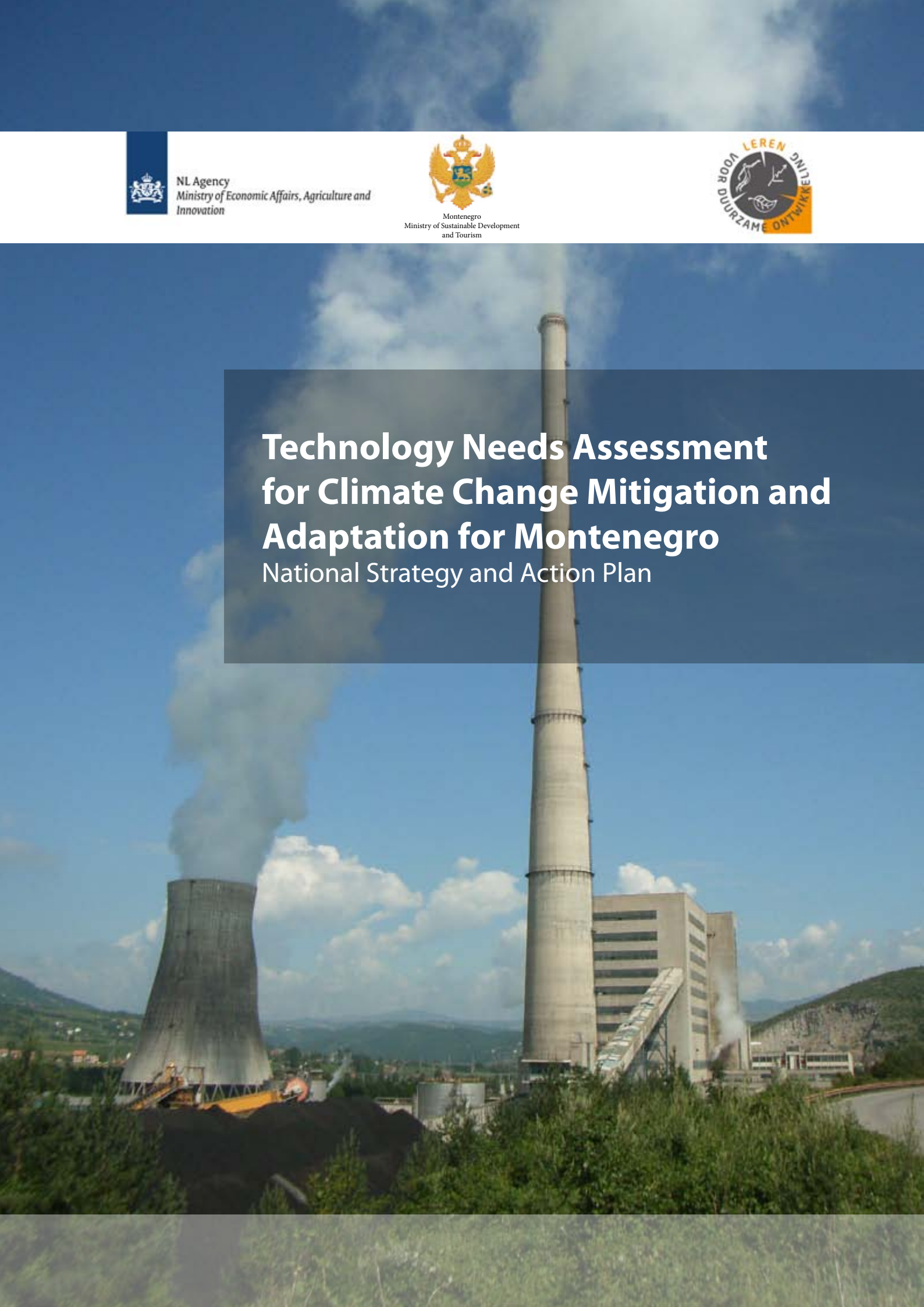

NL Agency
Ministry of Economic Affairs, Agriculture and Innovation

Montenegro
Ministry of Sustainable Development
and Tourism

LEREN VOOR DUURZAME ONTWIKKELING

Technology Needs Assessment for Climate Change Mitigation and Adaptation for Montenegro

National Strategy and Action Plan

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National Strategy and Action Plan

Podgorica, October 2012

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Listof abbreviations

AP – Action plan
APP – Aluminium plant Podgorica
CC – Climate change
CHP – Combined heat and power
CO2 – Carbon dioxide
COP –Conference of Parties to UNFCCC
CTCN – Climate Technology Centre and Network
DJF – December, January, February
DNA – Designated National Authority
EBRD – European Bank for Reconstruction and Development
EE – Energy efficiency
EEA – European Environment Agency
EMEP – European Monitoring and Evaluation Programme
EPA – Environmental Protection Agency
GDP – Gross domestic product
GHG – Greenhouse gases
HMI – Hydro-meteorological Institute
HPP – Hydropower plant
IPCC – Intergovernmental Panel on Climate Change
ITS – Intelligent transport system
JIN – Joint Implementation Network
JJA – June, July, August
kgoe – Kilogram of oil equivalent
kWh – Kilowatt hour
LPG – Liquid petroleum gas
MAM – March, April, May
MCDA – Multi Criteria Decision Analysis
MLTLS – Medium to long term large scale technologies
MLTSS – Medium to long term small scale technologies
Mt – Megatonne
MW – Megawatt
NAMA – Nationally Appropriate Mitigation Actions
NAP – National Adaptation Plans
NC – National communication
ppm – Parts per million
PT – Public transport
R&D – Research & development
RES – Renewable energy sources
SC – Steering committee
SD – Sustainable development

SME – Small and medium sized enterprises
SON – September, October, November
SPV – Solar photovoltaic panels
SRES – Special Report on Emission Scenarios
STLS – Short term large scale technologies
STP – Solar thermal power plant
STSS – Short term small scale technologies
TEC – Technology Executive Committee
TNA – Technology Needs Assessment
toe – Tonne of oil equivalent
TPP – Thermal power plant
UNDP – United Nations Development Programme
UNEP – United Nations Environment Programme
UNFCCC – United Nations Framework Convention on Climate Change
VAT – Value added tax

1 Summary

TNA Montenegro process and results presented in this document have emerged from a series of activities organised in the period May 2011 – October 2012 with the aim to inform about and involve all the stakeholders in the **assessment of priority needs for technological innovation, solutions, knowledge and approaches** for reducing the emissions of greenhouse gases on one, and reducing vulnerability of natural and socio-economic systems to expected changes of the climate on the other side.

Various stakeholders **took part in the TNA process**, including representatives of ministries competent for climate change and related issues, relevant agencies and institutions (such as Environmental Protection Agency, Forest Administration, Hydro-meteorological and Public Health Institutes, etc.), local self-governments and business sector (energy, industry, forestry, tourist organisations), as well as experts from University, non-governmental sector and international organisations.

Priority development sectors are agriculture, forestry, energy and tourism; development of transport and infrastructure are also very important. Poverty reduction and alleviation of regional development disparities stand out as the key socio-economic priorities, whereas environmental priorities include protection of biodiversity, water resources and coastal area, waste management improvements etc.

According to the **existing models and climate change projections** for Montenegro, an increase in average temperature of up to 1.3°C can be expected in certain areas by 2030 if global emissions grow at moderate rate, while changes in precipitation regime will range from + 5% to - 20% depending on the season and area. However, if global emissions grow more intensely, much more dramatic changes in the basic climate parameters can be expected in longer term. In the worst case scenario, average temperatures in the north of the country could increase by as much as 4.8°C until the end of the century, while precipitation in the south could be halved. The level of Adriatic Sea could rise for a maximum of 35 cm.

Implications of climate change for development are significant. Changes in quantities and patterns of precipitation will in a long run lead to reduced flows and water resources abundance, which can, according to some estimation, reduce energy generation potential for hydropower sources by 25%. Available estimations of climate change damages for Montenegrin economy show that substantial decrease of revenues (in the range of € 33 to 68 million per year) from tourism could be expected in the far future, while damages from climate change that will be incurred to HPP Piva were estimated at close to € 7 million per year already as of 2030.

Negative impacts of climate change on agricultural production are linked to limited plant growth and development i.e. to substantial reduction of yields due to crop production vulnerability to temperature and precipitation changes, reduced availability of agricultural land and decrease in the content of organic matter in soils. Decreases in livestock production are also possible as a result of occurrence of new animal diseases due to heat stress.

Negative impacts of climate change on forests include movement of vegetation zones, reduced growth, reduced number of species, drying out of forests and more frequent forest fires. Loss of species (especially in water environments) and reduced productivity of ecosystems are some of the main expected impacts of climate change on biodiversity. As for the coastal area, expected negative impacts include loss of space and biodiversity and beach erosion due to higher level and temperature of the sea. Changed climate has direct and indirect, mainly negative effects on health as it causes changes and processes in human bodies that can lead to injuries and occurrences of infectious and non-infectious diseases, with possible lethal outcome. Climate change leads to growth, fast development, reproduction and geographical expansion of vectors (mosquitoes, ticks, etc.).

Protection and conservation of water, soil, forests and coastal ecosystems, development of sustainable systems in agriculture, development of capacities for adequate responses to climate change in health sector, planning and development of tourism and energy facilities in accordance with changed climate conditions are all necessary in order to ensure that development goals are not put at risk.

Relevant **sub-sectors for climate change mitigation and adaptation** have been identified based on the data from the Greenhouse Gases Inventory for 2009 and information from the First National Communication. Priority sub-sectors were selected based on the assessments of TNA participants. Sub-sectors where technological interventions were expected to generate the highest benefits for the achievement of development priorities (environmental, economic and social), reduction of greenhouse gases emissions and reduction of vulnerability were prioritised.
An overview of the priority sub-sectors is shown in the Table A below.

Table A: Overview of priority TNA sub-sectors

Priority mitigation sub-sectors	Priority adaptation sub-sectors
• Energy supply (41% of total GHG emissions) • Energy consumption in residential and service sectors (9% of the emissions) • Aluminium production (30% of the emissions) • Road transport (12% of the emissions)	• Water resources • Public health • Agricultural land • Agricultural production • Coastal area • Forests

Energy supply and industry (aluminium production) sectors are characterised by out-dated and inefficient technologies. The most significant single emitters of greenhouse gases are thermal power plant Pljevlja and Aluminium Plant Podgorica (synthetic gases from electrolyses). Both facilities operate with old and insufficiently upgraded technologies which as a result have high emissions. In energy consumption sub-sectors (households and services sector/construction, transport) emission intensive and inefficient technologies are also prevailing. Montenegrin economy is almost three times more energy intensive than the EU economy (measured by energy consumption per unit of GDP).

As for possibilities to reduce emissions, use of technologies for increased efficiency in energy supply and consumption and orientation towards renewable energy sources were suggested in the so far analyses. Fuel switch in transport and heat generation facilities was also suggested. For industrial processes (aluminium production) it was recommended to reconstruct electrolysers and equip them with automatic controls in in order to reduce duration and frequency of anode effects. Application of recommended measures and technologies is however quite slow, and the most significant progress has been made with preparation of projects for utilisation of RES and with implementation of energy efficiency measures in households and services/ construction sectors (insulation, efficient lighting, energy audits, initial steps with application of solar technologies etc.).

Development plans in energy sector mainly focus on further use of hydropower, primarily through large hydropower plants. Development of small hydropower plants is also planned, as well as development of wind turbines and better utilisation of solar energy (which is for the time being one of the least used energy sources). Despite the focus on renewable sources, there is a plan to build the second block of the TPP Pljevlja, which is currently receiving renewed attention. Potential impacts of climate change and adaptation needs are not sufficiently integrated in energy sector development plans.

The main characteristics of priority **sub-sectors for adaptation** (where lack of detailed, specific and quantified data on vulnerability and adaptation potential is highly pronounced) are:

•The ways in which water resources are used are not fully in line with sustainability requirements and are not based on estimated climate change risks;

•There is no adaptation strategy for public health; information basis and capacities are not sufficient so that diseases caused by climate change could be prevented and risks from extreme weather events reduced;

• Potential for vulnerability reduction is not sufficiently used for agricultural land since necessary information and capacities are lacking; in agricultural production sub-sector there is no specific scientific research and institutional and other capacities needed to ensure systematic response to adaptation challenges are lacking;

• Planning and management of resources in coastal area are fragmented and do not include expected risks due to climate change;

• Capacities for planning and implementation of sustainable forest management measures (as the most suitable framework for adaptation) are insufficient.

Suitable technologies were identified for priority sub-sectors and classified into appropriate categories (from short term small scale technologies to medium to long term ones with large scale of deployment).

Prioritisation of technologies within different categories was conducted based on assessments of benefits they would generate. Programme TNAssess was used as a technical support for prioritisation of a certain number of technologies. TNAssess enables assessments for at least four criteria – development benefits for environment, economy and society, as well as benefits for emission reductions or adaptation. In some cases additional criteria such as market potential were included in the assessments.

TNA participants scored and weighted each of the selected criteria. Based on these assessments, the programme generated overall benefits from deployment of a given technology and enabled graphic and table overviews. Sensitivity analysis was performed for the results in order to get robust assessments. Final decision on priority technologies was made on the basis of total benefits and earlier estimations of costs and emission reductions.

For categories where less than three technologies were identified, TNAssess was not used; instead, priorities were decided based on participants' evaluations of the potential of specific technology to contribute to the fulfilment of climate and development goals. An overview of **priority technologies** is given in the Tables B and C below.

In the final stage of TNA Montenegro **objectives** were set (also shown in the Tables B and C) and **barriers** that slow down or hinder deployment of technologies at desired scale were identified. In response to identified barriers, solutions were proposed and measures were defined to create enabling environment and accelerate deployment of technologies.

National TNA strategy was thus compiled, with the following constituent parts:

1. Portfolios of priority technologies for mitigation and adaptation with costs and benefits;

2. Objectives i.e. desired levels of deployment of individual technologies; and

3. Set of measures for acceleration of transfer, deployment and diffusion of technologies (which comprise action plan for strategy implementation).

Table B: Priority technologies for climate change mitigation with estimated emission reduction potential, assessment of benefits, deployment objectives and costs

Sub-sector/ prioritised technology	Potential for mitigation in Mt (for 25 y)	Result of TNAssess - benefits	Objective (aspirational level of deployment)	Estimated total costs over 25 years in € (for set objectives)
Sub-sector: Energy supply				
Small HPP	11.05	309	420 GWh annually (92 MW installed capacity); 10 - 15% of total supply	228,969,600
Solar photovoltaic panels	0.4	241	50 MW	191,226,750
Solar thermal plants (STP)	0.96	Not done	50 MW	244,182,100
Plasma gasification	2.83	Not done	70 MW	1,199,519,300
Sub-sector: Energy consumption				
Solar systems	0.18	273	80% of all households (individual buildings); widespread use in collective housing and in service sector	384,196,613
Insulation of buildings	0.03	222	90% of the total housing stock	1,288,568,925
Efficient air-conditioning	0.02	Not done	All commercial buildings, 50% of housing units	280,156,814
Automated control of energy consumption in buildings	0.28	Not done	All public institutions and large commercial buildings, app 50% of large housing objects (collective housing)	258,596,250
Sub-sector: Transport				
Public transport improvements	Not done	Not done	System enhancement and doubling the number of passengers by 2025	Not estimated
Liquefied petroleum gas	0.027	Not done	30% of the entire vehicle fleet	49,500,000
Bike lanes	Not done	Not done	Development of cycling infrastructure in urban centres and expansion/ linkages to national and regional networks	Not estimated
Electric vehicles	0.027	207	3% (or 9,000 vehicles) of the total number of private vehicles at the end of 25 years	393,300,000
Plug-in hybrids	0.009	168	1,7% (or 5,000 vehicles) of the total number of private vehicles at the end of 25 years	180,000,000
Intelligent transport system	0.134	Not done	The system covers main transport centres	21,000,000
Sub-sector: Aluminium production				
Increasing the efficiency and operating temperature in electrolysers	3.525	Not done	All electrolysers over the course of 25 years	2,167,200
Alumina point-feeding and better process control	3.525	Not done	All electrolysers over the course of 25 years	5,569,200
Inert anodes	3.525	Not done	All electrolysers over the course of 25 years	20,066,250

Note: Estimation of emission reductions in aluminium production sub-sector of 3.525 Mt is cumulative for all three technologies.

Table C:Priority adaptation technologies and measures with indicated adaptation potential, assessment of benefits, deployment objectives and categories of costs

Sub-sector/ priority technology (or measure)	Potential for adaptation in sub-sectors (over the course of 25 years)	Result of TNAssess - benefits	Objective (aspirational level of deployment)	Costs of deployment
Sub-sector: Water resources				
Treatment of drinking water in households	Provision of drinking water of adequate quality	Not done	Ensure adequate treatment of drinking water in households when necessary	Low
Rainwater harvesting	Decreasing the pressure on surface and groundwater by provisioning additional quantities of water	Not done	Better and safer use of technology in areas with scarce water resources	Relatively low
Wastewater treatment and reuse	Preservation of water quality, savings in available quantities of clean water	213	Wastewater treatment plants for agglomerations with > 10,000 inhabitants by 2025; widespread reuse	Very high
Reduction of losses	Preservation of water resources, increase in available water quantities	135	Half current losses in water supply systems by 2025	High
Use of water efficient appliances	Savings of up to 1/3 of water used in households	Not done	Elimination of inefficient appliances from the market by 2025	Moderately high
Sub-sector: Public health				
Strategy and AP for prevention and mitigation of impacts	Lowering of risks from illnesses occurring as a consequence of climate change	Not done	Preparation of strategic documents, improvements in data availability	Low
Control of drinking water	Prevention of occurrence and spreading of waterborne diseases	176	Halve the share of population that is currently not covered by regular drinking water control programmes by 2025	Moderately high
Strengthening supervision and control of infectious diseases	Control of spreading of infectious diseases related to climate change (and of vectors spreading)	166	Establish the system for supervising new and prospective diseases	Relatively low
Medical research	Contribution to health protection and reduction of vulnerability to climate change	Not done	Transfer of knowledge from other countries, planning and implementation of priority medical research on health impacts of CC	Moderately high
Strengthening health sector capacities, especially in emergency services	Timely reaction of health services mitigates effects of climate change on health	Not done	Capacity building for adequate response to health challenges caused by CC	Moderately high
Sub-sector: Agriculture				
Sprinkler and drip irrigation	Optimisation of water resources use, increase of production, assistance to producers with adaptation	313	Irrigation systems on some 50% of suitable areas or 35,000 ha by 2025	Moderately high
Adequate manure use and soil fertility control	Lowering of impacts of heat and water stress on cultivated crops	252	Enhancing the system for soil fertility control and adequate manure use	Moderately high
Combined agricultural production	Lowering of risks for production on smaller agricultural holdings	213	Strengthening support system for development of combined production as a form of adaptation to climate change	Moderately high

Sub-sector/ priority technology (or measure)	Potential for adaptation in sub-sectors (over the course of 25 years)	Result of TNAssess - benefits	Objective (aspirational level of deployment)	Costs of deployment
Practical training for producers	Reduction of vulnerability through application of modern agricultural practices and knowledge	201	Advancement and expansion of existing programmes	Relatively low
Sub-sector: Coastal area				
Integrated management (including set-back line)	Decrease of risks from CC, development of settlements and economy in a climate-resilient manner	289	Establish ICZM system – legal and institutional framework – and define set-back line in accordance with Barcelona Convention requirements in the next 5 years	Moderately high
Protection and restoration of wetlands	Prevention or attenuation of flood waves, reduction of erosion	161	Enhancing the system for protection of valuable wetland ecosystems	Relatively low
Systematic observation and monitoring of changes in the coastal area	Provision of reliable information on baseline conditions and on continuous changes in coastal area	Not done	Development of comprehensive and reliable information system by 2025 and establishment of continuous monitoring of coastal processes	Moderately high
Sub-sector: Forests				
Implementation of sustainable forest management practices	Protection measures (maintenance and protection of existing forests; conversion of coppice into high forests; rehabilitation of degraded forests) increase resilience to CC	238	Improving management and implementing protective measures in order to improve resilience of forests to CC	Moderately high
Sustainable forest management planning	Preservation of productivity of forests and forest ecosystems health, and conservation of soil and water resources	186	Enhancing the system for management planning in order to mitigate future negative impacts of CC on forest ecosystems	Moderately high

TNA strategy for energy sector is strongly relying on the use of solar technologies. If adequate support measures are implemented, solar sources could, together with small hydropower plants, reach an installed capacity of 200 MW over the course of the next 25 years. In combination with technologies for efficient energy consumption which have been prioritised in the TNA process, this would contribute significantly to emission reduction and decrease of dependence on energy imports as well as to achievement of other important goals such as harmonisation with the EU climate policy, increase of EE and competitiveness, market development, employment, improvement in the quality of housing conditions, and others. As for the **TNA strategy for road transport** sub-sector, it is based on improvements of public and non-motorised transport modes and gradual introduction of low-emission technological solutions for vehicles and traffic regulation. In case long term solution is found for the only plant in the sub-sector of **aluminium production** and the plant continues to operate, introduction of thee TNA priority technological measures would be an efficient and cost effective way to substantially decrease duration of anode effects and thus reduce emissions of synthetic gases.

TNA strategy for priority adaptation sub-sectors is complementary with relevant sectoral policies and goals and is mainly based on technologies and measures that will: a) contribute to rational use of water, land and forest resources and to preservation of their quality; b) strengthen public health sector to provide adequate responses in climate change context; c) provide adequate support with adaptation to agricultural producers; and d) strengthen structures for integrated management in the coastal area.

TNA priority technologies can be deployed at desired scale only with systematic **support measures** (elaborated in detail in the action plan). Cross-sectoral measures that should be paid special attention are:

- Fiscal (lowering of VAT and customs rates) and financial (subsidies, favourable loans) incentives;
- Awareness raising and educational campaigns;
- Trainings to transfer and disseminate necessary specialists knowledge and skills;
- Discouraging unsustainable behaviours (by adopting and implementing appropriate instruments, regulations and standards);
- Improved cooperation and coordination among competent institutions as well as with other stakeholders (private sector, scientific and research community, civil society);

• Enhancing databases and information systems;

• Conducting studies, analyses and research for better understanding of implications of climate change for economy, society and the environment.

The EU integration process will give a strong impetus for the implementation of **TNA strategy and action plan** since TNA results are based on the same premises as the European climate change mitigation and adaptation policies. Implementation of TNA results and recommendations will also have synergetic effects for a range of national policies and programmes, such as, for example, recently adopted objective of 33% share of renewable sources in total energy consumption and energy efficiency programmes. Some of the key recommendations for strategy and action plan implementation are:

• Climate change concerns and results of TNA process should be integrated into sectoral policies and strategies; integration of TNA results with other UNFCCC processes such as national communications, NAMAs and NAP are of particular importance;

• Climate and sustainable development goals can be achieved through coordinated efforts and cooperation, despite limited administrative and other stakeholders' capacities;

• National Council on Sustainable Development can give an important contribution to improvements in inter-sectoral coordination and cooperation;

• It is necessary to promote TNA results and ensure continuous processes of capacity development at all levels;

• It is necessary to make additional efforts and ensure commitment of key stakeholders so the TNA would not remain just on paper; providing the needed funding for implementation requires modification of the so far state policies, strong support for technological innovations and active participation of all the stakeholders;

• Transfer of knowledge through networking and cooperation (including cooperation between local self-government units, scientific and research institutions and representatives of civil sector within the country and on international level) also represents an important condition for implementation of TNA results.

2 Technology needs assessment process: key information

2.1 Introduction

Technology needs assessment (TNA) is a set of activities that determine the priorities for mitigation and adaptation to climate change in a country. The purpose of TNA is to identify technology needs (needs for new equipment, techniques, practical knowledge and skills, approaches, etc.) and prepare programmes and projects that will support and accelerate the transfer of technology and knowledge, in accordance with the negotiations held globally under the umbrella of the UN Framework Convention on Climate Change (UNFCCC) and the recommendations arising from them. The technology needs assessment process is consultative and it includes the involvement of a broad range of stakeholders in a society in order to consider priorities, identify barriers and propose priority measures for the deployment of low emissions and technologies for adaptation to climate change.

TNA Montenegro has been conducted through the project implemented by the Ministry of Sustainable Development and Tourism – Department for Support to the National Council for Sustainable Development from May 2011 to October 2012. The project was financed from the environment fund of the Dutch Government's G2G[1] Programme that aims to assist candidate countries to fulfil the criteria for membership in the European Union (EU), through the NL Agency that operates within the Dutch Ministry for Economic Affairs, Agriculture and Innovation. The Project was implemented in accordance with the new TNA Handbook[2] prepared by UNDP and UNFCCC based on the mandate given by COP13 (13th Conference of the Parties). The Handbook contains instructions and recommends methods for the implementation of TNA process with multi-sectoral approach and considering a long-term development vision of the country and related economic, social and environmental priorities. Apart from TNA Handbook, tools and instrument used in different stages of the process also include:

- TNAssess programme, which among other things enables prioritizing of sectors and technologies based on several criteria and records results of the process;

- ClimateTechWiki – online database with descriptions of a large number of technologies[3] ;

- Publications of UNEP Risoe Centre[4] , etc.

[1]G2G is short for Government to Government Programme.
[2]TNA Handbook is available on the website of the UN Framework Convention on Climate Change http://unfccc.int/ttclear/jsp/TNA Handbook.jsp
[3]http://climatetechwiki.org
[4]http://tech-action.org/guidebooks.htm

The goal of the project was to strengthen the capacity of the Government of Montenegro and other relevant actors to define low emission development strategies adapted to climate change by prioritising technologies that will ensure:

- Highest benefits in terms of economic, social and environmental improvements;

- Contribution to greenhouse gas emissions reduction in the context of national, EU and UNFCCC policies; and

- Contribution to increased resilience to climate change in priority sectors.

2.2 TNA in the context of national and international climate policy

Montenegro ratified UNFCCC by succession in 2006 and became a member of the Convention as a Non-Annex 1 Party on January 27, 2007. The Kyoto Protocol was ratified in 2007 by adopting the Law on Ratification (Montenegro Official Gazette no. 17/07). In June 2012, negotiations on the accession to the EU were opened, where climate change will have an important place within the chapter on environment.

Even though separate national policy on climate change did not exist so far, a number of strategies and plans have set the foundation for this policy. National Strategy for Sustainable Development (2007) has, for example, set general goals and directions for action in the field of climate change, and this topic, as a global priority, was paid special attention in the National Environmental Policy (adopted in 2008). Lately, there are some evident efforts to integrate climate change concerns into sector policies, strategies and plans. The First National Communication on Climate Change was completed and submitted to UNFCCC in 2010 and it represents a significant initial document for understanding and monitoring the climate change phenomenon in Montenegro. Preparation of the Second National Communication is currently under way. On the global level, climate change policy is defined through UNFCCC negotiations and implemented in accordance with obligations accepted by member countries. Significant attention is being paid lately to the preparation of national strategies for low carbon development, identification of Nationally Appropriate Mitigation Actions (NAMAs), and the preparation of National Adaptation Plans (NAPs) for developing countries. The emphasis is on the identification of needs through participatory processes within the countries. Also, more attention is being paid to financing mechanisms for climate policies of developing countries and to the technology transfer.

Efforts to establish a mechanism to improve the development and transfer of technologiesrelevant for climate change have been stepped up during the last 5 years (after COP13 in Bali in 2007). The decision to establish the Technology Mechanism was made in 2010 in Cancun at the COP16. The Mechanism consists of the Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN), whereas the development of operational modalities of the Mechanism and links with financing mechanisms are still being developed.

There is a growing support for the standpoint that efforts in the field of climate change have to be based on national strategies that will not deal with climate change as an isolated issue, but in the context of sustainable development, i.e. with a view to achieving economic, social and environmental goals in parallel with the reduction of greenhouse gas emissions and improved resilience to climate change. TNA process offers a detailed methodological framework exactly for this approach.

TNA process is also very important in the context of EU accession. The EU energy and climate package adopted in December 2008 emphasizes the necessity for a reduction in greenhouse gas emissions (GHG) and the increase of share of low carbon and no carbon energy technologies in economic and energy systems of member and accession countries. The EU Roadmap for Moving to a Competitive Low Carbon Economy in 2050 sets an ambitious goal of reducing GHG emissions by 80-95% before 2050 and estimates the investments necessary to achieve this goal at around €270 billion a year (or around 1.5% of GDP). At the same time, the estimated benefits from mitigation measures are very important and to a great extent compensate for (or even go beyond) the necessary investment. Fuel savings are thus estimated at €175 – 320 billion a year, whereas other significant benefits include new jobs in innovative industries, higher competitiveness through development and transfer of mitigation technologies, improved conditions for health care of population (for example, through better air quality due to a shift to low carbon transport), etc.

TNA process fits very well in the national context since it can play an important role in the process of harmonising the domestic with EU policy and practice in the field of climate change and contribute to fulfilment of obligations towards UNFCCC (through, for example, contribution to the formulation of NAMAsor NAP, if orwhen these processes are conducted in the country). Time of implementation for TNA Montenegro coincides with the increased importance that is globally given to the technology transfer and the increase of global funds for climate change issues. Results of the process can also serve as inputs for the revision of the National Strategy for Sustainable Development and the preparation of the Second National Communication to the UNFCCC.

2.3 TNA Montenegro participants

During the TNA process in Montenegro, efforts were made to inform and involve all relevant actors. The process of informing stakeholders and potential partners in the project started in June 2011through meetings held with representatives of different institutions and three regional meetings organised with the purpose to introduce the project (regional meetings were held in Cetinje, Berane and Žabljak; conclusions from the meetings are available in an annex to the Montenegrin version of the document).

Starting point for initial identification of stakeholders were activities on the preparation of the First National Communication to the UNFCCC and other projects and initiatives in the field of climate change. During the preparatory informational activities, ministries with key responsibilities related to mitigation and adaptation to climate change, Governmental and scientific agencies and institutions relevant for climate change issues (such as the Environmental Protection Agency, Forest Administration, Hydro-meteorological Institute, Institute of Public Health, Biotechnical Institute, Public Enterprise for Coastal Management, etc.), representatives of local self-governments, business representatives (through associations such as chambers of commerce and tourist organisations, as well as individual businesses from energy, industry and forestry sectors), University experts, non-governmental sector and international organisations were all contacted. Most actors showed interest in the project and remained actively involved during the entire process. Overall, around 50 individuals, representatives of different institutions and organisations, have taken part in the project activities (full list of participants in the process is available in an annex to the Montenegrin version of the document).

Steering Committee (SC) of the project was established in September 2011 with the goal to provide support to theTNA process. The SC consists of 14 members from the Ministry of Sustainable Development and Tourism (Department for Climate Change and the Designated National Authority – DNA), Ministry of Economy (Sectors for Energy, Energy Efficiency and Industry and Entrepreneurship), Ministry of Transport and Maritime Affairs, Ministry of Agriculture and Rural Development (Forestry Sector), Environmental Protection Agency, Hydro-meteorological Institute, Institute for Public Health, Faculty of Metallurgy and Technology, Chamber of Commerce, NGO Green Home and UNDP. During the process, the SC members:

- Supported and facilitated the preparation and implementation of work plans and programmes;

- Provided suggestions and inputs towards the drafting and revision of relevant documents, including the final TNA report and action plan;

- Actively participated in project activities, promoted TNA process and provided information about it;

- Contributed to the involvement of all relevant stakeholders.

Most SC members actively participated in the work during the entire process[5] . The responsibility for coordination of project activities and their implementation was with the representatives of the Department for Support to the National Council for Sustainable Development (from the Ministry of Sustainable Development and Tourism), national TNA coordinator and Dutch partners (representatives of the NL Agency and the consulting company JIN - Joint Implementation Network), who made the core TNA team. Broader TNA team also included members of the Advisory Body.

2.4 Difference in the approachesfor mitigation and adaptation

During the TNA Montenegro, equal attention was paid and all project activities were implemented for both mitigation and adaptation to climate change. However, due to availability of data (both on the national level and in tools and sources recommended in the TNA Handbook) and the nature of technologies, certain differences appeared in the details of assessment for mitigation and adaptation. These differences can be summarised in the following way:

1. In the technology identification stage, information available from ClimateTechWiki for adaptation technologies and measures have proved to be quite limited, which is why publications of UNEP Risoe Centre and other available sources, especially the First National Communication, have been mainly used. As a result, description of adaptation technologies was much more general and contained less quantified elements than mitigation technologies.

2. Measures and technologies that were recognised as desirable for adaptation contained much more non-market or so called "soft technologies"[6] . Together with difficulties to quantify certain parameters for the deployment of such technologies, this has led to a situation where costs for adaptation technologies and measures could not be estimated. Instead of full estimation of costs, cost categories were determined– ranging from low (with total estimated capital and operational costs under € 6.25 million during the 25 years of deployment), through relatively low andmoderately high, tohigh and very highcosts (more than € 62.5 million in the period of deployment). For each technology/ measure, certain values within these 5 cost categories were entered in TNAssess programme (in the description of technologies), in order to enable continuation of the prioritisation process by using TNAssess. However, the ratio between costs and benefits as one of the results of technology prioritisation was not used for further considerations(priority technology/ measures were instead decided solely based on the prioritisation of benefits) in the field of

[5]The exceptions were representatives of the Designated National Authority and of the Chamber of Commerce who could not combine participation in the TNA process with other obligations due to limited capacity within their organisations.
[6]Non-market or soft technologies include activities on capacity building, behavioral change, information networks, trainings and research, etc.

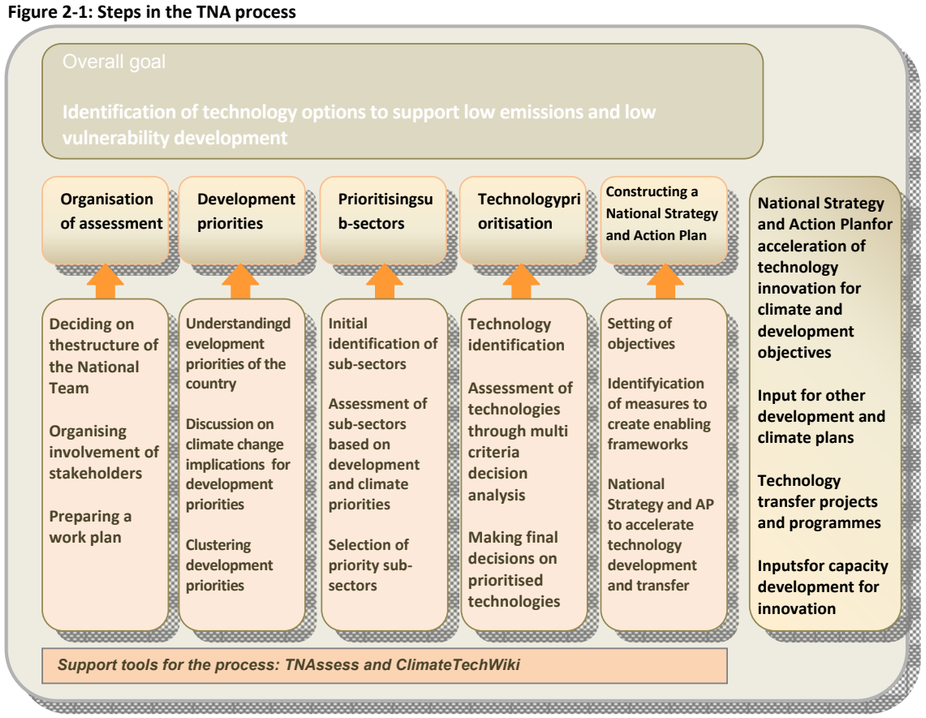
adaptation. Unlike adaptation, for mitigation technologies costs were estimated in detailand the ratio between costs and benefits was taken in consideration when the final decisions were made about priority technologies.

3. Finally, identification of barriers that are currently impeding or slowing down the use of prioritised technologies in Montenegro was done on a general level for adaptation, without analysis of specific categories of barriers (enabling environment, market chain and support services), as it was the case for mitigation.

2.5 Key steps in the process

The TNA Handbook recommends the process to be carried out in five steps (Figure 2-1) in a participatory manner, i.e. through workshops involving all relevant stakeholders.

Figure 2-1: Steps in the TNA process



Source: TNA Handbook, 2010

Based on these recommendations, all the necessary steps were conducted for TNA Montenegro through several activities of the core and the broader TNA team, engagement of technical experts for technology identification, estimation of costs and emission reductions, as well as through the organisation of three project workshops and several consultative and work meetings during the course of the project. Overview of specific steps and results is shown in the Table 2-1.

Table 2-1: Steps in TNA Montenegro

Step	Purpose	Results
Preparatory activities (May – October 2011)	Preparing the activity plan, introducing stakeholders to the purpose and way of project implementation, mobilising stakeholders, establishing the TNA team	- Individual and regional meetings - Information about the project disseminated - Steering Committee established - 1st workshop prepared
1st project workshop, Kolašin (November 2011)	Considering sustainable development priorities in the context of climate change and prioritisation of sectors and sub-sectors for mitigation and adaptation	- List of development priorities for three pillars of sustainable development (economic, social, environmental) - List of priority sub-sectors for mitigation and adaptation
Engagement of experts for technology identification for priority sub-sectors (January – February 2012)	Identification of mitigation and adaptation technologies; proposing short and long lists of technologies	- Proposed long and short lists of technologies for priority sub-sectors - Description of short listed technologies - Estimation of emission reductions and costs of technologies
Meetings for selection of technologies for prioritisation, Podgorica (February 2012)	Familiarisation of TNA participants with proposed technologies; defining technologies adequate for Montenegro and preparation of the 2nd workshop	- Adopting the list of technologies or proposals for corrections / additions - Participants introduced to technologies that will be prioritised - Description of technologies entered into TNAssess - 2nd workshop prepared
2nd Project Workshop, Podgorica (March 2012)	Prioritisation of selected technologies by categories and sub-sectors	- Prioritisation by using TNAssess for categories where more technologies are identified - Final decision about priority mitigation and adaptation technologies
Meetings to analyse conditions for the deployment of technologies/ measures, Podgorica (May 2012)	Identification of barriers and solutions/ measures for the deployment of prioritised technologies and setting of objectives (desired scope/ level of application for specific technologies or measures)	- List of barriers impeding the application of prioritised technologies - Defined objectives for the deployment of technologies/ measures - Identified solutions i.e. measures to overcome barriers
Activities on summing up the results of the process and preparation of the final workshop (June – September 2012)	Aggregation and rationalisation of measures, proposing priority measures and their characterisation, preparation of the first draft of TNA Report	- List of measures aggregated by sectors, with proposed priority measures - Characterisation of priority measures for the action plan - First draft of the TNA Report - Final workshop prepared
Final Workshop,Ulcinj (October 2012)	Validation of previous results, agreement on the guidelines for the national strategy and action plan for the deployment/ acceleration of technologies	- Defined measures for the action plan - Defined national strategy - Suggestions for the revision of the draft TNA Report
Completion of the project (October 2012)	Integration of conclusions and recommendations in the draft TNA Report	- Final draft TNA Report - Translation and printing

3 Identification of development priorities

3.1 Existing development plans and priorities

Service sector had a dominant role in the structure of Montenegrin GDP in 2010 with the share of around 57%, whereas industrial production (including mining and energy sector) accounted for around 14% and agriculture and forestry for around 9%. One fifth of the domestic product was (for the same year) generated in the public sector (administration, education, health). Priority development sectors are tourism, agriculture, energy, transport and forestry, and the key socio-economic development priorities are poverty reduction and reduction of regional disparities. Significant attention, at least on a declarative level, is paid to environmental protection (priorities include protection of biodiversity, water resources and coastal area, improvements in waste management, etc.) and sustainable development issues.

Most important among the general documents dealing with country's development issues are the National Strategy for Sustainable Development, Spatial Plan of Montenegro, and Strategy of Regional Development. Apart from these, there is also a large number of sectoral strategies and plans, with goals and priorities that are not always consistent.

Climate change is a relatively new policy area. As already mentioned, the First National Communication to the UNFCCC was completed in 2010, and a preliminary assessment of the possible impact of climate change on the economy was carried out at the same time. The level of integration of climate change concerns in sectoral strategies is still not on a satisfactory level, but there are certain positive developments to this endfor energy, forestry, biodiversity, tourism and regional development [7].

Examples of development priorities defined in strategic documents and plans are given in the Table 3-1(the list of strategic documents and policies used in this stage of the TNA process and a detailed list of priorities defined in these documents are available in an annex to the Montenegrin version of the document). Identified priorities were used by the TNA participants as a reference for consideration of a long-term development vision in the context of climate change and the definition of framework for further steps in TNA Montenegro.

[7]Sector strategic document such as the Energy Policy by 2030, National Forestry Policy, National Biodiversity Strategy and Action Plan, Tourism Development Strategy, and Strategy of Regional Development to a certain extent tackle the climate change issues.

Table 3-1: Examples of development priorities identified in the national documents

Environmental development priorities	
Objective	**Description**
Efficient pollution control and reduction	Improving air quality in urban environments, strengthening the environmental management instruments, improved waste management and development of climate change policy
Protection of the sea and the coastal area, protection of biodiversity	Preserving the natural balance and the ecosystem resilience
Adaptation to climate change	Defining adaptation measures as a response to climate change
Environmental protection in the context of regional development; special support for underdeveloped areas	Application of low carbon technologies, sustainable use of resources and development of communal infrastructure
Sustainable energy development	EE, RES, rational use of energy potential with integration of environmental protection principles
Minimising negative impacts from the development of transport infrastructure and transport on the environment	Planning and construction of roads, pollution control
Protection and improvement of all components of biological diversity, and their sustainable use	The basic principles for protection of biodiversity is the ecosystem approach; climate change is recognised as a threat
Ensuring a long-term resistance and productivity of forests and related ecosystems	Sustainable management of forest resources (social, economic and environmental functions)
Strengthening the role of forests in mitigation and adaptation to climate change	Investigate potential of forests for CO_2removal, risks for forests from climate change; include CC in forestry planning
Economic development priorities	
Objective	**Description**
Accelerating economic growth and development and reducing regional development disparities	Development of services; SME development and increasing employment in the northern region (mountain tourism, production of healthy food, sustainable forestry)
More balanced development of self-government units and regions	Development of human resources and infrastructure; development of competitiveness through sustainable use of economic, rural and cultural resources
Reducing dependence on energy imports	Rational use of hydro potentials in the basins of Morača, Zeta, Lim, Piva, Tara, Ibarand Ćehotina rivers; construction of TPP Pljevlja 2 (and the heating system for Pljevlja)
20% of the total consumption of primary energy from renewable resources[8]	Besides hydro potential, the priority is solar energy; development of cogeneration
Increasing energy efficiency	Savings of9% of the average final consumption (without Aluminium Plant Podgorica) until 2018
Using renewable energy sources	Researching potentials, creating a favourable environment
Rational use of energy in transport and promotion of EE measures	Improving public transport and railroad transport; energy efficiency and low-emission vehicles, integration of EE criteria in projects
Improving primary agricultural production and processing	Improving safety and quality of food, environmental protection, protection of animals and of plants health
Quality in construction	Development and application of technical standards
Developing the necessary tourist and related infrastructure	Developing transport and communal infrastructure, construction/ upgrading of tourist capacities
Development of Montenegro as "all-year-round" tourist destination	Diversification of offer
Competitiveness of wood processing industry, contribution to social and economic development of rural areas	

[8]During the Energy Community Ministerial Coucil meeting held in October 2012, new objectives for the share of RES by 2020 have been set for the Community member countires; renewed objective for Montenegro is 33%.

Social development priorities	
Objective	**Description**
Poverty reduction	To reduce poverty; ensure equal access to services and resources
Improved standards and availability of housing	Higher availability of apartments and provision of a quality housing stock, especially for economically vulnerable and poor
Reducing children's exposure to air pollution	Air pollution, cigarette smoke, lead in fuels
Science and technology development, increasing their contribution to overall development with the highest possible application of new and development of own knowledge and technologies	Priority fields are: science and education, environment, tourism, agriculture, health of population, energy sector
Reducing unemployment	Creating new jobs, incentives for youth employment, promoting entrepreneurship
Strengthening social cohesion	Employment for women, prevention of social exclusion and poverty

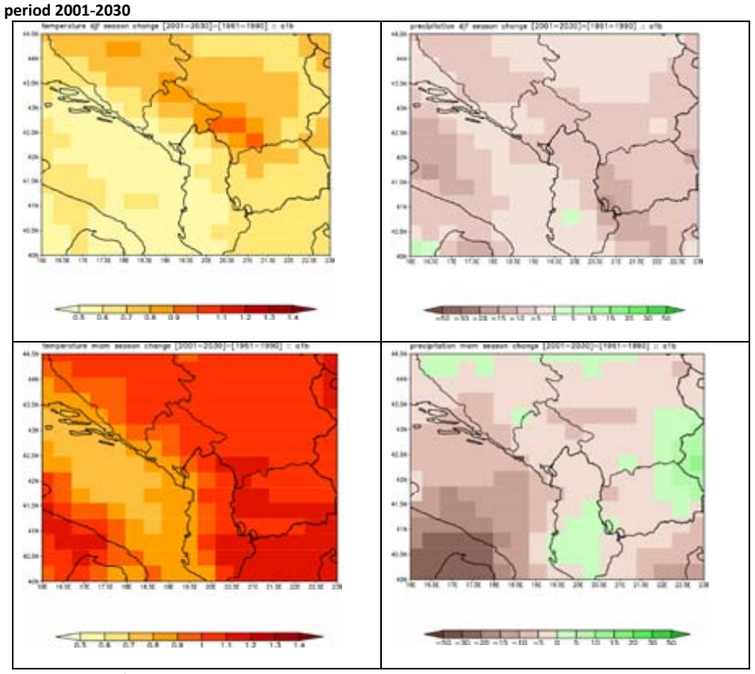
Sources: National Strategy for Sustainable Development and sectoral strategic documents in the areas of environment, energy, agriculture, forestry, transport, construction, housing, tourism, health, science, etc.

3.2 Climate change implications for development in Montenegro

Projections of climate changes for the territory of Montenegro were done by using the Regional Climate Model EBU-POM. The Model was developed based on global emission scenarios defined in the IPCC Special Report on Emissions Scenarios (SRES)[9] . The results of Climate Model EBU-POM were focused on the A1B and A2 scenarios. In relation to the concentration of greenhouse gasses, A1B is considered as "moderate" and A2 as "high" scenario. The projected CO_2 concentrations at the end of 21st century for scenario A1B are at around 690 ppm and for A2 at around 850 ppm (which is approximately 2 or 2.2 times higher value than the current 385 ppm). Model results for Montenegrin territory were analysed for the periods 2001-2030 and 2071-2100 for two basic meteorological parameters – temperature and precipitation. Expected changes in these parameters are shown in relation to average values of the base period 1961-1990 (Figures 3-1 and3-2) for four seasons: DJF – December, January, February; MAM – March, April, May, JJA – June, July, August and SON – September, October, November.

[9] The Special Report on Emissions Scenarios, Nakicenovic and Swart, 2000. SRES recognises four families of emission scenarions: A1, B1, A2 and B2.

Figure 3-1: Changes of temperature at 2 m (in°C) (left panels) and accumulated precipitation (in%) (right panels) for DJF (upper panels) and MAM (lower panels) seasons on the territory of Montenegro under A1B scenario for the period 2001-2030

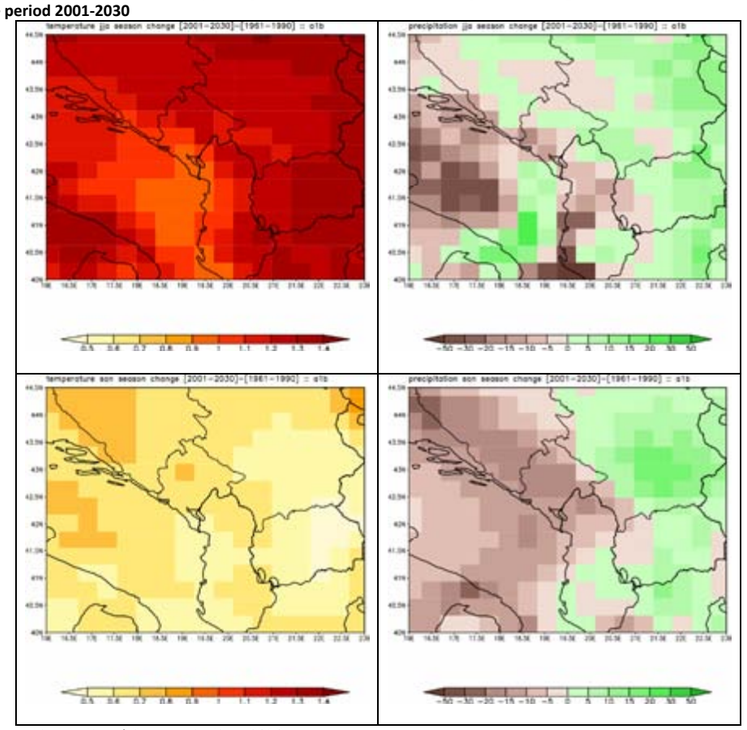


Source: First National Communication, 2010

According to the results of the model, changes (increases) in average seasonal temperature until 2030 will range between 0.6°C and 1.3°C depending on the season and the area. Except for autumn (SON) season, changes of temperature will be more significant in the northern, mountainous part of Montenegro than in the areas closer to the Adriatic Sea. The highest increase in temperature can be expected during the summer season (JJA) equalling to 1.3°C in the north and 1°C in the coastal area.

As for changes in precipitation, the model forecasts both negative and positive changes depending on the part of the country and the season. Very small increase in precipitation (up to 5%) in comparison with the values from the period 1961-1990 can be expected for the summer season (JJA) in northern/central parts and for the spring (MAM) season in the far northeast of the country. For other parts and seasons a decrease in precipitation of up to 10% can be expected, whereas a more significant precipitation deficit with the decrease of as much as 20% is foreseen for the central to southern part during the summer (JJA) and for almost the entire territory of Montenegro during the autumn season (SON).

Figure 3-2: Changes of temperature at 2 m (in °C) (left panels) and accumulated precipitation (in %) (right panels) for JJA (upper panels) and SON (lower panels) seasons on the territory of Montenegro under A1B scenario for the period 2001-2030



Source: First National Communication, 2010

The most dramatic changes of basic climate parameters could be expected at the end of this century during the summer season in case of global increase in CO_2 emission according to the A2 scenario. If this scenario materialises and according to the results of EBU-POM model, people, economy and natural systems in the north of Montenegro would face an increase in the average temperature of 4.8°C whereas precipitation in the south would be reduced by half (it would amount to only 50% of the average value for the period 1960-1991). According to the results of the model, the level of Adriatic Sea could rise by 35 cm maximum.

Available information indicates that climate change will have significant implications for development perspectives not only in Montenegro, but in the whole region. Data from the fourth IPCC Report showed that Southeast Europe was one of the areas where some of the most pronounced manifestations of climate change were expected. It is estimated, for example, that by 2070, a reduction of more than 25% in the potential for electricity generation at the existing power plants can be expected [10].

[10] Source: The IPCC Fourth Assessment Report for Working Group II (Kundzewicz et al., 2007) , published in UNFCCC/ UNDP TNA Handbook from 2010.

According to the First National Communication, changes in the quantity and regime of precipitation in Montenegro will in a long-term lead to reduced flows and abundance of water resources. On the other hand, in combination with the emerging extreme weather conditions, a higher frequency and intensity of floods is expected. Negative impacts of climate change on forests include movement of vegetation zones, reduced growth, reduced number of species, drying out of forests and more frequent forest fires. Loss of species (especially in water environments) and reduced productivity of ecosystems are some of the main expected impacts of climate change on biodiversity. In case of the coastal area, expected negative impacts include loss of space and biodiversity and beach erosion due to higher level and temperature of the sea.

Negative impact of climate change on agricultural production is reflected in limited growth and development of crops, i.e. in significantly reduced yields due to sensitivity of crop production to changes in temperature and precipitation, reduced available agricultural land and lower content of organic matter in soil. It is also possible that cattle breeding will be reduced and that new animal diseases will appear due to heat stress.

Based on available models and data, the UNDP study that was developed within the course of preparation of the First National Communication on Climate Change[11] dealt with estimations of economic damages that could occur in certain sectors due to impacts of climate change, for scenarios of moderate (A1B) and strong (A2) climate change, in the near (until 2030) and far future (until the end of this century). Estimations were, among others, done for water resources (the impact of reduced flow due to climate change on revenues from electricity sales from HPP Piva was analysed) and tourism (the impact of temperature rise on visits and revenues from tourism was analysed). The results showed that significant reductions in revenues could be expected for tourism (between € 33 and 68 million a year) in the far future, whereas the damage from climate change, i.e. reduction of revenues from electricity sales in HPP Piva were estimated at around € 7 million a year for as soon as 2030.

Changed climate has direct and indirect, mainly negative effects on health asit causes changes and processes in human bodies that can lead to injuries and occurrences of infectious and non-infectious diseases, with possible lethal outcome. Climate change leads to growth, fast development, reproduction and geographical expansion of vectors(mosquitoes, ticks, etc.).

Having in mind possible changes of the climate and related impacts, identification and application of technologies, approaches and knowledge that enable low emission and low vulnerability development is particularly significant for the achievement of development objectives and long-term sustainability in Montenegro.

[11]UNDP Montenegro, The Economic Impacts of Climate Change in Montenegro: A First Look, 2010

Preservation and conservation of water, land, forests and coastal ecosystems, development of sustainable systems in agriculture, development of capacities for adequate responses to climate change in the health sector, planning and development of tourism and energy facilities in accordance with changed climate conditions are all necessary in order to ensure that development goals are not put at risk.

3.3 Long-term development vision in the context of climate change

One of the first activities in the TNA process in Montenegro was consideration of development priorities and an attempt to define a long-term vision of sustainable development in thecontext of climate change. With this in mind, participants of the first project workshop in Kolašin discussed future development priorities for the environment, economic and social development. Conclusions from the discussion were then compared with the overview of development priorities from official planning and strategic document. Lastly, a final selection of development priorities for TNA process was made and registered in TNAssess (detailed reportavailable in an annex to the Montenegrin version of the document). The selection is shown in the Table 3-2 and it served as a reference framework for checking further decisions in the TNA process including determination of priority sub-sectors, prioritisation of mitigation and adaptation technologies, and definition of the national strategy for acceleration of technology innovations as a way to achieve climate and development goals.

Table 3-2: Development priorities in the context of climate change

Social priorities	Economic priorities	Environmental priorities
Poverty reduction	Reducing dependence on energy imports	Sustainable forest management
Climate change education	Improved mobility of the population	Air quality
Improvements in the public health system in the context of climate change	Enhancing agricultural production and food industry	Improvements in waste management
Improving the quality of life for most vulnerable categories	Raising competitiveness of wood processing industry	Sustainable water management
Improving construction standards	Enhancing construction standards (planning and building)	Protection of biodiversity
Strengthening social cohesion	Better use of tourism potentials	Sustainable renewable (new) and alternative energy sources
Reducing sensitivity to CC in agriculture and forestry	Reducing unemployment	
Strengthening the governance system, especially on the local level	Science and technology development	
	Selection of favourable options and technologies in energy sector	

4 Identification of key sub-sectors for reduction of emission and vulnerability to climate change

Montenegro is a low GHG emitter, both in absolute and relative terms. Total emissions of carbon dioxide (CO_2) as the most important greenhouse gas were 2.7 Mt in 2008, while the emissions per capita were approximately 1.8 times lower than the European average (Table 4-1). Other GHGs emitted in Montenegro are methane (mainly originating from agriculture and organic waste), nitrous oxide (mainly agriculture – use of mineral fertilisers) and carbon tetrachloride and carbon hexafluoride (synthetic gasses from aluminium production).

Table 4-1: Selected energy and climate indicators for 2008: Montenegro, countries in the region and the EU

Country	Gross inland consumption per capita (kgoe)	Energyintensity (toe/ GDP Meuro '00)	Electricity consumption per capita (kWh)	CO_2emissions (Mt)	CO_2emissions per capita (kg)
Albania	701	400	1,372	3.9	1,227
Bosnia and Herzegovina	1,296	-	2,385	19.5	5,181
Croatia	2,062	293	3,497	20.9	4,720
Kosovo	1,104	619	2,038	7.15	3,405
Macedonia	1,455	673	3,161	9.0	4,333
Montenegro	1,866	488	6,029	2.7	4,355
Serbia	2,102	-	3,751	49.2	6,695
EU-27	3,641	169	5,731	3,849.5	7,719

Sources: National statistics and energy balances, responses to EC Questionnaires, and http://ec.europa.eu/energy/publications/statistics/statistics_en.htm

Data from the Table 4-1 show that in 2008, Montenegrin economy spent 1.7 times more energy than Croatian in order to produce a unit of GDP, whereas in relation to the EU, energy intensity of the Montenegrin economy was almost 3 times higher (using 488 tonnes of oil equivalent per million of GDP expressed in 2000 euros, compared to EU-27 average of 169 toe).

As already mentioned in the Chapter 3.2, natural environment, economic and social systems are highly vulnerable to expected negative impacts of climate change, and this emphasizes the need for comprehensive actions in the area of adaptation.

4.1 Identification and description of sub-sectors

The starting points for **identification of priority sectors for mitigation** in the TNA process were the Greenhouse Gas Inventory of the Environmental Protection Agency (EPA) for 2009 and the data from the First National Communication (NC). Inventory for the First NC was done for 1990 and 2003 according to the IPCC classification of sectors, where key sectors are energy, industrial processes, agriculture, land-use change and forestry, and waste. TNAssess programme used as a support tool for TNA Montenegro is based on the same (IPCC) classification of sectors, but it also enables modifications of sectors and sub-sectors, depending on the availability of national data. Due to the fact that disaggregated data (data on the sub-sector level) from the First NC Inventory were not available, and the fact that this document did not contain data for years later than 2003, a decision was made for TNA to use EPA's Inventory amended with an estimated emission of synthetic gasses (from aluminium industry) based on the data from the First NC. EPA keeps emission inventories according to EMEP/ EEA Air Pollutant Emission Inventory Guidebook from 2009 and IPCC Guidelines for National Greenhouse Gas Inventories from 2006. EPA GHG Inventory for 2009 contains data for key greenhouse gases – carbon dioxide, methane and nitrous oxide[12] . The processes of compiling GHG inventories and emissions monitoring is still being improved. Emissions by sub-sectors for 2009 that were used in TNA Montenegro are shown in the Table 4-2. Total emissions were 5.6 Mt CO_2 equivalent, with energy sector (energy supply and consumption in transport, residential and service sectors) having the highest share of more than 60% of the total emissions, followed by aluminium industry (synthetic gases) with around 30%. Contributions from agriculture and waste sectors were at the level of 5% and 1% of the total emissions respectively. Sub-sector of forest fires was included because of the importance of forests and ever more pronounced problem of forest fires, even though available data showed very low emissions.

[12] Sector classification includes the following 11 categories: 1) Combustion in Energy and Transformation Industries; 2) Non-industrial Combustion Plants; 3) Combustion in Manufacturing Industry; 4) Production Processes; 5) Extraction and Distribution of Fossil Fuels; 6) Solvent and Other Product Use; 7) Road Transport; 8) Other Mobile Sources and Machinery; 9) Waste Treatment and Disposal; 10) Agriculture; and 11) Other sources and Sinks.

Table 4-2: GHG emissions by most important sub-sectors

Sub-sector	Notes	GHG emissions	
		in Mt CO_2 eq	in % of total
Energy supply	For 2009, emissions registered in the relevant EPA Inventory category (category 01, see footnote 12) were almost entirely from TPP Pljevlja	2.30	41%
Energy consumption (residential sector and services)	It is related to combustion plants in residential and service sectors (boilers < 20 MW, other combustion plants)	0.50	9%
Aluminium production	Estimated emission of synthetic gases for 2003 (from the First National Communication)	1.70	30%
Road transport	Data from the EPA Inventory (category 07, footnote 12) for road transport	0.65	12%
Forest fires	Data from the EPA Inventory (category 11, footnote 12) derived from information on burnt areas	0.01	0%
Solid waste disposal at landfills	Data used for the calculation of emissions are from the National Waste Management Plan (estimated and not measured quantities of waste)	0.07	1%
Animal husbandry	Sources of data for calculation of emissions are Monstat and the Ministry of Agriculture; emissions are mostly related to management of manure and fermentation.	0.30	5%
TOTAL		**5.33**	**98%**

Source: EPA's Inventory and the First NC

Energy supply and consumption sectors (especially in transport, households and service sub-sectors/ construction) are characterised by obsolete and inefficient technologies. Measures and technologies determined in the First NC as a proposed way to change this situation and reduce emissions can be attributed to the following four groups:

1. Increasing the efficiency of electricity generation in the thermal power plant Pljevlja;

2. Orientation towards new renewable energy sources (wind, small hydro power plants);

3. Increasing the efficiency in energy consumption through:

   - Heat generation in industrial facilities (revitalisation of boilers, CHP),

   - More efficient vehicles in transport (hybrid vehicles, electric vehicles) and more frequent use of public transport,

   - Using heat pumps and quality insulation of buildings, using solar energy and small cogenerations for heating needs in households and the service sector,

- Using more efficient lighting (in households and the service sector),

- EE appliances(energy labels);

4. Fuels switch:

- For heating needs(LPG instead of coal in boilers), and

-I n motor fuels (introducing biofuels and hydrogen).

Recommended measures related to industrial processes are reconstruction and instalment of automatic controls in electrolysers in the Aluminium Plan Podgorica (APP)in order to reduce the duration and frequency of anode effects, and installation of a dry gas purification system in electrolysis.

Application of proposed measures and technologies is very slow, and the most significant progress was made in the preparation of projects for the use of renewable energy sources and implementation of energy efficiency measures in households and the service sector/construction (e.g. insulation, efficient lighting, energy audits of buildings, initiating the use of solar technologies, etc.). Main limitations for the application of these measures and technologies are insufficient capacities – technical, financial, organisational and human.

Development plans in the energy sector [13] are mainly based on further use of hydro potential, predominantly through large hydro power plants. The current Strategy for Energy Development as well as the available drafts of the updated Strategy foresee the construction of large hydropower plants with installed capacity of almost 500 MW. There is also a plan to build small hydropower plants with the installed capacity of 80 to 100 MW, wind power plants with total installed capacity of around 120 MW and to use solar energy in a better way (which is currently, having in mind the potential, one of the least used energy sources). Possibilities for the use of biomass are still not fully researched. Despite the focus on renewable sources, there is a plan to build the second block of the TPP Pljevlja which is currently receiving renewed attention.

Plans to improve energy efficiency are linked to the objective of reducing final energy consumption by 1% annually (12% until 2020) compared to the average consumption for the period 2002-2006. There are no quantified goals for transport sector, but the road transport sub-sector is recognised as a priority one for optimisation and savings.

Road transport is responsible for around 88% of final energy consumption in the sector[14] with almost exclusive use of fossil fuels (petrol, diesel, kerosene). Strategic plans for industry development do not exist, and the future of APP as the most important plant when GHG emissions are considered is highly uncertain due to serious financial, technological and organisational problems.

[13] Defined by the Energy Development Strategy until 2030, which is currently being revised.
[14] Railroad transport's share is around 2% and air and maritimetransport account for the remaining 10%.

Identification of sub-sectors for adaptation was undertaken with the aim to recognise those areas where it would be possible to implement the most efficient actions for adaptation to climate change, i.e. the areas with the most pronounced vulnerability. Since consideration of climate change and adaptation issues are relatively new in Montenegro, the problem TNA team faced was the lack of detailed, specific and quantified data about vulnerability and potentials for adaptation, and the only available national sources were the First NC and the UNDP study The Economic Impacts of Climate Change in Montenegro: A First Look, 2010. These resources and discussions at the first project workshop in Kolašin resulted in information systematised and presented in the Table 4-3. These identified sub-sectors were then prioritised.

Table 4-3: Sub-sectors relevant for adaptation to climate change

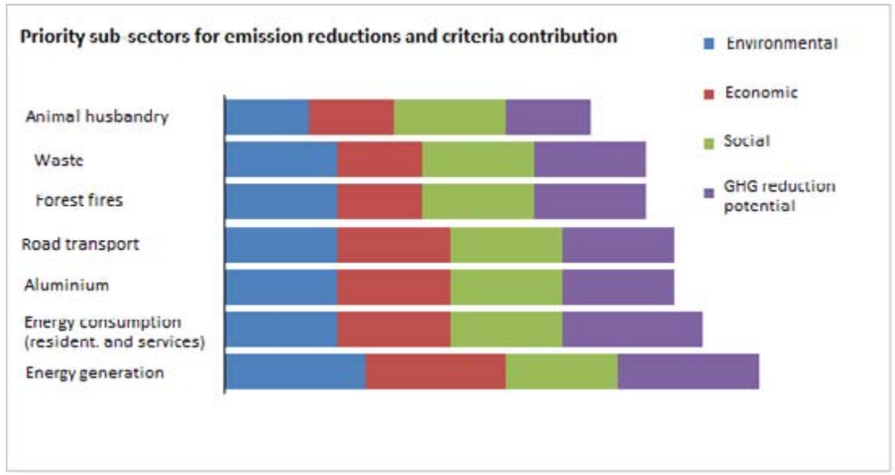
Sector	Sub-sector	Vulnerability and characterisation of sectors
Water resources	Water quantity	Water resources are highly vulnerable to climate change and the need for adaptation measures is exceptionally high. Maintaining the quantity and quality of water is of great importance for public health and sectors such as water supply, agriculture, tourism and energy. Current ways of using water resources in Montenegro do not fully comply with sustainability criteria and they are not based on estimated risks from climate change.
Public health	Public health	People's health ishighly sensitive to changes in climatic factors. Economic implications of climate change negative impacts on health include lower productivity, costs of treatment and others. It is necessary to have an adaptation strategy for public health in order to improve the information base and knowledge, build capacities, prevent diseases caused by climate change and reduce risks from extreme weather events.
Coastal zone	Coastal zone	Sea level rise and increase in temperature can significantly threaten the space and natural resources in the coastal area, which is extremely important for national development priorities. Changes are necessary in the planning and management in this area in order to minimise the expected negative impacts in the future and ensure sustainable development.
Energy	Energy supply	The expected reduction of flows will have a negative impact on generation from hydro sources. On the other hand, an increased demand for energy is expected as a result of changes in climatic conditions (e.g.for air conditioning). Potential effects of climate change and adaptation needs are not sufficiently integrated in the energy sector development plans at the moment.
Forests	Forest management and forestry	The role of forests in the regulation of climate and carbon dioxide removal is of great importance. Forest ecosystems are at the same time highly vulnerable to climate change, and forestry is one of the priority development sectors in the country. Insufficient capacities for planning and implementation of measures for sustainable forest management (among other things also manifested in unplanned logging) represent a significant threat for the achievement of defined climate and development goals.
Agriculture	Agricultural land	Accelerated erosion, reduction of available land surfaces and decreasing content of organic matter in soil are the main expected impacts of climate change that contribute to vulnerability in this sub-sector. Potential to reduce vulnerability are currently not used on a significant scale since there is a lack of necessary information and capacities.

Agriculture	Agricultural production	It is expected that agricultural production too will be affected by climate change and that the conditions for achievement of development goals (increased production and competitiveness) will be significantly aggravated by the change in climate factors. A small-scale progress towards better adaptation is evident(through the application of regular agro-technical measures andincentives for certain types of production) but there is still no systematic response to adaptation challenges (specific scientific research and application of results, institutional and other capacities are lacking).
Biodiversity	Biodiversity	Biodiversity is highly vulnerable to climate change and the expected impacts in this areainclude reduced numbers and loss of species, and lower productivity of ecosystems. On the other hand, services provided by ecosystems are essential for maintenance of natural equilibrium, economy and human wellbeing. Adaptation measures in the sub-sector are only in the initial stage.
Tourism	Tourism	Tourism is a development priority in Montenegro and one of the sectors that are highly vulnerable to climate change. Changes in demand for tourist services and tourist season are possible due to changes in temperature, quantity of precipitation/ snow, sea level rise, beach erosion, etc. which is why there is a high potential for adaptation in the sector.

4.2 Prioritisation of sub-sectors

At the first project workshop held in Kolašin in November 2011, the participants had a chance to assess the priority of identified sub-sectors according to maximum potential benefits that can be achieved in these sectors for TNA development priorities, mitigation and adaptation. Prioritisation was done through a simple matrix that made it possible for all participants to contribute. The participants were expected to answer the question on how much (on the scale between 0 and 5) would interventions (in terms of introducing a certain technology or measure for mitigation or adaptation) in a given sub-sector contribute to achievement of development priorities (environmental, economic and social) and reduction of GHG emissions/vulnerability. A score of 0 meant that the given intervention would not be beneficial at all, whereas 5 meant that potential activities were very desirable (i.e. that they would provide maximum benefits for development priorities, emissions and vulnerability reductions). After the results were summarised, rationales for the ratings were provided and recorded in TNAssess. The results are shown in the Figure 4-1 below (full report on prioritisation is only available in an annex to the Montenegrin version of the document).

Figure 4 1: Results of sub-sectors prioritisation



Source: TNAssess Montenegro

Based on the results of prioritisation, a final decision was made on the most important sub-sectors for the deployment of new technologies and measures in order to achieve climate (mitigation and adaptation) and development goals. As for mitigation, four sub-sectors were selected as the workshop participants assessed that interventions in those sub-sectors would generate highest total benefits (these are the sub-sectors represented with the longest bars in the upper part of the Figure 4-1 i.e. those with the highest sum of benefits for the different criteria). In the prioritisation of adaptation sub-sectors, energy generation was highly ranked (after water resources, public health

and coastal area) but was not taken into account for further steps in the TNA process as the participants thought it was more important and sufficient to consider this sub-sector for the emission reduction technologies. Forest and agriculture sectors (more precisely – forest management, agricultural land and agricultural production sub-sectors) were added to adaptation priorities). Final selection of sub-sectors for mitigation and adaptation is shown in the Table 4-4 and it served as aguideline for further steps in the TNA process.

Table 4-4: Priority sub-sectors for mitigation and adaptation

Priority sub-sectors for mitigation	Priority sub-sectors for adaptation
• Energy supply (41% of total GHG emissions) • Energy consumption in residential and service sectors (9% of emissions) • Aluminium production (30% of emissions) • Road transport (12% of emissions)	• Water resources • Public health • Agricultural land • Agricultural production • Coastal area • Forests

5 Prioritisation of technologies for low emissions and low vulnerability development

Technology prioritisation process in TNA Montenegro was implemented in three steps:

1. Identification, categorisation[15] and familiarisation with technologies/ measures in order to enable the group of involved stakeholders to assess the applicability of given technologies in the national context;

2. Technology prioritisation by using the TNAssess programme and participants' evaluations; and

3. Making final decisions on priority technologies.

5.1 Identification, categorisation and familiarisation with technologies

Identification of technologies for priority sub-sectors started with the engagement of several technical experts for different sectors for mitigation and adaptation. Based on Chapter 5 and Annex 7 of the TNA Handbook, technology descriptions from the website ClimateTechWiki, UNEP Risoe Centre manuals and other available sources, the experts:

- Identified possible technology options for priority sub-sectors and developed a long list of available technologies;

- Recommendedthe available technologies/measures that are applicable and adequate for conditions in Montenegro, thus developing a short list of technologies;

- Collected data about technology options/measures from the short list in a form requested by TNAssess, thus creating technology option pages (these technology optionpages are available in an annex to the Montenegrin version of the document) for each technology;

- Estimated costs(capital, operational and other) of deployment of the proposed technology options; for mitigation sub-sectors costs were estimated in detail whereas for adaptation technologies/measures the constituting elements of costs were only identified and the cost categories were estimated – ranging from low to very high[16] .

Collected information on different technological options from the short list were presented at the technology familiarisation meetings in order to enable the participants to haveactive and informed involvement in the prioritisation at the second TNA workshop. The meetings were also an opportunity to check the shortlisted technologies with participants who could propose adding or removing items from the list as well as changes in the presented information. As a result of this process, 27 technologies for mitigation and 34 technologies for adaptation were identified in total and assessed to be of interest for climate and development policy in Montenegro.

When the identification process was completed, information about selected technology options was entered in TNAssess in appropriate categories. Overview of all technologies and measures (by category) for priority sub-sectors is provided in the Table 5-1. Data processed and categorised in this way served as a basis for the next step in the process – determining priority options, i.e. options that will make the largest contribution to the achievement of climate and development goals in the country.

[15] Categories of technologies and/ or measures as a basis for the TNA process are: small scale (eg. technologies that are applied at the household level) or large scale technologies, and short term (currently available in the market) or medium to long term technologies (currently in pre-commercial or research stage, available in mid- to long term).

[16] All technologies/ measures are attributed to one of the 5 cost categories explained in Chapter 2.4.

Table 5-1: Selected technologies for mitigation and adaptation (by category and sub-sector)

Mitigation technologies	
Energy supply	**Energy consumption**
Short term/ small scale (STSS) 1. Small HPP 2. Onshore wind plants 3. Solar photovoltaic panels 4. Small CHP plants, biomass Short term / large scale (STLS) 1. Large hydropower plants Medium to long term/ small scale (MLTSS) 1. Solar thermal power plants Medium to long term / large scale (MLTLS) 1. Natural gas plants (combined cycle) 2. Plasma gasification	Short term/ small scale (STSS) 1. Solar systems 2. Heat pumps 3. Insulation 4. Efficient lighting 5. Efficient refrigerators (efficient household appliances) 6. Use of natural gas Short term / large scale (STLS) *No identified technologies* Medium to long term / small scale (MLTSS) 1. Efficient air conditioning systems Medium to long term / large scale (MLTLS) 1. Automated control of energy consumption in buildings
Road transport	**Aluminium production**
Short term/ small scale (STSS) 1. Liquefied petroleum gas Short term / large scale (STLS) 1. Biofuels Medium to long term / small scale (MLTSS) 1. Electric vehicles 2. Hybrids 3. Plug-in hybrids 4. Efficient diesel engines Medium to long term / large scale (MLTLS) 1. Intelligent transport system	Short term/ small scale (STSS) 1. Increasing efficiency and working temperature in electrolysers Short term / large scale (STLS) 1. Point feeding of alumina and better process control Medium to long term / small scale (MLTSS) *No identified technologies* Medium to long term / small scale (MLTSS) *No identified technologies* Medium to long term / large scale (MLTLS) 1. Inert anodes

Adaptation technologies/ measures	
Water resources	**Public health**
Short term/ small scale (STSS) 1. Rainwater harvesting 2. Treatment of drinking water in households Short term / large scale (STLS) 1. Wastewater treatment and reuse 2. Water losses management, discovering and repairing damages in water supply systems 3. Flood hazard mapping 4. Flood warnings Medium to long term / small scale (MLTSS) 1. Use of water efficient appliances Medium to long term / large scale (MLTLS) *No identified technologies/ measures*	Short term/ small scale (STSS) 1. Strategies and APs for prevention and mitigation of effects Short term / large scale (STLS) 1. Control of drinking water quality 2. Maintenance and upgrading of water supply and sewerage infrastructure 3. Strengthening supervision and control of infectious diseases 4. Early warning system Medium to long term / small scale (MLTSS) 1. Medical research Medium to long term / large scale (MLTLS) 1. Air quality monitoring and examining the impacts of climate change on health 2. Capacity building in the health sector, especially for emergency service
Agricultural land	**Agricultural production**
Short term/ small scale (STSS) 1. Adequate fertilisation and soil fertility control 2. Constructing terraces 3. Sprinkler and drip irrigation 4. Water usersassociations Short term / large scale (STLS) *No identified technologies/ measures* Medium to long term / small scale (MLTSS) *No identified technologies/ measures* Medium to long term / large scale (MLTLS) *No identified technologies/ measures*	Short term/ small scale (STSS) *No identified technologies/ measures* Short term / large scale (STLS) 1. Integrated crop protection 2. Livestock health control 3. Combined agricultural production 4. Practical training for producers 5. Forest usersassociations 6. Agrobiodiversity Medium to long term / small scale (MLTSS) *No identified technologies/ measures* Medium to long term / large scale (MLTLS) *No identified technologies/ measures*
Coastal area	**Forests**
Short term/ small scale (STSS) *No identified technologies/ measures* Short term / large scale (STLS) 1. Periodic beach nourishment 2. Flood-proofing of structures 3. Wetland protection and restoration 4. Integrated management (including set-back line) Medium to long term / small scale (MLTSS) *No identified technologies/ measures* Medium to long term / large scale (MLTLS) 1. Systematic observation and monitoring of changes in the coastal area	Short term/ small scale (STSS) *No identified technologies/ measures* Short term / large scale (STLS) 1. Systematic monitoring of changes in forest ecosystems 2. Planning of sustainable forest management 3. Implementing sustainable forest management measures 4. Preventing forest fires Medium to long term / small scale (MLTSS) *No identified technologies/ measures* Medium to long term / large scale (MLTLS) *No identified technologies/ measures*

Information on selected technological options for mitigation sub-sectors included quantification of the possible reduction in GHG emissions if a given technology was applied. The assumption for the estimation of emission reductions for the energy consumption sub-sector was the deployment of technologiesat full technical potential in the next 25 years (for example: application of solar systems for water heating or efficient refrigerators and air conditioning systems in all households and commercial buildings in the service sector). Assumptions for estimation of emission reductions in the energy supply sub-sector were made based on the goals set by relevant strategic documents for renewable energy sources or comparative experiences of other countries. For the transport sector, realistic scales of future deployment of selected technologies were assumed, and on that basis of such assumptions emission reductions wereestimated. Finally, for the aluminium production, the assumption for calculating emission reductions was the introduction of proposed technologies for all electrolysers in the only plant in the aluminium industry– Aluminium Plant Podgorica.

Estimations for energy consumption in residential and service sectors were based on calculation of energy savings that would be achieved by technology deployment and application of emission factors to calculate emission reductions having in mind a hypothetical substitution of energy produced in TPP Pljevlja with saved energy. Emission reductions for energy supply technologies were calculated in a similar way (using emission factors and supposed substitution of energy generated in TPP Pljevlja with energy from new technologies). For certain technologies in the transport sector calculations were done based on technical characteristics of different types of vehicles and assumed level of technology deployment, i.e. the level of substitution of existing vehicles with new, more favourable options in the course of the next 25 years. For the technology of improved transport management the estimation was based on a rough assumption that such improvements would lead to an overall reduction of emissions from the assumed/future number of vehicles (with current performances) by 15%. Finally, estimation in the aluminium sub-sector was done based on the assumption that the application of all three proposed technologies would jointly lead to a significantly shorter time of anode effects and reduced emission of synthetic gasses, i.e. to a cumulative reduction of their emissions of 3.5 Mt CO_2 equivalent in the next 25 years.

Costs estimations for the mitigation sub-sectors was done for the same level of technology deployment that was assumed in calculating emission reductions, and by applying available unit costs (e.g. prices per solar system, square meter of insulated outer walls, MW of installed capacity etc.). When estimating total costs for the introduction of new low-emission vehicles in the road transport sub-sector, difference in prices between conventional and new vehicles was only taken into account. As already mentioned, for technologies/measures selected for adaptation sub-sectors estimation of costs was limited to categories of costs.

5.2 Prioritisation of technologies

Technology prioritisation was a central item on the agenda of the second project workshop held in March 2012 in Podgorica. The goal of the workshop was to come to a portfolio of prioritised technologies and measures for mitigation and adaptation in each of the previously determined priority sub-sectors through involvement of different stakeholders, discussions and assessments – scoring and weighting of various options based on selected criteria.

Prior to the workshop, information about the identified technologies were entered into TNAssess programme for different categories (as given in the Table 5-1). The programme allows prioritisation to be executed based on Multi Criteria Decision Analysis (MCDA) for all categories within which three or more technologies were identified. Practically, using MCDA in TNA process means that the levels of priority of certain technologies within the same category are determined by evaluating benefits from each of these options in relation to several parameters. As a minimum, TNAssess enables assessment against four criteria – development benefits for environment, economy and society, as well as mitigation or adaptation benefits. Besides these four basic criteria, TNAssess enables inclusion of other criteria, such as a market potential (possibilities for market expansion) and internal rate of return of investments, or creation and adding of new criteria (e.g. ease of implementation etc.). On the basis of their previous knowledge, information on technologies/measures which they received through the TNA process and discussions at the workshop, the participants of the second project workshop evaluated i.e. assigned scores to all options in technology categories in which there was a sufficient number of them (three or more) to carry out TNAssess prioritisation. In total, three TNAssess prioritisations were carried out in mitigation sub-sectors (for appropriate categories of technologies for energy generation and consumption, and transport) and six prioritisations in adaptation sub-sectors (one in each of the respective categories for water resources, public health, agricultural land, agricultural production, coastal zone and forests).

Scores were assigned for each selected criteria[17] on a scale 0 – 100, whereas the 0 score did not mean that deployment of the given technology would not bring any benefits, but that the contribution of such technology to total benefits would be the lowest in comparison to other options in the group (the evaluation score of 100 was assigned to options with the largest perceived contribution). Appropriate rationales were provided for all assigned scores.

[17] The basic criteria which were taken into account for most prioritisations were: 1) contribution to emission (or vulnerability for adaptation) reductions; 2) contribution to economic development; 3) contribution to social development; and 4) contribution to environmental protection. For a number of prioritizations in mitigation sub-sectors, market potential was also used as a criterion.

Participants of the workshop then **assigned appropriate weights for each of the scored criteria** and provided rationales for their decisions. Assessments of criteria weights are used in TNAssess to convert ranges of criteria scores to a common measure unit. This conversion is performed in such a way that for each criterion a difference between the least and most preferred options is analysed, and conclusion is made about the significance of such difference. A criterion for which the participants believe that the difference between the least and most preferred option is the most significant, is assigned the greatest weight of 100. The next criterion, for which this difference is considered to be the second most important one, is assigned the weight closest to the best-rated criteria, and so on.

Examples of scoring and weighting for one criteria (environmental) for the category of medium to long term/ small scale technologies in road transport sub-sector are given below (Tables 5-2 and 5-3)as an illustration (detailed reports for all TNAssess prioritisations are available in an annex to the Montenegrin version of the document). As for the mitigation technologies, the scoring of contributions to emission reduction was not done by the workshop participants. Instead, the ranking for this criterion was automatically included in the prioritisation results on the basis of emission reduction estimates from the previous step.

Table 5-2: Examples of assessments for prioritisation criteria for medium to long term/ small scale technologies in the road transport sub-sector

Prioritisation criteria: contribution to GHG emissions reduction

Technological options	Estimated reduction of emissions (megatons of CO_2 equivalent)
Hybrid vehicles	0.02
Plug-in hybrids	0.009
Efficient diesel engines	0.072
Electric vehicles	0.027

Note: Over 75% of vehicles in Montenegro presently use diesel as fuel, and, therefore, a potential for application of efficient diesel engines technology is bigger in comparison to other technologies/types of vehicles. Due to possibility for its larger application, this technology has a bigger potential for GHG emission reduction compared to all other prioritised technologies.

Prioritisation criteria: contribution to environmental protection

Technological options	Scores	Rationale
Hybrid vehicles	50	Hybrid vehicles are estimated to generate half as many benefits to environment as electric vehicles, since they still use fossil fuels to a significant degree.
Plug-in hybrids	75	Environmental benefits from plug-in hybrids are estimated to be in-between those for hybrids and electric vehicles. The distances these vehicles can pass propelled by electricity is larger in comparison to hybrid vehicles, which results in lower use of fossil fuels and lower emissions of air-polluting substances.
Efficient diesel engines	0	Although efficient diesel engines would reduce pollution generated by diesel-powered vehicles, combustion of fossil fuels in engines would still release certain amounts of polluting substances. Application of this technology would bring combined effects. On one side, continuing the use of diesel-powered vehicles, though more efficiently, would give relatively small contribution in terms of pollution reduction per car. On the other side, taking into account that 75% ofall vehicles in Montenegro are diesel-powered, total savings in fuel consumption could be significant. Participants concluded that in the long term it is more important to value low level of environmental protection per car, which would be achieved by application of this technology and it was thus given the lowest score.
Electric vehicles	100	Electric vehicles were estimated to give the most significant contribution to environmental protection, mainly through reduction of local air pollution (in addition to GHG emission reduction which was discussed under previous criteria). Environmental benefits could be even larger if power supply from a network could be (partially) replaced by charging batteries at off-grid stations.

Source: TNAssess Montenegro

Table 5-3: Example of assigned weights to prioritisation criteria for the category of medium to long term/ small scale technologies in the road transport sub-sector

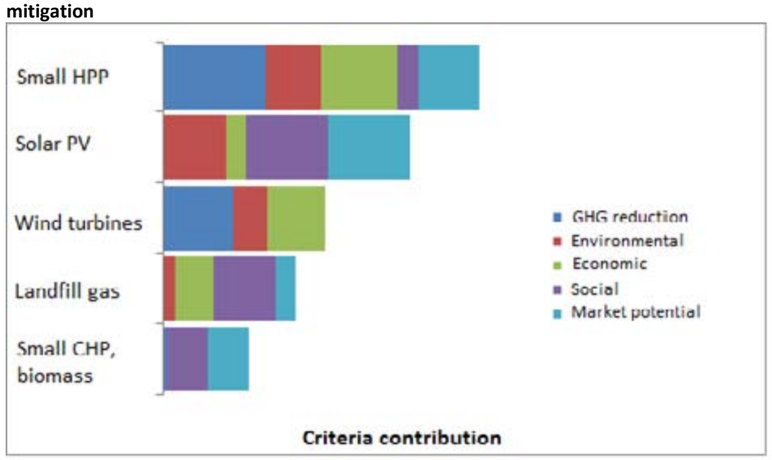
	Assign weight to improvement				
Criterion	**Least preferred**	**Most preferred**	**Consider…**	**Weight**	**Rationale**
GHG reduction	Plug-in hybrids	Efficient diesel engines	The improvement in GHG reduction criterion in moving from investing in 'Plug-in hybrids', to investing in 'Efficient diesel engines'.	60	GHG emissions generated by transport are rising in Montenegro. Reduction which would be achieved by shifting from plug-in hybrids to efficient diesel motors could be significant, since diesel-powered vehicles are widely used. However, participants were concerned with the burden which diesel-powered vehicles represent for local air quality, and, therefore, they decided that the improvement, which would be achieved by transfer from efficient diesel engines to electric vehicles, is much more significant for the environmental criteria. The participants assigned the weight of 60 to GHG emission reduction.
Environment	Efficient diesel engines	Electric vehicles	The improvement in environmental cr. in moving from investing in 'Efficient diesel engines', to 'Electric vehicles'.	100	Improvements that would be achieved if efficient diesel engines were replaced with electric vehicleswould encompass elimination of significant air pollution. The participants considered this improvement as the most significant.
Economic	Efficient diesel engines	Electric vehicles	The improvement in economic criterion in moving from investing in 'Efficient diesel engines', to investing in 'Electric vehicles'.	90	A shift from efficient diesel engines to electric vehicles would lead to significant savings in fuel costs, since there would be no more need for diesel. In terms of net present value, such change would represent a strong progress for the total vehicle fleet in Montenegro, almost as important as environmental improvement. The participants were quite optimistic about the scope of the potential use of electric and hybrid vehicles. One of the arguments was that Montenegro was a small country and as such could be interesting to producers of these technologies as a testing ground.
Social	Electric vehicles	Efficient diesel engines	The improvement in social criterion in moving from investing in 'Electric vehicles', to investing in 'Efficient diesel engines'.	50	A shift from electric vehicles to efficient diesel engines would lead to improvements in terms of social acceptance. However, in comparison to the improvements due to a shift from the least to the most preferred option for environmental and economic criterion, this improvement was assessed to be half as significant. Economic improvement is more tangible since the electric vehicle prices would fall as this technology develops, while the fuel prices would rise. It can be expected that social acceptability of electric and other vehicles (which are now substantially more expensive) will also increase with lower prices.

Source: TNAssess Montenegro

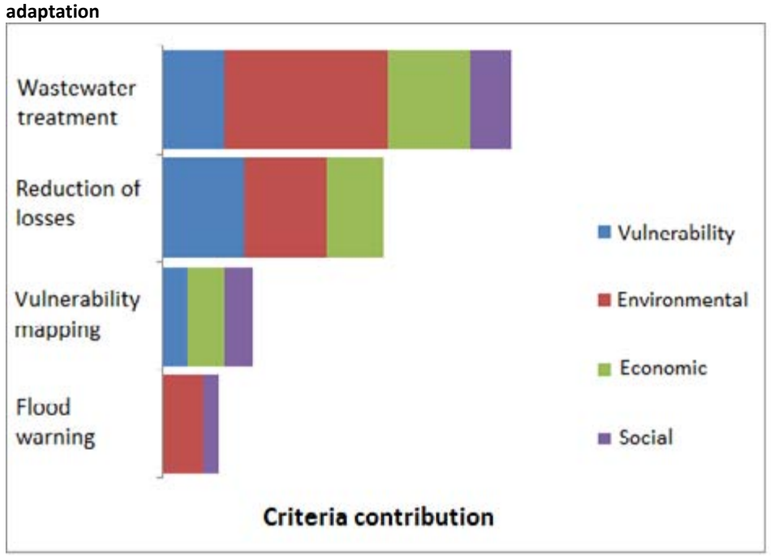
Based on scores and weights assigned in this way, the programme generates **overall benefits from technology deployment and enables graphic and table presentation of results.** Examples of results for two TNAssess prioritisations are given in the Figure 5-1.

Figure 5-1: Graphic overview for prioritisations in energy supply and water resources sub-sectors

Result of TNAssess prioritisation of short term small scale technologies in the energy supply sub-sector - mitigation



Result of TNAssess prioritisation for shorttermlarge scale technologies in the water resources sub-sector – adaptation



Source: TNAssess Montenegro

Energy supply graph shows that based on the workshop participants' assessments, small hydropower plants are ranked as a number one priority, whereas solar photovoltaic panels (SPV) are the second most preferred option. Overall benefits (derived from assessed contribution to GHG emission reduction and scoring and weighting of the selected criteria) for small hydropower plants and SPV have the scores of 304 and 241 respectively. In the cumulative score for small HPPs emission reduction criteria contributes the most, whereas social criterion and market potential have the largest contribution to the total benefits for solar panels.

For prioritised short term large scale technologies in the water resources sub-sector, benefits from wastewater treatment and reuse have had the total score of 213, and this option was ranked as the highest priority, while benefits from the second most preferred technology (reduction of losses in water supply systems) was given the overall score of 135. For wastewater treatment, it was assessed that the greatest contribution to overall benefits was realized on the basis of environmental protection, while economic criterion also had significant contribution. The graph from the Figure 5-1 also shows that, when two priority technologies for water resources in this group are considered, it was estimated that reduction of losses contributes much more to vulnerability reduction in the sub-sector than wastewater treatment and reuse.

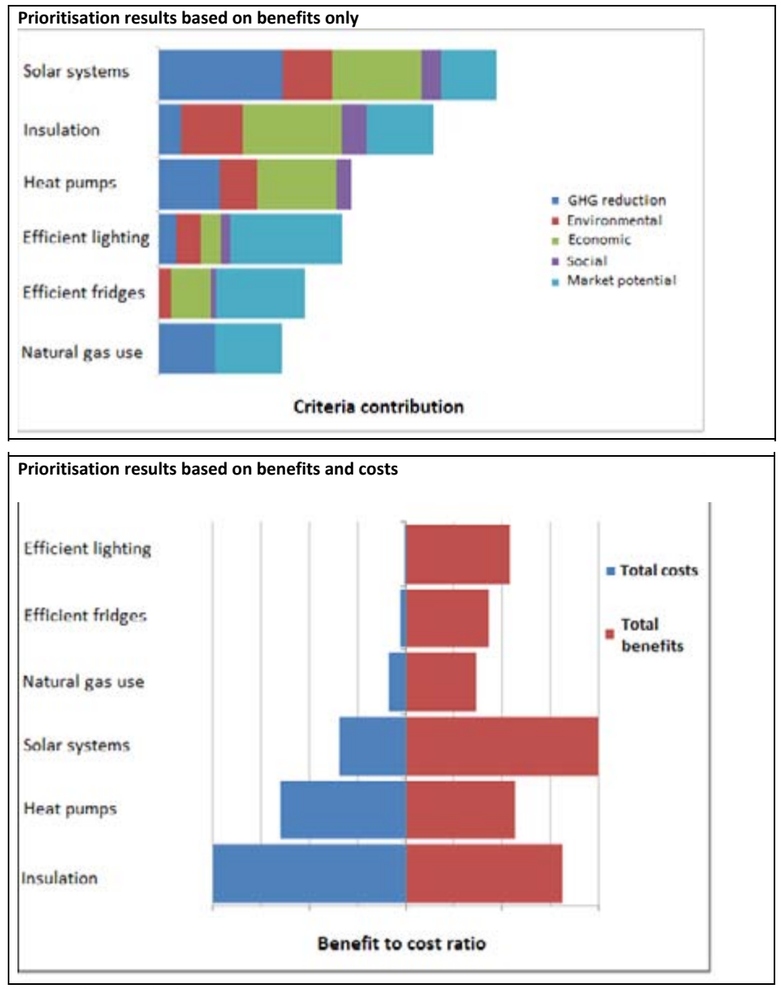
Besides prioritisation of technological options and measures based on the benefits generated by their deployment, which has been discussed so far, TNAssess also enables prioritisation on the basis of benefit to cost ratio. Category of small scale short term technologies relevant for mitigation and energy consumption sub-sector is used as an example (Figure 5-2) to illustrate and discuss results of TNAssess prioritisations based on costs and benefits. Out of six identified options in this category, solar systems for water heating were assessed as a number one priority on the basis of benefits they provide for selected criteria (emission reduction, contribution to development priorities, market potential). Among individual criteria, the greatest contribution to the cumulative score of 273 was provided by emission reduction (which was estimated at 0.18 Mt CO_2 equivalent in comparison to 0.034 Mt estimated for insulation as the second most preferred option). Total benefits from deployment of the second priority option –insulation of buildings–received the score of 222, while the largest contributionsto the overall score were made on the grounds of economic criteria (reduction of heating and cooling costs) and market potential.

As shown in the Figure 5-2, priorities are different if relationship between benefits and costs is taken into account. The most favourable ratio (and thus the highest priority) is recorded for the option of efficient lighting, since estimated costs for application of this technology are quite low and benefits significant, while the second best option from the benefits only prioritisation – insulation of buildings – is assessed as the least preferred option in terms of benefits to costs ratio. Such a result for insulation of buildings is due to exceptionally high costs estimated at over € 1.8 billion over the

course of 25 years (at the level of full technical potential, i.e. application on all the buildings).

The example from the Figure 5-2 indicates how the TNAssess prioritisation results may be interpreted and used by stakeholders to decide on the best technological options in terms of maximising benefits for implementation of sustainable development priorities and fulfilment of potential for GHG emission reduction, while minimizing the costs. Prioritisation on the basis of benefit to cost ratio was not carried out for adaptation technologies/measures, since precise cost estimates were not done for these technologies.

Figure 5-2: Results of TNAssess prioritisation for small scaleshort term technologies in the energy consumption sub-sector



Source: TNAssess Montenegro

For technology categories where **less than three technologies were identified,** priorities were determined without using TNAssess on the basis of criteria similar to those applied in the programme. The participants of the workshop were asked to assess priority levels taking into account potential of each technology/measure to contribute to emissions or vulnerability reduction, and to achievement of development priorities. Opinions were then summarized into an overall assessment of priority levels of different technologies.

As a result of these assessments and TNAssess prioritisations, at the end of the second project workshop, one or two priority technological options were singled out for all categories in which technologies were identified during the first step in the prioritisation process for each of the priority sub-sectors. During their work, participants of the second workshop decided to add two more options– bike lanes and public transport improvements –as new priorities in the categories of short term/ small scale and short term/ large scale technologies (public transport improvement was included as the first priority in its category, besides application of liquefiedpetroleum gas, and bike lanes were added as a sole priority in respective category).

When TNAssess prioritisations are conducted, the programme enables sensitivity analysis of results obtained based on the original assessments (scoring and weighting for each criterion). The purpose of the analysis is to come to reliable/robust choices (assessments) in the situation where there are some uncertainties.

The graph generated by the TNAssess programme for sensitivity analysis (example from the prioritisation of short term large scale technologies in the public health sub-sector is given in the Figure 5-3)shows robustness of assessmentson the most preferred (i.e. priority or highest ranked) technological option in relation to changes in scores and criterion weights. The name of the most preferred option appears at the top of the graph. All the criteria are then listed and colours (or empty fields) are used to indicate how robust is the assessment on the most preferred option in relation to potential increase (on the right hand side) or decrease (on the left side) in the assigned scores. Indications which may appear in the graph have the following meanings:

Red colour: Cumulative weightwould have to change by 5 percentage points or less in order to change the most preferred option.

Yellow colour: Cumulative weight would have to change by 5 – 15 points in order to change the most preferred option.

Green colour: Cumulative weight would have to change by more than 15 percentage points in order to change the most preferred option.

Blank field: No change in cumulative weight would change the most preferred option.

In cases when increase or decrease in criteria weights would result in a change of the most preferred option, the name of the new most preferred option is shown besides the coloured field. Blank or green field in the graph means that a result is robust and that even significant changes in the cumulative scores would not affect the most preferred option; robustness of results marked with yellow field can be assessed as lower but still acceptable, while the red field indicates that a result is not robust and that initial assessment should be repeated (traffic light approach).

Figure 5-3: An example of sensitivity analysis

The most preferred option	Control of drinking water			
	Reduce cumulative weight	**Criterion**	**Increase cumulative weight**	
Infrastructure maintenance		Vulnerability		Infectious diseases
		Environment		Infrastructure maintenance
Infectious diseases		Economic		Infrastructure maintenance
Infectious diseases		Social		Infrastructure maintenance

Source: TNAssess Montenegro

For the example from the Figure 5-3, scoring results are relatively robust for vulnerability criterion, and robust for all other criteria. Namely, if cumulative weight originally assigned for vulnerability criterion (in the prioritisation where control of drinking water came out as the most preferred option)would increase by 5 – 15 percentage points, drinking water control would no longer be the most preferred option, and control of infectious diseases would take its place.

In cases when analysis by TNAssess programme indicated that achieved results were sensitive to minor changes in assigned weights, participants of the workshop reconsidered original assessments and intervened in such a way to obtain robust results, with all "green lights", or green and yellow (more details about sensitivity analysis for all prioritisations carried out in TNAssess are available in an annex to the Montenegrin version of the
document).

5.3 Final decision on priority technologies

Based on discussions from the second project workshop and a review of results of TNAssess prioritisations, the TNA team decided to select technologies and measures summarized in the Tables 5-4 and 5-5 as the best technological options for achievement of development and climate goals. These technologies and measures were examined further (analysis of conditions for their deployment and diffusion and identification of measures for improvement of these conditions) in order to formulate the national strategy and establish an action plan for accelerating application and transfer of priority technologies.

Table 5-4: Priority technologies for mitigation

Cat.	Prioritised technology	Potential for mitigation in Mt (cumulative reduction over 25 years)	Result of TNAssess - benefits	Estimated total costs during 25 years in € (at the level of technical potential)
Sub-sector: Energy supply				
STSS	Small hydropower plants (80 MW)	11.05	309	199,104,000
	Solar photovoltaic panels (10 MW)	0.4	241	38,245,350
STLS	Large hydropower plants [1)] (487 MW)	64.66	not carried out	1,413,274,000
MLTSS	Solar thermal power plants (20 MW)	0.96	not carried out	97,672,840
MLTLS	Plasma technology (70 MW)	2.83	not carried out	1,199,519,300
Sub-sector: Energy consumption				
STSS	Solar water heating systems	0.18	273	636,249,169
	Insulation of buildings	0.03	222	1,840,812,750
MLTSS	Efficient air-conditioners in households and service sector	0.02	not carried out	466,928,024
MLTLS	Automated energy management in buildings	0.28	not carried out	779,180,000
Sub-sector: Transport				
STSS	Improvements in public transport [2)]			
	Liquefied petroleum gas	0.027	not carried out	49,500,000
STLS	Bike lanes [2)]			
MLTSS	Electric vehicles	0.027	207	393,300,000
	Plug-in hybrids	0.009	168	180,000,000
MLTLS	Intelligent transport system	0.134	not carried out	21,000,000
Sub-sector: Aluminium production				
STSS	Increasing the efficiency and operating temperature in electrolysers	3.525[3)]	not carried out	2,167,200
STLS	Alumina point-feeding and better process control	3.525[3)]	not carried out	5,569,200
MLTLS	Inert anodes	3.525[3)]	not carried out	20,066,250

Notes: 1)A concern over environmental impact of large hydropower plants has been expressed (particularly with respect to protected areas), and the importance of environmental impact assessment was stressed. Due to these concerns, large scale hydropower plants have not been considered at the meetings (for identification of barriers and solutions) which were held in May. 2) Transport technologies/ measures which were added following proposals of the participants at the second project workshop (TNAssess was therefore not used to analyse them); cost and emission reduction estimations were not done for these technologies. 3) Total for all three technologies.

Table 5-5: Priority technologies and measures for adaptation to climate change

Cat.	Prioritised technology	Potential for adaptation in sub-sectors (over the course of 25 years)	Result of TNAssess - benefits	Costs of deployment of a measure or technology
Sub-sector: Water resources				
STSS	Treatment of drinking water in households	This method ensures appropriate quality drinking water and thus reduces vulnerability to climate change effects.	not carried out	Low
	Rainwater harvesting	This method can provide significant quantities of water for irrigation and washing, which represents a "relief" for standard water supply systems and provides for reduced pressure on surface and ground water sources. Simultaneously, this method contributes to protection against floods and erosion.	not carried out	Relatively low
STLS	Reduction of losses and maintenance of water supply systems	Reduction of losses in water supply system contributes to preservation of water resources and increases the quantity of available water.	135	High
	Wastewater treatment and reuse	Climate change leads to reduction in quantities of fresh water and changes in quality of water resources. Wastewater treatment prior to discharge into natural recipients is a precondition for preservation of good water quality, and it may also represent a new, supplementary resource. Reuse of certain categories of wastewaters contributes to saving available quantities of clean water.	213	Very high
MLTLS	Use of water efficient appliances	Use of such appliances made in line with European standards can save up to 1/3 of quantity of water consumed by households, which, in light of reduced availability of water resources, represents a significant potential.	not carried out	Moderately high
Sub-sector: Public health				
STSS	Preparation of strategies and national APs	The measure can significantly contribute to reduction of vulnerability by planning adequate activities to protect human health and reducerisks of illnesses caused by climate change.	not carried out	Low
STLS	Control of drinking water quality	Consumption of safe drinking water (i.e. prevention of occurrence and spreading of waterborne diseases) is a precondition for preservation of health. Monitoring the quality of drinking water and keeping it at the satisfactory level prevents creation of favourable conditions for development of bacteria, viruses, insects etc.	176	Moderately high
	Strengthening of supervision and control of infectious diseases	Infectious diseases are an important socio-medical problem, particularly under conditions of pronounced climate change which contributes to reproduction and spreading of vectors. By monitoring the situation on the ground control over disease spreading may be significantly improved.	166	Relatively low
MLTSS	Medical research	Results of medical research have the potential to significantly contribute to improved health protection and reduction of vulnerability to climate change. They would also contribute to development of health protection system capacities to respond to CC.	not carried out	Moderately high

MLTLS	Capacity building of the public health sector, especially the emergency service	A well organised public health sector is necessary to deal with extreme weather conditions as one of the anticipated consequences of climate change. Timely action of public health sector services mitigates the consequences of climate change and contributes to preservation of health.	not carried out	Moderately high	
	Sub-sector: Agriculture				
STSS	Sprinkler and drip irrigation	These measures help optimise the use of water resources by reducing consumption of water in agriculture, which is important in situations when water shortages are experienced. Agricultural production benefits from irrigation through increased yields and stabilisation, which gives producers significant guarantees.	313	Moderately high	
	Adequate manure use and soil fertility control	This method can reduce influence of heat and water stress, as well as their joint impact on cultivated crops.	252	Moderately high	
STLS	Combined agricultural production	Application of this measure can significantly reduce production risk at smaller agricultural holdingssince it provides a wide range of options to reduce vulnerability.	213	Moderately high	
	Practical training for producers	Practical training for producers promotes sustainable resource management, environmental protection, and application of up-to-date agricultural practices and knowledge, which all together lead to reduction of risk from CC andimprove adaptation abilities.	201	Relatively low	
	Sub-sector: Coastal area				
STLS	Integrated management (including set-backs)	Application of ICZM methods and tools would lead to changes in coastal zone planning and management, which would significantly reduce the risk from climate change and improve development of settlements and economy in a climate-resilient way.	289	Moderately high	
	Wetland protection and restoration	Through water retention and prevention or attenuation of flood waves, as well as through reduction of erosion, this technology can significantly contribute to a long-term reduction of vulnerability to climate change. Wetland areas contribute to a spontaneous adaptation to sea level rise.	161	Relatively low	
MLTLS	Systematic observation and monitoring	Design of adaptation measures and monitoring their application and effects, as well as reduction of vulnerability to climate change, are impossible to achieve without reliable information on baseline conditions and continual changes in coastal area.	not carried out	Moderately high	
	Sub-sector: Forests				
STLS	Sustainable forest management (protective measures)	Introduction and wide application of this technology would lead to significant reduction of vulnerability. Protective measures which are primarily considered within this technology are: maintenance and protection of existing forests; conversion ofcoppice into high forests; rehabilitation of degraded forests etc.	238	Moderately high	
	Forest management planning	Introduction and wide application of this technology would lead to significant reduction of vulnerability to climate change. Criteria for sustainable forest management include biodiversity conservation, preservation of forest productivity and of forest ecosystems health, and conservation of land and water resources.	186	Moderately high	

6 Preparation of strategy and action plan for priority technologies

After priority technologies have been determined, the next steps in TNA Montenegro were conducted in order to provide an answer to the question on how transfer, development, deployment or diffusion of these technologies can be stimulated and accelerated and to formulate remaining elements of the national TNA strategy. The first in a row of these steps was organisation of preparatory meetings for development of the national strategy, which were separately held for mitigation and adaptation at the end of May 2012. The meetings gathered majority of participants of TNA process and were aiming to:

- Remind participants of development priorities that served as a starting point for TNA process;
- Definethe desired scale of technology deployment, i.e. to set specific goals for different technologies;
- Identify system barriers which prevent deployment of technologies on the desired scale;
- Suggest solutions for elimination of barriers, i.e. for creation of enabling environment for deployment of technologies for low-emission development adapted to climate change.

At the meeting dedicated to mitigation technologies, the barriers from three key categories (barriers related to existence of enabling environment, market chain related barriers and support services related barriers) were discussed, while at the meeting on conditions for deployment of adaptation technologies and measures, barriers were discussed in general terms.

Preparatory meetings resulted in comprehensive materials with detailed elaboration of barriers and proposals of solutions, i.e. measures for elimination of barriers for each of the prioritised technologies, as well as with proposed objectives for desired levels of deployment of individual technologies. In the period after these meetings and in preparing for the final workshop, TNA team has analysed and aggregated identified barriers.

Proposed solutions have been rationalised and turned into measures for acceleration of priority technologies deployment. The measures were then classified by technology development stages (research and development or R&D – deployment – diffusion)[18], by sub-sectors and by the following groups of measures: 1) networking; 2) policies and instruments for their implementation; 3) organisational and behavioural change;

[17] Almost all priority technologies which are identified through TNA Montenegro are in the deployment and diffusionstages, which means that these are tested, mature market technologies which are either present (but not sufficiently diffused) in Montenegro or there are possibilities and interest for their application (as in case of solar thermal power plants). Nevertheless, for some of these technologies it is necessary to implement activities from the research and development stage in order to further explore the potentials and possible needs for adaptation to local conditions.

4) market, system support and financial services; 5) training, education and development of skills; and 6) international cooperation and intellectual property rights. Following aggregation and grouping of measures, proposal of priority ones was made based on discussions from the May meetings and with the intention to validate such proposals at the final workshop. Finally, the proposed priority measures were characterised in a way as to prepare elements necessary for formulation of action plan (brief description of measures was included, implementation time frame determined, responsibility for implementation assigned and costs needed to implement the measures estimated). At the same time, draft of the final TNA report was prepared.

Estimation of costs done as a part of characterisation of measures for the action plan only refers to elements and activities necessary to prepare implementation of measures, whereas potential infrastructure or fiscal interventions and their financial implications were not encompassed. For example, costs related to installation of new measuring equipment were not taken into account when estimating costs for water charging based on used quantities (one of the measures for reduction of losses in water supply systems). Instead, costs were estimated based on efforts needed to implement organisational and other improvements in companies that manage water supply systems. Similarly, estimated costs for tax breaks and other incentives (these have been identified as measures needed to accelerate deployment of several mitigation technologies) do not entail total amount needed for such measures (how much would, for example, lowering of VAT for certain equipment and materials cost the state budget) but only the costs of administrative efforts to define possibilities and establish incentivising schemes. Elements used for the estimation of costs for creation of enabling environment for deployment of priority technologies are thus primarily referring to administrative (policy making and implementation) and capacity building costs, as well as to the costs for networking, improvements in the availability of information, training and awareness raising activities and similar.

Due to the fact that the scope of certain measures from the action plan has not been defined precisely (for example, with the level of detail to which action plan measures have been developed it was not possible to decide the exact number of persons for whom certain training was needed or whether such training would be provided through study visits, longer and certified training programmes or shorter seminars), these cost estimates should be taken as a rough indicator of financial assets needed to prepare and implement different measures. The approach to cost estimation was conservative (lowest possible amounts were used) and generally speaking it entailed determination of the needed number of activities or elements (e.g. number of campaigns that need to be conducted, meetings to be held, persons to be trained) and unit costs, or determination of annual costs for certain activities and its multiplication by the number of years planned for implementation. It is necessary to distinguish the TNA action plan's costs for creation of enabling environment from the technologies deployment costs (which were discussed in the Chapter 5).

When materials (including TNA draft report, aggregated barriers and solutions, and proposal of priority measures for the action plan) were prepared as discussed in the previous paragraphs, final TNA workshop was organised and held on October 4 and 5 2012 in Ulcinj. The workshop programme was set up in such a way to first remind participants of the previous steps in the process and familiarise them with the draft report. During the second workshop session, summarised results of the preparatory meetings from May 2012 were presented to participants, and their opinion was sought regarding the proposed objectives for deployment of technologies/measures and the main identified barriers and solutions.

Based on the received opinions and suggestions, final objectives for the deployment of priority technologies were established and key barriers and solutions were confirmed/amended. Agreed objectives and barriers for mitigation technologies are shown in the Table 6-1, and for adaptation in the Table 6-2. Suggestions of the workshop participants pertinent to the solutions have been integrated in the TNA action plan (the final version of the action plan is included in the Annex 1).

Table 6-1: Priority technologies for emission reductions: objectives, costs and key barriers for deployment

Technology	Objective (aspirational level of deployment)	Costs over 25 years (in €)	Key barriers	
ENERGY SUPPLY				
1. Small HPP	420 GWh annually (92 MW installed capacity); 10 - 15% of total supply from SHPPs	228,969,600	• Lack of coordination, insufficient control and capacities to point investors in desired direction; inefficient administrative procedures • Insufficient level of valid information on deployment possibilities, insufficiently investigated resources • Lack of capacities on the significance of RES • Uncertainties regarding environmental impacts • Low purchase prices (applies to all the RES)	• Grid connection issues • Insufficient financing sources • Not enough examples off good practices, limited knowledge on technologies (especially for STP, plasma) • Resistance to application of new technologies • High technology prices (especially for STP, plasma) • No networks to facilitate transfer of knowledge • No support for research and development for solar technologies
2. Solar photovoltaic panels	50 MW	191,226,750		
3. Solar thermal plants (STP)	50 MW	244,182,100		
4. Plasma gasification	70 MW	1,199,519,300		
ENERGY CONSUMPTION				
1. Solar systems	80% of all households (individ. buildings); widespreaduse in collective housing and in service sector	384,196,613	• Slow acceptance of new technologies, low level of awareness • Undeveloped market (small number of companies) • Not enough good examples from practice, insufficient promotion • Insufficiently developed incentives for users and other actors in the chain	• High technology prices; high VAT and customs rates • Unfavourable general conditions, affordability • Insufficient capacities, inadequate qualifications • Unregulated market, lack of standards and quality control • Recycling • Insufficient coordination and cooperation
2. Insulation	90% of the total housing stock	1,288,568,925		
3. Efficient air-conditioning	All commercial buildings, 50% of housing units	280,156,814		
4. Automated control of energy consumption in buildings	All public institutions and large commercial buildings, app 50% of large housing objects (collective housing)	258,596,250		
ROAD TRANSPORT				
1. Public transport improvements (PT)	System enhancement and doubling the number of passengers by 2025	Not estimated	• State policy to promote PT does not exist, financial support to increase the level of services is lacking • Lack of awareness (among citizens, at institutions) and information on benefits • Undeveloped infrastructure (for cycling and use of other technologies, e.g. for the improvement of PT and introduction of ITS) • High vehicles prices, non-competitiveness • Lack of interest among distributers • Technical limitations of vehicles – imperfections of technologies	• Unregulated and under-developed market for LPG • No conditions for batteries recycling • No reliefs or subsidies to stimulate procurement of vehicles • Lack of support for necessary research for introduction of ITS and its development • Lack of qualified staff for establishment/ maintenance of IT system
2. Liquefied petroleum gas	30% of the entire vehicle fleet	49,500,000		
3. Bike lanes	Development of cycling infrastructure in urban centres and expansion/ linkages to national and regional networks	Not estimated		
4. Electric vehicles	3% (or 9,000 vehicles) of the total number of private vehicles at the end of 25 y	393,300,000		
5. Plug-in hybrids	1,7% (or 5,000 vehicles) of the total number of private vehicles at the end of 25 y	180,000,000		
6. Intelligent transport system (ITS)	The system covers main transport centres	21,000,000		
ALUMINIUM PRODUCTION				
1. Increasing the efficiency and operating temperature in electrolysers	All electrolysers over the course of 25 years	2,167,200	• Non-fulfilment of contractual obligations and regulations, inertia on the side of state institutions • Uncertain future of APP (on-goingdecommissioning of cells has nearly halved the number of operational ones; reactivation of decommissioned cells would be exceptionally expensive) • Electricity prices subsidised for a long period of time • The need to adjust technologies to local conditions	• Lack of research and development, links between industry and R&D do not exist • High costs of new technology (cheaper and less sustainable current option continues being used) • Lack of local expertise and capacities for installing and managing new technologies
2. Alumina point-feeding and better process control	All electrolysers over the course of 25 years	5,569,200		
3. Inert anodes	All electrolysers over the course of 25 years	20,066,250		

Final objectives for technology deployment in energy sub-sectors have been set based on strategic documents, development priorities, comparative experiences of other countries and, in the opinion of TNA participants – realistic possibilities (provided that adequate support measures are implemented). Objectives for the road transport sub-sector have been derived from the discussions of stakeholders taking part in the TNA process and they reflect necessary and possible improvements in the public transport system, including development of non-motorised modes of transport, and introduction and diffusion of low-emissions vehicle technologies. As for the aluminum production sub-sector, the objectives are set having in mind the need to apply the three interlinked priority technological measures in all the electrolysers in the APP (supposing the so far capacity of the plant).

Table 6-1 also contains deployment costs for different technologies adjusted to the final objectives. For example, costs of deployment of solar systems, which have been estimated for the maximum technical potential in the previous chapter, are now re-calculated for the set objective: application in 80% of all households from individual buildings (houses) and widespread use (app 45% of all units) in collective housing (apartment buildings) and service sector.

As for the energy sector barriers, it can be said that despite significant efforts to enhance the planning and regulatory framework of renewable energy sources (RES) and implementation of energy efficiency measures, examples of conflicting and de-stimulating policies, regulations and procedures are still evident. Insufficiently stimulating purchase prices and (limited) possibilities to connect to electric grid reprsent major barriers for RES. Important barrier for most technologies in the sub-sectors of energy consumption (in residential and service sectors) and energy supply is lack (or non-enforcement) of standards for products, materials and execution of works. Lack of awareness on importance of RES and EE technologies, insufficient interest among citizens, lack of capacities and abilities, insufficient knowledge about technologies and insufficient number of demonstration projects to present advantages of different options, are also inhibiting. Insufficient local expertise for development and preparation of projects is another significant deficiency of the system for deployment of new technologies and their diffusion in Montenegro (for energy sector and in general). Participants of the TNA process concluded that some of the most important barriers for technologies deployment include lack of fiscal and financial incentives (which negatively affects prices and reduces affordability) and low availability of favourable financial sources for both private and public sectors.

In the sub-sector of road transport, the key barriers are related to the lack of adequate policies and measures to stimulate deployment of low emission and zero-emission transport means and modes, insufficient capacities and insufficiently developed awareness. The current state-of-affairs of transport infrastructure, organisation in the system and condition of the vehicle fleet (private and public transport vehicles alike) are also stressed as major shortcomings. With respect to aluminium production, the key barrier for implementation of priority technology options is a serious crisis faced by the only producer in Montenegro.

Table 6-2: Priority technologies and measures for adaptation: objectives and key barriers

Priority technology/ measure (*with objectives*)	Key barriers
WATER RESOURCES	
1. Treatment of drinking water in households (*Ensure adequate treatment of drinking water in households when necessary*)	• There are no regulations or advices on water treatment in households • Harvested rainwater has a limited usability (further treatment could be needed, use for agriculture possible), technology is regionally relevant • It is necessary to meter consumption and have economic prices of water (including in rural areas) • Out-dated water supply and sewage systems • Lack of financial sources • Management capacity and ownership of water supply systems in rural areas • Tradition and social values: use of drinking water for other purposes is common; lack of awareness on the need to preserve water • Insufficient knowledge on possibilities to reuse water, lack of interest • Lack of infrastructure for the use of technical water • Wastewater treatment is financially demanding • Affordability of efficient appliances, unavailability of information
2. Rainwater harvesting (*Better and safer use of technology in areas with scarce water resources*)	
3. Wastewater treatment and reuse (*Wastewater treatment plants for agglomerations with > 10,000 inhabitants by 2025;widespread reuse*)	
4. Reduction of losses, detection and reparation of damages in water supply systems (*Half current losses in water supply systems by 2025*)	
5. Use of water efficient appliances (*Elimination of inefficient appliances from the market by 2025*)	
PUBLIC HEALTH	
1. Strategy and action plan for prevention and mitigation of impacts (*Preparation of strategic documents, improvements in data availability*)	
2. Control of drinking water (*Halve the share of population that is currently not covered by regular drinking water control programmes by 2025*)	• Lack of data and knowledge on expected effects of climate change and impacts on health • Insufficient cooperation and exchange between EPA, HMIand health system • Irregular control of drinking water from local water supply systems, wells and other individual solutions • There is no system for supervising new and prospective diseases • Insufficientcapacities of relevant services: lack of staff, especially of medical doctors, inadequate equipment and technical means • Knowledge on operating under changed climate conditions is lacking
3. Strengthening supervisions and control of infectious diseases (*Establish the system for supervising new and prospective diseases*)	
4. Medical research (*Transfer of knowledge from other countries, planning and implementation of priority medical research on health impacts of CC*)	
5. Strengtheninghealth sector capacities, especially in emergency services (*Capacity building for adequate response to health challenges caused by CC*)	
AGRICULTURE	
1. Sprinkler and drip irrigation (*Irrigation systems on some 50% of suitable areas or 35,000 ha by 2025*)	• Reduced availability of water in the future • Relatively high investment costs for advanced irrigation systems (dripping), lack of incentives • Lack of information on the ground, insufficient advices • Weak information basis (registers) on agricultural producers, soil fertility and manure application • Lack of knowledge on soil management under climate change conditions, insufficient cooperation (in the country and with international research centres) • Inadequate control of the use of artificial fertilisers,
2. Adequate manure use and soil fertility control (*Enhancing the system for soil fertility control and adequate manure use*)	

AGRICULTURE	
3. Combined agricultural production (*Strengthening support system for development of combined production as a form of adaptation to climate change*) **4. Practical training for producers** (*Advancement and expansion of existing programmes*)	insufficient use of organic and lack of experience with micro-biological manures • Undeveloped associations of producers • There are social and cultural barriers that slow down acceptance of new knowledge and skills • Climate change concerns are not sufficiently integrated into support and training programmes for transfer of knowledge • Local knowledge and specificities are not paid enough attention in trainings for producers
FORESTS	
1. Implementation of sustainable forest management practices (*Improving management and implementing protective measures in order to improve resilience of forests to CC*) **2. Sustainable forest management planning** (*Enhancing the system for management planning in order to mitigate future negative impacts of CC on forest ecosystems*)	• Limited capacities of all the stakeholders to apply new approaches, limited research capacities • Limited awareness on the necessity of sustainable management • Short-term benefits take precedence over long-term sustainable management • It is necessary to adjust techniques and methods for forestry planning to local conditions • Difficulties with inclusion of private forests into planning • Market for wood products of lower value is not developed • Weak control of forest exploitation, non-enforcement of regulations and plans in carrying out concession contracts • Lack of information to support application of modern technologies, lack of knowledge on climate change • Insufficient inter-sectoral cooperation
COASTAL AREA	
1. Integrated management(including set-back line) (*Establish ICZM system – legal and institutional framework – and define set-back line in accordance with Barcelona Convention requirements in the next 5 years)* **2. Protection and restoration of wetlands** (*Enhancing the system for protection of valuable wetland ecosystems*) **3. Systematic observation and monitoring of changes in the coastal area** (*Development of comprehensive and reliable information system by 2025 and establishment of continuous monitoring of coastal processes*)	• Insufficiently developed legal and institutional framework • Low awareness on CC impacts • Pressures to build in the immediate vicinity of the coastline and in sensitive areas • Conflicting regulations and competencies • Inadequate capacities at national and local levels • Spatial planning system does not integrate CC risks • Lack of awareness on importance of wetlands • Lack of systematised baseline data on sea and coastal area and their limited availability • Lack of projections on trends caused by CC • Insufficient local expertise

Lack of detailed knowledge and information on vulnerability and the most appropriate responses to climate change together with insufficient capacitieshave been recognised as the most important barriers for deployment of adaptation technologies and measures. The scale in which internationally known modern adaptation strategies and measures are used and adjusted to local conditions is unsatisfactory. Weak organisation, lack of coordination and cooperation between responsible institutions and other actors are also emphasised as a significant problem in different sub-sectors, along with insufficient level of supervision over implementation of regulations. Similar to the situation with mitigation technologies, lack of awareness represents another significant limitation. For technologies and measures which encompass certain activities on infrastructure development (e.g. establishment of information systems, interventions on water supply and waste water treatment systems, application of irrigation systems, enhancement of technical equipment etc.), lack of financial resources represents an exceptionally important barrier.

Objectives for deployment of adaptation technologies and measures mainly refer to the period until 2025. The have been set based on the existing conditions and discussions of the TNA participants on possible and necessary improvements in order to reduce vulnerability to climate change and ensure achievement of development goals under changed climatic conditions.

Final results of the TNA process have been formulated through the discussions on the final workshop and amendments of materials from the preparatory meetings (held in May 2012). At the same time, decisions needed to finalise national strategy and action plan for acceleration of technological innovations for climate and development goals have been made. **Constituent parts of TNA strategy for Montenegro** are:

1. Portfolios of priority technologies for emission reductions and adaptation with costs and benefits;

2. Objectives or aspirational levels of deployment of individual technologies; and

3. Set of measures to accelerate transfer, deployment and diffusion of technologies (action plan for the implementation of strategy was derived from those).

Key recommendations for national level strategic decision making (i.e. for implementation of TNA strategy) are elaborated in the following paragraphs. In addition, a number of projects the realisation of which would make a strong impetus for strategy and action plan implementation are listed, as identified by the TNA participants. Finally, some general considerations on strategy implementation and financing are provided.

Analyses conducted in the TNA process recommend solar technologies as a high priority for energy sector (energy supply and consumption in residential and service sectors), which is responsible for half of the total emissions of greenhouse gases. Solar water heating systems have been prioritised as a technology that helps achieve significant energy savings. In the energy supply sub-sector TNA objective has been set at 100 MW of installed capacity for solar photovoltaic panels and solar thermal power plants at the end of 25 years. TNA recommends acceleration of deployment of these technologies which are now at the very beginning[19] or, as is the case with solar thermal power plants, non-existent, since they have significant potential and have not been paid sufficient attention in the so far policies.

If adequate support is provided for their application, solar sources and small hydropower plants (TNA objective for SHPPs has been taken over from innovated Energy development strategy) would have installed capacity of around 200 MW at the end of 25 years period, which is close to current capacity of TPP Pljevlja and is slightly below one fourth of the total installed capacity in the country. By applying these technologies, emissions would be reduced for more than 15 Mt of CO_2 equivalent, which is roughly three times the total annual emissions (counting the 2009 level). Necessary investments (not taking into account expected lower prices of solar technologies over the time) are in the range of € 26 million a year.

Together with application of technologies for efficient use of energy that have been prioritised in the TNA process (insulation of buildings, use of efficient air conditioners, automated energy management in buildings) and of other EE measures and technologies, such development in the energy sector would significantly contribute to a decrease of dependence on energy imports but also to fulfilment of other, very important goals such as harmonisation with the EU climate policy, increase in EE and competitiveness, market development and employment, reduction of pollution and improvements in the quality of housing conditions, and others. On the other hand, meeting the climate and especially the EU goal of reducing CO_2 emissions for 80 - 95% until 2050 can hardly be guaranteed if solutions such as development of second block of TPP Pljevlja are opted for in energy sector development. Likewise, mobilisation of necessary financial resources for incentives for EE and RES technologies can hardly be achieved if support (through direct or indirect subsidies) for energy and emission intensive industries such as aluminium production is continued. Large hydropower plants were not included in TNA strategy (even though their potential for emission reductions is significant and undisputed) due to negative environmental impacts and some controversies that have followed so far plans for development of these facilities.

Plasma technology has been prioritised in the category of long term technologies in energy supply sub-sector despite some uncertainties (related to its applicability, environmental impacts and similar) and very high costs. It was assessed this option should be further examined, primarily due to the fact it has a potential to generate significant benefits not only for energy generation but also for waste management (resolving the problem of final disposal of waste).

As for the TNA strategy in road transport sub-sector, it is based on public transport improvements and development of alternative transport modes (such as cycling, for example), with gradual introduction of technological solutions for vehicles and traffic regulation that substantially contribute to emission reductions.

Introduction of TNA prioritised technologies into Aluminium plant Podgorica would be, when it comes to emission reduction, the most cost effective intervention since it would lead to substantially reduced emissions (for 3.5 Mt) with relatively low investment (€ 28 million over the course of 25 years). If the plant continues to operate, improvements in the existing technological processes or introduction of new technology are an obligation APP will have to fulfil in the future under the Law on integrated pollution prevention and control (which requires use of best available technologies). Current decommissioning of cells[20] due to restricted electricity supply and financial losses further complicates situation and it is questionable whether it will be possible to put these cells back into operation (due to exceptionally high costs of re-instigating decommissioned cells) or will it be necessary to construct new ones. In case a long-term sustainable solution for the plant is found and it continues operating,

TNA recommendation is to, as a minimum, introduce proposed (Table 6-1) technological measures and thus ensure substantial emission reduction.

TNA strategy for priority adaptation sub-sectors is complementary with relevant sectoral policies and goals and is mainly based on technologies and measures that will:

[19] According to the results of 2011 population census, for example, only 109 out of the total number of 247,000 housing units have had the equipment for solar energy utilisation. Montesol project that is being implemented since last year provides favourable conditions for instalment of solar collectors; so far, around 100 households have used this support. There is also a programme of support for instalment of solar equipment at remote mountain summer cottages (where the state finances 70% of the total cost of installation).

[20] According to media reports, almost 50% of all cells has been decomissioned as of October 2012.

• Contribute to rational use of water and preservation of water quality;

• Strengthen public health sector to provide adequate responses to negative health impacts of climate change;

• Contribute to preservation of agricultural land quality and help agricultural producers to sustain production and adapt to changed climatic conditions;

• Improve planning and management of forests in order to increase their resilience to climate change;

• Strengthen structures and develop instruments for integrated management in the coastal area.

TNA strategy can be implemented i.e. priority technologies can be deployed at desired level only if systematic support measures are carried out as detailed in the action plan. Cross-sectoral measures that should be paid special attention are:

• Fiscal (lowering of VAT and customs rates) and financial (subsidies, favourable loans) incentives;

• Awareness raising and educational campaigns (changing people's mind sets);

• Trainings to transfer and disseminate necessary specialists knowledge and skills;

• Discouraging unsustainable behaviours (by adopting and implementing appropriate instruments, regulations and standards);

• Improved cooperation and coordination among competent institutions as well as with other stakeholders (private sector, scientific and research community, civil society);

• Enhancing databases and information systems;

• Conducting studies, analyses and research for better understanding of implications of climate change for economy, society and the environment.

In addition to the recommendation of paying special attention to cross-sectoral measures, a number of pilot/demonstration projects (at the level of project ideas) has been identified and recommended in the TNA process. Realisation of these projects is seen as a way to strongly contribute to the implementation of strategy and action plan. Proposed projects are:

Organisation of workshops and preparation of manuals for making and installing solar collectors (while integrating guidelines for protection of space and the environment)

Mojkovac as a pilot municipality for achievement of climate and development goals by using RES and EE technologies: preparation and implementation of several small scale projects (small HPP on gravitational water supply system, efficient public lighting, solar and other RES technologies for supplying electricity to remote households not connected to grid, and similar) that would have a demonstration character and are recognised in the local Green agenda; researching possibilities for construction of solar thermal power plant at the location of restored mining tailings

Feasibility study for development of bike lanes in Podgorica with proposal of the most feasible solutions (pilot lanes) in accordance with existing spatial plans

Pilot project for using electric vehicles/buses in public transport with mobile charging stations with solar panels

Preparation of pollination map, including survey of the existing conditions (measurements and organisation of data), strengthening of cooperation among expert services (health, meteorological, forestry, spatial planning) and creation of preconditions for prevention and treatment of pollen related illnesses

Analysis and assessment of vulnerability of agricultural producers for extreme weather conditions and climate change in general

Preparation of study on coastal area wetlands (significance for reduction of vulnerability to CC in coastal area, links with Natura 2000, degree to which they are endangered and necessary protection measures)

Research on vulnerability of different types of forests to climate change

Adoption of national climate policy and systematic integration of climate change concerns into sectoral policies are very important for the **implementation of TNA strategy and action plan.** On the other hand, TNA represents a significant contribution to both of these processes (formulation of climate policy and integration into sectoral) because it offers concrete analyses and parameters which can be used by decision makers to evaluate different alternatives and opt for appropriate solutions. The EU integration process will represent an important impetus for the implementation of TNA strategy and action plan since TNA results are based on the same premises as the European climate change mitigation and adaptation policies. Implementation of TNA results and recommendations will have synergetic effects for a range of national policies and programmes, such as, for example, recently adopted objective of 33% share of renewable sources in total energy consumption and energy efficiency programmes. A very important role for the TNA implementation is also played by transfer of internationally available knowledge through networking and cooperation on all levels, including local (cooperation of municipalities with corresponding partners in other countries) and the level of scientific and research centres. It is also necessary to mobilise local knowledge as an important resource and to apply it in a way that serves the function of acceleration of technology deployment.

As for **financing of the deployment of priority TNA technologies and action plan**, a strong and unambiguous state support is needed, both through provision of financial incentives and participation in project funding, as well as through adequate policy making and implementation. Local self-governments are also in a position and need to contribute, within the limits of their competencies.

Mobilisation of financial resources of the private sector is exceptionally important, and can be done, among other ways, through public private partnerships and through creation of favourable conditions for investments. International climate funds and bilateral assistance represent yet another channel for raising part of the necessary funds for deployment of TNA technologies. International financing institutions (especially EBRD) are also important.

After objectives and barriers aggregated by sectors/sub-sectors have been confirmed, participants of the final workshop considered (then) proposed action plan with priority measures and their characterisation (description, responsibilities, estimated costs for implementation of measures etc.).

Suggestions provided were used to finalise **TNA action plan**, which in addition to prioritised contains other identified measures, and which has been, in line with suggestions from the final workshop, amended to include recommendations for monitoring and evaluation at the sub-sector level. While defining TNA measures, every effort was made to ensure they are sustainable and effective, and that there is no incompatibility among them. Final TNA action plan in a table format is included in the Annex 1.

7 Conclusions and recommendations

TNA Montenegro process and results presented in this document have emerged from a series of activities organised in the period May 2011 – October 2012 with the aim to inform about and involve all the stakeholders in the assessment of priority needs for technological innovation, solutions, knowledge and approaches for reducing the emissions of greenhouse gases on one, and reducing vulnerability of natural and socio-economic systems to expected changes of the climate on the other side.

Identification of development priorities in the context of climate change and of priority sub-sectors for mitigation and adaptation were the initial steps in the process. The next step referred to identification of appropriate mitigation and adaptation technologies and measures.

Prioritisation of technologies/measures within different categories (from short term/small scale technologies to medium to long term/large scale ones) was conducted based on estimated costs and contributions to emission and vulnerability reductions, as well as based on participants' assessments of benefits that would be generated by their application. Technologies were assessed for several criteria including contribution to climate and sustainable development goals. TNAssess programme was used as technical support for prioritisation of a certain number of technologies.

In the final stage of the TNA process objectives were set and measures identified for creation of favourable environment for deployment of priority technologies. These activities marked completion of work on the national strategy and action plan for acceleration of technology deployment. Measures included in the action plan were defined as responses to barriers which currently slow down or prevent transfer, deployment and diffusion of new technologies and approaches.

Methodology and recommendations of the new TNA Handbook (prepared in 2010 by UNDP under the auspices of UNFCCC) were used to conduct TNA Montenegro. Experiences with the application of the new Handbook in Montenegro can be summarised in the following way:

• TNA methodology represents a solid framework for systematic implementation of the process with clear links between various process stages;

• Methodology proposed in the TNA Handbook is not always easy to follow in an environment where a wide range of stakeholders is working together;

• Application of TNA methodology in Montenegro has been made more difficult because of uncertainties and lack of information that were particularly pronounced for adaptation sub-sectors; these have hindered quantification of certain elements and made assessment of benefits less precise;

• Introduction of multi criteria decision analysis (MCDA) in the procedure of technology assessment has given a new quality to the entire process and offered a possible model for further consideration of sustainable development options in the country;

• Tools and information sources recommended in the Handbook (such as the ClimateTechWiki database and TNAssess) have facilitated the process, especially when it comes to mitigation technologies; at the same time, the need to improve information and technical solutions for supporting the process have been identified;

• Flexible approach and adjustment of certain recommendations from the Handbook to local conditions, participants in the process and available time and information is necessary.

TNA process has contributed to awareness raising on climate change in Montenegro and represents an important source of information for further steps in formulating and implementing climate policy. Analyses done through TNA Montenegro go a step further compared to relevant considerations from the National Communications as they discuss certain issues in a more specific way and propose solutions for low emissions and low vulnerability development. The process has also demonstrated importance of participation of different stakeholders for generation of additional knowledge and information and for the quality of overall results. TNA results encapsulated in the strategy and action plan can be used to support preparation of documents such as Second National Communication, National Sustainable Development Strategy (the review of which is forthcoming), NAMAs and NAP.

TNA document informs decision makers on advantages and disadvantages of different approaches and on implications of climate change for future development. At the same time, portfolio of priority technologies is recommended to relevant institutions, together with the action plan for acceleration of their deployment. It is up to the government to make choices regarding the manner and dynamics of implementation of TNA recommendations based on available administrative, technical and financial capacities. TNA also defines a set of actions and measures where stakeholders other than administration have the key role in their implementation.

Majority of technologies prioritised in the TNA process are short term technologies, which means that they are well known commercial technologies present at markets. Systematic effort for creation of enabling environment is necessary if deployment of these technologies is to be accelerated. At the same time, importance of research and development has been emphasised for transfer and diffusion of technological innovations as a necessary element for deployment of certain short term (pertaining to further research of potential, collection of data and vulnerability assessments, the need to adjust to local conditions and similar) and especially for medium to long term technologies.

TNA strategy and action plan complement several of the current programmes and projects in the areas of climate, energy and other policies and a growing number of initiatives to direct country's development towards low-carbon technologies and green economy. At the same time, TNA Montenegro indicates that attainment of development, climate and EU integration goals is possible if the so far practices of favouring emissions and energy intensive project and solutions is modified and support redirected towards new technologies that contribute to achievement of sustainable development goals and generate higher total benefits.

Having in mind conducted process and considering overall conditions it is possible to single out the following recommendations for the TNA implementation:

• Climate change concerns and results of TNA process should be integrated into sectoral policies and strategies; integration of TNA results with other UNFCCC processes such as national communications, NAMAs and NAP are of particular importance;

• Presentation and promotion of the key TNA recommendations and results is needed; Ministry of Sustainable Development and Tourism should play a lead role in pointing out the climate change issues and the need for their thorough consideration in preparing development plans and programmes;

• Climate and sustainable development goals can be achieved through coordinated efforts, despite limited administrative and other stakeholders' capacities;

• Integrated approach is needed in stimulating application of EE and RES technologies and measures;

• Inter-sectoral cooperation has an important role for the implementation of TNA strategy and action plan; it can be stimulated and developed through appropriate forums for continued discussions on priority technologies;

• National Council on Sustainable Development can give an important contribution to improvements in inter-sectoral coordination and cooperation; continuation of work of the Steering Committee established under the TNA project and expansion of this body to include representatives of the Ministry of Finance could also serve as a forum to support implementation of TNA strategy and action plan;

• Continuous processes on capacity development at all levels are necessary;

• It is necessary to make additional efforts and ensure commitment of key stakeholders so the TNA would not remain just on paper; providing the needed funding for implementation requires modification of the so far state policies and active participation of all the stakeholders;

• It is necessary to improve availability of advices and examples of good practices for planning and implementing adaptation technologies/measures;

• Transfer of knowledge through networking and cooperation (including cooperation between local self-government units, scientific and research institutions and representatives of civil sector within the country and on international level) also represents an important condition for implementation of TNA results.

8 Annex 1: TNA action plan for creation of enabling environment and acceleration of technologies deployment

GENERAL ABBREVIATIONS USED IN MITIGATION SUB-SECTORS AND MEANING OF COLOURS

R&D = research and development
Depl = deployment
Diff = diffusion
PPP = public private partnership
RES = Renewable energy sources
EDS = Energy development strategy

Colour	*Group of strategic measures*
	Establishing networks of users/ stakeholder groups
	Policies and measures/ instruments
	Behaviour and organisational changes
	Market, system support and financial services
	Training and education
	International cooperation and intellectual property rights

Abbreviations used for the energy consumption sub-sector

Technologies
SWH = Solar water heating system
IB = Insulation of buildings
EAC = Efficient air conditioners
A = Automated energy consumption mngt

ME = Ministry of economy
MSDT = Ministry of sustainable development and tourism

Sub-sector: Energy consumption	Techn (abbr)	Stage			Description	Time scale (yrs)			Responsibility	Costs (€)
Strategic measures by group		R&D	Depl	Diff		5	10	15		
Priority measures										
Regulating waste disposal and recycling (obligations of different actors in product cycle management)	SWH, EAC				Adoption of appropriate regulations, implementation				MSDT, importers, installers	53,000
Energy-labelling for buildings	IB, SWH				Development of capacities of auditors, process acceleration, criteria widening (EU)				ME, MSDT, local self-governments	300,000
Development of standards for products, materials and execution of works; adjustment of standards to local conditions	IB, SWH				Consultations, development and adoption of standards				ME, MSDT, Standardisation Institute, associations, international bodies	250,000

Quality control/ implementation of standards; improved inspection	IB, SWH				Strengthening the capacities of relevant inspections, fostering the role of associations				ME, MSDT, local self-governments	225,000
Alleviation of burden related to the issuance of permits and other administrative procedures	SWH, IB				Consultations and definition of alleviations				Local self-governments, MSDT	50,000
Effective information campaigns (direct contact) and promotion (positive examples, confidence building)	SWH, IB				Project specific and general campaigns				ME, civil society (NGO and media), users	250,000
General awareness raising activities (including activities through educational system - children as a primary target group)	SWH, IB, EAC, A				Development and implementation of educational programs for kindergartens and schools				ME, MSDT, Ministry of education, non-governmental sector	195,000
Demonstration projects	SWH				Identification of technology "champions", dissemination and use of information on advantages/ benefits				ME, local self-governments, international organisations, civil society (NGO and media)	136,000
Financial incentives (VAT and import tariffs reductions or exemption, subsidies) for deployment of technologies	SWH, IB, EAC				Analysis of possibilities, adoption of regulations and their implementation				Ministry of finance, ME, MSDT, local self-governments	15,000
Research and studies on possibilities of applying automated energy management in buildings	A				Defining terms of reference, engagement of consultants, preparation of studies				ME, MSDT	60,000
Market development (offer and demand) and training of market chain participants	A				Analyses, stimulating activities, incentives				ME, MSDT	45,000
Trainings for equipment designers, distributors and installers	SWH				Preparation and implementation of training programmes				ME, associations and chambers of economy	125,000
Education of construction workers/ staff; training for developers that execute insulation works	IB				Revision and amendments to the current programs for vocational schools; preparation and implementation of the training programmes for developers				ME, Ministry of education, MSDT, associations and chambers of economy	255,000

Enabling transfer of knowledge and information	SWH, A				Continuous cooperation with countries with advanced technology application; information exchange and cooperation especially relevant for decision makers				ME, MSDT, associations and chambers, international organisations	150,000
Help with obtaining licences for installers	SWH				Support and negotiations				ME, economic associations, international organisations	50,000
Other identified measures (non-characterised)										
Networking, participation in international networks	SWH, A									
Development of LED standards for design	SWH									
Regulations on mandatory use of SWH in the future	SWH									
Develop appropriate regulatory system (regulations/ obligations) for automated energy mngt	A									
Develop PPPs as a models to encourage use of automated energy mngt in public buildings	A									
Dissemination of information on advantages of automated energy mngt (investments return rate for different types of buildings, demonstration of advantages for building owners)	A									
Incentives for domestic production (favourable loans)	SWH									
Development of systems for adequate disposal and recycling at the end of life cycle	SWH, EAC									
Introduction of home appliances adjusted to automated energy management systems	A									

Development of necessary professions and skills through the education system	SWH									
Incentives for domestic production (help with license obtaining)	SWH									
Monitoring and evaluation for the energy consumption sub-sector										
The key indicators to monitor and evaluate implementation of TNA action plan for energy consumption sub-sector are: 1) number of housing units and commercial premises with SWH systems; 2) estimated share of insulated buildings in the total stock of housing and commercial objects; 3) number and description of labelling schemes (buildings, appliances) applied in the country; 4) number of demonstration project and awareness raising campaigns for TNA prioritised technologies; 5) existence of and level of fiscal and financial incentives for TNA technologies; 6) number of buildings with automated energy consumption management.										

Abbreviations used for the energy supply sub-sector

Technologies
SHP = Small hydropower plants
SPV = Solar photovoltaic panels
STPP = Solar thermal power plants
PL = Plasma technology

ME = Ministry of economy
MSDT = Ministry of sustainable development and tourism
MARD = Ministry of agriculture and rural development
EPCG = Electric power company of Montenegro
EPA = Environmental Protection Agency
HMI = Hydro-meteorologicalInstitute

Sub-sector: Energy supply		Stage				Time scale (yrs)				
Strategic measures by group	Techn (abbr)	R&D	Depl	Diff	Description	5	10	15	Responsibility	Costs (€)
Priority measures										
Adoption and implementation of regulations on minimum water flows for ecosystems protection	SHP				Collection of data, measurements, transfer of experience from other countries, adoption of regulations				MARD, MSDT, ME, HMI, non-governmental sector	45,000
Improving administrative procedures for construction of SHP, clear definition of steps (energy permits, spatial planning, issuance of water use concessions, etc.)	SHP				Inter-sectoral cooperation, capacity building				ME, MSDT, MARD	175,000
Stimulating tariffs (feed-in tariffs) for electricity from RES	SHP, SPV				Analysis of possibilities, adoption of a dynamic plan for progressive and stimulating tariffs followed by necessary regulations				ME, Regulatory agency, non-governmental sector, EPCG	35,000
Harmonisation of strategic documents (EDS and Network Development Plan) and transfer of relevant parameters to other documents/ lower- ranking plans	SHP, SPV, STPP				Analysis of the existing documents and plans, coordination, alignment				ME, MSDT, MARD	25,000
Unambiguous and active state support for deployment of new technologies for energy generation in line with EU policies	SHP, SPV, STPP				Defining state position, advocacy at international level and application in other national policies				Government, National sustainable development council	no additional costs
Regulate conditions for development of STPP in detail, including definition of purchase prices for generated energy	STPP				Adoption of regulations				ME, Regulatory agency, MSDT, non-governmental sector	35,000
Replicate good international and national experiences, apply lessons learnt from related initiatives	SPV, STPP				Identification of examples of good practise, study visits; analysis of reasons for limited success of related initiatives				ME, local self-governments, international organisations, civil society (NGO and media)	195,000
Improvements in waste management system (collection, data)	PL				Organizational improvements in waste collection system, establishment of information system				MSDT, local self-governments, EPA	390,000
Improvement of coordination and cooperation between institutions, strengthening supervision/ inspection	SHP, SPV				Strengthening institutional capacities, particularly for inspections				ME, MARD, MSDT, EPA, local self-governments	150,000
Research and development, better availability of data (locations for SHP, available potential/ flows, limitations)	SHP				Defining terms of reference, engagement of consultants, field work				ME, Ministry of science, academic community, HMI, private sector (interested investors)	280,000

Information and demonstration projects	SPV				Identification of technology "champions", dissemination and use of information on advantages/ benefits				ME, local self-governments, international organisations, civil society (NGO and media)	135,000
R&D, further examination of potential for STPP and cost benefit analyses for possible projects	STPP				Defining terms of reference, engagement of consultants for assessments and plans for STPP and preparation of preliminary documentation				ME, local self-governments, academic community, international organisations	230,000
Further examination of plasma technology, identification of needs for adaptation to local conditions	PL				Analyses, preparation of the studies, study visits				ME, MSDT, academic community	50,000
Feasibility studies for Montenegro with respect to plasma technology	PL				Defining terms of reference, engagement of consultants and preparation of feasibility study				ME, local self-governments, academic community, international organisations	180,000
Fiscal and financial incentives (VAT and import tariffs reductions or exemption, subsidies) for deployment of technologies	SHP, SPV, STPP				Analysis of possibilities, adoption of regulations and their implementation				Ministry of finance, ME, MSDT, local self-governments	25,000
Development of financial instruments for RES investments	SHP, SPV, STPP				Analysis of internationally and nationally available favourable sources of financing for RES; national strategy and RES financing guide				ME, MSDT, international organisations and financial institutions; international and domestic banks	90,000
Preparation of STPP pilot project (Mojkovac mining tailings site)	STPP				Preparation of terms of reference, engagement of consultants				ME, MSDT, Mojkovac Municipality, international organisations	180,000
Strengthening capacities for design and development of preparatory project documentation, including impact assessments	SHP, STPP				Seminars, trainings, study visits; cooperation and transfer of experiences from other countries				ME, EPA, MARD, local self-governments, consultants	200,000

Development of capacities for connected SPV and STPP	SPV, STPP				Seminars, trainings, study visits; cooperation and transfer of experiences from other countries				ME, economic associations, particularly equipment importers and installers	80,000
Partnership (licences for technology deployment) and foreign investments	STPP				Cooperation and negotiations				ME, local self-governments	25,000
Other identified measures (non-characterised)										
Networking, participation in international networks	SPV									
Preparation of required plans and strategic documents for STPP	STPP									
Regulations on waste disposal and recycling	SPV, STPP									
Avoidance of bad practices which demotivate investors	SHP, STPP									
Selection of suitable locations for STPP (marginal areas) - integrated approach	STPP									
Incentives for equipment producers and generation of new jobs	SHP, SPV									
PPP between local authorities and private sector for SHP	SHP									
Grid improvements (including steps towards development of smart grids) and facilitation of connections for all RES	SHP, SPV, STPP									
Recycling market development	SPV, STPP									
Enhancement of Montenegrin energy system interconnections with neighbouring countries	SHP, SPV, STPP									
Procurement of licences, negotiations about intellectual property rights protection for plasma technology	PL									

Transfer of experiences from other countries	SPV, STPP									
Monitoring and evaluation for the energy supply sub-sector										
The key indicators to monitor and evaluate implementation of TNA action plan for energy supply sub-sector are: 1) number of housing units and commercial objects with solar photovoltaics; 2) levels of purchase prices for electricity generated from RES; 3) installed capacity for solar technologies and small hydropower plants in the country; 4) number of demonstration project and awareness raising campaigns for TNA prioritised technologies; 5) existence of and level of fiscal and financial incentives for TNA technologies; 6) information on applicability of plasma and solar thermal power plants technologies.										

Abbreviations used for the road transport sub-sector

Technologies/ measures

PT = Public transport improvements
LPG = Liquefied petroleum gas
BL = Bike lanes
EV = Electric vehicles
H = Plug-in hybrids
ITS = Intelligent transport system

MTMA = Ministry of transport and maritime affairs
MSDT = Ministry of sustainable development and tourism
ME = Ministry of economy

Sub-sector: Road transport	Techn	Stage				Time scale (yrs)				
Strategic measures by group	(abbr)	R&D	Depl	Diff	Description	5	10	15	Responsibility	Costs (€)
Priority measures										
Development of strategy for public transport promotion, improvements in transport policy (including route plan)	PT				Collection of data, consultations, preparation and adoption of documents				MTMA, local self-governments, carriers associations, MSDT	25,000
Regulate the market for LPG use in vehicles (standards, licencing of installers, LPG quality) and improve control	LPG				Adoption of regulations and strengthening of capacities of relevant inspections				ME, MTMA, private sector (associations)	28,000

Improvement of infrastructure (bike lanes, parking areas, bicycle usage counters)	BL				Preliminary studies and incentives for construction of lanes and development of other conditions to encourage the use of bicycles in bigger towns; integration into spatial plans				Local self-governments, MTMA, MSDT, international organisations	190,000
Use public procurement system as a mechanism for stimulating and promoting the use of electric vehicles and plug-in hybrids	EV, H				Prepare advices/ instructions to give priority to electric vehicles and hybrids in public procurement procedures whenever possible; if necessary, make changes of relevant regulations				Public procurement administration, MTMA, Ministry of finance	no additional costs
Introduce alleviations for registration and use of electric vehicles and plug-in hybrids	EV, H				Analysis of possibilities, defining alleviations and adoption of appropriate regulations				MTMA, Ministry of interior, MSDT	15,000
Adopt appropriate policy/ strategy as a framework for establishment of ITS	ITS				Collection of data, consultations, preparation and adoption of documents				MTMA, Ministry of interior, Ministry of finance, MSDT	25,000
Organizational and technical improvements in public transport (intercity transport, in bigger towns); develop an on-line router	PT				Improvements related to timetable and punctuality, service quality, access to information, bus stops etc., including preparation of online router for public transport				Local self-governments, MTMA, private sector/ carriers	470,000
Promotion of non-motorized transport	BL				Discouraging the use of vehicles in certain areas (e.g. restriction of parking possibilities in city centres, one-way streets, etc.)				Local self-governments, MTMA, Ministry of interior, civil society (NGOs, media)	40,000
Subsidies and fiscal incentives for procurement of low emission vehicles (including electric vehicles) for public transport and taxi services	PT, EV				Analysis of possibilities, defining subsidies and incentives, adoption of appropriate regulations				MTMA, Ministry of finance, local self-governments, carriers associations	17,000
Introduction of incentives for application of LPG (financial alleviations, administrative incentives)	LPG				Analysis of possibilities, defining incentives and adoption of appropriate regulation				MTMA, Ministry of finance, Ministry of interior, local self-governments	15,000

Develop market (LPG supply network, installers)	LPG				Promoting and stimulating the use of LPG in vehicles				Private sector (fuel distributors, equipment installers), ME, MTMA	90,000
Introduce tax reliefs to reduce the price of electric vehicles and plug-in hybrids; introduce incentives for importers/ distributors	EV, H				Analysis of possibilities, defining tax reliefs and incentives for distributors and buyers of vehicles				Ministry of finance, MTMA, associations of distributors	35,000
Provide missing elements for the basis for establishment of intelligent transport system (data collection, research etc.)	ITS				Defining required information, data collection, defining and implementing the necessary research				MTMA, Transport directorate, Monteput, academic community, local self-governments	230,000
Educational programs for cycling (at schools and for the public); educational programs on public and low-emission transport	BL, PT, LPG, EV, H				Enhancement and carrying out of educational programs for schools and general public				Ministry of education, MTMA, MSDT, civil society (NGOs and media)	230,000
Training of staff, ITS capacities development	ITS				Seminars and trainings, study visits				MTMA, Transport directorate, local self-governments	60,000
Securing financial support (donations, favourable loans, partnership schemes and pilot initiatives) for vehicle fleet renewal, including introduction of electric vehicles and hybrids	PT				Cooperation with international organisations and producers, development and implementation of support programs				MTMA, local self-governments, carriers' associations, MSDT	45,000
Other identified measures (non-characterised)										
Restricted import of old vehicles (minimum Euro 3)	PT									
Raising awareness on advantages of public transport	PT									
Promotion of low emission transport modes (railway) in intercity transport	PT									
Information and promotion of LPG use, particularly for public transport	LPG									
Promotion and raising awareness of users and particularly distributors of electric vehicles and plug-in hybrids	EV, H									

Achieve better compliance and coordination (between plans, institutions/ different actors in transport system)	ITS									
Develop battery recycling system	EV, H									
Develop battery charging infrastructure	H									
Enhancements in the transport system (infrastructure, equipment at roads)	ITS									
Monitoring and evaluation for the road transport sub-sector										
The key indicators to monitor and evaluate implementation of TNA action plan for road transport sub-sector are: 1) numbers of passengers in public transport; 2) level of penetration of low-emission vehicles in private and vehicle fleets of transport service providers (carriers in public transport, taxi services); 3) number of car sales establishments marketing electric and hybrid vehicles; 4) share of vehicle fleet with LPG fittings; 5) number and length of bike lanes; 6) share of transport system (cities, areas, roads) covered by intelligent transport system.										

Abbreviations used for the aluminium production sub-sector

Technologies

E = Increasing efficiency
PFS = Point-feeding system
IA = Inert anodes

APP = Aluminium Plant Podgorica
ME = Ministry of economy
EPCG = Electric power company of Montenegro
MSDT = Ministry of sustainable development and tourism
EPA = Environmental Protection Agency

Sub-sector: Aluminium product.		Stage				Time scale (yrs)				
Strategic measures by group	Techn (abbr)	R&D	Depl	Diff	Description	5	10	15	Responsibility	Costs (€)
Priority measures										
Specifying conditions under which APP uses electricity	E, PFS, IA				Defining long-term pricing policies for electricity for APP				ME, APP, EPCG	no additional costs
Deciding on APP's future, harmonisation of goals, better coordination and compliance with regulations	E, PFS, IA				Negotiations and decision-making; strengthening of capacities, particularly inspection				Government of Montenegro, APP, ME, MSDT, EPA	90,000

Adoption of action plan to regulate disposal of solid waste that would remain from the current anode production	IA				Preparation and adoption of the document				APP, MSDT, EPA, consultants	25,000
Rearrangement of the current technology for anodes, with a possibility to use some of the old production lines	IA				Preliminary studies and analyses				APP, academic community/ consultants	35,000
Securing financing sources	E, PFS, IA				Preparation of financing plan, negotiations with potential financiers				APP, ME, Ministry of finance	17,000
Technological research in cooperation with the national scientific research community (alternatively: purchase of licences)	E, PFS, IA				Analyses and studies for application of technologies, defining technological solutions				APP, academic community/ consultants	270,000
Training and certification for equipment installers	PFS, IA				Seminars and practical training				APP, designers or producers of technologies	40,000
Training technical and operational staff to work with the new technologies	E, PFS, IA				Seminars and practical training				APP, designers or producers of technologies	85,000
International cooperation for provision of licences	E, PFS, IA				Cooperation, transfer of knowledge and experiences, ensuring required licences				ME, APP	25,000
Other identified measures (non-characterised)										
Campaigns for raising public's awareness on importance of technological interventions aimed at reducing APP's dependence on energy and improvement of competitiveness	E, PFS, IA									
Monitoring and evaluation for the aluminium production sub-sector										
Implementation of TNA action plan in aluminium production sub-sector can be monitored and evaluated based on the pace (time frame) and degree (number of electrolysers) to which the APP is equipped with the three priority technological measures.										

GENERAL ABBREVIATIONS USED IN ADAPTATION SUB-SECTORS AND MEANING OF COLOURS

R&D = research and development
Depl = deployment
Diff = diffusion
PPP = public private partnership
CC = climate change
GIS = Geographic Information System

Colour	*Group of strategic measures*
	Establishing networks of users/ stakeholder groups
	Policies and measures/ instruments
	Behaviour and organisational changes
	Market, system support and financial services
	Training and education
	International cooperation and intellectual property rights

Abbreviations used for the public health sub-sector

Technologies/ measures

SAP = Strategy and action plan for CC and health
DWC = Drinking water control
IDS = Infectious diseases supervision
MR = Medical research
CB = Capacity building to respond to CC

MH = Ministry of health
HC = Health centres
PHI = Public Health Institute
HMI = Hydro-meteorological Institute
EPA = Environmental Protection Agency
MARD = Ministry of agriculture and rural development
MSDT = Ministry of sustainable development and tourism

Sub-sector: Public health Strategic measures by group	Techn (abbr)	Stage R&D	Stage Depl	Stage Diff	Description	Time scale (yrs) 5	Time scale (yrs) 10	Time scale (yrs) 15	Responsibility	Costs (€)
Priority measures										
Networking as a means for capacity development in the health sector	MR, CB				Participation in international networks and initiatives for exploring the impact of CC on health				MH, PHI, HC, academic community	120,000
Enhancing the information basis (data collection, research) for CC impacts on health	SAP				Collection and organization of the existing data, surveys, improvements in public health statistics				MH, PHI, HC, HMI, EPA	170,000
Development of capacities for quality response to negative impacts of CC on health, particularly under extreme conditions	SAP				Organizational enhancements, transfer of knowledge and information				MH, PHI, HC	90,000
Enhancing accessibility of information (publications, advices) related to protection of wells and the importance of controlling the quality of drinking water	DWC				Follow-up and improvements of the past practice of publishing the advices, development of more effective ways to transfer the knowledge to users				PHI, MARD, local self-governments	70,000
Campaigns aimed at raising awareness on the control of drinking water	DWC				Preparation and realization of campaigns				PHI, MARD, MORT, academic community, civic sector (NGO and media)	125,000
Enhancing cooperation and data exchange with other institutions and sectors (EPA, HMI)**; multi-sectoral approach** (cooperation with veterinary services, biologists, entomologists etc.) **especially important for IDS**	MR, IDS				Defining the needs, modes of reporting/ data exchange and coordination mechanisms; implementation				MH, PHI, HC, EPA, HMI, MARD, Veterinary administration, academic community	225,000

Integration of local water supply systems into regular monitoring of drinking water quality	DWC				Defining priority, developing capacities of water supply systems managers, securing the funds to subsidise DWC programmes for priority local water supply systems				MSDT, PHI, local self-governments, owners/ managers of local waters supply systems	170,000
Infrastructure development (information system) and collection of data needed for supervision and control of new and prospective infectious diseases	IDS				Programming, data collection, training of the medical personnel				MH, PHI, HC	205,000
Defining and implementing priority research (in areas such as vector borne diseases, impacts of heat waves, pollination maps etc.)	MR				Defining and implementing priority studies and surveys				PHI, academic community	160,000
Improving technical capacity (equipment) of the health sector (particularly for emergency services) for activities under CC conditions	CB				Defining the needs, securing the financial sources, strengthening of the technical capacities				MH, PHI, Emergency services, HC	420,000
Other identified measures (non-characterised)										
Enhancing strategic framework	SAP									
Alignment of drinking water regulations with the European regulations	DWC									
Improvements in water supply systems and water sources protection	DWC									
Strengthen the services for supervision of infectious diseases (Health centres and PHI) through education of doctors	IDS									
Trainings and development of capacities for planning and implementation of medical researches	MR									
Transfer of international experiences	MR, IDS									
Monitoring and evaluation for the public health sub-sector										
The key indicators to monitor and evaluate implementation of TNA action plan for public health sub-sector are: 1) participation in international networks on climate change health impacts; 2) expansion of health statistics system to include data relevant for climate change; 3) establishment of the system to supervise and control new and prospective diseases; 4) number of studies/ surveys on health impacts of climate change in Montenegro; 5) share of population covered by regular drinking water quality control programme.										

Abbreviations used for the water resources sub-sector

Technologies/ measures

TDW = Treatment of drinking water in households
RH = Rainwater harvesting
RL = Reduction of losses
WWT = Wastewater treatment and reuse
EA = Efficient appliances

MARD = Ministry of agriculture and rural development
MSDT = Ministry of sustainable development and tourism
MH = Ministry of health
PHI = Public Health Institute
EPA = Environmental Protection Agency
HMI = Hydro-meteorological Institute

Sub-sector: Water resources	Techn (abbr)	Stage			Description	Time scale (yrs)			Responsibility	Costs (€)
Strategic measures by group		R&D	Depl	Diff		5	10	15		
Priority measures										
Water charging by quantity of consumed water (measuring equipment, reducing illegal connections)	RL				Technical and organizational improvements at enterprises which manage water supply systems				Local self-governments, Water supply systems, MSDT, MARD, Water administration	975,000
Stimulating policy (prices and other incentives) for reuse of water	WWT				Analysis of possibilities, defining the incentives, adoption of appropriate regulations				MARD, MSDT, Water administration	27,000
Improved implementation of regulations (particularly for polluters and wastewater discharges)	WWT				Strengthening capacities of relevant services, particularly inspection				MARD, MSDT, Water administration, EPA	350,000
Labelling of products/ appliances	EA				Support for application of international labelling systems, information diffusion				ME, MSDT	20,000
Improvements in managing local water supply systems	RL				Capacity development in local water supply systems, organizational improvements				Local self-governments, MSDT, MARD, Water administration, owners of water supply systems	630,000
Information and educational campaigns for efficient appliances and reduced consumption in households	EA				Preparation and implementation of information campaigns				Local self-governments, Water supply systems, MSDT, MARD, ME	48,000
Advices on good hygienic practice for drinking water, particularly under extreme conditions (such as floods)	TDW				Publications and other means to disseminate information on the need and ways to additionally treat drinking water in households				PHI, MH	50,000
Advices on facilities and methods for safe and efficient rainwater harvesting , ways of using rainwater and on possible need for further treatment	RH				Preparation of advices related to design and construction of facilities and ways in which to use rainwater				MSDT, HMI, PHI	35,000
Support for rainwater Infrastructure construction	RH				Analysis of possibilities, defining the incentives, adoption of adequate regulations				MARD, MSDT, Ministry of finance	17,000
Use of favourable financial sources (EU and other sources) for investments (detection of losses, repairs and maintenance of water supply system, construction of wastewater treatment and reuse facilities)	RL, WWT				Preparation of projects and programs, securing favourable financial sources (favourable loans, international projects) to reduce water losses and develop wastewater treatment and reuse systems				Local self-governments, MSDT, MARD, Water administration	1,800,000
Examining possibilities and promotion of water reuse for agriculture and other purposes whenever possible / acceptable	WWT				Defining terms of reference for required studies, implementation of analyses, promotion of results				MSDT, EPA, MARD	120,000
Educational and information campaigns (starting from kindergartens) about the necessity to preserve water resources	RL, WWT				Enhancement of school/ kindergarten curriculum and educational campaigns for public				Ministry of education, MSDT, MARD, EPA, HMI, civil society (NGO and media)	230,000
Other identified measures (non-characterised)										
Block tariffs as a mechanism to stimulate rational water consumption	RL									
Regulations on the use of technical water	WWT									
Adequate penalty policy for excessive pollution and non-purposeful and wasteful water consumption	WWT									
Reduction of import taxes and creation of other incentives for wider application of efficient appliances	EA									

Increasing the use of household appliances for drinking water treatment	TDW									
Strengthening of civil sector and cooperation to attain the goals of rational water use	RL									
PPP as a financing model for improvements in water supply sector	RL									
Monitoring and evaluation for the water resources sub-sector										
The key indicators to monitor and evaluate implementation of TNA action plan for water resources sub-sector are: 1) number of publications, educational and information campaigns, and educational programmes modifications on treatment of drinking water in households, rainwater harvesting, rational use of water resources and use of efficient household appliances; 2) annual data on losses in water supply systems; 3) annual quantities of reused water; 4) number of wastewater treatment plants and share of population connected to them; 5) annual investments for improvements of water supply, wastewater treatment and water reuse infrastructure.										

Abbreviations used for the agricultural sector (sub-sectors agricultural land and production)

Technologies/ measures

I = Irrigation (sprinkler and drip irrigation)

F = Proper use of fertiliser and soil fertility control

CP = Combined production

PT = Practical training

MARD = Ministry of agriculture and rural development

MSDT = Ministry of sustainable development and tourism

BTF = Biotechnical Faculty

EPA = Environmental Protection Agency

HMI = Hydro-meteorological Institute

Sub-sector: Agriculture		Stage				Time scale (yrs)				
Strategic measures by group	Techn (abbr)	R&D	Depl	Diff	Description	5	10	15	Responsibility	Costs (€)
Priority measures										
Agricultural producers associations, creation of clusters; establishment of networks for transfer of knowledge and technologies	F				Help with establishment of associations, clusters and networks; stimulating participation in international networks	x		x	MARD, local self-governments, extension services, BTF, non-governmental sector	140,000
Improving control of the use of artificial fertilizers	F				Fostering capacities of relevant services, particularly extension services and inspection				MARD, local self-governments, BTF, extension services, EPA	120,000
Stimulating measures to improve life standard in rural areas and to provide for engagement of younger labour force	CP				Defining and enhancement of rural development policy measures, promotion				MARD, local self-governments, international organisations	135,000
Institutional agreements and associations of water users in order to avoid excessive use of water resources and possible conflicts	I				Consultations, defining needs for irrigation, involvement of agricultural representatives (associations, expert services) into the process of river basin management planning				MARD, extension services, agricultural producers associations , Water administration, local self-governments, HMI, EPA	70,000
Help with promotion of combined production (through agricultural producers association)	CP				Preparation of promotional information and their diffusion				MARD, local self-governments, extension services, BTF, agricultural producers associations	54,000
Development of specific knowledge about combined production as an example of good practice for climate change adaptation **and efficient transfer of knowledge to producers**	CP				Analyses and studies, demonstration of results, publications and advices				BTF, extension services, local self-governments	185,000
Subsidising part of irrigation systems costs as an incentive for producers	I				Analysis of possibilities, defining subsidies and adoption of appropriate regulations				MARD, Ministry of finance, extension services, agricultural producers associations	17,000
Intensifying researches of soil fertility, introduction of climate change related issues and transfer i.e. practical application of results	F				Design of necessary research, preparation of terms of reference, engagement of consultants, implementation of researches and application of results				BTF/ academic community, MARD, extension services	360,000

Promoting application of organic fertilisers and continuation of research on microbiological fertilizers	F				Research on microbiological fertilisers, field tests; preparation of promotional materials on organic fertilisers and their dissemination				BTF, extension services, local self-governments, agricultural producers associations	160,000
Opening organic fertilizers processing plant	F				Analysis of the situation, preparation of plans and defining incentives				MARD, BTF, agricultural producers associations	25,000
Availability of financial resources to agricultural producers	F				Securing favourable financing sources (agro-budget, favourable credits, international projects) to improve conditions of production				MARD, Ministry of finance, international organisations, development banks/ funds	90,000
Ensure additional investments by government and local self-governments so that rural areas are covered with practical training as much as possible and that scientific and technical knowledge is transferred to producers quickly	PT				Analysis of possibilities and needs, preparation of multi-annual investment plan				MARD, local self-governments, Ministry of finance, extension services, BTF	32,000
Trainings for designing, installation, maintenance and management of irrigation systems	I			x	Seminars and practical training				Extension services, equipment producers/ distributors, agricultural producers associations	89,000
Development of capacities of competent services, particularly in relation to vulnerability of agriculture to climate change	CP			x	Strengthening capacities of competent services, exchange of experiences, seminars, study visits				BTF, extension services, local self-governments, MARD	120,000
Provision of advices on advantages of combined production in the climate change context	CP			x	Field work, information dissemination to agricultural producers				Extension services, local self-governments, MARD, agricultural producers associations	180,000
Expanding and improving specialized training programs on locally suitable agricultural practices for water and land management, crop cultivation and animal husbandry **in the climate change context**	PT			x	Transfer of knowledge and information about necessary changes in agricultural practice in the context of climate changes				Extension services, local self-governments, MARD, agricultural producers associations	160,000
Validation and dissemination of information on traditional agricultural practices and development of appropriate technologies which combine this knowledge with modern strategies	PT		x		Cooperation with international scientific and other institutions, transfer of knowledge and information, implementing appropriate analyses and defining recommendations for domestic production				BTF, academic community, extension services, local self-governments, agricultural producers associations	120,000
Other identified measures (non-characterised)										
Advancement of policy and regulatory framework; improvement of information systems	F									
Promotion of rural tourism development as a way to additionally foster combined production	CP									
Improving coordination and cooperation (scientific institutions, expert and administrative services)	F									
Providing information on possible negative effects of improper irrigation (soil degradation, erosion, excessive water consumption, damaged crops etc.)	I									
Development of irrigation equipment market	I									
Securing stable financial sources for soil fertility control	F									
Organization of seminars and procurement of equipment for transfer of knowledge	PT									

Monitoring and evaluation for the agricultural sub-sectors
The key indicators to monitor and evaluate implementation of TNA action plan for agricultural sub-sectors are: 1) area of agricultural land covered by irrigation systems; 2) improved records (statistical data) for the use of fertilisers; 3) use of organic fertilisers; 4) number of studies and specific research on management of agricultural soil and production under changed climate conditions; 5) inclusion of climate change issues in training and information dissemination programmes for agricultural producers.

Abbreviations used for the coastal area sub-sector

Technologies/ measures

ICZM = Integrated coastal zone management
WP = Wetlands protection
SOM = Systematic observation and monitoring

MSDT = Ministry of sustainable development and tourism
MARD = Ministry of agriculture and rural development
EPA = Environmental Protection Agency
PECZM = Public enterprise for coastal zone management
HMI = Hydro-meteorological Institute

Sub-sector: Coastal area		Stage				Time scale (yrs)				
Strategic measures by group	Techn (abbr)	R&D	Depl	Diff	Description	5	10	15	Responsibility	Costs (€)
Priority measures										
Development of legal and institutional framework for integrated management in line with provisions of Barcelona Convention	ICZM				Adoption of new regulations, defining the responsibility and strengthening institutional framework				MSDT, local self-governments, PECZM, MARD, EPA	180,000
Enhancements in spatial planning system and introduction of set back line (as required under the ICZM Protocol of Barcelona Convention)	ICZM				Introduction of the integrated management principles and ecosystem approach in spatial planning; defining the set back line				MSDT, local self-governments, PECZM	75,000
Preparation of wetlands protection and rehabilitation plans	WP				Analyses of situation, preparation of plans				MORT, local self-governments, PECZM, academic community (including Institute of Marine Biology), non-governmental sector	45,000
Ensuring that necessary space for wetlands protection/ rehabilitation is "reserved" in the appropriate spatial plans	WP				Defining criteria, changes in spatial planning documentation				MSDT, local self-governments	35,000
Raising awareness on the importance of wetland areas for climate change adaptation	WP				Promotional activities, dissemination of information				MSDT, local self-governments, PECZM, academic community, civic sector (NGO and media)	90,000
Development of a well-functioning service for continuous monitoring of the sea and coast; application of new monitoring technics and tools for projections of trends under CC conditions	SOM				Capacity development				MSDT, local self-governments, PECZM, Institute of Marine Biology, EPA, HMI	225,000
Analyses/ studies for more detailed examination of vulnerability to CC in coastal zone	ICZM				Preparation of terms of reference, engagement of consultants, preparation of targeted studies				MSDT, local self-governments, PECZM, Institute of Marine Biology, academic community, HMI, EPA	255,000
Improving the information basis, amendments of the existing databases and GIS development	ICZM				Collecting and organizing the existing data, additional observation and research, data geo-referencing				MSDT, local self-governments, PECZM, EPA, Institute of Marine Biology, Water administration, HMI	430,000
Implementation of topographic (from land and air) and bathymetric **surveys, collection of data** on coastal line position, coastal ecosystems, frequency and magnitude of floods, etc.	SOM				Defining needs, implementation of necessary surveys and data collection				MSDT, local self-governments, PECZM, EPA, Institute of Marine Biology and other expert institutions, consultants, non-governmental sector	370,000

Exchange of knowledge and information, development of capacities for wetlands protection	WP				Cooperation and exchange of knowledge and information with international organizations				MSDT, local self-governments, PECZM, academic community (including the Institute of Marine Biology), non-governmental sector	65,000
Other identified measures (non-characterised)										
Efficient implementation of regulations	ICZM									
Securing financial resources for adequate wetlands management and/or rehabilitation	WP									
Strengthening of capacities, training and development of integrated management skills	ICZM									
Trainings on application of monitoring technics	SOM									
Monitoring and evaluation for the coastal area sub-sector										
The key indicators to monitor and evaluate implementation of TNA action plan for coastal area sub-sector are: 1) adoption of new regulations in line with requirements of Barcelona Convention; 2) institutional strengthening (establishment of new institutions/ services or organisational improvements of the existing ones) for ICZM; 3) determination of the set back line; 4) status of wetland areas.										

Abbreviations used for the forests sub-sector

Technologies/ measures

PM = Protective measures (sustainable management)
MP = Forest management planning

MARD = Ministry of agriculture and rural development
MSDT = Ministry of sustainable development and tourism
EPA = Environmental Protection Agency
HMI = Hydro-meteorological Institute

Sub-sector: Forests		Stage				Time scale (yrs)				
Strategic measures by group	Techn (abbr)	R&D	Depl	Diff	Description	5	10	15	Responsibility	Costs (€)
Priority measures										
Networking, transfer of information and knowledge related to forest management planning under changed climate	MP				Assistance with networking and information exchange, achieving higher levels of transparency with preparation of plans				MARD, Forest administration, associations in the forestry sector, international organisations, non-governmental sector	40,000
Integration of climate change issues intoforest management strategy (to preserve forest health, forested areas and natural abilities of forests ecosystems to adapt)	PM				Data collection and analyses of the existing conditions, definition of priorities, preparation of inputs for the strategy				MARD, Forest administration, local self-governments, international organisations, non-governmental sector	15,000
Implementation of laws, plans and contracts; supervision	PM				Strengthening capacity of relevant inspection and forest protection services				Inspection administration, MARD/ Forest administration, MSDT	180,000
Determination and monitoring of indicators relevant for the state of forests in the climate change context (functional monitoring)	MP				Consultations and determination of indicators, definition of obligations to monitor them				MARD, MSDT, Forest administration, HMI, EPA	23,000

Preparation of projects for afforestation and rehabilitation of degraded forests (due to logging or forest fires)	PM, MP				Definition of priorities, preparation of projects, mobilisation of donor funds for implementation				MARD, Forest administration, MSDT, associations in the forestry sector, international organisations, civic sector (NGO and media)	120,000
Research activities on vulnerability of certain types of forest trees in Montenegro to CC	MP				Defining terms of reference, implementation of analyses and researches				MARD, Forest administration, MSDT, academic community, international organisations	200,000
Activities aimed at raising awareness on sustainable forest management and planning as ways to adapt to CC	PM, MP				Promotional activities, organizational improvements				MARD, Forest administration, MSDT, associations in the forestry sector, international organisations, civil society (NGO and media)	80,000
Development of market for low-value wood assortments (wood processing plants, biomass heat and/or power plants)	PM				Analyses, stimulating actions, incentives				MARD, Forest administration, private sector	45,000
Support to projects for fast growing forest plantations (with medicinal and aromatic herbs and other non-timber products) **in order to reduce pressure on natural resources**	PM				Exchange of information, preparation and implementation of projects				MARD, Forest administration, academic community, international organisations	200,000
Securing financial support for investments in green economy options in forestry (e.g. use of low-value wood and waste for biomass heat and power plants)	PM				Development of schemes to stimulate development of green economy initiatives (e.g. contracts for favourable use of wood/ wood wastes in return for investments in technology development)				MARD, Forest administration, private sector	30,000

Linking the existing tools and databases (inventory, management planning software, GIS) **to strengthen the planning system**	MP				Improving coordination, capacity building				MARD, Forest administration	50,000
Training and development of capacities for implementation of protective measures	PM				Seminars, trainings, study visits				MARD, Forest administration, associations in the forestry sector	180,000
Capacity building for competent institutions and staff training for adaptation measures in forest management planning; improving cooperation and coordination	PL				Capacity building; seminars, trainings, study visits				MARD, Forest administration, academic community, international organisations	230,000
Other identified measures (non-characterised)										
Establishment of associations of all actors in the chain (owners, users and others) for better coordination	PM									
Investigation of the need for adjustment of modern international technologies in forest management planning to local conditions	MP									
Monitoring and evaluation for the forest sub-sector										
The key indicators to monitor and evaluate implementation of TNA action plan for forests sub-sector are: 1) level of integration of climate change concerns into forestry planning; 2) capacity of forestry sector to deal with climate change issues in management planning; 3) number of studies/ research on vulnerability of forests to climate change; 4) number and scope of projects for implementation of protective measures to enhance natural capacity of forest ecosystems to adapt.										

9 Annex 2: References

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