SECAP

Sustainable Energy and Climate Action Plan for the City of Belgrade

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Contents

Tables

Figures

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Glossary

BEI	Baseline Emission Inventory
BUR	Biennial Update Report
CAPEX	Capital Expenditures
CO_2	carbon dioxide
CoM	Covenant of Mayors
DH	District Heating
EBRD	European Bank for Reconstruction and Development
EPA	Environmental Protection Agency
GCAP	Green City Action Plan
GHG	Greenhouse Gas
ICLEI	International Council for Local Environmental Initiatives
ICT	Information & communication technologies
IPCC	Intergovernmental Panel on Climate Change
ISEB	Information system for Belgrade energy
JRC	Joint Research Centre
MEI	Monitoring Emission Inventory
MMR	Monitoring Mechanism Regulation
MRV	Monitoring, reporting and verification
NCCS	National Climate Change Strategy
NCV	Net Calorific Values
OECD	Organisation for Economic Co-operation and Development
PE	Public Enterprise
PIU	Project Implementation Unit
PPPs	Public Private Partnerships
PUC	Public Utility Company
SEA	Strategic Environmental Assessment
SECAP	Sustainable Energy and Climate Action Plan
SO	Strategic Objective
UNFCCC	United Nations Framework Convention on Climate Change
VRA	Vulnerability and Risk Assessment

Foreword

Dear fellow citizens,

In front of you is the strategic document *Sustainable Energy and Climate Action Plan 2030*, which was created in a transparent and participatory way in cooperation with experts from Serbia and Europe.

Different energy production processes directly affect climate change. From the industrial revolution until today, due to the burning of fossil fuels and the emission of large amounts of carbon dioxide and other greenhouse gases, human civilization has caused accelerated climate change. This is evidenced by the increasing frequency of floods and droughts, which cause great socio-economic consequences. Energy stability is key to the economic growth and prosperity of any society, and in the 21st century, it is more than ever necessary to produce and use energy in an efficient and sustainable way.

In order to reduce the effects of global warming, the European Union has decided that all member states will be climate neutral by 2050, which means that carbon dioxide emissions must be zero. That is why it is important for Belgrade, as the capital of Serbia, to serve as an example for other local municipalities to start the process of decarbonization in time.

The main strategic goal of the plan is to reduce carbon dioxide emissions by 40% by 2030. In order to achieve this, it is necessary to implement projects in the field of energy efficiency, to expand district heating, to introduce renewable energy sources in the energy mix of the city and to continue with intensive greening of the city. With this plan, the City of Belgrade positions the protection of the environment as one of the strategic priorities and is also a precondition for the use of "green" funds of the European Union.

With this approach and by investing in ecology, we send a clear message that it is necessary to change the awareness of the environment in order to preserve and improve it. Our further economic growth must be based on the principles of sustainable development, which means that our economic policy is always aimed at preserving the environment in order to give our local contribution in the fight against the global climate crisis.

Prof. dr Zoran Radojičić,
Mayor of Belgrade

Executive Summary

The City of Belgrade signed **the Covenant of Mayors (CoM) for Climate and Energy** on 5 October 2018. As a signatory, the City made a commitment to:

- **Reduce its carbon dioxide (CO_2)** emissions by at least 40%
- **Increase its resilience** to the impacts of climate change
- Provide secured **access to sustainable and affordable energy** by 2030.

Within two years of becoming a signatory, a **Sustainable Energy and Climate Action Plan** (SECAP) must be submitted to the CoM. The SECAP should define relevant climate mitigation and adaptation objectives for the municipality to achieve its commitments to the CoM. Thereafter, the City is required to report progress using the SECAP monitoring template, and to adjust priorities accordingly.

This document presents the contents of Belgrade's SECAP, which comprise:

- Inventories, including **a comprehensive Baseline Emissions Inventory (BEI)** for climate change mitigation and a **Vulnerability and Risk Assessment (VRA)** for climate change adaptation
- Actions, featuring an overview of aggregated data on climate mitigation and adaptation and specific **key and non-key actions for climate mitigation and adaptation** in the municipality
- An overview of strategy to implement the SECAP, including **targets**, **roles and responsibilities** of authorities involved, **financial capabilities**, **public involvement,** and **monitoring process.**

Inventories (BEI and VRA)

The **BEI** was developed by calculating CO_2 emissions using an activity-based approach. The impacts of the measures on climate mitigation, individually and in combination, were evaluated against a hypothetical baseline scenario. The latter was based on the growth of demand in the BEI sectors driven by socio-economic parameters (population, and gross domestic product – GDP) and assumed that none of the SECAP's actions would be implemented. Belgrade's BEI was developed for 2015 and considers only CO_2 emissions. The BEI covers the following sectors:

- Buildings, equipment, and facilities: residential buildings; municipal buildings; public lighting
- Transport: municipal fleet; public transport; private transport
- Local energy production: heat generation.

According to the baseline scenario, the **energy consumption in 2030 will grow by 16.6% compared to 2015,** with energy use in the transport sector growing by 76.3% and energy use in the buildings sector decreasing by 16.6%. **CO_2 emissions in 2030 will be reduced by 7.2% compared to 2015**, which will mostly be the result of improvements in energy efficiency in buildings (resulting in reductions of 27.7%) and growth of transport emissions by 59.0%. The larger influence of the buildings sector, as a percentage of energy and BEI emissions, results in the lower percentage of savings having a higher absolute impact than the increase in emissions from transport

The SECAP's VRA builds upon Belgrade's 2015 Adaptation Action Plan[1]. Key messages from the vulnerability and risk assessments include the following:

[1] City of Belgrade, Secretariat for Environmental Protection (2015) Climate Change Adaptation Action Plan and Vulnerability Assessment.

- **Population**: The vulnerability of the population to heat waves, extreme cold and floods is estimated as high, due to its high exposure to these effects, and low adaptive capacity. The main risks include worsening of existing health issues from heat stress, poorer air quality with negative effects on respiratory illnesses, conditions that enable the spread of disease and illness, and greater occurrences of injuries and deaths from storm-related accidents.
- **Economy**: The main industries identified as vulnerable in Belgrade include the energy and mining sectors owing to their dependency on the city's infrastructures. Risks include disruptions to tourism and industry.
- **Infrastructure**: Current bouts of extreme cold and flooding present a high risk to energy supply and traffic infrastructures in Belgrade, which are assessed as highly vulnerable owing to their high exposure and associated low adaptive capacity. Water supply and sewerage is particularly vulnerable to extreme weather.
- **Natural resources**: Water resources and their quality are highly vulnerable to the effect of heatwaves and droughts. Heatwaves, extreme cold and heavy precipitations/floods, as effects of climate change, are expected to significantly reduce air quality in Belgrade. The vulnerability of agriculture and forestry has been estimated as high to all the effects of climate change. The vulnerability of biodiversity and ecosystems in Belgrade to heatwave and drought is estimated to be high, due to high exposure and low adaptive capacity.

Actions for climate mitigation and adaptation

Building on the established inventories, **the SECAP provides an overview of the vision, strategic objectives, as well as a long list of potential options (i.e. actions**). These were developed in coordination with the creation of a Green City Action Plan (GCAP), as the City of Belgrade also expressed a desire to tackle a broad set of environmental challenges (including water, air and soil issues) through drafting and implementing a GCAP (part of the Green Cities Framework of the European Bank for Reconstruction and Development – EBRD).

Belgrade's long-term vision established by the SECAP states that: ***"We are smartly developing a capital for all citizens and especially children, pursuing the ideals of an even greener, healthier, and more sustainable future.".*** This vision is addressed by strategic objectives for climate mitigation and adaptation with regard to: energy and efficiency; urban planning and mobility; and resilience. Priority sectors to achieve these objectives include: transportation, buildings, energy, water and wastewater, and land-use planning.

In total, the SECAP includes 36 actions currently already underway or that need to be implemented in order for Belgrade to address climate change. These comprise:

- Nineteen actions to reduce net greenhouse gas (GHG) emissions through direct investments or policies, which will encourage more sustainable and low emissions behaviour and investment, including three actions also addressing energy poverty
- Seventeen actions to increase the City's adaptation to climate change and subsequent resilience. These actions are mostly focused in the water sector, but also address land-use, afforestation, etc., and

Administrative structure and monitoring process

The **Project Implementation Unit (PIU) Team** should be established immediately, once the SECAP is adopted, and should include all entities and institutions responsible for substantial CO_2 emissions. The PIU Team should consist of representatives of the Secretariat for Environmental Protection, Secretariat for Energy, Secretariat for Transport, Secretariat for Public Transport, Secretariat for Finance, Secretariat for Investments, PUC District Heating Company, PUC Public Lighting, PUC Public Transport Enterprise. Coordination of the

PIU Team should be provided by the Mayor's Office. The role of the PIU Team will be to initiate projects, lead their implementation, ensure fulfilment of the SECAP's goals and prepare regular reports to the CoM.

The total estimated capital expenditures (CAPEX) and associated investment (including for studies) required to implement the SECAP over the next 10 years is EUR 5.16 billion. A significant portion of this sum will be provided by the City or companies owned by the City.

Progress with delivery of the strategic objectives will be measured against mid-term targets identified in the SECAP. **Eight such targets have been identified for climate mitigation, and eight for climate adaptation**.

Table 0.1: Summary of BEI, 2030 emissions trajectory in the baseline, and emissions totals with measures in 2030

Emissions (t CO2)	2015 (BEI) (tCO2)	Emissions - 2030 - baseline (assuming national-level policies) (tCO2)	Emissions - 2030 with measures (tCO2)	Reductions against 2015
Residential buildings	5,229,392	3,683,859	2,450,567	53.1%
Municipal buildings	819,807	814,940	397,544	51.5%
Public lighting	148,716	148,716	98,704	33.6%
Transport	1,473,288	2,341,915	1,270,922	13.7%
Total	**7,671,203**	**6,989,429**	**4,217,738**	**45.0%**

1 Introduction

1.1 Background

1.1.1 The Covenant of Mayors

The City of **Belgrade signed the Covenant of Mayors (CoM) for Climate and Energy on 5 October 2018. Belgrade made a commitment to reduce its carbon dioxide (CO_2) emissions by at least 40%, increase its resilience to the impacts of climate change, and provide secured access to sustainable and affordable energy by 2030**. The city needs to submit a Sustainable Energy and Climate Action Plan (SECAP) within two years following their adhesion to the CoM.

1.1.2 The SECAP process

The CoM supports local authorities with mainstreaming climate change mitigation, adaptation and energy poverty actions into relevant policies and strategies. It also aims to reduce energy demand and to promote local energy resources in ensuring supply is sufficient to meet demand.

The CoM takes a holistic approach to climate change mitigation and adaptation across sectors within local communities. In this context and with respect to climate change mitigation, sectors refer to: municipal, tertiary (non-municipal) and residential buildings; equipment/facilities; transport; industry; waste; local electricity production; and local heat/cold production. According to the CoM, vulnerable sectors to climate change within a municipality include: buildings; transport; energy; water; waste; land use planning; agriculture and forestry; environment and biodiversity; health; civil protection and emergency; tourism; education; and information and communication technologies (ICT).

Within two years of becoming a signatory, a SECAP must be submitted to the CoM in which relevant climate change mitigation and adaptation objectives for the municipality are defined according to a robust evidence base. Thereafter, there is a commitment to report progress using the SECAP monitoring template with the intention of adjusting priorities accordingly. The **timeframes for reporting on monitoring vary** for different components of the SECAP: a monitoring report on key climate change mitigation actions is required within two years of joining the initiative, within four years for most other key actions, and within six years for a complete monitoring report.

Guidelines on reporting are available via the Covenant of Mayors website[2].

The SECAP's content:

- The strategy, including **targets**, **roles and responsibilities** of authorities involved, **financial capabilities**, **public involvement,** and **monitoring process;**
- Inventories, including **emission inventories** for climate change mitigation and a **vulnerability and risk assessment** for climate change adaptation;
- Actions, featuring an overview of aggregated data on climate change mitigation and adaptation and specific **key and non-key actions for climate change mitigation and adaptation** in the municipality.

Process for reporting:

- Signatories develop the SECAP and secure the local authorities' approval;

[2] Covenant of Mayors for Climate and Energy Library: https://www.eumayors.eu/support/library.html [last accessed: 18/06/2019]

- Signatories report using the *MyCovenant* and SECAP template. Reporting must reflect the information included in the accompanying Action Plan;
- Signatories upload accompanying Action Plans to the *MyCovenant*;
- Signatories complete the reporting checklist before finalising submission.

Consistency checks:

The European Commission's Joint Research Centre (JRC) is tasked with reviewing the submitted SECAPs to ensure that submissions are consistent and meet the basic reporting needs, including:

- An outline of the CoM climate change mitigation and adaptation commitments;
- Detailed account of the Baseline Emission Inventory (BEI) and Climate Vulnerability and Risk Assessment (VRA);
- Minimum sectoral coverage in planning, inventory reporting and the selection of actions (specified for climate change mitigation actions only).

1.1.3 Coordination with the EBRD Green City Action Plan (GCAP)

In addition to development of the SECAP, the City of Belgrade also expressed a desire to tackle a broad set of environmental challenges (including water, air and soil issues) through drafting and implementing a Green City Action Plan (GCAP). The GCAP forms part of the Green Cities Framework of the European Bank for Reconstruction and Development (EBRD). The methodology for the GCAP has been developed by the EBRD together with the Organisation for Economic Co-operation and Development (OECD) and International Council for Local Environmental Initiatives (ICLEI). The "EBRD GCAP Methodology" is available at the Bank's website[1] and is designed to guide a city through four main steps:

- Step 1: Establishing a Green City Baseline;
- Step 2: Developing a GCAP;
- Step 3: Implementing the plan; and
- Step 4: Reporting on progress and outcomes.

As the GCAP also covers climate change mitigation and adaptation, it was important throughout the development of the SECAP to ensure coordination between these two processes, particularly during the selection of actions to be implemented by the two plans.

1.2 Context

1.2.1 Climate change policy in Belgrade

Belgrade's climate policy is directly influenced by Serbia's national policy. Serbia ratified the Paris Agreement in May 2017 and has committed to reduce greenhouse gas (GHG) emissions by 9.8% (as compared to the 1990 baseline year) by the year 2030.[3] Additionally, Serbia is a "Non-Annex I" country under the United Nations Framework Convention on Climate Change (UNFCCC), which means that it has committed to:

- Periodically submitting National Communications to the UNFCCC, including information on the country's GHG inventory, climate change mitigation actions and plans, and climate change impacts, vulnerabilities, and adaptation. Serbia has submitted two National Communications and is in the process of developing its third;

[3] See https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Serbia/1/Republic_of_Serbia.pdf

- Submitting a Biennial Update Report (BUR) every two years, outlining the GHG inventory, progress on climate change mitigation (GHG reduction) measures, and planned mitigation measures. Serbia submitted its first BUR in 2016.

The legal basis for work on climate issues and creation of national GHG inventories in Serbia is the Law on Air Quality[4]. A Law on Climate Change has been drafted and is being discussed by the Ministry of Environmental Protection within its climate change working group, which includes governmental officials, experts and members of civil society. Serbia is expected to establish institutional and procedural arrangements to implement the EU Monitoring Mechanism Regulation (MMR) and to strengthen the administrative capacities of the relevant institutions in the field of climate change.

1.2.2 National GHG Inventory System

The competent authority for data collection in Serbia is the Environmental Protection Agency (EPA). The EPA started to prepare the GHG inventories in early 2013, covering the period 1990 – 2013, and updates them on a regular basis. The country is using the methodology of the 2006 IPCC Guidelines for National GHG Inventories. To date, there are no legal instruments to compel operators to share information on GHG emissions.

1.2.3 Low Carbon-Development Strategies

Serbia's **National Climate Change Strategy** (NCCS) is currently being prepared. Its development started in July 2016 and its first deliverable (identification of policy gaps) is being finalized. The NCCS and associated action plan will identify priority GHG emissions-reduction measures and define the responsible institutions for specific options together with timelines for implementation and overall financial resource requirements. The NCCS will also provide a framework for an adaptation policy addressing the priority areas of agriculture, forestry, and water management. The climate change action plan will describe the short-term actions covering the first phase of the implementation of the NCCS.

The potential for Serbia to cost-effectively reduce its GHG emissions will be assessed through the preparation of quantitative scenarios and projections, which will be reported on regularly. These will cover key economic sectors and address the years 2020, 2025, 2030 and 2050.

Scope of the NCCS and climate change action plan – in preparation

The scope of the **NCCS** comprises:

- The background to, and need for, a climate change strategy in Serbia;
- Long-term goals and objectives for the policies to be implemented;
- GHG mitigation: potentials and related impacts;
- Climate change adaptation: priorities and main measures;
- The institutional framework and arrangements for inter-ministerial cooperation;
- Cost and benefits of the NCCS;
- Finance for implementation; and
- Priorities for the initial implementation phase (2020).

The scope of the **Climate change action plan** comprises:

- Proposed policy measures per sector up to 2020 with outlook to 2030;
- Required resources, including financing;
- Actions to be carried out by public authorities and regulators;

[4] Official Gazette of the Republic of Serbia "OG RS" No. 36/2009, 10/2013

- Clear timelines and outcome indicators for these activities; and
- Type and frequency of activities to monitor progress.

1.3 Methodology used to develop the SECAP

The **SECAP must be based on and include the results of a comprehensive BEI and VRA,** which were addressed as the first step in developing the SECAP.

For the VRA, the SECAP builds upon the 2015 Adaptation Action Plan[5]. The review of the Adaptation Action Plan also identified potential issues with the reported information in the risk and vulnerability assessment and formulated clarification questions for the local authority, where appropriate.

The BEI was developed according to the methodologies described in the guidebook, "How to develop a Sustainable Energy and Climate Action Plan (SECAP)': PART 2 – Baseline Emission Inventory (BEI) and Vulnerability and Risk Assessment (VRA)"[6], This included calculation of CO_2 emissions using the activity-based approach. The **impacts on climate change mitigation of measures considered, individually and in combination,** were evaluated against a hypothetical baseline scenario. It was based on the growth of demand in the BEI sectors driven by socio-economic parameters (population, GDP) and assumed that no measure from the SECAP would be implemented. However, it accounted for national-level mitigation measures. The results of the BEI and projections are described in Chapters 3and 4and further details are given in Annex G.

The findings of **the VRA and BEI were presented at a stakeholder workshop at Belgrade's City Hall on 3 December 2019**. These engaged organisations including the City Hall, city secretariats, city public enterprises and utility companies, UN agencies actively engaged with the city, and civil society representatives. Stakeholder feedback was used to confirm sectors of energy consumption to be considered in the BEI, noting that it must include three of the four key sectors identified in the CoM templates (namely Municipal Buildings, Equipment/Facilities; Residential Buildings; Tertiary Buildings and Transport). While there was no formal requirement for stakeholders to prioritise the findings of the VRA, they provided comments on their perceptions of risks and vulnerabilities. Detailed feedback received on the BEI and VRA is presented in Annex A.

Building on the established baselines, **the next steps involved coordination with the development of the GCAP. An overall vision, strategic objectives, as well as a long list of potential options (i.e. actions) were identified**. Key current plans by sector were reviewed to identify potential projects that could be included in the GCAP and the SECAP. These options were collated into a "long list" containing all potential projects and highlighting gaps in understanding of the challenges. Feedback was sought from technical experts via the City's "Working Group", which allowed the long list to be reduced in length. Each of the actions on this abbreviated long list were subsequently evaluated against a series of qualitative criteria to ensure that they were likely to be effective and appropriate to the objectives of the GCAP or SECAP. This resulted in shortlists of options for further consideration. The details of the assessment are presented in Annex C, while the list of options is presented in Annex D.

Due to the COVID-19 crisis, it was not possible to organise a stakeholder workshop at this stage (in March 2020). However, materials were shared with key stakeholders. Options for the overall vision were evaluated through online voting posted on the City website. Following the voting, further consideration of the results and discussion with stakeholders led to final selection of the preferred vision by the Mayor (see Annex B for more details).

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[5] City of Belgrade, Secretariat for Environmental Protection (2015) Climate Change Adaptation Action Plan and Vulnerability Assessment.

6 Joint Research Institute (2018) Guidebook 'How to develop a Sustainable Energy and Climate Action Plan (SECAP)'. Available at – https://publications.jrc.ec.europa.eu/repository/bitstream/JRC112986/jrc112986_kj-nb-29412-en-n.pdf

Due to the continuation of the COVID-19 crisis, it was not possible to hold face-to-face discussions. Thus, **the selected long-term vision, strategic objectives and short-listed options were validated at an online ("Zoom") stakeholder workshop on 13 July 2020**. There were 28 participants who split for breakout discussions about particular fields of interest. This workshop resulted in a final list of options for inclusion in the GCAP and SECAP documents.

Building on stakeholder feedback, project fiches presenting the short-listed measures were finalised and the development of the SECAP (and GCAP) started. The draft SECAP has been shared with stakeholders to receive feedback and it will also undergo a Strategic Environmental Assessment (SEA).

The above process has taken place over almost two years, starting in October 2018, and rigorously followed the CoM reporting guidelines in effect at the time. These guidelines were updated in March 2020, including a new reporting template. Most research and stakeholders' consultation activities pre-date the new guidelines. To maintain the relevance of approvals and feedback collected in this process, the information collected has not been altered and content subject to approval was neither added nor removed. Hence, some assumptions had to be made when transposing existing knowledge to the new template.

2 Vision and strategic objectives

2.1 Long-term vision

As Belgrade became a signatory to the CoM on 5 October 2018, the SECAP's ultimate strategic objective stems from the City's commitment to reduce its CO_2 emissions by at least 40%, increase its resilience to the impacts of climate change, and provide secured access to sustainable and affordable energy by 2030.

In parallel, the ongoing GCAP process sets out that strategic objectives are required to define long-term goals (10-15 years), guide the direction of the SECAP and ensure its contribution to the vision. Hence, the following joint long-term vision was selected for the City's GCAP and SECAP:

"We are smartly developing a capital for all citizens and especially children, pursuing the ideals of an even greener, healthier, and more sustainable future."

The long-term vision is broken down into strategic objectives for climate change mitigation and adaptation with regard to: energy and efficiency; urban planning and mobility; and resilience. Priority sectors to achieve these objectives include: transportation, buildings, energy, water and wastewater, and land-use planning.

Section 2.2 provides more details on the SECAP's targets and commitments and Chapter 6 presents actions to achieve these targets.

2.2 Targets and commitments

2.2.1 Mitigation

The SECAP's overall climate change mitigation target is to reduce CO_2 emissions recorded in the BEI by at least 40% by 2030, as compared to 2015. A longer-term target beyond 2030 was not examined, though it is important that actions taken today set the city on a trajectory towards future lower emission scenarios.

The table below provides an overview of climate change mitigation targets and commitments, which were jointly agreed for the SECAP and GCAP.

Table 2-1 Climate change mitigation targets[7]

CO2 target	Unit	Target year	Base year	Reduction type	Population estimate in target years
40	%	2030	2015	Absolute	1.93 Million

[7] The numbering of the strategic objectives (SO) correspond to the numbering and sectoral reference included in the GCAP.

Towards energy and efficiency measures

Strategic objective	Mid-term target
S.O.B1 – Take action to improve the energy efficiency of the city's buildings	Achieve the reduction in final energy consumption in municipal buildings by 40% compared to 2015 and by 20% in residential buildings beyond the ambition of national legal requirements through encouraging renovation and nearly zero energy buildings where possible.
S.O.E1 – Developing and improving the efficiency of the district heating distribution network	Rehabilitation of the district heating distribution network to create programmes, tailored to various groups of consumers, to result in efficient, accessible connections for 97,000 new customers (half for heating and half for heating and hot water) of various types of end-users by 2030 - and thereby reduce air pollution.
S.O.E2 – Cut GHG emissions from the City	Reduce GHG emissions for the city by at least 40% by 2030– by broad means but particularly through improvements to district heating and adoption of renewables.

Towards urban planning and mobility

Strategic objective	Mid-term target
S.O.T1 – Improve city mobility and reduce congestion	Cut journey times around the city so that the average commute for citizens is below 30 minutes (currently 32.5)
S.O.T2 – Enhancing Green Mobility in Central City Area	Improve green mobility in the central area by increasing the share of trips by green modes (walking, cycling) by 5% (currently <2%), with share of 80% for cycling and 20% for walking and 100% "clean" public transport in the central area
S.O.T3 – Increasing use of alternatively fuelled vehicles	Encourage a transition to e-vehicles, achieving 40% for bus, 80% for taxi, 100% for city owned vehicles, 80% of commercial transport vehicles and 20% in private vehicles of vehicle fleet by 2030

Towards resilience

Strategic objective	Mid-term target
S.O.W3 – Capture and treat wastewater	Achieve at least a 40% connection rate for residential and commercial properties connected to a sewage network with treatment
S.O.SW1 – Improvement of infrastructure for separate collection, sorting, reuse and recycling of waste	Implement infrastructure investments to enable at least 15% Municipal Solid Waste recycling rates

2.2.2 Adaptation

Following the options workshop held on 19 July 2020, the following strategic objectives and targets related to adaptation were retained for the SECAP and GCAP.

Table 2-2 Climate adaptation targets[8]

Towards energy and efficiency measures

Strategic objective	Mid-term target
S.O.B2 – Using our buildings to create green space	Maximise opportunities for green infrastructure in and around buildings including green vertical spaces and other localised green spaces for building users in accordance with the existing Climate Change Adaptation Action Plan.

[8] The numbering of the strategic objectives (SO) correspond to the numbering and sectoral reference included in the GCAP.

Towards urban planning and mobility

Strategic objective	Mid-term target
S.O.L1 – More intensive use of existing underused urban structures by increasing compactness, density and overall urban quality on selected planned locations/zones (along the main public transportation corridors)	Champion reuse of land in urban areas over greenfield development. On average 40% of development should be on brownfield land by 2025 raising to 50% by 2030.
S.O.L2 – Preventing sprawl by limiting unnecessary suburban land take and expansion of construction land.	Limit expansion of urban development into green areas such as forests, agricultural areas, and important ecosystems to no more than 5% of total development per year.
S.O.L3 – Substantially increasing the role of Green City Infrastructure	Develop a planned network of urban green infrastructure and open space to provide ecological (e.g. Climate Resilience) and social benefits (e.g. access) to achieve at least 20% of the cities total area but with at least 7% of each municipality being green.

Towards resilience

Strategic objective	Mid-term target
S.O.W1 – Reduce the losses in the network to achieve water saving and reuse	Reduce the losses in the water network to less than 20%
S.O.W2 – Protect more of the city from the risk of flooding	Reduction in the number of properties at risk of flooding (particularly from stormwater flooding) in the city in line with the Conclusions of the national flood strategy which is currently under development
S.O.CCA1 – The city is aware of its vulnerabilities to climate change and actively planning to adapt (disaster risk informed urban planning)	Consideration of adaptation, resilience and disaster risk is clearly mainstreamed into all of the city's major decision-making processes evidenced by a clear mandate and institutional structures to operationalise the plan.
S.O.GS1 – Substantially increase the "tree cover" of Belgrade territory's territory	Increase the forested area of Belgrade by 10% between 2020 to 2025

2.3 Administrative structure/staff capacity allocated

In the process of developing the SECAP, the consulting team (including Mott MacDonald, Ricardo and E Co.) engaged with the Working Group of the City of Belgrade. This Working Group is composed of 17 representatives of city units, i.e. secretariat, city public enterprises and institutions. The project coordinator on behalf of the City, Ms Katarina Kulić, who works in the Mayor's office, and has concurrently been the president of the Working Group. The engagement of the Working Group led by Ms Kulić enabled a high degree of cooperation between the project team and the Mayor, his team and city institutions, and also confirmed the City's commitment to the project's realization. Other participants included the Main City Architect, Energy Manager, representatives from the Secretariat for Environmental Protection, Secretariat for Energy, Secretariat for Transport, Secretariat for Public Transport, Public Utility Company (PUC) District Heating company, PUC City Sanitation company, PE Belgrade Water company, Public Health Institute of Belgrade and PE Belgrade Urban Planning Bureau. The Working Group includes relevant representatives who influence the adoption and implementation of policies related to the reduction of CO_2 emissions in Belgrade. As the same Working Group covers the GCAP and SECAP projects, it includes representatives of various fields, such as energy, transport, greenery, water supply, waste, public health, etc.

The Working Group's role during the project was reflected in the preparation and delivery of materials, defining goals, proposing options for the implementation of measures, etc. All these activities were realised through the expert consulting team and the Working Group cooperating, including in several organised workshops and mutual communication in different phases of the project.

The Project Implementation Unit (PIU) team should be established immediately when the SECAP is adopted and should include all entities and institutions responsible for substantial CO_2 emissions. This PIU team should consist of representatives of the Secretariat for Environmental Protection, Secretariat for Energy, Secretariat for Transport, Secretariat for Public Transport, Secretariat for Finance, Secretariat for Investments, PUC District Heating Company, PUC Public Lighting, PUC Public Transport Enterprise etc. Coordination of this team should be provided by the Mayor's office. The role of the PIU will be to initiate projects, lead their implementation, take care of the fulfilment of the goals of the SECAP and to prepare regular reports to the CoM.

It is important to emphasize that the energy management system of the city of Belgrade should be strengthened in order to increase the capacity to implement all planned measures in order to meet the objectives of SECAP. The energy management system is a legal obligation.

2.4 Stakeholder engagement

In the process of developing the SECAP, it was very important to ensure the consensus of a wide range of stakeholders whose activities are related to GHG emissions, climate adaptation and the environment in general. Inclusion of institutions responsible for various areas of energy and transport at the City and State level, as well as the largest producers of GHG gases, was the first priority. In addition, it was necessary to ensure the participation of the scientific community, the non-governmental sector, international organizations, financial institutions, and the media. Thus, a wide range of representatives participated in and made significant contributions to the workshops held between October 2018 and the end of the project. These representatives were from relevant ministries (for mining and energy, for environmental protection, for EU integration etc.), city secretariats (for environmental protection, for energy, for transport, for public transport, for health care etc.), national-level companies (PC Electric Power Industry etc.) and city-owned companies (PUC District Heating Company, PUC City Sanitation company, PUC Public Lighting company etc), several most important non-governmental organizations in this field (Serbian Green Building Council, RES Foundation), faculties (Faculty for Mechanical Engineering, Faculty for Mining and Geology etc.), international institutions (UN Environment, UNDP, GIZ etc.), financial institutions (EBRD, KfW, EIB etc.), media (Serbian Broadcasting company) and professional journals (Balkan Green Energy News, Energetski portal etc.).

The role of city institutions was to provide materials and information on the current situation, plans and projects, the City's strategic documents, as well as to propose and review options for the realisation of goals. Public institutions had the role of highlighting compliance with the state strategic plans and current projects. The role of the scientific community and the non-governmental sector was very important in providing experiences and good practices, as well as compliance with the interests of as many stakeholders as possible, primarily citizens.

2.5 Budget

The following tables show the overall budget for the 10-year period from 2021 through 2030. Note that the total amount of financing has the following characteristics:

- It does not include operations and maintenance costs which may be incurred.
- Investment which would be undertaken by municipally owned companies is counted under "Local Authority's own resources".
- The city will endeavour to obtain additional financial support through non-reimbursable sources (grants) from both donors (bilateral and multi-lateral) and the central government. For the time being,

for the most part this amount is included in “Local Authority’s own resources” but may be shifted over time.

- A significant portion of the total investment cost of the plan will likely come through debt or other investment mobilised via, for example, Public Private Partnerships (PPPs). In the case where the investment is likely to be on the balance sheet of the city, it is counted as “Local Authority’s own resources” whereas in the case where the investment will be covered off of the city’s balance sheet, it is listed under Public or Private External Sources or “Not allocated to any sources”.

The total estimated capital expenditures (CAPEX) / investment (including for studies) identified for implementation of the SECAP over the next 10 years is a total of EUR 5.16 billion– a significant portion of which would come from the city or companies owned by the city (see the tables below).

Table 2-3 Overall budget foreseen for the implementation of the SECAP

Overall budget foreseen for plan implementation			
Total (€)	**Mitigation (%)**		73%
	Adaptation (%)		27%
Budget period			
		From:	2021
		To:	2030

Table 2-4 Financing sources for the SECAP

Financing sources			Share in % of overall budget
Local Authority's own resources		Yes	63%
External sources			
	> Public	Yes	1%
	> Private		36%
Not allocated to any sources			
Total (million EUR)			**5,164**

2.6 Monitoring, reporting and verification (MRV)

Progress on the strategic objectives will be measured against the mid-term targets identified in Section 2.2 and reported according to the CoM monitoring process and timeline. This involves:

- Reporting any potential changes to the initial strategy;
- Updating information on human and financial resources.

Specific provisions for monitoring of climate change mitigation and adaptation are presented below. Where possible, monitoring indicators, units and baseline years have been identified for each climate change mitigation and adaptation action in Chapter 6.

2.6.1 Climate change mitigation

The CoM signatories commit to reporting on the progress of climate change mitigation actions every two years after the SECAP’s submission date. Progress is monitored via submission of a monitoring report. The aim of monitoring is to assess the progress made towards the climate change mitigation target set in the SECAP. Every six years, the monitoring report should include the monitoring emission inventory (MEI).

For climate change mitigation, the monitoring report should:

- Provide **final energy consumption and CO_2 emissions data** by energy carrier and by sector for a recent monitoring year;
- Provide information on the mitigation-related action plans and individual adaptation action, including **new opportunities** for action and the **co-benefits** arising from the implementation of SECAP actions.

The Secretariat for Environment is responsible for monitoring progress towards the target, in close cooperation with the Secretariat of Energy and Secretariat of Transport, who are the main data providers and collect data on implemented measures from implementing entities, where needed.

The values for the indicators described in Annex G should be updated for the monitoring year in order to develop MEI. The progress indicators for the climate change mitigation actions are described for each action in Chapter 6.

It is important to emphasize that a large part of the city's emissions profile is covered within the City of Belgrade's energy management system (EnMS). The EnMS will continue to be strengthened in order to increase the capacity to implement all planned measures to meet the goals of the SECAP. The EnMS is a legal obligation. Using inputs from the EnMS should make future MEIs relatively straightforward to compile for some sectors (e.g. public buildings).

2.6.2 Climate change adaptation

For climate change adaptation in particular, the monitoring report should:

- Provide an indication of the **status of adaptation and the level of completeness of actions** within the adaptation cycle;
- **Report on climate hazards, vulnerabilities, and impacts** faced in the City of Belgrade;
- Provide information on the adaptation-related action plans and individual adaptation actions, including **new opportunities** for action and the **co-benefits** arising from the implementation of SECAP actions.

As part of the City's 2015 Climate Change Adaptation Plan, the Climate Change Adaptation Working Group was responsible for collecting data, monitoring the implementation of project activities, and analysing critical climate change adaptation developments. However, the Working Group does not appear to be established and monitoring has not been fully operationalised.

As part of Strategic Objective CCA1[9], a working group on climate change adaptation will be established and be responsible for the operationalisation of a monitoring framework to track adaptation actions in the City.

[9] "The city is aware of its vulnerabilities to climate change and actively planning to adapt"

3 Baseline Emission Inventory

3.1 Methodological notes

CO_2 emissions were calculated using a formula shown below, adapted from the Intergovernmental Panel on Climate Change (IPCC) methodology Tier 1 sectoral approach for the local level. It is consistent with the formula provided in the Guidebook 'How to develop a Sustainable Energy and Climate Action Plan (SECAP), which is based on activity data on fuel consumption and emission factors:

$$\text{Carbon dioxide emissions}_{\,j}\ (\text{t } CO_2) =$$

$$=\sum_s\sum_f\{\ \text{fuel consumption}_{\,sf}\ (\text{MWh}) \times CO_2 \text{ emissions factor}_{\,f}\ (\text{t } CO_2/\text{MWh})/1000,$$

lower index *s* refers to sector and lower index *f* - to the energy carrier.

Whenever the unit for fuel consumption was provided as mass or volume, the net calorific values (NCVs) were used to convert it to MWh.

The CO_2 emission factors (in Table 3-1) and NCVs (in Table 3-2) used for development of Belgrade's BEI were the ones used by the Ministry of Mining and Energy[10]. For coal and biomass used for heat generation, NCVs and emission factors were based on the mix of different types of biofuels and coal used in the Republic of Serbia for same purpose.

Table 3-1 Emission factors and NCVs of different fuels

	Emission factor
Fuel	**t CO2/MWh**
Natural gas	0.200
Heavy fuel oil	0.280
Heating Oil	0.270
Diesel	0.270
Gasoline	0.250
Lignite	0.360
Coal	0.351
Firewood	0.010
Biomass pellets and briquettes	0.028

Table 3-2 The NCVs of different fuels

		NCV
Fuel	**Unit**	**kWh/ Unit**
Natural gas	1000 m^3	9260.556
Heavy fuel oil	t	11353.333
Heating Oil	t	11886.305
Diesel	1000 L	10222.222

[10] http://www.mre.gov.rs/dokumenta-efikasnost-izvori.php

		NCV
Gasoline	1000 L	8835.278
Lignite	t	2089.722
Coal	t	4093.894
Firewood	m^3	1840.000
Biomass pellets and briquettes	t	4750.000

The average emissions factor from electricity and heat are shown in Table 3-3. The CO_2 emission factor for electricity was determined according to the rulebook on the form of the annual report on the achievement of the energy savings targets (adopted in August 2018 in relation to final consumption)[11]. The high value of the electricity emission factor was due to the fact that the majority of electricity in the Republic of Serbia (up to 71% in 2015) was / is generated by coal power plants. The emission factor for heat was calculated based on the methodology described in the sustainable energy action plan (SEAP) guidebook[12] and was based on actual emissions from Belgrade's heat production facilities and heat consumption, as given in Table 3-3. It is just slightly lower than the national heat emission factor (0.290 t CO_2/MWh).

Table 3-3 CO_2 emission factors for electricity and heat

	Emission factor
Energy Carrier	**t CO2/MWh**
Electricity	1.100
Heat	0.266

3.2 BEI of Belgrade's SECAP

Belgrade's BEI was developed for 2015 and considers only CO_2 emissions. The BEI covers the following sectors:

- Buildings, equipment, and facilities: residential buildings; municipal buildings; public lighting
- Transport: municipal fleet; public transport; private transport
- Local energy production: heat generation

The energy consumed in Belgrade in 2015, in the sectors considered, amounted to 14,376 GWh and associated CO_2 emissions were 7,671Gg. As evident in the figure below, **55% of energy was consumed by the residential sector, followed by the transport sector with 38%**. The largest energy carrier consumed was electricity (36%), followed by diesel (27%). Electricity was predominantly used by the buildings sector and the large consumption of electricity was due to the fact that many **households still used electricity for heating and hot water,** as the heat network did not cover the whole city. The natural gas distribution network was still under development.

[11] http://www.mre.gov.rs/doc/efikasnost-izvori/Pravilnik-o-obrascu-godi%C5%A1njeg-izve%C5%A1taja-2018-09-19/Pravilnik_o_izmenama_pravilnika_o_obrascu_godi%C5%A1njeg_izve%C5%A1taja_o_ostvarivanju_cil%D1%98eva_u%C5%A1tede_energije_65-18.pdf?uri=CELEX:32009L0028

[12] How to develop sustainable energy action plan (SEAP) – guidebook, part 2, European Union, 2010.

Figure 3-1 Energy consumption by sector and energy carrier in Belgrade in 2015

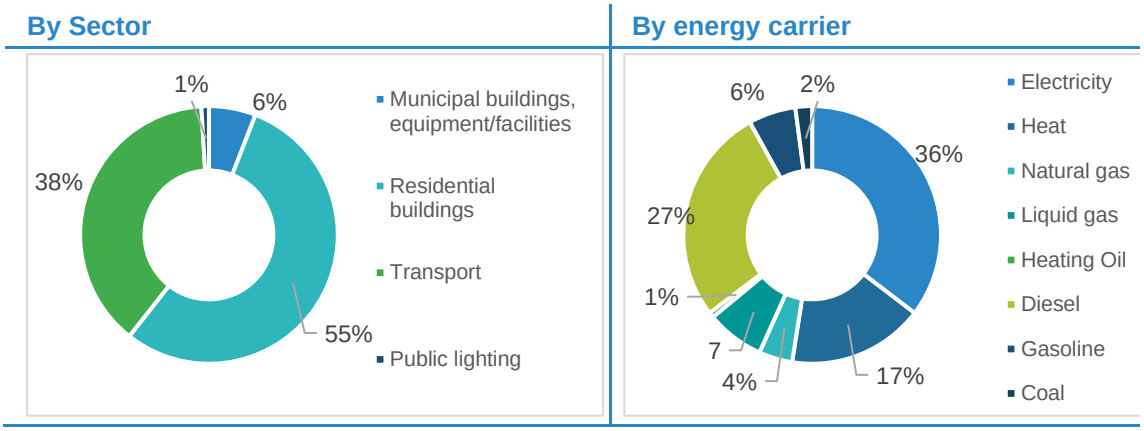


Figure 3-2 shows CO_2 emissions by sector and fuel in 2015. **68% of emissions were from the residential sector, followed by the transport sector with only 19%**. Overall, the buildings sector was responsible for 79% of emissions. Among energy carriers, 68% was emitted due to the consumption of electricity owing to the large national emission factor applied to electricity (1.1 t CO_2/MWh), which is three to five times higher than the emission factors used for fossil fuels such as natural gas consumption.

Figure 3-2 CO_2 emissions by sector and energy carrier in Belgrade in 2015

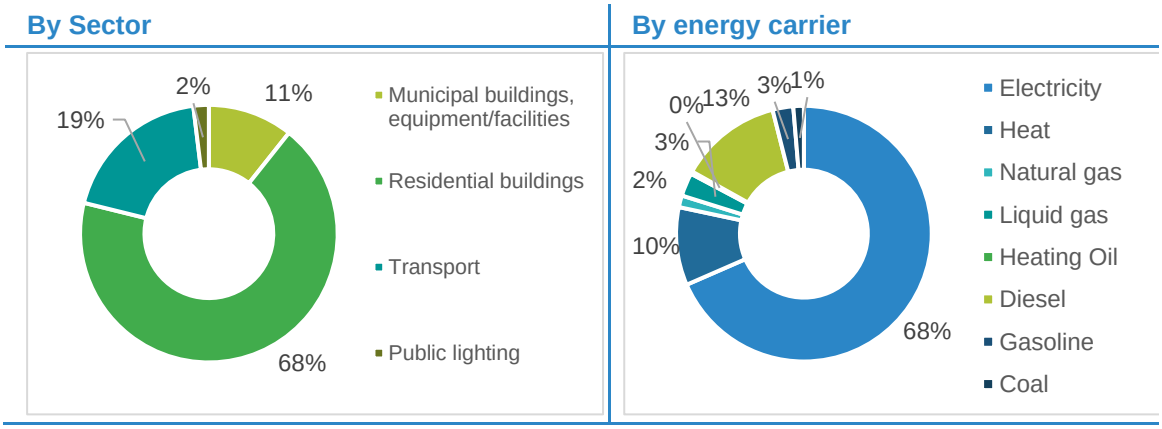


Table 3-4 and Table 3-5 show energy consumption and emissions by sector and fuel in 2015. Activity data that was used estimate the BEI is described in Annex G.

Table 3-4 Final energy consumption in 2015 in sectors considered under Belgrade's SECAP

Sector	Final energy consumption [MWh]											
	Electricity	Heat/cold	Fossil fuels						Renewable energies			Total
			Natural gas	LPG	Heating oil	Diesel	Gasoline	Coal	Other	Solar thermal	Geothermal	
BUILDINGS, EQUIPMENT/ FACILITIES AND INDUSTRIES												
Municipal buildings, equipment/ facilities	708,688	79,254	32,412	0	16,879	0	0	8,986	0	0	0	846,218
Residential buildings	3,886,218	2,232,604	524,573	0	71,639	0	0	273,754	860,752	830	16,000	7,866,370
Public lighting	135,196	0	0	0	0	0	0	0	0	0	0	135,196
Subtotal	4,730,102	2,311,858	556,985	0	88,517	0	0	282,739	860,752	830	16,000	8,847,784
TRANSPORT												
Municipal fleet	0	0	0	0	0	254	1,273	0	0	0	0	1,527
Public transport	44,149	0	12,039	25,812	0	661,283	62,024	0	0	0	0	805,308
Private and commercial transport	219	0	0	956,467	0	3,026,802	737,899	0	0	0	0	4,721,388
Subtotal	44,369	0	12,039	982,279	0	3,688,339	801,196	0	0	0	0	5,528,222
TOTAL	**4,774,471**	**2,311,858**	**569,025**	**982,279**	**88,517**	**3,688,339**	**801,196**	**282,739**	**860,752**	**830**	**16,000**	**14,376,007**

Table 3-5 CO_2 emissions in 2015 in sectors considered under Belgrade's SECAP

Sector	CO_2 emissions [MWh]											
	Electricity	Heat/cold	Fossil fuels							Renewable energies		Total
			Natural gas	LPG	Heating oil	Diesel	Gasoline	Coal	Other	Solar thermal	Geothermal	
BUILDINGS, EQUIPMENT/ FACILITIES AND INDUSTRIES												
Municipal buildings, equipment/ facilities	779,557	21,003	6,482	0	4,557	0	0	3,235	0	0	0	819,807
Residential buildings	4,274,840	591,648	104,915	0	19,342	0	0	98,551	0	0	0	5,229,392
Public lighting	148,716	0	0	0	0	0	0	0	0	0	0	148,716
Subtotal	5,203,112	757,719	111,397	0	23,900	0	0	101,786	0	0	0	6,197,915
TRANSPORT												
Municipal fleet	0	0	0	0	0	69	318	0	0	0	0	387
Public transport	48,564	0	2,408	5,937	0	178,547	15,506	0	0	0	0	250,961
Private and commercial transport	241	0	0	219,987	0	817,237	184,475	0	0	0	0	1,221,940
Subtotal	48,805	0	2,408	225,924	0	995,852	200,299	0	0	0	0	1,473,288
TOTAL	**5,251,918**	**757,719**	**113,805**	**225,924**	**23,900**	**995,852**	**200,299**	**101,786**	**0**	**0**	**0**	**7,671,203**

4 GHG projection

4.1 Baseline scenario

The baseline scenario assumes the changes to the GHG emissions in the BEI sectors over the period 2016-2030 without climate change mitigation actions which have been considered in this document (but including national-level measures). The changes are driven by the changes in socio-economic parameters (such as population and GDP) and the introduction of nationwide measures that are outside of the City's influence (such as appliance standards, the biofuel target for the transport sector, and changes in the energy production / transformation mix).

According to the baseline scenario, the energy consumption in 2030 will grow by 16.6% compared to 2015, with energy use in the transport sector growing by 76.3% and energy use in the buildings sector decreasing by 16.6%. CO_2 emissions in 2030 will be reduced by 7.2% compared to 2015, which will mostly be the result of improvements in energy efficiency in buildings (resulting in reductions of 27.7%) and the growth of transport emissions by 59.0%. The larger influence of the buildings sector, as a percentage of energy / BEI emissions, results in the lower percentage of savings having a higher absolute impact than the increase in emissions from transport.

Figure 4-1 shows the growth of energy consumption in BEI sectors and Figure 4-2 shows the projections of CO_2 emissions of the sectors covered in the BEI in the baseline scenario.

Additional information on the baseline scenario assumptions are provided in Annex G.

Figure 4-1 Baseline projections of final energy consumption (MWh) of BEI sectors

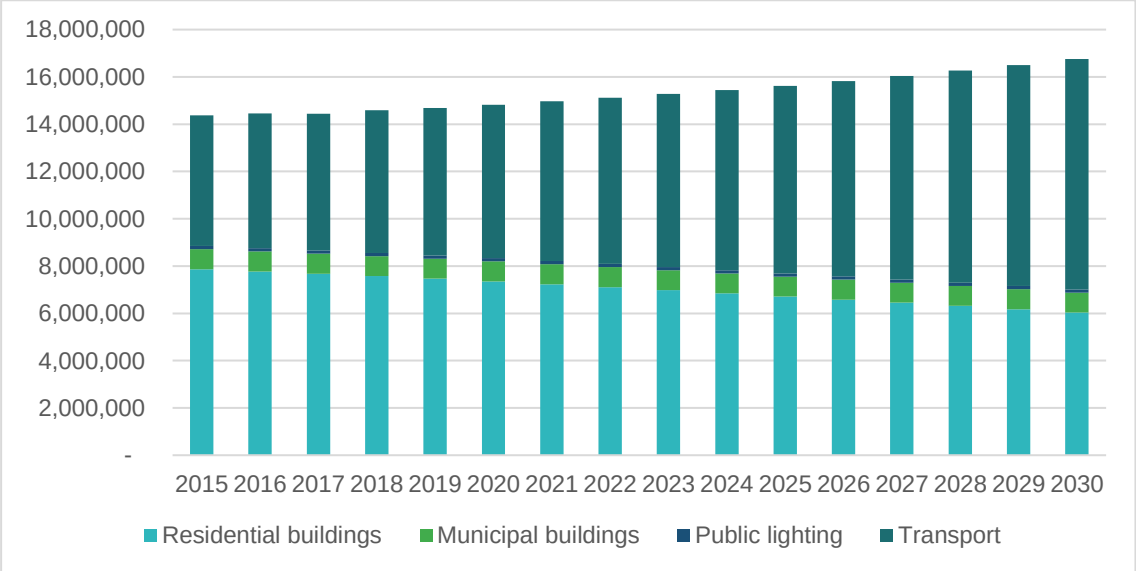
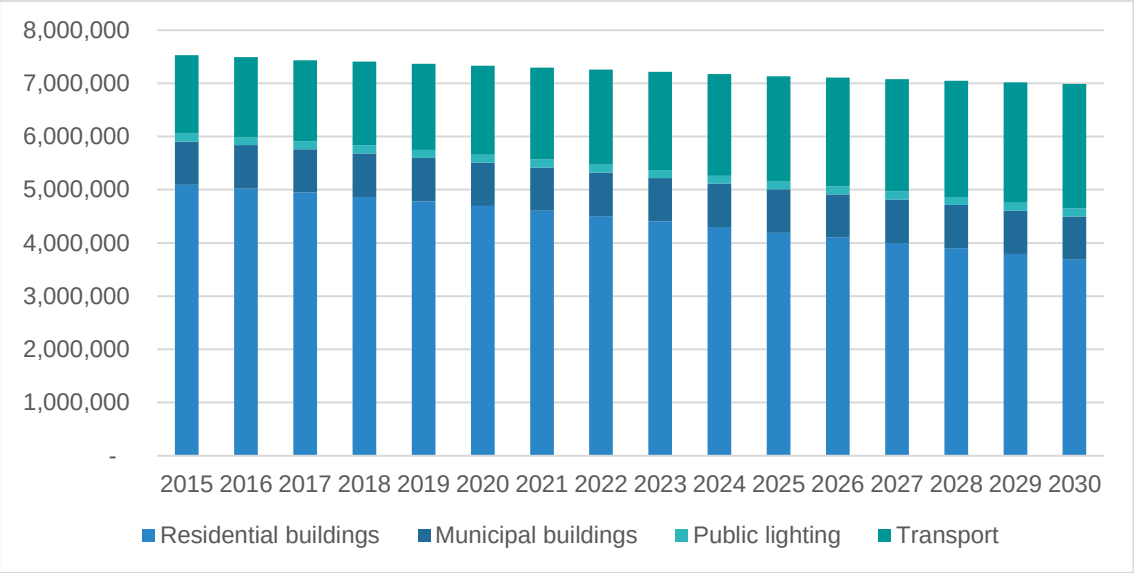


Figure 4-2 Baseline projections of CO_2 emissions (t) from BEI sectors



4.2 Climate change mitigation scenario

The climate change mitigation scenario assumes the implementation of mitigation actions described in this document (see Chapter 6). The implementation of these actions results in a projected total emission reduction of 45.0% compared to the BEI and 39.7% compared to the baseline scenario. The largest reductions occur in residential buildings – 51.9% compared to the BEI and 33.5% compared to the baseline scenario. These reductions also incorporate the effects of actions from local energy production, which result in the reduction of the emission factor for district heat.

Figure 4-3 shows the growth of energy consumption in BEI sectors and Figure 4-4 shows the projections of CO_2 emissions of BEI sectors in mitigation scenario. Table 4-1 shows the savings of final energy, renewable energy production and CO_2 emission reductions for energy efficiency and urban planning and mobility actions, as compared to the baseline scenario in 2030.

Summary of BEI, 2030 emissions trajectory in the baseline, and emissions totals with measures in 2030

Emissions (t CO2)	2015 (BEI) (tCO2)	Emissions - 2030 - baseline (assuming national-level policies) (tCO2)	Emissions - 2030 with measures (tCO2)	Reductions against 2015
Residential buildings	5,229,392	3,683,859	2,450,567	53.1%
Municipal buildings	819,807	814,940	397,544	51.5%
Public lighting	148,716	148,716	98,704	33.6%
Transport	1,473,288	2,341,915	1,270,922	13.7%
Total	**7,671,203**	**6,989,429**	**4,217,738**	**45.0%**

Figure 4-3 Projections of final energy consumption (MWh) of BEI sectors in mitigation scenario

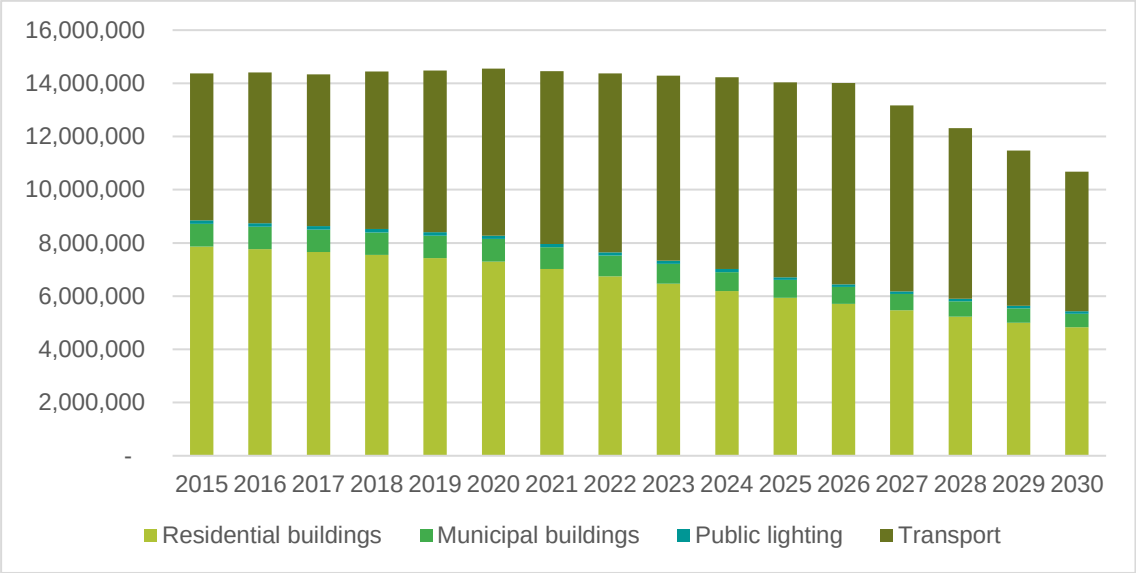


Figure 4-4 Projections of CO2 emissions (t) from BEI sectors in mitigation scenario

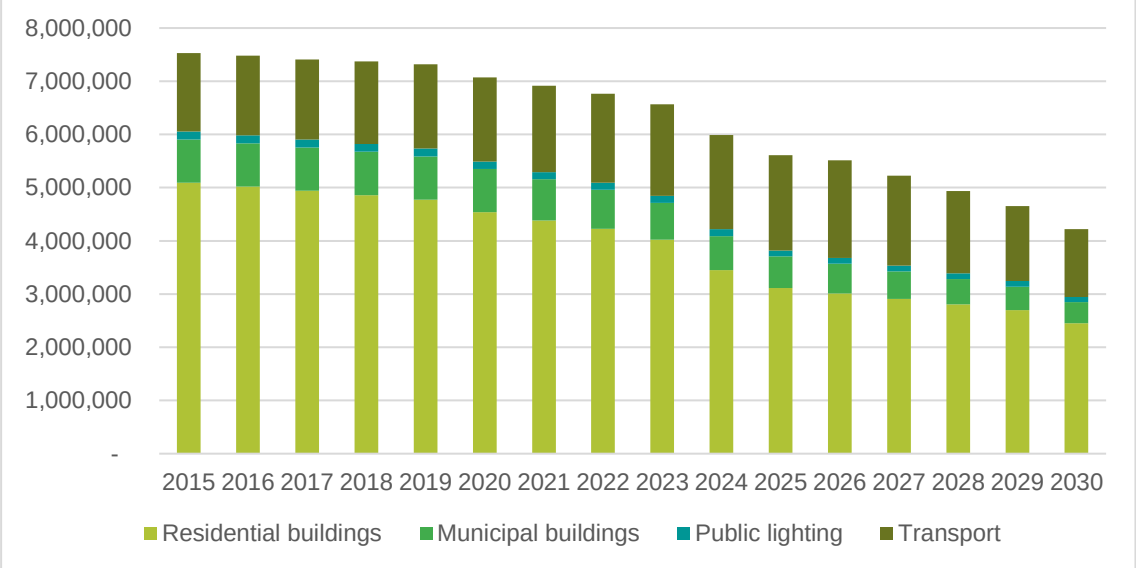


Table 4-1 Impacts of energy efficiency actions in 2030, as compared to the baseline scenario

No	Action	Energy savings	Renewable energy production	CO_2 reduction
		MWh/a	MWh/a	t CO_2/a
1	E1 - Connecting to the natural gas distribution network	Not estimated, partially included in LE2		
2	LE1 - Development and improvement of the district heating distribution network	0	0	300,048
3	LE2 - Improvement energy efficiency district heating heat sources	0	0	535,964
4	PL1 - Energy efficiency in public lighting	28,529	0	31,382
5	PL2 - Smart lighting switches	22,123	0	24,335
6	B1 - Renovation / Energy efficiency and use of RES in municipal buildings	338,487	84,622	407,470
7	B3 - Energy efficiency and use of RES in residential buildings	1,350,078	34,460	553,033
8	B4 - Regulations and incentive measures in residential buildings			
	Total effect of all actions	**1,584,944**	**119,082**	**1,700,698**

Table 4-2 Impacts of urban planning and mobility actions in 2030, as compared to the baseline scenario

No	Action	Energy savings	Renewable energy production	CO_2 reduction
		MWh/a	MWh/a	t CO_2/a
1	T1- Extension and development of the Belgrade Metro and train	3,577,649	0	684,861
2	T3 - Purchase of electric buses/trams and busses that use RES with infrastructure development	236,449	55,180	44,265
3	T4 - Bicycle-Sharing System	676,628	0	158,339

No	Action	Energy savings	Renewable energy production	CO_2 reduction
		MWh/a	MWh/a	t CO_2/a
4	T5 - Encouraging walking and/or cycling within the city through improved pedestrian facilities and cycle ways			
5	T6 - Commercial transport policy – City logistics	111,469	3,497	67,320
6	T7 - Plan for a network of public chargers for electric vehicles			
7	T8 - Incentives and financing of e-vehicles for public and private commercial vehicles (range 200km/day)			
8	L1 - Linear Park	Not estimated, supporting measure		
9	L2 - Brownfield Development Programme	Not estimated, supporting measure		
10	L4 - Study for a City-wide programme for urban green infrastructure development	Not estimated, supporting measure		
11	L5 – Study on Urban Land Management Policies and Instruments	Not estimated, supporting measure		
	Total effect of all actions	**4,490 741**	**58,677**	**1,070,993**

5 Risk and vulnerability assessment

5.1 Overview

The vulnerability and risk assessment provided in this section summarises the information reviewed from Annexes 3 and 4 to the 2015 Action Plan.

The 2015 Adaptation Action Plan for the City of Belgrade provides a historical overview of extreme weather events occurring in the city over a twenty-year timeframe between 1995 and 2014. These include heatwaves, extreme cold, droughts, heavy precipitation and flooding and storms. The overview outlines the vulnerabilities associated with the various extreme weather events. Projected climate change scenarios (for the periods 2021-2050 and 2071-2100) were also used to ascertain the extent of vulnerabilities going forward with respect to the likely outcome of changing climate on historical extreme weather events.

For additional context, a summary of the methodology used for the vulnerability and risk assessment included in the 2015 Adaptation Action Plan for Belgrade is set out below.

The 2015 Adaptation Action Plan: methodology used for the vulnerability and risk assessment[13]

The assessment reviewed vulnerabilities across sectors in the City of Belgrade, determining the extent to which systems throughout the city were able to cope with adverse climate or weather induced impacts, reflecting on historical climate change impacts and understanding the associated risks and opportunities identified. This was accompanied by spatial analysis to ascertain local vulnerabilities.

Modelled data was then used to project future vulnerabilities for the timeframe between 2021-2050 and 2071-2100. Projections were derived from the ORIENTGATE project against a 1971-2000 reference period.

A stakeholder consultation was undertaken to discuss the results of the vulnerability assessment, to establish the need for action, and to select actions that could then be integrated within the Adaptation Action Plan.

The Plan includes a framework for monitoring and implementation with a mechanism for reported monitoring data to feed into the risk and vulnerability assessment.

5.2 Climate hazards

According to the assessment, **heatwaves, extreme cold and flooding** present the highest risks to Belgrade. While extreme cold has historically had severe impacts, the projected climate scenarios indicate that overall temperature increases should have a balancing effect, reducing the likelihood of extreme cold in the future. An overview of extreme weather events is presented in the table below.

[13] City of Belgrade, Secretariat for Environmental Protection (2015) Climate Change Adaptation Action Plan and Vulnerability Assessment.

Table 5-1 Overview of historic and projected extreme weather events affecting Belgrade

Extreme weather events	Observed climate trends (1995 – 2014)	Projected climate change scenarios (medium scenario A1b for 2021-2050 and 2071-2100)
Extreme heat	Involving high temperatures of above 39 degrees Celsius over extended periods between June and August, at times accompanied by an extreme lack of precipitation. The rate of frequency with which heat waves are reported appears to be greater in more recent years with seven of the eight incidents reported occurring between 2000 and 2013.	Mean summer temperatures are projected to increase by 1.25 degrees Celsius between 2021-2050 and by 5.4 degrees Celsius between 2071-2100 with the number of hot days also set to increase by 12 and 60 days, during the respective timeframes.
Extreme cold	Involving extended periods over the winter with the number of consecutive ice days and snow days above the annual average. The reported incidents indicate that the rate of frequency has increased in more recent years.	Projections indicate that an overall a balancing effect can be expected to mitigate occurrences of extreme cold owing to overall temperature increases.
Droughts	Several incidents of drought in Belgrade have occurred but the most significant involved no rainfall for an extended period of over two consecutive months and reduced precipitation by 15% of the average. Both incidents occurred at the same time as the previously reported heat waves.	Precipitation projections indicate that limited change is forecast for the summer months between 2021 and 2050; however, between 2071 and 2100, reductions in precipitation of 20 to 40% are forecast with greater risks of drought as a result.
Heavy precipitation and floods	Heavy precipitation involving up to more than 200 mm of rain in a week i.e. the equivalent of three months' rain under normal	Precipitation projections indicate that limited change is forecast for the summer months between 2021 and 2050 and limited risk of heavy precipitation in the longer timeframe (between 2071 and 2100) based on general declining trends. No changes are expected in the number of days with heavy precipitation.

	conditions. Flooding has led to disaster in Belgrade with two events having particularly damaging consequences for the city.	
Storms	Occurring during the summer months, storm frequency and intensity has increased between 2009 and 2014.	Increasing intensity and frequency of storms during summer months is expected to continue.

An overview of the expected changes in the intensity and frequency of extreme weather events is presented in the table below together with a rating of their potential impact. Sea level rise, landslides and forest fires are not reported, as they are not relevant to Belgrade.

Table 5-2 Climate hazards affecting Belgrade

Hazards	Impact of hazard	Expected changes in intensity/frequency	Timeframes
Extreme heat	High	Mean summer temperatures are projected to increase by 1.25 degrees Celsius between 2021-2050 and by 5.4 degrees Celsius between 2071-2100 with the number of hot days also set to increase by 12 and 60 days, during the respective timeframes.	Medium-term
Extreme cold	High	Projections indicate that an overall a balancing effect can be expected to mitigate occurrences of extreme cold owing to overall temperature increases.	Medium-term
Droughts & water scarcity	Moderate	Precipitation projections indicate that limited change is forecast for the summer months between 2021 and 2050; however, between 2071 and 2100, reductions in precipitation of 20 to 40% are forecast with greater risks of drought as a result.	Long-term
Heavy precipitation and floods	High	Precipitation projections indicate that limited change is forecast for the summer months between 2021 and 2050 and limited risk of heavy precipitation in the longer timeframe (between 2071 and 2100) based on general declining trends. No changes are expected in the number of days with heavy precipitation.	Long-term
Storms	Moderate	Increasing intensity and frequency of storms during summer months is expected to continue.	Long-term

5.3 Vulnerable sectors

Vulnerabilities were determined according to the City's climate sensitivities and adaptive capacities. The impact of climate changes on a receptor and the extent to which the receptor can cope with that change are considered. Receptors were categorised as: population, infrastructure, built environment, economy, or natural resources.

The main risks to the city's economy concern tourism and industry. **Tourism** is vulnerable to **extreme heat and drought** in the summer months and the expected impact on **water quality and supply**. The main industries identified as vulnerable in Belgrade include the **energy and mining sectors.** This is because of their dependency on the city's infrastructures (including transport, energy and water supply) and the anticipated **disruptions to these services due to occurrences of extreme temperatures, heavy precipitation and flooding**.

Future risks to the economy were also assessed with respect to retail. Overall, the risks were assessed as low / medium. Extreme heat was identified as posing a high risk to retail due to potential disruptions to the transportation of goods and changes in buying behaviour.

Building stock and materials probably face more damage due to high and very high risk of **heat waves, droughts, and storms in summer and floods in summer and winter.** The built environment relates to existing buildings, urban infrastructure (such as pavements etc.). In Belgrade, the built environment is highly exposed to climate hazards rendering it highly vulnerable, especially in densely built–up areas.

The vulnerability of natural resources is very high. Open green spaces demonstrate a high level of vulnerability to almost all of the potential effects of climate change. It is estimated that the Belgrade **water resources, and their quality are highly vulnerable** to the effect of **heatwaves and droughts**. It is estimated that **heat waves, extreme cold and heavy precipitations/floods**, as effects of climate change, will significantly affect the **deterioration of air quality** in Belgrade.

The **vulnerability of agricultural and forestry** is estimated as high to all the effects of climate change. The **vulnerability of biodiversity and ecosystems** in Belgrade to heatwaves and droughts is estimated to be high, due to their high exposure and low adaptive capacity. The vulnerability of biodiversity and ecosystems to the effects of extreme cold is estimated as medium.

The detailed VRA that has been already presented to stakeholders at earlier stages of the development of the SECAP is presented in Annex E. However, given the changes to the SECAP template this information has been transposed to provide an overview per each hazard.

Table 5-3 provides an overview of the SECAP sectors' vulnerability to climate hazards, while details are recorded in Annex F. As this assessment was developed under the old guidelines, the following caveats apply:

- Civil protection and emergency, education and ICT sectors' vulnerabilities have not been assessed; and
- "Risk of impact" is reported instead of "current vulnerability level". However, the indicators for vulnerability included in the detailed assessment are informed by current vulnerabilities.

Table 5-3 Overview of sectors' vulnerability to climate hazards

Hazards	Vulnerable sectors	Risk of impact
Extreme heat	Buildings/equipment/facilities	Very high risk of impact in the summer months
	Transport	High risk of impact in summer months.
	Energy production and supply	High risk of impact in summer months.
	Water supply and sewerage	Very high risk of impact in the summer months.
	Land use planning	Very high risk of impact in the summer months.
	Agriculture, forestry and biodiversity	Very high risk of impact in the summer months, high in the winter months.
	Health	High risk of impact in spring and summer months
	Tourism	Medium risk of impact in summer month.
Extreme cold	Buildings/equipment/facilities	Medium risk of impact in winter months.
	Transport	Medium risk of impact in winter months.

Hazards	Vulnerable sectors	Risk of impact
	Energy production and supply	Medium risk of impact in winter months.
	Water supply and sewerage	Low risk of impact in the winter months.
	Land use planning	Low risk of impact.
	Agriculture, forestry and biodiversity	Low risk of impact.
	Health	High risk of impact winter months
	Tourism	Medium risk of impact in winter month.
Heavy precipitation and floods	Buildings/equipment/facilities	Very high risk of impact in summer months, high in winter months.
	Transport	Very high risk of impact in summer months, high in winter months.
	Energy production and supply	Very high risk of impact in summer months and high in winter months.
	Water supply and sewerage	Very high risk of impact in the summer and high in the winter months.
	Land use planning	High risk of impact in the summer months, medium in winter months
	Agriculture, forestry and biodiversity	High risk of impact in the summer months, medium in winter months
	Health	High risk of impact in summer and winter months
	Tourism	Medium risk of impact in summer month, low in winter months.
Droughts & water scarcity	Buildings/equipment/facilities	High risk of impact in summer months and medium in winter months.
	Transport	Medium risk of impact in summer months, low in winter months
	Energy production and supply	High risk of impact in summer months and medium in winter months.
	Water supply and sewerage	Very high risk of impact in the summer and high in the winter months.
	Land use planning	Very high risk of impact in the summer months.
	Agriculture, forestry and biodiversity	Very high risk of impact in the summer months, high in winter months
	Health	High risk of impact in summer months and medium risk in winter months
	Tourism	High risk of impact in summer month, medium in winter months.
Storms	Buildings/equipment/facilities	High risk of impact in summer months, medium in winter months.
	Transport	High risk of impact in summer months, medium in winter months.
	Energy production and supply	Very high risk of impact in summer months and high in winter months.

Hazards	Vulnerable sectors	Risk of impact
	Water supply and sewerage	Very high risk of impact in the summer and high in the winter months.
	Land use planning	Very high risk of impact in the summer months.
	Agriculture, forestry and biodiversity	Very high in summer months; high in winter months (except for biodiversity to which storms present a low risk).
	Health	High risk of impact in summer months and medium risk in winter months
	Tourism	Medium risk of impact in summer months.

5.4 Adaptive capacity

Two types of vulnerabilities can be distinguished: vulnerability stemming from the socio-economic context, and vulnerability stemming from the physical and environmental situation.

Adaptive capacities to socio-economic vulnerability in Belgrade include the following:

- The population has a low adaptive capacity and high sensitivity to climate (in particular the elderly, infants and children, people with mobility impairments, chronic illnesses, etc.). There is no pronounced spatial distribution of poverty; and
- Industry (namely mining and energy) has a low adaptive capacity, due to its dependency on transport infrastructures.

Adaptive capacities to physical and environmental vulnerability in Belgrade include the following:

- Infrastructure: City infrastructures flagged as having low adaptive capacity due to their high exposure include: road transport (with the busy routes and streets the most vulnerable), electricity and district heating systems, and water supply and sewerage;
- Natural resources: the adaptation plan observed low adaptive capacity for open green spaces, water resources, agricultural and forestry, biodiversity and ecosystems;
- Built environment: limited adaptive capacity due to high exposure to extreme weather conditions of building stock and materials.

5.5 Vulnerable population groups

The **vulnerability of the population to heatwaves, extreme cold and floods is estimated to be high,** due to their high exposure and low adaptive capacity. The vulnerability of the population to the effects of droughts and storms in Belgrade is estimated as medium.

For each climate hazard, vulnerability amongst the population is detailed in Table 5-4.

Table 5-4 Vulnerable population groups

Hazards	Vulnerable categories	Vulnerability level
Extreme heat	The elderly, babies and children, the chronically ill, workers who work outdoor (exposed to heat), people with mobility impairments, homeless, athletes, people who live or work in central urban municipalities etc. The potential consequences are deaths, mainly due to cardiovascular diseases, spread of vector-borne and infectious diseases, altered allergy patterns, heat stress	High vulnerability
Extreme cold	The elderly, the chronically ill, highly vulnerable persons, workers who work outdoor (exposed to cold), people with mobility impairments, homeless.	High vulnerability

Hazards	Vulnerable categories	Vulnerability level
	The potential consequences are casualties and fatalities, spread of respiratory and infectious diseases, deterioration of the state of cardiovascular patients	
Droughts and water scarcity	People who live or work in affected areas, especially the elderly, the chronically ill, babies and children, workers who work outdoor (exposed to heat or cold), people with mobility impairments, athletes, the homeless. The potential consequences are effects on the air, hygienic conditions, diseases caused by consuming poor-quality water and food.	Medium vulnerability
Heavy precipitation/ flood	All persons who live or work in affected areas, especially the elderly, the chronically ill, babies and children, workers who work outdoors (exposed to heat or cold), people with reduced mobility, athletes, homeless etc. Particularly sensitive inhabitants of the city municipalities in the vicinity of rivers Sava and Danube: Obrenovac, Lazarevac, Zemun, Novi Beograd, Rakovica, Zemun, Čukarica, Palilula, Savski Venac. The potential consequences are casualties and fatalities, spread of infectious diseases due to contaminated water, deterioration of state of chronic patients due to difficulty in providing of lack of medical assistance (diabetes, dialysis etc.)	High vulnerability
Storm	All persons who live or work in affected areas, especially the elderly, babies and children, the homeless, workers who work outdoor, etc. The potential consequences are casualties and fatalities	Medium vulnerability

6 Actions

6.1 Overview

The SECAP consists of 36 different actions to be taken / currently already underway in Belgrade to address climate change. These include:

- 19 actions to reduce net GHG emissions – either through direct investments or policies which will encourage more sustainable / low emissions behaviour and investment;

17 actions to increase the resilience of the City / adapt to climate change. These are mostly focused in the water sector, but also included measures in land-use, afforestation, etc.Additionally, among these 36 actions, three will have significant impacts on energy poverty in the City and seven can be considered key actions, as they are already either in the process of being implemented or pre-implementation activities have been completed. Table 6-1 below shows the titles of the actions, and how they are categorised. The order and numbering of the measures have been kept as they were developed in coordination with the GCAP.

In the subsequent sections, an overview is provided of each action and additional details are presented for key actions. Furthermore, detailed project fiches have been developed as part of the GCAP for measures that have been newly proposed. These project fiches have been discussed in detail with key stakeholders.

Table 6-1 Overview of actions

Name of action	Mitigation	Adaptation	Energy poverty	Key action
Energy and efficiency				
E1 - Connecting to the natural gas distribution network	✓		✓	No
LE1 - Development and improvement of the district heating distribution network	✓		✓	Yes
LE2 - Improvement energy efficiency district heating heat sources	✓			No
PL1 - Energy efficiency in public lighting	✓			Yes
PL2 - Smart lighting switches	✓			No
B1 - Renovation / Energy efficiency and use of RES in municipal buildings	✓			No
B3 - Energy efficiency and use of RES in residential buildings	✓		✓	No
B4 - Regulations and incentive measures in residential buildings	✓			No
Urban planning and mobility				
T1- Extension and development of the Belgrade Metro and train	✓			Yes
T3 - Purchase of electric buses/trams and busses that use RES with infrastructure development	✓			No
T4 - Bicycle-Sharing System	✓			No
T5 - Encouraging walking and/or cycling within the city through improved pedestrian facilities and cycle ways	✓			No
T6 - Commercial transport policy – City logistics	✓			No
T7 - Plan for a network of public chargers for electric vehicles	✓			No

Name of action	Mitigation	Adaptation	Energy poverty	Key action
T8 - Incentives and financing of e-vehicles for public and private commercial vehicles (range 200km/day)	✓			No
L1 - Linear Park	✓			No
L2 - Brownfield Development Programme	✓			No
L4 - Study for a City-wide programme for urban green infrastructure development	✓			No
L5 – Study on Urban Land Management Policies and Instruments	✓			No
L6 - Donji Dorcol Superblock project		✓		No
Resilience				
B2 - Greening city buildings		✓		No
CCA1 – Integrating climate adaptation into Belgrade's decision-making processes, including policy developments and project investments		✓		No
CCA3 - Expansion of water services-public taps, etc.		✓		No
E3 - Landscaping to reduce noise on roads (2020-2024)		✓		No
E4 - Afforestation and Greening Programmes		✓		No
E5 - Biodiversity Management Measures (2020-2030)		✓		Yes
E17 - Green spaces		✓		Yes
E24 – Elaboration of greening projects and greening of school yards, kindergartens yards, public enterprises yards and other public areas that are not in the jurisdiction of maintaining public utility companies		✓		No
WW1 - Small watercourse and drainage channel rehabilitation		✓		No
WW2 - Water saving and loss reduction		✓		No
WW3 - Sustainable Urban Drainage Policy		✓		No
WW4 - Development of flood protection measures		✓		No
WW5 - Wastewater Treatment Programme		✓		No
WW6 - Rainwater storage and retention		✓		No
WW9 - Water retention schemes		✓		Yes
W4 - Water treatment facility for conversion of contaminated water from landfill to industrial water		✓		No[14]

6.2 Energy and efficiency

The following actions are underway or planned for energy production, transformation, distribution, and for end-use consumption efficiency, which either reduce GHG emissions or promote adaptation and improve resilience to climate change.

[14] Although this action is currently being implemented, it has been included as a non-key action given the limited adaptation benefits that it provides.

Table 6-2 All energy efficiency actions

Mitigation	Adaptation	Energy poverty	Responsible body	Stakeholders	Costs
Key actions					
LE1 - Development and improvement of the district heating distribution network (Q3 2021 – Q4 2030)					
This measure proposes to address four key areas of activity in one programme - Namely 1. Reduction of losses in the heat distribution network - The works are carried out in accordance with the Appendix containing road sections to be replaced (integral part of the Rehabilitation program), with adjustments to the new condition determined in the previous heating seasons. 2. Expansion of the heat distribution network - Within the planning documentation, it is envisioned that distribution network will be constructed according to the dynamics of fulfilling the purpose of the city's construction land and land for public purpose (during 2018 and 2019 the conditions for joining have been issued for 1,950,000 m2) 3. Interconnection of existing heating plants - Planned procurement of technical documentation for interconnection of heating plants 4. Closing the boiler rooms and connecting their users to the district heating system. 3 more schools will be added to the list of achievements from this year.					
✓	×	✓	PUC District heating company (JKP "Beogradske elektrane") and parts of the City administration - Secretariat for Energy, primarily, then Secretariat for Environmental Protection.	Ministry of Mining and Energy, IFIs, banks, PUC Electric Power Industry of Serbia (JP EPS), investors of construction of new buildings, City of Belgrade – Secretariat for Education and Children's Welfare, Secretariat for sport (connection of schools, kindergartens, sport centers etc. to district heating system), manufacturers and sellers of equipment etc.	€ 350 - 400 M: 1. Reduced losses in distribution network: € 100 M 2. Expansion of distribution network: € 200 - 250 M 3. Interconnection: € 45 M 4. Shutting down boiler rooms: € 5 - 15 M
PL1 - Energy efficiency in public lighting (Q3 2021 – Q3 2025)					
Substitution of old, inefficient lamps by more efficient ones, such as low pressure, high pressure lamps or LED.					
✓	×	×	PUC Public Lighting Company (JKP " Javno osvetljenje") and parts of the City administration - Secretariat for Energy, primarily	Ministry of Mining and Energy, international financial institutions, banks, possible candidates for PPP, manufacturers and sellers of equipment etc.	€ 15.2 M for switching bulbs – based on € 400 x 38,000 mercury bulbs.
Non-key actions					
E1 - Connecting to the natural gas distribution network (Q3 2021 – Q4 2030)					
This action involves an investment by the city to expand the natural gas distribution network. The city would be responsible for investment in its own buildings and develop a policy / incentive programme to support the residential sector and other commercial sector based on demonstrated interest. *Connecting buildings (municipal, public or residential) to the natural gas distribution network is significantly preferable to solid fuel (coal), diesel, and electricity-based heating which is currently wide-spread. Switching to natural gas would reduce GHG emissions and provide much more efficient use of energy.*					
✓	×	✓	City of Belgrade – Secretariat for Environmental Protection primarily and parts of the City administration - Secretariat for Energy, Secretariat for	Ministry of Mining and Energy, owners of the public and tertiary buildings, citizens, international financial institutions, investors in the construction of new buildings, natural gas distributors licensed for the territory of Belgrade	€ 200-300 M based on doubling the number of consumers – 30,000 - 40,000 new consumers, € 5,000 - 7,000 per connection, or more for some big consumers.

Mitigation	Adaptation	Energy poverty	Responsible body	Stakeholders	Costs
			Investments, Secretariat for Education and Children's Welfare, and parts of the city administration that conduct the implementation by the Law on planning and construction and participate in issuing the necessary conditions, permits and consent during the construction.		Most of this would be paid for by customers but some small subsidies from the city (e.g. 10%) could trigger increased uptake.
LE2 - Improvement energy efficiency district heating heat sources (Q3 2021 – Q1 2025)					
This measure includes three basic components: 1. Increasing the share of thermal energy from cogeneration; 2. Increasing energy efficiency of district heating plants; 3. Introducing solar energy (and other RES) into the district heating system					
✓	×	×	PUC District heating company (JKP " Beogradske elektrane") and parts of the City administration – Secretariat for Energy	Ministry of Mining and Energy, international financial institutions, banks, investors of construction of new buildings, manufacturers and sellers of equipment etc.	€ 300-400 M
PL2 - Smart lighting switches (Q3 2021 – Q4 2030)					
Electronic photo-switches can reduce the electricity consumption in public lighting by reducing night burning hours (turning on later and turning off earlier). A Tele-management system enables the lighting system to automatically react to external parameters like traffic density, remaining daylight level, road constructions, accidents, or weather circumstances. *The proposal includes a remote-control device in the distribution cabinets of public lighting. This investment would be of a great importance and is a much smaller investment than the installation of smart switches in lamps. There are about 2,457 switchboards in Belgrade and 200,000 lamps and it Is not possible to install smart switches for individual control of each lamp. For that reason, the proposal is to first establish control and the possibility of control on distribution cabinets and only then to consider the idea of installing individual smart devices in lamps.*					
✓	×	×	PUC Public Lighting Company (JKP " Javno osvetljenje") and parts of the City administration - Secretariat for Energy, primarily.	Ministry of Mining and Energy, international financial institutions, banks, possible candidates for PPP, manufacturers and sellers of equipment etc.	€ 35.63 M based on € 14,500 per switchboard x 2,457 switchboards – though more detail is needed on the number of light circuits in the city which would actually be implemented. Each circuit is supplied from one distribution cabinet and all connected lamps will be together remotely controlled. Controlled distribution cabinets also make it possible to remotely

Mitigation	Adaptation	Energy poverty	Responsible body	Stakeholders	Costs
					control from central dispatching point.
B1 - Renovation / Energy efficiency and use of RES in municipal buildings (Q3 2021 – Q4 2030)					
This action involves a holistic approach to renovation of public buildings by the city through a combination of analysis (i.e. investment-grade energy audits) followed by investments in measures including: *1. Renovation / Energy efficiency of municipal buildings - Typical measure, can include the building envelope, replacement of windows, roofs, heating/cooling improvements, lighting, appliances, green procurement rules* *2. Building management and energy monitoring in municipal buildings - Typical measure, can include training and awareness raising for management of building. Required under Serbian legislation.* *3. Use of renewable energy / efficient energy supply in municipal buildings - Typical measure, usually includes solar PV* or water heating, or biomass, and heat pumps.					
✓	×	×	City administration - Secretariat for Energy, as the leading entity, then Secretariat for Environmental Protection, Secretariat for Investments, Secretariat for Education and Children's Welfare, Secretariat for General Affairs, as these secretariats can also lead such projects, and parts of the city administration that conduct the implementation by the Law on planning and construction and participate in issuing the necessary conditions, permits and consent during the construction.	Schools, sport centres, kindergartens, Ministry of Mining and Energy, international financial institutions, banks, manufacturers and sellers of equipment etc.	€ 200-300 M assuming € 50 – 100 / m2 (There are a number of municipal buildings under the heritage protection, for which the costs are slightly higher than for ordinary buildings. However, the upper limit of this interval would also likely cover these costs.)
B3 - Energy efficiency and use of RES in residential buildings (Q3 2021 – Q4 2030)					
This action involves a holistic approach to renovation of existing residential buildings from residents themselves with the city's support through a combination of analysis (i.e. investment-grade energy audits) followed by investments in measures including:1. Encouraging the use of efficient equipment in residential buildings - Typical measures can include heating/cooling, lighting, appliances and can be implemented through grants, loans, or information campaigns 2. Renovation program for residential buildings - Typical measures can be implemented by the municipality with co-investments from the residents 3. Introduction of end-use heat metering and consumption-based billing 4. Realization of the project of reducing the number of individual heat sources by introducing renewable energy sources (heat pumps etc.)					
✓	×	×	City administration - Secretariat for Energy, as the leading entity, then Secretariat for Investments and parts of the city administration that conduct the	Ministry of Mining and Energy, Ministry of Construction, Transport and Infrastructure, building owners, real estate developers, manufacturers and sellers of equipment, etc.	€ 930 M assuming 46.4 million m2 residential buildings – of which 40% would be impacted at 50 €/m2 – much of the investment coming from building owners. Perhaps

Mitigation	Adaptation	Energy poverty	Responsible body	Stakeholders	Costs
			implementation by the Law on planning and construction and participate in issuing the necessary conditions, permits and consent during the construction.		20 - 40% from the city / other sources.
B4 - Regulations and incentive measures in residential buildings (Q3 2021 – Q4 2030)					
This action involves a wholistic approach to ensuring that new residential buildings are sustainable and go beyond current national standards, including: Energy efficiency and renewable energy measures in new residential constructions, namely: 1. Building regulations that consider energy use in new constructions / major renovations of existing buildings (residential buildings) – going beyond the requirements of national legislation 2. Encouraging through financial support the use of renewable energy / efficient energy sources (residential buildings) - Typical measure usually includes solar PV or water heating, or biomass, or heat pumps.					
✓	×	×	City administration - Secretariat for Energy, as the leading entity, then Secretariat for Investments and parts of the city administration that conduct the implementation by the Law on planning and construction and participate in issuing the necessary conditions, permits and consent during the construction.	Ministry of Mining and Energy, Ministry of Construction, Transport and Infrastructure, building owners, real estate developers, manufacturers and sellers of equipment, etc.	€ 540 M assuming 13.5 million m2 of new / completely renovated buildings – of which 100% would be impacted at 40 €/m2 – much of the investment coming from building owners. Perhaps 10% from the city / other sources.

Table 6-3 Further details of key actions on energy efficiency

Mitigation	Adaptation	Energy poverty	Action
✓	×	✓	**LE1 - Development and improvement of the district heating distribution network (Q3 2021 – Q4 2030)**
Sector			Sector: Local Heat/Cold Production Tool / Area of intervention: District heating/cooling network (new, expansion, refurbishment) Policy instrument: NA
Estimated impacts			Estimated CO_2 Reductions by 2030: 300,048 tonnes/yr compared to baseline scenario

Progress Indicators	Heat losses in district heat distribution network Number of customers connected with district heat network
Climate hazards addressed	NA
Outcome reached	Reduced energy poverty indicators
Vulnerable groups targeted	NA
✓ × ×	**PL1 - Energy efficiency in public lighting (Q432021 – Q3 2025)**
Sector	Sector: Public lighting Tool / Area of intervention: Energy Efficiency Policy instrument: NA
Estimated impacts	Estimated CO_2 Reductions by 2030: 31,382 tonnes/yr compared to baseline scenario
Progress Indicators	Number and types of bulbs for public lighting
Climate hazards addressed	NA
Outcome reached	Estimated final energy savings by 2030: 28,529 MWh/yr compared to baseline scenario
Vulnerable groups targeted	NA

6.3 Urban planning and mobility

The following actions are underway or planned for urban planning and mobility, which either reduce GHG emissions or promote adaptation and improve resilience to climate change.

Table 6-4 All urban planning and mobility actions

Mitigation	Adaptation	Energy poverty	Responsible body	Stakeholders	Costs
Key actions					
T1- Extension and development of the Belgrade Metro and train (Q4 2021 – Q4 2030)					
First component is the expansion of the BG train line with 2 new lines was planned: • *Makiš – Rakovica – Karaburma, length 13.7 km* • *Novi Beograd-Nikola Tesla Airport-national stadium length 16.2 km (in perspective up to 2027 to Obrenovac).* *The second component is the expansion of the existing tram network in total length of 28.7 km* *This action is foreseen to support investment in construction of the planned lines. Since the planning and design status is known, assumption is that this will be done through Design- build contract.*					
✓	×	✓	BG Metro and train, Secretariat for Public Transport	Government of the Republic of Serbia, City of Belgrade, Secretariat for Investment, Secretariat for Public transport	€ 200 million
Non-key actions					
T3: Purchase of electric buses/trams and busses that use RES with infrastructure development (Q3 2021 – Q4 2030)					

Mitigation	Adaptation	Energy poverty	Responsible body	Stakeholders	Costs
Phase 1 is planning and investing in e-vehicles infrastructure (chargers, maintenance depots, etc.). In addition, for 5400 bus-stops, according to the study received from Secretariat for Public Transport, renovation of existing bus-stops should include modern lighted by solar panels with info-displays, chargers for mobiles, etc. *Phase 2 is aligned with currently planned purchase for City public transport:* • *Component 1. Solo e-Bus vehicles (10 pcs)* • *Component 2.Solo e-Bus vehicles (5 pcs)* • *Component 3.Electric vehicles for pedestrian zone (3 pcs)* • *Component 4.Secretariat for public transport with the JKP "GSP Beograd" has a plan to renew the fleet of public transportation of GSP buses. For a period from 2020-2024, the procurement is planned: the joint buses with propulsion on the KPG (Euro 6)-330 vehicles, solo buses on the KPG (Euro 6) – 190 vehicles, buses for school transportation with propulsion on KPG (Euro 6) – 25 vehicles.* • *Component 5. There is also consideration of a substantial number of Trams (cca130 trams in 10 years).* *There is also consideration of a substantial number of Trams (50 trams in 10years)*					
✓	×	×	JKP "GSP Beograd"	City of Belgrade; Secretariat for Public Transport	Phase 1 CAPEX INFRA (EUR 50 million) Phase 2.1-4 CAPEX : EUR 380 million EUR Phase 2.5 CAPEX (130 trams X EUR 4 million = EUR 520 million EUR) TOTAL CAPEX 950 million EUR
T4 - Bicycle-Sharing System (Q3 2021 – Q2 2027)					
This measure envisages the introduction of the public bicycle-sharing system in the transport offer of the city, as an alternative type of transport and one of the possibilities for improving the existing traffic system. The bicycle-sharing system is a service that allows users to rent bicycles for short distances, which expands the tourist offer of the city. The implementation of the measure envisages: • *Establishment of this system in the area of Belgrade through the construction of bicycle rental stations.* • *Monitoring the effects of the implementation of public bicycle systems.* • *Defining measures for maintenance and improvement of the future system in accordance with the goals.* *The description is harmonized with the city project of the Public Bicycle System:* • *Planned 150 docking stations* • *in the first phase, 100 stations will be realized* • *the whole fleet will be in electric bicycles.* • *The selection of equipment and operators is provided through a competition.* • *The system must be integrated into the public transport ITS.* *A primary goal of bicycle-sharing systems has been to reduce traffic congestion and promote clean air and healthy lifestyle, particularly in large urban areas. A popular and relative low-cost option for supporting transition from private car use (and potentially public reluctance to use public transport in the wake of the Covid-19 pandemic) this could be a significant quick win investment.* • *Phase 1 – 100 docking stations* • *Phase 2 – 50 docking stations* *As with most cities, growing private car use is a challenge. Encouraging walking and cycling as alternatives has wide ranging benefits as well as being relatively inexpensive. The principal appears to enjoy political support with existing proposals to increase pedestrianised areas and cycle lanes, but these could be usefully scaled up. There are well*					

Mitigation	Adaptation	Energy poverty	Responsible body	Stakeholders	Costs
established public and private models for such schemes which would ideally be introduced in parallel with additional cycle friendly infrastructure (such as cycle paths).					
✓	×	×	Secretariat for Transport	City of Belgrade, Secretariat for Public Transport; Private partners	€ 6.45 million – representing 150 stations at € 35,000, 1000 bicycles at € 600 each, € 200,000 for software development, and € 400,000 for a depot
T5 - Encouraging walking and/or cycling within the city through improved pedestrian facilities and cycle ways (Q3 2021 – Q4 2030)					
This option is considering development of new and enhancing existing walking and cycling infrastructure. About 493 km is planned in the next 10 years, according to the Sustainable urban mobility Plan. • *Phase 1 – by 2022, 133 km,* • *Phase 2 – by 2027, 80 km,* • *Phase 3 – by 2030, 280 km,* *Enhancing pedestrian areas are planned by 2030.* *This action is comprised with planning and designing phase, followed by investment in construction of new bicycle pathways. This process will for sure be related to some policy changes and supported by public awareness campaigns.*					
✓	×	×	Secretariat for Transport	Secretariat for Public Transport; Belgrade Land Development Public Agency, Secretariat for Urbanism, Secretariat for investments	€ 33 million – representing approximately € 60,000 / km of bicycle lane1, plus € 3 million for pedestrian areas.
T6 - Commercial transport policy – City logistics (Q3 2021 – Q3 2022)					
New policy development with action plan. The objective is to cut the number of lorries and vans entering the urban Belgrade area in the morning peak by 40% by 2026. Another target is to cut daily vehicle movements by coordinating rubbish collection. This measure includes planning and development for logistics so space will be available for consolidation. Having depots (consolidation centres) in the right places (near ring-roads, such as Belgrade bypass, UMP SMP) will reduce the miles travelled by freight vehicles. With this measure HDV's will not be able to enter the city. All deliveries are supposed to be supported by LDV's and preferably e-vehicles. This policy applies on all freight, including transport of construction materials.					
✓	×	×	Secretariat for Transport	City of Belgrade; Secretariat for Public Transport; Serbian Chamber of Commerce	€ 500,000
T7 - Plan for a network of public chargers for electric vehicles (Q3 2021 – Q3 2026)					
The aim of this measure is to support the planning of charging stations for electric vehicles (EV) in a city in which the objective is to maximize the number of serviced vehicles under a fixed budget for building the stations. *Phase 1 – Operationalization plan for E-chargers (with policy changes)* *Taking into consideration the maximum capacity of each possible site for installing a station, in terms of the number of plugs that each one can have, and the distance from that location and each demand point, which is measured in walking time. To be able to apply these models, we would develop a charging demand model for based on parking data, considering that the higher the parking time, the greater the probability of charging. First assessment is based on use an existing mobility survey to extract parking data and establish a demand grid, and then we apply the models that gives us the optimal location for charging stations for the entire city allowing to compare both.* *Phase 2 – Purchase and Construction of needed infrastructure*					

Mitigation	Adaptation	Energy poverty	Responsible body	Stakeholders	Costs
With construction of outbuildings in the parking lot with solar panels in order to provide energy for electrical charging, applies the main sustainable goal.					
✓	×	×	Secretariat for Transport	City of Belgrade; Secretariat for Public Transport; owners of the electric vehicles – the City, private companies, taxi drivers etc.	€ 10 million – representing approximate investments of € 25,000 per station (mix of fast charging and slower charging) for 400 stations
T8 - Incentives and financing of e-vehicles for public and private commercial vehicles (Q3 2021 – Q3 2026)					
Establishment of fund which will finance the purchase of all commercial vehicles (public and private), when daily mileage of those vehicles is not more than 200 km per day. The wide range of stakeholders includes delivery services, taxis, cargo, public enterprises, public utility companies, city owned vehicles, e-cargo bikes, etc.					
✓	×	×	New Implementing agency	City of Belgrade; Serbian Chamber of commerce, Ministry of Mining and Energy	€ 1 million annually (€ 5,000 per unit)
L1 - Linear Park (Q2 2021 – Q2 2023)					
The linear park is a green urban redevelopment project covering a distance of 4.6 km from the Concrete Hall to the Pančevo Bridge, with an area of 46.7 ha. The planning proposal for the park protects the area of the ecological network of the Republic of Serbia of international importance as well as important ecological corridors. The linear park will provide public green areas, within which intervention zones have been proposed including 10 thematic units, intended for park, cultural, educational, sports and commercial facilities. These 10 thematic units are elaborated by different architectural teams. The total estimated value of the investment is € 40-50 million, of which it is estimated that about half of that amount will be provided by property owners along the park, the value of which will increase with its realization. The Park design has been developed in a participatory process involving citizens, NGOs, and other interest groups and the same applies to development of Detailed Regulation Plan which is underway. This will be followed by detailed Park design documentation and then investment.					
✓	×	×	Directorate for Construction Land and Construction of Belgrade (PC), Secretariat for Urban Planning and Construction,	Urban Planning Institute of Belgrade	€ 50 million
L2 - Brownfield Development Programme (Q3 2021 – Q3 2024)					
Development of a programme to activate abandoned, derelict or underused sites in order to increase urban densities and provide compact, mixed use urban spaces. Brownfield and infill development will reduce urban sprawl and land take at urban edges limiting open space, natural land and habitat loss. *The Programme includes preparation of a register of potential brownfield development sites (Step 1) as a basis for a feasibility study including assessment of sites including remediation needs/costs and land ownership issues, sites re-use scenarios and financing options depending on the viability and profitability as well as public sector role (infrastructural prerequisites and possible PPPs) (Step 2). Priority sites will be identified, taking into account also proximity to public transport hubs. Finally, inputs for GUP amendments will be defined including possible density bonuses (for example, for use of green infrastructure elements as climate adaptation measures), participatory analysis of broader socio-cultural context of proposed sites and elaboration of development briefs as a basis for urban design competitions (Step 3). The Programme includes also the establishment of a system of incentives for qualified brownfield development projects as well as identification of 2-3 pilot projects. In addition, funding sources for pilot projects will be established, including, where appropriate, land value capture and financial instruments at preferential conditions, blending IFI, pre-accession EU and national sources (including grant-based TA) (Step 4).*					
✓	×	×	Secretariat for Environmental Protection, Secretariat for Urban Planning and Construction,	Ministry of Economy, Institute of Cultural Heritage Protection – Belgrade, University of Belgrade – Faculty of Architecture, Institute of	€ 500,000

Mitigation	Adaptation	Energy poverty	Responsible body	Stakeholders	Costs
			Urban Planning Institute of Belgrade	Architecture and Urban and Spatial Planning of Serbia	
L4 - Study for a City-wide programme for urban green infrastructure development (Q3 2021 – Q3 2023)					
Development of the Programme supporting private and public sector green infrastructure (GI) projects, from individual building/site interventions, urban areas and redevelopment projects to large urban green corridors and networks. The Programme will also cover development of urban farming and gardening projects as well as involvement of local community groups in green areas collaborative management (planning, maintenance, biodiversity awareness and participatory monitoring). *The steps for carrying this out will be as follows:* • *Step 1: The typology of GI projects, mainly based on the Plan of general regulation (PGR) for green areas, will be developed.* • *Step 2: A group of 50-60 GI projects covering all types (from single plot interventions to urban scale corridors and networks) will be identified and assessed according to established criteria including contribution to urban natural capital and ecosystem services, biodiversity conservation, increased climate resilience through adaptation, public green space provision, air quality and urban cultural landscape values.* • *Step 3: Implementation instruments for a subset of 10-15 pilot projects will be developed including EU funding sources, financial instruments (preferential loans) and TA grants for innovative projects, different incentives (reduced urban impact fees, density bonus and faster permitting process).*					
✓	×	×	Secretariat for Environmental Protection, PUC "Zelenilo-Beograd", Secretariat for Urban Planning and Construction.	Urban Planning Institute of Belgrade, NGOs.	€ 500,000 for the study (programmes)
L5 – Study on Urban Land Management Policies and Instruments (Q3 2021 – Q3 2022)					
The action is focused on introduction of new urban land management instruments that will facilitate sustainable urban development and implementation of urban plans. The study will be prepared to analyse policy options and possible instruments in addressing excessive urban land take (construction land expansion), low density and sprawl development, private land banking, urban land readjustment and general implementation deficit. The priority instrument will be the introduction of an easily calculated, reported and monitored indicator of urban land take sustainability that can be implemented through existing General urban plan (GUP). This instrument prevents the unjustified expansion of construction land unless at least, for example, 80% of it has already been built. By doing so it reduces conversion of open space, farmland and woodland thereby limiting habitat loss and fragmentation due to urban land take. The second simple and proven instrument is urban land development density bonus in exchange for open and green space provision which can also be implemented through statutory urban plans. The study should result in specific proposals for policy / regulatory changes which could be adopted.					
✓	×	×	Secretariat for Urban Planning and Construction, Directorate for Construction Land and Construction of Belgrade (PC)	Urban Planning Institute of Belgrade, Institute of Architecture and Urban & Spatial Planning of Serbia, City municipalities.	€ 100,000
L6 - Donji Dorcol Superblock project (Q3 2021 – Q3 2024)					
This is an urban redevelopment pilot project that introduces principles of sustainable urban mobility in the Donji Dorcol urban block. It is based on the idea of redirecting transit traffic to the main city roads and opening secondary city streets within the block for people with their closure to motorized traffic. This significantly improves the local quality of life - valuable public space is conquered, walking, cycling, and socializing are stimulated, while reducing the negative consequences of traffic, such as accidents, noise and polluted air. This project is linked to ambitious plans for the development of the Linear Park in the immediate vicinity of Donji Dorcol, which means great potential for synergy for both projects, in particular through extension of green infrastructure elements from Linear park towards Donji Dorcol.					

Mitigation	Adaptation	Energy poverty	Responsible body	Stakeholders	Costs
Part of the street parking places will be moved to underground garages and 2 garage houses on the edges of the block thus freeing up valuable public spaces with street trees and other types of greenery. The total estimated value of the investment is € 12-15 million, of which it is estimated that about 40% will be spent for the construction of 2 garage houses with 400 parking places.					
✓	✓	×	Directorate for Construction Land and Construction of Belgrade (PC), Secretariat for Urban Planning and Constructions	Citizens, Secretariat for Transport	€ 12-15 million

Table 6-5 Further details of key action on urban planning and mobility

Mitigation	Adaptation	Energy poverty	Action
✓	×	×	**T1- Extension and development of the Belgrade Metro and train (Q4 2021 – Q4 2030)**
Sector			Sector: Transport Tool / Area of intervention: Modal shift to public transport Policy instrument: NA
Estimated impacts			Estimated CO_2 Reductions by 2030: 684,861 tons/a compared to baseline scenario
Progress Indicators			Passenger turnover of Belgrade metro and train, energy use in Belgrade metro and train
Climate hazards addressed			NA
Outcome reached			Estimated final energy savings by 2030: 3,577,649 MWh tons/a compared to baseline scenario
Vulnerable groups targeted			NA

6.4 Resilience

The following actions are underway or planned to increase resilience of the population, the built environmental and the industry to the impacts of climate change by reducing their vulnerability and exposure.

Table 6-6 All resilience actions

Mitigation	Adaptation	Energy poverty	Responsible body	Stakeholders	Costs
Key actions					
E5 - Biodiversity Management Measures (2020-2030)					
1. Preservation and improvement of existing protected natural resources, their extension and continuous management procedure improvements including measures of care and protection of existing valuable trees, planting of park seedlings, setting up of info boards. *2. Development of a modern and unique forestry information system that will be compatible with the EU information and communication system (EFIS) by unifying data at the forestry sector level and the integral environmental information system of the City of Belgrade.*					
×	✓	×	PUC "Zelenilo Beograd"	Secretariat for Environmental Protection, Ministry of Environmental Protection, Institute for Nature Conversation of Serbia, CSOs, IUCN	€ 221,000
E17 - Green spaces (2020)					
Afforestation of areas that are under the management system of PUC "Beogradvode" and raising of aisles with PUC "Zelenilo Beograd". The process of finding new areas for afforestation is ongoing. City municipalities have submitted their surface proposals and are looking for afforestation areas in accordance with the DRP for Green Area System.					
✓	✓	×	Secretariat for Environmental Protection	PUC "Greenery Belgrade", PUC "Beogradvode", PE "Srbijasume", Ministry of Environmental Protection, CSOs	Not yet defined
WW9 - Water retention schemes (2020-2025)					
Retention basins should be designed and built as local storm water control facilities, i.e. basins that temporarily store excess storm runoff and then discharge it at a rate not to exceed the downstream channel capacity. The retention basins should provide the 100-year runoff storage volume at the outfall point of the developed watershed. Regulating water flows will strengthen resilience for flood management.					
×	✓	×	PUC "Beogradvode"	Secretariat for Environmental Protection, Secretariat for Utilities and Housing Services, PUC Water Supply and Sewage of Belgrade	Not yet defined
Non-key actions					
B2 - Greening city buildings (Q1 2021 –Q1 2022)					
Building refurbishment programmes that involve retrofitting buildings with green infrastructure such as green walls, green roofs, and green outdoor space to increase energy efficiency and boost adaptation and resilience potential.					
✓	✓	×	Secretariat for Environmental Protection	Secretariat for Environmental Protection, Ministry of Agriculture, Forestry and Water Management, University of Belgrade –Faculty of Forestry,	€ 150,000 (study only); OPEX to be established by the city

			University of Belgrade –Faculty of Biology	
CCA1 – Integrating climate adaptation into Belgrade's decision-making processes, including policy developments and project investments (continuous)				
(1) Reducing climate sensitivities and increasing adaptive capacities and (2) Enhancing the sustainability and impact of action taken by the City by taking into account potential climate change impacts during the planning phase.				
×	✓	×	Secretariat for Environmental Protection	City administration and key public utility companies. The awareness raising campaign would target the entire population of Belgrade.	€ 250,000 in technical assistance; two full-time staff within the City administration
CCA3 - Expansion of water services-public taps, etc. (2020-2022)				
185 public drinking fountains and 43 fountains are supplied from the water supply system. During the summer months, water tanks and mobile taps are installed at the several checkpoints in the city.				
×	✓	×	PUC Water Supply and Sewage of Belgrade	Secretariat for Utilities and Housing Services, Public Health Institute of Belgrade, PUC "Greenery Belgrade"	Not yet defined
E3 - Landscaping to reduce noise on roads (2020-2024)				
(1) Planting new and replenishing existing tree lines along the streets in residential areas. 10,000 seedlings. (2) Protective green belts will be erected in locations that are planned in DRP for Green Area System. (3) Planting new and replenishing existing green protection belts next to busy roads by planting 5,000 seedlings of hardwoods and conifers (such as the E75 highway - passing through Belgrade and other roads).				
✓	✓	×	Public utility company "Zelenilo Beograd" and Secretariat for Environmental Protection	Ministry of Environmental Protection, PE "Srbijasume", Secretariat for Utilities and Housing Services, Secretariat for Transport, Ministry of Construction, Transport and Infrastructure	€ 1.68 million
E4 - Afforestation and Greening Programmes (Q3 2021 –Q2 2029)				
Upscaling existing initiatives through: (1) Planting of other park greenery on a total area of 178,827 m2 – decorative bush, hedges, roses and other floral material. (2) Erecting 10,000 m2 of green wall. (3) Vertical greening of pillars and retaining walls in 50 locations. (4) Reclamation of devastated and neglected spaces in 50 locations. (5) Roof gardens and green facades (1,000 m2).				
✓	✓	×	Secretariat for Environmental Protection	Ministry of Agriculture, Forestry and Water Management, University of Belgrade –Faculty of Forestry, University of Belgrade –Faculty of Biology	€ 100,000,000 (Afforestation: 2,000 €/ ha2; Green roofs/green walls: 150 €/ m); OPEX to be established by the City.
E24 – Elaboration of greening projects and greening of school yards, kindergartens yards, public enterprises yards and other public areas that are not in the jurisdiction of maintaining public utility companies (2020-2021)				
Implementation of the 10 conceptual landscape solutions in schoolyards which have been developed previously.				
×	✓	×	Secretariat for Environmental Protection, Secretariat for Education and Children's Welfare	PUC "Greenery Belgrade", Secretariat for Utilities and Housing Services, CSOs	Not yet defined
WW1 - Small watercourse and drainage channel rehabilitation (Q1 2021 –Q4 2030)				

Program of water management facilities for the regulation of watercourses regarding flood protection, erosion, and flash floods on category II watercourses in the city of Belgrade in 2020. This involves: (1) Development of registers of pollution sources of the most endangered small watercourses with by including "small" sources of pollution and (2) Quality improvement the most endangered small watercourses, and taking protection measures.					
×	✓	×	PWC "Beograd vode"	City of Belgrade – Secretariat for Environmental Protection, Secretariat for Investments	€2.5m/year (capital maintenance costs) – total of € 25 million; OPEX: <10% of CAPEX / year
WW2 - Water saving and loss reduction (Q3 2021 –Q4 2025)					
(1) Development and implementation of water conservation plan for Belgrade, including the measures for water distribution optimization, water harvesting and reuse, water saving measures in households; (2) water consumption monitoring systems in industry and households, etc.(3) Improvement of water distribution systems and better water management; (4) Reduction of losses through better leakage management; (5) Increase of the capacity of drinking water reservoir through the construction of new reservoirs for drinking water and rehabilitation of the existing.					
×	✓	×	City of Belgrade Secretariat for housing and communal utilities; Belgrade Water Supply and Sewerage Company; Belgrade Land Development Public Agency, PE	City of Belgrade; Secretariat for Environmental Protection; Secretariat for Investments	CAPEX: € 40,000,000
WW3 - Sustainable Urban Drainage Policy (Q3 2021 –Q2 2022)					
Policy measures to implement principals of Sustainable Urban Drainage within the city. This would be in conjunction with improved management of urban rainwater collectors and open canals for draining rainwater, including the regulation of streams.					
×	✓	×	Secretariat for Utilities and Housing Services, Secretariat for Economy, Secretariat for Urban Planning and Construction, PWC Belgrade Water Company, PUC Belgrade Water Supply and Sewerage	Secretariat for Environmental Protection, Ministry for Environmental Protection, private companies; Urban Planning Institute of Belgrade	€ 250,000 (study only); no direct OPEX but potentially costs associated with enforcement
WW4 - Development of flood protection measures (Q3 2021 –Q4 2024)					
There are existing schemes in place to address capacity problems in combined sewer systems, however the City would benefit from the expansion of that programme reducing flood risk in other areas of the city and improving resilience to climate change.					
×	✓	×	PWC Serbian Water Company, PWC Belgrade Water Company	City of Belgrade -Secretariat for Environmental Protection, Secretariat for the Defence, Emergency Situations, Communications and Coordination of Public Relations	Preliminary design quotes € 4.46 m per year x 4 years = € 17.84 m
WW5 - Wastewater Treatment Programme (Q3 2021 –Q4 2029)					
(1) Development of hydraulic model and quality monitoring system for rivers Sava and Danube; (2) Elaboration of the missing planning and technical documentation for the wastewater treatment plant for the city's communal wastewaters and construction of interceptor and other missing infrastructure, construction of wastewater treatment plant.					

×	✓	×	Ministry for Construction, transport, and infrastructure	City of Belgrade –Secretariat for Environmental Protection, Secretariat for Utilities and Housing Services, Secretariat for Investments, Belgrade Land Development Public Agency, PUC Belgrade Water Supply and Sewage	CAPEX: € 771 m
WW6 - Rainwater storage and retention (Q3 2021 –Q1 2025)					
Retention basins should be designed and built as local storm water control facilities, i.e. basins that temporarily store excess storm runoff and then discharge it at a rate not to exceed the downstream channel capacity. The retention basins should provide the 100-year runoff storage volume at the outfall point of the developed watershed.					
×	✓	×	Belgrade Water Company	City of Belgrade –Secretariat for Investments, PUC Water Supply and Sewage of Belgrade, Secretariat for Environmental Protection, Belgrade Land Development Public Agency	CAPEX: € 6 m
W4 - Water treatment facility for conversion of contaminated water from landfill to industrial water (2020-2021)[15]					
A facility for wastewater treatment will be built so that water from the Vinča landfill will be treated until reaching the quality of industrial/technical water.					
×	✓	×	Private partner "Beo čista energija"	Secretariat for Environmental Protection, Secretariat for Utilities and Housing Services, PUC City Sanitation	Entirely financed by the PP “Beo čista energija”.

Table 6-7 Further details of key action on resilience

Mitigation	Adaptation	Energy poverty	Action
✓	✓	×	**E5 - Biodiversity management measures (2020-2030)**
Sector			Environment and biodiversity
Estimated impacts			Possible benefits in terms of carbon capture and resilience benefits associated with greenspace
Climate hazards addressed			Droughts, Heavy precipitation / floods
Outcome reached			Conservation of biodiversity on the territory of Belgrade
Vulnerable groups targeted			All the flora and fauna with low adaptive capacity, ecosystem.
✓	✓	×	**E17 - Green spaces (2020)**
Sector			Land use planning
Estimated impacts			Possible benefits in terms of carbon capture and resilience benefits associated with greenspace
Climate hazards addressed			Heat waves
Outcome reached			Better living conditions, public health, reduction of CO2 emissions

[15] Although this action is currently being implemented, it has been included as a non-key action given the limited adaptation benefits that it provides.

Vulnerable groups targeted	The elderly, babes and children, the chronically ill, workers who work outdoor (exposed to heat), people with mobility impairments, homeless, athletes, people who live or work in central urban municipalities
× ✓ ×	**WW9 - Water retention schemes (2020-2025)**
Sector	Water; Waste
Climate hazards addressed	Heavy precipitation / floods, Storms
Outcome reached	Flood prevention on the territory of Belgrade
Vulnerable groups targeted	All persons living or working in affected areas, especially vulnerable categories of the population: the chronically ill, the elderly, babies, children, especially vulnerable people, homeless. Particularly sensitive inhabitants of the municipalities in the vicinity of rivers Obrenovac, Lazarevac, Zemun, Novi Beograd, Rakovica, Zemun, Čukarica, Palilula, Savski Venac.

Appendices

A. Feedback received from stakeholders on BEI and VRA

Emissions Sources

The following table identifies the Energy Consumption Sectors from the CoM (Baseline Emissions Inventory Sheet) which are proposed to be considered within the Baseline Emissions Inventory.

Table A.1: Proposed sectors for inclusion in the Emissions Baseline

Sector	Key Sector	Recommendation on Inclusion	Comments
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES			
Municipal buildings, equipment/facilities	Yes	Include	Significant opportunity for benefit in public buildings and facilities.
Tertiary (non-municipal) buildings, equipment/facilities	Yes	Consider Excluding	The city has limited control over non-municipal tertiary buildings. Stakeholders felt that (in terms of GCAP sectors) industrial heat and energy loads be excluded due to this lack of influence. It is likely that a similar principal would apply to the commercial sector. It is noted that this is a "key sector" however the methodology requires three of four key sectors to be considered and excluding Tertiary facilities would remain within this parameter. We recommend further consideration of the inclusion of Tertiary Buildings as a sector once there is a clearer view on the potential to influence the sector (i.e. once the study has begun to investigate tangible actions).
Residential buildings	Yes	Include	There is potential for improvement in this are both in terms of sources of energy (encouraging the use of district heating or renewables over solid fuel which has both climate and air quality challenges) and thermal efficiency.
Public lighting	No	Include	Not a key sector but Stakeholders feel that there is opportunity to reduce energy consumption in this area.
TRANSPORT			
Municipal Fleet Public transport Private and commercial transport	Yes	Include	Transport has been identified as a priority in the Green City Action Plan, including indicators 10-10.3 which relate to vehicle efficiency and identify that there is significant opportunity in vehicle efficiency to be made (as well as overall reductions in use)

Risks and Vulnerabilities

The following table identifies Policy Sectors identified in the CoM methodology which may be adversely impacted by Climate Change. It presents a brief comment on each sector in light of stakeholder feedback received at the workshop 3rd December 2019.

Table A.2: Comments on Vulnerability Assessment following workshop

Impacted Policy Sector	Impact level in SECAP Technical Assessment	Relevance of Stakeholder Comments
Buildings	High	Climate resilience was not specifically addressed in the Buildings discussion and is considered to remain high risk.
Transport	High	The transport network does have some vulnerabilities which are not yet well understood. Suggestion is that intelligent traffic systems may help to make the network more resilient to extreme events. However further consideration is needed on the impact on (for example) Public Transport Infrastructure.
Energy	High	Resilience to extreme events was rated high priority by stakeholder citing vulnerability of district heating plants to flooding and a need for energy diversification to provide better resilience.
Water	High	Flooding, distribution and demand management remain concerns to stakeholders (although it was noted that water quality is not considered a priority area in the GCAP).
Agriculture and Forestry	High	The city's environmental strategy appears to rely heavily on the concept of afforestation. Ensuring that forests are resilient to climate change will make the wider strategy more resilient.
Environment and Biodiversity	High	Ecology and biodiversity were rated as a priority in the workshop. It is reasonable extrapolate that protecting diversity from Climate Change is as important as protecting biodiversity from inappropriate land changes.
Health	High	Health is not a GCAP sector, however Air Pollution and Extreme Heat and Cold were identified as challenges to be considered which also have relationships to public health and climate.
Tourism	Moderate	Tourism wasn't identified as a significant element of the GCAP, although it was noted that tourism may have a role to play in providing an economic justification for developing greenspace.
Other: Social Infrastructure	High	Health care facilities and schools (and other social infrastructure operated by the City) would be considered priorities within the wider context of Municipal Buildings.
Other: Industry	High	Stakeholders were reluctant to include emissions and environmental performance of industrial units (which are predominantly in the Private Sector and therefore under limited influence from the city). However industrial properties may remain vulnerable to adaptation risks such as flooding.

B. Development of Vision

Approach to Developing Vision

Our approach for developing the Vision was to hold broad consultation to collect ideas and concepts. These were subsequently formulated into a draft Vision for discussion in a workshop. We welcomed direct inputs from the Mayor on his vision for a Green Belgrade.

Consultation was conducted to a wide audience through popular social media channels, with guidance provided by the City on the most appropriate channels. This included:

- Facebook: https://www.facebook.com/bg.gradonacelnik
- Twitter: @beograd_RS
- Instagram: https://www.instagram.com/dr_gradonacelnik/?hl=en

The Consultants developed a brief introduction and question for stakeholders to respond to.

After collating responses, the Consultant performed a basic qualitative analysis of the responses to identify and classify themes.

Options Considered

The City provided 3 overarching visions for voting. In addition, it was possible for anyone to suggest their own ideas. The offered visions were:

1) Achieve the goal of continuous, sustainable development of a smart city recognized as a centre of excellence in terms of protecting the environment and health of its citizens, as well as rational resource management. (marked red in figure 2.1)
2) We are smartly developing a capital for all citizens and especially children, pursuing the ideals of an even greener, healthier, and more sustainable future. (marked blue in figure 2.1)
3) We enable citizens to make their lives healthier and the planet cleaner. (marked green in figure 2.1)

Results of Consultation Exercise

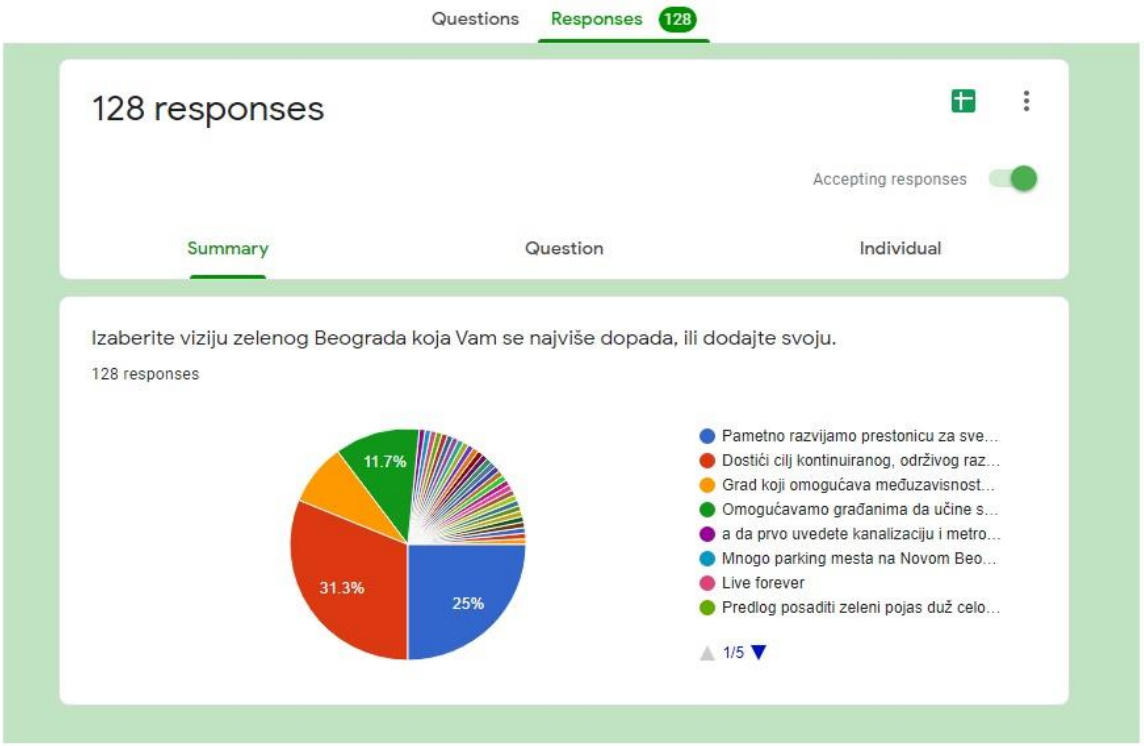
128 responses were received. The qualitative analysis of the free text suggests led to an additional Vision option:

4) A City that enables the interdependence of natural ecosystems and human activity. (marked orange in figure 2.1)

The four Vision options each received greater than 10% of the public vote.

The outcome of the exercise is presented in the figure below.

Figure 2.1: Visioning results



Selected Vision

The City provided the results from the public consultations and voting to the Consultant on 10th April, and identified the "winning" vision as:

> *Achieve the goal of continuous, sustainable development of a smart city recognized as a centre of excellence in terms of protecting the environment and health of its citizens, as well as rational resource management.*

In second place was:

> *We are smartly developing a capital for all citizens and especially children, pursuing the ideals of an even greener, healthier, and more sustainable future.*

The third ranked was:

> *We enable citizens to make their lives healthier and the planet cleaner*.

The last with the score greater than 10% was:

A City that enables the interdependence of natural ecosystems and human activity

The selected vision has been further discussed with stakeholders and results have been considered by the Mayor too who decided to choose the vision that was ranked in the second place.

As presented in the SECAP above, the selected vision is therefore:

> ***We are smartly developing a capital for all citizens and especially children, pursuing the ideals of an even greener, healthier, and more sustainable future.***

C. Approach to Options Assessment

The following approach was followed to develop a shortlist. Each component is described in more detail below.

Identification of Options

The Consultants undertook a review of key current plans by sector to identify potential projects that could be included in the GCAP and the SECAP. This was based on information collected as a part of the political framework report and is not replicated in this report. Key documents included:

1. Belgrade City Environmental Protection Program
2. The Development Strategy of the City of Belgrade
3. Climate Change Adaption Action Plan and Vulnerability Assessment

This was also informed by engagement with stakeholders primarily through a prioritisation workshop held in December 2019, but also by technical engagement throughout the process of developing the policy and regulatory framework and the technical assessment reports.

These options were then collated into a “questionnaire” which took the format of a table containing all potential projects and highlighting gaps in the Consultant’s understanding of the challenges. Requests were then directed to technical experts within the City and the City managed enterprises (via the City’s “Working Group”[1]), to solicit feedback on the “long list”.

The initial “long list” of options totalled 109 potential Actions based on the research done during the Technical Assessment and Prioritisation (of challenges), stakeholder workshops and bilateral engagement with City officials[2].

A further activity was undertaken to refine and rationalise these Actions into a shorter list of potential projects. Projects were aggregated for the following key reasons:

1. Several projects could be usefully rationalised into as one programme of Actions delivered together
2. Identified Actions had duplicated similar or identical objectives and could be usefully rationalised into one Action
3. The actions had a Climate Adaptation driver, but it was possible to embed them in another Action following the principle of “mainstreaming” Adaptation and Resilience rather than addressing it as a separate issue.

This aggregation resulted in a list of 76 Actions in total which we considered to as the “Long List” of projects to be considered in the Options Analysis. This full list (and the analysis described below), is presented in Annex D.

Evaluation of “Long List”

The Long List of Actions was correlated against the Strategic Objectives, evaluated against a series of qualitative criteria (defined below), ranked based on relative scores against the qualitative criteria, and filtered to ensure that actions to be included in the GCAP or SECAP are likely to be effective and appropriate to the GCAP or SECAPs objective. The results of this evaluation are detailed in Appendix D but a summary of the results is given in Chapter 5 of this report (organized according to the Strategic Objective).

Multicriteria Assessment

Each potential Action was subjected to a basic multicriteria analysis, testing each proposal against five key criteria to determine their level of suitability for inclusion in the GCAP. These include:

1. **GCAP benefit** – Will it have a meaningful impact on a priority area or strategic objective that has been identified in the GCAP development process?
2. **Additionality** – Will inclusion in the GCAP significantly improve the probability of the project being delivered? Projects that are already being delivered under other programmes should not be included unless they could be scaled up.
3. **Deliverability** – Based on expert opinion and the limited data available, is it likely to be technically deliverable?
4. **Indicative likelihood of financing** – Is it likely to be within the capacity of the city to afford the project or for other financing entities (government, IFIs, donors) to finance it?
5. **Political alignment** – are there significant political factors that mean the project should not be included? (this should be guided by the City)[3]

Alternative Criteria were set out to determine whether or not projects should be considered for inclusion in the SECAP, which has a narrower focus on Climate Change issues. These included

6. **Mitigation potential** – is the project likely to meaningfully contribute to reducing or offsetting the City's carbon emissions?
7. **Adaptation potential** – is the project likely to meaningfully contribute to the City's potential to adapt or be resilient to climate vulnerabilities?

The full qualitative framework for this analysis is set out in Table C.1: MCA Criteria.

Table C.1: MCA Criteria

	0 (Eliminate) – None	1 – Limited/Low	2 Good/Moderate	3 Excellent/High
GCAP Criteria				
Benefit	The project will not contribute to delivering strategic objectives or could damage the prospects of achieving a strategic objective	The project will contribute to strategic objectives but is unlikely to make a material impact.	The project is well aligned and will have a notable and measurable impact on a strategic objective	The project is very well aligned with strategic objectives and will have a transformative impact on a single objective or a notable and measurable impact on multiple objectives
Additionality	The project is ongoing and already funded or has secure funds committed and cannot / should not be scaled up	Inclusion in the GCAP may provide an alternative source of funding and make a project more likely to happen or be scaled up	Inclusion in the GCAP will likely improve the scale of a project or significantly improve its prospects of going ahead	The project is not otherwise included in existing / ongoing programmes or is at a low scale and will not happen / be scaled up without inclusion in the GCAP and subsequent implementation.
Deliverability	The project is unlikely to be technically feasible or relies on technologies that are not yet available.	The project is deliverable in principal but would be extremely technically challenging and high risk.	The project is feasible in principal and deliverable with a 5-10-year timeline but may require additional capacity amongst key implementing actors.	The project is proven to be feasible and could be delivered quickly (i.e. <5 years) given capacity of the key implementing actors.

Indicative likelihood of financing	The project is likely to be outside the City's budget and / or does is not likely to be interesting for other sources of finance.	The project is potentially affordable for the city and / or interesting for other sources of finance, but it is likely that it would significantly diminish the city's ability to implement other projects.	The project is likely to be comfortably within the limits of resources for the city and / or would be interesting for other sources of finance.	The project is easily within the limits of resources of the city and / or is highly likely to be interesting for other sources of finance.
Political alignment	The project is counter to a key political position of the Mayor or the Council and is highly likely to be rejected.	The project would be politically contentious and is likely to face significant political opposition.	The project is well aligned and is unlikely to face substantial political objection.	The project is fully aligned with existing political commitments and would be uncontentious during the approval process.
Additional SECAP Criteria				
Mitigation potential	Likely to create significant additional GHG emissions	Neutral or Marginal benefit for GHG emissions potential	Notable and measurable impact on GHG emissions	Very large impact on GHG emissions
Adaptation potential	Likely to reduce resilience to climate change	Neutral or Marginal benefit adaptation / resilience potential	A clear direct benefit in terms of adaptation/resilience benefit.	Significant adaptation / resilience benefit.

Assessors (Consultant's sector experts) used the multicriteria assessment (MCA) framework to score each option from zero to three to indicate the extent to which it aligned to the Green Cities programme's broad objectives. The scoring mechanism was adjusted for each criteria, as described in Table 4.1, but followed the principals below:

1. **No alignment** (projects which are not aligned with the criteria and therefore scored zero above were recommended to be excluded from the GCAP[4])
2. **Limited/Low Alignment**
3. **Good/Moderate Alignment**
4. **Excellent/High Alignment**

As the assessment was qualitative, there was a risk of subjective bias from different reviewers. To mitigate this, an online workshop was undertaken amongst the assessors to understand the methodology and several examples from a range of sectors were analysed collectively to form a common understanding of the criteria amongst the assessment team. The ratings were subsequently reviewed by the Team Leader and the Financial Expert to identify areas where inconsistencies in approach may have emerged. These were then adjusted by the team to form the final scoring.

Application of Weightings

The results of the MCA provide an objective basis for proposing a technical prioritisation of options. However, due to the narrow band of scoring (0-3) there was limited differentiation between the scores, and it was considered beneficial by the Consultant's team to apply weightings to the overall scores to provide a mechanism for further differentiating between the "Proposed Actions".

Weightings (x5) were added to:

1. **Benefit** – the importance of benefit (which relates to the objective's ability to address Strategic Objectives) was elevated as this is the fundamental purpose of the plan
2. **Deliverability** –elevated to ensure that implementable projects were prioritised
3. **Indicative likelihood of financing –**elevated to ensure that projects which were likely to attract finance were prioritised

A neutral weighting (x1) was added to other criteria:

4. **Additionality** - Not elevated as it was of most use as a binary measure for exclusion (i.e. if it added nothing to existing plans, it should not be considered). While it is useful to differentiate scales of additionality for prioritisation of selected Actions, it was not felt to be a critical screening criterion.
5. **Political Alignment** - Our assessment provides an indication of likely political challenge based on the Consultants' experience. This is useful in understanding if projects may be politically contentious. However, political decisions will be made during debates as part of the process to consider adoption of the GCAP by elected representatives of the City, rather than by the Consultant at this stage. Therefore, minimal additional weight was added to this criterion.

Ranking of GCAP Options

Weighted scores derived from the process above were then summed for each Action, to give an indicative level of priority and provide a common basis on which to rank Actions. We have chosen to use a percentage score to approximately indicate where an Action ranks within the list of options (with 100% being most favourable and 0% being least favourable). However, there are a number of important limitations to this method which should be highlighted:

1. The scoring used is qualitative and while based on expert opinion, is therefore subjective.
2. The data available to make decisions on individual actions is limited and therefore it is based on the Consultant's experience of the type of project, rather than being a detailed assessment of the specific Action.
3. The scores allocated are not a linear scale - i.e. one cannot infer that the difference between a score of 1 and 2 represents the same scale of change as the difference between 2 and 3, or that differences between categories are similar. As a result, "summing" the scores across categories (as we have) and providing a numerical value may inaccurately infer a level of analytical rigour that is not intended.

Consideration was given to developing thresholds for categories of projects to help provide a stronger objective basis for categorising Actions into high, medium, or low priority groups (and ultimately where appropriate to screen out Actions). However, based on the limitations described above we concluded that this was not appropriate and that the ranked scores should only be used as a broad guide to the assessor when developing conclusions about each Action.

Overall Assessment of GCAP Actions

Based on a combination of the percentage score and notes provided by assessors and expert judgement, each Action was reviewed to determine whether it should be a High Priority (i.e. that it is a key intervention), Medium Priority (it is a valuable intervention), Low Priority (it is a constructive intervention but of limited value), or if it should be excluded (it is not aligned to the Strategic Objectives or it is perceived to perform poorly on a number of the criteria). A conclusion for each option is provided in the "GCAP Conclusion" column of Annex D.

Any projects scoring zero in any of the MCA categories described above were considered to be "non-aligned" and were excluded on the basis of this score. The detailed assessment table presented in Annex D records these projects (31 in total) and identifies the explicit rationale for excluding them.

An additional 6 options were "manually" screened by the Consultant's Team Leader because despite the scoring indicating that they had some benefit, it was felt that this benefit wasn't sufficient or sufficiently well

aligned to the Strategic Objectives to justify inclusion. Where this was the case a justification has been provided in the “GCAP Conclusion” column of Annex D.

Overall Assessment of SECAP Options

SECAP options were evaluated primarily on their perceived benefit in terms of GHG Emissions or Resilience/Adaptation potential (captured by the “Mitigation Rating” or the “Adaptation” criteria outlined in Table C.1: MCA Criteria above). Broadly where Actions had scored >1 on either of those criteria they were considered for inclusion in the GCAP. However, these were reviewed individually, and due consideration was given to the other criteria considered in the GCAP assessment as background to this. A total of 41 Actions were identified for further consideration in the SECAP.

[1] This is a group established by the City of Belgrade designed to represent the main sectors which the GCAP examines to provide a coordinated focal point for the delivery of the GCAP.

[2] This engagement has become more difficult as City officials are diverted to maintain essential services during the COVID-19 pandemic, and we consider it likely that we have received all of the feedback we are likely to receive.

[3] Note that with limited engagement possible as a result of the Covid-19 crisis, these judgements have been made by the consultants supporting this process rather than the City’s representatives and this will be a key area of interest during the city’s review and stakeholder engagement process.

[4] Note that this did not necessarily exclude the project from consideration in the SECAP

D. Detailed Assessment of Measures

No	Sector	Measure title	Measure description	Primary Strategic Objective	Other Strategic Objectives	Implementing Body	Benefit -	Additionality	Deliverability	Indicative Likelihood of Finance	Political Alignment	Weighted Score (GCAP)	GCAP % Rank	GCAP Conclusion	Priority Level	Mitigation -	Adaptation -	SECAP Relevance	Rationale for consideration in SECAP
B1	Buildings	Renovation / Energy efficiency and use of RES in municipal buildings	Wholistic approach to renovation of buildings through a combination of Measures including 1. Renovation / Energy efficiency of municipal buildings - Typical measure, can include the building envelope, replacement of windows, roofs, heating/cooling improvements, lighting, appliances, green procurement rules 2. Building management and energy monitoring in municipal buildings - Typical measure, can include training and awareness raising for management of building. Required under Serbian legislation. 3. Use of renewable energy in municipal buildings - Typical measure, usually includes solar PV or water heating, or biomass.	B1/E2			2	3	3	3	3	46	82%	Strongly aligned to objectives B1 and E2. Perhaps less impactful in direct carbon emissions terms than measure B2 (for residential buildings) due to the smaller number of buildings but potentially a better early intervention as a) municipal building projects could be progressed more quickly if they are within the control of the City and b) it demonstrates feasibility and leadership to other building owners.	High Priority	2	2	Yes	Good mitigation potential (although overall impact will be limited by number of Buildings). Energy efficiency and improved access can create improved resilience. Note this was not a high priority in previous studies.
B2	Buildings	Greening city buildings	building refurbishment programmes that involve retrofitting buildings with green infrastructure such as green walls, green roofs, and green outdoor space to increase energy efficiency and boost adaptation and resilience potential.	B2	B1, E2, CCA1		3	3	3	3	3	51	95%	Greening city buildings is in line with existing policy commitments announced by the city and should therefore have strong existing political support. It provides opportunities for natural systems to provide regulating services for the city and therefore impacts a wide range of issues from biodiversity, to energy efficiency, and climate resilience. There are no serious perceived barriers. In many cases this would be better undertaken as a part of wider building rehabilitation projects, however it could be a	High Priority	2	3	Yes	Greening buildings can Improve building efficiency by up to 30%. Green areas contribute to resilience in a range of ways including buffering thermal risks and providing natural attenuation for rainfall

No	Sector	Measure title	Measure description	Primary Strategic Objective	Other Strategic Objectives	Implementing Body	Benefit -	Additionality	Deliverability	Indicative Likelihood of Finance	Political Alignment	Weighted Score (GCAP)	GCAP % Rank	GCAP Conclusion	Priority Level	Mitigation -	Adaptation -	SECAP Relevance	Rationale for consideration in SECAP
														standalone measure on some buildings.					
B3	Buildings	Energy efficiency and use of RES in residential buildings	1. Encouraging the use of efficient equipment in residential buildings - Typical measures, can include heating/cooling, lighting, appliances and can be implemented through grants, loans, or information campaigns 2. Renovation program for residential buildings Typical measure, can be implemented by the municipality with co-investments from the residents 3. Introduction of end-use heat metering and consumption-based billing 4. Realization of the project of reducing the number of individual heat sources by introducing renewable energy sources (heat pumps etc.) 5. Financial incentives for reduction of fossil fuels use for heating	B1/E2	CCA1	Secretariat for Energy, primarily, 3. JKP "Beogradske elektrane"	3	3	3	3	2	50	89%	Well aligned with existing policies and city objectives. Inclusion in the GCAP could improve uptake, either at a small scale through a "SEFF" style lending product or at a large-scale programmatic level. There are some potential challenges in terms of users being comfortable with domestic level metering and also in persuading private residents to commit to schemes. However, there are examples of successful schemes in Serbia suggesting it could be relative "quick win".	High Priority	3	2	Yes	Significant mitigation potential across a sector with a large number of consumers Adaptation benefits in energy supply resilience, building resilience and human health factors
B4	Buildings	Regulations and incentive measures in residential and tertiary buildings	1. Building regulations that consider energy use in existing / new constructions (residential and tertiary buildings) 2. Encouraging the use of renewable energy (residential and tertiary buildings) - Typical measure usually includes solar PV or water heating, or biomass.	B1/E2	CCA1		3	2	3	2	3	45	67%	Regulatory measures are available at national levels. The city could develop either tougher targets or incentive schemes to encourage private uptake of RES and energy efficiency measures in buildings that go beyond basic compliance.	Mediu m Priority	2	2	Yes	National policy already in development but will likely have an impact on GHG emissions. Energy efficiency and improved access can create improved resilience. Note this was not a high priority in previous studies.

No	Sector	Measure title	Measure description	Primary Strategic Objective	Other Strategic Objectives	Implementing Body	Benefit -	Additionality	Deliverability	Indicative Likelihood of Finance	Political Alignment	Weighted Score (GCAP)	GCAP % Rank	GCAP Conclusion	Priority Level	Mitigation -	Adaptation -	SECAP Relevance	Rationale for consideration in SECAP
B5	Buildings	Upgrade of Belgrade water and Sewage Supply Programme	External joinery replacement, adding insulation in order to increase energy efficiency	B1	B2, E2, CCA1	Office building maintenance sector	3	0	3	3	3	0	0%	This programme is completed	Exclude	2	2	Yes	Good mitigation impact per building (although low no of buildings means this is likely to be nominal overall) Similarly on adaptation, there may be benefits but they will be minimal
CCA 1	Climate adaptation and resilience	Climate Awareness	Public health type awareness raising activity around Climate Change and Adaptive Behaviours - Informing employees about the environment and climate change.	CCA1	E2	Sector for Integrated Quality System / Information service.	2	1	3	3	3	44	60%	Institutional measures and capacity will be considered in the SECAP for adaptation and resilience. It is more appropriate to capture this in that document than include as a measure in the GCAP. As such we propose that this is excluded from the GCAP	Medium Priority	1	2	Yes	There is an existing assessment of vulnerability, but it does not appear to have gained wide exposure amongst city authorities. This could help improve mainstreaming of resilience issues into decision making.
CCA 2	Climate adaptation and resilience		Afforestation– planting a total of 50,000 seedlings of hardwoods and conifers for the purpose of increasing the total green fund of the City.	CCA1		PUC „Zelenilo Beograd “	3	0	2	3	3	0	0%	This measure was integrated into Measure E4	Exclude	1	1	No	
CCA 3	Climate adaptation and resilience	Expansion of water services-public taps, etc.	185 public drinking fountains and 43 fountains are supplied from the water supply system. During the summer months, water tanks and mobile taps are installed at the several checkpoints in the city.	CCA1			0	1	3	3	3	0	0%	This measure was not considered to be significant for the GCAP but may be considered in the SECAP.	Exclude	1	2	Yes	Some resilience benefit for citizens during hot periods.
E1	Environmental quality (air)	Connecting to the natural gas distribution network	The plan is to replace the existing boilers with complete natural gas boiler and equipment (in addition to the District Heating Measures covered in LE1)	E1	CCA1	Secretariat for Environmental Protection	3	2	3	2	3	45	67%	Connecting properties to district heating is the preferred solution to reducing reliance on solid fuel boilers (which are a substantial contributor to air quality challenges in the city). However, were this being not possible or practical, connections to natural gas boilers is significantly preferable and	Medium Priority	2	2	Yes	Potential for improvements to GHG emissions. Resulting health benefits associated with reduced emissions from boilers could improve individual resilience to respiratory problems which can in turn have benefits in terms of resilience to other health related

No	Sector	Measure title	Measure description	Primary Strategic Objective	Other Strategic Objectives	Implementing Body	Benefit -	Additionality	Deliverability	Indicative Likelihood of Finance	Political Alignment	Weighted Score (GCAP)	GCAP % Rank	GCAP Conclusion	Priority Level	Mitigation -	Adaptation -	SECAP Relevance	Rationale for consideration in SECAP
														therefore it is reasonable to consider this as a complementary measure.					impacts of climate change.
E2	Environmental quality (air)	Air Quality Data system	Establish an air quality information system as part of Belgrade's integral environmental information system During 2016 and 2017, the project "GIS air quality" was drafted, and during 2018 and 2019, the GIS Quality of Environmental Factors project, which also included air quality. Contractors are obliged to enter monthly and annual air quality data regularly.	E1		Secretariat for Environmental Protection	2	1	3	1	3	34	47%	There is an existing system and the cost of upscaling it would be relatively small. Our suggestion is that it would be better to include systems such as this in a wider smart city objective (L3 rather than have a separate activity)	Low Priority	1	1	No	
E3	Environmental quality (noise)	Landscaping to reduce noise on roads	1. Planting new and replenishing existing tree lines along the streets in residential areas. 10,000 seedlings. 2. Protective green belts will be erected in locations that are planned in DRP for Green Area System 3. Planting new and replenishing existing green protection belts next to busy roads by planting 5,000 seedlings of hardwoods and conifers (such as the E75 highway - passing through Belgrade and other roads)	GS1	L3, E2, GS1	Public utility company "Zelenilo Beograd" and Secretariat for Environmental Protection	1	1	3	2	3	34	47%	this is a useful ongoing programme. It is perhaps better to consider as a part of a wider Green Infrastructure and/or planting strategy (such as proposed in E4)	Exclude	2	2	Yes	Potential benefits in terms of carbon capture and natural services providing resilience
E4	Environmental quality (green spaces)	Afforestation and Greening Programs	There is an existing objective to increase the forest area to 20% of Belgrade's territory through the implementation of the Belgrade Forestry Strategy. BUC "Zelenilo Beograd" have an aim to - plant a total of 50,000 seedlings of hardwoods and conifers. Planting of other park greenery on a total area of	L3/B2/ GS1		PUC “Zelenilo Beograd”	3	3	2	3	3	46	82%	There are existing ambitious targets to for tree planting in Belgrade however and there are projects in progress financed directly by the city. However, these have potential for significant upscaling to achieve the city's existing objectives.	High Priority	3	3	Yes	Potential benefits (and if scale is large, the significant benefits) in terms of carbon capture and natural services providing resilience

No	Sector	Measure title	Measure description	Primary Strategic Objective	Other Strategic Objectives	Implementing Body	Benefit -	Additionality	Deliverability	Indicative Likelihood of Finance	Political Alignment	Weighted Score (GCAP)	GCAP % Rank	GCAP Conclusion	Priority Level	Mitigation -	Adaptation -	SECAP Relevance	Rationale for consideration in SECAP
			178,827 m2 - decorative bush, hedges, roses and other floral material. Erecting 10,000 m2 of green walls. Vertical greening of pillars and retaining walls in 50 locations. Reclamation of devastated and neglected spaces in 50 locations. Roof gardens and green facades (1,000 m2).																
E5	Environmental quality (biodiversity)	Biodiversity Management Measures	1. Preservation and improvement of existing protected natural resources, their extension and continuous management procedure improvements including measures of care and protection of existing valuable trees, planting of park seedlings, setting up of info boards. 2. Development of a modern and unique forestry information system that will be compatible with the EU information and communication system (EFIS) by unifying data at the forestry sector level and the integral environmental information system of the City of Belgrade- Experts will carry out the monitoring of the Great War Island. GIS of green areas that are in the regular system of maintenance of PUC "Zelenilo Beograd" was create.	Bio1	L3, E2, CCA1	PUC “Zelenilo Beograd”	2	1	2	1	3	29	45%	This is an ongoing project which is useful to capture in the SECAP but not a high priority for the GCAP	Exclude	2	3	Yes	Possible benefits in terms of carbon capture and resilience benefits associated with greenspace.
E7	Environmental quality (air)	Improvement of air quality control programs by aligning the list of parameters monitored with EU	The air quality control Program on Belgrade's territory was adopted for 2020-2021. All parameters controlled, measuring sites, and measuring frequency are	-		Secretariat for Environmental Protection	3	0	3	1	3	0	0%	This programme is completed	Exclude	1	1	No	

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		air quality standards	in accordance with domestic regulations.																
E8	Environmental quality (air)	Optimization of air quality control measuring points and the introduction of new ones	The air quality control Program on Belgrade's territory was adopted for 2020-2021. By introducing new measuring places and restructure of existing all municipal municipalities is covered by the network of measuring places	-		Secretariat for Environmental Protection	3	0	3	1	3	0	0%	This project is close to completion	Exclude	1	1	No	
E9	Environmental quality (air)	Development of air emission registers within the registers of environmental pollution sources on the territory of the administrative area of the City of Belgrade	The database developed has been developed and adapted to the Cad corp information system used by the Secretariat. By creating reports in the database, it is possible to obtain data on emissions that polluters have put into the data LRIZ (ЛРИЗ) database.	-		Secretariat for Environmental Protection	2	0	3	1	3	0	0%	This database has been developed	Exclude	1	1	No	
E12	Environmental quality (noise)	Acoustic zoning of the city territory (project proposal)	The “Acoustic zoning of the city territory” project is in progress, which will encompass entire city territory as a continuation of the “Acoustic zoning of a part of the city centre” that was accomplished between 2014-2016	-		Secretariat for Environmental Protection	1	0	3	1	3	0	0%	This is not aligned to strategic objectives and is due for completion in 2021	Exclude	1	1	No	
E13	Environmental quality (noise)	Expand and modernize the noise monitoring system	The Noise Measurement Program for the Territory of Belgrade 2020-2021 has been adopted. With the introduction of new measurement sites and the redistribution of existing ones, all city municipalities are covered by a network of measurement sites.	-		Secretariat for Environmental Protection	1	0	3	3	3	0	0%	Not aligned to strategic objectives and is an ongoing programme	Exclude	1	1	No	

No	Sector	Measure title	Measure description	Primary Strategic Objective	Other Strategic Objectives	Implementing Body	Benefit -	Additionality	Deliverability	Indicative Likelihood of Finance	Political Alignment	Weighted Score (GCAP)	GCAP % Rank	GCAP Conclusion	Priority Level	Mitigation -	Adaptation -	SECAP Relevance	Rationale for consideration in SECAP
E17	Environmental quality (green spaces)	Green spaces	Afforestation of areas that are under the management system of PUC “Beogradvode” and raising of aisles with PUC “Zelenilo Beograd”. The process of finding new areas for afforestation is ongoing. City municipalities have submitted their surface proposals (must be checked) and are looking for afforestation areas in accordance with the DRP for Green Area System.	GS1	LS3	Secretariat for Environmental Protection	3	0	2	2	3	0	0%	This activity is currently ongoing and overlaps with E4 so is excluded on the grounds it duplicates that measure.	Exclude	2	3	Yes	Possible benefits in terms of carbon capture and resilience benefits associated with greenspace.
E18	Environmental quality (green spaces)	Green space increase (afforestation, greening, green roofs, green walls urban pockets, green corridors)		GS1	LS3	PUC “Beogradvode” and PUC “Zelenilo Beograd” - planned funds 10,000,000.00 RSD (EUR 85,000). PUC "Ada Ciganlija" 5,000,000.00 RSD (EUR 42,500).	3	0	2	2	3	0	0%	Overlaps with E4 and is excluded. It is also an existing activity	Exclude	1	3	No	Potential benefits from greenspace but overlaps with measure E4 so was excluded on that basis.
E19	Environmental quality (green spaces)	Green Roof at "Gradsko Stambeno"	A green roof was to be created. New green spaces will be erected at locations planned by the DRP for Green Area System.	GS1	LS3	Secretariat for Environmental Protection		0				0	0%	This project is completed	Exclude	1	3	No	Project is completed so no additional benefit to be had.
E21	Environmental quality (green spaces)	Tree Protection	Development of programs for protection and maintenance of tree lines and other public green spaces in municipalities where green spaces are not managed by UC “Zelenilo Beograd”	GS1	LS3		3	0	3	3	3	0	0%	This is an ongoing operational management issue rather than a new intervention. Any afforestation/greening activities undertaken under E4 would require long term	Exclude	1	1	No	

No	Sector	Measure title	Measure description	Primary Strategic Objective	Other Strategic Objectives	Implementing Body	Benefit -	Additionality	Deliverability	Indicative Likelihood of Finance	Political Alignment	Weighted Score (GCAP)	GCAP % Rank	GCAP Conclusion	Priority Level	Mitigation -	Adaptation -	SECAP Relevance	Rationale for consideration in SECAP
														management and maintenance.					
E23	Environmental quality (green spaces)	Elaboration of feasibility study and technical recommendations for the introduction of the green roofs concept		B2			3	0	3	3	3	0	0%	Such a study is understood to be underway	Exclude	1	1	No	
E24	Environmental quality (green spaces)	Elaboration of greening projects and greening of school yards, kindergartens yards, public enterprises yards and other public areas that are not in the jurisdiction of maintaining public utility companies	Implementation of conceptual Solutions.	B2			3	0	3	3	3	0	0%	This is a concept project, the outcome of which may generate specific opportunities under E4.	Exclude	1	3	Yes	Could provide diffuse opportunities for adaptation and resilience measures on a site by site basis.
E28	Environmental quality (biodiversity)	Identifying areas that have the potential to be designated as protected natural areas	The Institute for Nature Conservation of Serbia is the only institution that can provide the expert basis for new protection proclamations.	Bio1	CCA1	Institute for Nature Conservation of Serbia	2	0	3	1	3	0	0%	Appears this is underway through the Institute for Nature Conservation of Serbia	Exclude	2	1	Yes	Potential carbon capture benefits if it leads to reduced deforestation but will be difficult to quantify
E29	Environmental quality (biodiversity)	Updating cadastre of wetlands and wet areas (ponds, meadow belts, specimens of preserved or endemic vegetation, endemic animal species) that are important for biodiversity conservation	Measures of care and protection of existing valuable trees, planting of park seedlings, setting up of info boards.	Bio1		PUC “Zelenilo Beograd”	2	0	3	1	3	0	0%	This is understood to be an ongoing activity	Exclude	1	1	No	

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E30	Environmental quality (biodiversity)	Biodiversity		Bio1			2	0	3	1	3	0	0%	Ongoing activity which doesn't require additional support	Exclude	1	1	No	
E31	Environmental quality (biodiversity)	Establishing permanent monitoring of protected areas, biodiversity, and geodiversity	Continuous monitoring by the Faculty of Forestry, the Faculty of Biology, and the Siniša Stanković Institute in the Great War Island	Bio1			3	0	3	3	3	0	0%	This is understood to be an ongoing activity	Exclude	1	1	No	
E33	Environment	Establish and constantly maintain a unified environmental information system (as part of the National Information System)	Continuous monitoring by the Faculty of Forestry, the Faculty of Biology, and the Siniša Stanković Institute in the Great War Island.	Bio1			2	0	3	3	3	0	0%	This is understood to be an ongoing activity due to complete this year.	Exclude	1	1	No	
E34	Environment	Establish and constantly maintain a unified environmental information system (as part of the National Information System)	In the course of 2018 and 2019, the Project "GIS Quality of Environmental Factors" was created, thus becoming a unique database for the analysis of environmental factors. Also, through this project, all the databases available to this Secretariat are linked into a single information system.	Bio1		Secretariat for Environmental Protection	2	0	3	3	3	0	0%	This database has been developed in 2018/19	Exclude	1	1	No	
L1	Land use	Linear Park Project	Modification and adoption of planning details of regulation for better use of abandoned temporary sites and brownfield sites Adopted DRP. The old railway is under reconstruction to become a green area.	L3	T1, L1, L2, E2, GS1, CCA1	The Secretariat for Urbanism and the Secretariat for Environmental Protection. The Belgrade City	2	2	3	3	3	45	67%	There is an ongoing project to develop a linear park project from Beton Hala to Pancevo Bridge. The project is already in design which may pose additionality challenges however it may be beneficial to include the project in the GCAP if	Medium Priority	3	2	Yes	Brownfield development in general could contribute to reductions in GHG emissions if linked to sound transport planning principals. In this case benefit may be limited if the area is a part (although there may be carbon capture opportunities). Potential to contribute

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						Directorate for City Construction and Building.								additional financing may be required.					through Climate smart and resilient planning/design
L2	Land use	Brownfield Development Programme	Measure to cover all stages from register creation, re-use scenarios and GUP amendments, land release conditions, profitability and bankability assessment, financing model, architectural competition, and implementation of selected pilots. This should include industrial and military sites (noting a preference to develop along corridors). Specific tools might include a register of brownfield sites, assessment of remediation needs/costs and model site reuse scenarios and financing options.	L1	T1, L2, L3, E2, CCA1		3	2	2	3	3	45	67%	An assertive and systematic plan for developing brownfield sites Belgrade would be significantly beneficial to creating a dense city core and alleviating pressure on greenfield land around the city. Ideally this would be tied to the policies in the new GUP.	Medium Priority	3	2	Yes	Brownfield development in urban areas can have a strong impact if linked to sound transport policy. Preserving greenspace will also help maintain existing resilience. Also have potential to contribute through Climate smart and resilient planning/design
L3	Land use	Developing a strategy for smart urban development of Belgrade	The city has developed plans for "smart city" principals and is interested in further development of smart city principals in urban planning and wider utility provision. Currently the main areas of focus are transportation and energy systems, with other areas such as environment and greenspace not well developed. It is possible that a stronger enabling framework for Smart technologies would be beneficial across sectors (and perhaps beyond just land use).	Cross Cutting Measure			3	3	2	3	2	45	67%	Developing smart city technologies is a useful cross cutting measure (which is perhaps more usefully framed outside "land use" as an objective. The city is understood to have made some progress on adopting smart cities technologies particularly in transport and energy sectors, but there is much scope to take greater advantage of technology. A city scale strategy could be highly beneficial. Objectively it has scored as a mid-level priority against our qualitative criteria, but our expert judgement is that it would be a useful enabling measure for many other sectors and therefore	High Priority	3	2	Yes	As a cross cutting measure there are lots of opportunities (such as smart metering, smart transport planning, improved management of greenspace and natural services etc) but may be difficult to directly quantify benefits.

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														we have decided to rate as a "High Priority"					
L4	Land use	City wide programme for urban green infrastructure (GI) development	Development of programme with investment platform in support of private and public sector projects, from individual buildings to large urban renewal projects. A good example of this would be the PUC "GSP" Belgrade garages which could have a "green belt" or fence to prevent emissions from the facility. The programme could also include a Green Infrastructure Financing facility or be linked to such a programme should an appropriate facility be established. It would be beneficial to pair this with soft measures such as biodiversity awareness and capacity building programmes for both technical stakeholders and wider civil society.	L3	E2, CCA1		3	3	2	3	3	46	82%	Addresses a wide range of objectives at a strategic scale and is particularly important for adaptation and resilience related measures. There have been significant commitments to green infrastructure from the city and a systematic approach to delivering those will a) maximise cumulative benefit b) act as an enabling vehicle to implement projects.	High Priority	3	3	Yes	Significant scope for both mitigation and resilience planning if these factors are built into the principals of GI planning.
L5	Land Use	Urban Land Management Policies and Instruments	Development of a framework of new instruments (ideally within the upcoming GUP) with the objective of focusing development on existing areas and limiting sprawl and new land take. This might include: Revised Urban Development Fees, effective urban land readjustment instruments, urban land development density bonuses in exchange for open and greenspace provision, taxation of underused urban construction land and clear indicators and targets for sustainable land take, including plans that clearly identify development	L2	L1, L3, T2, E2, CCA1		3	2	2	2	1	38	54%	These are important enabling measures which have scored relatively low against our criteria as they do not deliver infrastructure and may be challenging to agree across stakeholders. However, we believe that enabling policies such as these are critical to effective urban planning and therefore, we have rated as a high priority.	High Priority	2	2	Yes	Potential to mitigate future carbon costs by limiting sprawl and can help preserve natural regulating services which improves resilience.

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			sites and limit off plan development.																
LE1	Local energy production	Development and improvement of the district heating distribution network	This measure proposes to address four key areas of activity in one programme - Namely 1. Reduction of losses in the heat distribution network - The works are carried out in accordance with the Appendix containing road sections to be replaced (integral part of the Rehabilitation program), with adjustments to the new condition determined in the previous heating seasons. 2. Expansion of the heat distribution network - Within the planning documentation, it is envisioned that distribution network will be constructed according to the dynamics of fulfilling the purpose of the city's construction land and land for public purpose (during 2018 and 2019 the conditions for joining have been issued 1,950,000 m2) 3. Interconnection of existing heating plants - Planned procurement of technical documentation for interconnection of heating plants Novi Beograd – Dunav – Konjarnik - first phase– and later Voždovac, Novi Beograd-Banovo Brdo, Novi Beograd (Zemun)-Galenika, Cerak-Miljakovac. The technical documentation will cover the construction and reconstruction of large diameter heat 4. Shutting down boiler rooms	E1	E2, CCA1	JKP" Beogradske elektrane" and parts of the City administration - Secretariat for Energy, primarily, then Secretariat for Environmental Protection, and parts of the city administration that conduct the implementation by the Law on planning and construction and participate in issuing the necessary conditions, permits and consent during the construction.	3	3	3	3	3	51	95%	Top rated measure - Likely significant impacts on GHG emissions, improved district heating and through the inclusion of the reduction of reliance on solid fuel boiler systems, potentially a substantial impact on Air Quality which is a critical environmental indicator for the GCAP. While there are significant components of improvements to district heating which are currently in progress or under consideration for finance using existing budgets, inclusion in the GCAP could improve scale and speed of implementation. Schemes are not technically unusual and are likely to be attractive to lenders (Subject to due diligence and creditworthiness of implementing agencies).	High Priority	3	2	Yes	Substantial opportunity in mitigation terms as well as resilience benefits in terms of energy and particularly heat security

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			and connecting its consumers to the district heating system. 3 more schools will be added to the list of accomplishments this year																
LE2	Local energy production	Improvement energy efficiency district heating heat sources including:	1. Increasing the share of thermal energy from cogeneration 2. Increasing energy efficiency of district heating plants 3. Introducing solar energy into the district heating system	E2	E1, CCA1	JKP "Beogradske elektrane" and parts of the city administration that conduct the implementation by the Law on planning and construction and participate in issuing the necessary conditions, permits and consent during the construction.	3	2	3	2	3	45	67%	Coupled with LE1 (which covers distribution) this measure aims to improve efficiency of district heating sources through co-generation, energy efficiency measures and potentially RES. There will be concerns around prolonging coal use with co-generation from international lenders, however it is likely that further improvements to the heat sources is an area of opportunity for investment through the GCAP process.	Medium Priority	2	1	Yes	Potential GHG emissions savings (depending on configuration and reliance on coal). This will need further exploration.
PL1	Public lighting	Energy efficiency in public lighting	Substitution of old lamps by more efficient ones, such as low pressure, high pressure lamps or LED.	E2		JKP "Public Lighting"	2	1	3	3	3	44	60%	This is a straightforward measure which is likely to be beneficial in carbon terms. However, there is an ongoing programme and it is not clear how much additional benefit inclusion in the GCAP will achieve.	Medium Priority	3	1	Yes	Significant potential emissions savings
PL2	Public lighting	Smart lighting switches	Electronic photo-switches can reduce the electricity consumption in public lighting by reducing night burning hours (turning on later and turning off earlier). A Telemanagement system enables the lighting system to	E2		JKP "Public Lighting"	1	2	3	3	3	40	56%	It is unclear at this stage how much benefit this would achieve in terms of emissions reductions. However, if paired with PL1 would be a cost-effective measure.	Low Priority	2	1	Yes	Some emissions benefits but most cost effective if linked with PL1

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			automatically react to external parameters like traffic density, remaining daylight level, road constructions, accidents, or weather circumstances.																
PL3	Public lighting	Lighting PPP	Command Control Centre - Limited information was available on this project however it is understood to have been completed.	E2		JKP "Public Lighting"	1	0	2	3	3	0	0%	Limited data was available on this specific programme. However, measures PL1 and PL2 are likely to cover this type of activity and therefore this item was excluded.	Exclude	1	1	No	
T1	Transport	Extension and development of Belgrade Metro and train	The expansion of the BG train line with 2 new lines was planned: -Makiš – Rakovica – Karaburma, length 13.7 km, -Novi Beograd-Nikola Tesla Airport-national stadium length 16.2 km (in perspective up to 2027 to Obrenovac) The general project envisions the construction of two lines of Belgrade's Metro: -From Železnik to Mirijevo, 21.3 km with 23 stations and -From Zemun to Mirijevo, 19.2 km with 20 stations. A phase-building construction is envisioned, and for the first phase, the line 1 has been adopted to be from the starting station in Železnik to the Karaburma railway station, totalling 16.5 km with 16 stations.	T1	T2, E2, L2	Government of the Republic of Serbia, City of Belgrade, Secretariat for Investment, Secretariat for Public transport, Secretariat for Finance, BG Metro, and train	3	2	2	2	3	40	56%	This is a very significant project which is already underway. It has significant potential to benefit a range of the strategic objectives. It is likely to go ahead and there are likely to be elements that would benefit from international finance. It received a fairly low score on deliverability due to its scale, complexity, and cost. However, our view is that it is a valid project for inclusion in the GCAP.	Medium Priority	3	1	Yes	Significant scheme important for addressing transport emissions.
T2	Transport	Continuation of development of Inner ring roads (UMP, SMT)	The expansion of the Inner ring-road UMP was planned: -Sector II - Phase 2 - Topcider, 50 mEUR, -Sector III , 70 mEUR -Sector IV , 65 mEUR	T1	T2, E2, L2	Government of the Republic of Serbia, City of Belgrade, Secretariat	2	2	2	2	3	35	52%	It is difficult to justify road building schemes as a part of the GCAP in isolation as there is a strong argument that alleviating congestion by improving capacity for	Low Priority	2	1	Yes	Some potential benefit in terms of reduced congestion but may be offset by additional traffic generation. Further

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			-Sector V , 60 mEUR TOTAL to be financed 245mEUR The expansion of the Inner ring-road SMT was planned: -Danube bridge (ada Huja), 180 mEUR, -Connection to interchange Lasta, 72 mEUR -Borska - Interchange Lasta , 50 mEUR TOTAL to be financed 302mEUR			for Investment, Secretariat for transportation, Secretariat for Finance,								private vehicles simply creates additional private car trips, however if it were coupled with sensible policy measures to reduce travel in the city centre itself, it could play an important role in enabling car free policies in the city centre (such as T6 and T9). We have therefore retained the project but noting that funding this in isolation of such measures would not be consistent with the spirit of the Green Cities programme.					information required to understand.
T3	Transport	Purchase of electric buses and busses that use RES	1. Solo Electric Buses-30 vehicles, solo trolleybuses with autonomy – 40 vehicles, joint trolleybuses with autonomy – 20 vehicles, trams (high capacity) – 50 vehicles (note that purchasing new trolleybuses is no longer supported by the city) 2. Planned purchase: 1. Solo e-Bus vehicles (10 pcs) 2. Solo e-Bus vehicles (5 pcs) 3. Electric vehicles for pedestrian zone (3 pcs) 4. Secretariat for public transport with the JKP "GSP Beograd" has a plan to renew the fleet of public transportation of GSP buses. For a period from 2020-2024, the procurement is planned: the joint buses with propulsion on the KPG (Euro 6)-330 vehicles, solo buses on the KPG (Euro 6) – 190 vehicles, buses for school transportation with propulsion	T3	T1, T2, E2, CCA1	City of Belgrade Secretariat for Public Transport JKP "GSP Beograd"	3	2	2	3	2	44	60%	Purchase of vehicles is a popular financing measure as it often comes with a clear revenue model, can deliver carbon benefits (dependent on the source of energy for Electric Vehicles) and encourage higher rates of public transport ridership. It is well aligned to GCAP objectives. There is however an additional programme ongoing, and while it is scalable, it may be that sufficient resources are in place to achieve desired outcomes.	Medium Priority	2	2	Yes	Potential for GHG emissions (depending on energy sources - noting Belgrade grid energy has a high emissions factor). Newer busses tend to be more resilient to extreme weather events.

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			on KPG (Euro 6) – 25 vehicles.																
T4	Transport	Public Cycling System	Develop a public cycling system (such at London "Santander Cycles" or Paris "Vélib" system to Encourage Walking or Cycling in the city.)	T2	T1, E2	Secretariat for Public Transport	2	2	3	3	3	45	67%	A popular and relative low-cost option for supporting transition from private car use (and potentially public reluctance to use public transport in the wake of the Covid-19 pandemic) this could be a significant quick win investment. There are well established public and private models for such schemes which would ideally be introduced in parallel with additional cycle friendly infrastructure (such as cycle paths).	Medium Priority	3	1	Yes	Potential significant GHG savings in the transport sector
T5	Transport	Encouraging walking and/or cycling within the city through improved pedestrian facilities and cycleways	Surčinska SIDEWALK and cycling track, 2,8 km 47 million. Mirijevski bulevar, Ustanička - In the planning phase. Sustainable urban mobility Plan in the final phase. Expanding the pedestrian zone. Introducing automatic access control to the pedestrian zone. "Vrabac" service in the pedestrian zone.	T2	T1, E2, L2	Secretariat for Public Transport	3	2	3	3	3	50	89%	As with most cities, growing private car use is a challenge (which may be exacerbated post Covid 19 if people are uncomfortable using public transport). Encouraging walking and cycling as alternatives has wide ranging benefits as well as being relatively inexpensive. The principal appears to enjoy political support with existing proposals to increase pedestrianised areas and cycle lanes, but these could be usefully scaled up.	High Priority	3	1	Yes	Potential significant GHG savings in the transport sector
T6	Transport	Commercial transport policy	Policy measures to try to reduce commercial traffic on the road during peak hours and improving efficient distribution of materials. Typical measures would	T1	T1, E2, L2	Secretariat for Transportation	3	2	3	3	3	50	89%	There are existing policies in place to reduce commercial traffic into the city centre both operationally (in terms of restricting commercial	High Priority	3	1	Yes	Potential significant GHG savings in the transport sector

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			include allowing commercial distribution vehicles during night-time, construction consolidation centres, consolidation logistic centres, etc											traffic) and planning terms (e.g. planned logistics hubs). Further measures to distribute commercial traffic through less busy times would be beneficial for air quality and congestion and inclusion of such measures in the GCAP could act as a catalyst for this to happen more quickly. There is a potential link to measure					
T7	Transport	Plan for the network of public chargers for electric vehicles	Construction of outbuildings in the parking lot connected to renewables supply in order to provide clean energy for electrical charging.	T3	T2, E2	Secretariat for Transportation	3	3	3	3	3	51	95%	Encouraging electric vehicles is likely to have long term benefits in terms of both local air pollution and potentially climate emissions (noting that currently grid based energy in Belgrade has a high emissions factor and therefore a linkage to RES is critical to achieve benefits). Currently there are no known programmes of this type ongoing and therefore inclusion in the GCAP could be a catalyst to start rolling out low carbon charging infrastructure and help make the city ready for the transition to electric vehicles which is likely to occur in the coming years.	High Priority	2	1	Yes	Some GHG potential dependent on sources of energy.
T8	Transport	Incentives and financing of e-vehicles for public and private commercial vehicles (range 200km/day)	Establishment of fund who will finance purchase of all commercial vehicles (public and private), when daily mileage of those vehicles is not more than 200km per day. Wide range of stakeholders includes delivery services, taxis, cargo, Public enterprises, public utility	T3	T2, E2	Secretariat for Transportation	3	3	3	3	2	50	89%	An important set of incentives for people to purchase and use alternatively fuelled vehicles, this (in conjunction with enabling measures such as T7) should not be particularly contentious. However further work will be necessary to understand	High Priority	3	1	Yes	Some GHG potential dependent on sources of energy.

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			companies, city owned vehicles, etc.											the extent of existing city powers to provide such incentives.					
T9	Transport	Encouraging modal shift from private cars to public transport	Implementation of "Push and Pull" measures that encourage PT use and discourage private car use in the city centre. Typical measures include strict parking policies, implementation of bus lanes, development Park and Ride sites, congestion charging etc.	T1	T2, E2		3	2	1	3	1	38	54%	Push and Pull measures to encourage PT / Active travel and discourage private car use are very important. However, as the public transport network is currently close to capacity, our view is that this needs additional PT transport infrastructure to be delivered before significant use of these measures can be made (and likely partial delivery of the metro/rail lines). However, it is a very important long-term action therefore we have rated as a Medium Priority.	Medium Priority	3	1	Yes	Potential significant GHG savings in the transport sector
T10	Transport	Encouraging low carbon vehicles	Implementation of incentives such as tax reductions, lower parking rates, low and ultra-low emissions zones etc	T2	T2, E2		2	2	2	3	1	38	54%	Important long-term measures to encourage update of new vehicle technologies. However, some measures are politically challenging (Ultra Low Emissions Zones etc). There are also short-term challenges in encouraging electric vehicles charged from the grid as the emission factors are currently high.	Medium Priority	1	1	No	
T11	Transport	Existing Public transport fleet replacement / renewal programme	Secretariat for public transport with the JKP "GSP Beograd" has a plan to renew the fleet of public transportation of GSP buses. For a period from 2020-2024, the procurement is planned: the joint buses with propulsion on the KPG (Euro 6)-330 vehicles, solo	T2	E2, CCA1	City of Belgrade Secretariat for Public Transport, JKP "GSP Beograd"	3	2	3	3	3	50	89%	Replacement of aging vehicle fleets is a useful intervention. It is noted that the item itself is based on an existing procurement activity and there may be limited opportunity to expand the programme. It is also important to note	Medium Priority	2	2	Yes	While it is understood that there is likely to be a stop on Diesel bus purchases, other technologies such as CNG might provide useful GHG reductions. Newer busses tend to cope

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			buses on the KPG (Euro 6) – 190 vehicles, buses for school transportation with propulsion on KPG (Euro 6) – 25 vehicles.											that recent announcements from the City suggest that diesel busses are now likely to be phased out. However, the purchase of CNG busses is still possible as well as electric vehicles (see T3).					better with extreme weather events.
W1	Solid waste	Procurement of vehicles and equipment for landfill	The purchase of the Bulldozer machine is planned to be used by the end of September (until the date of handing over to the private partner).	-		PUC “Gradska čistoća”	1	0	2	2	3	0	0%	Appears to be a completed small procurement activity	Exclude	1	1	No	
W1	Solid waste	Procurement of vehicles and equipment for wet and dry cleaning of public areas	1. Pressure washing machine. 2. Tank trucks. 3. Electric cleaners. 4. Small cleaners. 5. Multifunctional machine. 6. Electric vacuum cleaners (in progress) 7. Accessories for maintaining hygiene - brooms. 8. Cleaning tools. 9. Snow-clearing tools. All procurements are planned for 2020.	-		PUC “Gradska čistoća” / Secretariat from Communal and Housing Issues	1	0	3	2	3	0	0%	This is understood to be an ongoing activity	Exclude	1	1	No	
W2	Solid waste	Installation of underground containers	Underground containers for recyclable and mixed municipal waste are being installed, for the needs of the utility users	SW1		Secretariat for Environmental Protection / PUC “Gradska čistoća”	2	1	2	2	3	34	47%	This is an ongoing programme which has the potential to be scaled up. It could result in a "quick win" investment but is probably relatively low impact as the work is ongoing anyway.	Medium Priority	1	1	No	
W3	Solid waste	National Landfill database	Every year a list of wild dumps is made, based on which they are being removed.	-		Secretariat for Environmental Protection / PUC “Gradska čistoća”	1	1	2	2	3	29	45%	This is a national action rather than a city action. While this is an important action it is not strongly aligned to the strategic objectives which focus on recycling for waste.	Exclude	1	1	No	

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W4	Solid waste	Water treatment facility for conversion of contaminated water from landfill to industrial water	A facility for wastewater treatment will be built so that water from the Vinča landfill will be treated until reaching the quality of industrial/technical water.	-	CCA1	According to the Vinča PPP contract (September 29, 2017), the private partner "Beo čista energija" is obliged to build and put into operation this facility.	2	0	2	3	3	0	0%	Covered by an existing PPP arrangement	Exclude	1	2	Yes	Some potential benefit in resilience terms but quite site specific and the project is already being financed by IFIs with climate agendas.
W5	Solid waste	Blue Recycling Bins	Supply of bin for domestic separation of waste for the selective collection of recyclable waste 1. Distribution of 52,000 blue bins (capacity 240 litres) for recyclable waste in settlements with individual housing. In the parts of Belgrade, where individual housing is predominant, it is planned to install 1,200 pieces of recycling vessels for the disposal of recyclable waste. 2. After the purchase, the containers will be placed in locations suitable for utility users	SW1		PUC “Gradska čistoća” / financing provided by the Secretariat for Environmental Protection	2	2	2	2	3	35	52%	A low-cost intervention that could have a good impact on kerbside recycling rates.	Medium Priority	1	1	No	
W6	Solid waste	Household Hazardous Waste	Establishment of a system for separate collection of hazardous waste from households 1. Within the recycling centres, a space was created and arranged for the establishment of special courts for receiving certain types of hazardous household waste. 2. The idea is that citizens can	W1		PUC “Gradska čistoća” / financing provided by the Secretariat for Environmental Protection.	2	2	2	3	3	40	56%	Complementary to measure W12, this measure would extend potential recycling sites to also receive hazardous wastes. If the facilities were to exist, this would be an inexpensive addition.	Medium Priority	1	1	No	

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			bring hazardous household waste to all recycling centres.																
W7	Solid waste	Municipal Waste Transfer Stations	Construction of two transfer stations, in New Belgrade and Rakovica, for transfer of waste to the landfill facility in Vinča 1. Preparation of urban-technical documentation is in progress. 2. Preparation of planning and technical documentation is underway, after which the transfer station will be built.	-		Secretariat for Environmental Protection / PUC "Gradska čistoća" / PUC "Mladenovac" / Mladenovac Municipality.	0	2	2	3	3	0	0%	This is a relatively low-cost low impact measure which is within the scope of usual city budgets. As it relates to general municipal waste rather than recycling it does not have a strong alignment with objectives. There is not a strong case for inclusion in the GCAP.	Exclude	1	1	No	
W8	Solid waste	Remediation of landfills in Sopot, Mladenovac and Grocka	Remediation will be carried out in accordance with the law	-		City of Belgrade / Secretariat for Environmental Protection, "Beo čista energija" / Mladenovac Municipality / Sopot Municipality / PUC "Mladenovac" / PUC "Sopot".	1	0	1	2	3	0	0%	This is understood to be an ongoing activity	Exclude	1	1	No	
W9	Solid waste	Green Waste Composting	By the decision of the Mayor of Belgrade in 2016, locations for recycling centres and transfer stations were determined. One of the convenient locations for this purpose is the location in the municipality of Surčin (Dobanovci).	SW1	E2		1	2	1	2	3	25	45%	This has been evaluated as having a very low level of impact on strategic objectives and it is proposed to exclude.	Exclude	1	1	No	
W10	Solid waste	Organization of an animal waste collection system		-		PUC "Veterina Beograd"	1	2	1	1	3	20	44%	Limited relevance to the GCAP and low impact	Exclude	1	1	No	

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W11	Solid waste	Biogas production	Construction of a facility for gas production out of manure and biomass on the “PKB” site	E2		ACB (PKB) Korporacija	2	2	2	2	3	35	52%	This could have a benefit in terms of reduced GHG emissions (although not aligned to the CoM Baseline Emissions Inventory). It is likely to be a substantial investment with reasonable profitability.	Medium Priority	2	1	Yes	Some limited benefit which should be captured If the project is likely to go ahead.
W12	Solid waste	Recycling Collection Centres	Construction and equipping of at least 14 centres for separate collection of recyclable waste - recycling yards - one in each of the city municipalities covered by the Local Plan for Solid Waste Disposal in Belgrade, as well as recycling yards on the territory of the Lazarevac and Obrenovac municipalities 1. Development of technical documentation is in progress 2. So far, three recycling centres have been equipped: within the PUC "Gradska čistoća" facility – Novi Beograd, at Milan Toplice Street 1 Voždovac, (within the PUC “Gradska čistoća” Višnjička 55 b (new hall within the "Waste" facility). In addition, one recycling centre was donated by the Kingdom of Norway and is located at Django Reinhart bb - Mirijevo settlement, GO Zvezdara. Technical documentation for 5 more recycling centres is under development.	SW1	E2	Secretariat for Environmental Protection / PUC “Gradska čistoća”	3	3	3	2	3	46	82%	Recycling rates in Belgrade are low with the vast majority of waste going direct to landfill and in future to an Energy from Waste Plant. It is desirable to divert recyclables to ensure that they are recovered, and these are important facilities to enable that. 3 sites have been built and locations identified for a further 4 however 14 are needed in total.	High Priority	1	1	No	
W13	Solid waste	Construction of a bulky waste deconstruction facility.	It is planned that PUC "Gradska čistoća" will provide a facility for dismantling bulky waste for recycling within the recycling centres.	SW1	E2	PUC "Gradska čistoća"	1	2	2	2	3	30	46%	A useful measure to address bulk waste dumping which is a challenge in the city. However, it is likely that this is a relatively small	Exclude	1	1	No	

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														investment which is best addressed within existing budgets rather than adding to the GCAP.					
W14	Solid waste	Installation of underground containers	Transformation of existing underground municipal waste containers into underground containers (3 m³) for recyclable waste - 900 pieces in total, 300 pieces annually	SW1		PUC “Gradska čistoća” / financed by the Secretariat for Environmental Protection	0	0	2	2	3	0	0%	This is understood to be an ongoing activity noting that further opportunity for underground containers are included in	Exclude	1	1	No	
WW1	Water and wastewater	Small watercourse and drainage channel rehabilitation	Program of water management facilities for the regulation of watercourses regarding flood protection, erosion, and flash floods on category II watercourses in the city of Belgrade in 2020. Examples of areas considered for this measure include: Barajevo; Pinosava; Bela stena; Kaluđerica	W2	W3, CCA1		3	2	2	3	3	45	67%	A specific scheme targeting a number of small watercourses which require hydraulic improvement to reduce flood risk and improve drainage. Good benefits but as it is already underway there are challenges related to additionality. However, the scheme could be expanded to cover additional secondary water courses. It is possible that this measure should be merged together with WW4	Medium Priority	1	3	Yes	Regulating water flows will strengthen resilience for flood management
WW2	Water and wastewater	Water saving and loss reduction	1. Reconstruction of 50km/year of the water supply network in order to decrease losses. 2. Construction of wastewater treatment plants. In the first phase - the complex "Makiš". In the second phase: all other production facilities.	W1	E2, W3, CCA1	2. Capital Facility Preparation Service	2	3	2	3	3	41	59%	This is a well-tested type of project and is unlikely to be a challenging project to move forward. However, water losses (while a valid area for a strategic objective) did not come out strongly as a challenge in the technical assessment and therefore should not be ahigh priority	Medium Priority	2	3	Yes	There may be benefits in terms of reduced pumping effort in the distribution network depending on the scale of reduction of losses. Improved access to clean water can have benefits in times of drought (although WEI suggest Belgrade is not strongly vulnerable).

No	Sector	Measure title	Measure description	Primary Strategic Objective	Other Strategic Objectives	Implementing Body	Benefit -	Additionality	Deliverability	Indicative Likelihood of Finance	Political Alignment	Weighted Score (GCAP)	GCAP % Rank	GCAP Conclusion	Priority Level	Mitigation -	Adaptation -	SECAP Relevance	Rationale for consideration in SECAP
WW 3	Water and wastewater	Water drainage	• Design, build and maintain urban rainwater collectors and open canals for draining rainwater, including the regulation of streams; • Extend the use of water permeable surface materials for the paving in new development areas;	W2	CCA1	JKP BVK	3	1	3	3	3	49	88%	In conjunction with WW4, development of new urban rainwater collector infrastructure could substantially improve localised flooding risks. There is also potential to develop wider SUDS principals in planning and design through measures such as using water permeable materials and retention in new development areas. These suds principals should be integrated into the new GUP as requirements for permission to develop areas.	High Priority	1	3	Yes	Regulating water flows will strengthen resilience for flood management
WW 4	Water and wastewater	Development of flood protection measures	1. Batajnički Collection System 2. Visoke Čukarica zone collector -Currently in the basic design development stage which will serve as basis for planning documentation 3. Operational plan for defence from floods on category II waters in the city of Belgrade for 2020 year	W2	CCA1, W3	1. JKP BVK 2. Directorate for Construction Land and construction of Belgrade	3	2	3	3	3	50	89%	There are existing schemes in place to address capacity problems in combined sewer systems, however inclusion in the GCAP could lead to an expansion of that programme reducing flood risk in other areas of the city and improving resilience to climate change.	High Priority	1	3	Yes	Potential adaptation/resilience benefit through improved drainage regulation
WW 5	Water and wastewater	Wastewater Treatment Programme	Elaboration of the missing planning and technical documentation for the wastewater treatment plant for the city's communal wastewaters and construction of interceptor and other missing infrastructure, construction of wastewater treatment plant	W3	CCA1, W2	Ministry for Construction, transport, and infrastructure JKP BVK	3	1	3	3	3	49	88%	The absence of domestic wastewater treatment in a major modern capital city is a known gap with significant progress already made in the development of solutions. However, inclusion in the GCAP may	High Priority	1	2	Yes	Will strengthen resilience to manage with heavy rainfall (where wastewater overflow can have serious implications for clean water supply and spread of disease)

No	Sector	Measure title	Measure description	Primary Strategic Objective	Other Strategic Objectives	Implementing Body	Benefit -	Additionality	Deliverability	Indicative Likelihood of Finance	Political Alignment	Weighted Score (GCAP)	GCAP % Rank	GCAP Conclusion	Priority Level	Mitigation -	Adaptation -	SECAP Relevance	Rationale for consideration in SECAP
WW 6	Water and wastewater	Rainwater storage and retention	Retention basins should be designed and built as local storm water control facilities, i.e. basins that temporarily store excess storm runoff and then discharge it at a rate not to exceed the downstream channel capacity. The retention basins should provide the 100-year runoff storage volume at the outfall point of the developed watershed	W2	CCA1	JKP BVK	3	2	2	1	3	35	52%	While these have potentially high benefit in climate resilience terms, our assessment was that there was insufficient information available to clearly recommend such measures. Were these to be promoted as a part of a wider green infrastructure/SUDS strategy or integrated into other measures (such as WW3 or WW4) it may be more attractive.	Medium Priority	1	3	Yes	Improving access to clean water will strengthen resilience in periods of drought.
WW 7	Water and wastewater	Industrial Wastewater Treatment	Improved wastewater treatment at industrial facilities prior to discharge to waterbodies.	W3			0	0	2	1	2	0	0%	Pollution control from industrial outlets was not developed as a priority area for the GCAP as it was felt that this sat primarily with operators/regulators rather than the city	Exclude	1	1	No	
WW 8	Water and wastewater	Water research project	Supporting research: new and innovative projects in the field of water management and water protection Project: Revitalization of Lake at Trešnja locality by setting a Floating Island system.	W3	W2	Secretariat for Environmental Protection	1	0	2	2	3	0	0%	Already planned and therefore not additional	Exclude	1	1	No	
WW 9	Water and wastewater	Water retention schemes	1.Reva- It is currently unregulated valley – regulation needed 2. Lasta There is a project documentation 3. Kumodraž 1 There are project documents 4. Kumodraž 2 Scheduled 5. Nerve Lasta 4 planned Retenzija 6. Mokra Gora planned 7. Autocommand planned 8. Zarkovacka planned 9. Makiško Polje planned	W2			3	0	3	3	3	0	0%	There is limited scope to expand this existing project and therefore the project was excluded	Exclude	1	3	Yes	Regulating water flows will strengthen resilience for flood management

No	Sector	Measure title	Measure description	Primary Strategic Objective	Other Strategic Objectives	Implementing Body	Benefit -	Additionality	Deliverability	Indicative Likelihood of Finance	Political Alignment	Weighted Score (GCAP)	GCAP % Rank	GCAP Conclusion	Priority Level	Mitigation -	Adaptation -	SECAP Relevance	Rationale for consideration in SECAP
			10. Padina planned 11. Jelezovac planned 12. Business Zone 3 planned																
WW 10	Water and wastewater	Catering Wastewater treatment	Improved wastewater treatment at catering facilities prior to discharge to networks.	W3			0	0	2	1	2	0	0%	Pollution control from commercial outlets was not developed as a priority area for the GCAP as it was felt that this sat primarily with operators/regulators rather than the city	Exclude	1	1	No	

E. Vulnerabilities and risks as presented in earlier stages of the development of the SECAP

The vulnerability and risk assessment provided in this section summarises the information gathered in annexes 3 and 4 to the 2015 Action Plan.

Vulnerabilities are determined **according to climate sensitivity and adaptive capacity** in the city. This considers how climate changes will impact on a receptor and the extent to which the receptor can manage the change. Receptors are categorised as follows: population, infrastructure, built environment, economy and natural resources.

For each of these receptors, the vulnerabilities identified are considered together with the climate hazards and extent and probability of exposure to establish the risks facing the City of Belgrade. In particular, the assessment establishes:

- The **impact according to exposure to climate hazards** (based on historic occurrences reported by the city) **and vulnerability** (according to climate sensitivity of the receptor and its adaptive capacity).
- The **risk according to the probability of climate hazards** (based on projections) **and the impact** (as a factor of exposure and vulnerability, as described above)

The purpose of assessing the associated vulnerabilities and risks is to identify where climate change adaptation actions can have a meaningful effect. In particular, it should establish where Belgrade has:

- Low adaptive capacity and high sensitivity to climate change (high vulnerability).
- Significant exposure to climate hazards and high vulnerability among the receptors exposed to the hazard (large impact).
- High probability of climate hazard expected to have a large impact (amounting to high risk).

A brief summary of the vulnerability and risk assessment is provided for each receptor, followed by an overview table of current vulnerabilities and risks for each identified climate hazard. A traffic light coding system is applied to indicate the level of risks with high risk coloured red, medium coloured amber and low coloured green.

Note that external factors including socio-economic, governance and climate change mitigation and adaptation actions are considered in the prioritisation of climate change adaptation actions but not in the following vulnerability and risk assessment.

Population

The **vulnerability of the population to heat waves, extreme cold and floods** is estimated as high, due to the high exposure to these effects, and low adaptive capacity. The vulnerability of the population to the effects of droughts and storms in Belgrade is estimated as medium.

All people who reside and work in the affected areas are vulnerable, in particular **the elderly, infants and children, people with mobility impairments, chronic illnesses,** etc. There is no pronounced spatial distribution of poverty – we can say that vulnerable social groups in terms of poverty are spread across the entire administrative area of Belgrade. As regards the eldest population (over 80 years of age), and the allocation of chronically ill patients, it is estimated that most vulnerable parts of Belgrade include central city municipalities, i.e. the central urban administrative territory (Stari Grad – 20.5 % of population over 65 years

of age, Vračar – 20.2%, Savski Venac – 18.4 %), and suburban municipalities Sopot and Barajevo (Sopot 20.2%; Barajevo 18.3%).

An overview of the current vulnerability and future risks to the population of Belgrade is presented below. In sum, **the main risks** include **worsening of existing health issues** from heat stress, poorer air quality with **negative effects on respiratory illnesses**, conditions that enable the **spread of disease** and illness and greater occurrences of injuries and deaths from **storm related accidents.**

Table E.1: Vulnerability and risk assessment for the population of Belgrade

Climate hazards	Current vulnerability	Future risks	Areas at greatest risk	Risk of impact
Extreme Heat	Fatalities (cardiovascular stress); spread of infectious and water-borne diseases; altered allergies; heat stress	Greater occurrences of current vulnerabilities.	Central urban municipalities	High risk relating to spring/ summer months
Extreme Cold	Casualties and fatalities (cardiovascular stress); respiratory illnesses; spread of infectious diseases	Reduced vulnerabilities associated with winter illnesses because of the warmer temperatures (fewer respiratory and infectious diseases and injuries such as bone fractures and frostbites)	-	High risk relating to winter months
Extreme Precipitation / Floods	Casualties and fatalities (deterioration of state of chronic patients due to difficulty in providing of lack of medical assistance - diabetes, dialysis etc.); spread of infectious diseases	Growing spread of diseases due to contaminated water; increasing damages and injuries during and after floods; increasing utilisation of health care system; greater mental stress	River-side municipalities	High risk throughout the year
Droughts	Respiratory illnesses; diseases caused by consumption of poor-quality water and food	Decreased air quality, accompanied by more respiratory troubles; increased allergic reactions through pollen flight and other allergens; lower	-	Medium risk in winter months; high risk in summer months

Climate hazards	Current vulnerability	Future risks	Areas at greatest risk	Risk of impact
		quality of water and food, especially milk products		
Storms	Casualties and fatalities	Increasing number of casualties and fatalities; greater mental stress	-	Medium risk in winter months; high risk in summer months

Economy

The main risks to the city's economy concern tourism and industry. **Tourism** is vulnerable to **extreme heat and drought** in the summer months and the expected impact on **water quality and supply**. The main industries identified as vulnerable in Belgrade include the **energy and mining sectors** owing to their dependency on the city's infrastructures (including transport, energy and water supply) and the anticipated **disruptions to these services owing to occurrences of extreme temperatures, heavy precipitation and flooding**.

Future risks to the economy were also assessed with respect to retail. Overall, the risks were assessed as low / medium. Extreme heat was identified as posing a high risk to retail owing to potential disruptions to the transportation of goods and changes in buying behaviour.

Table E.2: Vulnerability and risk assessment for the economy in Belgrade

Climate hazards	Current vulnerability	Future risks	Areas at greatest risk	Risk of impact
Tourism				
Extreme Heat	Changes to tourism season; increasing costs, e.g. for cooling	Changes to tourism season; Increasing damages of cultural monuments and institutions	Monuments and other tourist facilities, public budget, hoteliers and restaurateurs	Medium risk in summer months
Extreme Cold	Changes to tourism season; increasing costs, e.g. for heating	Decreasing damages to tourism infrastructure; Decreasing maintenance costs of tourism infrastructure	Public budget, hoteliers and restaurateurs	Medium risk in winter months
Extreme Precipitation	Changes to tourism season; increasing	Increasing damages; Increasing costs for	Monuments and other tourist facilities,	Medium risk in summer months; low in winter months
Floods				

Climate hazards	Current vulnerability	Future risks	Areas at greatest risk	Risk of impact
	costs for maintenance repair	protection and repairs; Decrease of heritage and leisure tourism	public budget, hoteliers and restaurateurs	
Droughts	Changes to tourism season; increasing costs for water supply	Increasing costs for water supply; Deterioration of water quality on public beaches	Public budget	High risk in summer months; medium in winter months
Storms	Changes to tourism season; increasing costs for maintenance repair	Increasing damages; Increasing costs for protection and repairs	Monuments and other tourist facilities, public budget, hoteliers and restaurateurs	Medium risk in summer months
Industry				
Extreme Heat	Lower efficiency; cooling problems and higher costs; shortfall of workers	Increasing costs for water supply; Lower efficiency and loss of business continuity; More problems in outdoor construction works, including temporary termination; Increasing costs for wastewater treatment;	Consumers, industries with the need for cooling, workers	High risk in summer months
Extreme Cold	Damages; increasing costs, e.g. for heating; efficiency changes	More problems in outdoor construction works, including temporary		Medium risk in winter months

Climate hazards	Current vulnerability	Future risks	Areas at greatest risk	Risk of impact
		termination of works;		
Extreme Precipitation Floods	Damages/ failures	Increasing costs for water supply; Loss of business continuity;	Industrial complexes near rivers or industries that depend on bridges and other infrastructure affected by floods	Very high risk in summer months; high in winter months
Droughts	Water scarcity / cooling problems; supply problems due to limited bulk transport	Greater damage to stock or equipment; Loss of business continuity;	Consumers, industries with high water consumption, workers	High risk in summer months; medium in winter months
Storms	Damages/ failures	Greater damage to stock or equipment; Loss of business continuity;	Consumers, industrial complexes in the whole city	Medium risk in summer months; low in winter
Retail				
Extreme Heat	Changes in buying behaviour	Problems with transportation of goods; changes in buying behaviour	Consumers (access and price level), shop owners, stores in the affected areas	High risk in summer months
Extreme Cold		-		Low
Extreme Precipitation Floods		Problems with transportation of goods;		Medium risk in summer months
Droughts		Changes in buying behaviour		Medium risk in summer months
Storms	Damages/ failures	Problems with transportation of goods;		Medium risk in summer months

Infrastructure

The city infrastructures considered in the vulnerability and risk assessment include: transport infrastructures; energy production and supply infrastructures; water supply and sewerage infrastructures; ad social infrastructure facilities and systems.

Current bouts of **extreme cold and flooding** present a high risk to **energy supply and traffic infrastructures** in Belgrade which are assessed as highly vulnerable owing to high exposure and low adaptive capacity. **Extreme heat and drought** present a lower risk to **energy supply infrastructure**. **Water supply and sewerage** is particularly vulnerable to **extreme weather**. The vulnerability of water supply and sewerage to effects of heat waves, droughts, floods and storms is estimated as high, extreme cold is estimated as medium. **Social infrastructure facilities** and systems are highly vulnerable to the **indirect effects of drought** (increasing pressure on the social infrastructure expected to increase poverty and social unrest resulting in higher pressure on health care facilities and social system institutions).

Table E.3: Vulnerability and risk assessment for infrastructures in Belgrade

Climate hazards	Current vulnerability	Future risks	Areas at greatest risk	Risk of impact
Transport				
Extreme Heat	Damages; greater maintenance costs; changes to consumption patterns and social behaviours affecting demand and supply	Increase of damages; Higher maintenance and fuel costs, high rebuilding costs; Less mobility (transport infrastructures);	Throughout the city roads, railways, and waterways, are at risk. Congested routes are at the highest risk (e.g. main roads passing through the city and main traffic intersections).	High risk in summer months
Extreme Cold	Damages; greater maintenance costs; changes to consumption patterns affecting demand and supply			Medium in winter months
Extreme Precipitation	Damages; hindrance to traffic flow	Increase of damages; Higher maintenance and rebuilding costs; Less mobility		Very high risk in summer months; high in winter months
Floods				
Droughts	Challenges transporting bulk material (linked to transport infrastructures)	Inland navigation on rivers might be difficult or impossible		Medium in summer months; low in winter
Storms	Damages; hindrance to traffic flow	Increased damages; Higher maintenance costs		High risk in summer months; medium in winter months
Energy production and supply				
Extreme Heat	Damages; greater maintenance costs;	Increased damages; Less electricity	The main energy producers and	High in the summer months

Climate hazards	Current vulnerability	Future risks	Areas at greatest risk	Risk of impact
	changes to consumption patterns and social behaviours affecting demand and supply	production; Problems in distribution; Higher maintenance costs; Interruption of electricity supply due to excessive use of cooling;	distributors for the city are at high risk and the entire electrical grid more widely. Power and heating plants	
Extreme Cold	Damages; greater maintenance costs; changes to consumption patterns affecting demand and supply	-	Power and heating plants; and the electricity grid.	Medium risk in winter months
Extreme Precipitation Floods	Damages; interruption to power supply	Increased damages or failures on production and distribution facilities (Open pit Kolubara, Power plant "TEN-T", etc.); Less electricity production; Problems in distribution; Higher maintenance costs		Very high in summer and high in winter
Droughts	Cooling problems; higher maintenance costs, e.g. environmental requirements; lower electricity production	Increase of cooling problems; Hydropower potential may be reduced; Less electricity production		High in summer and medium in winter
Storms	Damages	Increased damages; Less electricity production; Problems in distribution, including the interruption of electricity supply; Higher maintenance costs		Very high in summer and high in winter
Water supply and sewerage				
Extreme Heat	Damages; greater maintenance costs; changes to consumption patterns and social behaviours affecting demand and supply; water quality problems (water supply infrastructures)	Water availability may be significantly reduced due to higher water demand; Problems in distribution; Water quality deterioration; Higher maintenance costs;	Public health, technical infrastructure, public budget through higher maintenance costs, water supply utilities. In particular: installations for water supply and sewerage infrastructure and open retention basins for collecting storm	Very high in the summer months
Extreme Cold	Damages; greater maintenance costs;	-		Low in the winter months

Climate hazards	Current vulnerability	Future risks	Areas at greatest risk	Risk of impact
	water quality problems (relating to water supply infrastructures)		water are at high risk throughout the city.	
Extreme Precipitation	Damages; soil and water quality problems (relating to water supply infrastructures)	Damages to water and sanitation infrastructure; Pressure on the sewage network, leading to leakage;		Very high in summer and high in winter
Floods				
Droughts	Water quality and supply problems (relating to water supply infrastructures); higher maintenance costs	Water availability may be significantly reduced due to higher water demand; Problems in distribution; Water quality deterioration; Higher maintenance costs		Very high in summer and high in winter
Storms	Damages; water quality problems (relating to water supply infrastructures)	Increased damages		Very high in summer and high in winter
Social infrastructure				
Extreme Heat	Damages; greater maintenance costs; changes to consumption patterns and social behaviours affecting demand and supply; higher crime rates; more patients in hospital beds	Increase of damages; Higher maintenance and fuel costs, high rebuilding costs	Hospitals, homes for the elderly, kindergartens, schools, public spaces, sports complexes, the City Assembly.	High in the summer months
Extreme Cold	Greater maintenance costs; more patients in hospital beds	-		Low in winter months
Extreme Precipitation	Damages; greater maintenance costs; more patients in hospital beds; greater use of emergency services	Increase of damages; Higher maintenance and rebuilding costs		Medium in summer and low in winter
Floods				
Droughts	Changes to consumption patterns and social behaviours affecting demand and supply (affecting water)	Problems in water supply for health care facilities; Higher pressure on social infrastructure institutions; Increased use of cooling may cause higher costs and pressure to electricity system		Very high in summer and high in winter

Climate hazards	Current vulnerability	Future risks	Areas at greatest risk	Risk of impact
Storms	Damages; greater maintenance costs; more patients in hospital beds; greater use of emergency services	Damages on social infrastructure facilities (health care, education, social services, cultural); Increasing maintenance costs on health care facilities, educational facilities and social system facilities;		Medium in summer and low in winter

Built environment

Building stock and materials will probably face more damage due to high and very high risk of **heath waves, droughts, and storms** in summer and **floods** in summer and winter. The built environment relates to existing buildings, urban infrastructure (such as pavements etc.). In Belgrade, the high exposure of the built environment to the climate hazards renders it highly vulnerable to climate hazards, especially in densely built–up areas.

Table E.4: Vulnerability and risk assessment for the built environment in Belgrade

Climate hazards	Current vulnerability	Future risks	Areas at greatest risk	Risk of impact
Extreme Heat	Damages to asphalt; heat island effect; greater demand for cooling; higher maintenance costs	Increased damages to building stock	Buildings, technical and urban infrastructure, especially in densely built-up areas, roads and railroads, all the buildings in the affected areas, paved surfaces	Very high (summer)
Extreme Cold	Damages to asphalt; heat island effect; greater demand for heating; higher maintenance costs			Medium (winter)
Extreme Precipitation	Damages; surface runoff; torrential streams			Very high (summer); high (winter)
Floods				
Droughts	Higher water demand; collapse of dikes			High (summer); medium (winter)
Storms	Damages, demolition and failures			High (summer); medium (winter)

Natural resources

The vulnerability of natural resources is very high. Open green spaces demonstrate a high level of vulnerability to almost all of the potential effects of climate change. It is estimated that the Belgrade **water resources and their quality are highly vulnerable** to the effect of **heat waves and droughts**. It is estimated that **heat waves, extreme cold and heavy precipitations/floods**, as effects of climate change, will significantly affect the **deterioration of air quality** in Belgrade.

The **vulnerability of agricultural and forestry** has been estimated as high to all the effects of climate change. The **vulnerability of biodiversity and ecosystems** in Belgrade as an effect of heat wave and drought is estimated to be high, due to high exposure and low capacity to adapt. The vulnerability of biodiversity and ecosystems to the effects of extreme cold is estimated as medium.

Table E.5: Vulnerability and risk assessment for natural resources in Belgrade

Climate hazards	Current vulnerability	Future risks	Areas at greatest risk	Risk of impact
Green spaces				
Extreme Heat	Loss of plants; higher maintenance costs (irrigation costs)	Wild fires; greater irrigation; loss of plants	Ecosystem, state and appearance of parks, sensitive flora and fauna, the public budget; Special: urban green areas, especially core green areas	Very high in summer months
Extreme Cold	Damages to plants	Reduced damage from frost		Low
Extreme Precipitation	Damages to plants and infrastructures	Damages to infrastructure and plants		High in summer months; medium in winter months
Floods				
Droughts	Loss of plants; higher maintenance costs (irrigation costs); wild fires	Wild fires; greater irrigation; loss of plants		Very high in summer months
Storms	Damages to plants and infrastructures	Damages to infrastructure and plants		Very high in summer months; high in winter months
Water & air quality				
Extreme Heat	Spread of disease and bacteria; lower groundwater recharge; higher evaporation rates (changes to water flows);	Problems with water supply; greater concentration of air pollutants and allergens; spread of disease	Whole ecosystem, fauna, flora, human health, ground water recharge, water industry.	Very high in summer months

Climate hazards	Current vulnerability	Future risks	Areas at greatest risk	Risk of impact
			Particularly the inner city on sites that are considered most vulnerable.	
Extreme Cold	Higher concentration of pollutants and allergens affecting air quality	-	Human health, ecosystem, flora and fauna	Low
Extreme Precipitation Floods	Water quality; spread of diseases	Deterioration of groundwater quality and in quality of open water flows; greater concentration of air pollutants and allergens; spread of disease	-	High in summer months; medium in winter months
Droughts	Lower water flows	Problems with water supply; deterioration of water quality in open water flows; greater concentration of air pollutants and allergens;	Whole ecosystem, fauna, flora, human health, ground water recharge, water industry	Very high in summer months; high in winter months
Storms	-	Deterioration of water quality in open water flows; Increasing risk of torrential floods and erosion;	-	High in summer months; medium in winter months

Climate hazards	Current vulnerability	Future risks	Areas at greatest risk	Risk of impact
Agriculture, forestry & biodiversity				
Extreme Heat	Changes in growth cycles; wild fires; species decline/ loss	Changes in growth cycles; loss of harvest; damage to crops and trees; wild/ forest fires; loss of species and / or diversity; alien invasive species; pest and disease outbreak; increased irrigation	Farmers, consumers, the food industry, municipal gardens. Forest ecosystems, wood industry, consumers, land. Flora and fauna with low adaptive capacity, ecosystem.	Very high in summer months; high in winter months
Extreme Cold	Loss of harvest and livestock; Reduced food sources for animals	Balancing effect on extreme cold resulting in warmer climates in which certain crops may thrive.		Low
Extreme Precipitation Floods	Damages/ loss of harvest; torrential streams; deterioration in soil quality; soil erosion; loss of species; invasive alien species	Loss of/ damage to habitats; loss of harvest; loss of species and / or diversity; alien invasive species; pest and disease outbreak; soil erosion		High in summer months; medium in winter months
Droughts	Damages/ loss of harvest; species loss/ decline	Changes in growth cycles; wild/ forest fires; increased irrigation; pest and disease outbreak		Very high in summer months; high in winter months

Climate hazards	Current vulnerability	Future risks	Areas at greatest risk	Risk of impact
Storms	Damages/ loss of harvest; loss of natural resources	Damage to habitats; soil erosion		Very high in summer months; high in winter months (except for biodiversity to which storms present a low risk)

F. Detailed vulnerability and risk assessment

Hazards	Vulnerable sectors	Risk of impact	Vulnerability indicators
Extreme heat	Buildings/ equipment/ facilities	Very high risk of impact in summer months. Buildings, technical and Urban infrastructure are at greatest risk, especially in densely built-up areas, roads and railroads, all the buildings in the affected areas, paved surfaces.	Damages to asphalt; heat island effect; greater demand for cooling; higher maintenance costs; increased damages to building stock.
	Transport	High risk of impact in summer months. Throughout the city roads, railways, and waterways, are at greatest risk. Congested routes are at the highest risk (e.g. main roads passing through the city and main traffic intersections).	Damages; Maintenance and fuel costs, Rebuilding costs; Less mobility (transport infrastructures);
	Energy production and supply	High risk of impact in summer months. The main energy producers and distributors for the city are at high risk and the entire electrical grid more widely.	Increased damages; Less electricity production; Problems in distribution; Higher maintenance costs; Interruption of electricity supply due to excessive use of cooling;
	Water supply and sewerage	Very high risk of impact in the summer months. Public health, technical infrastructure, public budget through higher maintenance costs, water supply utilities are at greatest risk. In particular: installations for water supply and sewerage infrastructure and open retention basins for collecting storm water are at high risk throughout the city.	Water availability may be significantly reduced due to higher water demand; Problems in distribution; Water quality deterioration; Higher maintenance costs;
	Land use planning	Very high risk of impact in the summer months. Ecosystem, state and appearance of parks, sensitive flora and fauna and the public budget are at greatest risk. Special: urban green areas, especially core green areas	Loss of plants; higher maintenance costs (irrigation costs)
	Agriculture, forestry and biodiversity	Very high risk of impact in the summer months, high in the winter months	Changes in growth cycles; loss of harvest; damage to crops and trees; wild/

Hazards	Vulnerable sectors	Risk of impact	Vulnerability indicators
		Farmers, consumers, the food industry, municipal gardens are at greatest risk. Forest ecosystems, wood industry, consumers, land. Flora and fauna with low adaptive capacity ecosystem are at greatest risk.	forest fires; loss of species and / or diversity; alien invasive species; pest and disease outbreak; increased irrigation
	Health	High risk of impact in spring and summer months Central urban municipalities are at greatest risk.	Fatalities (cardiovascular stress); spread of infectious and water-borne diseases; altered allergies; heat stress
	Tourism	Medium risk of impact in summer month. Monuments and other tourist facilities, public budget, hoteliers and restaurateurs are at greatest risk.	Changes to tourism season; Increasing damages of cultural monuments and institutions; Increasing costs (eg. for cooling)
Extreme cold	Buildings/equipment /facilities	Medium risk of impact in the winter months. Buildings, technical and Urban infrastructure are at greatest risk, especially in densely built-up areas, roads and railroads, all the buildings in the affected areas, paved surfaces.	Damages to asphalt; heat island effect; greater demand for heating; higher maintenance costs; increased damages to building stock.
	Transport	Medium risk of impact in winter months. Throughout the city roads, railways, and waterways, are at greatest risk.. Congested routes are at the highest risk (e.g. main roads passing through the city and main traffic intersections).	Damages; Maintenance costs, Rebuilding costs; Changes to consumption patterns affecting demand and supply
	Energy production and supply	Medium risk of impact in winter months. Power and heating plants; and the electricity grid are at greatest risk.	Damages; greater maintenance costs; changes to consumption patterns affecting demand and supply
	Water supply and sewerage	Low risk of impact in the winter months. Public health, technical infrastructure, public budget through higher maintenance costs, water supply utilities are at greatest risk. In particular: installations for water supply and sewerage infrastructure and open retention basins for	Damages; greater maintenance costs; water quality problems (relating to water supply infrastructures)

Hazards	Vulnerable sectors	Risk of impact	Vulnerability indicators
		collecting storm water are at high risk throughout the city.	
	Land use planning	Low risk of impact. Ecosystem, state and appearance of parks, sensitive flora and fauna and the public budget are at greatest risk. Special: urban green areas, especially core green areas	Damages to plants
	Agriculture, forestry and biodiversity	Low risk of impact. Farmers, consumers, the food industry, municipal gardens are at greatest risk. Forest ecosystems, wood industry, consumers, land. Flora and fauna with low adaptive capacity ecosystem are at greatest risk.	Loss of harvest and livestock; Reduced food sources for animals; Balancing effect on extreme cold resulting in warmer climates in which certain crops may thrive.
	Health	High risk of impact winter months Reduced vulnerabilities associated with winter illnesses because of the warmer temperatures (fewer respiratory and infectious diseases and injuries such as bone fractures and frostbites)	Casualties and fatalities (cardiovascular stress); respiratory illnesses; spread of infectious diseases.
	Tourism	Medium risk of impact in winter month. Public budget, hoteliers and restaurateurs are at greatest risk.	Decreasing damages to tourism infrastructure; Decreasing maintenance costs of tourism infrastructure; Increasing costs (eg. for heating)
Heavy precipitation and floods	Buildings/equipment /facilities	Very high risk of impact in summer months, high in winter months. Buildings, technical and Urban infrastructure are at greatest risk, especially in densely built-up areas, roads and railroads, all the buildings in the affected areas, paved surfaces.	Damages; surface runoff; torrential streams; increased damages to building stock.
	Transport	Very high risk of impact in summer months, high in winter months. Throughout the city roads, railways, and waterways, are at risk. Congested routes are at the highest risk (e.g. main roads passing through the city and main traffic intersections).	Damages; hindrance to traffic flow; Maintenance costs, Rebuilding costs; Less mobility
	Energy production and supply	Very high risk of impact in summer months and high in winter months. Power and heating plants; and the electricity grid are at risk.	Increased damages or failures on production and distribution facilities (Open pit Kolubara, Power plant

Hazards	Vulnerable sectors	Risk of impact	Vulnerability indicators
			"TENT", etc.); Less electricity production; Problems in distribution; Higher maintenance costs
	Water supply and sewerage	Very high risk of impact in the summer and high in the winter months. Public health, technical infrastructure, public budget through higher maintenance costs, water supply utilities are at greatest risk. In particular: installations for water supply and sewerage infrastructure and open retention basins for collecting storm water are at high risk throughout the city.	Damages to water and sanitation infrastructure; Pressure on the sewage network, leading to leakage.
	Land use planning	High risk of impact in the summer months, medium in winter months Ecosystem, state and appearance of parks, sensitive flora and fauna and the public budget are at greatest risk. Special: urban green areas, especially core green areas	Damages to infrastructure and plants
	Agriculture, forestry and biodiversity	High risk of impact in the summer months, medium in winter months Farmers, consumers, the food industry, municipal gardens are at greatest risk. Forest ecosystems, wood industry, consumers, land. Flora and fauna with low adaptive capacity ecosystem are at greatest risk.	Loss of/ damage to habitats; loss of harvest; loss of species and / or diversity; alien invasive species; pest and disease outbreak; soil erosion
	Health	High risk of impact in summer and winter months River-side municipalities are at greatest risk.	Growing spread of diseases due to contaminated water; increasing damages and injuries during and after floods; increasing utilisation of health care system; greater mental stress
	Tourism	Medium risk of impact in summer month, low in winter months. Monuments and other tourist facilities, public budget, hoteliers and restaurateurs are at greatest risk.	Changes to tourism season; Increasing damages; Increasing costs for protection and repairs; Decrease of heritage and leisure tourism

Hazards	Vulnerable sectors	Risk of impact	Vulnerability indicators
Droughts	Buildings/equipment /facilities	High risk of impact in summer months and medium in winter months. Buildings, technical and Urban infrastructure are at greatest risk, especially in densely built-up areas, roads and railroads, all the buildings in the affected areas, paved surfaces.	Higher water demand; collapse of dikes; increased damages to building stock.
	Transport	Medium risk of impact in summer months, low in winter months Throughout the city roads, railways, and waterways, are at risk. Congested routes are at the highest risk (e.g. main roads passing through the city and main traffic intersections).	Challenges transporting bulk material (linked to transport infrastructures); Inland navigation on rivers might be difficult or impossible.
	Energy production and supply	High risk of impact in summer months and medium in winter months. Power and heating plants; and the electricity grid are at risk.	Increase of cooling problems; Higher maintenance costs; Hydropower potential may be reduced; Less electricity production
	Water supply and sewerage	Very high risk of impact in the summer and high in the winter months. Public health, technical infrastructure, public budget through higher maintenance costs, water supply utilities are at greatest risk. In particular: installations for water supply and sewerage infrastructure and open retention basins for collecting storm water are at high risk throughout the city.	Water availability may be significantly reduced due to higher water demand; Problems in distribution; Water quality deterioration; Higher maintenance costs
	Land use planning	Very high risk of impact in the summer months. Ecosystem, state and appearance of parks, sensitive flora and fauna and the public budget are at greatest risk. Special: urban green areas, especially core green areas	Loss of plants; higher maintenance costs (irrigation costs); wildfires
	Agriculture, forestry and biodiversity	Very high risk of impact in the summer months, high in winter months Farmers, consumers, the food industry, municipal gardens are at greatest risk. Forest ecosystems, wood industry, consumers, land. Flora and fauna	Changes in growth cycles; wild/ forest fires; increased irrigation; pest and disease outbreak

Hazards	Vulnerable sectors	Risk of impact	Vulnerability indicators
		with low adaptive capacity ecosystem are at greatest risk.	
	Health	High risk of impact in summer months and medium risk in winter months	Decreased air quality, accompanied by more respiratory troubles; increased allergic reactions through pollen flight and other allergens; lower quality of water and food, especially milk products; diseases caused by consumption of poor quality water and food
	Tourism	High risk of impact in summer month, medium in winter months. Public budget is at greatest risk.	Changes to tourism season; Increasing costs for water supply; Deterioration of water quality on public beaches
Storms	Buildings/equipment /facilities	High risk of impact in summer months and medium in winter months. Buildings, technical and Urban infrastructure are at greatest risk, especially in densely built-up areas, roads and railroads, all the buildings in the affected areas, paved surfaces.	Damages, demolition and failure; increased damages to building stock.
	Transport	High risk of impact in summer months, medium in winter months. Throughout the city roads, railways, and waterways, are at risk. Congested routes are at the highest risk (e.g. main roads passing through the city and main traffic intersections).	Damages; hindrance to traffic flow; Maintenance costs
	Energy production and supply	Very high risk of impact in summer months and high in winter months. Power and heating plants; and the electricity grid are at risk.	Increased damages; Less electricity production; Problems in distribution, including the interruption of electricity supply; Higher maintenance costs
	Water supply and sewerage	Very high risk of impact in the summer and high in the winter months. Public health, technical infrastructure, public budget through higher maintenance costs, water supply utilities are at greatest risk. In	Increased damages; Higher maintenance costs

Hazards	Vulnerable sectors	Risk of impact	Vulnerability indicators
		particular: installations for water supply and sewerage infrastructure and open retention basins for collecting storm water are at high risk throughout the city.	
	Land use planning	Very high risk of impact in the summer months. Ecosystem, state and appearance of parks, sensitive flora and fauna and the public budget are at greatest risk. Special: urban green areas, especially core green areas	Damages to infrastructure and plants
	Agriculture, forestry and biodiversity	Very high in summer months; high in winter months (except for biodiversity to which storms present a low risk) Farmers, consumers, the food industry, municipal gardens are at greatest risk. Forest ecosystems, wood industry, consumers, land. Flora and fauna with low adaptive capacity ecosystem are at greatest risk.	Damage to habitats; soil erosion; loss of harvest
	Health	High risk of impact in summer months and medium risk in winter months	Increasing number of casualties and fatalities; greater mental stress
	Tourism	Medium risk of impact in summer months. Monuments and other tourist facilities, public budget, hoteliers and restaurateurs are at greatest risk.	Changes to tourism season; Increasing damages; Increasing costs for protection and repairs

G. Indicators database – activity data and key assumptions projections in the baseline and mitigation scenarios

The sections below detail the activity data that was used to develop the BEI of this SECAP.

Developing GHG emission projections for Belgrade's SECAP

The projections were estimated using inter-connected excel files, and were made separately for buildings, district heating (DH), public lighting and transport sectors. Buildings and DH projections were interdependent.

Total energy consumption and emissions for each year in each scenario is calculated as a sum of energy consumption and emissions for each considered sector, respectively.

The sections below show the methodologies for calculations of energy consumption in each individual sector, including main assumptions for end-uses in base year, the assumptions on demand drivers and exogenous parameters (which are same for all scenarios), and the changes of main parameters in baseline scenario and in mitigation scenario for 2030. For baseline scenario the changes are result of demand drivers and exogenous parameters only, whereas in mitigation scenario changes related to mitigation actions and depicted in their quantitative goals are also included.

Buildings sector

Methodology and base year assumptions

The largest energy consumers in Serbia are **households**, subsequently they are also a **substantial source of CO_2 emissions**. This is the field where **significant energy efficiency improvements could be made**.

The overall buildings area in Belgrade is not known. However, the total living area of residential buildings stock according to the 2011 census is 44,446,320 m^2. There were 1,793 thousand people living in Belgrade in 2015 in 606,433 households. 58.5% of them live in multi-apartment blocks and remaining in single houses. Table G.1: gives information on residential buildings stock. It is planned that Information system for Belgrade energy (ISEB) contains data on the total area of the public buildings, but although it is in development since 2013, data have not yet been completed. Also, the Secretariat for Property and Legal Affairs records the data on the areas of the buildings that are in the jurisdiction of the City, but the data for the part of the buildings are taken from the statistics and do not contain information in m^2.

Table G.1: Residential buildings stock and area in Belgrade

Type of building	Number of units	Number of households	Living area (square metres)
Multi-apartment blocks	157,225	355,019	29,812,770
Single houses	125,707	251,414	16,633,550
Total	**282,932**	**606,433**	**46,446,320**

Residential buildings construction was the most intensive during the 1960s, 1970s and 1980s. Like other eastern states of that time, Serbia and Belgrade built multi-store buildings whose goal was to secure the largest number of apartments possible in the shortest amount of time. A modular system – panel houses made of prefabricated elements – did not consider energy efficiency.

Between 1960 and 1985, building construction in Belgrade was the most intense, but unfortunately the buildings from this period have the most inefficient heating. The building quality in terms of thermal insulation of the buildings is low, with additional deterioration over time due to inadequate maintenance. Thermal insulation was often not used at all or it was poorly installed, while the windows and doors today are also in inadequate condition. It is also evident that some heating installations are oversized, or the furnaces are in poor condition.

Between 1985 and 1999, buildings were constructed following the standard that is practically the same as the current EU standards. Nevertheless, inappropriate application of regulations and high number of mistakes in construction has led to poor energy efficiency characteristics of housing funded in Belgrade. Thus, the **energy spent in an average house in Serbia nowadays is sufficient to heat 3-4 low-energy-houses or 8-10 passive houses**.

Investors in new buildings are obliged to obtain an energy passport for the house and to take care that the building is going to be constructed under energy efficiency rules. In order to establish more rational energy expenses, new buildings must have a system for measuring heat and expenditures. In contrast, the number of buildings that were built before the new regulation and in which the heat expenses are calculated per surface unit, is still substantial.

The total area of other (tertiary) and municipal buildings stock is not known. Table G.2: Municipal buildings stock in Belgrade shows the number of buildings owned by the local authority in Belgrade by their type.

Table G.2: Municipal buildings stock in Belgrade

Type of building	Number of units
City administration buildings	17
Public and utility companies	712
Other companies and organizations	1
Culture institutions	44
Social protection institutions	46
Physical culture institutions	11
Health institutions	226
Pharmacies	127
Child protection institutions	378
Primary schools	336
High schools	79
Municipal administration buildings	17
Others	13
Commercial Buildings	1

Information on energy consumption in Belgrade is given in Table G.3: Energy Consumption in buildings in Belgrade in 2015. It shows significant **consumption of electricity for buildings sector, equalling to 84 kWh per square metre for residential sector**. Most of the data in the table was obtained from Energy information system of Belgrade[16].

Table G.3: Energy Consumption in buildings in Belgrade in 2015

Sub-sector	Electricity [MWh]	Heat [MWh]	Natural gas (1000 cubic meter)	Heating oil (1000 t)	Lignite (1000 t)	Other biomass (1000 cubic meter)	Solar thermal [MWh]	Geothermal [MWh]
Municipal buildings, equipment/ facilities	708,688	79,254	3,500	1	4			
Residential buildings	3,886,218	2,232,604	56,646	6	131	468	830	16,000

The projections of energy consumption in residential sector are based on the household numbers and the final energy consumption values per household for following end uses:

- Heating
- Hot water consumption
- Cooling consumption
- Electric appliances
- Lighting

For each year, the energy consumption for specific type of energy carrier is calculated as the sum of energy used for each of the end-uses, where these energy carriers are consumed. The energy used for each end use itself is calculated as the product of the number of households that use the specific energy carrier for specific end use and their final energy consumption values per household, as depicted in formula below.

$$FEC_{ec} = \sum_{EU=1}^{5} N_{ec,eu} * FEC_{ec,eu}$$

Where *ec* denotes energy carrier and *eu* denotes end use, *N* denotes number of households and FEC final energy consumption. Emissions are calculated by multiplying the FEC values with the emission factors of specific fuels.

The calculation of heating and hot water demand for 2015 is based on DH information, which is the most complete for Belgrade. The number of customers connected for heating only and for heating hot water is known. For single month that demand of hot water is just 2% of total demand. Based on this information demand for heating and hot water was calculated with the assumption that heating occurs for 6 month and HW for 12, using the formula below.

x -heating demand

x*6+x/0.98*0.02*12=total DH consumption.

[16] https://iseb.beograd.gov.rs

Afterwards it was assumed that demand is same in all dwellings and in case of other fuels the final consumption was corrected using the efficiencies of specific heating /HW devices. And then, using this data the amount of households using specific type of fuel was estimated. For natural gas, coal, oil, biomass it was assumed that they are totally used for heating. If there is some share used for hot water and cooking it will be small and here assumed to be negligible. Geothermal and solar (thermal) energy are used for hot water

For electricity use for cooling the assumption is that in 2015, 60% of dwellings had the cooling devices. Demand per dwelling was calculated using heating demand (for electricity) but corrected by the number of hours (2 months 6 hours per day). To calculate the number of bulbs for lighting it was assumed that in 2015 the average wattage of inefficient bulbs was 75W and efficient ones 10W, and the share was 80%-20%. Calculated bulb-hours is 13.76.

Remaining consumption of electricity is used for electric appliances which also includes cooking appliances.

The resulting figures for energy consumption by household and number of households using specific energy community are shown in Table G.4: Final energy consumption per households by different end uses (MWh/household) and Table G.5: Number of households using specific energy carrier for different end uses:

Table G.4: Final energy consumption per households by different end uses (MWh/household)

End use	Electricity	Heat / cold	Natural gas	Heating oil	Coal	Other biomass	Solar thermal	Geothermal
Heating	6.35	6.35	7.48	9.08	9.08	12.71		
Hot water	2.84	2.84					2.84	2.84
Cooling	0.53							
Lighting	0.31							
Other electric appliances	1.10							

Table G.5: Number of households using specific energy carrier for different end uses

No of households	Electricity	Heat/ cold	Natural gas	Heating oil	Coal	Other biomass	Solar thermal	Geo-thermal	Total
Heating	150,563	337,566	70,169	7,892	30,156	67,728	-	-	664,074
Hot water	627,334	30,816	-	-	-	-	292	5,632	664,074
Cooling	398,444	-	-	-	-	-	-	-	398,444
Lighting	664,074	-	-	-	-	-	-	-	664,074
Other electric appliances	664,074	-	-	-	-	-	-	-	664,074
									3,054,741

In municipal buildings the energy consumption was not split by end uses because information is not available. Therefore, projections were made according to the total final energy consumption in these buildings.

Demand drivers and other exogenous assumptions

The analysis of residential energy growth vs GDP for Serbia showed that they are decoupled. Therefore, GDP is not used as a driver - only population numbers and average efficiency improvements are used to project changes in overall fuel consumption in baseline case. Population growth rate is assumed to be 0.5% per year based on population projections of Statistical Office of the Republic of Serbia. The size of households is assumed to remain unchanged. Another external parameter also includes the share of households with cooling which was assumed to be 90% in 2030.

Table G.6: Demand drivers for residential sector

Parameter	Unit	Data Source	2015	2030
Population	persons	Statistical Yearbook of Belgrade 2015, p. 16: BELGRADE – BASIC DATA - Population 2015 – estimation	1,793,000	1,932,285
Household size	persons per household	Statistical Yearbook of Belgrade 2015, p. 72: AREA, POPULATION AND HOUSEHOLDS BY CENSUSES, Persons per 1 household	2.7	2.7
Households	Households	Formula	664,074	715,661

In addition, the number of new buildings and old buildings were calculated separately with assumptions of 2% of destruction rate per year for existing building stock. This assumption resulted in 31% of the projected number of dwellings being built between 2015 and 2030. It was assumed that due to national level measures the energy consumption per household for heating and cooling will be 50% less than in existing buildings by 2030.

In addition, the following assumptions were made regarding the improvements of technology efficiencies due to eco-design regulations, which result in decrease of final energy consumptions:

- **For heating and hot water -** 30% improvement for electric, coal, oil and biomass devices and 17% improvements in natural gas devices
- **For cooling -** 50% improvement for cooling devices and
- **For other appliances -** 40% improvements for other electric appliances
- **For lighting** it was assumed that by 2025 all bulbs will be efficient.

Scenario Specific assumptions

The changes in baseline scenario are based only on demand drivers and exogenous assumptions described above. The mitigation scenario maintains these assumptions but also adds additional assumptions defined by the quantitative goals for mitigation measures in this sector and also in DH sector, which mainly relate either to households using different types of fuel (Table G.8: Household numbers using different energy carriers in 2015 and in 2030 for baseline and mitigation scenarios) or to the final energy consumption in households for different end uses (Table G.7: Final energy consumption per dwelling (MWh/household) in 2015 and in 2030 for baseline and mitigation scenarios).

Table G.7: Final energy consumption per dwelling (MWh/household) in 2015 and in 2030 for baseline and mitigation scenarios

End use / Energy carrier	2015	2030 baseline	2030 mitigation
Heating: Existing Dwellings			
Electricity	6.35	4.45	3.56
District heat	6.35	6.35	4.07
Natural gas	7.48	6.20	4.96
Coal	9.08	6.35	5.08
Oil	9.08	6.35	5.08
Biomass	12.71	8.90	7.12
Heating: New Dwellings			
Electricity	6.35	2.22	1.39
District heat	6.35	6.35	3.18
Natural gas	7.48	3.10	1.94
Coal	9.08	3.18	1.99
Oil	9.08	3.18	1.99
Biomass	12.71	4.45	2.78
Cooling: Existing Dwellings			
Electricity	0.53	0.26	0.26
Cooling: New Dwellings			
Electricity	0.53	0.13	0.13
Hot Water			
Electricity	2.84	1.99	1.99
District heat	2.84	2.84	2.27
Solar	2.84	1.99	1.99
Geothermal	2.84	1.99	1.99
Lighting			
Electricity	0.31	0.05	0.05
Other electric appliances			
Electricity	1.10	0.66	0.66

Table G.8: Household numbers using different energy carriers in 2015 and in 2030 for baseline and mitigation scenarios

End use / Energy carrier	2015	2030 baseline	2030 mitigation
Heating - Total			
Electricity	150,563	202,150	118,205
District heat	337,566	337,566	434,584

End use / Energy carrier	2015	2030 baseline	2030 mitigation
Natural gas	70,169	70,169	60,824
Coal	30,156	30,156	26,140
Oil	7,892	7,892	6,841
Biomass	67,728	67,728	69,066
Cooling			
Electricity	398,444	536,254	536,254
Hot Water			
Electricity	627,334	678,922	612,912
District heat	30,816	30,816	79,325
Solar	292	292	10,792
Geothermal	5,632	5,632	12,632
Lighting			
Electricity	664,074	715,661	715,661
Other electric appliances			
Electricity	664,074	715,661	715,661

For municipal buildings, the baseline scenario assumed no change of energy consumption by 2030, whereas the mitigation scenario assumed the reduction of final energy consumptions according to mitigation measures. Table G.9: Final energy consumption in municipal buildings (MWh/a) in 2015 and in 2030 for baseline and mitigation scenarios shows the resulting values.

Table G.9: Final energy consumption in municipal buildings (MWh/a) in 2015 and in 2030 for baseline and mitigation scenarios

Energy carrier	2015	2030 baseline	2030 mitigation
Electricity	708,688	708,688	354,344
District heating	79,254	79,254	39,627
Natural gas	32,412	32,412	16,206
Coal	8,986	8,986	4,493
Oil	16,879	16,879	8,439
Renewable energy	-	-	84,622

Local Heat Production / District heating

Methodology and base year assumptions

Heat in Belgrade is generated by plants operated by PUC “Beogradske elektrane”. The total production capacity of "Beogradske elektrane" is 2,917.4 MW, that is 2,880 MW+37.4MW (economizers in generation plants "Novi Beograd", "Konjarnik", "Vozdovac", "Cerak" and Dunav"). Heating energy is produced in 59 heating sources - 14 generation plants and 45 boiler rooms; therewith heat is taken over from four heating sources (Galenika, Energy and Maintenance, and Topčider - Military Institution). The largest generation plant within the "Beogradske elektrane" is Plant "Novi Beograd", the largest in South East Europe. This plant consists of eight Heat Only Boilers with total capacity of 920 MW and Steam Boilers with capacity of 3 x 16 t/h producing steam for own needs. Plant is fuelled by natural gas and heavy fuel oil. During the heating season 2010/2011, heat only boiler with capacity of 140 megawatts was put into operation; this is the largest heat only boiler in South East Europe.

The heating network in Belgrade is a system of pipelines and measuring and regulating devices that connect generation plants and end users. Beneath the streets of Belgrade extends 730 km long hot water network or 1,460 km, including the length in both directions. **81% of the customers connected to heating network are residential customers and remaining are commercial**. The heating network covers overall around 21.8 million square metres.

Natural gas is used predominantly to generate heat however, some oil products, coal and biomass are also used. Share of gas and heavy fuel oil in total planned fuel consumption changes depending on the price of these fuels. Table G.10: Fuel consumption and emissions from heat generation in Belgrade in 2015 gives information on fuel consumption and emissions for 2015 based on data received from “Beogradske elektrane”.

Table G.10: Fuel consumption and emissions from heat generation in Belgrade in 2015

Fuel	Fuel/energy consumed	Units	2015 Fuel Consumption (MWh)	share	2015 CO_2 emissions (t CO_2)
Natural gas	354,475	1000 m3	3,282,637	89.8%	656,527
Heavy fuel oil	29,984	t	340,415	9.3%	95,316
Coal	2,852	t	11,675	0.3%	4,203
Biomass (briquettes)	768	t	3,533	0.1%	-
Biomass (pellets)	2,103	t	10,305	0.3%	-
Heating oil	521	t	6,196	0.2%	1,673
Total			**3,654,761**		**757,719**

The **network is on average 25 years old** and there are **significant water losses from the network**, comprising 13.9% of generated heat in 2015. The 2015 the heat generation plants operated with the capacity factor of 12.9% and average efficiency of 90.5%.

Belgrade power plants once had a cogeneration facility, but since 2000, they have been out of function as uneconomical due to the fuel used - crude gasoline. There are two small cogeneration plants (at the Belgrade Clinical Centre and Imlek industry) according to the Register of privileged electricity producers and they are of symbolic capacity. The used fuel is natural gas. The Belgrade Energy Strategy has emphasized the importance of cogeneration plants, but also their symbolic share (1%) in the produced heat energy (state of 2006). In the

Action Plan for Renewable Energy Sources of the Republic of Serbia, the construction and implementation of these plants is planned.

The **methodology of calculating the energy use** for DH production and associated emissions is based on the demand for district heat in residential sector.

Generation of district heat is calculated using the following formula

$$G_{DH}=(FEC_{DH\_R}+FEC_{DH\_C})/(1-L_{DH})$$

Where G_{DH} is generation of *DH*, FEC_{DH_R} is final energy consumption of DH in residential sector, FEC_{DH_c} is final energy consumption of DH in commercial and service sector and L_{DH} is losses in DH network.

The generation of DH by specific fuel type is calculated based on the share of corresponding plants and fuel consumption then is calculated based on their efficiencies.

Values for 2015 (base year) are based on the data collected and used for BEI and are shown in Table G.11: 2015 values of parameters used for calculation DH generation and Table G.12: 2015 values of parameters used for calculation of fuel consumption for generating DH.

Table G.11: 2015 values of parameters used for calculation DH generation

Parameters	Unit	2015
Final Energy Consumption - Residential	MWh	2,232,604
Final Energy Consumption - Commercial	MWh	612,359
DH Demand - Total	MWh	2,844,963
Losses	%	13.95%
Heat generation	MWh	3,306,002

Table G.12: 2015 values of parameters used for calculation of fuel consumption for generating DH

Fuel	Unit	DH Generation share by fuel (2015)	DH Generation Efficiencies (2015)
Natural gas	Percent	90.57%	91%
Heavy fuel oil	Percent	8.74%	85%
Coal	Percent	0.21%	61%
Biomass (briquettes)	Percent	0.07%	67%
Biomass (pellets)	Percent	0.24%	78%
Heating oil	Percent	0.16%	85%

Demand drivers and other exogenous assumptions

The calculation of demand for DH is based on the calculation of final energy consumption in residential sector which is different for baseline and mitigation scenarios. The commercial and service sectors maintain the same share in overall demand as in 2015. No other external drivers and parameters are used.

Scenario Specific assumptions

The baseline scenario assumes the changes of demand in baseline scenario for residential sector and no other changes in other parameters, whereas the mitigation scenario is based on mitigation scenario for residential sector and changes in other parameters according to quantitative goals for mitigation measures. Table G.13: The values of parameters used for calculation DH generation in 2015 and in 2030 for baseline and mitigation scenarios, Table G.14: The share of DH generation by fuel in 2015 and in 2030 for baseline and mitigation scenarios and Table G.15: Efficiencies of DH generation by fuel in 2015 and in 2030 for baseline and mitigation scenarios show differences in the values for these parameters.

Table G.13: The values of parameters used for calculation DH generation in 2015 and in 2030 for baseline and mitigation scenarios

Parameters	Unit	2015	2030 baseline	2030 mitigation
Final Energy Consumption - Residential	MWh	2,232,604	2,232,604	2,232,604
Final Energy Consumption - Commercial	MWh	612,359	612,359	612,359
DH Demand - Total	MWh	2,844,963	2,844,963	2,844,963
Losses	%	13.95%	13.95%	9.76%
Heat generation	MWh	3,306,002	3,306,002	3,152,728

Table G.14: The share of DH generation by fuel in 2015 and in 2030 for baseline and mitigation scenarios

Fuel	Unit	2015	2030 baseline	2030 mitigation
Natural gas	Percent	90.57%	90.57%	6.70%
Heavy fuel oil	Percent	8.74%	8.74%	0.00%
Coal	Percent	0.21%	0.21%	0.00%
Biomass (briquettes)	Percent	0.07%	0.07%	0.72%
Biomass (pellets)	Percent	0.24%	0.24%	0.02%
Heating oil	Percent	0.16%	0.16%	0.00%
Cogeneration	Percent	0	0	92.56%

Table G.15: Efficiencies of DH generation by fuel in 2015 and in 2030 for baseline and mitigation scenarios

Fuel	Unit	2015	2030 baseline	2030 mitigation
Natural gas	Percent	91%	91%	94%
Heavy fuel oil	Percent	85%	85%	90%
Coal	Percent	61%	61%	66%
Biomass (briquettes)	Percent	67%	67%	67%
Biomass (pellets)	Percent	78%	78%	78%
Heating oil	Percent	85%	85%	87%

The resulting DH emission factors are shown in the table below.

Table G.16: Emission factor of DH in 2015 and in 2030 for baseline and mitigation scenarios

Parameter	Unit	2015	2030 baseline	2030 mitigation
Emission factor of DH	t CO2 /MWh	0.27	0.27	0.02

Public lighting sector

In Belgrade the first electric bulb was turned on in 1892 for public lighting. The then city administration, choosing between electric and gas lighting, opted for a more modern scientific and technical achievement. The maintenance of the network and public lighting facilities in the area of the City of Belgrade (except the Lazarevac Municipality) was entrusted to PUC "Public Lighting" Belgrade.

The electricity supply for public lighting is determined by the lighting and public lighting shutdown calendar adopted by the City Assembly. According to expert estimation around 95% of the streets of Belgrade (which make 3,977km) is lighted. There were total of 112,405 luminaries installed in 2015 with the capacity of 22,415 kW, which makes around 200 watts per fixture.

Electricity consumption for public lighting is given in Table G-17. Information is based on data form Belgrade's statistical yearbook and expert estimates.

Table G.17: Energy consumption in public lighting

Purpose	Consumption (MWh)
Street lighting	121,676
Other lighting (i.e. traffic lights, decorations, etc)	13,520
Total	**135,196**

Methodology and base year assumptions

Data on Lighting Sources for Public Lighting for 2018 include the following:

Types of luminaires used in 10 central city municipalities:

- Metal halogen sources - Mainly represented in central city street lighting and pedestrian areas
- Sodium Sources - the Most Widespread Light Sources, ~ 110,000 Lamps in 10 Central Municipalities
- Mercury sources - less than 3,000 poultry luminaires in 10 central city municipalities.
- Incandescent sources - only in some parts of suburban municipalities
- LED sources - Mainly used in the area of decorative lighting of facades of important city and state buildings in combination with metal halide light sources.

10 central city municipalities (total number of lamps about 140 thousand)

- Sodium light sources ~ 110,000 luminaires (main city roads)
- Metal-halogen light sources (in central city streets, pedestrian corridors ...)

- Mercury light sources> 3000 (in less developed parts of the city)
- LED sources (illuminate pedestrian corridors, some pedestrian crossings, park areas; decorative lighting, and from 2019 the use of LED sources when performing new functional lighting installations)

Types of lamps used in 7 suburban municipalities (total number of lamps about 68 thousand)

- 51% mercury sources (~ 35,000 lamps)
- 48% Sodium Sources (~ 32,000 Lamps)
- 1% incandescent light sources (incandescent) and LED sources

Electricity consumption for public lighting is the sum of electricity consumption of street lighting and other lighting (i.e. traffic lights, decorations, etc.), which is assumed to remain unchanged. Emissions are calculated by multiplying the FEC values with the emission factors for electricity.

The energy consumption of street lighting is based on the amount of different types of bulbs used for street lighting, their average capacities and operation hours. For each year, the electricity consumption for street lighting is calculated as the sum of energy used for each of the different types of bulbs, which is the product of the number of number of bulbs, their capacities and operation hours as depicted in formula below.

$$FEC_{sl} = \sum_{bt=1}^{4} N_{bt} * C_{bt} * oh$$

Where *bt* denotes bulb type and *oh* denotes operation hours.

For 2015 the information on the bulbs is based on the information received from the city hall, typical calcifies of certain bulbs and total electricity consumption in 2015. It was assumed that average operation hours are 11 hours per day.

Bulb type	Total Number of bulbs - 10 central municipalities	Total Number of bulbs - 7 suburban municipalities	Total Number of Bulbs	Capacity (watts)	Electricity consumption (MWh)	Share
Sodium	110,000	32,000	142,000	112	64,047	68%
Mercury	3,000	35,000	38,000	299.3	45,669	18%
Metal halogen	13,500	0	13,500	100	5,420	6%
LED	13,500	1,000	14,500	112	6,540	7%
Total	140,000	68,000	208,000		121,676	100%

Demand drivers and other exogenous assumptions

The total number of bulbs is assumed to be unchanged by 2030, as well as the share of electricity used for other lighting (i.e. traffic lights, decorations, etc.).

Scenario Specific assumptions

The baseline scenario assumed no change of energy consumption by 2030, whereas the mitigation scenario assumed the reduction of final energy consumptions according to mitigation measures. Table G.18: The values of parameters used for calculation of electricity consumption for public lighting in 2015 and in 2030 for baseline and mitigation scenarios shows the resulting values.

Table G.18: The values of parameters used for calculation of electricity consumption for public lighting in 2015 and in 2030 for baseline and mitigation scenarios

Main parameters	Unit	2015	2030 baseline	2030 mitigation
Total number of Bulbs	bulbs	208,000	208,000	208,000
Average bulb operation time per day	hours	11	11	9
Electricity use for other lighting (i.e. traffic lights, decorations, etc.)	MWh	13,520	13,520	13,520
Bulb numbers - Sodium	bulbs	142,000	142,000	142,000
Bulb numbers - Mercury	bulbs	38,000	38,000	-
Bulb numbers - Metal halogen	bulbs	13,500	13,500	13,500
Bulb numbers - LED	bulbs	14,500	14,500	52,500

Transport sector

Belgrade holds a strategic geographical location as a centre of Western Balkans and is well connected to the important trans-European transport networks. Serbia is a transit country, with many local and foreign vehicles travelling on its road network. Three major motorways and 17 state roads are passing/ending in the wider City area. The network of streets in Belgrade is 2,500 km long.

Methodology and base year assumptions

Belgrade had 295 personal vehicles per 1,000 inhabitants in 2015 and the number is gradually raising. The number of cars per household has been constantly growing in the last 10 years and currently there are **0.94 vehicles per household**. Number of car owners is biggest in the City centre, where the income of families is higher. The **average age of the private cars in Belgrade is 13.8 years**, but there is a positive trend. According to the recent statistics, the number of new cars registered in Belgrade is rising every year. Still, most of the purchased vehicles are old used cars with significant mileage, imported from Western Europe.

Table G.19: Private and commercial transport stock and fuel economy shows the information on the stock private and commercial vehicles, their fuel consumption and operation data. The information is based on data from the Statistical yearbook of Belgrade and expert estimates based on national energy balances. As seen, 66.8% registered passenger vehicles, **70.0% of light commercial vehicles and 90% of heavy-duty vehicles in City were using diesel fuel in 2015.**

Table G.19: Private and commercial transport stock and fuel economy

Vehicle type	Total Number of vehicles	How many are in operation (%)	Split by Fuel (%)				Fuel Economy			
			Gasoline	Diesel	LPG	Elect-ricity	Gaso-line (litre/ 100 km)	Diesel (litre/ 100 km)	LPG (kg/ 100 km)	Electricity (kWh/ 100 km)
Passenger cars	469,234	90.0%	17.7%	66.8%	15.5%		10	7	12	
Mopeds and Motorcycles	9,026	90.0%	93.0%	2.0%		5.0%	5	6		30
Light Commercial Vehicles	221	90.0%	15.0%	70.0%	15.0%		12	12	12	
Heavy Goods Vehicles	49,895	90.0%	10.0%	90.0%			45	45	42	

Table G.20: Operational data of private and commercial transport

Vehicle type	Annual Mileage (km/year/vehicle)	Percentage of annual mileage driven in Belgrade (%)	Load factor (passenger/vehicle or tones /vehicle)	Annual passenger or freight turnover (passenger-kms ot tone-kms)
Passenger cars	13,500	70%	1.35	5,387,627,480
Mopeds and Motorcycles	2,000	90%	1.05	15,353,226
Light Commercial Vehicles	30,000	70%	3.5	14,619,150
Heavy Goods Vehicles	30,000	20%	30	8,082,990,000

The City has a good bus network coverage. Trams and trolley-buses also serve the existing urban area. The coverage of bus network has increased with introduction of new lines and small busses that can reach the narrow roads. Introduction of lanes dedicated only for public transit started after 2000. In the following years up to 2010 the “yellow” lanes were created in 29 city streets. **The public transport modal share (including trams and taxis) in total passenger turnover (expressed in passenger-kms) equals to 28.6%.**

Taxis provide a publicly available service and are therefore considered part of public transport. However, the lack of regular schedules, routes and set stations (characteristic of public transport) gives it a semi-private character but they are recognised as a useful supplement to conventional public transport.

Table G.21: Public transport stock and fuel economy and Table G.22: Operational data of public transport show the information on the stock and activity data for public transport which was used for development of BEI of Belgrade. The information was obtained from the statistical yearbook of Belgrade, Secretariat for Public

[17] Registered vehicles minus vehicles used for public transport and municipal fleet

transport and Urban Public Transport Enterprise "Beograd" (Gradsko Saobraćajno Preduzeće), Transport Company "Lasta" and private public transport operators (Avalabus, Arriva, Lastra, etc.), which provided activity data for public transport as well as information on fuel purchases.

According to data received, 98% registered buses in City are using diesel fuel. In comparison with previous years the trend is relatively stable. Despite the state strategy on higher tariffs for fossil fuels (petrol and LPG have 10-20% lower price), the key reason for lack of downtrend is import of used buses from Western Europe. When we add the average age of 10.2 years of major (GSP) fleet[18], then the reasons for the poor fuel economy presented below is clear.

Table G.21: Public transport stock and fuel economy

Vehicle type	Total Number of vehicles	Split by Fuel (%)					Fuel Economy				
		Gasoline	Diesel	LPG	CNG	Electricity	Gasoline (litre/100 km)	Diesel (litre/100 km)	LPG (kg/100 km)	CNG (kg/100 km)	Electricity (kWh/100 km)
Mini-bus	16		100.0 %					24			
Trolley	87					100.0%					297
Bus	1,250		98.0%	0.5 %	1.5 %		45	45	42	42	
Taxi	6,850	39.0%	48.0%	8.0 %	5.0 %		10	7	12	12	

Table G.22: Operational data of public transport

Vehicle type	Annual Mileage (km/year/ vehicle)	Annual passenger turnover (passengers/ year)	Load factor (passenger/ vehicle)	Annual passenger turnover (passenger-kms)
Mini-bus	107,815	5,175,101	11	18,975,369
Trolley	60,805	48,975,000	90	476,100,000
Bus	105,630	514,224,000	100	13,203,800,000
Taxi	26,277	8,000,000	2	270,000,000
Total		**568,374,101**		**13,968,875,369**

The development of the railway network is based on relocation of the central station (close to completion) and completion of the newly constructed Central “Prokop” station. The length of the railway network within the City limits is 161km, but urban rail is not considered in the SECAP and therefore public rail transport includes only trams. Despite 30 years of planning for the **“Belgrade Metro” project, no construction has started yet**.

[18] http://www.gsp.rs/statistika.aspx

Table G.23: Fuel consumption and passenger turnover in rail transport gives information on the activity data and energy consumption for trams in Belgrade in 2015.

Table G.23: Fuel consumption and passenger turnover in rail transport

Rail type	Annual passenger turnover (passengers/year)	Annual passenger turnover (passenger-kms)	Electricity consumption (kwh)
Tram	95,644,000	1,595,373,367	28,419,930

The municipal vehicle fleet consists from the vehicles of local authority. The stock and other activity data are given in Table G.24: Municipal fleet stock and fuel economy. The data was obtained from the secretariat of general affairs. The annual mileage was calibrated to match the data on fuel purchase, as given in Table G.25: Fuel purchase and consumption by municipal fleet .

Table G.24: Municipal fleet stock and fuel economy

Vehicle type	Total Number of vehicles	Fuel Economy		Annual Mileage (km/ year/ vehicle) (km)
		Gasoline (litre/ 100 km)	Diesel (litre/ 100 km)	
Type 1 - Gasoline V <1.5	50	9.3		17,900
Type 2 - Gasoline 1.5<V <2.0	25	13.6		17,900
Type 3 - Diesel V <1.5	1		8.0	16,700
Type 4 - Diesel 1.5<V <2.0	13		9.3	16,700
Type 5 - Diesel V >2.0	2		10.1	16,700

Table G.25: Fuel purchase and consumption by municipal fleet

Energy Carrier	Consumption (purchased amount)	Consumption (bottom-up calculation)
Gasoline (litres)	144,069	144,095
Diesel (litres)	24,821	24,821

Overall fuel consumption in transport sector was calculated using the bottom-up approach and activity data presented in this chapter. Table G.26: Fuel consumption in transport sector in 2015 in Belgrade shows the total fuel consumption in transport sector in the city of Belgrade in 2015.

Table G.26: Fuel consumption in transport sector in 2015 in Belgrade

Sub-sector	Electricity (kWh)	Natural gas (kg)	LPG (kg)	Diesel (litres)	Gasoline (litres)
Municipal fleet				24,821	144,095
Public transport	44,149,216	1,911,839	2,005,280	64,690,766	7,020,000
Private and commercial transport	219,332		74,304,718	296,100,224	83,517,380
Total	**44,368,548**	**1,911,839**	**76,309,998**	**360,815,811**	**90,681,475**

The projections of energy consumption in transport sector are based on energy consumption for the following end uses:

i. Public transport, including
   2. Buses
   3. Mini-buses
   4. Trolleys
   5. Tram and metro
   6. taxi
i. Light duty vehicles (LDV)
ii. Mopeds and motorcycles
iii. Light commercial vehicles
iv. heavy goods vehicles
v. Municipal service fleet.

For each year, the energy consumption for specific type of energy carrier is calculated as the sum of energy used for each of the end-uses, where these energy carriers are consumed. The energy used for each end use itself is calculated as the product of the activity (expressed either in mpkm, tkm or vkm) that use the specific energy carrier for specific end use and their energy intensity, as depicted in formula below.

$$FEC_{ec} = \sum_{EU=1}^{10} A_{ec,eu} * EI_{ec,eu}$$

Where *ec* denotes energy carrier and *eu* denotes end use, *A* denotes activity and *EI* denotes energy intensity. Emissions are calculated by multiplying the FEC values with the emission factors of specific fuels.

All Base year values used to calculate Activity levels and energy intensities are given in BEI indicators data.

Demand drivers and other exogenous assumptions

The driver for transport GDP growth. GDP growth rates are based on IMF projections and are assumed to grow by between 2%-4% before 2020 and by 4%[19] afterwards. The demands for vehicles then grows with

[19] Data source https://www.imf.org/external/pubs/ft/weo/2019/02/weodata/weorept.aspx?pr.x=98&pr.y=7&sy=2015&ey=2024&scsm=1&ssd=1&sort=country&ds=.&br=1&c=942&s=NGDP_RPCH&grp=0&a=

respect to GDP and according to the elasticities described in the table below. Elasticity for LDVs is based on calculation of the elasticity of registered vehicle numbers for 2010-2017 in comparison to GDP growth in the same period. The elasticities for 2-wheelers and commercial transport is based on elasticity of 10-year average growth of FEC/GDP growth. Public transport elasticity is assumed to be zero.

Table G.27: Elasticities of growth of transport activity with regards to GDP

End use	Elasticity
Private LDV passenger mobility /GDP	1.71
Private 2-wheelers passenger mobility /GDP	0.94
Public transport passenger mobility /GDP	-
Freight mobility /GDP	0.94
Municipal fleet /GDP	0.20

Other assumptions include the achievement of 10% share of biofuels for each transport group, and improvement of energy intensities by 20% for LDVs, taxi an municipal fleet and by 10% for other road vehicles.

Scenario Specific assumptions

The changes in baseline scenario are based only on demand drivers and exogenous assumptions described above. The mitigation scenario maintains these but also adds additional assumptions defined by the quantitative goals for mitigation measures in this sector and also in DH sector, which mainly relate either to modals share of different types of transport (Table G.28: Modal share of different modes of transport in 2015 and in 2030 for baseline and mitigation scenarios), share of vehicles using specific fuel in each of the modes (Table G.29: The share of vehicles by energy carrier in each end use in 2015 and in 2030 for baseline and mitigation scenarios) and their energy intensities (Table G.30: Energy intensities by fuel and mode in 2015 and in 2030 for baseline and mitigation scenarios).

Table G.28: Modal share of different modes of transport in 2015 and in 2030 for baseline and mitigation scenarios

Share of mode	2015	2030 baseline	2030 mitigation
Passenger transport			
Public Transport	55.67%	39.60%	54.27%
LDVs	19.27%	35.34%	14.66%
Mopeds and motorcycles	0.05%	0.07%	0.07%
Walking and Cycling	25.00%	25.00%	31.00%
Passenger: Public Transport			
Bus (existing type)	84.83%	84.83%	6.66%
Bus (efficient)	0.00%	0.00%	44.18%
Mini-bus	0.12%	0.12%	0.09%
Trolley	3.06%	3.06%	2.22%
Tram and metro	10.25%	10.25%	45.60%

Share of mode	2015	2030 baseline	2030 mitigation
Taxi	1.73%	1.73%	1.26%
Freight			
Light commercial vehicles	0.18%	0.18%	0.18%
Heavy Goods vehicles	99.82%	99.82%	99.82%

Table G.29: The share of vehicles by energy carrier in each end use in 2015 and in 2030 for baseline and mitigation scenarios

End use / Energy carrier	2015	2030 baseline	2030 mitigation
Passenger: Public: Bus			
Diesel	98%	88%	0%
Diesel (efficient)	0%	0%	50%
Biofuel	0%	10%	0%
Biodiesel (efficient)	0%	0%	10%
CNG	1.50%	1.50%	0%
LPG	0.50%	0.50%	0%
Electricity from solar chargers	0%	0%	40%
Passenger: Public: mini-bus			
Diesel	100%	90%	10%
Biofuel	0%	10%	10%
Electricity from solar chargers	0%	0%	80%
Passenger: Public: Trolley			
Electricity from grid	100%	100%	100%
Passenger: Public: Tram			
Electricity from grid	100%	100%	100%
Passenger: Taxi			
Gasoline	39%	39%	10%
Diesel	48%	38%	0%
CNG	5%	5%	0%
LPG	8%	8%	0%
Biofuel	0%	10%	10%
Electricity from solar chargers	0%	0%	80%

End use / Energy carrier	2015	2030 baseline	2030 mitigation
Passenger: LDVs			
Gasoline	18%	18%	18%
Diesel	67%	57%	57%
LPG	16%	16%	16%
Biofuel	0%	10%	10%
Electricity from solar chargers	0%	0%	0%
Passenger: Mopeds and motorcycles			
Gasoline	93%	83%	63%
Diesel	2%	2%	2%
Biofuel		10%	10%
Electricity from grid	5%	5%	5%
Electricity from solar chargers	0%	0%	20%
Freight: Light commercial vehicles			
Gasoline	15%	15%	10%
Diesel	70%	60%	0%
LPG	15%	15%	0%
Biofuel	0%	10%	10%
Electricity from solar chargers	0%	0%	80%
Freight: Heavy Goods vehicles			
Gasoline	10%	10%	10%
Diesel	90%	80%	80%
Biofuel	0%	10%	10%
Electricity from solar chargers	0%	0%	0%
Municipal Fleet			
Gasoline	78%	78%	0%
Diesel	22%	22%	0%
Electricity from solar chargers	0%	0%	100%

Table G.30: Energy intensities by fuel and mode in 2015 and in 2030 for baseline and mitigation scenarios

End use / Energy carrier	Unit	2015	2030 baseline	2030 mitigation
Passenger: Public: Bus				
Diesel	MWh/mpkm	46.00	41.40	41.40
Diesel (efficient)	MWh/mpkm	36.80	33.12	33.12
Biofuel	MWh/mpkm	46.00	41.40	41.40
Biodiesel (efficient)	MWh/mpkm	36.80	33.12	33.12
CNG	MWh/mpkm	26.45	23.80	23.80
LPG	MWh/mpkm	54.06	48.66	48.66
Biofuel	MWh/mpkm	46.00	41.40	41.40
Electricity from solar chargers	MWh/mpkm	15.86	14.28	14.28
Passenger: Public: mini-bus				
Diesel	MWh/mpkm	223.03	200.73	200.73
Biofuel	MWh/mpkm	223.03	200.73	200.73
Electricity from solar chargers	MWh/mpkm	76.91	69.22	69.22
Passenger: Public: Trolley				
Electricity from grid	MWh/mpkm	33.04	33.04	33.04
Passenger: Public: Tram				
Electricity from grid	MWh/mpkm	17.81	17.81	17.81
Passenger: Taxi				
Gasoline	MWh/mpkm	589.02	471.21	471.21
Diesel	MWh/mpkm	477.04	381.63	381.63
CNG	MWh/mpkm	503.77	403.02	403.02
LPG	MWh/mpkm	1 029.78	823.82	823.82
Biofuel	MWh/mpkm	589.02	471.21	471.21
Electricity from solar chargers	MWh/mpkm	164.50	131.60	131.60
Passenger: LDVs				
Gasoline	MWh/mpkm	654.47	523.57	523.57
Diesel	MWh/mpkm	530.04	424.03	424.03
LPG	MWh/mpkm	1 144.20	915.36	915.36
Biofuel	MWh/mpkm	654.47	523.57	523.57
Electricity from solar chargers	MWh/mpkm	182.77	146.22	146.22

Passenger: Mopeds and motorcycles				
Gasoline	MWh/mpkm	420.73	378.65	378.65
Diesel	MWh/mpkm	584.13	525.71	525.71
Biofuel	MWh/mpkm	584.13	525.71	525.71
Electricity from grid	MWh/mpkm	285.71	257.14	257.14
Electricity from solar chargers	MWh/mpkm	285.71	257.14	257.14
Freight: Light commercial vehicles				
Gasoline	MWh/mtkm	302.92	272.63	272.63
Diesel	MWh/mtkm	350.48	315.43	315.43
LPG	MWh/mtkm	441.33	397.20	397.20
Electricity from solar chargers	MWh/mtkm	120.85	108.77	108.77
Freight: Heavy Goods vehicles				
Gasoline	MWh/mtkm	132.53	119.28	119.28
Diesel	MWh/mtkm	153.33	138.00	138.00
LPG	MWh/mtkm	180.21	162.19	162.19
Electricity from solar chargers	MWh/mtkm	52.87	47.59	47.59
Municipal Fleet				
Gasoline	MWh/mvkm	1.51	1.20	1.20
Diesel	MWh/mvkm	1.05	0.84	0.84
Electricity from solar chargers	MWh/mvkm	0.36	0.29	0.29