

REPORT ON STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA) OF THE LOW-CARBON DEVELOPMENT STRATEGY OF MONTENEGRO

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LIST OF ABBREVIATIONS

Abbreviation	Full term
CBAM	Carbon Border Adjustment Mechanism
CO₂	Carbon dioxide
CO₂eq	Carbon dioxide equivalent
EE	Energy Efficiency
EnC	Energy Community
ETS	Emissions Trading System
EU	European Union
GHG	Greenhouse Gases
IPPU	Industrial Processes and Product Use
LCDS	Low-Carbon Development Strategy
LEAP	Low Emissions Analysis Platform
LULUCF	Land Use, Land-Use Change and Forestry
Mtoe	Million tonnes of oil equivalent
NDC	Nationally Determined Contribution
NECP	National Energy and Climate Plan
OIE / RES	Renewable Energy Sources
PMI	Partnership for Market Implementation
RAA	Renewables Acceleration Areas
RED III	Renewable Energy Directive (EU) 2023/2413
SEA	Strategic Environmental Assessment
SPU	Strategic Environmental Assessment (Montenegrin acronym)
WAM	With Additional Measures
WEM	With Existing Measures

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Legal Basis:

Law on Strategic Environmental Assessment (“Official Gazette of the Republic of Montenegro”, No. 80/05 of 28 December 2005 and “Official Gazette of Montenegro”, No. 73/10 of 10 December 2010, 40/11 of 8 August 2011, 59/11 of 14 December 2011 and 52/16).

Direktorica

Marina Spahić



1 INTRODUCTION

The preparation of this document enabled a systematic review of the objectives, measures, and development scenarios of the Low-Carbon Development Strategy (LCDS) in relation to their potential impacts on the environment and human health. Through the SEA process, key risks, spatial constraints, and potential conflicts were identified, providing a clear basis for improving the content and priorities of the LCDS.

SEA findings and recommendations are used to adjust sectoral measures and select more environmentally acceptable development options, as well as to define measures to avoid, reduce, or mitigate negative impacts. Particular attention was given to the cumulative effects of planned interventions and to the need to align decarbonisation objectives with the protection of biodiversity, water, soil, and land use. In this way, the SEA supports the LCDS as a key strategic framework, with clearly defined measures that simultaneously contribute to the achievement of climate objectives and environmental protection.

Low-carbon development is a development concept emerged with Paris Agreement¹, back in 2015, introducing an encouragement (not obligation) to create long-term strategies for achieving low-carbon, climate-resilient development in countries worldwide. As of November 2025, the United Nations Framework Convention on Climate Change (UNFCCC) lists 80 submitted “long-term low greenhouse-gas emission development strategies” in its portal.

European Union launched European Green Deal in 2019, presenting it as the EU’s growth strategy. It consists of a package of policy initiatives, which set the EU on the path to a green transition, with the ultimate goal of reaching climate neutrality by 2050.

So called “Governance Regulation”² turns the Paris Agreement encouragement² into an obligation for EU member states. The Governance Regulation has been incorporated into the Energy Community legal framework, thus obliging its member states, including Montenegro, to develop long-term low-carbon strategy. So far, five Energy Community countries implemented this obligation (Bosnia and Herzegovina, Georgia, North Macedonia, Serbia and Ukraine).

The main purpose of long-term low-carbon strategies is to provide countries with a forward-looking roadmap for transforming their economies in line with climate goals, guiding structural changes across key sectors: energy, transport, industry, buildings, and land use, so that national development becomes compatible with deep decarbonisation and, ultimately, climate neutrality. They should also support coherent planning and enable a more orderly and just transition.

It is of utmost importance to develop such long-term policies in an open and transparent manner, providing effective opportunities for the public to participate in their preparation. The main tool to ensure transparency and participation is Strategic Impact Assessment, ensuring that the strategy rests on sound analytical foundations and benefits from stakeholder endorsement.

¹ Article 4.19 of the Paris Agreement https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-d&chapter=27&clang=_en

² Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, <https://eur-lex.europa.eu/eli/reg/2018/1999/oj/eng>

1.1 Legal basis and purpose of the SEA

Legal basis of the SEA for Low Carbon Development Strategy (LCDS) for Montenegro is embedded in the Law on Strategic Impact Assessment³ and Decision on the preparation of a strategic environmental impact assessment for the low-carbon development strategy⁴.

The Law on SEA elaborates in details SEA procedure and contents of the SEA report, while the Decision on SEA preparation for LCDS notes the following elements:

- The Strategy is prepared and adopted under Article 7 of the Law on protection from negative impacts of Climate Change⁵ (the law has been amended in December 2025);
- It is a national strategic document covering the entire territory of the country and addressing climate change;
- A Strategic Environmental Impact Assessment Report, prepared in accordance with Article 15 of the Law on Strategic Environmental Impact Assessment, will accompany the Strategy;
- The Report will assess the Strategy's potential impacts on the environment and human health, identify risk areas and effects on protected zones, and propose measures to prevent or reduce negative impacts, including possible cross-border effects;
- The Report will be prepared within the same timeframe as the Strategy itself;
- The assessment process will ensure public participation and consultation with relevant authorities and organizations, including a formal public discussion, in line with legal requirements.

As noted above, the purpose of SEA is to assess the Strategy's potential impacts on the environment and human health, identify risk areas and effects on protected zones, propose measures to prevent or reduce negative impacts and ensure public participation and consultation with relevant authorities and organizations.

LCDS targets reducing GHG emissions from each of the major emitting sectors such as power generation, energy use in transport, industry and buildings and non-energy sectors such as agriculture, waste, forestry and land use, as close to zero as possible, based on available technologies and their expected evolution.

On the other hand, the SEA objectives are to direct transition of these sectors to low-carbon economy with minimal impacts on environment and human health and to assess emerging technologies in the light of environment-friendly solutions. Moreover, it should ensure that Montenegro achieve the climate neutrality objective without compromising environmental quality, public health, employment, or citizens' economic well-being, safeguarding the principles of a just transition to the greatest extent possible.

In general, the main objectives of SEA are:

- ❖ ensuring that environmental issues and human health are fully taken into account when developing plans and programs;
- ❖ establishment of clear, transparent and efficient procedures for strategic assessment;
- ❖ ensuring public participation;
- ❖ ensuring sustainable development;

³ Law on SEA OG MNE No. 80/2005, 59/2011, 52/2016 and 84/2024

⁴ Decision on on the preparation of a strategic environmental impact assessment for the low-carbon development strategy, OG MNE No. 54/2025

⁵ Law on the Protection Against Negative Impacts of Climate Change and the Protection of the Ozone Layer OG MNE No. 73/19

- ❖ improving the level of protection of human health and the environment.

Figure 1 - General objectives of SEA



In this particular case, specific objectives of SEA are related to ensuring the smooth transition to climate neutrality, not as an imperative “at any cost”, but profoundly thought out, choosing win-win solutions over compromises.

1.2 Context, geographical and temporal scope of the assessment

LCDS is a national strategic document covering the entire territory of the country, with a far-reaching time horizon by 2050.

The context in which the Low-Carbon Development Strategy (LCDS) is being developed is essential for understanding both its purpose and its structural design. Montenegro is preparing this Strategy at a moment when international climate obligations, domestic development priorities, and the need to preserve valuable environmental resources all intersect. Recognising this context allows for an assessment where LCDS is not viewed as an isolated policy effort, but rather as a forward-looking instrument that advances sustainable development and constitutes an integral component of Montenegro’s EU accession process.

1.3 Institutional framework and roles of key actors in the process

Development of LCDS and related SEA is led by the Ministry of Ecology, Sustainable Development and Northern Region Development. Environment Protection Agency of Montenegro has a key role in the SEA process. Ensuring coherence with other national development and sectoral policies requires broad consultation with government institutions and local authorities.

The LCDS is a long-term, cross-sectoral document, which makes the identification of affected and interested parties a complex task. Stakeholders include not only those directly impacted by future projects subject to EIA requirements, such as local communities, community members, and businesses, but also those affected more broadly by the decarbonisation process, including potential job losses, rising energy costs, or regional disparities. Interested parties extend to NGOs, civil society organisations, business representatives, and the wider public, as its measures can generate both positive and negative effects across society.

Vulnerable groups may be disproportionately affected and at risk of exclusion from participation due to limited access to information or resources. These include workers and small businesses linked to high-carbon sectors, rural or remote communities, low-income households susceptible to energy poverty, and young people who will inherit long-term climate impacts.

Table 1 presents the list of key stakeholders with their roles, relevant legislation governing their role in the SEA process and potential impacts of LCDS.

Table 1 - Stakeholder mapping

Stakeholder	Roles and responsibilities	Relevant Legislation	Potential impacts /interests
Ministry of Ecology, Sustainable Development and Development of the Northern Region	Competent authority for development of LCDS Competent authority for development of SEA	Law on climate change – Art. 8 Law on SEA, Art. 4, Art 9 Decision on conducting of SEA	Policy incoherence Difficulties in implementation
Environment Protection Agency	Competent authority for consent on SEA Competent authority for transboundary SEA procedure Quality control	Law on SEA, Art 6 Law on SEA, Art. 18 Law on SEA Art 21	Policy incoherence Outlined projects subject to EIA
Sectoral ministries and bodies	Participation of authorities and concerned organisations - Provision of opinions and comments	Law on SEA, Art. 17	Policy incoherence Outlined projects subject to EIA
Local authorities	Participation of authorities and concerned organisations - Provision of opinions and comments	Law on SEA, Art. 17	Uneven regional development Outlined projects subject to EIA
Association of municipalities	Channel of communication – municipalities Participation of authorities and concerned organisations - Provision of opinions and comments	Law on SEA, Art. 17	
Municipality of Pljevlja	Channel of communication – affected stakeholders Participation of authorities and concerned organisations - Provision of opinions and comments	Law on SEA, Art. 17	Success of Just Transition
High-carbon industries	Affected stakeholders	Law on SEA, Art. 17	Job loss
Small businesses connected to high-carbon industries	Affected stakeholders	Law on SEA, Art. 19	Job loss
Low-carbon industries	Affected stakeholders	Law on SEA, Art. 19	Boost of business
Chamber of Commerce	Channel of communication – industry/businesses Protection of business interests Provision of opinions	Law on SEA, Art. 17	
Workers in high-carbon industries	Affected stakeholders	Law on SEA, Art. 19	Job loss

Trade associations	Channel of communication – workers Worker’s rights protection	Law on SEA, Art. 19	
Environmental NGOs	Channel of communication / general public Interested stakeholders /Environment Protection	Law on SEA, Art. 19	Policy incoherence Outlined projects subject to EIA
Other Civil Society Organisations	Channel of communication – vulnerable groups Interested stakeholders/ social protection, protection of vulnerable groups	Law on SEA, Art. 19	Policy incoherence
Low-income households	Affected stakeholders	Law on SEA, Art. 19	Energy poverty
Rural and remote communities	Affected stakeholders	Law on SEA, Art. 19	Energy poverty Limited access to LCDS benefits
Governments of the neighbouring countries	Interested stakeholders/Regional cooperation	ESPOO Convention/Kyiv Protocol	Outlined projects subject to EIA
Energy Community	Regional cooperation/Quality control	Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, Article 15	Impact on EU long-term low-carbon strategy
World Bank	Strategic Partner, provision of financial support for development of LCDS and SEA Quality control	WB Environmental and Social Framework	Quality of LCDS & SEA
ECA & EcoEnergy	LCDS Developer	Law on climate change, Art. 8 and 9	Quality of LCDS
GES Montenegro	SEA Report Developer	Law on SEA, Art 16	Quality of LCDS & SEA

2. OVERVIEW OF THE STRATEGY AND ITS RELATION TO OTHER PLANS AND PROGRAMMES

2.1. Main components and objectives of the LCDS

Despite the complexity of the topic and highly technical requirements for developing emission scenarios, LCDS has very simple structure and is written clearly and precisely allowing easy understanding of its concepts.

Document is divided in three major sections:

- ❖ Section 1 introduces the objectives of the LCDS, how it fits within the legal and policy framework for climate change action in Montenegro, and its role in meeting international obligations for the country.
- ❖ Section 2 provides sector-by-sector assessments, drawing from relevant sectoral strategy and planning documents to identify details on mitigation and adaptation policy measures in relation to emission reduction as well as governance, social, and international dimensions. These are split into “energy” and “non-energy” sectors, based on whether GHG emissions stem from energy consumption or from other (non-energy) processes
- ❖ Section 3 presents aggregate emissions reduction achieved through the LCDS.

The main objectives of the LCDS are:

- Establish a long-term pathway for Montenegro to achieve climate neutrality by 2050, in line with its domestic legislation and international commitments.
- Guide the development and implementation of policies and measures (PAMs) needed to reduce greenhouse-gas emissions across all major sectors of the economy.
- Enhance and extend the ambition of the National Energy and Climate Plan (NECP) by identifying additional measures that can accelerate decarbonisation and support long-term low-emission development.
- Ensure Montenegro’s alignment with EU climate and energy legislation, including future integration into the EU Emissions Trading System (EU ETS) and broader EU climate neutrality objectives.
- Define sector-specific policies and measures that reduce emissions from power generation, transport, buildings, industry, waste, agriculture, and LULUCF.
- Provide quantitatively modelled emission-reduction trajectories using the LEAP model to assess the impacts of different policy combinations up to 2050.
- Strengthen cross-sectoral coordination by aligning long-term climate planning with energy, transport, industrial, and land-use strategies.
- Support policy consistency with international obligations, including NDC updates, Energy Community requirements, and EU accession commitments.
- Identify governance, social and economic dimensions of decarbonisation, including impacts on households, businesses, and vulnerable groups.

2.2. Key measures and priority areas

LCDS priority sectors are identified in accordance with requirements related to long-term strategies⁶. Key measures are presented in the Table 2 below.

Table 2 - Key measures by sector

ENERGY/Power generation		
PG.1	Power generation	Alignment of the carbon price with the EU Emissions Trading System price by 2028.
PG.2	Power generation	Retirement of TPP Pljevlja by 2035.
PG.3	Power generation	Full deployment of the renewable energy generation projects included in ETSDP and not deployed under the NECP
ENERGY/Transport		
T.1	Transport	Develop and publish a transport decarbonisation strategy, including formalising targets included in the LCDS.
T.2	Transport	Reduce car kilometres by 25% by 2035.
T.3	Transport	Increase rail share of freight transport.
T.4	Transport	100% electrification of rail infrastructure by 2040.
T.5	Transport	90% of road transport vehicles zero emissions by 2050.
ENERGY/Industry and manufacturing		
IM.1	Industry and manufacturing	95% of industrial and manufacturing fossil fuel use to be replaced with electricity.
ENERGY/Buildings		
B.1	Buildings	Implementation of Montenegro's Building Renovation Strategy.
NON-ENERGY/Industrial Production and Product use (IPPU)		
IPPU.1	Industrial production and product use	Development and implementation of plans for Phases II, III and IV for reduction of HFC use in line with the Kigali Amendment.
NON-ENERGY/Agriculture		
AG.1	Agriculture	Assignment of responsibility within the Ministry of Agriculture, Forestry and Water Management to monitor international developments in agricultural mitigation technologies.
NON-ENERGY/Waste		
W.1	Waste	Assignment of responsibility within the Ministry of Ecology, Sustainable Development and Northern Development to monitor international developments in waste management technologies and processes.
NON-ENERGY/Land use, land use change and forestry		
LU.1	LULUCF	Conversion of coppice to high forests.
LU.2	LULUCF	Consider inclusion of carbon removals from soils for Forest Land, Cropland and Grassland for the LULUCF sector.

The key measures and priority areas outlined above constitute the analytical basis for the subsequent assessment of potential environmental and health impacts. In addition to the measures listed above, the LCDS implicitly relies on the development of Battery Energy Storage Systems (BESS) as a supporting technology for the energy transition. BESS enable the integration of variable renewable energy sources by providing short-term energy storage, load shifting and system balancing, thereby increasing grid flexibility and reducing the need for fossil-fuel-based reserve capacity. Although not defined as a standalone policy measure, BESS represent an enabling infrastructure component for achieving the

⁶ Regulation (EU) 2018/1999, Article 15.4.b

emission reduction targets envisaged under the energy sector measures. These measures are further examined in the SEA regarding their likely effects, cumulative interactions and consistency with environmental protection objectives.

2.3. Development scenarios

This chapter provides a descriptive overview of the development scenarios considered within the Low-Carbon Development Strategy . The detailed assessment of their environmental and health implications, as well as the comparison of alternatives, is presented in Chapters 6 and 7.

LCDS considers three scenarios for long-term decarbonisation: the NECP With Existing Measures (WEM) scenario, the NECP With Additional Measures (WAM) scenario, and the LCDS scenario, each being more ambitious than the previous. The LCDS builds upon the NECP, incorporating enhanced long-term action to deliver deep emissions reductions across all major emitting sectors.

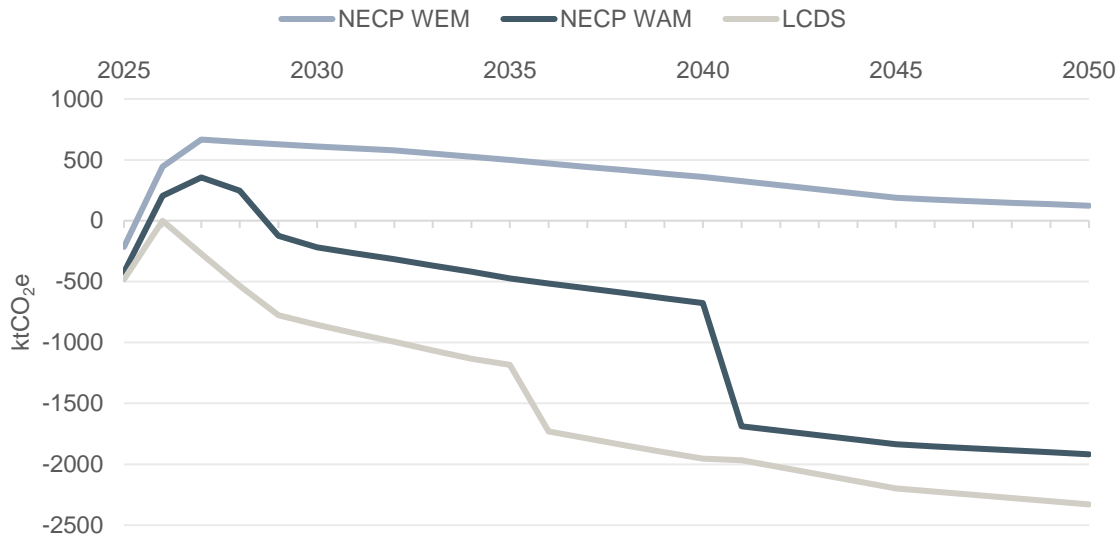
The NECP WEM scenario reflects a continuation of measures already under implementation and therefore represents the lowest-ambition pathway. The scenario's defining characteristic is that TPP Pljevlja remains in operation with unchanged utilisation, with insufficient new-built renewable energy generation capacity to reduce the plant's utilisation before 2050. As a consequence, emissions from the power generation sector do not fall by 2050, and coal remains structurally embedded in the generation mix. Moderate emissions reductions occur in transport, waste, IPPU, agriculture, and buildings sectors, driven by the limited PAMs already in place. The WEM scenario fails to deliver transformative change, and does not achieve net-zero emissions at any point, as the continued operation of TPP Pljevlja dominates the emissions profile.

The NECP With Additional Measures (WAM) scenario represents a medium-ambition pathway. It includes all PAMs from the WEM scenario, plus a package of additional measures focused particularly on the period up to 2035. One of the central outcomes of these measures is a significant reduction in total emissions relative to the WEM scenario, with the power sector playing a pivotal role. Planned retirement of TPP Pljevlja is 2041, marking the complete elimination of coal-related GHG emissions. This structural shift allows the WAM scenario to achieve net-zero emissions between 2030 and 2035, driven by renewable energy expansion and system-wide electrification. Additional measures include substantial uptake of electric vehicles, modal shifting in transport, electrification of machinery, and enhanced waste management systems. Proposed Policies and Measures within NECP, according to the corresponding scenario, are given in the Annex I.

The LCDS scenario represents Montenegro's most ambitious climate scenario. It assumes full implementation of all NECP PAMs and incorporates additional long-term measures to drive down sectoral emissions as close to zero as technically feasible. In the power sector, the LCDS envisages a sharp decline in emissions ahead of 2030 as new renewable capacity, particularly solar and wind, becomes operational. The retirement of TPP Pljevlja is envisaged in 2035 and results in complete elimination of power-sector GHG emissions starting from 2036. To support system security, the scenario assumes deployment of new dispatchable capacity, including some hydro developments, though their realisation remains uncertain due to environmental considerations.

The NECP WEM scenario demonstrates the insufficient progress of current measures alone. The NECP WAM scenario outlines a feasible pathway to net-zero emissions through enhanced renewable energy and electrification policies. The LCDS scenario builds on this to define a leading, technology-forward pathway aimed at minimising residual emissions across the economy and achieving the biggest possible degree of decarbonisation by mid-century. The common thread across the ambitious scenarios is the pivotal role of phasing out TPP Pljevlja through a rapid build-out of renewable generation and/or carbon pricing, which unlocks the achievement of net-zero emissions.

Figure 2 - Net GHG emissions across scenarios (LCDS)



2.4. Relationship of the Strategy with other relevant national and international policies

Alignment with international policies

Paris Agreement

In its chapter on “International Context”, LCDS is starting from the Paris Agreement, recognizing the invite to the signatories to submit NDC-aligned long-term low emissions development strategies (LT-LEDS) that provide just transitions to net zero emissions by or around 2050, taking into account national circumstances, concluding that Montenegro’s LCDS fulfils this requirement. SEA analysis shows that NDC3 and LCDS might need better coherence.

Energy Community

LCDS also notes that Montenegro is a Contracting Party to the Energy Community and thereby bound by the Energy Community *acquis* that transposes climate and energy legislation of the EU, including the Governance Regulation (EU) 2018/1999. It notes that the Regulation requires the periodic development of National Energy and Climate Plans (NECPs), but there is no mention of the Article 15 and Annex IV which regulate mandatory contents of long-term strategies. In accordance with the Article 15 of the Regulation (EU) 2018/1999, LCDS shall cover:

- a) total greenhouse gas emission reductions and enhancements of removals by sinks;
- b) emission reductions and enhancements of removals in individual sectors, including electricity, industry, transport, the heating and cooling and buildings sector (residential and tertiary), agriculture, waste and land use, land-use change and forestry (LULUCF);
- c) expected progress on transition to a low greenhouse gas emission economy, including greenhouse gas intensity, CO₂ intensity of gross domestic product, related estimates of long-term investment, and strategies for related research, development and innovation;
- d) to the extent feasible, expected socio-economic effect of the decarbonisation measures, including, inter alia, aspects related to macro-economic and social development, health risks and benefits and environmental protection;

- e) links to other national long-term objectives, planning and other policies and measures, and investment.

The current version of LCDS needs more focus on research and innovation, expected socio-economic effect of the decarbonisation measures, health risks and benefits and environmental protection, which will be elaborated through this SEA, as well as better alignment with investment policy, being a long-term development policy.

Alignment with national policies

The National Energy and Climate Plan (NECP)

Table 3 - NECP, Key objectives

Key objectives	Energy Community targets for Montenegro	National targets	WEM scenario in 2030	WAM scenario in 2030
Primary energy consumption	0.92 Mtoe	0.92 Mtoe	0.98 Mtoe	0.90 Mtoe
Final energy consumption	0.73 Mtoe	0.73 Mtoe	0.76 Mtoe	0.72 Mtoe
Share of renewable energy sources in gross final energy consumption	50%	50%	43%	54%
Reduction of GHG emissions	55% (total 2.42 MtCO ₂ eq)	55% (total 2.42 MtCO ₂ eq)	total 3.06 MtCO ₂ eq	total 2.40 MtCO ₂ eq

LCDS should be much more than a time horizon extension of NECP. Being a general development strategy, it should not be focused solely on climate change and energy, but also on other economic sectors and a society as a whole. The process of transition towards a low-carbon economy is continuous and long-term, it involves the whole society and economy. The transition process should be thought out and adapted to the possibilities and available resources. It is an opportunity to improve the existing infrastructure and technological solutions, innovations, by the transfer of advanced technologies, significant structural changes in all sectors, encourages increase in industrial production, investment cycle, development of new activities, economy and opens new jobs with a sustainable perspective.

Updated Nationally Determined Contribution of Montenegro

Montenegro has also adopted an updated Nationally Determined Contribution (NDC) for 2030 and 2035⁷. The updated NDC sets ambitious targets for reducing greenhouse gas (GHG) emissions by 55% by 2030 and 60% by 2035, representing a significant increase compared to the previous NDC, which envisaged a reduction of 35%. The document was adopted in February 2025.

⁷ NDC <https://www.gov.me/dokumenta/c0362fe5-2e4a-47c3-802d-0f052483e36d>

The updated NDC covers all sectors of the economy, including land use, land-use change and forestry (LULUCF). Accordingly, Montenegro will implement mitigation measures in the energy, industry, agriculture and transport sectors, with a particular focus on forest ecosystems as key carbon sinks.

New Climate Change Law

The Parliament of Montenegro has recently adopted a new Climate Change Law⁸, which will require amendments to existing secondary legislation and the adoption of new legal acts in order to further align the national emissions trading system (ETS) with the EU ETS acquis.

In this context, the Ministry is intensively working on the development of a new carbon pricing policy, with technical support provided by the World Bank, in coordination with the EU4GREEN project. Carbon pricing is considered one of the key policy instruments for achieving the climate mitigation targets set out in the NDC and NECP.

Within the framework of the “Carbon Pricing Readiness Support Plan” under the Partnership for Market Implementation (PMI), financed by the World Bank, a Carbon Pricing Impact Assessment and an Assessment of the Interaction between Carbon Pricing and Electricity Generation Planning have been prepared. These analyses provide a solid basis for assessing the impacts of the Carbon Border Adjustment Mechanism (CBAM) on the electricity sector in Montenegro and for strengthening the existing national ETS.

In addition, a Decarbonisation Communication Strategy for the period 2025–2028 has been prepared, and Green Hydrogen Development Programme with an Action Plan for the period 2026–2028 adopted.

Mapping of Optimal Locations for the Development of Solar and Wind Power Plants

The mapping of optimal locations for the development of solar and wind power plants in Montenegro is a study currently under preparation, aimed at implementing the requirements of the RED III Directive regarding the designation of Renewables Acceleration Areas (RAA zones). Due to minimal conflicts with natural values, permitting procedures for renewable energy projects within RAA zones will be shortened.

Although the RED III Directive has not yet been transposed into the Montenegrin legislative framework, the measure to map optimal locations for the development of solar and wind power plants is in line with the recommendation adopted by the Energy Community Ministerial Council in December 2024, which called on its Contracting Parties, including Montenegro, to prepare the necessary legislative and institutional framework for the implementation of provisions related to the establishment of RAA zones.

In order to provide guidance to decision-makers and the professional community in the Contracting Parties, the Energy Community, in cooperation with The Nature Conservancy, prepared the manual for designation of RAA. . The methodology described in the Blueprint has already been applied in Montenegro through the preparation of a pilot study in the Municipality of Nikšić, while a project applying the same approach at the national level is currently underway.

Study on the Improvement of Energy Efficiency of Buildings

The Study on the Improvement of Energy Efficiency of Buildings was prepared in 2025 as part of Montenegro’s obligations as a Contracting Party to the Energy Community, in accordance with the

⁸ Law on Climate Change OG MNE No. 149/2025

requirements of Directive 2010/31/EU on the energy performance of buildings. The Study aims to establish a long-term renovation strategy to improve the energy efficiency of the national stock of public and private, residential and non-residential buildings in a cost-effective manner.

3. EXISTING STATE OF THE ENVIRONMENT IN MONTENEGRO

3.1. Air Quality and GHG Emissions

Air quality in Montenegro represents one of the key environmental challenges, particularly in urban and industrially burdened areas where exceedances of concentrations of suspended particulate matter PM_{10} and $PM_{2.5}$ are frequently recorded. The most affected municipalities are Pljevlja, Bijelo Polje, Podgorica, and Nikšić, where high particulate concentrations predominantly originate from the

combustion of solid fuels in households. Health risks are particularly pronounced in relation to PM_{2.5} particles, which account for the largest share of premature deaths associated with air pollution.

Table 4 – Key sources of air pollutants (data from air emission inventory for 2023)

Key sectors/pollutants	NOx (kt)	SOx (kt)	PM2.5 (kt)	PM10 (kt)
Power generation	47%	99%	3%	4%
Road transport -heavy vehicles (trucks & buses)	39%	/	3%	3%
Household heating	/	/	84%	79%
Key sector ratio in total emissions	85%	100%	90%	96%

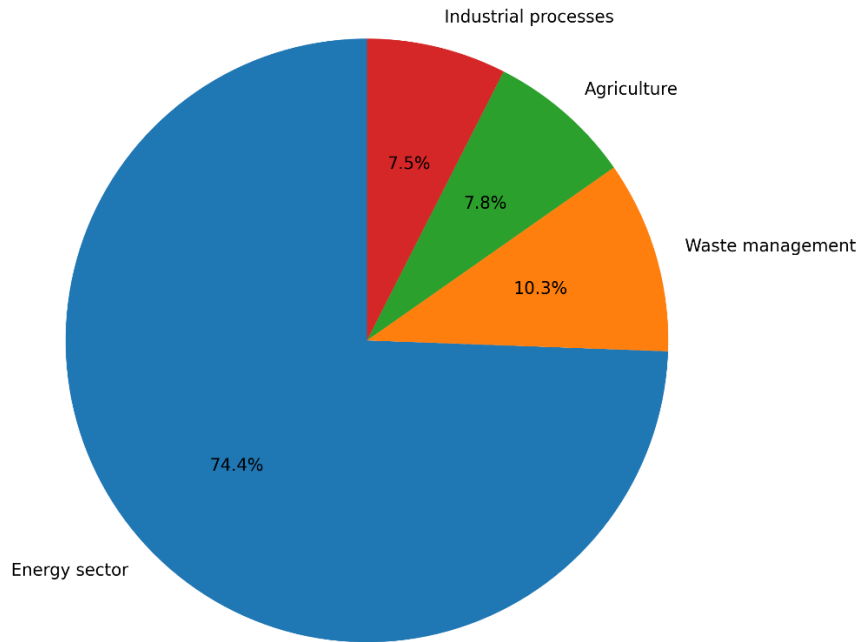
The household heating sector remains the main generator of local pollution during winter, with a noticeable increase in the use of low-quality biomass. Although the modernization of the housing stock is ongoing, estimates indicate that around 60% of individual heating systems are energy-inefficient, continuing to contribute to high emissions of PM_{2.5} and PM₁₀.

Electricity production at Pljevlja Thermal Power Plant was a key source of sulfur dioxide and nitrogen oxide emissions, which should be largely (up to 80%) overcome with the completed environmental reconstruction. During the test period of operation of the thermal power plant in December 2025, there were high concentrations of sulfur dioxide.

With regard to greenhouse gas (GHG) emissions, the energy sector remains the largest source, accounting for as much as 74.5% of total national GHG emissions in 2022. This is followed by waste management (10.3%), agriculture (7.8%), and industrial processes (7.5%). The Pljevlja coal-fired thermal power plant remains the most significant single source of emissions in the country⁹.

Figure 3 – GHG emissions by sector

⁹ National GHG Inventory, 2022



With respect to GHG emissions, the degradation of CO₂ sinks in the LULUCF sector is becoming an increasingly pronounced challenge. An increase in the number of forest fires, slow restoration of degraded forest areas, and reduced afforestation rates are leading to a lower level of CO₂ absorption compared to previous decades.

3.2. Climate and Climate Change Trends

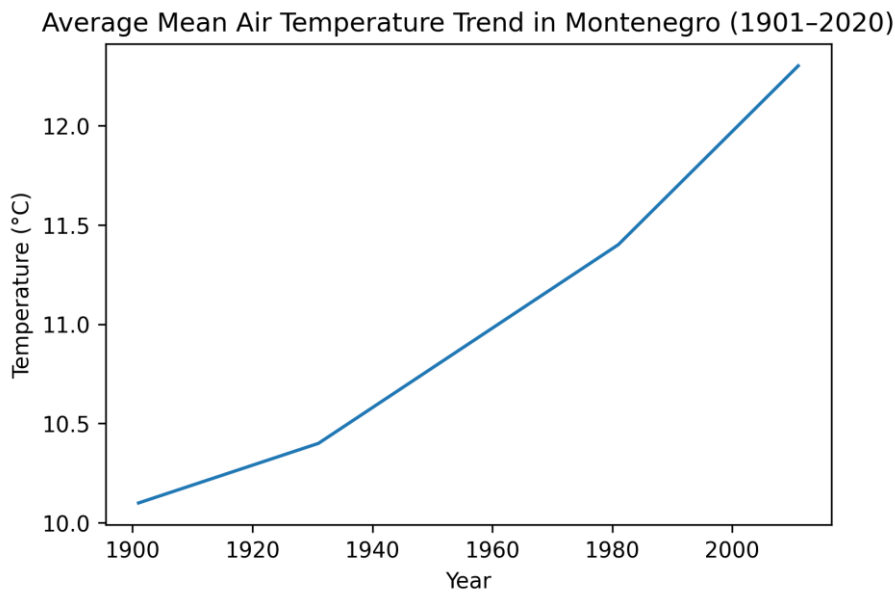
Climatic conditions in Montenegro are characterised by strong regional contrasts and pronounced climate variability, resulting from a combination of coastal, continental, and mountainous influences. The coastal part of the country has an average annual temperature of 14–16°C and high precipitation levels ranging from 1,400 to 2,200 l/m², while mountainous areas record average annual temperatures falling below 0°C, with extremely high snow cover reaching up to 200 cm in certain regions. The northern lowland areas exhibit the greatest temperature contrasts, with annual amplitudes of 50–60°C and minimum winter temperatures dropping to as low as –28 to –32°C, while summer temperatures reach 35–40°C, accompanied by frequent temperature inversions and the formation of “cold air pools.” Analysis of climate trends indicates that Montenegro is already experiencing clear manifestations of climate change¹⁰.

Over the past ten years, a significant increase in the number of tropical days has been recorded, particularly in the central and southern climatic regions, where summer temperatures increasingly exceed 35–40°C. This is accompanied by frequent episodes of strong northerly winds, which increase the risk of forest fires. At the same time, extreme weather events are becoming more pronounced: heavy cyclonic rainfall and stormy southerly winds are recorded in the coastal area, intense snowfall occurs in mountainous zones, and late spring and early autumn frosts are becoming increasingly frequent, negatively affecting agricultural production¹¹.

¹⁰ Third National Communication of Montenegro

¹¹ Third National Communication of Montenegro

Figure 4 - Average mean air temperature trend in Montenegro (1901–2020)



Source: *Third National Communication of Montenegro*¹²

The impact of heatwaves represents one of the most serious climate-related risks in the country. During the period 2022–2023, Montenegro recorded a twofold increase in mortality during extreme heat compared to the EU average—mortality among women increased by 8–10%, and among men by 5–6% annually—indicating a high sensitivity of the population to rising temperatures. Estimates suggest that the number of deaths associated with extreme temperatures will rise to 55–100 per year in the period 2036–2064, while economic losses from premature mortality are estimated at EUR 2–4 million annually by 2050. Climate stress also affects agriculture, with shifts in vegetation cycles, reduced yields of traditional crops, and an increased frequency of plant diseases. In mountainous areas, the duration of snow cover is shortening, affecting water resources, biodiversity, and winter tourism.

Overall, current climate trends in Montenegro indicate an accelerated increase in temperatures, a growing number of extreme events, intensification of drought periods, and rising climate-related risks to public health, agriculture, tourism, and infrastructure.

3.3. Water Resources (Hydrology, Quality and Pressures)

Montenegro has abundant and diverse water resources due to its specific hydrological conditions, varied relief, and high levels of precipitation throughout the year. The country's hydrographic system is divided between two major river basins, the Adriatic and the Danube, which contributes to the formation of numerous surface and groundwater bodies. In the coastal and mountainous zones, particularly during the winter months, high precipitation levels support the continuous replenishment of water resources, but at the same time increase the risk of flash floods, erosion processes, and seasonal river overflows.

Overall, the quality of surface and groundwater in Montenegro is generally favourable; however, deviations from good ecological and chemical status are recorded in certain urban and industrially burdened areas. The most significant pressures on surface waters stem from insufficiently developed

¹² Third National Communication of Montenegro

systems for the collection and treatment of municipal wastewater, inadequate waste disposal, erosion, agricultural activities, and local industrial pollution.

Groundwater, which represents the primary resource for public water supply, is generally of good quality. However, in areas of intensive urbanisation and agricultural activity, local risks of pollution are recorded, particularly due to inadequate sewerage infrastructure and the limited natural capacity for water filtration into the subsurface. Seasonal fluctuations in flow further affect groundwater availability, with summer periods often bringing reduced water quantities in smaller springs and streams, which may compromise ecological stability and the continuity of water supply.

Water quality is most severely affected in watercourses flowing through larger urban centres, where elevated concentrations of nitrogen and phosphorus are present due to partially treated municipal wastewater. Although the number of wastewater treatment plants is increasing, their functionality and maintenance remain uneven.

Climate change contributes to greater fluctuations in water levels, increased turbidity, and a reduction in ecological flow in sensitive water bodies, which in turn affects aquatic biodiversity and the status of fish populations.

3.4. Soil and Geological Characteristics

Soil and geological conditions in Montenegro are shaped by a highly diverse relief, climatic influences, and geological structure, resulting in a wide range of soil types with varying levels of fertility and sensitivity. Mountain massifs, limestone formations, river valleys, and the coastal zone play a dominant role in the landscape, while the largest part of the country's territory consists of hilly and mountainous areas characterised by well-developed erosion and denudation processes. This physico-geographical diversity has determined the distribution and characteristics of soil types, ranging from highly fertile alluvial soils in river valleys to skeletal and shallow soils in mountainous zones.

Agricultural land covers a significant portion of the territory; however, a large share of this area consists of pastures and natural grasslands, while highly fertile soils account for only a small proportion of the total area. The most productive arable land is mainly located in the Zeta-Bjelopavlići Plain and in a limited number of river valleys, whereas hilly and mountainous areas are predominantly covered by soils of limited fertility and high susceptibility to erosion. Processes of pasture overgrowth, resulting from rural depopulation and the abandonment of traditional agricultural practices, are altering soil structure and contributing to the transformation of open landscapes into forest complexes.

The geological substrate of Montenegro is predominantly composed of carbonate rocks, primarily limestone and dolomite, with a significant presence of flysch and magmatic complexes in certain zones. Such a geological composition facilitates rapid infiltration of precipitation, the occurrence of numerous springs and underground flows, but also increases soil sensitivity to degradation and material loss, particularly on steep terrain. In lowland areas, where alluvial and colluvial sediments prevail, soils are more productive but are also exposed to the risks of pollution and excessive urbanisation.

The main pressures on soils in Montenegro arise from intensive agricultural practices, forestry, mineral resource exploitation, infrastructure development, urbanisation, and industrial activities. These processes contribute to the reduction of high-quality agricultural land, spatial fragmentation, degradation of the topsoil layer, and loss of the natural characteristics of the substrate. Erosion is one of the most pronounced problems, especially in hilly and mountainous areas, where both surface and torrential forms of soil degradation occur. Climatic factors, particularly the increased frequency of extreme precipitation events and drought periods, further intensify erosion processes, soil

degradation, and slope instability. Droughts lead to reduced soil moisture, deterioration of soil structure, and decreased productivity, while intense rainfall causes surface runoff, landslides, and torrential flows. These changes increase soil vulnerability, contribute to the loss of organic matter, and reduce the soil's water retention capacity.

3.5. Biodiversity and Protected Areas

Montenegro is a country with rich biodiversity resulting from the combination of climatic diversity, complex geological structure, and a large number of different ecosystems. Within a relatively small territory, Mediterranean, continental, and mountainous ecological conditions intersect, enabling the existence of numerous habitats and a wide variety of plant and animal species, including a high proportion of endemics. This biogeographical diversity makes Montenegro an important European and global centre of biodiversity.

The network of protected areas in the country comprises a total of 79 designated sites, covering more than 190,000 hectares, which corresponds to approximately 11.6% of the national territory. The structure of this network includes national parks, nature parks, special reserves, natural monuments, and protected landscapes. Although territorial coverage is significant and increasing, the management of protected areas remains a challenge, particularly with regard to the preparation and implementation of management plans, the availability of professional capacity, and the securing of financial resources. Only a limited number of protected areas have adopted management plans, while for the majority it is still necessary to establish appropriate administrative and technical mechanisms for the effective implementation of conservation measures.

Montenegro possesses numerous natural areas of international importance, among which sites important for birds, important plant areas, and locations protected under UNESCO World Heritage and Biosphere programmes are particularly notable. Of special significance is the Ulcinj Saltworks, one of the most important bird habitats along the Adriatic migratory corridor, which has Ramsar site status and serves as a key wintering, feeding, and resting area for a large number of species. The conservation of such areas is of crucial importance for the regional and European network of ecologically significant sites.

The process of establishing the Natura 2000 ecological network is ongoing and represents one of the most important steps in biodiversity protection. To date, the mapping of species and habitats has covered a large part of the terrestrial territory, while activities continue in the remaining areas with the support of international programmes and national institutions.

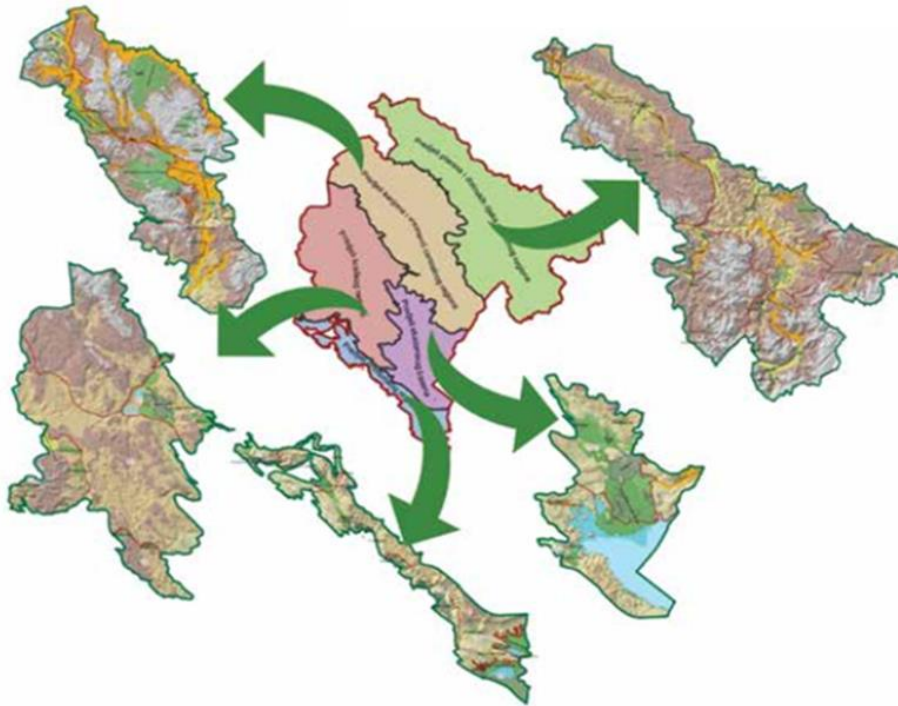
Biodiversity in Montenegro faces numerous pressures, including urbanisation, infrastructure and energy projects, agricultural intensification, exploitation of natural resources, and unplanned construction. Sensitive habitats, particularly in coastal and low-mountain zones, are affected by spatial fragmentation, loss of natural areas, and disruption of ecological processes. Climate change further increases ecosystem vulnerability by affecting seasonal dynamics, water regimes, and the spatial distribution of species.

3.6. Cultural Heritage, Landscape Values and Land Use

The landscape of Montenegro is shaped by strong contrasts between coastal, hilly–mountainous, and high-mountain areas, making it one of the most diverse territories in the Balkans. Within a relatively small area, Mediterranean, continental, and mountainous landscapes alternate, while a large part of the country is characterised by steep terrain, canyon valleys, plateaus, and a coastal zone with distinctive natural and cultural features. The high diversity of relief and natural processes contributes

to the formation of landscape units of exceptional value, but at the same time increases their sensitivity to spatial change.

Figure 5 - Distribution of Landscapes in Montenegro



Source: Spatial Plan of Montenegro until 2040

Montenegro possesses exceptionally rich cultural heritage, encompassing layers of tangible and intangible heritage developed through different historical periods and cultural influences. Traditional architecture, archaeological sites, religious buildings, historic urban cores, and rural settlements represent key elements of the country's spatial identity. Many sites are of outstanding national and international importance, and some are inscribed on the World Heritage List, confirming their universal value and the need for long-term preservation.

Changes in demographic and socio-economic trends influence landscape dynamics. Depopulation of rural areas leads to the abandonment of traditional forms of agriculture and the overgrowth of pastures, which alters landscape structure, increases fire risk, and accelerates succession towards forest habitats. In urban and coastal zones, increased pressure on space is recorded due to the expansion of construction areas, tourism development, and infrastructure, resulting in landscape fragmentation and the loss of natural and cultural values.

The coastal area is particularly sensitive, as the attractiveness of the space creates tensions between the need to protect natural and cultural resources and the intensive development of tourism and associated infrastructure. Coastal zone management requires balancing economic development with the preservation of visual, ecological, and cultural landscape values. Mountain areas, which contain high-value landscapes, are increasingly under pressure from the development of tourism facilities, energy infrastructure, and transport infrastructure.

Among the most significant areas is the Natural and Cultural-Historical Region of Kotor, recognised internationally as an exceptional combination of natural and anthropogenic values. In addition to this area, numerous other sites exhibit a high level of cultural and landscape value, including historic towns,

traditional rural areas, historic infrastructure, religious complexes, and archaeological sites, all of which testify to the country's rich history and cultural diversity.

Although cultural heritage and landscape values are largely well preserved, they are facing increasing pressures. The most pronounced challenges are associated with intensive urban development, unplanned construction, infrastructure and tourism projects, as well as the depopulation of rural areas, which leads to the deterioration of traditional architecture and changes in landscape patterns. These pressures are particularly evident in coastal zones, where the most attractive areas are also the most vulnerable to spatial interventions. In addition, increasingly evident climate change further affects the conservation of cultural heritage and landscape values.

Pressures on land arise from multiple sectors, including agriculture, forestry, urbanisation, industry, energy, mining activities, and transport.

The current structure of land use shows a trend in which natural and cultural characteristics are becoming increasingly threatened due to spatial fragmentation, unregulated construction, and the abandonment of traditional land management practices.

3.7. Population and Human Health

The demographic profile of Montenegro is characterised by long-term trends that affect the overall social structure and place increasing pressure on the public health system. The population is ageing at an accelerated pace, and the proportion of elderly people is continuously increasing, particularly in northern municipalities that have been most affected by long-term depopulation and the out-migration of younger population groups. These processes result in a reduction of the working-age population and an increase in the share of vulnerable groups, which has direct implications for health care and social protection needs.

Climate change and environmental degradation are increasingly affecting public health. Extreme temperatures, especially during summer heatwaves, represent one of the most significant health risks to the population. Air quality is also one of the key risk factors for public health in Montenegro.

The population is also exposed to other risks related to climatic and environmental conditions, including floods, landslides, droughts, and wildfires. Extreme precipitation contributes to flooding that threatens settlements, infrastructure, and public health safety, while prolonged droughts affect water quality and availability, increasing the risk of diseases associated with inadequate hygiene and sanitation. Wildfires, which are becoming increasingly frequent, cause immediate health impacts due to smoke inhalation, as well as long-term effects resulting from vegetation loss and land degradation.

The health care system faces additional challenges, including shortages of staff in certain medical specialisations, uneven regional access to health services, and an increasing prevalence of chronic diseases, which places further strain on the capacity of primary and secondary health care. Combined with demographic trends and the growing influence of climatic and environmental factors, these challenges underline the need to strengthen preventive programmes, improve public health monitoring, and integrate health considerations into the planning of climate change adaptation and mitigation measures.

3.8. Existing Economic and Infrastructural Context

The economic development of Montenegro is characterised by a pronounced sectoral imbalance, in which service activities play a dominant role, particularly tourism, trade, and transport. Tourism is the most significant economic sector and has a strong influence on demand for infrastructure, energy,

water resources, and space, especially in the coastal area, which experiences the highest intensity of seasonal fluctuations. This economic structure leads to increased environmental pressures during the summer months, including higher volumes of waste generation, increased water consumption, pressure on wastewater systems, and traffic-related emissions.

The industrial sector has declined significantly over recent decades; however, areas with historical industrial heritage remain, including former metallurgical and chemical complexes that represent potential sources of local soil, water, and air pollution. In the energy sector, a coal-fired thermal power plant dominates as the largest single source of greenhouse gas emissions and air pollution, while renewable energy sources—primarily hydropower, along with the increasingly important role of wind and solar energy—are gaining greater significance within the national energy system.

The energy network requires upgrades to meet growing consumer demand and to enable the integration of new renewable energy sources. Transport infrastructure, particularly the road network, faces limitations in capacity and safety, while the rapidly increasing number of vehicles contributes to higher emissions and pollution in urban areas. Railway infrastructure has limited scope and functionality, and its potential to reduce transport-related pressures remains underutilised.

Wastewater and solid waste management systems show significant disparities among municipalities. Although some cities have developed modern wastewater treatment systems, a large number of settlements still lack adequate sewerage infrastructure, which affects surface water quality and places additional pressure on aquatic ecosystems. Solid waste management also remains challenging, with the presence of uncontrolled disposal sites, a lack of regional sanitary landfills, and limited recycling capacities.

Based on findings from Montenegro's National Adaptation Plan Montenegro's economy is vulnerable to climatic and environmental pressures. Increasingly frequent extreme weather events, including droughts, floods, and wildfires, affect infrastructure, agriculture, tourism, and energy stability. Extreme temperatures increase energy demand, while droughts and floods impact water supply, agricultural conditions, and infrastructure safety. The tourism sector is particularly exposed to climate change, as changes in temperature, sea quality, wildfire risks, and water availability can significantly influence seasonality and the overall attractiveness of destinations.

4. IDENTIFICATION OF HIGH-RISK AREAS AND EXISTING ENVIRONMENTAL PROBLEMS

This Chapter identifies areas exposed to increased potential risk as a result of the implementation of measures and projects envisaged under the Draft Low-Carbon Development Strategy (LCDS). The chapter focuses on the spatial identification of zones of increased vulnerability, where, due to the concentration of planned activities, existing environmental pressures and the limited absorption capacity of the territory, enhanced pressures and cumulative effects may occur.

This chapter does not assess impacts on individual environmental components but provides the analytical basis for their assessment. A detailed analysis of the impacts of the LCDS on individual environmental components is presented in Chapter 7.

4.1. Areas at risk

Based on the analysis of the draft LCDS, as well as other key strategic documents of Montenegro (the NECP, the Spatial Plan of Montenegro until 2040, and the ETSDP), it is unequivocal that the greatest development pressure in the coming period will occur in areas designated for the construction of solar power plants, wind farms, and hydropower plants.



Considering the scale and locations of the planned projects, it can be concluded that these areas will be exposed to certain environmental, spatial, climatic, and socio-economic risks as a result of the implementation of large energy infrastructure projects. According to the analysis of the current and planned situation, three groups of locations have the highest potential level of risk exposure: areas planned for the construction of solar power plants, areas planned for the construction of wind farms, and areas planned for hydropower plants.

Areas Planned for Solar Power Plants



According to the Draft LCDS, and taking into account the NECP, the Spatial Plan of Montenegro until 2040, and the ETSDP, solar power plants with an installed capacity ranging from 50 to over 500 MW are predominantly planned in the municipalities of Cetinje, Nikšić, Šavnik, Pljevlja, Rožaje and Bijelo Polje.

The main environmental risks in these areas include permanent habitat loss and fragmentation, particularly in locations where large-capacity solar power plants are planned. There is also a potential impact on animal migration corridors.

Additionally, land degradation represents one of the dominant environmental risks, as the construction and operation of solar power plants may cause changes in micro-relief, removal of vegetation cover, and increased exposure of the topsoil to erosion processes. Such changes may result in reduced soil fertility, watercourse turbidity, occurrence of landslides, and permanent loss of the natural characteristics of the area.

When viewed cumulatively, all these factors may lead to the degradation of the ecological stability of the area and a reduction in the overall resilience of ecosystems to external pressures and climate change.

Areas Planned for Wind Farms



According to the Spatial Plan of Montenegro until 2040, wind farms are planned in the areas of Sinjajevina, Krnovo, Brajići, Bijela, Korita, Kolašin and Šavnik.

A specific environmental risk in these areas is the collision of birds and bats with wind turbines, particularly along bird migratory corridors. Additionally, the construction of wind farms can partially contribute to habitat fragmentation, while noise and vibrations generated by the turbines may also affect the surrounding fauna.

From a spatial-planning perspective, the construction of wind farms requires significant interventions in the landscape, given that these are mountainous locations. This includes the opening of new access roads, land levelling, and the construction of turbine foundations. All these activities may disturb the existing relief, increase erosion, and lead to visible changes in the landscape.

At the socio-economic level, the construction of wind farms carries the risk of generating resistance from local communities, among other reasons due to noise, visual impact, and the potential reduction in the area's attractiveness for tourism. In municipalities such as Šavnik and Nikšić, where spatial-planning documentation and key strategic documents foresee the construction of multiple wind farms, there is also a risk of cumulative impacts of projects on the area.

Areas Planned for the Construction of Hydropower Plants



From an environmental protection perspective, large, planned hydropower projects (HPP Komarnica, HPP Kruševo, as well as the reconstruction and expansion of existing facilities) carry the highest level of risk due to the long-term and irreversible nature of their impacts, which manifest across wide areas.

Specific hydropower projects planned for implementation in the coming period have been identified in accordance with the National Energy and Climate Plan of Montenegro (NECP) and the Low-Carbon Development Strategy. Key projects include HPP Komarnica (171.9 MW) on the Komarnica River, HPP Kruševo (82 MW) in the Piva River basin, the expansion of HPP Perućica (58.5 MW) on the Zeta River, as well as SHPP Otilovići (3.3 MW) in the Čehotina River basin. These projects represent the main planned hydropower interventions that may have significant impacts on the hydromorphology of watercourses, aquatic ecosystems, and associated protected areas, and their consideration is therefore essential in the context of assessing the cumulative impacts of the Strategy.

From an ecological standpoint, the construction of hydropower plants leads to the loss of aquatic and terrestrial ecosystems, as large areas of land become flooded or permanently altered. Such changes disrupt habitats of many species, altering the biodiversity of entire watercourses and surrounding terrestrial ecosystems. One of the most significant negative effects is the interruption of fish migration corridors, as dams prevent the natural movement of individuals along the river, which may lead to population declines or the complete disappearance of certain species in specific locations. At the same time, changes in hydrology and sedimentation regimes alter the natural flow of the river, affect sediment loads, increase turbidity, and disturb the dynamics of aquatic and riparian ecosystems.

From a spatial-planning perspective, the creation of reservoirs requires the flooding of large areas and the permanent transformation of space, thereby changing the physical identity of entire valleys, canyons, and river regions. Such interventions often lead to the disturbance of natural landforms, removal of vegetation cover, and destabilisation of terrain, which increases the risk of landslides, erosion, and secondary soil instability.

Socio-economic risks are also significant, as hydropower plant construction often requires the resettlement of local populations, leading to lasting changes in traditional ways of life and the loss of cultural heritage. Flooding of arable land reduces the availability of agricultural areas, resulting in economic consequences, while landscape and ecosystem changes affect the attractiveness of the area in terms of tourism potential.

For this chapter, focusing on the projects listed in the LCDS draft, a risk assessment (1–9) was carried out using a matrix derived from international methodologies (EU SEA Guidance, IFC Performance Standards, UNEP EIA/SEA Manual), which enabled the identification of the risks analyzed above.

A tabular overview of the identified risks and their likelihood of occurrence is provided in the table 5.

Table 5- Identified Risks and Likelihood of Impact

Type of facility	Key Risks	Likelihood (1–3)	Intensity (1–3)	Risk Score (R)	Note
Solar power plants	Habitat loss, land fragmentation, land-use conflicts, visual impact; land degradation, erosion, impact on fauna	2	2	4 (medium–high)	Risk increases proportionally with the size of the facility
Wind farms	Bird/bat collisions, noise, visual impact, degradation of mountain habitats; cumulative effects of multiple wind farms in the same region	3	2	6 (high)	Highest biodiversity risk among all RE technologies; cumulative analysis required
Hydropower plants	Land flooding, hydrology alteration, erosion and landslide risk, socio-economic impacts; impact on watercourses and fish populations	3	3	9 (high)	Highest strategic risk; cumulative impact very high

The risk assessment for the Northern Region is very high, as this region has the largest number of planned solar, wind, and hydropower plants, which creates strong cumulative pressures on ecosystems and the landscape. The Northern Region is identified as the area exposed to the highest cumulative environmental risk, due to the concentration of planned solar, wind and hydropower projects within ecologically sensitive and spatially constrained mountainous areas. The overlap of multiple energy infrastructures increases pressure on ecosystems, landscape values and local communities, while the limited environmental carrying capacity heightens the risk of cumulative effects. In addition, planned hydropower developments within the Tara and Drina river basins may give rise to potential transboundary impacts, as alterations of hydrological regimes and aquatic ecosystems could extend beyond national borders, requiring consideration in accordance with transboundary EIA and SEA principles.

Figure 6 – Map of risk



The risk assessment for the Central Region is medium–high, primarily due to the occupation of large areas and habitat fragmentation.

The assessment for the Southern Region is medium, because although many energy projects is not planned in this region, it is highly sensitive due to tourism and the visual values of the landscape.

Pljevlja coal region in transition

Based on the conducted analysis, the Municipality of Pljevlja has been identified as a specifically defined area exposed to increased cumulative risks in the context of the transition towards a low-carbon economy. The key risks are primarily associated with the planned closure of the Pljevlja Thermal Power Plant and the cessation of activities in the coal sector, which for decades have constituted the backbone of the local economy, employment, and the energy identity of this area.



In line with the Low-Carbon Development Strategy (LCDS), the phasing-out of coal, i.e. the closure of the thermal power plant and, subsequently, the coal mine, represents a key measure for achieving climate objectives and improving air quality. At the same time, this process entails pronounced socio-economic transition risks if not accompanied by adequate support measures. Potential adverse impacts include job losses, a decline in local incomes, and further deterioration of

demographic trends, alongside an increased risk of social exclusion for certain groups of the population.

During the analysis, it was also considered that Pljevlja is already burdened by long-standing air quality problems, land degradation, and outstanding environmental liabilities resulting from previous industrial activities. These factors further reduce the area's resilience to abrupt structural changes. Therefore, in addition to the objective of reducing greenhouse gas emissions, existing environmental and socio-economic challenges must be duly considered.

The SEA highlights the need for the measures envisaged under the LCDS to be complemented by clearly defined measures, including the preparation and implementation of an Action Plan incorporating various mechanisms aimed at ensuring the sustainable development of this part of the Northern Region.

5. GENERAL AND SPECIFIC ENVIRONMENTAL PROTECTION OBJECTIVES RELEVANT TO THE STRATEGY

5.1. National environmental objectives

Environmental objectives of Montenegro are based on fundamental principles as defined in the Constitution and the Law on Environment, proclaiming *an integral system of environmental protection which provides a comprehensive preservation of the quality of the environment, preservation of biological and natural diversity, rational use of natural resources and energy in the most favorable way for the environment, as a basic condition of sustainable development.*

The Law on Environment (OG MNE No. 52/2016, 73/2019 and 84/2024) prescribes that, when adopting strategies, plans, programs and regulations, the Parliament of Montenegro, the Government and local self-government units, within their competences, must encourage sustainable development, and integrate environmental protection requirements established by that law and special regulations must be included in the preparation and implementation of established policies and activities in all areas of economic and social development.

In that context, requirements for a high degree of environmental protection and improvement of the quality of the environment must be an integral part of all starting points aimed at balanced economic development, ensuring that:

- natural resources are used under conditions and in a manner that ensures the preservation of the value of geodiversity, biodiversity, protected natural assets and areas;
- renewable natural resources are used under conditions that ensure their permanent and efficient renewal and constant quality improvement;
- non-renewable natural resources are used under conditions that ensure their long-term economic and reasonable use, including limiting the use of strategic or rare natural resources and substitution with other available resources, composite or artificial materials;

Fundamental principles, *inter alia*, also include that the *activity and/or procedure will be abandoned, that is, it will not be carried out, which has a scientifically proven or presumed probability of harmful*

and permanently harmful impact on the environment. When it is not certain what consequences may be caused by a possible intervention, all available procedures for evaluating expected impacts and appropriate measures must be implemented in order to avoid negative consequences for human health and the environment.

National environmental objectives of Montenegro are strongly articulated in the National Strategy for Sustainable Development by 2030 (NSSD). Strategic goals of NSSD rely on sustainable development goals as defined by the UN 2030 Agenda for Sustainable Development.

NSSD sets important targets in the area of environment protection:

- proportion of disturbed endangered habitats halved;
- no loss of priority habitats by 2030 (linked to spatial planning control);
- fragmentation of key habitats halted;
- forest fires: continuous reduction trend;
- forests and forest land must account for at least 75% of total land biocapacity;
- increase CO₂ sinks through sustainable forest management and afforestation;
- water and air quality improved.

These targets should be largely taken into account when planning new developments/infrastructure projects both in energy and non-energy sectors.

Montenegro's path towards circular economy should also serve as a guidance for further greening of economy.

LCDS objectives should be harmonised with the Spatial Plan of Montenegro, as well. Some inconsistencies relate to spatial conflicts of certain projects with the planned utilization, which puts those projects in the low-probability category.

Montenegro's national environmental goals are shaped by its commitment to sustainable development, EU accession requirements, and the need to protect its exceptionally rich natural heritage. LCDS objectives are largely in line with these objectives.

5.2. EU environmental and climate objectives

The European Union's environmental objectives are deeply interconnected with its vision for a low-carbon future, forming the backbone of the EU's climate and energy policy framework. core environmental objective linked to low-carbon development is the decarbonisation of the energy system. EU policy prioritizes rapid expansion of renewable energy, improved energy efficiency, phase-out of coal, and modernization of electricity networks. The Renewable Energy Directive sets binding targets for increasing the share of renewables, while the Energy Efficiency Directive requires Member States to reduce energy consumption across all sectors. These measures are complemented by the EU Emissions Trading System (ETS), which caps emissions from power generation and heavy industry and steadily tightens the limit to drive emission reductions and promote clean technologies.

Transport, one of the EU's largest sources of emissions, is addressed through the Sustainable and Smart Mobility Strategy, which aims to cut transport emissions by 90% by 2050. Objectives include large-scale electrification of vehicles, expansion of charging infrastructure, modal shifts to rail and public transport,

and adoption of sustainable fuels. Similar ambitions apply to buildings, where the Renovation Wave targets doubling the annual renovation rate to improve energy performance and reduce emissions.

Biodiversity and land-use also form part of the low-carbon agenda. The EU Biodiversity Strategy for 2030 and the Forest Strategy emphasize protection and restoration of ecosystems that act as natural carbon sinks—wetlands, forests, soils, and marine habitats. Strengthening these carbon sinks supports the EU-wide climate neutrality objective by compensating for hard-to-abate emissions. In parallel, circular-economy policies aim to decouple economic growth from resource use, reduce waste, and lower lifecycle emissions, reinforcing low-carbon pathways throughout production and consumption chains.

Together, these environmental objectives form an integrated framework: reducing emissions, improving energy efficiency, boosting renewable energy, restoring ecosystems, promoting sustainable mobility, and shifting to a circular economy. A national Low-Carbon Development Strategy aligned with European priorities must therefore not only lower greenhouse gas emissions but also enhance resilience, preserve natural capital, and ensure that the transition is socially equitable and economically competitive.

On its accelerated path to EU accession Montenegro needs to intensify its efforts to fully converge with the EU regulatory and policy framework.

5.3. Integration of global climate and environmental goals




UNFCCC and Paris Agreement





Parties to the United Nations Framework Convention on Climate Change and the Paris Agreement are encouraged to prepare long-term strategies to reduce greenhouse gas (GHG) emissions, while simultaneously supporting sustainable development.

Agenda 2030

Low-carbon development cuts across several Sustainable Development Goals (SDGs). Although SDG 13 (Climate Action) is the core driver, multiple SDGs contain explicit targets related to emissions reduction, energy transition, transport decarbonization, and resource efficiency, as presented in the table 6.

Table 6 - SDGs related to LCDS

Sustainable Development Goals		Key targets related to LCDS
 <p>SDG 7 Affordable and Clean Energy</p>		7.2: Increase the share of renewable energy. 7.3: Double the rate of energy efficiency improvement. 7.a/7.b: Expand clean-energy technologies and infrastructure.
 <p>SDG 9 Industry, Innovation and Infrastructure</p>		9.4: Upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and adoption of clean technologies.
 <p>SDG 11 Sustainable Cities and Communities</p>		11.2: Provide sustainable transport systems. 11.6: Reduce environmental impact of cities (air quality, waste).

 <p>12 RESPONSIBLE CONSUMPTION AND PRODUCTION</p>	<p>SDG 12 Responsible Consumption and Production</p>	<p>12.2 Achieve sustainable management and efficient use of natural resources. 12.5: Reduce waste generation through recycling and prevention.</p>
 <p>13 CLIMATE ACTION</p>	<p>SDG 13 Climate Action</p>	<p>13.1–13.3: Strengthen climate resilience, implement climate policies, improve awareness.</p>
 <p>14 LIFE BELOW WATER</p>	<p>SDG 14 Life Below Water</p>	<p>Indirect but relevant - Reducing emissions lowers ocean acidification.</p>
 <p>15 LIFE ON LAND</p>	<p>SDG 15 Life on Land</p>	<p>15.1,15.2: Sustainably manage forests and halt deforestation. Protect biodiversity and carbon-rich ecosystems.</p>

6 ANALYSES OF DEVELOPMENT SCENARIOS AND POSSIBLE ALTERNATIVES

6.1. Description of the Considered Scenarios and Alternatives

LCDS explains the approach to developing the LCDS scenario as follows: *“To ensure alignment across energy and climate planning, the LCDS uses the NECP as a basis, and then proposes additional policies and measures (PAMs) that can further emission reduction ambition. As such, analysis in the LCDS is based around three scenarios:*

- *NECP WEM scenario (the lowest ambition scenario).*
- *NECP WAM scenario (medium ambition scenarios).*
- *LCDS scenario (highest ambition scenario).*

These scenarios have been developed bottom up and are nested.¹³”

Taking into account that NECP scenarios are briefly explained in the section 2.3 and already elaborated in the NECP and related SEA, and considering the fact that both NECP scenarios are nested in the LCDS, objective of this SEA is to consider other possibilities of future development taking into account three possible situations:

- “No-action” scenario (without Strategy implementation)
- LCDS scenario
- LCDS sensitivity scenario.

A comparative table of environmental and health impacts across the No-Action, WEM and LCDS/WAM scenarios, including the role of Battery Energy Storage Systems (BESS) as a factor influencing air-quality improvement and system flexibility, is provided in Annex III.

6.2 Comparative analysis of the impacts of scenarios on the environment and human health

The “no-action” scenario assumes that no Low-Carbon Development Strategy is adopted and implemented, and that no further climate-policy effort is undertaken besides NECP.

In practice, this means that:

- long-term decarbonisation pathway is guided by NECP scenarios with reduction of GHG emissions of -81.7% in 2050 (with existing measures) or -333.2% in 2050, compared to 2022, in WEM scenario.
- climate neutrality is achieved between 2030 and 2035 under WEAM scenario¹⁴;
- coal phase out is prolonged to 2040 and beyond;
- local air quality is still under pressure from power generation, industry and residential sector, followed by adverse health impacts due to population exposure;

¹³ LCDS 2025

¹⁴ Ibid

- sectoral emissions remain stable not converging towards zero, without LCDS measures which need an update every five years.

In other words, the main added value of LCDS is that it transforms early net-zero already achieved by NECP WAM scenario into deep, durable, economy-wide decarbonisation. In the “no-action” scenario further GHG emission reduction of 9% compared to 2022 is missing as well but does not represent a huge difference if the NECP WAM ambitious scenario is implemented.

The absence of the LCDS would also mean weaker enhancement of the national carbon sink, limiting the contribution of forests and land use to long-term climate targets.

Environmental and health benefits—such as cleaner air, improved living conditions and reduced exposure to pollutants—would be significantly smaller, as emissions from energy use and industry would remain higher for longer.

Finally, without the LCDS, Montenegro risks fossil lock-in, lower investment attractiveness and slower alignment with EU accession requirements, especially those related to the Green Deal, ETS expansion and long-term climate neutrality. Even under optimistic fuel-price assumptions (e.g. declining coal prices), this scenario remains environmentally and economically unsustainable since carbon-border costs (CBAM) and EU ETS linkage would significantly penalize exports and coal-based power generation.

Reductions in greenhouse gas emissions under the considered scenarios (WEM, WAM and LCDS) are expressed in terms of net emissions, defined as the balance between gross emissions from all sectors and CO₂ removals by carbon sinks, primarily within the land use, land-use change and forestry (LULUCF) sector.

Scenarios showing reductions exceeding 100% relative to the reference year do not imply negative gross emissions but rather indicate that CO₂ removals exceed remaining sectoral emissions, resulting in net negative emissions. Such outcomes are highly dependent on assumptions regarding the strengthening of national carbon sinks through sustainable forest management and other LULUCF-related measures.

In the “no-action” scenario, although net-zero emissions may be temporarily achieved under more ambitious NECP measures, additional reductions in gross emissions and the long-term enhancement of carbon sinks provided by the LCDS are absent. As a result, early net balance does not represent a durable, structural, economy-wide decarbonisation pathway, but remains limited by the scope of existing measures.

6.3 Reasons for Selecting the LCDS scenario

The LCDS scenario represents the most ambitious decarbonisation development option compared to the NECP WEM and WAM scenarios, as it entails the implementation of the full package of climate policies and measures defined in the Strategy, including those taken over from the NECP, as well as additional interventions in the energy, transport, buildings, industry, waste and F-gas sectors. The LCDS scenario is oriented towards achieving deep decarbonisation by 2050, starting from the assumption that both the NECP WAM and the LCDS scenarios allow for the achievement of a climate-neutral energy system in the period between 2030 and 2035, while the LCDS ensures a further and more sustained reduction of emissions after that period, as well as a greater extent of structural changes in key sectors.

In the energy sector, the LCDS scenario envisages an accelerated transition towards renewable energy sources. This includes a substantial increase in installed wind and solar power capacities and full utilisation of renewable energy projects included in various planning documents.

Battery Energy Storage Systems (BESS) represent an important cross-cutting factor differentiating the LCDS/WAM scenario from lower-ambition pathways. By enabling higher integration of variable renewable energy sources, BESS reduce the need for fossil-fuel-based balancing and peaking generation, contributing indirectly to improved air quality and reduced health impacts. In addition, BESS enhance system flexibility and reliability, limiting the need for environmentally intensive backup infrastructure and supporting the overall environmental performance of the LCDS/WAM scenario.

As discussed throughout of this document, an increased deployment of renewable-energy and infrastructure, may exert local pressure on biodiversity, water and landscape, especially when it comes to projects not realised in other scenarios for various reasons such as legal, financial, spatial and environmental constraints.

LCDS foresee an earlier coal phase-out which brings positive synergistic effects in reduction of GHG emissions and environmental and health benefits, but at the moment does not provide solid basis for just transition of the Pljevlja coal region. Facing an uneven regional development, Montenegro needs to pair just transition with coal phase-out dates, respecting the “leaving no one behind” principle of Agenda 2030.

Accelerated EU accession process coupled with intensified financial support including through Reform and Growth facility and other EU funds are providing a one-time opportunity to push for important infrastructure projects which cannot be realised without ambitious forward-looking public policies such as LCDS. However, LCDS needs more substantial analysis of investment needs and economic viability of proposed measures.

6.3.1 Sensitivity scenario

LCDS is strongly based on presumption of full implementation of NECP, which scenarios are nested into LCDS scenario.

In reality, policies and plans are rarely implemented in full, especially long-term strategies where it was not possible to foresee all risks and developments over time. For example, NECP identifies one risk that could hinder the growth of RES as the limitation of the state budget. Most of the new capacity would rely on support mechanisms such as FIT/CfD or net metering, which affect the national budget through national utilities and electricity prices.

LCDS provides SWOT analysis for all analysed sectors. These analyses clearly point out to possible risks and threats that could endanger implementation.

In the energy sector, which is a driver for decarbonisation of all other sectors, LCDS recognises the following:

- Transition for the Pljevlja region will have to be carefully managed and adverse impacts of coal retirement mitigated.
- An increased carbon price could lead to higher near-term power prices ahead of retirement of TPP Pljevlja, while delays in achieving market coupling with the EU will present a risk to renewable energy developers.
- Montenegro’s competitive advantage to enable renewable generation exports is not well established.

- Grid strengthening will have to be successfully deployed to ensure the grid can accept growth in renewable generation.
- Additional hydroelectric capacity may not be feasible if non-climate environmental impacts are determined to be significant.
- Despite strong ambition, uncertainty remains about the future size of the European green hydrogen market.

In addition, LCDS provides for a sensitivity scenario, which, according to the current condition is closer to reality. Within this scenario, large HPP (Komarnica, Krusevo) are not or not fully realised due to environmental and other constraints, while realisation of solar energy potential is at high risk caused by grid capacity and financial limitations. As a result of lower development of new build renewable energy, Montenegro remains reliant on power imports throughout the period to 2050 and does not become an exporter of power at any point. As a result, the price of electricity will significantly rise affecting the entire economy.

Moreover, LCDS recognises similar risks in the transport sector:

- High up-front cost of electricity charging infrastructure and fleet renewal;
- Successful implementation contingent on development of renewable electricity generation capacity and having sufficient grid capacity;
- Uptake of EVs across the EU is likely to create surplus supply of second-hand ICE vehicles, Montenegro needs to avoid becoming a major sales market for these second-hand vehicles leading to carbon lock in;
- Reliance on improvement in EV technologies;
- Use of hydrogen for heavy goods vehicles (HGVs) and buses reliant on improvements in vehicle technologies and availability of affordable fuel.

Further uncertainties on renewal of car fleet, based on the current renewal trends and high prices of electric vehicles lead to higher consumption of fossil fuel, primarily diesel, which persists in the transport sector in 2050, if instead of 90% zero emission vehicles by 2050 only 27% is realised.

Risks for full electrification of rail network is also elaborated in this SEA.

Interestingly, the conclusion on aggregate impact on emissions of the high-risk measures not being realised is relatively small. It implies that relatively small GHG emission reduction will have high costs in anyway – if high risk measures are realised, high financial and environmental price will be paid and if not, full decarbonisation will not be possible, Montenegro will be dependent on electricity imports which will greatly affect electricity prices.

Although LCDS warns on expected impact of CBAM mechanism on electricity prices, deeper analysis is not available for better comparison of all options.

Sensitivity tests (e.g. limited implementation of hydropower, slower electrification, alternative technology costs) show that, even under less favourable assumptions, the LCDS scenario remains environmentally superior to WEM and no-action.

7. IDENTIFICATION AND ASSESSMENT OF POTENTIAL ENVIRONMENTAL AND HEALTH IMPACTS

The purpose of this chapter is to provide systematic and transparent identification and assessment of the potential environmental and health impacts that may arise from the implementation of LCDS, with particular emphasis on the LCDS scenario.

Since LCDS is a national long-term policy, the assessment focuses on broad, cumulative and long-term effects on environment and human health, while recognising that more detailed, site-specific impacts will be addressed at later stages through project EIAs, permitting and spatial planning processes.

The analysis therefore concentrates on how the package of policies and measures (PaMs) and the resulting emission trajectories and technology choices affect climate, air, water, soil, biodiversity, landscape, material assets and population, rather than, for example, describing the dust or noise generated by a single construction site.

The chapter is explicitly grounded in the scenario and sectoral analysis presented in the LCDS, covering power generation, transport, industry and manufacturing, buildings, agriculture, forestry and waste sectors and it interprets these modelled changes in GHG emissions as drivers of environmental risk or benefit.

The assessment focuses on the possible impacts on the following:

- 1) Biodiversity and ecosystems – condition and integrity of terrestrial, freshwater and coastal ecosystems;
- 2) Air quality – emissions and concentrations of air pollutants;
- 3) Water – status of surface and groundwater bodies, including quantity and quality aspects;
- 4) Soil and land – erosion, contamination, land-use change and land take for infrastructure.
- 5) Landscape and cultural heritage – the visual and cultural character of places and the integrity of valued landscapes and heritage sites, including architectural and archaeological heritage;
- 6) Climate – changes in GHG emissions, timing of net-zero, and the role of carbon sinks;
- 7) Population and human health – exposure to environmental hazards and broader well-being;
- 8) Material assets and resources – energy, transport and waste infrastructure.

Given the strategic level of the LCDS, the assessment applies a qualitative significance scale that combines several dimensions:

- magnitude of change relative to the baseline and alternative scenarios;
- spatial extent (local, regional, national or cross-border);
- duration (short-term, medium-term, long-term and whether effects extend beyond 2050);
- reversibility or persistence of effects (e.g. whether habitats can realistically be restored);
- sensitivity or vulnerability of affected receptors (for example, protected habitats, vulnerable groups); and
- cumulative and synergistic character of impacts across sectors.

Impacts are then expressed as major / moderate / minor, positive or adverse.

Key impact drivers embedded in the LCDS scenario

LCDS scenario measures can be summarized as:

- ❖ a rapid decline in emissions from power generation, reaching zero in 2036 when TPP Pljevlja retires;
- ❖ a profound shift in the transport fuel mix, with internal combustion engines steadily replaced by zero-emission vehicles and modal shift to rail and bus;
- ❖ substantial electrification and efficiency gains in industry and buildings, including reduced dependence on biomass and fossil fuels for heating;
- ❖ gradual but significant reductions of IPPU and waste emissions through improved industrial practices, waste infrastructure and methane capture; and
- ❖ stabilised or enhanced LULUCF sink, conditional on better forest management and fire prevention.

These drivers can create extremely strong positive climate and air quality effects, but also necessitate large investments in renewables, grid infrastructure, building renovation and waste facilities, which, if inappropriately sited or designed, may generate adverse environmental impacts.

A summary of the key impacts on individual environmental components is presented in Annex II.

7.1. Expected significant impacts

Initial overview presented in the Table 7 below represents LCDS scenario measures and sectors that would probably be significantly affected by those measures.

Table 7 - LCDS measures and possible significant impacts

	1 biodiversity	2 air	3 water	4 soil	5 landscape	6 climate	7 population	8 infrastructure
PG.1						x	x	
PG.2		x	x			x	x	x
PG.3	x	x	x	x	x	x	x	x
T.1		x				x	x	x
T.2						x	x	
T.3		x				x		x
T.4	x				x		x	x
T.5						x	x	x
IM.1		x					x	x
B.1		x				x	x	x
IPPU.1*								
AG. 1*								
W.1*								

LU.1	x	x		x	x			
LU.2						x		

**No significant impacts are expected for measures IPPU.1, AG.1 and W.1, in accordance with their current formulation which largely depends on future technological developments.*

Power generation measures

PG.1 – Alignment of the carbon price with the EU Emissions Trading System price by 2028, although it can be considered a game changer which will induce structural changes in power generation system of the country, significant direct impacts are expected in GHG emissions reduction (6-climate change) and rise of electricity prices which will affect entire population (7).

PG.2 – Retirement of TPP Pljevlja by 2035 – is expected to have significant impact on GHG emissions and achievement of climate neutrality well ahead of 2050, accompanied with an improvement of the local air quality which is significant from the aspect of human health, but will also significantly impact Pljevlja coal region in transition as well as the entire power generation infrastructure in Montenegro.

PG.3 - Full deployment of the renewable energy generation projects included in ETSDP and not deployed under the NECP – seem to be the most potential measure since it consists of the set of projects that can strongly affect all considered receptors.

Transport measures

T.1 – Develop and publish a transport decarbonisation strategy, including formalising targets included in the LCDS – it is considered that low-carbon transport strategy can significantly affect air quality, GHG emissions, population and infrastructure in terms of development infrastructure for e-mobility.

T.2-Reduce car kilometres by 25% by 2035 – significant impacts are expected in terms of GHG emissions and behavioural change of population towards more sustainable and healthier transport choices. This measure might not significantly affect the air quality since majority of air emissions is not coming from passenger cars.

T.3 – Increase rail share of freight transport – the significance of this measure depends on the increase of share which is not specified. However, if significant results are achieved, it can positively impact air quality due to reduction of emissions from heavy road transport vehicles, modest reduction of GHG emissions and have some impact on improvement of infrastructure.

T.4 – 100% electrification of rail infrastructure by 2040 is a very ambitious measure, having in mind Montenegro’s terrain. It might require substantial interventions on the existing infrastructure passing through protected areas (e.g. Skadar Lake National Park) and landscapes, while it will benefit the infrastructure and population, providing better mobility.

T.5 - 90% of road transport vehicles zero emissions by 2050 – another ambitious measure with most impacts on GHG emissions, population and infrastructure.

Other measures

IM.1 - 95% of industrial and manufacturing fossil fuel use to be replaced with electricity – significant impacts are related to improvement of air quality and human health, higher prices of products and infrastructure due to higher electricity consumption.

B.1 – Implementation of Building Renovation Strategy (although the strategy is not adopted yet) could affect the air quality and GHG emissions, population and infrastructure. The main effect being in less energy demand and greater energy efficiency.

IPPU.1 - Development and implementation of plans for Phases II, III and IV for reduction of HFC use in line with the Kigali Amendment

AG.1 – Assignment of responsibility within the Ministry of Agriculture, Forestry and Water Management to monitor international developments in agricultural mitigation technologies.

WG. 1 - Assignment of responsibility within the Ministry of Ecology, Sustainable Development and Northern Development to monitor international developments in waste management technologies and processes.

For this group of measures (IPPU.1, AG.1 and WG.1) significant impacts cannot be estimated at the moment. Future innovations might but also might not bring revolutionary solutions with zero emissions and benefits for both environment and people.

LU.1 - Conversion of coppice to high forests - increase of GHG emissions sinks will impact climate system, but also biodiversity, landscapes and soil.

LU.2 - Consider inclusion of carbon removals from soils for Forest Land, Cropland and Grassland for the LULUCF sector, being a purely technical measure related to calculation of GHG emissions can affect only climate sector.

It is expected that LCDS, being a climate policy instrument has the strongest impact on climate sector. Most of the measures will also affect population, positively or negatively. Detailed analysis of the recognized impacts is provided in the next sections.

7.1.1 Biodiversity

Renewable energy infrastructure

Solar parks, wind farms and associated grid infrastructure can affect biodiversity in multiple ways:

- Wind turbines may cause bird and bat mortality through collisions, particularly on migratory routes or near roosting and feeding areas; they can also disturb wildlife through noise and movement and alter the visual character of open landscapes.
- Large solar parks may result in loss of habitat, especially if sited on previously semi-natural grasslands or shrublands and can create barriers to movement for some species.
- New transmission corridors can fragment forests and scrub habitats, open up previously undisturbed areas and alter the landscapes valued for their natural appearance.

The LCDS does not specify exact locations for these projects but relies on the ETSDP and Spatial Plan of Montenegro until 2040 to identify corridors and zones, signalling that conflicts with protected areas and high-biodiversity sites must be managed at the spatial-planning and EIA project stage. Despite the provisions of the Law on Nature Protection banning certain activities in protected areas, both NECP and LCDS scenarios still retain projects located in or strongly affecting protected areas.

The impact of renewable infrastructure on biodiversity and landscape is therefore judged as major adverse irreversible impact, taking into account their cumulative effects as well.

For example, hydropower projects like Komarnica and Kruševo can have substantial implications for aquatic and riparian biodiversity, including loss of riverine habitats, changes in fish communities and degradation of canyon or valley ecosystems with high conservation value.

The LCDS sensitivity scenario, which assumes non-development or partial development of these projects due to legal, financial and environmental constraints, demonstrates an awareness that hydropower is a high-risk option in certain locations, and suggests that alternative RES could, to an extent, compensate for non-delivery of controversial projects.

Railway electrification

The existing railway network in Montenegro is around 240–250 km long, however, it is extremely rugged, which makes electrification and upgrades difficult and costly. The network crosses the Dinaric Alps, with very steep gradients, narrow river gorges and unstable slopes, with hundreds of tunnels and bridges, including the Mala Rijeka viaduct, one of Europe’s highest railway bridges. It passes to the sides of the Morača and Tara valleys and across Skadar Lake National Park and Ramsar site, associated wetlands, designated Emerald Network zones, Rumija Emerald site and numerous landscapes with extraordinary values.

The expected impacts on protected areas, habitats and species might be temporary, during the works, but also irreversible, taking into account that power supply infrastructure needs to be placed in remote mountainous areas with limited grid capacity, while also avoiding sensitive habitats and protected sites.

Afforestation

Restoring carbon sinks can be beneficial for a wide range of species and ecosystem functions. It should be noted that afforestation is beneficial only when done in the right place, with appropriate native species and ecologically sensitive design. In the wrong context, it can significantly harm biodiversity, especially in open habitats and areas with high ecological value.

Table 8 - Expected impacts on biodiversity

BIODIVERSITY		
Measure	Impact	Note
PG.3 – Additional RES	Major, state level, long-term, irreversible, negative.	Special focus on protected areas, sensitive habitats and cumulative effects
T.4 – Railway electrification	Moderate, state level, short-term, but also irreversible at some points, negative	Special focus on protected areas and cumulative effects
L.1 – Coppice to high forest	Moderate, state level, long-term, positive	To be performed in right places, with appropriate native species and ecologically sensitive design

7.1.2 Air quality

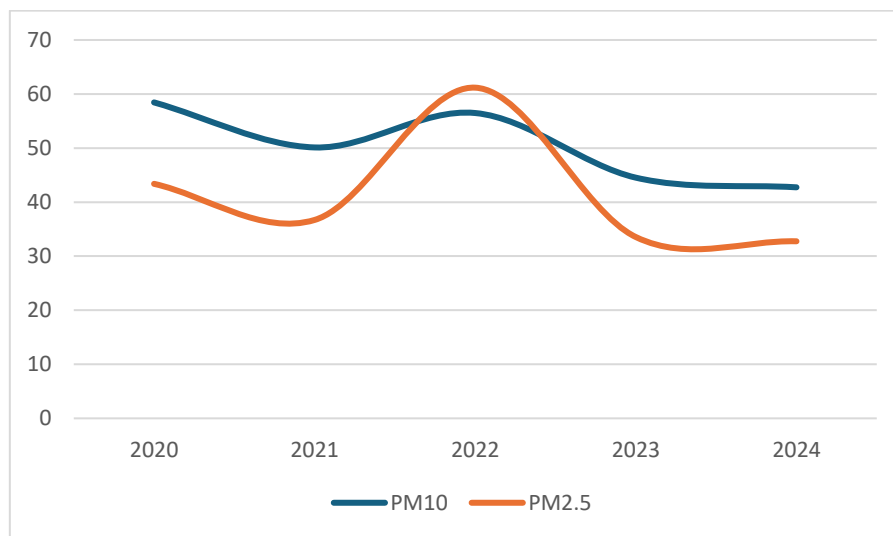
Transformation of the power sector

Emissions of air pollutants from TPP Pljevlja shall be drastically reduced (at the national level) by the recently completed reconstruction, although the test period will show to what extent. Reconstructions include a flue gas desulphurization plant (DeSOx) and the plant for the reduction of nitrogen oxides in flue gases (DeNOx).

However, interventions on the plant would have twofold effects, providing a heat source for district heating system in Pljevlja, thus reducing the impact of the outdated boiler which is currently used against all regulations on limit values of emissions from medium combustion plants, as well as from individual heating sources.

The period of reconstruction, when TPP was out of operation clearly shows an improvement of local air quality, as presented in the figure below:

Figure 7 - PM concentrations ($\mu\text{g}/\text{m}^3$) in Pljevlja 2020 - 2024



With retirement of the TPP, the expected positive impact of district heating will depend on the choice of fuel used for the heating system. Use of biomass can contribute to reduction of GHG emissions, but on the other hand can negatively impact air quality in terms of content of benzo(a)pyren in products of incomplete combustion.

To summarize, power generation measures would have the following impacts on air quality:

- Further reduction of SOx and NOx emissions in relation to post-reconstruction phase, which is positive, irreversible change on the state level, though the extent of the change is difficult to assess at the moment. TPP Pljevlja is a major source of SOx and NOx emissions in the country with respective share of 99% and 47%¹⁵ in the total emissions. Constructed De-SOx and De-NOx plants are expected to achieve respectively up to 80% and up to 30% of reduction of the total emissions.
- The impact of retirement of TPP Pljevlja on local air quality in Pljevlja would depend on the alternative for district heating system, as well as on the price of electricity (considering the import of electricity as well) and the final choice of heating fuel by the citizens not connected to the district heating system. The impact is local.
- Additional RES would in a long-term and at the national level have a positive impact.

¹⁵ Inventory of air emissions 2025 (with data for 2023, as per methodology) available at: <https://www.ceip.at/status-of-reporting-and-review-results/2025-submission/#M>

Decarbonisation of the transport sector

Road transport currently contributes to 6.8%¹⁶ of total NOx emissions at state level, and those emissions are coming from busses and heavy vehicles. Road transport contribution in emissions of other pollutants is negligible. Also, generation of particulates by "non-exhaust" impact of the road transport (tire wear, brake wear, road surface abrasion, and resuspension of dust) will not be affected by decarbonisation efforts. Hence, decarbonisation of the transport sector, especially in terms of rail electrification and use of hydrogen powered buses would have a moderate positive impact on air quality.

Decarbonisation of industry and manufacture

Although industry and manufacture are not among major sources of air pollution according to the inventory of air emissions¹⁷, replacing of 95% of industrial and manufacturing fossil fuel use with electricity will greatly contribute to improvement of local air quality.

Buildings and small combustion sources

The LCDS recognises that although buildings, especially residential, do not contribute a high share of CO₂ emissions due to the large role of biomass, they are nonetheless important for local air pollution and forest pressures, because biomass heating is often highly inefficient and produces significant particulate emissions.

Building renovation strategy (not adopted yet) should aim at:

- improving the thermal performance of buildings through insulation and other efficiency measures;
- progressively replacing biomass and fossil fuel boilers with efficient electric systems and, in some locations, heat pumps or district heating;
- reducing overall energy demand in both commercial/institutional and residential buildings.

Considering that residential heating is a major source of particulate matter emissions (84% of PM_{2.5} and 79% of PM₁₀)¹⁸ the impact of this measure is major, positive and on the state level.

Finally, afforestation efforts if coupled with improved forest management, reduced illegal logging for energy and stronger fire prevention could have a major positive impact on air quality in the country.

Table 9 - Expected impacts on air quality

AIR QUALITY		
Measure	Impact	Note
PG.2 - Reduction of SOx and NOx emissions (Retirement of TPP Pljevlja)	Moderate, state level, long-term, positive	Large part of SOx and NOx emissions already reduced by reconstruction of TPP
PG2 – Improvement of air quality (Retirement of TPP Pljevlja)	Local, not possible to estimate other features	Impact depends on currently unknown options for household heating in the future

¹⁶ Ibid

¹⁷ ibid

¹⁸ Ibid

PG3 – Additional RES	Moderate, state level, long-term, positive	
IM1 – Fuel to electricity	Minor, local, positive	
B1 – Building renovation	Major, medium-term, positive	Strategy not adopted
L1 – Coppice to high forest	Major, state level, long-term, positive	To be coupled with improved forest management, reduced illegal logging for energy and stronger fire prevention.

7.1.3. Emerging technologies and circular-economy aspects

The deployment of emerging technologies under the LCDS, including Battery Energy Storage Systems (BESS) and green hydrogen, is expected to generate predominantly positive environmental and health impacts at the strategic level. By enabling higher integration of renewable energy sources and reducing reliance on fossil-fuel-based balancing and peaking generation, these technologies contribute to improved air quality and a reduction of pollution-related health risks. BESS enhance system flexibility and stability, while green hydrogen produced from renewable electricity supports long-term decarbonisation of hard-to-abate sectors; however, its environmental performance will depend on production pathways, electricity demand and water use.

Energy storage using green hydrogen is also associated with certain challenges: the energy efficiency of the entire chain - from hydrogen production by electrolysis, through storage, to re-conversion into electricity - is lower compared to direct use of electricity or battery storage. Also, hydrogen production requires significant amounts of electricity and water, which imposes the need for careful planning of locations and capacities, especially in the context of protecting water resources.

From a resource-use and waste-management perspective, increased deployment of battery systems introduces life-cycle and end-of-life considerations, which are addressed through the principles of the circular economy and the requirements of the EU Battery Regulation (Regulation (EU) 2023/1542).

Batteries for electric vehicles and stationary storage systems present a particular challenge due to the content of critical and potentially hazardous materials, such as lithium, cobalt, nickel and electrolytes. Although these batteries contribute to a significant reduction in emissions during the use phase, their end-of-life requires strictly controlled collection, storage, recycling and treatment processes to prevent risks to the environment and human health, including fires, leakage of hazardous substances and pollution. At the same time, efficient recycling enables the recovery of valuable materials and the reduction of dependence on primary raw materials, which has both economic and strategic benefits.

Solar panels have a relatively long working life (25-30 years), but after that period, they will generate considerable amounts of waste. This waste contains valuable materials such as aluminum, glass, copper and silicon, but also potentially dangerous substances depending on the technology (eg lead, cadmium or other chemicals in certain types of panels). If adequate collection, recycling and reuse systems are not provided, inadequate disposal of solar panels can lead to land and water pollution, as well as to the loss of secondary raw materials.

Similarly, wind turbines - and especially blades made of composite materials based on resins reinforced with glass fibers - represent a significant challenge from the point of view of recycling. These composite materials are designed to be light, strong and durable, but due to their complex structure, they are difficult to separate and reprocess using classic recycling methods. After the end of the working life of

wind turbines, which is usually 20-25 years, the blades become bulky and specific waste that often cannot be efficiently recycled in existing systems.

Therefore, it is necessary to plan in advance the capacities for managing this type of waste, if not already precisely defined by the State Waste Management Plan, including the application of extended producer responsibility systems and alignment with EU regulations on waste from batteries and electrical and electronic equipment.

7.1.4 Water

Retirement of TPP Pljevlja

Ecological reconstruction of TPP Pljevlja progressively remove a long-standing pressure on local water bodies, as cooling water discharges, potential leaks from ash disposal sites and mine drainage, which are brought under tighter control and ultimately eliminated by planned closure of operations.

If closure is accompanied by proper reclamation of ash dumps and mining areas, including stabilisation of slopes, capping of contaminated surfaces, management of leachate and re-vegetation, the long-term trajectory for water quality in the Pljevlja area should be strongly positive, with reduced loads of suspended solids and heavy metals entering local streams.

This aspect of the LCDS therefore represents a moderate positive impact on the local water environment, with the caveat that the quality of mine closure and reclamation planning will be decisive.

Hydropower expansion and river ecosystems

The LCDS envisages hydropower development, both refurbishment of existing plants and potential construction of new large projects, as part of its strategy to increase renewable generation and enable coal phase-out, although the sensitivity scenario explicitly recognises that some of these projects face environmental and legal constraints and therefore might not be delivered.

Hydropower projects are associated with a well-known set of environmental risks:

- ❖ alteration of natural flow regimes, including reduced flows downstream of dams and changes in seasonality, which can affect aquatic habitats and riparian vegetation;
- ❖ barriers to fish migration and fragmentation of river systems, with knock-on effects on biodiversity;
- ❖ sediment trapping in reservoirs, leading to erosion downstream and changes in channel morphology;
- ❖ and, during construction, temporary increases in sediment loads, pollution risks and disturbance.

In catchments where high-conservation-value river stretches would be inundated or heavily modified, these impacts may be significant and partly irreversible.

If all identified hydropower projects were built without strong mitigation and careful siting, the overall impact on water bodies and ecosystems would likely be moderate to major adverse at river-basin level.

Table 10 – Expected impacts on water bodies

WATER		
Measure	Impact	Note

PG.2 – Retirement of TPP	Moderate, local, long-term, positive	
PG.3 – Additional hydropower	Major, state level, long-term, irreversible, negative.	Special focus on protected areas, sensitive habitats and cumulative effects

7.1.5 Soil

Land requirements of renewable energy and network projects

The LCDS anticipates the development of large new capacities of solar PV and wind power, along with significant reinforcement and extension of transmission and distribution networks and the installation of battery energy storage systems (BESS).

Even if Montenegro’s overall land area is large relative to the footprint of such infrastructure, individual projects can:

- ❖ convert agricultural or semi-natural land to industrial use;
- ❖ create fragmentation of habitats through access roads, fences and array layouts;
- ❖ and, where built on slopes or sensitive soils, increase the risk of erosion and landslides during construction and operation.

At national scale, the proportion of land affected is likely to remain modest, but in particular locations, such as ridgelines used for wind farms, plateaus targeted for solar parks, or narrow valleys traversed by new power lines, the local impact on land and soil can be moderate, and, in visually or ecologically sensitive areas, also problematic for landscape and biodiversity.

Accordingly, without mitigation, the impact of RES and grid build-out on soil and land is assessed as moderately adverse, localised in space and generally reversible if decommissioning and restoration are properly planned.

Afforestation

Despite the moderate nutrient depletion of the soil and the change of diversity of understory vegetation, transformation of coppice to high forests can have positive impacts on soil, providing for improved soil structure and stability, reduced erosion, better infiltration and moisture retention, prevention of landslides, etc.

Table 11 – Expected impacts on soil

SOIL		
Measure	Impact	Note
PG.3 – Additional RES	Moderate, local, long-term, reversible, negative.	
L.1 – Coppice to high forest	Moderate, state level, long-term, positive	To be performed in right places, with appropriate native species

		and ecologically sensitive design
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7.1.6 Landscape

The LCDS’s landscape impacts arise mainly from renewable-energy infrastructure, hydropower projects and associated grid expansion. Railway electrification can also affect some sensitive landscapes. While national-level effects are moderate, local impacts can be significant, especially in Montenegro’s visually prominent ridgelines, canyons and protected areas. New infrastructures present high landscape risk with potential to fragment or industrialise scenic areas. Cumulative transformations across multiple sectors magnify these effects, making spatial planning, avoidance of sensitive landscapes and rigorous EIAs essential for reducing harm.

Projects should be excluded from or reconfigured to avoid:

- National parks (Durmitor, Lovćen, Prokletije, Biogradska Gora, Skadar Lake);
- Proposed Natura 2000 and Emerald sites;
- Ecological corridors, riparian zones, wetlands;
- Boka bay (UNESCO World Heritage Site);
- Vulnerable landscapes as defined in local landscape plans.

These areas have high scenic and ecological value and development there would present significant landscape degradation risks.

Transforming coppice into high forest produces a noticeable shift in the visual and structural character of the landscape. In areas where maquis is characteristic landscape element, combined with traditional terraces with olive groves, this transformation can cause loss of cultural landscape.

Figure 8 – Herceg Novi, Landscape plan 2024



Table 12 – Expected impacts on landscape

LANDSCAPE		
Measure	Impact	Note
PG.3 – Additional RES	Major, local, long-term, irreversible, negative	Special focus on protected areas and cumulative effects
T.4 – Railway electrification	Minor, local, long-term, irreversible, negative	Special focus on protected areas and cumulative effects
L.1 – Coppice to high forest	Minor, local, long-term, negative / positive	Negative impact relates to characteristic landscapes, mainly in coastal area.

7.1.7 Climate impacts

Greenhouse gas emissions and net-zero timing

Under the LCDS scenario, gross GHG emissions fall to 322 kt CO₂e by 2050, or roughly 9% of 2022 levels, with agriculture representing the largest remaining emission source and all other sectors brought close to zero through the combined effect of the PaMs.

Both NECP WAM and LCDS achieve net-zero territorial emissions between 2030 and 2035, when the build-out of new renewable generation reduces the utilisation of TPP Pljevlja sufficiently for the forest sink to offset residual emissions in other sectors. The crucial difference is that NECP WEM never reaches net zero, because it neither turns TPP Pljevlja off nor deploys enough new low-carbon capacity, so power sector emissions remain essentially flat out to 2050.

From a climate perspective, the LCDS scenario therefore represents a major positive impact: it both accelerates the timing of deep decarbonisation and sharply lowers cumulative emissions. The impact is largely irreversible, and it significantly improves Montenegro's alignment with the Paris Agreement temperature goals and EU climate-neutrality trajectory.

Transport sector measures are quite ambitious and costly (T4, T5), which makes their implementation uncertain.

Taking into account that among other measures there is no concrete actions in sectors of agriculture and waste that combined contribute about 25% to the total GHG emissions, measures from remaining sectors (Industry and manufacture, buildings and industrial processes and product use) have only minor impact on emissions reduction.

Contribution of LULUCF measures to increase of sinks is not quantified in LCDS.

Table 13 – Expected impacts on climate and GHG emissions

CLIMATE		
Measure	Impact	Sector contribution to GHG emissions
Power Generation measures	Major, state level, long-term, positive	43%
Transport measures	Major, state level, long term, positive (ambitious)	27%
Other measures	Minor, state level, long-term, positive	30% (Agriculture 14.4%, Waste 10.3%)

7.1.8 Population and human health

Reduction of air-pollution-related health burdens

The most direct and powerful health effect of the LCDS scenario arises from the combined reduction in emissions from power generation, industry and manufacture, road transport and low-efficiency heating, which collectively are responsible for a large share of current exposure of population to air pollution, with major contribution of the residential heating sector.

Considering the scale of the changes, the overall impact on human health from improved air quality is classified as major positive, with benefits accruing relatively early in the implementation period and increasing as decarbonisation deepens.

Just Transition aspects for Pljevlja region

The most sensitive social and health dimension of the LCDS is the just transition of Pljevlja coal region, where livelihoods and local economies have long been tied to TPP Pljevlja and associated coal mine.

Closure of the TPP Pljevlja by 2035 and possible downsizing of mining operations may, in the absence of strong support measures, lead to:

- job losses and reduced household income;
- deepening of energy poverty due to increase of electricity prices;
- additional out-migration and demographic changes;
- further imbalance of uneven regional development;
- stress and anxiety that can have negative health implications.

The LCDS acknowledges this risk and points to the need for a dedicated Just Transition Plan that will design employment, retraining, economic diversification and social-support measures for the region, although it needs to the extent feasible to elaborate further on this issue.

The absence of reliable just transition plan makes the impact of this measure as major negative at local level.

Decarbonisation of transport sector

While better mobility contributes to the general well-being, especially if the behavioural change related to reduction of passenger car kilometers is shifted to healthier transport options such as walking and cycling, decarbonisation of transport sector can also have negative impacts on population due to its costs. Decarbonisation of public transport (both road and rail) can also cause more costly mobility.

In 2024 there were total of 306.665 registered vehicles, of which only 713 are electric vehicles¹⁹. The average age of vehicles in Montenegro is 17.30 years²⁰. Average price of an electric passenger vehicle is about 46,000 EUR, while average wage in Montenegro is about 1000 EUR. In order to achieve 90% of zero-emission vehicles by 2050, almost every citizen needs to buy a new electric car.

Thermal comfort

Building renovation measures envisaged by LCDS should be further elaborated and officially enacted to ensure improvement of thermal comfort in both winter and summer, especially for low-income households and vulnerable groups. Better-insulated dwellings, more efficient heating systems and access to district heating or affordable and efficient electric heating mean that households can maintain healthier indoor temperatures at lower operating cost and with reduced reliance on polluting fuels.

If renovation programs and tariff-support schemes are designed with clear objectives, the health and equity benefits can be substantial; the impact is therefore assessed as major positive, with the scale of benefit dependent on the targeting quality and implementation speed.

¹⁹ MONSTAT Statistical yearbook 2024 https://monstat.org/cg/publikacije_page.php?id=2324

²⁰ Road Safety Report for 2024 <https://www.gov.me/dokumenta/8e3bc916-a679-4a19-9f20-fa18929ec75e>.

7.1.9 Infrastructure

The LCDS implies a very large volume of construction and refurbishment activities over multiple decades: new RES projects, grid reinforcements, building renovations, wastewater plants and transport infrastructure upgrades. Investment needs are in general poorly assessed by LCDS, if assessed at all. The document needs substantial chapter on possible source of financing and at list approximate costs of the LCDS measures taking into account their long-term horizon.

Improvement of infrastructure has in general a major positive impact at the state level, but it has to be assessed on the basis of reliable estimate of cost.

In this section it is important to draw attention to waste management issues which will arise with more intensive use of modern zero-carbon technologies, including waste solar panels, waste batteries of electric cars and other possible waste which can be considered as major, long-term negative impact at state level.

7.2. Cumulative, synergistic, and transboundary impacts

The environmental consequences of implementing the LCDS extend far beyond the effects of individual projects or sectoral actions. Since the strategy encompasses a broad portfolio of mutually reinforcing policies and investments across energy, transport, industry, agriculture, waste management, and land use, its impacts must also be considered in cumulative, synergistic, and transboundary dimensions.

Cumulative and cross-sector impacts

The LCDS produces several important cumulative effects that go beyond the sum of sector-specific impacts:

- ❖ The combination of rapid decarbonisation in power, transport and buildings yields very large co-benefits for air quality and health, reinforcing the climate benefits.
- ❖ Multiple sectors, such as power, transport, tourism and agriculture compete for land and water, which means that spatial planning and integrated water resource management become critical to avoid cumulative habitat loss and over-use of water resources.
- ❖ The sensitivity scenario demonstrates that delayed or partial delivery of some PaMs (notably hydropower, solar and transport electrification) can significantly alter the balance of impacts, reinforcing the importance of adaptive management and regular LCDS reviews.

Overall, the cumulative impacts for climate, air quality and health are strongly positive, while the potential cumulative adverse effects on biodiversity, water and landscapes are in some cases manageable provided that robust safeguards, good spatial planning and high-quality project EIAs are systematically applied.

Conversely, the implementation of numerous energy, infrastructure and agricultural measures may lead to spatially cumulative pressures on land and natural resources. The expansion of renewable-energy infrastructure—particularly wind farms, solar parks, hydropower reservoirs, and associated grid networks—will require land in various regions of Montenegro. Although each installation may affect only a small area, together they can contribute to incremental habitat fragmentation, soil sealing, and changes in landscape character if not carefully sited.

Additional cumulative pressure may arise from parallel investments under other national programmes, such as tourism development, transport-corridor modernisation, and industrial-zone expansion. When concentrated in sensitive mountain valleys, coastal zones or karst plateaus, these overlapping land uses can lead to loss of ecological connectivity, increased erosion, and visual intrusion.

Biodiversity and ecological connectivity

From an ecological perspective, cumulative impacts are expected mainly through fragmentation of habitats caused by the progressive spread of infrastructure across previously undeveloped landscapes. The combined presence of new energy facilities, transport corridors and urban extensions could isolate patches of natural habitat, affecting wildlife movement and gene flow. At the same time, improved forest management, afforestation with native species and reduced illegal logging provide a countervailing cumulative benefit by expanding and improving forest ecosystems.

If renewable-energy projects are concentrated in limited regions, for instance along the coastal wind corridors or central highlands, cumulative effects on bird and bat populations may become significant, even if individual projects are minor. For this reason, cumulative-impact assessment at landscape scale should accompany every new investment, incorporating data from existing and planned developments within a 30-kilometre radius or ecological zone.

Socio-economic and health outcomes

The interaction of multiple LCDS measures also produces cumulative effects on society and human health. However, the socio-economic restructuring of coal-dependent regions, if not managed carefully, may lead to cumulative stress arising from job losses, migration and perceived insecurity.

Transboundary impacts

Transboundary impacts are predominantly beneficial, contributing to cleaner air, improved water quality in shared basins and enhanced ecological connectivity across borders. Among transboundary risks are hydropower projects which implementation is not certain due to domestic environmental concerns.

In general, the implementation of the LCDS is expected to generate net cumulative and synergistic benefits for Montenegro and its neighbouring countries, reinforcing regional sustainability objectives and supporting the Western Balkans' transition toward climate neutrality.

7.3. Uncertainties and limitations of the assessment

Every environmental assessment, regardless of its methodological approach, is accompanied by a set of uncertainties and inherent limitations. These arise from the complexity of natural and socio-economic systems, the need to use projections and assumptions in place of empirical data, and the evolving character of policies and technologies. The assessment of the LCDS is no exception: it is a forward-looking document that spans over more than two decades, encompassing multiple sectors, actors, and external drivers.

Input assumptions

Strategic planning is always based on numerous input assumptions regarding economic growth, population trends, electricity prices, technology penetration rates, efficiency improvements, and policy implementation timetables. Even minor variations in these parameters can lead to substantial differences in projected greenhouse-gas emissions, energy demand, and consequently the scale of environmental impacts. Furthermore, the LCDS scenario assumes full and timely implementation of all planned policies and measures envisaged in NECP.

Despite the development of sensitivity scenario, LCDS does not adequately assess the viability of certain measures including the early retirement of TPP Pljevlja, rapid electrification of transport, and large-scale building renovation as well as their possible economic, social and environmental consequences.

Data availability and quality

Data on investment needs are limited and of different level of estimation where available. Source of financing is not considered in LCDS. Therefore, it was not possible to assess the financial feasibility of these measures and establish a good balance between gains and potential risks.

Limited empirical evidence on new technologies

Some LCDS measures, given the extended time horizon are too vague to analyse their environmental impacts. For example, in sectors like waste and agriculture LCDS foresee “monitoring of international developments in mitigation technologies”. In other cases, measures involve emerging technologies with limited deployment history in Montenegro, which life-cycle impacts and waste-management options are still evolving. Consequently, the assessment can only approximate their long-term impacts based on international benchmarks and indicative literature.

Long time horizon and evolving external context

The LCDS extends to 2050, covering a period in which technological, economic and climatic conditions are expected to change substantially. Over such a long horizon, external variables, including global energy prices, carbon-market dynamics, EU climate policy, and regional economic trends, may diverge from the assumptions used in the current analysis.

In conclusion, the uncertainties identified in this assessment are common for strategic environmental studies conducted at an early stage of policy development. They do not undermine the fundamental finding that the LCDS will have predominantly positive outcomes, but they highlight the need for data improvement, continuous monitoring and institutional adaptability.

8. MEASURES TO PREVENT, REDUCE AND MITIGATE NEGATIVE IMPACTS

The implementation of the LCDS represents one of the most transformative policy frameworks in Montenegro's modern environmental history. While its aggregate contribution to climate change mitigation, air-quality improvement, and long-term health protection is overwhelmingly positive, the large number of construction activities, land-use changes, and sectoral transitions implied by the strategy inevitably create a range of potential local-scale environmental and social risks. These include land disturbance and habitat fragmentation arising from new renewable-energy and transmission projects, temporary deterioration of local air quality and noise during construction works, hydrological changes and biodiversity impacts linked with hydropower development and short-term socio-economic effects connected to the progressive closure of coal-based energy facilities.

The environmental and health assessment of the LCDS demonstrates that, while the strategy will generate very substantial overall benefits for climate, air quality, and public health, certain components may still produce localised or sector-specific adverse effects associated with the construction of renewable-energy and transport infrastructure, the development of new hydropower facilities, increased land take for solar parks or substations, or the short-term social impacts linked to the restructuring of the coal sector.

To ensure that the LCDS is implemented in a manner fully consistent with the principle of sustainable development and with the environmental safeguards required under the EU acquis and the national legislation, the Government and implementing institutions should adopt a coherent package of preventive, mitigation and compensatory measures that apply across all sectors.

The overall hierarchy should be:

- ❖ Avoid adverse effects where possible through strategic planning and project siting.
- ❖ Minimise impacts that cannot be avoided by applying best available techniques (BAT) and strict operational management.
- ❖ Restore or rehabilitate affected areas after work is completed.

- ❖ Compensate or offset any remaining residual impacts that cannot reasonably be mitigated.

In parallel, cross-cutting actions such as capacity building, public participation, environmental monitoring and transparency of data must accompany technical measures to ensure long-term accountability and adaptive management.

8.1. Regulatory and technical measures by sector

Policy-level preventive measures

(a) Integration of environmental criteria into LCDS implementation

All strategic decisions made under the LCDS, such as the selection of renewable-energy projects, transport corridors, or industrial investments, should be screened for environmental sensitivity at an early stage. This requires that SEA and EIA procedures be systematically applied in accordance with national law and EU Directives, ensuring that environmental and health considerations are embedded before financing or permitting decisions are taken. The screening should explicitly examine potential effects on climate, air, water, soil, biodiversity, cultural heritage and human health, as well as cumulative and transboundary effects. Ministries and agencies responsible for energy, transport, agriculture, industry and construction shall ensure that no major LCDS-related project proceeds to the financing or permitting phase without an environmental assessment proportionate to its potential significance.

(b) Spatial planning and zoning for low-impact development

Spatial planning documents including the Spatial Plan of Montenegro 2040 and sectoral development plans (energy, transport, waste, tourism, agriculture), should designate low-conflict zones for renewable-energy and industrial development and exclude or restrict activities in ecologically sensitive or high-value landscapes. The mapping of biodiversity hotspots, bird migration routes, protected areas, floodplains and groundwater-protection zones must be fully integrated into planning and permitting processes. Renewable-energy and industrial zones should be delineated in areas of low ecological and landscape value, preferably on brownfield sites, degraded lands, abandoned quarries or areas of low agricultural productivity, while zones of high ecological sensitivity, including protected areas, proposed Natura 2000 sites, riparian corridors, floodplains and karst groundwater-protection areas, must be excluded from large-scale development.

(c) Application of the “Do No Significant Harm” DNSH principle

Every major LCDS measure funded through public programmes or international financial institutions should be subject to screening against the DNSH principle as defined under the EU Taxonomy Regulation²¹. This screening ensures that climate-mitigation measures do not generate disproportionate harm to water, biodiversity, circular economy or pollution-prevention objectives.

(d) Capacity building and institutional strengthening

Implementation of mitigation measures presupposes adequate technical and human capacity within state and local institutions. Therefore, the Ministry of Ecology, Sustainable Development and Development of the North, the Environmental Protection Agency and local environmental

²¹ Regulation (EU) 2020/852 on the establishment of a framework to facilitate sustainable investment <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32020R0852>

departments should be strengthened through targeted training, staffing and equipment support to carry out environmental assessment, inspection, and monitoring duties. Capacity building should extend to municipal planners, public utilities and private developers to ensure consistent understanding and application of environmental standards.

Sector-specific technical and management measures

Power generation and renewable energy development

The expansion of renewable-energy capacity, although crucial for decarbonisation, must be accompanied by stringent safeguards. Hydropower plants should be designed and operated to maintain ecological flows, ensure downstream sediment continuity, and incorporate fish-passage facilities. Reservoir operations must include adaptive management protocols that respond to seasonal hydrological variations and climate-change projections. New hydropower facilities should only be permitted after comprehensive basin-level cumulative-impact assessments demonstrate compatibility with the objectives of the EU Water Framework Directive.

For wind-energy projects, site selection should avoid major bird-migration routes and areas with high concentrations of bats or raptors. Developers should employ turbine layouts that minimise collision risks and adopt operational curtailment or temporary shutdowns during peak migration periods. Pre- and post-construction monitoring programmes should document wildlife interactions, with publicly accessible results.

Solar-energy developments should prioritise disturbed or low-biodiversity areas such as industrial zones, landfills and former mining areas. Vegetation beneath solar arrays should be managed through natural groundcover or low-impact grazing rather than chemical herbicides, thereby reducing soil erosion and maintaining ecological function. Each project must include a decommissioning and land-restoration plan defining how panels and infrastructure will be dismantled and recycled after their service life.

The electric-transmission network and battery-storage systems (BESS) should be routed along existing corridors wherever possible to avoid new fragmentation of habitats. Design standards must ensure compliance with noise, electromagnetic-field and fire-safety requirements, and communities located near large substations should be consulted and informed of safety procedures.

For battery energy storage systems, mitigation measures should include appropriate site selection avoiding protected and sensitive areas, compliance with fire safety and operational standards, and the establishment of end-of-life battery management and recycling schemes in line with EU regulatory requirements. Environmental assessment at the project level should be applied where required.

Coal mining / transition area

The gradual decommissioning of TPP Pljevlja and its associated lignite mines shall be guided by a detailed Environmental Rehabilitation and Mine Closure Plan approved by the competent authority. This plan must address slope stability, backfilling, drainage control, and prevention of acid mine drainage. Contaminated soils and ash deposits should be isolated using impermeable liners or encapsulation methods, followed by covering with clean topsoil and revegetation using native plant species. Long-term groundwater and surface-water monitoring should continue for at least a decade after closure to verify the absence of contamination. Reclaimed areas can be repurposed for renewable-energy facilities or recreation once environmental stability is demonstrated.

Transport and mobility infrastructure

All new or upgraded roads and railways should include environmentally sensitive design features, such as wildlife overpasses and underpasses, storm-water-management systems with oil separators, and acoustic barriers near settlements. Construction activities must adhere to approved Construction Environmental Management Plans (CEMPs) specifying dust suppression, noise control, and safe storage of fuels and lubricants. During operation, maintenance regimes should minimise herbicide use and ensure proper disposal of replaced materials. The promotion of electrified rail and public transport systems will reduce noise and vibration emissions and must be supported by proper environmental monitoring of depots and charging stations.

Industry and manufacturing sectors

Industrial facilities undergoing modernisation should apply Best Available Techniques (BAT) for energy efficiency, emission control and waste management. Operators must establish integrated environmental-management systems certified under ISO 14001 or equivalent, incorporating emergency-response and accident-prevention plans. Fuel-switching initiatives should include evaluation of water and air-pollution implications to avoid burden-shifting. Continuous emission monitoring (CEMS) should be mandatory for large installations, with real-time data reported to the Environmental Agency.

Buildings and construction activities

Large-scale building-renovation programmes should incorporate safe handling and disposal of hazardous construction materials, including asbestos insulation, lead-based paints and refrigerants. Workers must receive training in occupational health and safety, and all renovation projects shall prepare waste-management plans aiming for maximum material recovery and recycling. Noise and dust from construction sites should be controlled through time restrictions, on-site watering, and use of covered vehicles. Municipal authorities must supervise compliance through regular inspections.

Agriculture, forestry and LULUCF

In the agricultural sector, mitigation focuses on the introduction of sustainable land-management practices such as conservation tillage, precision fertilisation, integrated pest management and drip irrigation. Buffer strips along watercourses should be maintained to reduce nutrient runoff, and animal-waste management systems should prevent leakage of effluents to soil and groundwater.

Forestry activities should prioritise mixed-species reforestation with native varieties adapted to local climatic conditions. Forest-road construction should follow contour lines to minimise erosion, and degraded forest lands should be rehabilitated using natural regeneration techniques. Comprehensive forest-fire prevention programmes, combining early-warning systems, surveillance and local-community training, must be maintained throughout the LCDS implementation period.

Waste and wastewater management

All new or upgraded landfills should be equipped with impermeable liners, leachate-collection and treatment systems, and gas-capture facilities to prevent contamination and reduce methane emissions. Modern Material-Recovery Facilities (MRFs) and anaerobic-digestion plants should be developed to divert biodegradable waste from landfill, while wastewater-treatment plants must include tertiary treatment to remove nutrients and micro-pollutants. Sludge should be stabilised and either reused safely in agriculture (where quality standards permit) or disposed of in controlled conditions. Continuous monitoring of effluent quality is necessary to ensure compliance with discharge standards.

8.2. Adaptation and climate-resilience measures

While the principal purpose of the LCDS is to reduce Montenegro's greenhouse-gas emissions and achieve long-term climate neutrality, the strategy also recognises that climate change impacts are already occurring and will continue to intensify throughout the 21st century, even under ambitious mitigation scenarios. Rising temperatures, shifting precipitation patterns, prolonged droughts, floods, forest fires, heatwaves and sea-level rise all pose increasing risks to the country's ecosystems, economy and population.

Consequently, a comprehensive national climate strategy must address not only mitigation but also adaptation and resilience-building. The integration of adaptation measures ensures that the decarbonisation process itself remains sustainable under changing climatic conditions and that key infrastructure, livelihoods and ecosystems are safeguarded against future hazards. This chapter therefore identifies and evaluates the adaptation and climate-resilience components embedded in the LCDS and proposes additional complementary actions consistent with the Law on Climate Change, the forthcoming National Adaptation Plan (NAP), and the priorities of Montenegro's National Climate Change Strategy to 2030.

Climate-risk context for Montenegro

Montenegro's location and topography make it one of the most climate-sensitive countries in South-Eastern Europe. Historical observations and regional climate projections indicate a clear warming trend of 1.2–1.5 °C since 1960 and a likely additional increase of 1.5–2.5 °C by mid-century. Precipitation is projected to decline by 10–20 % in the southern and coastal zones and to shift seasonally in the north, with wetter winters and drier summers. These changes will heighten the frequency of droughts, flash floods, soil erosion, wildfires, and heat-stress events.

Key vulnerabilities include:

- ✓ Water resources – declining summer flows in rivers, reduced groundwater recharge and competition among hydropower, agriculture and domestic uses.
- ✓ Forestry and biodiversity – higher risk of forest fires, pest outbreaks, and habitat shifts in sensitive mountain and coastal ecosystems.
- ✓ Agriculture – increased water demand, crop yield variability, and soil degradation.
- ✓ Energy infrastructure – exposure of hydropower generation to low flows, and of transmission lines to storms and landslides.
- ✓ Human health – heat-related illness, respiratory stress and vector-borne diseases.
- ✓ Coastal zones – erosion, salt-water intrusion and flooding linked to sea-level rise.

The LCDS therefore emphasises that achieving a low-carbon economy must go hand in hand with enhancing resilience to these projected changes.

Integration of adaptation principles into the LCDS

Sector-specific adaptation and resilience measures

Energy sector

The decarbonisation pathway outlined in the LCDS is inherently linked with improved climate resilience of the energy system. Key adaptation measures include:

- ✓ Diversification of generation sources – By expanding solar, wind and biomass capacity, Montenegro reduces dependence on single resources that are sensitive to hydrological

variability. This diversification increases the system's resilience to drought and seasonal flow fluctuations.

- ✓ Grid reinforcement and digitalisation – Upgrading transmission and distribution networks with climate-resilient materials, underground cabling where feasible, and advanced monitoring systems reduces vulnerability to extreme weather, lightning and heat stress.
- ✓ Hydropower operation under variable climate – Basin-level water-management rules should be adjusted to maintain ecological flows during dry periods while optimising energy generation. Reservoir-operation protocols must account for changing inflow regimes and sedimentation patterns.
- ✓ Thermal-plant site rehabilitation – The closure of TPP Pljevlja and subsequent site restoration provide opportunities to design new land uses—such as solar parks or industrial parks—based on flood- and erosion-resistant layouts.

Transport

Transport infrastructure will experience increasing exposure to temperature extremes, heavy rainfall, and slope instability. Adaptation measures therefore include:

- ❖ Climate-resilient design standards for roads, bridges and railways, requiring drainage systems with greater capacity, temperature-resistant pavements and slope-stabilisation structures.
- ❖ Integrated risk mapping to identify vulnerable segments, particularly mountain passes, coastal roads and river crossings.
- ❖ Green and blue infrastructure (e.g., vegetated buffers) to manage runoff and reduce flood risk.
- ❖ Maintenance planning that includes routine inspection after extreme events and rapid repair protocols.
- ❖ Modal shift to public transport and rail, which not only reduces emissions but also offers higher system flexibility during climate disruptions.

Industry

Industrial facilities must adapt to climate-related disruptions in supply chains, water availability and cooling demand. Recommended actions include:

- ❖ Conducting climate-risk audits for large industrial complexes, focusing on flood, fire and temperature risks.
- ❖ Upgrading process-cooling systems to operate efficiently under higher ambient temperatures.
- ❖ Introducing closed-loop water systems and water recycling to reduce dependence on external supplies.
- ❖ Enhancing structural resilience of buildings and storage areas to withstand storms, wind and heavy precipitation.
- ❖ Promoting circular-economy practices that reduce resource intensity and waste under variable climate conditions.

Buildings and urban areas

Urban settlements are hotspots of climate vulnerability due to heat islands, flash flooding and energy poverty. The LCDS therefore should integrate the following resilience measures:

- ❖ Deep renovation programmes that include insulation, shading, natural ventilation and reflective surfaces, improving both energy efficiency and heat-wave protection.
- ❖ Green roofs, permeable pavements and urban trees to lower surface temperatures and absorb runoff.

- ❖ Updated building codes requiring flood-resistant materials in basement areas and higher standards for thermal comfort.
- ❖ Promotion of district-heating and cooling systems with renewable sources, which reduce strain on individual households during extreme temperatures.
- ❖ Establishment of early-warning and emergency-response systems for heatwaves in cooperation with public-health authorities.

Agriculture

Agriculture is one of the sectors most exposed to climate variability. Adaptation and resilience measures include:

- ❖ Efficient irrigation technologies, such as drip and sprinkler systems, and water-storage ponds adapted to local hydrology.
- ❖ Development of climate-resilient crop varieties and diversification of crop patterns to spread risk.
- ❖ Soil-conservation practices—mulching, cover crops, contour farming—to maintain moisture and reduce erosion.
- ❖ Agro-meteorological services and early-warning systems to help farmers plan planting and harvesting according to forecasts.
- ❖ Integrated pest and disease management anticipating shifts in pest populations due to warming.
- ❖ Strengthening of insurance schemes and financial mechanisms that help farmers recover from climate-related losses.

Forests, biodiversity and ecosystems

Forests and natural ecosystems are both victims and allies in climate adaptation. The LCDS embeds ecosystem-based adaptation through:

- ❖ Sustainable forest management that enhances species diversity and age structure, thereby improving resilience to pests, fires and droughts.
- ❖ Reforestation with native and drought-tolerant species on degraded or burned lands, restoring carbon sinks and stabilising soils.
- ❖ Expansion of protected areas and ecological corridors to facilitate species migration under changing climatic zones.
- ❖ Implementation of integrated forest-fire management systems, including surveillance, controlled burning, and community training.
- ❖ Wetland and peatland restoration to improve flood retention and groundwater recharge.

Water resources

Adaptation in the water sector is central to maintaining supply reliability and protecting ecosystems, and can be achieved through:

- ❖ Adoption of integrated river-basin management with scenarios for low-flow and extreme-flow conditions.
- ❖ Construction of small multipurpose reservoirs and inter-basin transfer systems to buffer seasonal shortages, ensuring ecological flows remain intact.
- ❖ Leakage reduction and demand management in urban water supply networks.
- ❖ Upgrading of wastewater-treatment plants to cope with variable inflows during floods and to maintain effluent quality during droughts.

- ❖ Expansion of storm-water infrastructure in cities to prevent combined-sewer overflows.
- ❖ Reuse of treated wastewater for irrigation where quality standards allow.

Health and social resilience

Human health and well-being are integral to resilience. The LCDS supports:

- ❖ Establishment of heat-health-warning systems and public-awareness campaigns during extreme heat events.
- ❖ Improvement of ventilation and cooling in hospitals, schools and care homes, using energy-efficient technologies.
- ❖ Enhanced vector-control programmes and monitoring of climate-sensitive diseases.
- ❖ Integration of climate-risk considerations into emergency-management and civil-protection plans.
- ❖ Promotion of social safety nets that protect vulnerable groups, especially in regions undergoing economic transition.

Institutional, policy and financial mechanisms for resilience

- ❖ The implementation of adaptation measures requires clear institutional arrangements and sustainable financing. Key mechanisms include:
- ❖ Establishing a National Council for Climate Adaptation and Resilience to coordinate cross-sectoral actions and monitor progress.
- ❖ Integration of climate-risk screening into public-investment planning, ensuring that all major projects undergo climate-resilience evaluation before approval.
 - ✓ Mobilisation of financial resources from the Green Climate Fund (GCF), EU Instrument for Pre-Accession Assistance (IPA III), EBRD Green Cities Programme, and national climate funds to support adaptation investments.
 - ✓ Strengthening of local-government capacity through training on vulnerability assessment, spatial planning under climate risks, and implementation of ecosystem-based approaches.
 - ✓ Development of public-private partnerships for insurance, green infrastructure, and resilience-oriented innovation.

Monitoring, evaluation and knowledge management

To ensure that adaptation measures deliver tangible results, the LCDS should establish a robust monitoring and evaluation system aligned with the national MRV framework and forthcoming NAP indicators. Suggested indicators include:

- ❖ Number and capacity of climate-resilient infrastructures built or upgraded.
- ❖ Area of forests restored or managed for climate adaptation.
- ❖ Volume of water saved through efficiency measures.
- ❖ Percentage of population covered by early warning systems.
- ❖ Number of municipalities integrating adaptation into local development plans.

Results should be compiled in biennial adaptation progress reports and disseminated through public platforms. Research institutions and universities should contribute through climate-impact modelling, vulnerability mapping, and evaluation of pilot projects. Lessons learned from implementation should feed back into future revisions of both the LCDS and the NAP.

A climate-resilience and adaptation matrix, outlining key climate hazards, affected sectors, adaptation measures and institutional responsibilities, is provided in Annex III.

8.3. Measures for the protection of biodiversity, water, and soil

Given Montenegro's exceptional ecological richness—hosting over 40 distinct habitat types, a high share of endemic species, and significant transboundary watersheds—the protection of biodiversity, water and soil represents both a national priority and a precondition for sustainable low-carbon development. The measures described in this section aim to ensure that the LCDS is implemented in a way that preserves ecosystem integrity, maintains hydrological balance, prevents land degradation, and sustains essential environmental services for present and future generations.

Legal and policy framework

These protection measures are grounded in national and international commitments, including:

- Law on Nature Protection (OG MNE No. 54/16, 18/19 and 84/2024);
- Law on Water (OG MNE No. 27/07 and 32/2011, 47/2011, 48/2015, 52/2016, 55/2016, 2/2017, 80/2017, 84/2018, i 84/2024);
- Law on Agricultural Land (OG MNE No. 15/92, 59/92 and 32/2011);
- Law on Environmental Impact Assessment (OG MNE No. 75/18 and 84/2024);
- Montenegro's National Biodiversity Strategy and Action Plan (NBSAP 2020–2030);
- Water Management Strategy (2022–2035); and

relevant EU directives, notably the Habitats Directive (92/43/EEC), Birds Directive (2009/147/EC), Water Framework Directive (2000/60/EC) and Soil Thematic Strategy.

Together, these instruments require that any new development under the LCDS adheres to the principles of ecological integrity, sustainable water use, soil conservation and the “do no significant harm” (DNSH) approach.

Measures for biodiversity protection

Strategic spatial planning and avoidance of sensitive areas

The first and most effective measure for biodiversity protection is the strategic avoidance of ecologically sensitive zones. All renewable-energy, transport and industrial projects planned under the LCDS must be subject to spatial screening using the most recent ecological datasets, Natura 2000 candidate-site maps, and biodiversity inventories.

Projects should be excluded from, or carefully reconfigured to avoid, the following:

- ❖ national parks and strict nature reserves (e.g., Durmitor, Biogradska Gora, Lovćen, Skadar Lake, Prokletije);
- ❖ proposed Natura 2000 sites and Emerald network areas;
- ❖ critical habitats for endangered or endemic species;
- ❖ ecological corridors connecting key habitats or protected areas;
- ❖ wetlands, karst springs and riparian zones that serve as biodiversity refugia.

This preventive approach shall be embedded into the Spatial Plan of Montenegro 2040 and local spatial plans, thereby ensuring that the siting of new facilities is ecologically compatible from the outset.

Environmental impact assessment and monitoring

All projects derived from the LCDS must undergo a comprehensive environmental impact assessment as part of the EIA process. This includes:

- ❖ baseline biodiversity surveys over at least two seasons;
- ❖ analysis of potential direct, indirect and cumulative effects on species and habitats;
- ❖ identification of avoidance, mitigation and compensation measures; and
- ❖ establishment of post-construction ecological monitoring plans.

Monitoring indicators should include bird and bat mortality at wind farms, vegetation recovery at construction sites, fish populations downstream of hydropower plants, and changes in land-cover patterns derived from remote sensing.

Protection of species and ecological corridors

Where renewable-energy or transport projects intersect migration routes of birds or bats, developers must design and implement species-specific mitigation, such as:

- ❖ turbine curtailment during high-risk migration periods;
- ❖ installation of radar-based shutdown systems;
- ❖ marking of power lines to prevent collisions; and
- ❖ establishment of ecological overpasses or underpasses for terrestrial fauna along roads and railways.

To maintain landscape connectivity, spatial plans should include the designation of ecological corridors between major habitat complexes. Corridors should be mapped, protected from fragmentation, and integrated into local land-use policies, ensuring genetic exchange and long-term ecosystem resilience.

Compensation and restoration of habitats

In cases where residual impacts on biodiversity are unavoidable, developers must implement ecological compensation or habitat restoration measures. Compensation measures are further elaborated in the section 8.5.

Measures for forest protection

- ❖ *Prevention and early detection of forest fires*
Apply preventive forest fire protection measures, including the maintenance of firebreaks, removal of flammable biomass, and the establishment of early fire detection systems in high-risk areas.
- ❖ *Sustainable forest management and restoration of degraded forest areas*
Implement planned logging in line with the principles of sustainable forest management, along with reforestation of degraded and fire-affected areas using native tree species and improvement of forest structure.
- ❖ *Monitoring and sanitary protection of forests*
Establish systematic monitoring of forest pests and diseases and apply timely sanitary measures to preserve the health status of forest ecosystems.
- ❖ *Strengthening supervision and control in the forestry sector*
Enhance inspection supervision and forest monitoring systems in order to prevent illegal logging and ensure the long-term protection of forest resources.

Capacity building and institutional strengthening

The Environmental Protection Agency (EPA) must be provided with sufficient human and financial resources to carry out biodiversity monitoring, maintain databases, and review ecological studies

submitted with EIA documentation. Training programmes should also be organised for municipal authorities, project developers and environmental consultants on biodiversity-sensitive design and management.

Measures for the protection of water resources

Integrated river-basin management

Protection of water resources requires an integrated, basin-level approach. All LCDS-related interventions affecting water quantity or quality, particularly hydropower, industrial processes, wastewater treatment and irrigation shall be coordinated under River Basin Management Plans (RBMPs) in line with the Water Framework Directive. Each RBMP must:

- ❖ maintain or achieve “good ecological and chemical status” of water bodies;
- ❖ define ecological flows that sustain aquatic ecosystems even during drought periods;
- ❖ establish monitoring programmes for hydrological and biological parameters;
- ❖ and integrate flood-risk management, land-use planning, and biodiversity conservation.
- ❖ Sustainable hydropower development

Hydropower remains a key element of Montenegro’s energy mix but also the main potential source of aquatic impact. Therefore:

- ✓ New hydropower plants should be authorised only after basin-level cumulative-impact assessments demonstrate compatibility with environmental objectives.
- ✓ Run-of-river schemes should be prioritised over large dams where feasible, to minimise reservoir impacts.
- ✓ Mandatory fish-passage structures and sediment-management systems must be incorporated in design.
- ✓ Reservoir operations should include adaptive flow management to maintain downstream ecosystems.
- ✓ Existing plants should undergo environmental retrofitting where ecological damage has been identified.

Specific Measures for Hydropower Projects

In order to prevent, reduce, and mitigate the negative impacts of planned hydropower projects on water resources, the following measures should be applied:

Ensure an environmentally acceptable flow (environmental minimum flow) downstream of dams and water intakes, in accordance with national legislation and the EU Water Framework Directive, in order to preserve the functionality of the river ecosystem, habitat continuity, and the survival of aquatic species.

Design and implement technical solutions to ensure the longitudinal connectivity of watercourses, including fish passes, bypass channels, or other appropriate solutions, in order to enable fish migration and maintain the ecological connectivity of the river system.

Prevent deterioration of water quality during construction by applying erosion and sediment control measures, including bank stabilization, limiting works within the riverbed, using sedimentation barriers, and controlled disposal of excavated material outside flood-prone areas.

Establish a reservoir management regime that minimizes sudden changes in downstream flow and water levels, in order to prevent negative impacts on aquatic organisms, riparian habitats, and water use downstream of the hydropower plant.

Prohibit the disposal of construction waste, hazardous materials, and surplus excavated material in riverbeds, floodplains, and areas of direct hydrological connectivity, and ensure controlled management of all wastewater generated at the construction site.

Establish a programme of continuous monitoring of hydromorphological and chemical water parameters, including flow, temperature, dissolved oxygen, turbidity, and biological indicators, before construction, during construction, and during the operation of the hydropower plant, in order to enable the timely implementation of corrective measures.

Avoid the construction of hydropower facilities in ecologically sensitive areas, particularly within protected areas, Natura 2000 candidate sites, key fish habitats, and source water protection zones, unless environmental impact assessment clearly demonstrates the acceptability of the intervention.

Pollution control and wastewater management

To protect both surface and groundwater:

- ❖ Municipalities must accelerate the construction and upgrading of wastewater-treatment plants, ensuring at least secondary treatment for all settlements and tertiary treatment in sensitive areas.
- ❖ Industrial effluents should be pre-treated to meet discharge standards before entering public systems.
- ❖ Agricultural runoff should be controlled through buffer strips, vegetative barriers and precision fertilisation.
- ❖ Storm-water management in urban areas should be improved with green infrastructure, retention ponds and permeable pavements.
- ❖ Groundwater abstraction must be monitored and licensed, with priority given to maintaining drinking-water sources and ecological flows.

Protection of karst and coastal waters

Given Montenegro's extensive karstic geology and shared coastal waters of the Adriatic Sea, protection of groundwater and marine ecosystems is critical. Specific measures include:

- ❖ Mapping and delineating karst vulnerability zones, prohibiting waste disposal and industrial activity in high-risk recharge areas.
- ❖ Establishing early-warning systems for pollution incidents in karst aquifers.
- ❖ Strengthening coastal-zone management to prevent wastewater and solid waste from entering the sea.
- ❖ Implementing the Marine Strategy Framework Directive (2008/56/EC) to maintain good environmental status of marine waters, including control of nutrient and plastic pollution.

Measures for the protection of soil

Prevention of soil sealing and erosion

Soil is a finite and non-renewable resource whose loss directly affects biodiversity, water regulation and food production. Under the LCDS, soil protection should be mainstreamed through:

- ❖ minimising land take and soil sealing during infrastructure construction by reusing brownfield or degraded areas;
- ❖ designing renewable-energy installations (e.g., solar parks) with minimal topsoil removal and maintaining vegetation cover beneath panels;
- ❖ implementing erosion-control measures on slopes, such as terracing, bioengineering, and stabilisation mats;
- ❖ avoiding construction in areas prone to landslides, floods or high erosion susceptibility.
- ❖ Prevention of contamination and remediation of degraded sites

To avoid soil contamination:

- ❖ Industrial facilities must comply with pollution-prevention and control standards (IPPC) for storage, handling and disposal of hazardous substances.
- ❖ Mining and energy sites, particularly around Pljevlja, should be remediated through removal or isolation of contaminated materials, installation of leachate barriers and re-vegetation.
- ❖ Agricultural soils should be monitored for heavy metals and pesticide residues, promoting integrated pest management to reduce chemical load.
- ❖ Illegal waste dumping and burning must be strictly sanctioned through increased inspections and fines.

Sustainable soil management in agriculture and forestry

Soil health is central to both adaptation and mitigation. The following sustainable-management practices should be promoted:

- ❖ Organic farming and composting to increase soil organic matter.
- ❖ Crop rotation and cover cropping to prevent nutrient depletion.
- ❖ Reduced tillage and conservation agriculture to preserve soil structure and moisture.
- ❖ Contour ploughing and grass strips on slopes to reduce runoff.
- ❖ Forest-management practices that avoid heavy machinery in sensitive soils and maintain forest litter for nutrient cycling.

Monitoring and research

A National Soil Information System should be established under the Environmental Protection Agency, integrating data on soil types, erosion risk, contamination, and land-use change. Periodic soil surveys (every 5–10 years) will help evaluate the effectiveness of protective measures and inform land-use planning. Cooperation with universities and research institutes will ensure methodological consistency and capacity building.

Cross-sectoral coordination and institutional responsibilities

Effective protection of biodiversity, water and soil requires cross-sectoral coordination among national and local institutions. The following arrangements are recommended:

- ❖ The Ministry of Ecology, Sustainable Development and Development of the North shall lead policy integration and oversight.
- ❖ The Environmental Protection Agency (EPA) shall monitor indicators, enforce standards, and maintain national databases and provide expert input on biodiversity and habitat management.
- ❖ The Water Administration shall coordinate river-basin planning and hydropower assessments.
- ❖ The Ministry of Agriculture, Forestry and Water Management shall promote sustainable land-use practices and soil conservation.

- ❖ Local governments shall implement spatial planning, green infrastructure and community awareness programmes.

Joint working groups and data-sharing platforms should be established to ensure that information flows effectively among sectors and that policies are mutually reinforcing.

The measures proposed for the protection of biodiversity, water and soil will play a decisive role in ensuring that the implementation of the LCDS produces net environmental benefits rather than shifting pressures from one domain to another. If systematically applied, these measures will:

- ❖ prevent irreversible habitat loss and fragmentation;
- ❖ maintain ecological flows and water quality;
- ❖ reduce erosion, contamination and land degradation;
- ❖ and enhance the resilience of natural systems that underpin Montenegro's economy and well-being.

By integrating ecosystem protection directly into low-carbon development, Montenegro can achieve a truly sustainable climate transition, preserving its natural capital as the foundation for a green, resilient and competitive future.

8.4 Social and health-related mitigation measures

The transition to a low-carbon economy carries significant implications for employment, income distribution and public health, particularly in regions historically dependent on coal. Social equity measures under the LCDS include targeted support for vulnerable groups and the promotion of a just transition for workers and communities affected by decarbonisation, particularly in the Pljevlja coal region, with the aim of preventing disproportionate social and health impacts associated with the implementation of the Strategy. The Government shall therefore prepare and implement a comprehensive Just Transition Plan for the Pljevlja region, coordinated by the Ministries of Labor, Energy, and Ecology. The plan should include measures for worker retraining, entrepreneurship support, development of new green industries, and community-level investment in health and education infrastructure. Environmental-rehabilitation projects in the region can provide transitional employment opportunities while improving local living conditions.

In parallel, all national energy-efficiency and building-renovation programmes should incorporate social-targeting mechanisms to prioritise low-income households, thereby reducing energy poverty and improving indoor air quality. Municipalities should establish public-health monitoring systems in areas with large infrastructure projects, tracking air pollution, noise and water-quality indicators, and publishing data regularly. During construction phases, developers must maintain effective grievance mechanisms allowing citizens to raise concerns about environmental or health nuisances and to receive timely responses.

Cross-cutting monitoring and governance measures

Effective mitigation is inseparable from monitoring and governance. The LCDS should therefore be supported by an integrated environmental-monitoring framework linked with the national greenhouse-gas MRV system. Key indicators should include sectoral GHG emissions, ambient concentrations of SO₂, NO₂ and particulate matter, ecological status of water bodies, forest-fire statistics, biodiversity indices and socio-economic indicators related to the just transition. Data should be collected by competent agencies and aggregated into an open-access online dashboard providing the public with transparent information on environmental trends and LCDS progress.

Inter-ministerial coordination should be established to oversee implementation of mitigation measures, evaluate monitoring results, and recommend corrective actions. The committee should include representatives of government, municipalities, academia, civil society and business. Its deliberations and annual reports should be publicly available to foster accountability.

Adaptive management and continuous improvement

Given the long-time horizon of the LCDS and the likelihood of evolving technologies and socio-economic conditions, mitigation measures must be dynamic rather than static. The strategy should therefore provide for five-year review cycles, synchronised with NECP updates, in which observed environmental outcomes are compared with projections and mitigation approaches are refined. Lessons learned from project-level EIAs, inspection reports and stakeholder feedback should feed directly into subsequent revisions of both policy and technical guidance. The principle of adaptive management will ensure that unforeseen negative effects are detected early and corrected efficiently.

Table 14 – Summary table of mitigation measures

Sector / Issue	Primary Negative Impact	Preventive / Mitigation Measure	Responsible Institution
Hydropower	Altered flow, biodiversity loss	Ecological flow, fish passes, sediment management, strict EIA	Ministry of Energy and Mining / Environmental Agency
Wind & Solar	Habitat loss, bird/bat mortality	Strategic siting, curtailment, decommissioning plan	Ministry of Energy and Mining / EPCG / private investors in RES / Local authorities
Grid & BESS	Land take, safety	Corridor planning, EMF & noise standards, emergency plans	CGES / EPCG / private investors in RES / Local authorities
Construction	Dust, noise, waste	CEMPs, waste sorting, traffic control	Contractors / Local inspectors
Agriculture & Forestry	Erosion, fertiliser runoff	Sustainable land management, mixed afforestation	Ministry of Agriculture, Forestry and Waters / Forestry Authority
Waste	Leachate, odour, methane	Modern landfills, methane capture, recycling	Local utilities / Environmental Agency
TPP Pljevlja Closure	Soil/water contamination	Reclamation plan, groundwater monitoring	EPCG / Ministry of Ecology, Sustainable Development and Development of the North
Social / Health	Job losses, local stress	Just Transition Plan, retraining, community health monitoring	Ministry of Labour / Ministry of Education, Science and Innovation / Public Health Institute / Municipality

Expected outcome of mitigation implementation

If the full suite of preventive, technical, social and governance measures outlined above is consistently applied, the residual adverse environmental impacts of LCDS implementation are expected to be minor, localised and reversible, whereas the beneficial impacts, especially those related to climate mitigation, air-quality improvement, public-health protection and ecosystem restoration, will be dominant and long-lasting. The integration of environmental safeguards into every stage of planning and investment will enable Montenegro to achieve its decarbonisation objectives while safeguarding the quality of its natural environment and the well-being of its citizens.

8.5. Compensatory measures and recommendations for integration into action plans

Even with the systematic application of preventive and mitigation measures, certain residual environmental effects of the Low-Carbon Development Strategy (LCDS) may remain unavoidable due to the scale, spatial distribution, and complexity of interventions required to achieve national climate neutrality. These include, for instance, localised habitat transformation caused by renewable-energy infrastructure, cumulative alterations in landscape character, or transitional socio-economic effects related to the restructuring of the coal sector.

The findings of this Strategic Environmental Assessment provide a framework for the implementation of the LCDS through its Five-Year Action Plans. Environmental risks, mitigation measures and monitoring recommendations identified in this SEA should be reflected, where relevant, in the design, prioritisation and sequencing of actions included in the Action Plan, particularly for measures that may result in location-specific or cumulative environmental impacts at the project level.

The purpose of this section is twofold:

- ✓ to define compensatory measures that can counterbalance residual negative impacts on biodiversity, water, soil and social systems once avoidance and mitigation have been exhausted; and
- ✓ to propose recommendations for the effective integration of all environmental, adaptation and compensatory measures into the LCDS Action Plans, sectoral implementation programmes and local development documents.

This ensures that environmental protection and sustainability principles are operationalised at every level of LCDS execution and become an integral part of decision-making, financing and monitoring processes.

Principles for compensatory measures

The concept of compensation in environmental planning is guided by the “mitigation hierarchy”:

- ❖ avoidance of impacts wherever possible;
- ❖ minimisation and restoration of disturbed areas; and finally
- ❖ compensation for residual, unavoidable losses through equivalent or greater environmental gains elsewhere.

Compensatory measures must therefore adhere to the following principles:

- ❖ Equivalence of ecological function: compensation should provide the same or higher biodiversity, water-regulation or soil-conservation value as the affected area;
- ❖ Proximity: compensation should occur in the same river basin, ecosystem type or administrative region to maintain ecological coherence;
- ❖ Permanence: measures must be maintained for the entire lifetime of the impact or permanently, if the original loss is irreversible;
- ❖ Additionality: compensatory actions must create new benefits beyond those already required by existing regulations or projects;
- ❖ Transparency and monitoring: all compensation sites and actions must be registered, monitored and reported through the national environmental-information system.

Compensatory measures for biodiversity

Habitat restoration and creation

Where renewable-energy or infrastructure projects under the LCDS cause unavoidable habitat loss or degradation, developers shall implement habitat-restoration programmes of equal or greater ecological value. Examples include:

- ❖ Reforestation and afforestation with native species to restore carbon sinks and wildlife habitat;
- ❖ Rehabilitation of degraded wetlands or riparian zones to re-establish ecological functions lost to hydropower or construction activities;
- ❖ Creation of artificial nesting sites, roosting platforms, or amphibian ponds to compensate for disturbed breeding habitats;
- ❖ Conversion of degraded agricultural land into semi-natural grasslands with high pollinator value.

These activities should be guided by the National Biodiversity Strategy and Action Plan (NBSAP) and executed in consultation with the Institute for Nature Conservation and local environmental authorities.

Biodiversity offset programmes

For significant residual impacts that cannot be fully compensated on-site, the Government should establish a Biodiversity Offset Mechanism, modelled on EU best practices. This could include:

- ✓ a National Biodiversity Offset Register where developers finance approved conservation projects in proportion to residual impacts;
- ✓ a Biodiversity Conservation Fund financed through offset fees, used to support restoration in priority areas;
- ✓ prioritisation of offsets that enhance connectivity between existing protected areas, thus improving the overall ecological network of Montenegro.

Long-term ecological monitoring and management

All compensation areas must be accompanied by long-term management plans (minimum 20 years), detailing maintenance activities, performance indicators, and periodic ecological monitoring. Data from these programmes should feed into the national environmental database to evaluate overall ecological gain and compliance with the “no net loss” target.

Compensatory measures for water resources

River and wetland rehabilitation

Where hydropower or infrastructure projects alter river morphology or flow regimes, compensatory measures should include:

- ❖ Restoration of natural river meanders and floodplains in adjacent or degraded stretches;
- ❖ Reconnection of side channels and wetlands to enhance water retention and biodiversity;
- ❖ Removal of obsolete weirs or barriers to improve fish migration in the same catchment;
- ❖ Riparian vegetation planting to stabilise banks and reduce sediment runoff.

These measures will restore hydrological and ecological functions in river systems affected by development.

Watershed management and groundwater recharge

To offset increased surface-water use or reduced infiltration, the LCDS action plans should support:

- ✓ construction of small retention structures and infiltration basins to enhance groundwater recharge;
- ✓ reforestation and soil conservation on upstream slopes to improve water-holding capacity;
- ✓ maintenance of ecological flow requirements through adaptive reservoir management and flow release;
- ✓ inclusion of water-compensation actions in River Basin Management Plans (RBMPs) to ensure cumulative consistency.

Compensatory measures for soil and land

Reclamation of degraded and contaminated sites

A key opportunity for compensation lies in the rehabilitation of brownfield and post-industrial sites. As new renewable or industrial projects occupy previously undisturbed land, an equivalent area of degraded land should be restored. Typical actions include:

- ❖ removal of contaminated topsoil and replacement with clean substrate;
- ❖ grading, drainage and re-vegetation of eroded areas;
- ❖ re-purposing of former mining or ash-disposal sites for green infrastructure, recreation, or ecological restoration;
- ❖ integration of these sites into the national soil-monitoring network for long-term verification of recovery.

Sustainable land-use compensation

Where infrastructure leads to irreversible land-take in productive agricultural areas, compensatory actions should include soil-improvement measures elsewhere, such as organic-matter enhancement, erosion-control programmes, and investment in sustainable irrigation. These offset actions maintain national soil productivity and ecological balance.

Socio-economic and community compensatory measures

The energy transition will entail structural adjustments in local economies, particularly in Pljevlja and surrounding municipalities. To prevent negative social consequences, compensatory measures should include:

- ❖ Just Transition Investments: Funding for employment diversification, worker retraining, and small-business development in renewable-energy and service sectors;
- ❖ Community-benefit schemes: Local communities hosting renewable-energy installations should receive direct benefits such as local infrastructure upgrades, green spaces, or support for cultural heritage preservation;
- ❖ Public health improvement programmes: Reinforcing healthcare facilities, air-quality monitoring, and environmental education in regions undergoing industrial restructuring;
- ❖ Participatory monitoring and grievance mechanisms ensuring transparent dialogue between developers, authorities and affected citizens.

These measures ensure that the LCDS produces a net positive outcome for both people and the environment.

Recommendations for integration into LCDS action plans

Each sectoral Action Plan (energy, transport, industry, agriculture, waste, LULUCF) must contain a dedicated subsection on environmental and social safeguards, referencing the mitigation, adaptation and compensatory measures defined in this assessment. These safeguards should be integrated into:

- ❖ performance indicators and milestones for project evaluation;
- ❖ eligibility criteria for public or donor financing;
- ❖ and environmental management plans required at project level.

Action Plans should clearly state that project preparation and financing are conditional upon compliance with national environmental regulations, EIA/SEA conclusions, and EU environmental directives.

Establishing a cross-sectoral implementation framework

To ensure coherence across sectors, the Government should create an Inter-Ministerial Coordination Mechanism for LCDS Implementation. This body should monitor the application of mitigation and compensation measures, harmonise data reporting, and coordinate updates to sectoral action plans.

Integration with financial and investment planning

Environmental and compensatory measures should be explicitly reflected in the LCDS Investment Plan. For every major project, the estimated costs of environmental mitigation, ecological restoration, and social compensation must be included as an integral budget component, not as an afterthought. International financial institutions (EBRD, EIB, World Bank) and the EU's Green Deal instruments already require this integration, providing a strong incentive for early budgeting.

Integration with monitoring and reporting frameworks

Action plans should link each compensatory measure to specific, measurable indicators, such as:

- ❖ hectares of habitat restored or created;
- ❖ kilometres of river rehabilitated;
- ❖ tonnes of contaminated soil remediated;
- ❖ number of jobs created in just-transition programmes;
- ❖ or percentage of project budgets allocated to environmental enhancement.

These indicators should be tracked through the LCDS monitoring platform and reported annually in the national environmental report.

Institutional capacity and governance recommendations

- Establish a National Register of Environmental and Social Compensation Projects managed by the Environmental Protection Agency. The register would track the status, location, financing and performance of compensatory measures.
- Create a Green Transition Fund, a dedicated financial mechanism to finance habitat restoration, community-benefit schemes and soil rehabilitation.
- Enhance public participation and transparency by publishing maps of compensation sites and allowing citizens and NGOs to monitor implementation outcomes.
- Strengthen local-government capacity to design, procure and supervise ecological restoration projects, ensuring that compensation benefits remain within affected regions.

When effectively implemented, the proposed compensatory measures and institutional recommendations will ensure that any residual adverse environmental or social effects of the LCDS are fully balanced by tangible ecological and community benefits. Integrating these measures directly into sectoral and municipal action plans will create a robust, transparent and adaptive framework in which environmental protection, social inclusion and low-carbon development advance together.

This approach will transform the LCDS from a purely mitigation-oriented document into a comprehensive sustainability strategy, capable of delivering measurable improvements in ecosystem health, water and soil quality, and human well-being across Montenegro.

In addition to sector-specific mitigation measures, a set of cross-sectoral measures is proposed to address cumulative environmental impacts and enhance ecosystem resilience, particularly in areas affected by hydropower development and legacy impacts of mining activities. These measures support the integration of nature-based solutions and ecosystem restoration within the implementation of the LCDS (Annex IV)

9 ENVIRONMENTAL MONITORING PROGRAMME

9.1. Proposed indicators for monitoring the effects of the Strategy

To effectively monitor the implementation of the Low-Carbon Development Strategy and the effects of the measures envisaged therein, it is necessary to track a defined set of environmental, climate and socio-economic indicators at national and sectoral levels. Key indicators include total annual greenhouse gas emissions and their sectoral structure, which enable the assessment of progress towards national climate targets and planned decarbonisation pathways defined by the LCDS and related strategic documents.

In addition, indicators related to air quality, such as concentrations of key air pollutants in urban and industrial areas, are essential for evaluating the impacts of energy transition measures on

environmental quality and public health. Monitoring should also encompass indicators related to biodiversity and ecosystems, including the status of protected areas, changes in land use linked to the development of energy infrastructure, as well as indicators of surface and groundwater quality in areas exposed to increased development pressures. Together, these indicators provide a comprehensive basis for assessing both direct and cumulative effects of Strategy implementation.

Table 15 - Proposed Indicators

Monitoring area	Key indicators
Climate and GHG emissions	Total net GHG emissions (kt CO ₂ eq/year, incl. LULUCF) Gross GHG emissions by sector CO ₂ removals by carbon sinks (LULUCF) Progress towards net-zero emissions
Air quality	Annual mean PM _{2.5} and PM ₁₀ concentrations Annual mean NO ₂ concentrations SO ₂ concentrations in industrial areas Number of exceedances of limit values
Water quality	Ecological and chemical status of surface waters in the surrounding of energy projects (HPPs, WPPs, SPPs) Hydromorphological parameters of watercourses downstream of hydropower facilities (flow, temperature, turbidity, dissolved oxygen)
Biodiversity, land use and soil	Area affected by energy and infrastructure projects (ha/year) Number of projects in or near protected areas Habitat fragmentation / impacts on ecological corridors Changes in forest area and carbon stock
Human health	Incidence of respiratory and cardiovascular diseases in areas with energy infrastructure projects
Social and just transition	Jobs lost in high-carbon sectors New jobs created in low-carbon sectors Retrained and re-employed workers Early retirements supported Population at risk of energy poverty Households benefiting from energy-efficiency measures

9.2. Institutional framework and data sources

Environmental monitoring in Montenegro is a legal obligation carried out through an established national monitoring system coordinated by the Environmental Protection Agency of Montenegro (EPA), in cooperation with other competent institutions. The EPA is responsible for the preparation and implementation of annual environmental monitoring programmes and for reporting on the state of the environment. Monitoring activities are supported by a dedicated department within the Agency, while specific measurements and analyses are conducted with the involvement of accredited external institutions authorised to perform environmental monitoring.

In addition to the state monitoring programme, legal entities and entrepreneurs operating facilities or activities with potential environmental impacts are required to monitor environmental parameters within the scope of their activities and to report the results to the EPA. This integrated approach ensures that monitoring data are collected from both public and private sources, strengthening the overall evidence base for assessing the effects of the Strategy.

9.3. Frequency and methodology of reporting

Monitoring data relevant to the implementation of the Strategy are collected on a continuous or periodic basis, depending on the type of indicator and the requirements of the national monitoring system. Reporting is primarily carried out through annual reports on the state of the environment and other regular reporting frameworks prepared by the EPA, which ensure consistency, transparency and comparability of data over time.

The monitoring methodology relies on established national monitoring networks, standardised measurement procedures and official reporting systems, ensuring alignment with both national legislation and international reporting obligations. The use of existing data sources and methodologies enables efficient tracking of trends and facilitates the integration of Strategy-related monitoring into the broader national environmental monitoring framework.

9.4. Thresholds and corrective measures

Monitoring results serve not only to document trends but also to identify deviations from planned objectives and emerging adverse effects. Where monitoring indicates that environmental quality thresholds, legal limit values or strategic targets defined under the LCDS and related documents are not being met, this should trigger a review of the underlying causes and the adequacy of existing measures.

In such cases, the responsible institutions should consider the introduction of corrective measures, which may include the adjustment of implementation timelines, strengthening of mitigation measures or revision of specific actions under the Strategy. This adaptive approach ensures that the implementation of the Low-Carbon Development Strategy remains responsive to monitoring results and aligned with the overarching objectives of environmental protection, climate mitigation and sustainable development.

10 OVERVIEW OF SIGNIFICANT TRANBOUNDARY IMPACTS

The relationship with neighbouring countries and the consideration of potential transboundary impacts within the Low-Carbon Development Strategy (LCDS) are based on international conventions and agreements ratified by Montenegro, primarily the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), as well as relevant bilateral and multilateral agreements. In accordance with the European Commission's Guidelines on Strategic Environmental Assessment (SEA), where a plan or programme is likely to have significant effects on the environment of other states, the procedure for transboundary consultations is envisaged.

Potential transboundary impacts may arise from planned hydropower and other water-related interventions within international river basins, particularly the Drina, Lim and Bojana rivers. Changes in hydrological regimes, sediment transport and water quality may propagate downstream beyond national borders, potentially affecting aquatic ecosystems and water uses in neighbouring countries. These potential downstream effects are of particular relevance in the context of cumulative developments within shared river basins and should be considered in line with transboundary SEA and EIA principles

We note that transboundary impacts of the scenarios defined under the National Energy and Climate Plan (NECP), including the With Existing Measures (WEM) and With Additional Measures (WAM) scenarios, have already been assessed within the Strategic Environmental Assessment of the NECP.

That assessment concluded that, based on projections up to 2030, no significant negative transboundary impacts on neighbouring countries were identified.

The LCDS scenario represents the most ambitious long-term development pathway and builds upon the NECP by introducing additional and strengthened decarbonisation measures across the energy, transport, industrial and other relevant sectors. Implementation of the LCDS scenario implies accelerated reduction of greenhouse gas emissions, earlier and more comprehensive phase-out of coal from the energy mix, increased deployment of renewable energy sources and enhanced energy efficiency. In this context, potential transboundary impacts under the LCDS scenario are of lower intensity compared to the NECP scenarios and are predominantly positive in nature.

The development of renewable energy sources, including wind farms in border mountainous areas and large-scale solar power plants, may give rise to potential transboundary implications, particularly with regard to bird migration routes, landscape values and indirect effects on tourism. Within the LCDS scenario, such impacts are addressed at the strategic level, applying the principles of prevention and precaution, and through the obligation to carry out environmental impact assessments at the level of individual projects, including transboundary consultations where applicable.

In contrast to the NECP scenarios, the LCDS scenario foresees an earlier closure of the Pljevlja Thermal Power Plant, thereby ensuring the long-term elimination of transboundary effects from emissions of sulphur dioxide (SO₂), nitrogen oxides (NO_x) and particulate matter (PM). This results in a pronounced positive transboundary impact on air quality and public health across the wider region.

Measures related to the electrification of transport, development of electric vehicle infrastructure and strengthening of the regional integration of Montenegro's electricity system have a strong regional dimension. Their implementation contributes to power system stability, more efficient integration of variable renewable energy sources and reduced emissions from transport, with predominantly positive effects at both local and transboundary levels.

Based on emission projections to 2050 under the LCDS scenario, no deterioration of air quality or emissions is expected that could result in significant negative transboundary impacts on Italy, Croatia, Albania or other neighbouring countries. On the contrary, measures envisaged under the LCDS contribute to a reduction of the regional pollution burden and greenhouse gas emissions, thereby reinforcing Montenegro's contribution to the achievement of shared regional and European climate and environmental objectives.

11 CONCLUSIONS

Key findings of the Strategic Environmental Assessment (SEA)

The Strategic Environmental Assessment of the Low-Carbon Development Strategy (LCDS) confirms that the LCDS represents a key long-term document for steering Montenegro towards climate neutrality by 2050, while simultaneously preserving natural resources, protecting public health, and enhancing socio-economic development. The LCDS builds upon the National Energy and Climate Plan and establishes a clearer and more ambitious framework for deep decarbonisation across all sectors, with particular emphasis on energy, transport, industry, buildings, and non-energy sectors.

The SEA further confirms that the LCDS, unlike earlier strategic documents, places greater emphasis on the social dimension of the energy transition and the need for a just transition in regions historically dependent on coal, particularly in the Pljevlja area. In this context, the Plan for a Just Transition of the Pljevlja Coal Mine through business transformation is recognised as a particularly positive example, as it provides a concrete, operational, and realistic framework for business diversification, employment preservation, and the gradual transformation of economic activities in line with the objectives of the LCDS, while simultaneously providing a clear pathway towards decarbonisation at the local level.

Assessment of the sustainability and environmental compatibility of the Strategy

The analysis carried out within the SEA indicates that the measures envisaged under the LCDS are expected to have predominantly positive environmental impacts, notably through a significant reduction in greenhouse gas emissions, improved air quality, reduced pressures on public health, and a long-term decrease in dependence on fossil fuels. In addition to climate benefits, the accelerated decarbonisation pathway contributes to reduced cumulative environmental pressures on ecosystems,

lower pollution loads in air, water and soil, and improved environmental conditions at both local and regional levels.

Of particular importance is the earlier phase-out of coal from the structure of energy production compared to the NECP scenarios, which leads to the long-term elimination of negative cumulative and transboundary impacts associated with lignite combustion. During the preparation of the SEA, it was established that a significant number of activities envisaged under the Just Transition Plan of the Pljevlja Coal Mine have already been initiated or implemented, indicating a high level of institutional readiness for transition and providing a solid basis for the environmentally sustainable implementation of the LCDS at local and regional levels.

Recommendations for implementation, monitoring, and review of the Strategy

Although the LCDS sets a clear strategic direction, the SEA identifies that the success of its implementation will largely depend on the availability of adequate financial, institutional, and human resources, as well as on effective environmental governance, monitoring and enforcement mechanisms to ensure that decarbonisation measures deliver their intended environmental benefits.

In conclusion, the SEA highlights the importance of continuous monitoring of environmental effects, regular review of progress towards decarbonisation objectives, and the application of adaptive management approaches during the implementation of the Strategy. These processes are essential to ensure that the Strategy remains environmentally compatible, socially balanced, and economically viable over the long term, while contributing to long-term environmental protection, reduced greenhouse gas emissions, and improved ecosystem resilience.

The Strategic Environmental Assessment concludes that the LCDS scenario results in a net-positive environmental outcome at the strategic level, with long-term benefits from significant emission reductions, improved air quality and reduced health risks outweighing localised and temporary environmental pressures associated with implementation.

12 SUMMARY

The Strategic Environmental Assessment (SEA) has been prepared for the Low-Carbon Development Strategy of Montenegro until 2050 (LCDS), in accordance with the Law on Strategic Environmental Assessment and Directive 2001/42/EC. The purpose of the SEA is to identify, describe and assess the likely significant effects of the Strategy on the environment and human health, and to propose measures to prevent, reduce and mitigate negative impacts, ensuring the integration of environmental and climate objectives into the strategic planning process.

The Strategy has been developed in the context of Montenegro's international and national obligations in the field of climate change, including the Paris Agreement, the Energy Community framework, the EU accession process, the National Energy and Climate Plan (NECP), and the updated Nationally Determined Contribution (NDC). The LCDS represents a long-term framework for reducing greenhouse gas emissions and transitioning towards climate neutrality, while taking into account economic, social and environmental dimensions of development.

The SEA covers the entire territory of Montenegro and a time horizon up to 2050. The assessment was carried out through an analysis of the existing state of the environment, identification of sensitive areas and key environmental problems, consideration of development alternatives, and assessment of cumulative, synergistic and transboundary impacts. Three development scenarios were considered: Scenario without activity, which implies that the strategy will not be implemented, LCDS scenario as the most ambitious option aimed at deep decarbonization, and LCDS sensitivity scenario, which indicates the real possibility of not implementing certain measures that were set within NECP and LCDS with extremely ambitious goals as well as controversial projects that are in conflict with the law, planning documents or principles of environmental protection.

The analysis of the existing environmental baseline indicates that Montenegro possesses significant natural resources and development potential, but also faces pronounced environmental pressures,

particularly in relation to air quality, greenhouse gas emissions, biodiversity, land use and increasing climate-related risks. Areas with elevated cumulative risks were identified, especially in zones planned for the development of energy infrastructure and in regions already burdened by existing environmental pressures.

The impact assessment shows that the LCDS scenario, although offering the greatest long-term positive effects, may also generate certain local negative impacts on land use, biodiversity and landscape if measures are not implemented with adequate spatial planning and the application of avoidance and minimisation principles.

The SEA identifies a set of measures to prevent, reduce and mitigate negative impacts, including technical and regulatory measures by sector, climate change adaptation measures, measures for the protection of biodiversity, water and soil, as well as social measures aimed at protecting vulnerable groups and supporting a just transition. Recommendations are also provided for the integration of SEA measures into future plans, programmes and action documents.

A monitoring programme has been proposed to track the implementation of the Strategy, with defined indicators, responsible institutions, reporting frequency and mechanisms for corrective actions in the event of significant deviations or unforeseen negative effects. The SEA concludes that the Low-Carbon Development Strategy, provided that the proposed measures are consistently implemented and an effective monitoring system is established, represents an environmentally acceptable and sustainable framework for Montenegro's long-term development, aligned with national and EU environmental and climate policy objectives.

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ANNEX I

Policies and measures NECP

No.	Name of the measure	Scenario
1	Ecological refurbishment of TPP Pljevlja	NECP WEM
2	Development of decentralised energy generation by producer – consumers (prosumers)	NECP WEM
3	New renewable power plants	NECP WEM
4	Additional renewable power plants	NECP WEM
5	Refurbishment of small hydro power plants	NECP WEM
6	Development of decentralised energy generation (distribution medium voltage connection)	NECP WEM
7	Additional development of decentralised energy generation (distribution medium voltage connection)	NECP WEM
8	Reduction of losses in the electricity transmission power network & Development of electricity transmission power network	NECP WEM
9	Reduction of losses in the electricity distribution power network & Development of electricity distribution power network	NECP WEM
10	Uniprom KAP: electrolysis cells replacement and overhauling	NECP WEM
11	Uniprom KAP: Cell hibernation	NECP WEM
12	Programme for the promotion of innovation and energy efficiency services in industry	NECP WEM
13	Development and implementation of energy efficiency regulatory framework in buildings	NECP WEM

14	Implementation of energy efficiency measures in public buildings	NECP WEM
15	Implementation of energy efficiency measures in public infrastructure	NECP WEM
16	Establishment and implementation of energy efficiency criteria in public tendering	NECP WEM
17	Energy labelling and eco-design requirements for energy related products	NECP WEM
18	Establishment and development of energy management in the public sector	NECP WEM
19	Financial incentives for citizens / private households (for energy efficiency investments)	NECP WEM
20	Reduction of HFCs in line with the Law Acknowledging Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer	NECP WEM
21	Reduction of bio-waste in municipal waste	NECP WEM
22	Increase of connection rate to sewerage system	NECP WEM
23	Development of the Just Transition Plan for the Pljevlja Coal Region	NECP WAM
24	Additional development of decentralised energy generation by producer - customers (prosumer)	NECP WAM
25	Prosumers in industry	NECP WAM
26	Developing battery energy storage systems (BESS)	NECP WAM
27	Risk Preparedness Plan	NECP WAM
28	Operationalisation of the Security Coordination Region	NECP WAM
29	Market coupling	NECP WAM
30	Implementation of European Balancing Platforms	NECP WAM
31	Demand response	NECP WAM
32	Pilot project for improving the “visibility” of the low-voltage network	NECP WAM
33	Operalisation of the Capacity Calculation Region	NECP WAM
34	Establishment of renewable energy communities	NECP WAM
35	Establishment of a dynamic electricity pricing model	NECP WAM
36	Improvement of network access procedures for citizen energy	NECP WAM
37	Green Hydrogen Development Plan with an Action Plan for the period 2026–2028	NECP WAM
38	Promotion of e-mobility	NECP WAM

39	Introduction of a mandatory share of biofuels in the fuel supply	NECP WAM
40	Ban on import of old vehicles (Euro 4 or lower standard)	NECP WAM
41	Passenger transport modal shift to public bus transport	NECP WAM
42	Passenger and freight modal shift to rail	NECP WAM
43	Biofuels in industry	NECP WAM
44	Financial incentives for introduction of hybrid special working machines in industry sector	NECP WAM
45	District heating in Pljevlja	NECP WAM
46	Methodology for defining energy-poor groups and measures to reduce energy poverty	NECP WAM
47	Support for organic agricultural production	NECP WAM
48	Support to manure management	NECP WAM
49	Increase of CH ₄ recovery in landfills	NECP WAM
50	Reduction in the area annually affected by wildfires	NECP WAM
51	Further increases in the share of industrial round wood used for long-term products	NECP WAM
52	Alignment of the carbon price with the EU Emissions Trading System price by 2028	LCDS
53	Retirement of TPP Pljevlja by 2035	LCDS
54	Full deployment of the renewable energy generation projects included in ETSDP and not deployed under the NECP	LCDS
55	Develop and publish a transport decarbonisation strategy, including formalising targets included in the LCDS	LCDS
56	Reduce car kilometres by 25% by 2035	LCDS
57	Increase rail share of freight transport	LCDS
58	100% electrification of rail infrastructure by 2040	LCDS
59	90% of road transport vehicles zero emissions by 2050	LCDS
60	95% of industrial and manufacturing fossil fuel use to be replaced with electricity	LCDS
61	Implementation of Montenegro's BRS	LCDS
62	Development and implementation of plans for Phases II, III and IV for reduction of HFC use in line with the Kigali Amendment	LCDS
63	Assignment of responsibility within the Ministry of Agriculture, Forestry and Water Management to monitor international developments in agricultural mitigation technologies	LCDS
64	Assignment of responsibility within the Ministry of Ecology, Sustainable Development and Northern Development to monitor international developments in waste management technologies and processes	LCDS
65	Conversion of coppice to high forests	LCDS

ANNEX II

Environmental component	Existing conditions	Key pressures and risks relevant to the LCDS
Air quality and GHG emissions	Frequent exceedances of PM ₁₀ and PM _{2.5} concentrations, particularly in Pljevlja, Podgorica and Nikšić; the energy sector is the dominant source of GHG emissions	Combustion of solid fuels in households, road traffic, Pljevlja thermal power plant; significant public health risks; need for accelerated decarbonisation
Climate and climate change	Increasing average temperatures, more frequent heatwaves and extreme weather events	Growing risks to human health, agriculture, water resources and infrastructure; need for climate adaptation measures
Water resources (surface and groundwater)	Generally good status, with localised deviations in urban and industrial areas	Insufficient wastewater treatment, erosion, climate-related pressures; sensitivity of water bodies to infrastructure and energy projects
Soil and geological characteristics	Large areas of erosion-prone and sensitive soils; limited availability of high-quality agricultural land	Soil erosion, urbanisation, infrastructure development, climate extremes; loss of soil fertility

Environmental component	Existing conditions	Key pressures and risks relevant to the LCDS
Biodiversity and protected areas	High biodiversity value and an extensive network of protected areas, with limited management capacity in some sites	Habitat fragmentation, energy and infrastructure projects, climate change impacts; risks to Natura 2000 and other sensitive areas
Land use and landscape	Dominance of forests and agricultural land; high landscape and visual values	Spatial conflicts related to energy infrastructure, urbanisation and tourism; visual and cumulative impacts
Population and human health	Ageing population; significant health risks linked to air pollution and heatwaves	Increased morbidity and mortality; need to integrate health considerations into LCDS implementation
Cultural heritage and cultural landscapes	High concentration of cultural heritage assets and valuable cultural landscapes	Pressures from urban development, infrastructure and tourism; risks to spatial integrity and authenticity
Economic and infrastructural context	Economy dominated by tourism and the energy sector; uneven infrastructure development	Climate vulnerability, pressure on natural resources; need for sustainable investment and infrastructure modernisation

ANNEX III

Aspect	No-Action scenario	WEM scenario	LCDS / WAM scenario
GHG emissions	Continued high emissions; no structural change	Moderate reduction; coal and fossil fuels remain significant	Deep emission reductions; pathway to climate neutrality
Air quality	Persistent poor air quality, especially in burdened areas (e.g. Pljevlja)	Limited improvement due to partial efficiency gains	Significant improvement due to coal phase-out, electrification and reduced fossil fuel use
Human health	High health burden from air pollution and climate extremes	Slight reduction of pollution-related health risks	Substantial reduction of pollution-related morbidity and mortality
Pressure on ecosystems	Continued degradation and cumulative pressures	Mixed effects; some pressures remain	Reduced long-term pressure despite localised impacts of RES
Energy system flexibility	Low flexibility; reliance on conventional generation	Moderate flexibility improvements	High flexibility through RES integration and storage solutions

Aspect	No-Action scenario	WEM scenario	LCDS / WAM scenario
Overall environmental performance	Negative	Moderate	Positive, with manageable localised risks

ANNEX IV

Measure	Responsible authority	Timeframe	Indicator
Integration of nature-based solutions (NbS) in hydropower planning (river restoration, ecological flow, riparian vegetation)	Ministry of Ecology, Sustainable Development and Northern Region Development; Water authorities	Medium to long term	Number of HPP projects incorporating NbS; ecological flow compliance
Ecosystem restoration in hydropower-affected river basins (Tara, Drina)	Ministry of Ecology; Environmental Protection Agency	Long term	Restored river length; improvement of ecological status
Rehabilitation of degraded land and ecosystems affected by mining legacies	Ministry of Ecology; local authorities	Medium term	Area of restored land; reduction of erosion and contamination
Application of nature-based solutions for erosion and flood-risk reduction	Water authorities; local governments	Medium term	Number of NbS measures

Measure	Responsible authority	Timeframe	Indicator
			implemented; reduced erosion/flood incidents
Strengthening cross-sectoral coordination for cumulative impact management	Ministry of Ecology; sectoral ministries	Short to medium term	Established coordination mechanisms; integrated assessments
Monitoring of ecosystem recovery and biodiversity in restored areas	Environmental Protection Agency	Long term	Monitoring reports; biodiversity indicators

ANNEX V

Hazard	Sector	Adaptation / resilience measure	Responsibility
Heatwaves	Energy, health	Grid flexibility, cooling measures, early-warning systems	Ministry of Energy; Ministry of Health
Floods	Water, infrastructure	Nature-based solutions, floodplain restoration	Water authorities; local governments
Droughts	Energy, agriculture	Water-efficient technologies, diversification of supply	Sectoral ministries
Wildfires	Forestry, ecosystems	Fuel management, ecosystem restoration	Ministry of Ecology; Forest authorities

Hazard	Sector	Adaptation / resilience measure	Responsibility
Extreme weather	Transport, energy	Climate-proof design standards	Line ministries