions by sector

Sector	Investment required by 2030 (BAM million)
Electricity	8,625
District heating	775
Transport	2,380
Buildings	4.170
Forestry	105.5
Agriculture	140
Waste	326
Cross-cutting sector	9.4
TOTAL	**16,530.9**

Table 21: Overview of the necessary investments by 2030 for the process of climate change adaptation

Outcome / area	Investment required by 2030 (BAM million)
Outcome 1	2.00
Outcome 2	1.02
Outcome 3	166.55
Agriculture	*121.95*
Water resources/water management	*14.25*
Forests and forest resources	*14.00*
Biodiversity and sensitive ecosystems	*2.50*
Tourism	*11.40*
Human health	*2.45*
Outcome 4	0.85
TOTAL	**170.42**

The Strategy contains opportunities for development, and many of the proposed activities are economically feasible without additional support. The required funding identified for the implementation of the Strategy is related to detailed planning, capacity building, testing of new approaches, research and development models, communication and co-financing. All this is necessary for the effective adoption of the 'green economy' concept.

At the entity level, Bosnia and Herzegovina has introduced certain financial support mechanisms for climate change mitigation, such as charging a fee for electricity produced from renewable energy sources. In addition, entities' environmental funds predominantly support energy efficiency in public buildings through grants and soft loans. Over the past ten years, Bosnia and Herzegovina has received international financial assistance for climate change mitigation and adaptation, from global funds and under bilateral programmes. It can be said that so far financial assistance has been focused on mitigating greenhouse gases while support for climate change adaptation is insufficient.

The financial resources necessary for the successful implementation of the Strategy exceed the currently available resources in Bosnia and Herzegovina. To cover the costs of climate change adaptation and mitigation, Bosnia and Herzegovina will also need assistance in technology transfer and capacity building. As financial institutions for the collection and distribution of funds for environmental protection in BiH, the RS Environmental Protection and Energy Efficiency Fund and the FBiH Environmental Protection Fund are active but the financial resources available to them are not sufficient. There is still no special fund for environmental protection in BD BiH.

Limited funding is expected to be available from national public sources in the near future. Thus, the financing of the actions for the implementation of the Strategy will be structured between:

- Entities' budgets,
- National funds,
- Private sector (including public-private partnership),
- Classic donors, banks, etc.,
- European Union funds developed in the accession process (IPA fund),
- Financial mechanisms under the United Nations Framework Convention on Climate Change – UNFCCC (including the Green Climate Fund (GCF), the Adaptation Fund, market mechanisms).

Where possible, actions will include public-private partnerships (PPPs), local communities and NGOs.

Climate change is an important priority of the EU foreign policy. The EU has agreed to allocate at least 20% of EU expenditure to climate change in the period 2014-2020. In the process of creating the budget for 2021-2027, the EC proposed an increase for climate integration and further strengthening of climate actions in the long-term EU budget. Therefore, the EC has proposed setting a more ambitious target for climate integration in all EU programmes, with the aim of allocating 25% of expenditure instead of 20% to contribute to climate change targets. Thus, if EUR 206 trillion was allocated for 2014-2020, the increase to 25% would amount to an additional EUR 114 trillion.[97] EU policy on climate change for developing countries dates back to 2003. The policy has since been updated to include and focus on specific areas, namely adaptation, disaster risk reduction and support for capacity development and technology transfer in sustainable agricultural and energy sectors, including climate change adaptation and mitigation strategies.

Given that emission reduction targets are set on a voluntary basis, according to the Paris Agreement, it is to be expected that the level of international assistance to reduce GHG emissions will commensurate with the ambitiousness of the targets in Bosnia and Herzegovina. Under the Copenhagen Accord and the 16th Session of the Conference of the Parties in Cancun, emphasis was placed on giving priority to climate change adaptation measures. Therefore, funds exist that specifically assist climate change adaptation measures, especially funds that help with climate change mitigation.[98] There are also funds that are specifically budgeted to assist miners and mines that will be forced to suspend production. It is important to monitor international sources of potential funding opportunities such as: Green Climate Fund; EU Cohesion Fund; Global Environment Facility; Adaptation Fund; Horizon 2020; LIFE Programme; Global Energy Efficiency and Renewable Energy Fund; Global Climate Partnership Fund (GCPF); Structural Funds; European Social Fund (ESF); European Union Solidarity Fund (EUSF); European Territorial Cooperation (ETC); European Maritime and Fisheries Fund (EMFF); European Globalisation and Adjustment Fund (EGF); Common Agricultural Policy CAP; European Regional Development Fund (ERDF); European Solidarity Fund.

For Bosnia and Herzegovina, the most important funding opportunities are the European Union's IPA funds and the Green Climate Fund of the United Nations Framework Convention on Climate Change. Funds from these sources will be needed to support implementation. Other potential funding includes GEF, EC FP8 and bilateral donor funding. Innovative partnerships will also be developed with multilateral funding agencies. In addition, as most of the above activities are related to infrastructural development, funds from international financial institutions can be sought.

Funding will also be sought from the private sector, in terms of infrastructure investments and business opportunities offered by some of the measures, through the identification of co-financing opportunities, public-private partnerships and economic activities in socially-owned enterprises.

Funds from the entities' budgets will be used for certain infrastructural interventions, however, the use of these funds will focus on measures and actions related to raising public awareness, capacity building, preparation of project documentation and the like.

[97] https://ec.europa.eu/clima/policies/budget/mainstreaming_en

[98] https://climatefundsupdate.org/the-funds/

8 NEXT STEPS

The 2020-2030 Climate Change Adaptation and Low Emission Development Strategy of Bosnia and Herzegovina represents a significant and important step forward towards a sustainable 'green economy' in Bosnia and Herzegovina. The Strategy serves as a comprehensive policy framework to address the climate change challenges that BiH is facing and facilitates access to international support for the implementation of activities.

From the plan of activities in the Strategy, the immediate next steps (2021-2023) mainly relate to:

- **Securing financing**. The Strategy provides clear justification, structure and specific activities required. Implementation of effective financing requirements and efforts should be concentrated on identifying and securing adequate financial resources
- **Capacity building of existing institutions**. There are a range of new skills and competencies required for effective implementation of the Strategy. It is necessary to further elaborate these through needs assessment exercises, and then to commence a capacity building programme. **Error! Reference source not found.** and Table 4 present a detailed description of m easures for the capacity building of existing institutions.
- **Institutional linkages**. Climate change issues are multi-disciplinary and multi-sectoral. Effective responses require adequate level of coordination and cooperation between sectors and institutions at different levels, new ways for institutions to work together, sharing of knowledge and information, and integrating planning, monitoring and evaluation. Initial activities will look at quick and simple ways of developing key institutional linkages and information flows.
- **Knowledge generation**. Although significant progress has been made since the 2014 floods in developing flood forecasting systems and strengthening the technical capacity of meteorological and hydrological services, it is important in the coming period to ensure the sustainability of the equipment and software, and work on developing and creating models for different climate scenarios to support risk management strategies and climate change mitigation measures. The next steps to address key gaps in knowledge generation and data and information provision are set out in action plans.
- **International programmes.** Identify international climate change mitigation programmes and projects in which BiH can participate or for which individual BiH entities may qualify. When applying and replicating technologies, it is necessary to take into account adaptation to local conditions and integration with existing technologies. Establish institutional informing of entrepreneurs in BiH about the opportunities for participation in these programmes through associations of employers and chambers of commerce.
- **Action plans.** Inform stakeholders in certain sectors of the goals and measures for low-emission development and, with their active involvement, develop action plans for individual sectors, bearing in mind their linkages with other sectors. In this process, it is crucial to identify training needs, build the capacity of domestic institutions to engage in sectoral international programmes and technology transfer.

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