

Having regard to Article 41, paragraph 34 of the Statute of the City of Zagreb (Official Journal of the City of Zagreb no 23/16, 2/18 and 23/18), the City Council of the City of Zagreb at its 23rd session held on 10 June 2019 adopted the following

City of Zagreb Sustainable Energy and Climate Action Plan (SECAP)

1 SUMMARY

The global climate change has become one of today's most demanding challenges. Scientific research has shown that its main reason is an increase in greenhouse gas emissions caused by combustion of fossil fuels, agriculture and cutting down of tropical forests. Climate change impact on a certain sector and that sector's vulnerability can be similar in several cases or on various locations, but, unfortunately, general adaptation guidelines do not exist. Each case is specific and in each case a specific solution should be applied. Climate change impact is global, but measures for adaptation to climate change are definitely local.

Climate change consequences affect the society and societal processes differently, but they all ultimately result in increased vulnerability. Climate change can be fought in two ways, by affecting the sources of climate change (mitigation) or by tackling and affecting consequences of climate change (adaptation). Mitigation of climate change is aimed at reducing greenhouse gas emissions and/or increasing capacities of absorption of such gasses.

The City of Zagreb energy policy has been aimed at sustainable energy development on the basis of the environment protection, energy efficiency, utilisation of renewable energy sources and sustainable construction principles for many years now. By joining the **Covenant of Mayors**, drafting and implementing the Sustainable Energy Action Plan, the City of Zagreb energy policy gained recognition in Europe, as well.

With the objective of mitigating climate change, the City of Zagreb was among the first European capitals to join the Covenant of Mayors, an extensive European Commission initiative started in January 2008. After holding consultations on the future of the Covenant of Mayors, on 15 October 2015 the European Commission initiated a new, integrated **Covenant of Mayors for Climate and Energy** (hereinafter referred to as "the Covenant"), which aims to surpass the 2020 targets. The signatories to this new Covenant agreed to reduce CO₂ emissions (and possibly of other greenhouse gasses) and to adopt a joint approach to tackling climate change mitigation and adaptation.

The Covenant signatories have undertaken to reduce CO₂ emissions (and possibly of other greenhouse gasses) in the co-signatory's local area by at least 40% until 2030 compared to the reference year, to increase resistance to climate change by applying the climate change adaptation principle, exchanging experiences, visions, results and practices with local and regional authorities in the EU and abroad, as well as to draft a **Sustainable Energy and Climate Action Plan – SECAP** (hereinafter referred to as "the Action Plan") within the period of two years of joining the Covenant and compile report documentation on the implementation of the Action Plan.

SECAP represents a key energy document which, based on the collected data on the current state, identifies and provides precise and clear guidelines for the implementation of projects related to measures of energy efficiency and use of renewable energy sources, as well as to the adaptation to climate change effects at the city level, which will result in the reduction of CO₂ emissions in the City of Zagreb by more than 40% until 2030. The Action Plan is focused on long-term climate change effects on local community areas, taking into consideration energy efficiency and providing measurable objectives and results related to the reduction of energy consumption and CO₂ emissions.

The key Action Plan chapters include an overview of the Baseline Emission Inventory (BEI) for 2008, which is the selected baseline year, an overview of the Monitoring Emission Inventory of CO₂ emissions for 2015, a comparison of the baseline and monitoring inventories, the methodology of drafting the Action Plan, mitigation actions and measures for the full duration of the plan, climate change Risk and Vulnerability Assessment (RVA), adaptation actions and measures for the full duration of the plan and a chapter on financing mechanisms.

The Baseline Emission Inventory encompasses three main end-consumption sectors: building, traffic and public lighting. These sectors serve as a basis for analyses of energy consumption and CO₂ emissions.

Precise and clear guidelines for carrying out energy efficiency, climate change adaptation and climate change mitigation projects have been outlined in the Action Plan. The time dynamics of the implementation of all measures, potential promoters to carry out activities, partners in carrying the activities out and key stakeholders have been outlined, whereas energy savings amounts (MWh) and

potentials for reducing CO₂ emissions have been additionally laid out for the measures in the area of climate change mitigation.

2 INTRODUCTION

2.1 Covenant of Mayors

The Covenant of Mayors represents the largest global initiative aimed at local energy and climate activities with the purpose of reducing energy consumption, CO₂ emissions, climate change impact and adaptation to climate change.

According to EUROSTAT data, the urban areas in the EU generate 80% of energy consumption and the corresponding CO₂ emissions, with a yearly increase of 1.9%. That is exactly why the European Commission's goal of reducing greenhouse gas emissions can only be achieved if local authorities, investors, citizens and their associations become involved in the process. Local and regional authorities in the EU Member States, along with their national governments, share the responsibility and actively accept the obligations to combat global warming via energy efficiency and renewable energy sources utilisation projects.

On 29 January 2008, the European Commission started an extensive initiative that connects the mayors of European cities that promote energy efficiency into a permanent network for exchanging experiences in implementing effective measures for increasing urban energy efficiency. The Covenant of Mayors can be perceived as advanced European cities' response to global climate change challenges, as well as the first and the most ambitious initiative of the European Commission which is directly aimed at actively including the local authorities and citizens, if they are willing, in the combat against global warming. The new bottom-up approach in carrying out energy and climate policy activities on the local level was first introduced by this initiative, which also became very popular and successful in a very short period. The Covenant has been joined by more than 9,000 signatories (local and regional authorities) from 57 countries. The bottom-up management approach, multi-sectorial cooperation model and the scope of activities suitable for the local level were outlined as key factors for success.

After holding consultations on the future of the Covenant of Mayors, in October 2015 the European Commission initiated a new, integrated Covenant of Mayors for Climate and Energy, which aims to surpass the targets for 2020. The signatories to this new Covenant agreed to reduce CO₂ emissions (and possibly of other greenhouse gasses) and to adopt a joint approach to tackling climate change mitigation and adaptation.



Picture 2.1 Covenant of Mayors for Climate and Energy – initiative's logo

Climate change adaptation implies predicting harmful climate change effects and undertaking the appropriate measures in order to prevent or reduce the damage these effects can cause and to use the opportunities which can open up during that process. It has been proven that proper planning and early adaptation action enable long-term savings.

The Covenant's signatories agree to the mutual vision for 2050:

- **Decarbonising local territory** and thereby contributing to limiting the global average increase in temperature to under 2°C, in accordance with the international Paris Agreement on climate reached at the COP21 conference in December 2015;
- **Strengthening the local territory's resistance** and thereby strengthening the capacity to adapt to unavoidable climate change impacts;
- **Allowing all citizens to access secure, sustainable and affordable energy** and contributing to higher quality of life and improvement in energy security;

The Covenant's signatories undertake to:

- **Reduce CO₂ emissions** (and possibly of other greenhouse gasses) in the co-signatory's local area by at least **40% until 2030**, compared to the baseline year, by increasing energy efficiency and utilising renewable energy sources;

- **Increase climate change resistance** by applying the climate change adaptation principle;
- **Exchange experiences, visions, results and practices** with local and regional authorities in the EU and abroad by directly cooperating and exchanging knowledge, in accordance with the Global Covenant of Mayors;
- **Draft a Sustainable Energy and Climate Action Plan** within the period of two years after joining the Covenant and compile the pertinent **report documentation** on the implementation of the Action Plan.

In order to translate their political orientation into practical measures and projects, the Covenant's signatories are obliged to draft an Action Plan outlining the key activities they aim to undertake, within the period of two years after their local council has ratified the action of joining the Covenant. The Action Plan has to contain a Baseline Emission Inventory for monitoring climate change mitigation activities and an Analysis of climate risks and assessment of individual sectors' vulnerability to climate change effects.

Joining the Covenant marks the beginning of a long-term process and entails affiliation with an active community of local areas, which undertake to report on the implementation of their plans and to improve their citizens' everyday life by implementing new activities and contributing to a sustainable future.

2.2 What exactly is the City of Zagreb Sustainable Energy and Climate Action Plan (SECAP)?

As a consequence of the consultations on the future of the Covenant of Mayors, which was upgraded to the Covenant of Mayors for Climate and Energy in October 2015, the Sustainable Energy Action Plan (SEAP) was also upgraded to the Sustainable Energy and Climate Action Plan (SECAP).

SECAP represents a key city energy document which, based on the collected data on the current state, identifies and provides precise and clear guidelines for the implementation of projects and measures of energy efficiency, use of renewable energy sources, as well as to the adaptation to climate change effects. The Action Plan is focused on long-term climate change effects on local community areas, taking into consideration energy efficiency and providing measurable objectives and results related to the reduction of energy consumption and CO₂ emissions. The main objective of the Action Plan is to reduce CO₂ emissions by more than 40 % by 2030 by implementing the suggested measures.

By signing the Covenant, the mayors have undertaken to draft a Sustainable Energy and Climate Action Plan which needs to be submitted to the European Commission within the period of two years after joining the Covenant, and to periodically compile the pertinent reports.

The Action Plan has to contain:

- Baseline emission inventory for monitoring climate change mitigation activities;
- Climate change mitigation measures;
- Risk analysis and assessment of individual sectors' vulnerability to climate change effects;
- Climate change adaptation measures.

The obligations from the Action Plan refer to the entire city area, with regards to both the public and private sector. The Plan defines activities in various sectors, but especially in the building, traffic and public lighting sectors, considering that the local authorities influence these sectors the most and that they contribute to energy consumption and CO₂ emissions the most.

The Action Plan has to be compliant with the EU, national and local institutional and legal framework in its every segment, as well as encompass the period up to 2030.

2.3 Energy and climate policy of the City of Zagreb

The public sector is legally bound to use energy rationally and manage it systematically in all its structures at the national, regional and local level. That is exactly why the public sector needs to encourage and promote the activities aimed at implementing measures for improving energy efficiency and reducing harmful gas emissions.

As the capital of the Republic of Croatia, the City of Zagreb is obliged and responsible, as well as willing to maximally support and implement the suitable measures aimed at rational energy use, energy efficiency, climate change adaptation, utilisation of renewable energy sources and environmentally friendly fuels, in addition to provide expert assistance to every interested local and regional community which does not have its own capacities but shows interest.

The City Office for Economy, Energetics and Environment Protection performs tasks having to do with economic development, investments, crafts, encouraging the development of crafts, small- and middle-sized enterprises, tourism and the development of tourism activities, hospitality services, trade, companies owned by the City, natural disaster damage, energy and energy development planning, heat energy, energy efficiency, renewable energy sources, environment protection, air protection, water

management and waters, sustainable waste management, noise protection, light pollution protection and other tasks from its purview.

The City Office for Economy, Energetics and Environment Protection took over the responsibilities of the City Office for Energetics, Environment Protection and Sustainable Development on 1 January 2018.

The legislative framework of the City of Zagreb energy and climate policy is outlined in *Annex 1 – Legislative Framework*.

2.3.1 Development of the energy and climate policy of the City of Zagreb

At its 204th session of 26 February 2008, the City Government of the City of Zagreb has accepted the Letter of Intent between the United Nations Development Programme and the City of Zagreb with Regard to Cooperation on the Systematic Energy Management in Cities and Counties in the Republic of Croatia project conducted by the Ministry of the Economy, Labour and Entrepreneurship and the United Nations Development Programme (UNDP).

By issuing the Statement on Energy Efficiency and Environment Protection Policy on behalf of the City of Zagreb, the Mayor has outlined the strategic orientation and the primary policy objectives of the competent City Administration of the City of Zagreb in further carrying out of the SGE project, promoting and implementing energy efficiency, sustainable development and environment protection by utilising renewable energy sources and implementing state-of-the-art energy technologies in the entire City of Zagreb area.

The Statement was signed by the Mayor at the Dverce Palace on 28 March 2008, which marked the start of the active implementation of the City of Zagreb Energy Efficiency Policy.

It should be stressed that the City of Zagreb is one of the first European capitals to have joined the Covenant of the Mayors, via the Decision of the City Assembly of the City of Zagreb from 30 October 2008. By doing so, the City of Zagreb expressed its support to this extensive initiative aimed at linking the mayors of energy aware European cities in a long-lasting network, the purpose of which is to facilitate the exchange of experiences in the implementation of effective measures for the improvement of urban energy efficiency.



Picture 2.2 Ceremonial signing of the Covenant of Mayors, the Hemicycle of the European Parliament, Brussels, 10 February 2009 (the Mayor of the City of Zagreb is fifth from the left in the first row)

As a Strategic Partner of the European Commission – Directorate-General for Energy in implementing the Covenant of Mayors in the Republic of Croatia and the greater region, the City of Zagreb has undertaken to provide expert assistance to the units of local and regional self-government which require it.

By adopting the Decision of 25 November 2008, the City Assembly affirmed the full membership of the City of Zagreb in Energy Cities, an association which connects units of local and regional self-government that use energy rationally, implement energy efficiency measures, use renewable energy sources and protect their environments. Energy Cities is a non-profit association founded in 1990 by European local self-government units, which intensively promotes local sustainable energy policy and encourages

cooperation between its members, aimed at exchanging experiences, knowledge and best practice examples from the energy efficiency and renewable energy sources areas.

The City of Zagreb hosted the second working conference under the umbrella of the SGE project *Sustainable Development of Cities*, which took place from 27 to 29 April 2009. It was organised and sponsored by the City of Zagreb, the United Nations Development Programme (UNDP), the North-West Croatia Regional Energy Agency (hereinafter referred to as "REGEA"), the Ministry of the Economy, Labour and Entrepreneurship, the Ministry of Environmental Protection, Physical Planning and Construction, Environmental Protection and Energy Efficiency Fund and the Association of Cities in the Republic of Croatia. The conference gathered around five hundred participants, primarily representatives of local and regional self-government units, county prefects, mayors, representatives of educational and scientific institutions, public, residential and commercial structure designers, investors in the construction sector, representatives of craft trades and economic operators, energy service companies (ESCO), development and energy agencies, as well as representatives of the media.

The Letter of Intent between the Mayors of Zagreb, Sarajevo, Podgorica and Skopje was signed at the conference, representing the first step in the preparation for joint application for the "Establishment of Energy Management Systems in Cities" project, funded by the *Deutsche Gesellschaft für Technische Zusammenarbeit* (GTZ) through the Open Regional Fund for South-East Europe – Energy Efficiency.

In order to encourage the implementation of energy efficiency measures and use of renewable energy sources, the City of Zagreb developed the "ZagEE – Zagreb Energy Efficient City" project, which was carried out under the 2012 Intelligent Energy Europe technical assistance programme for mobilising local energy investment. The project encompassed technical assistance funding and the drafting of the documentation required for energy efficiency renovations of buildings financed by grants. The beneficiaries were provided with possibilities to develop projects, draft cost-effectiveness studies and obtain the administrative documentation necessary to receive funding for energy efficiency renovations from sources other than the city budget, such as foreign banks and EU funds. The value of the ZagEE project amounted to 1,813,438 euro, whereas the overall planned investment value of the implementation of the measures for which technical documentation had been drafted was 29,379,114 euro. The financial returns on investments, excluding the grants, have been estimated to occur 13 years after the completion of the project. The ZagEE project supported energy efficiency renovations via the implementation of economically justified, energy efficient technologies and measures in structures owned by the City of Zagreb: 3 city administration buildings, 15 elementary school buildings, 7 secondary school buildings, 36 daycare buildings, 6 retirement home buildings, 3 community health centre buildings, 17 local self-government buildings and 3000 new LED public lighting units with a control management system.

The City of Zagreb continuously drafts yearly energy efficiency plans and triennial energy efficiency action plans, which it is obliged to draft according to the Energy Efficiency Act (Official Gazette no 127/14 and 116/18).

In 2010, the City of Zagreb affirmed the City of Zagreb Sustainable Energy Action Plan, drafted after the City had joined the Covenant of Mayors and in 2015 a report on its progress was submitted.

The above-mentioned projects, documents, plans and collaborations of the City of Zagreb indicate that the City of Zagreb continuously carries out a proactive energy and climate policy.

2.3.2 The City of Zagreb energy and climate policy vision

The City of Zagreb Administration resolutely and actively carries out the measures and processes of sustainable energy development planned with the purpose of accomplishing the City of Zagreb – a Sustainable Development City vision, in cooperation with all relevant domestic and foreign partners.

"We must serve as an example for popularising realistic possibilities of energy and direct financial savings and the reduction of harmful impact on the environment among our citizens, as well as conduct a proactive energy policy and raise our employees' and citizens' awareness of energy issues, environment protection and the criticality of efficient energy use."

Mayor of the City of Zagreb, Milan Bandić, opening ceremony of the 5th Zagreb Energy Week at the Dverce Palace on 14 May 2014

The benefits of the successfully performed process of drafting, implementing and monitoring the Action Plan are multi-faceted for both the City of Zagreb and its citizens, as well as when it comes to strengthening the political power of the city administration which will, by successfully completing the entire process, achieve the following goals:

- Demonstrate its orientation towards sustainable development of the City of Zagreb, based on the principles of environment protection, energy efficiency and renewable energy sources as sustainability imperatives of the 21st century;
- Strengthen the capacities of the City of Zagreb for facing the harmful climate change effects;
- Utilise the possibilities, offered by the development of a low-carbon society, for the progress of the economy and the society as a whole;
- Lay the foundations of sustainable energy development of the City of Zagreb;
- Establish new financial mechanisms for initiating and implementing energy efficiency measures and measures aimed at renewable energy sources use in the City of Zagreb;
- Ensure long-term secure energy supply in the City of Zagreb;
- Increase the quality of life of its citizens (improve air quality, reduce traffic congestion etc.).

The Covenant's signatories agree to the mutual vision for 2050:

- **Decarbonising local territory** and thereby contributing to limiting the global average increase in temperature to under 2°C, in accordance with the international Paris Agreement on climate reached at the COP21 conference in December 2015;
- **Strengthening the local territory's resistance** and thereby strengthening the capacity to adapt to unavoidable climate change impacts;
- **Allowing all citizens to access secure, sustainable and affordable energy** and contributing to higher quality of life and improvement in energy security;

2.3.3 The City of Zagreb energy and climate policy goals

The City of Zagreb energy and climate policy goals are reflected in energy savings and the estimated reduction of CO₂ emissions.

The goals that the City of Zagreb agreed to accomplish by signing the Covenant, are the following:

- **A 40% reduction in CO₂ emissions by 2030**, in comparison with 2008, the baseline year for the emission inventory;
- **Increasing climate change resistance** by applying the climate change adaptation principle.

According to the Baseline Emission Inventory, the emissions of CO₂ in 2008 amounted to 2,794,000 t, an amount which is expected to be reduced by 40% in 2030.

In comparison with the baseline 2008 and in compliance with the set level of emission reduction of 40%, the City of Zagreb should reduce its CO₂ emissions by approximately 1,118,000 t, meaning that its emissions ought not exceed 1,677,630.53 t in 2030.

3 METHODOLOGY

The Action Plan has been drafted in accordance with the Covenant of Mayors for Climate and Energy Reporting Guidelines and with the Sustainable Energy and Climate Change Action Plan template drafted by the Covenant of Mayors Office and the Mayors Adapt Office in association with the European Commission's Joint Research Centre.

In order to simplify the preparatory and implementing stage of the Action Plan and in order to enable European cities to compare their results, the European Commission prepared supporting documents, containing the guidelines and tools which helped draft this Action Plan:

1. *'How to develop a Sustainable Energy and Climate Action Plan (SECAP)' guidebook;*
2. *The Covenant of Mayors for Climate and Energy Reporting Guidelines;*
3. *Guidance materials and tools available at the Urban Adaptation Support Tool (Urban AST) platform.*

The first version of the City of Zagreb Sustainable Energy Action Plan (SEAP) was drafted in 2010, with the baseline year for calculating the savings being 2008. Reports on the implementation of that action plan were made in 2015, as part of the City of Zagreb Sustainable Energy Action Plan Revision document.

The Action Plan has to contain:

- Baseline emission inventory for monitoring climate change mitigation activities;
- Climate change mitigation measures;
- Climate risk analysis and assessment of individual sectors' vulnerability to climate change effects;

- Climate change adaptation measures.

3.1 Preparatory actions for initiating the process of drafting the Action Plan

The fundamental activity within the preparatory stage of drafting the Action Plan is the establishing of the political will to initiate the Plan and implement it. In order for the process to be successfully carried out, the support of the Mayor and the City Assembly of the City of Zagreb are vital. By joining the Covenant, the City Assembly has indicated its affirmative stance towards a sustainable energy development of the City of Zagreb, as well as made the first step towards such a development. Other steps must follow, with human resources development and ensuring the necessary funds being among the essential ones.

The tasks of the City Assembly in implementing the Action Plan are the following:

- To successfully integrate the goals and measures of the Action Plan into the City of Zagreb Development Strategy, the Zagreb Urban Agglomeration Development Strategy and other relevant strategic documents;
- To ensure that expert staff implements the outlined energy efficiency and renewable energy source measures, as well as the measures aimed at adapting to climate change effects;
- To ensure funds for the implementation of measures for which the City of Zagreb has been designated as the promoter;
- To timely and jointly coordinate the implementation of measures that do not fall under the competence of the city administration with the designated promoters and other involved stakeholders;
- To support continuous implementation of measures during the period of carrying out the Action Plan (until 2030);
- To ensure Plan implementation dynamics monitoring and reporting until 2030;
- To continuously inform citizens on Plan implementation;
- To ensure the participation of stakeholders and citizens, from the drafting stage to the stage of Action Plan implementation monitoring;
- To actively participate in the network of cities which have signed the Covenant, in order to continuously exchange positive experiences and mutual synergy in developing urban sustainable energy communities in Europe.

On behalf of the City Administration, the City Office for Economy, Energetics and Environment Protection is responsible for the coordination of drafting and implementing the Action Plan, as well as for monitoring and reporting on its implementation. The coordination capacity of the City Office for Economy, Energetics and Environment Protection is supplemented by tasks regarding the very implementation. One promoter and partners from the City Administration or other City of Zagreb bodies have been assigned to each individual measure. The stakeholders from the City of Zagreb area whose activities are affected by a certain measure are also included in the implementation of that measure.

Participation of as many stakeholders as possible in the preparatory stage of the Action Plan is expected in order to successfully and effectively commence the process of changing citizens' energy stances and behaviour, as well as raising their awareness of climate change effects.

Stakeholders in drafting the Action Plan were those entities:

- whose interests aligned in any way with the Action Plan;
- whose activities affect the Action Plan in any way;
- whose property, access to information, sources, expertise etc. are vital for the Action Plan to be successfully drafted and implemented.

Firstly, the stakeholders had to be identified and then their specific roles and tasks were outlined in the Process of Drafting, Implementing and Monitoring the Action Plan. The key stakeholders have been identified and outlined in *Annex 2 – Key stakeholders*.

The stakeholder inclusion and consultation process were primarily based on the experiences and insights gained by carrying out similar activities and projects such as Pentahelix (www.pentahelix.eu), which received its funding as part of the Horizon 2020 programme.

The key stakeholders were involved in the process of preparation and drafting of the Action Plan by participating in an array of workshops aimed at specific sectors. The workshops had been organised in such a way that the stakeholders' representatives were able to provide comments and expert support during the creation of measures for individual sectors.

3.2 LEAP-based modelling

The LEAP (Long-range Energy Alternatives Planning) programme was used in developing energy savings and CO₂ emission reduction scenario for 2030, in accordance with the suggested Action Plan measures.

LEAP¹, the Long-range Energy Alternatives Planning System, is a widely-used software tool for energy policy analysis and climate change mitigation assessment developed at the Stockholm Environment Institute. LEAP has been adopted by thousands of organisations in more than 190 countries worldwide. Its users include government agencies, academics, non-governmental organisations, consulting companies, and energy utilities. It has been used at many different scales ranging from cities and states to national, regional and global applications.

LEAP is an integrated, **scenario-based modelling** tool that can be used to track energy consumption, production and resource extraction in all sectors of the economy and for forecasting greenhouse gas emission sources.

LEAP supports a wide range of various modelling methodologies: as far as demand is concerned, these range from bottom-up technological tools and end use to top-down macroeconomic modelling. The newest version of LEAP also supports optimization modelling, allowing for the construction of lowest cost models, potentially under various energy system limitations such as limits on CO₂ or local air pollution.

LEAP is intended as a medium- to long-term modelling tool. Most of its calculations occur on an annual basis, and the time horizon can extend for an unlimited number of years. Studies typically include both a historical period known as the reference year, in which the model is run to test its ability to replicate known statistical data, as well as multiple forward looking scenarios. Typically, most studies use a forecast period of between 20 and 50 years.

3.2.1 Modelling in LEAP aimed at drafting the Action Plan

In order for comparisons between various scenarios which include activities outlined in the Action Plan to be possible, it is necessary to develop a scenario where Action Plan activities are not implemented and monitor the development of the effects on climate conditions. Such a scenario is called the business-as-usual scenario (BAU). Comparison between a scenario in which the Action Plan measures are implemented and the BAU scenario demonstrates the significance of the Action Plan in the clearest way.

In drafting the City of Zagreb Action Plan, a BAU consumption scenario was generated in LEAP, as were several iterations of the scenario in which the predicted measures aimed at reducing greenhouse gas emissions were implemented. The bottom-up methodology, which implies collection and entering of data by certain city offices and companies, was applied in creating the energy consumption and CO₂ emission inventories.

The **assumptions** used in modelling the energy savings scenarios for the period up to 2030 in LEAP are outlined in *Annex 3 – Assumptions used in modelling scenarios for the City of Zagreb SECAP for the period up to 2030*.

3.3 Drafting the Action Plan

The key element of the Action Plan is the goal of reducing CO₂ emissions of the City of Zagreb by 2030. The Action Plan has to set individual goals of reduction of CO₂ emissions for sectors and sub-sectors of energy consumption in the City of Zagreb area.

In order to set the actual 2030 goals of energy savings and CO₂ emission levels, it is necessary to collect quality data on the energy situation and energy consumption for the baseline year. The first step in doing that is classifying the energy consumption sectors in the City of Zagreb.

In accordance with the European Commission's guidelines, the energy consumption sectors of the City of Zagreb have been grouped into three main sectors and the district heating sector (Centralised Heating System):

- Building sector;
- Traffic;
- Public lighting;
- District heating (Centralised Heating System).

The **building sector** is divided into the following three sub-sectors:

¹ Heaps, C.G., 2016. Long-range Energy Alternatives Planning (LEAP) system. [Software version: 2018.1.8] Stockholm Environment Institute. Somerville, MA, USA. <https://www.energycommunity.org>

- Residential, public and city company buildings owned by the City of Zagreb;
- Commercial buildings not owned by the City of Zagreb;
- Residential buildings (excluding the residential buildings owned by the City of Zagreb).

The **traffic sector** is divided into the following three sub-sectors:

- City of Zagreb vehicle fleet;
- City of Zagreb public transport;
- Personal and commercial vehicles.

The **public lighting sector** is made up of the electric and gas public lighting network in the City of Zagreb area.

The **district heating sector** encompasses the Centralised Heating System in the City of Zagreb area.

The **list of the key data** required for the drafting of the Action Plan and **the sources of all the mentioned data**, on the basis of which the energy balance sheets, Baseline Emission Inventory, Monitoring Emission Inventory and the City of Zagreb Climate Change Analysis were generated, and which, in generating these bases, served as the foundation for developing the measures and activities of the Action Plan, are outlined in *Annex 4 – Data sources*.

The Baseline Emission Inventory (BEI) of CO₂ emissions was conducted for 2008, on the basis of collected data. The Monitoring Emission Inventory (MEI) of CO₂ emissions was conducted for 2015.

Both inventories were conducted in compliance with the Intergovernmental Panel on Climate Change (**IPCC**) protocol. The IPCC protocol for determining the emission levels of pollutants in the atmosphere is a protocol of the Intergovernmental Panel on Climate Change, which is the executive body of the United Nations Environment Programme (UNEP) and the World Meteorological Organisation (WMO) responsible for implementing the United Nations Framework Convention on Climate Change (UNFCCC). By ratifying the Kyoto Protocol in 2007, the Republic of Croatia agreed to monitor and report on the emission levels of pollutants in the atmosphere, in compliance with the IPCC protocol, which is why that nationally recognised protocol is used in generating the Baseline Emission Inventory of CO₂ emissions in the City of Zagreb.

Energy efficiency and renewable energy sources **measures and activities** and climate change adaptation measures **are identified** on the basis of CO₂ emissions data for individual energy consumption sectors and sub-sectors of the City of Zagreb, the analysis of the energy situation in energy balance sheets for previous years, energy consumption estimates for the period up to 2030 and many other relevant factors (City of Zagreb Urban Development Plan, City of Zagreb Development Strategy – Zagrebplan, Traffic System Master Plan, Urban Agglomeration Development Strategy etc.).

For the identified measures and activities, the implementation of which can result in reduction of CO₂ emissions, as well as in satisfactory economic and energy parameters, the Action Plan will outline the following:

- Energy savings potentials by 2030;
- CO₂ emissions reduction potentials by 2030;
- Time frame and implementation dynamics;
- Funding possibilities;
- Investment costs of the implementation.

3.4 Implementation of and reporting on the implementation of the Action Plan

The European Commission recommends that the larger cities establish an Action Plan Implementation Department. The City Office for Economy, Energetics and Environment Protection is responsible for coordinating the drafting of, implementing and monitoring the implementation of the Action Plan on behalf of the City Administration.

3.4.1 Monitoring and control of the implementation

The phase of Action Plan implementation monitoring and control has to simultaneously occur at several levels:

- Monitoring the dynamics of implementation of specific energy efficiency measures in accordance with the Priority Measures and Activities Plan;
- Monitoring the projects' implementation performance;
- Monitoring and control of the set energy savings goals for each individual measure of the Action Plan;
- Monitoring and control of the achieved reduction of CO₂ emissions for each individual measure of the Action Plan.

In order to successfully monitor the achieved savings in individual sectors and their sub-sectors and the accomplishment of the targets as to the reduction of CO₂ emissions, be it for individual measures, as well as within the scope of the entire Action Plan, a new CO₂ Emissions Registry of the City of Zagreb needs to be established. The European Commission recommendations state that the overall process of drafting, implementing and monitoring the implementation of the Action Plan would yield the best results if a new CO₂ Emissions Registry were to be established every two years and done so by applying the same methodology of establishment that was applied when the 2008 CO₂ Emissions Registry was established.

Only a uniform registry establishment methodology enables comparisons between registries and provides the answer on whether the goals relative to the reduction of CO₂ emissions have been achieved.

As part of the 2015 Energy Efficiency Action Plan Revision, the Monitoring Emission Inventory of CO₂ emissions was conducted in accordance with these instructions.

The City of Zagreb opted for monitoring the achieved savings and progress regarding the reduction of CO₂ emissions and drafting an Action Reporting every two years (submission of a form which does not include an emission inventory), as well as a Full Reporting every four years, including updates on adaptation activities and at least one Monitoring emissions Inventory (MEI form).

3.4.2 Identified implementation risks

When monitoring the implementation process, it is important to also monitor and minimise the risks. The Reporting Template of the Covenant of Mayors outlines the risks that have been noted on numerous occasions. The Action Plan implementation risks, as summarised in the Reporting Template, are outlined in Table 3.1. These risks are to be monitored during the implementation of the Action Plan in order for their influence to be minimised. The Table also contains a rating estimation of the outlined risks in order to facilitate the planning and risk management process.

Table 3.1 Identified risks for the implementation of the Sustainable Energy and Climate Action Plan, as summarised in the Reporting Document of the Covenant of Mayors and a rating estimation of the identified risks

Risk	Quality - high / medium / low
Limited funds	Medium
Non-existent or weak regulatory framework	Low
Lack of technical expertise	Low
Lack of support from key stakeholders	High
Lack of political support on other administrative levels	Medium
Changes in local policy priorities	Medium
Incompatibility with the national political orientation	Low
High costs or inadequacy of available technologies	High

3.4.3 Reporting

The Covenant of Mayors has made accessible the forms into which the main Action Plan parameters (the person responsible, energy consumption and CO₂ emissions by sectors in accordance with the EC classification, identified energy efficiency measures, targets etc.) are to be entered.

Considering the fact that the biennial reporting process requires that significant financial and human resources be properly allocated, there are two possibilities:

- Reporting every two years;
- Drafting an Action Reporting every two years (submitting a form which does not include an emission inventory) and a Full Reporting every four years, including updates on adaptation activities and at least one Monitoring Emissions Inventory (MEI form).

The City of Zagreb opted for drafting an Action Reporting every two years (submission of a form which does not include an emission inventory), as well as a Full Reporting every four years, including updates on adaptation activities and at least one Monitoring emissions Inventory (MEI form).

4 BASELINE EMISSION INVENTORY (BEI)

The covenant binds the signatories to conduct emission inventories. When drafting the first Action Plan, the baseline year must be defined and an emission inventory must be conducted for that year, i.e. the Baseline Emission Inventory.

The BEI provides a numerical overview of the amount of emitted CO₂ for the baseline year based on the energy consumption on the territory of a local self-government unit that is a signatory to the Covenant of Mayors. On the basis of the BEI, the sources of anthropogenic contribution to CO₂ emissions are

determined and the priorities of the reduction measures are set. The BEI is a key instrument in determining the performance of the planned activities aimed at achieving energy efficiency and reducing CO₂ emissions.

The City of Zagreb BEI was conducted for **2008**, which was selected as the **baseline year**. The main criterion in selecting the baseline year was the availability of the data required for calculating CO₂ emissions.

The BEI encompassed **three end-consumption sectors** in the City of Zagreb: building, traffic and public lighting sectors. Such a classification of sectors follows EC recommendations. Detailed energy analyses by end-consumption sectors and sub-sectors were made for the purpose of conducting the BEI and they are available under *Annex 5 – Energy consumption analyses and the Baseline Emission Inventory*.

The calculations encompassed direct emissions (fuel combustion) and indirect emissions (stemming from electricity and heat energy consumption) which are anthropogenic. Although the BEI covers CO₂ emissions, an overview of methane (CH₄) and nitrous oxide (N₂O) emissions was also provided for the traffic sector.

The City of Zagreb BEI was conducted in compliance with the IPCC **protocol**, a protocol of the Intergovernmental Panel on Climate Change, which is the executive body of the United Nations Environment Programme (UNEP) and the World Meteorological Organisation (WMO) responsible for implementing the United Nations Framework Convention on Climate Change (UNFCCC).

Since the IPCC does not provide recommendations on methodology regarding calculations of indirect emissions, such methodology was developed during the conducting of this inventory. A detailed description of the methodology used in determining specific emission factors for heat energy and fuel combustion and a detailed description of the IPCC methodology are given in the Basic Guidelines and Bases for Monitoring CO₂ Emissions study, which can be found in *Annex 7 – Basic Guidelines and Bases for Monitoring CO₂ Emissions for the Purpose of Drafting the City of Zagreb SEAP*. The study was commissioned by the City of Zagreb and it was conducted by REGEA employees in January 2010. The BEI structure firstly provides the baseline inventories of individual sectors, whereas the overview of the overall baseline inventory of all sectors is provided in the end.

4.1 Baseline Emission Inventory of the building sector of the City of Zagreb

The building sector CO₂ emissions encompass emissions stemming from electricity and heat energy consumption, as well as fuel combustion emissions. The fuel combustion emissions are calculated via standard emission factors (first level of the IPCC methodology calculations), whereas specific emission factors (Table 4.1) were determined for calculating the emissions stemming from electricity and heat energy consumption.

Table 4.1 Emission factors used for determining CO₂ emissions in the building sector

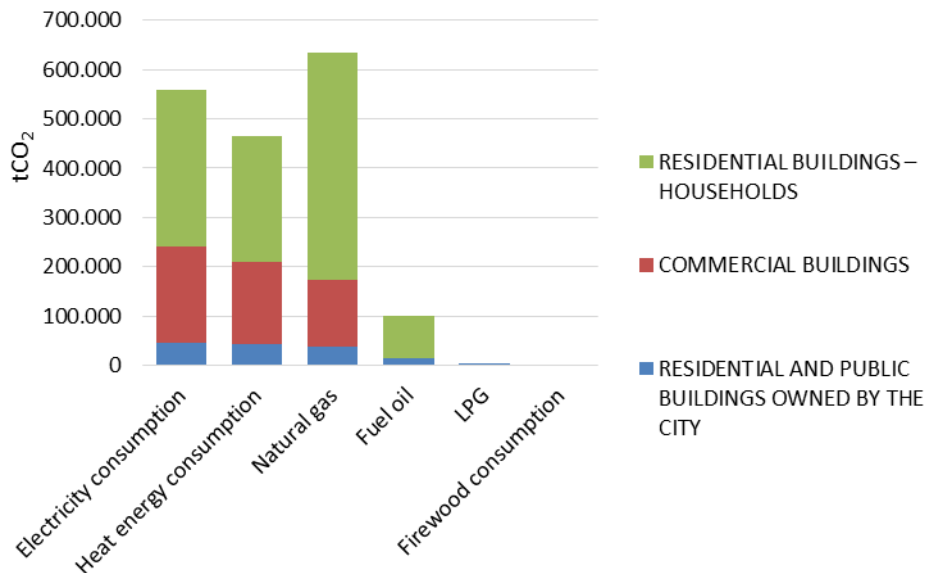
ENERGY SOURCE	Unit	CO ₂	CH ₄	N ₂ O
Electricity	g CO ₂ /kWh _{el}	323	-	-
Heat energy	g CO ₂ /kWh _t	244	-	-
Natural gas	t/TJ	55.8	0.005	0.0001
Fuel oil	t/TJ	76.6	0.010	0.0006
Liquefied petroleum gas	t/TJ	62.4	0.010	0.0006
Firewood	t/TJ	0.0	0.300	0.004

When providing information on CO₂e emissions, the emissions of CH₄ and N₂O have to be multiplied with the defined global warming potential, which amounts to 1 for CO₂, 21 for CH₄ and 310 for N₂O. Table 4.2 and Picture 4.1 demonstrate the CO₂ emissions in the building sector of the City of Zagreb.

Table 4.2 Building sector CO₂ emissions

CATEGORY	Emission, t CO ₂						Total
	Electricity consumption	Heat energy consumption	Natural gas consumption	Fuel oil consumption	LPG consumption	Firewood consumption	
RESIDENTIAL AND PUBLIC BUILDINGS OWNED BY THE CITY							
Schools	7,784.4	14,229.9	9,895.4	11,226.7	0.0		43,136.3
Healthcare	6,277.3	10,809.2	9,832.6	47.0	0.0		26,966.0

CATEGORY	Emission, t CO ₂						Total
	Electricity consumption	Heat energy consumption	Natural gas consumption	Fuel oil consumption	LPG consumption	Firewood consumption	
City administration	1,856.1	1,930.8	1,249.8	1,299.9	0.0		6,336.7
Culture	2,190.5	18.8	4,124.4	0.0	0.0		6,333.6
Commercial spaces and flats owned by the City	5,925.2	4,909.5	4,854.7	0.0	0.0		15,689.4
Zagrebački holding buildings	22,060.9	10,514.5	6,891.3	1,474.0	58.0		40,998.7
TOTAL	46,094.4	42,412.7	36,848.1	14,047.6	58.0	0.0	139,460.8
COMMERCIAL BUILDINGS							
TOTAL	194,800.3	166,677.3	137,311.7	0.0	0.0		498,789.3
RESIDENTIAL BUILDINGS – HOUSEHOLDS							
TOTAL	318,745.1	256,595.1	459,889.4	85,952.6	0.0	0.0	1,121,182.2
BUILDING SECTOR TOTAL	559,639.7	465,685.2	634,049.2	100,000.2	58.0	0.0	1,759,423.3



Picture 4.1 Building sector CO₂ emissions

With a share of 36%, natural gas consumption generated the most CO₂ emissions followed by electricity consumption (31.8%, indirect emissions) and heat energy consumption (26.5%), while fuel oil and LPG consumption generated less than 6% of emissions. Households generated the largest amount of emissions in the building sector (63.7%). Commercial buildings generated 28.3% of emissions, while buildings and companies owned by the City generated 7.9% of emissions. The CO₂e emissions generated by fuel consumption had also been calculated and they amounted to 1,760,000 t CO₂e for the building sector.

4.2 Baseline Emission Inventory of the traffic sector of the City of Zagreb

In urban areas, the traffic sector, and especially the road traffic, pollutes the air the most and strongly contributes to the amount of greenhouse gasses (CO₂, CH₄ and N₂O). The CO₂ emission amounts generated by motor vehicles depend on numerous parameters, main ones being fuel quality, engine and vehicle design, driving mode, weather conditions, engine maintenance and age etc.

The traffic sector BEI is divided into three sub-sectors:

- CO₂ emissions generated by City-owned vehicles;
- CO₂ emissions generated by public transport vehicles;
- CO₂ emissions generated by personal and commercial vehicles.

COPERT III, a European Environmental Agency (EEA) software, was used in calculating the emissions generated by fuel combustion and vaporisation in the traffic sector. The EMEP/CORINAIR methodology was applied in the calculations. Detailed descriptions of both the EMEP/CORINAIR methodology and the COPERT III software package have been provided in *Annex 7 – Basic Guidelines and Bases for Monitoring CO₂ Emissions for the Purpose of Drafting the City of Zagreb SEAP*.

4.2.1 CO₂ emissions generated by City-owned vehicles

The City-owned vehicles sub-sector encompasses the City Administration vehicle fleet and the fleets of all branches of Zagrebački holding.

Table 4.3 contains information on greenhouse gas emissions generated by the City of Zagreb vehicle fleet in 2008 by the type of fuel used, whereas Table 4.4 contains a summary overview of energy consumed and emissions generated, as well as CO_{2e} data related to this sub-sector.

Table 4.3 City of Zagreb vehicle fleet greenhouse gas emissions

CITY-OWNED AUTOMOBILES						
ENERGY SOURCE	Amount of fuel used		Emission, t			
	t	TJ	CO ₂	CH ₄	N ₂ O	CO _{2e}
Petrol	424.42	18.93	1,298.52	0.09	0.01	1,304.03
Diesel	4,237.49	180.94	13,262.97	0.90	0.11	13,315.62
LPG	2.52	0.12	7.37	0.00	0.00	7.40
Natural gas	33.23	1.61	90.07	0.01	0.00	90.29
TOTAL		201.60	14,658.93	1.01	0.12	14,717.35

Table 4.4 Total energy consumed, emissions generated and CO_{2e} emissions generated by City-owned vehicles

SUB-CATEGORY	Energy consumed, MWh	CO ₂ emissions, t	CO _{2e} emissions, t
City-owned vehicles	55,877.9	14,658.9	14,717.3

The City-owned vehicles generated 2.8% of the CO₂ emissions generated by the traffic sector of the City of Zagreb.

A detailed description of the methodology, consumption and fuel types, as well as information on emission factors and heating values used can be found in *Annex 7 – Basic Guidelines and Bases for Monitoring CO₂ Emissions for the Purpose of Drafting the City of Zagreb SEAP*.

4.2.2 CO₂ emissions generated by the City of Zagreb public transport

The City of Zagreb public transport sub-sector encompasses bus transport and electric vehicles (trams and the funicular). According to Zagrebački električni tramvaj (ZET) data, the bus transport fleet in 2008 consisted of 323 buses fuelled by diesel and biodiesel. Diesel consumption in 2008 amounted to 10,298.2 t, whereas biodiesel consumption amounted to 265.82 t, or 2.2% of the total city bus transport fuel consumption.

Table 4.5 contains data on fuel consumption and greenhouse gas emissions by bus categories.

Table 4.5 Fuel consumption and greenhouse gas emission data by bus categories.

SECTOR	SUB-SECTOR	TECHNOLOGY	NUMBER OF VEHICLES	FUEL CONSUMPTION, t	CO ₂ , t	CH ₄ , t	N ₂ O, t	CO _{2e} , t
Buses	Inter-city	Conventional	267	565.9	1,775.9	0.14	0.06	1,797.0
		Euro I	89	188.6	592.0	0.04	0.02	598.9
		Euro II	101	214.1	671.8	0.03	0.02	679.4
		Euro III	95	201.3	631.9	0.02	0.02	638.8
		Euro IV	76	161.1	512.2	0.02	0.02	517.8
		TOTAL	628	1,331	4,183.8	0.25	0.14	4,231.9
	City	Conventional	99	3,156.4	9,890.8	1.69	0.31	10,021.1
		Euro I	19	605.8	1,898.2	0.23	0.06	1,921.3
		Euro II	82	2,614.4	8,192.4	0.93	0.25	8,290.5
		Euro III	95	3,028.9	9,491.2	0.76	0.29	9,598.1
		Euro IV	28	892.7	2,797.4	0.16	0.09	2,827.5
		TOTAL	323	10,298.2	32,270	3.77	1.00	32,658.5
TOTAL			951	11,629.2	36,453.8	4.02	1.14	36,890.4

It should be mentioned that biodiesel fuel is carbon neutral, meaning that it does not emit CO₂, which is why there was no need for recording the CO₂ emissions generated by biodiesel consumption. Both emissions and emission factors were calculated in the COPERT III model.

Electric vehicles (trams and the funicular) indirectly contribute to greenhouse gas emissions. The emission factor of 323 g/KWh was calculated as the average value of emission factors, on the basis of the 2004-2007 data, by dividing the CO₂ emission amounts generated in HEP thermal power stations and the amount of electricity produced for each year. Table 4.6 shows data on electricity consumption and CO₂ emissions generated by electric vehicles in 2008.

Table 4.6 Electricity consumption and CO₂ emissions generated by electric vehicles in 2008

RAIL PUBLIC TRANSPORT (ELECTRIC VEHICLES)			
SUB-CATEGORY	ELECTRICITY	Emission factor	Indirect CO₂ emission
	kWh	gCO₂/kWh	CO₂, t
Tram	61,411,060	323	19,842.91
Funicular	52,942	323	17.11
Bus	21,926	323	7.08
TOTAL	61,485,928	323	19,867.10

Table 4.7 contains data on energy consumption and the corresponding CO₂ and CO_{2e} emissions generated in bus and rail transport.

Table 4.7 Energy consumption and the corresponding CO₂ and CO_{2e} emissions generated in bus and rail transport

CITY OF ZAGREB PUBLIC TRANSPORT			
SUB-CATEGORY	Energy consumed, MWh	CO₂ emissions, t	CO_{2e} emissions, t
TOTAL	138,029.0	56,320.9	56,757.5
Bus transport	137,967.5	36,453.8	36,890.4
Electric vehicles	61,500	19,867.1	19,867.1

A detailed description of the methodology, data on number, age and consumption of public transport vehicles, emission factors and other relevant data can be found in *Annex 7 – Basic Guidelines and Bases for Monitoring CO₂ Emissions for the Purpose of Drafting the City of Zagreb SEAP*.

4.2.3 CO₂ emissions generated by personal and commercial vehicles

The personal and commercial vehicles sub-sector is made up of the following categories:

- Personal vehicles;
- Vans;
- Freight vehicles;
- Mopeds and motorcycles.

Table 4.8 contains data on total fuel consumption by fuel type in the personal and commercial vehicles sub-sector for 2008.

Table 4.8. Total fuel consumption by fuel type in the personal and commercial vehicles sub-sector for 2008

Fuel consumption, t per year	Diesel	Unleaded petrol	LPG	Natural gas
Personal vehicles	56,472.7	124,361.2	2,282.7	33.2
Freight vehicles and vans	105,660.1	9,251.7	-	-
Mopeds and motorcycles	-	2,523.9	-	-
TOTAL	162,132.8	136,136.8	2,282.7	33.2

The calculation result generated via the COPERT III model is presented as the total amount of greenhouse gas emission per individual vehicle category.

Table 4.9 contains data on fuel consumption and the corresponding CO₂ and CO_{2e} emissions generated in the personal and commercial vehicles sub-sector.

Table 4.9 CO₂ and CO_{2e} emissions generated in the personal and commercial vehicles sub-sector

Personal vehicles and vans	Energy consumed, MWh	CO₂ emissions, t	CO_{2e} emissions, t
Personal vehicles	2,184,857.4	567,350.3	596,338.2
Freight vehicles and vans	1,368,158.0	361,069.9	367,921.5

Personal vehicles and vans	Energy consumed, MWh	CO ₂ emissions, t	CO ₂ e emissions, t
Mopeds and motorcycles	31,268.3	8,043.0	8,345.1
TOTAL	3,584,283.7	936,463.2	972,604.8

Methodology description, consumption comparisons, emission factors and other relevant data pertaining to the personal vehicles and vans sub-sector can be found in *Annex 7 – Basic Guidelines and Bases for Monitoring CO₂ Emissions for the Purpose of Drafting the City of Zagreb SEAP*.

4.2.4 Total CO₂ emissions of the City of Zagreb traffic sector

Table 4.10 contains data on energy consumed and CO₂ emissions generated for the traffic sub-sectors in the City of Zagreb.

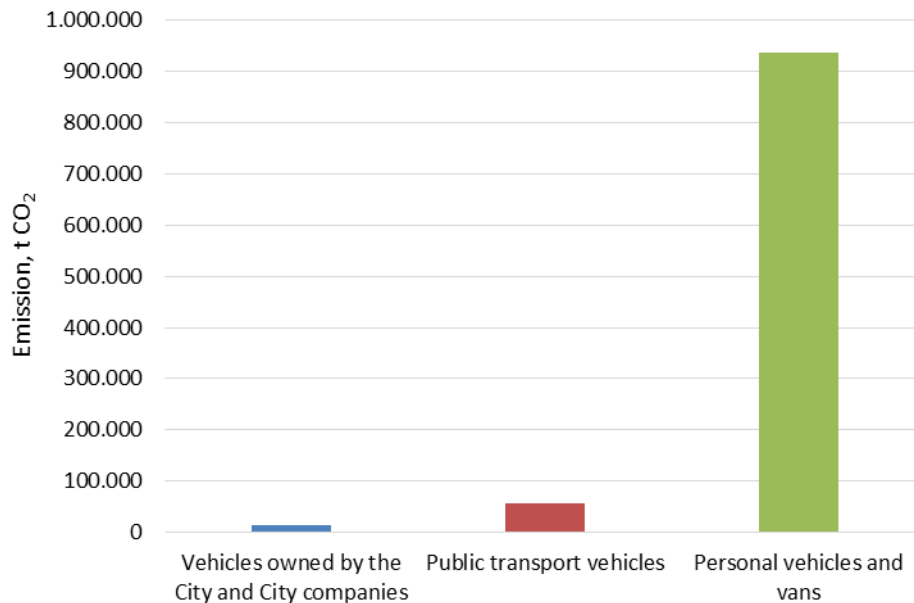
Table 4.10 Energy consumed and CO₂ emissions generated in the traffic sub-sectors in the City of Zagreb

Sector	Energy consumed, MWh	CO ₂ emissions, t	CO ₂ e emissions, t
Vehicles owned by the City and City companies	55,877.9	14,658.9	14,717.3
Public transport	138,029.0	56,320.9	56,757.5
Buses	137,967.5	36,453.8	36,890.4
Electric vehicles	61,500	19,867.1	19,867.1
Personal vehicles and vans	3,584,283.7	936,463.2	972,604.8
TOTAL	3,778,190.6	1,007,443.1	1,044,079.6

Picture 4.2 indicates the traffic sector fuel consumption, whereas Picture 4.3 indicates the corresponding CO₂ and CO₂e emission amounts.



Picture 4.2 Traffic sector fuel consumption



Picture 4.3 Traffic sector CO₂ emissions

The total emissions generated by the traffic sector amount to approximately 1,007 kt, 94% of which is generated by the personal vehicles and vans sub-sector.

4.3 Baseline CO₂ Emission Inventory of the City of Zagreb public lighting sector

The CO₂ emissions generated in the public lighting sector encompass the emissions generated by the electric and gas public lighting networks. The share of the gas network in the overall public lighting network is almost negligible. CO₂ emissions encompass both the direct and the indirect emissions. The direct CO₂ emissions are a result of fuel combustion, whereas the indirect CO₂ emissions are a result of electricity consumption.

Table 4.11 contains data on electricity consumption and the corresponding CO₂ emissions generated in the electric public lighting network, while Table 4.12 contains data on gas consumption and the corresponding CO₂ emissions generated in the gas public lighting network.

Table 4.11 Electricity consumption and indirect CO₂ emissions generated by the electric public lighting network

	Electricity consumption	Emission factor	Emission
	MWh	CO ₂ /MWh, t	CO ₂ , t
Public lighting - electricity	90,100	0.323	29,102.3

Table 4.12 Gas consumption and CO₂ emissions generated by the gas public lighting network

	Natural gas consumption, TJ	Emission, t			
		CO ₂	CH ₄	N ₂ O	CO ₂ e
Public lighting - natural gas	1.31	73.26	0.0066	0.0001	73.44

The total CO₂ emissions generated by the public lighting sector amounted to 29,175.56 t, 0.4% of which was generated by the gas public lighting network.

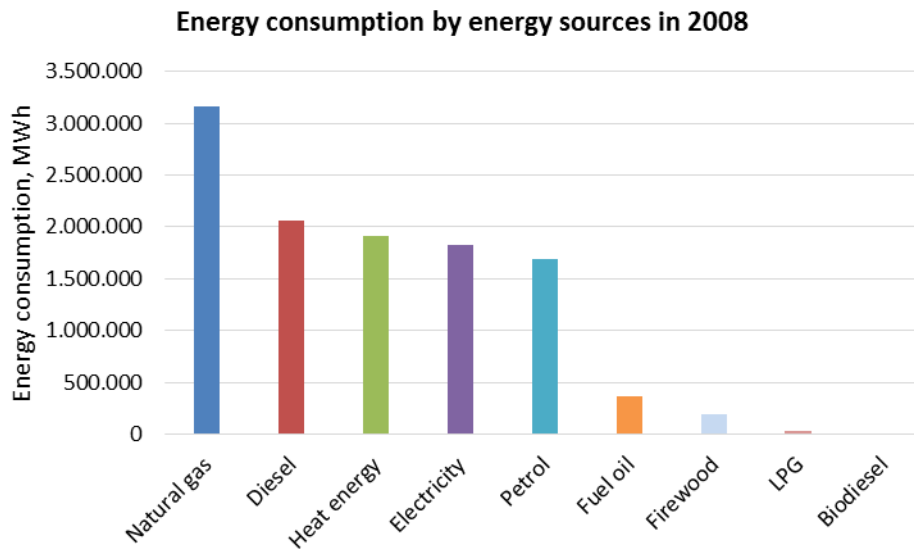
4.4 The overall City of Zagreb Baseline CO₂ Emission Inventory

4.4.1 City of Zagreb energy consumption – Baseline Emission Inventory

The 2008 City of Zagreb BEI encompasses CO₂ emissions generated in the building, traffic and public lighting sectors, based on the energy consumption data for each sector (Table 4.13 and Picture 4.4).

Table 4.13 Energy consumption in individual sectors by energy sources

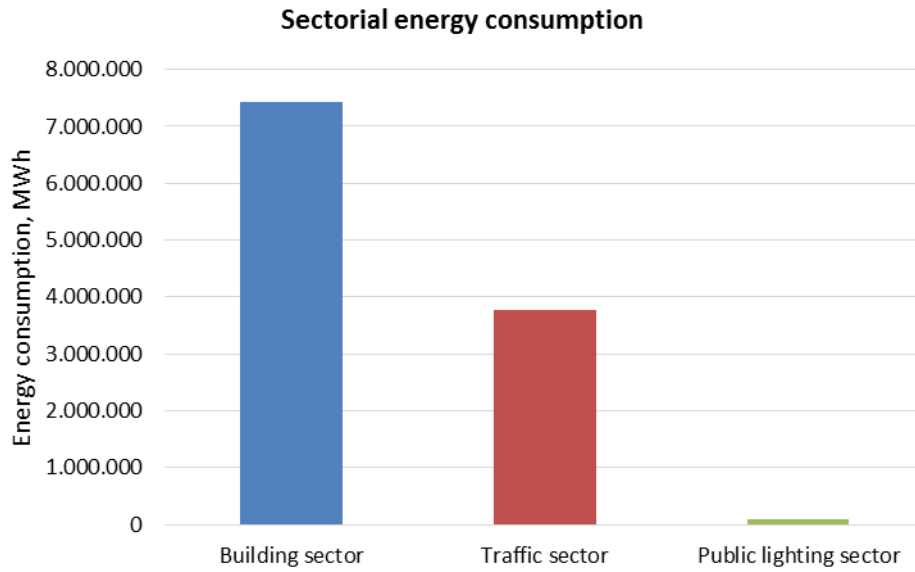
Energy source	Fuel consumption, MWh				%
	Traffic	Public lighting	Building sector	Total energy source consumption	
Diesel	2,061,493.1			2,061,493.1	18.23
Fuel oil			362,668.0	362,668.0	3.21
Petrol	1,686,583.7			1,686,583.7	14.91
Biodiesel	2,739.4			2,739.4	0.02
LPG	29,738.5		257.9	29,996.4	0.27
Natural gas	313.8	363.9	3,156,357.9	3,157,035.6	27.92
Firewood			275,269.9	187,201.0	2.43
Electricity	61,500	90,100.0	1,732,630.8	1,822,792.2	16.12
Heat energy			1,909,679.6	1,909,679.6	16.89
TOTAL	3,780,930.0	90,463.9	7,436,864.1	11,308,258.0	100.0
Individual sector's share, %	33.44	0.80	65.76	100.0	100.0



Picture 4.4 Energy consumption by energy sources in 2008

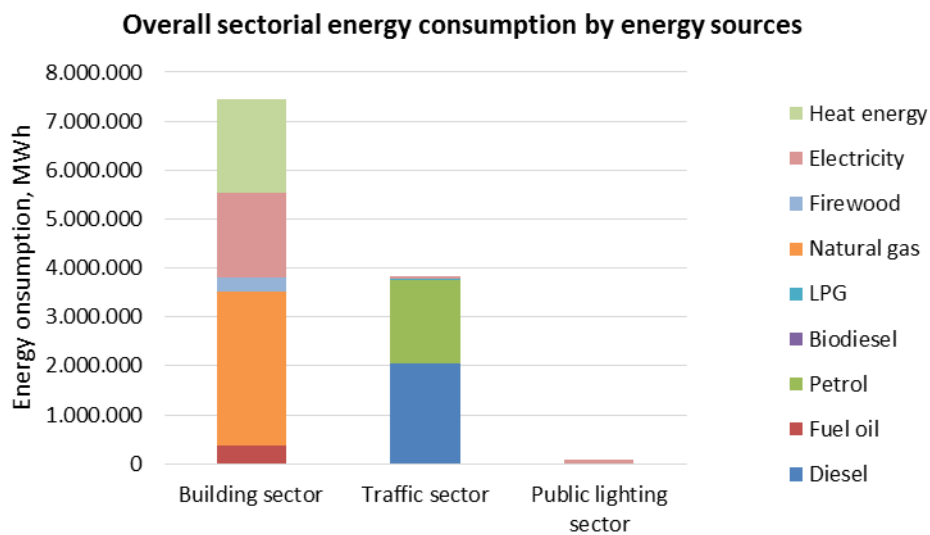
Picture 4.4 indicates that natural gas is the most used energy source. Natural gas consumption in 2008 amounted to 3,157 GWh, or 28.4% of the overall energy consumption. Natural gas is followed by electricity (2,061 GWh), diesel (1,910 GWh), DHS heat (1,823 GWh) and petrol (1,687 GWh). The combined shares of the consumption of these energy sources amount to 95% of overall energy consumption in the City of Zagreb.

The overall energy consumption in the analysed sectors of the City of Zagreb amounted to 11,308 GWh, 7,437 GWh of which were consumed in the building sector, followed by the traffic sector in which 3,781 GWh were consumed (Picture 4.5).



Picture 4.5 Energy consumption by sectors in 2008

Picture 4.6 indicates the overall energy consumption, by energy sources, in the City of Zagreb sectors.



Picture 4.6 Overall sectorial energy consumption by energy sources

The building sector consumed the most energy (66%) and is followed by the traffic sector (33.4%). Natural gas (3,157 GWh) and heat energy (1,910 GWh) were the most used energy sources in the building sector, while diesel (2,061 GWh) and petrol (1,687 GWh) were the most used energy sources in the traffic sector.

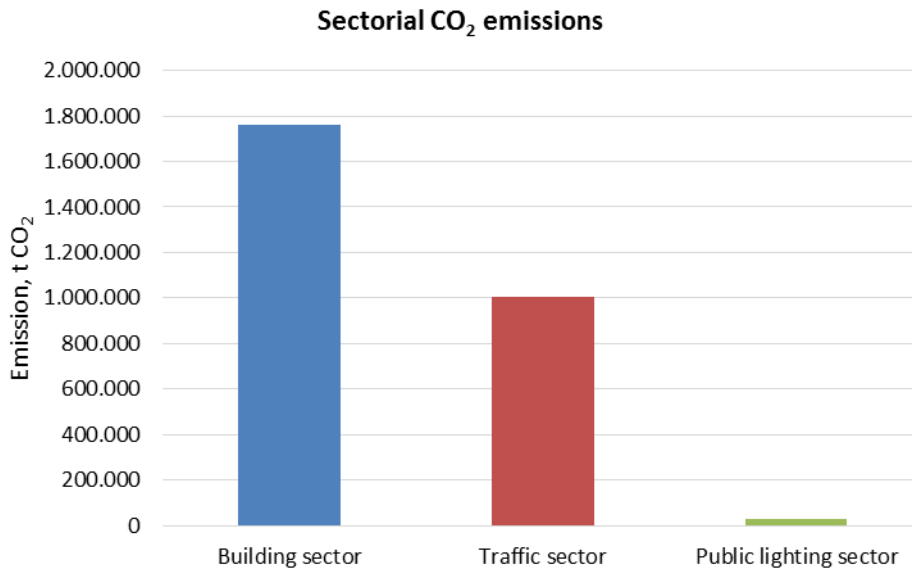
4.4.2 The City of Zagreb CO₂ Emissions – Baseline Emission Inventory

The City of Zagreb BEI encompasses direct CO₂ emissions generated by fuel combustion and indirect CO₂ emissions generated by electricity and heat energy consumption in the building, traffic and public lighting sectors. Table 4.14 contains data on CO₂ emissions by sectors and energy sources.

Table 4.14 CO₂ emissions by sectors and energy sources

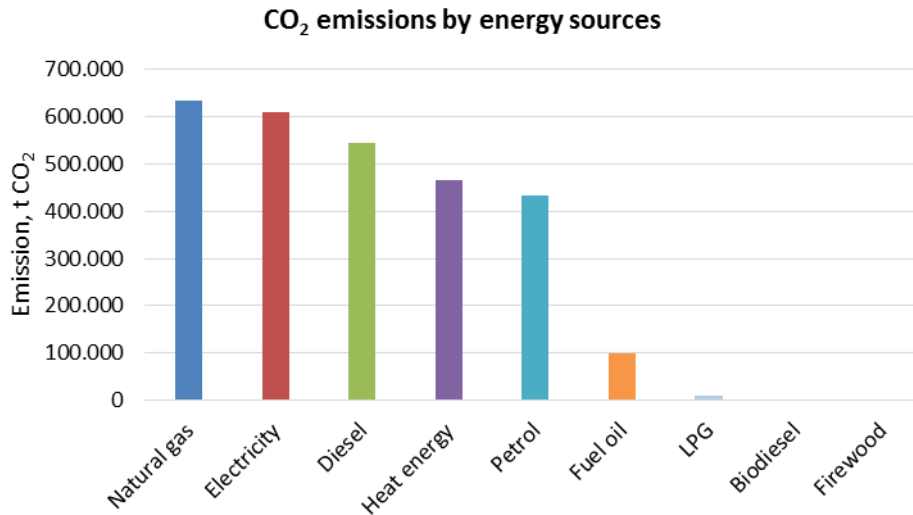
Energy source	Emission, t CO ₂				%
	Traffic sector	Public lighting sector	Building sector	Total energy source consumption	Share in the overall energy consumption
Diesel	545,266.1			545,266.1	19.50
Fuel oil			100,000.2	100,000.2	3.58
Petrol	433,828.8			433,828.8	15.52
Biodiesel	0.0			0.0	0.00
LPG	8,391.0		58.0	8,449.0	0.30
Natural gas	90.1	73.3	634,049.2	634,212.5	22.68
Firewood			0.0	0.0	0.00
Electricity	19,867.1	29,102.3	559,639.7	608,609.1	21.77
Heat energy			465,685.2	465,685.2	16.66
TOTAL	1,007,443.1	29,175.6	1,759,432.3	2,796,050.9	100.00
Individual sector's share, %	36.03	1.04	62.93	100.0	100.00

Picture 4.7 shows the total sectorial CO₂ emissions in tonnes, while Picture 4.8 indicates such emission by energy sources. Picture 4.9 provides a total overview of CO₂ emissions by sectors and energy sources.



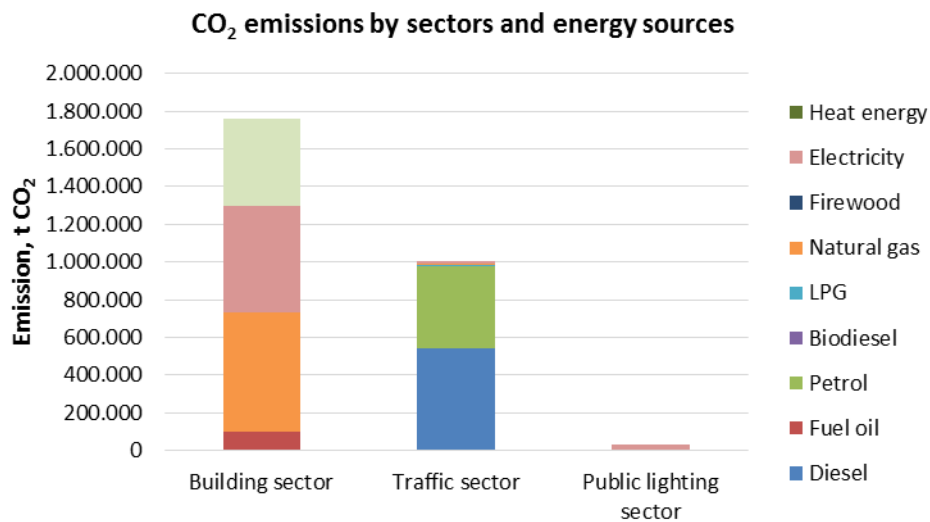
Picture 4.7 CO₂ emissions by sectors

The total CO₂ emissions amount to 2,796,000 t. The largest emitter, as well as energy consumer, was the building sector, which emitted 1,759,000 t of CO₂, and is followed by the traffic sector, which emitted 1,007,000 t of CO₂.



Picture 4.8 CO₂ emissions by energy sources

The CO₂ emissions generated by natural gas consumption amounted to 634,000 t in 2008, or 23% of the total amount of emissions. Natural gas is followed by electricity (609,000 t), diesel (545,000 t), heat energy (466,000 t) and petrol (433,000 t). The consumption of the above-mentioned energy sources emitted over 95% of CO₂ in the City of Zagreb.



Picture 4.9 CO₂ emissions by sectors and energy sources

The building sector emitted the most CO₂ (63%) and is followed by the traffic sector (36%). In the building sector, natural gas (634,000 t) and electricity (560,000 t) consumption generated the most emissions, whereas diesel (545,000 t) and petrol (433,000 t) consumption emitted the most CO₂ in the traffic sector.

The CO₂ emissions were calculated from the submitted data on energy consumption, while the emissions of the other two direct greenhouse gases (methane, CH₄, and nitrous oxide, N₂O) were calculated for the sectors in which emissions had been generated by fuel combustion. Table 4.15 contains data on sectorial CO₂e emissions.

Table 4.15 CO₂e emissions by sectors

	Traffic sector	Public lighting sector	Building sector	Total energy source consumption
CO ₂ e emissions, kt	1,044.2	29.1	1732.0	2805.3
Share	37.2	1.0	61.8	100

4.5 Conclusion

It is a well-known fact that more than 50% of greenhouse gas emissions are generated in cities and their surroundings. Furthermore, it is estimated that approximately 80% of the population of the European Union lives in cities. Therefore, it can be asserted that the city authorities play an extremely important role in climate change mitigation and environmental protection at the city, national and global levels. The 2008 City of Zagreb BEI encompasses direct (fuel combustion) and indirect (electricity and heat energy consumption) CO₂ emissions generated in three end-consumption sectors: 1) Building sector; 2) Traffic sector; and 3) Public lighting sector. The overall CO₂ emissions generated in the analysed sectors in the City of Zagreb amounted to 2,796,00 t in 2008.

By comparing the 2008 City of Zagreb BEI with the most recent National Emission Inventory, it can be seen that the traffic sector of the City of Zagreb generated 16.3% of the CO₂ emissions of the traffic sector of the Republic of Croatia, while the building sector of the City of Zagreb generated 21.6% of the CO₂ emissions of the building sector of the Republic of Croatia. On average, every citizen of the City of Zagreb generated 3.48 t of CO₂. The European Green City Index study analysed CO₂ emissions in 30 European cities in 2007. Oslo generated the least amount of CO₂ emissions per capita (2.19 t), whereas Dublin generated the most CO₂ emissions per capita (9.72). The average volume of CO₂ emissions per capita in the analysed cities amounted to 5.09 t. It can therefore be surmised that the amount of the CO₂ emissions per capita in the City of Zagreb is well below the average amount of the CO₂ emissions per capita generated in the 30 analysed European cities. However, since this BEI did not encompass the industry sector, the real amount of the CO₂ emissions per capita in the City of Zagreb is actually much higher.

5 THE 2015 MONITORING EMISSION INVENTORY (MEI)

Monitoring Emission Inventories (MEIs) should be conducted every two, that is, four years, for the purpose of monitoring the implementation performance of the Action Plan. Reports are drafted based on MEIs. In order to comply with the requirement of reporting on the implementation performance of the measures contained in its SEAP, the City of Zagreb conducted a MEI in 2015, as part of the City of Zagreb Sustainable Energy Action Plan Revision document.

The main criterion in selecting the baseline year was the availability of the data required for calculating CO₂ emissions. Unreliable energy consumption data and the necessity of their estimation would bring about inaccurate calculations of the MEI, which does not comply with the methodology prescribed by the European Commission.

The MEI encompassed three end-consumption sectors in the City of Zagreb: building, traffic and public lighting sectors. Such a classification of sectors is in accordance with the EC recommendations.

Energy consumption analyses and data on sectorial CO₂ emissions for 2015 are provided in *Annex 6 – The City of Zagreb Sustainable Energy Action Plan Revision*. This chapter presents the overall City of Zagreb MEI, outlines the total energy consumption by sectors and gives a summary overview of the energy consumption in the City of Zagreb for 2015.

The calculations encompassed direct (fuel combustion) and indirect (electricity and heat energy consumption) emissions. The methodology for conducting Emission Inventories was determined in the Action Plan and was used in conducting the MEI. The methodology of conducting the baseline and the monitoring inventories should be identical in order to enable viable comparisons.

The MEI data shall now be discussed, while the detailed energy analysis and comparisons can be found in the document attached in *Annex 6 – The City of Zagreb Sustainable Energy Action Plan Revision*.

5.1 Monitoring Emission Inventory of the building sector of the City of Zagreb for 2015

The building sector CO₂ emissions encompass emissions stemming from electricity and heat energy consumption, as well as fuel combustion emissions. The fuel combustion emissions are calculated via standard emission factors (first level of the IPCC methodology-driven calculations), whereas specific emission factors were determined for calculating the emissions stemming from electricity and heat energy consumption (Table 5.1).

Table 5.1 Emission factors used for determining CO₂ emissions of the building sector

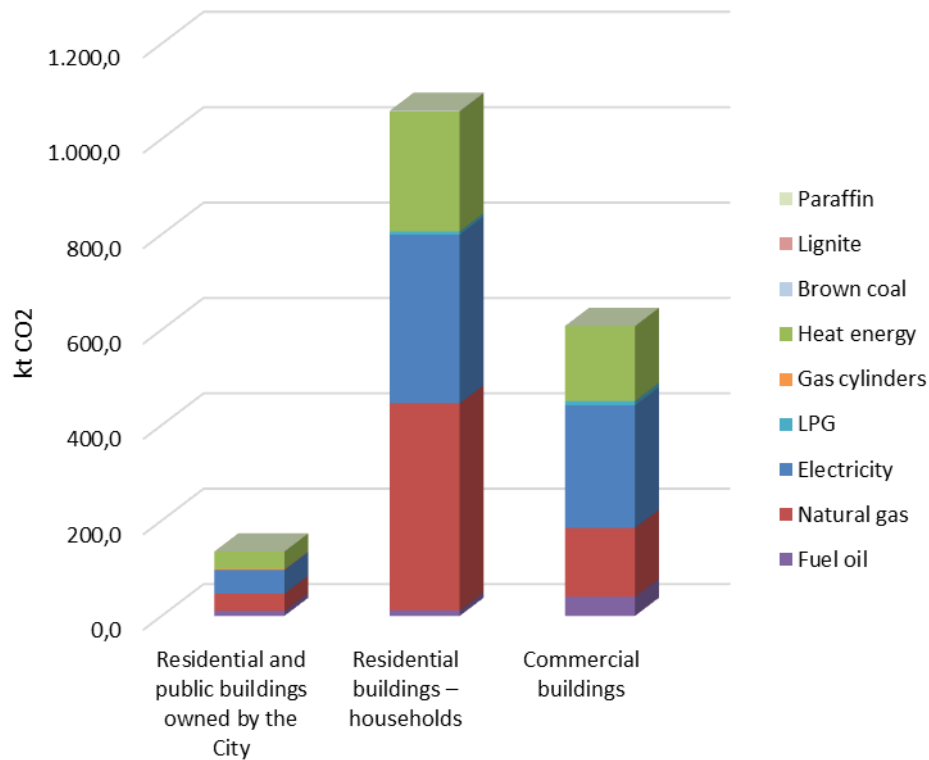
ENERGY SOURCE	Emission kg CO ₂ /kWh
Heavy fuel oil / Intermediate fuel oil	0.279
Extra-light heating oil / Light heating oil / diesel	0.267
Liquefied petroleum gas (LPG)	0.227
Natural gas / Compressed natural gas (CNG)	0.202
Biomass ²	0
Electricity	0.330
Heat energy	0.274
Lignite	0.364
Brown coal	0.346

Table 5.2 and Picture 5.1 demonstrate the CO₂ emissions of the building sector in 2015. Picture 5.2 indicates shares of consumption of individual energy sources used in the building sector in the total CO₂ emissions in 2015. Picture 5.3 indicates the individual sub-sectors' shares.

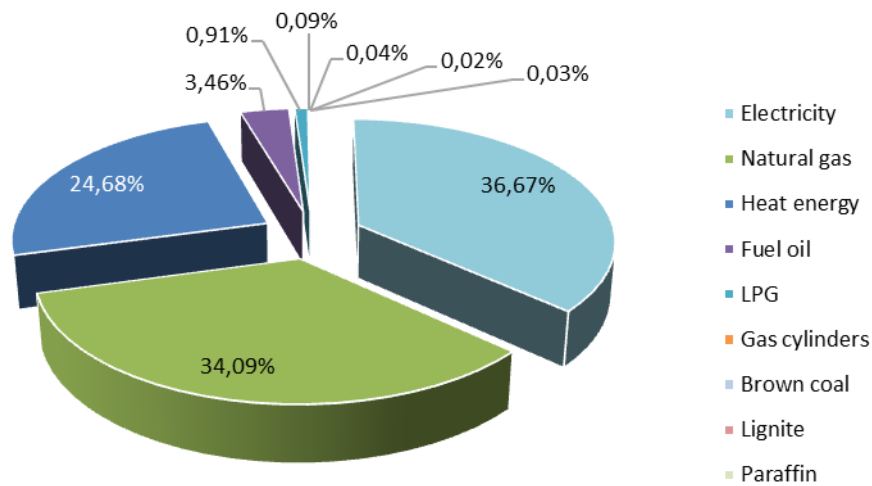
Table 5.2 Monitoring Emission Inventory of the building sector for 2015

Building sector - emission (kt CO ₂)										
Category	Fuel oil	Natural gas	Electricity	LPG	Gas cylinders	Heat energy	Brown coal	Lignite	Paraffin	TOTAL
Residential and public buildings owned by the City	10.5	35.8	50.2	0.163	1.7	36.6	-	-	-	135.12
Residential buildings - households	11.6	434.1	353.5	7.2	-	250.9	0.7	0.4	0.6	1,059.1
Commercial buildings	40.3	144.3	256.9	9.1	-	157.1	-	-	-	607.7
Building Sector Total	62.5	614.3	660.5	16.5	1.7	444.7	0.7	0.4	0.6	1,801.9

²Biomass includes firewood, woodchips, wood pellets, wood briquettes and charcoal. CO₂ emissions are also generated when biomass is burned, but, according to the IPCC recommendations, they are not counted since such emissions are considered to have been absorbed from the atmosphere by plants during the growth period.

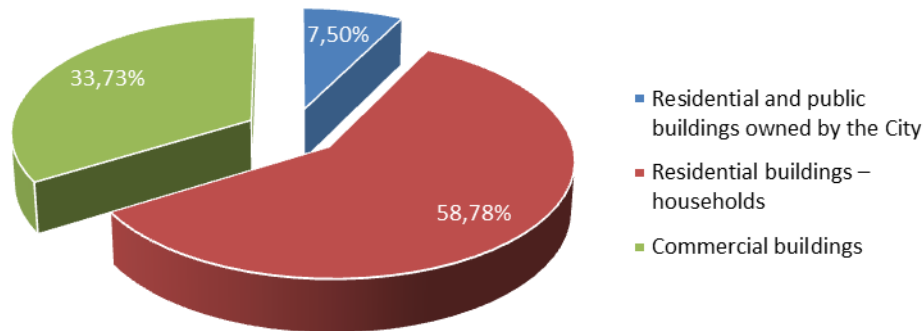


Picture 5.1 Monitoring Emission Inventory of the building sector for 2015, division by sub-sectors and energy sources



Picture 5.2. Shares of individual energy sources in the total building sector MEI for 2015

Electricity consumption generates the most emissions (36.66%), followed by natural gas consumption (34.10%) and heat energy consumption (24.68%), whereas consumption of other energy sources combined generates less than 5% of CO₂ emissions.



Picture 5.3. Shares of individual sub-sectors in the total building sector MEI for 2015

The residential buildings (households) sub-sector of the building sector generates the largest amount of emissions (58.77%), followed by commercial buildings (33.73%) and the sub-sector of residential and public buildings owned by the City (7.5%).

5.2 Monitoring Emission Inventory of the traffic sector for 2015

In urban areas, the traffic sector, and especially the road traffic, pollutes the air the most and strongly contributes to the amount of greenhouse gasses (CO₂, CH₄ and N₂O). The CO₂ emission amounts generated by motor vehicles depend on numerous parameters, main ones being fuel quality, engine and vehicle design, driving mode, weather conditions, engine maintenance and age etc.

The 2015 traffic sector MEI is divided into three sub-sectors:

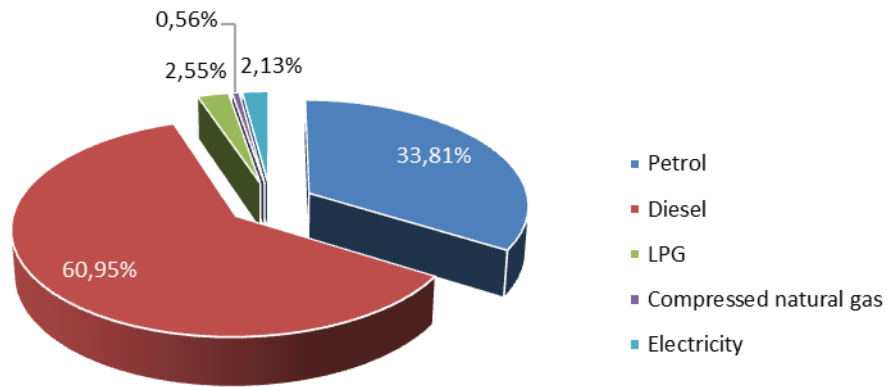
- CO₂ emissions generated by City-owned vehicles;
- CO₂ emissions generated by public transport vehicles;
- CO₂ emissions generated by personal and commercial vehicles.

Table 5.3 contains data on the 2015 MEI for the sub-sectors of the traffic sector.

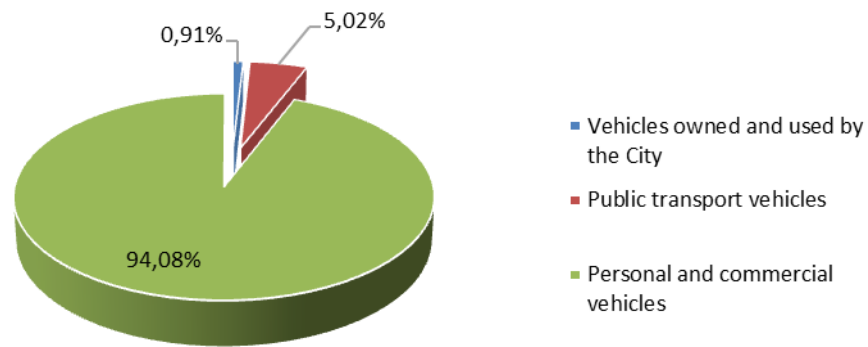
Table 5.3 The 2015 traffic sector MEI

TOTAL	TRAFFIC – emission (t CO ₂)			
	Vehicles owned and used by the City	Public transport	Personal and commercial vehicles	Total
Petrol	439.23	-	371,838.77	372,278.01
Diesel	9,470.62	25,685.17	635,886.83	671,042.61
LPG	-	-	28,042.65	28,042.65
Compressed natural gas	55.82	6,109.80	-	6,165.62
Electricity	-	23,426.05	-	23,426.05
Total	9,965.68	55,221.01	1,035,768.25	1,100,954.94

The overall 2015 traffic sector MEI indicates the total CO₂ emission amount of 1,100,954.94 t, 60.95% of which was emitted by diesel consumption and 33.81% of which was emitted by petrol consumption (Picture 5.4). Picture 5.5 indicates that the personal and commercial vehicles sub-sector generated the most CO₂ emissions (94.08%) in 2015.



Picture 5.4. Shares of individual energy sources in the total traffic sector MEI for 2015



Picture 5.5. Shares of individual sub-sectors in the total traffic sector MEI for 2015

5.3 Monitoring Emission Inventory of the public lighting sector of the City of Zagreb for 2015

The CO₂ emissions generated in the City of Zagreb public lighting sector encompass the emissions generated in the electric and gas public lighting networks. The share of the gas network in the overall public lighting network is almost negligible.

Table 5.4 contains data on electricity and gas consumption and the corresponding electric and gas public lighting networks' MEIs for 2015.

Table 5.4 Electricity and gas consumption and the corresponding MEIs for 2015

	Electricity consumption		Gas consumption		Electricity consumption generated emissions	Natural gas consumption generated emissions	Emission
	kWh	TJ	m ³	TJ	CO ₂ , t	CO ₂ , t	CO ₂ , t
Public lighting sector	81,294,000	292.66	304,860	10.42	26,827.02	584.82	27,411.84

The total 2015 public lighting sector MEI amounted to 27,411.84 t, with only 2.13 % of which being generated by the gas public lighting network.

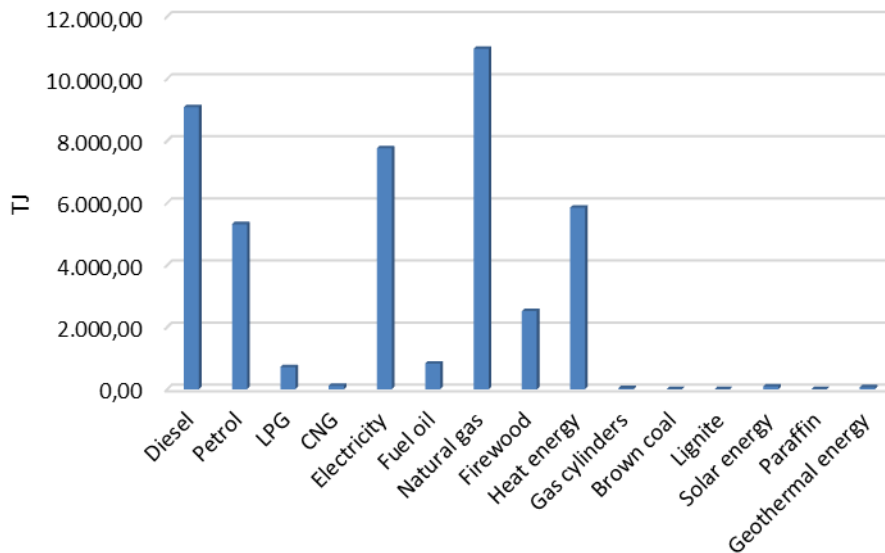
5.4 The overall City of Zagreb Monitoring Emission Inventory

5.4.1 The City of Zagreb energy consumption – Monitoring Emission Inventory

The 2015 City of Zagreb MEI encompasses CO₂ emissions generated in the building, traffic and public lighting sectors, based on the energy consumption data for each sector (Table 5.5 and Picture 5.6).

Table 5.5 Energy consumption in individual sectors by energy sources in 2015

Energy source	Fuel consumption, TJ			Total energy source consumption	%
	Traffic	Public lighting	Building		
Diesel	9,079.38			9,079.38	20.97 %
Petrol	5,312.56			5,312.56	12.27 %
LPG	444.73		261.80	706.53	1.63 %
CNG	109.88			109.88	0.25 %
Electricity	255.56	292.66	7,205.84	7,754.05	17.91 %
Fuel oil			824.40	824.40	1.90 %
Natural gas		10.42	10,949.53	10,959.95	25.31 %
Firewood			2,517.50	2,517.50	5.81 %
Heat energy			5,842.35	5,842.35	13.49 %
Gas cylinders			29.56	29.56	0.07 %
Brown coal			6.84	6.84	0.02 %
Lignite			4.32	4.32	0.01 %
Solar energy			90.00	90.00	0.21 %
Paraffin			7.74	7.74	0.02 %
Geothermal energy			60.37	60.37	0.14 %
TOTAL	15,202.11	303.08	27,800.25	43,305.45	100.00 %
Individual sector's share, %	35.10 %	0.70 %	64.20 %	100.00 %	/

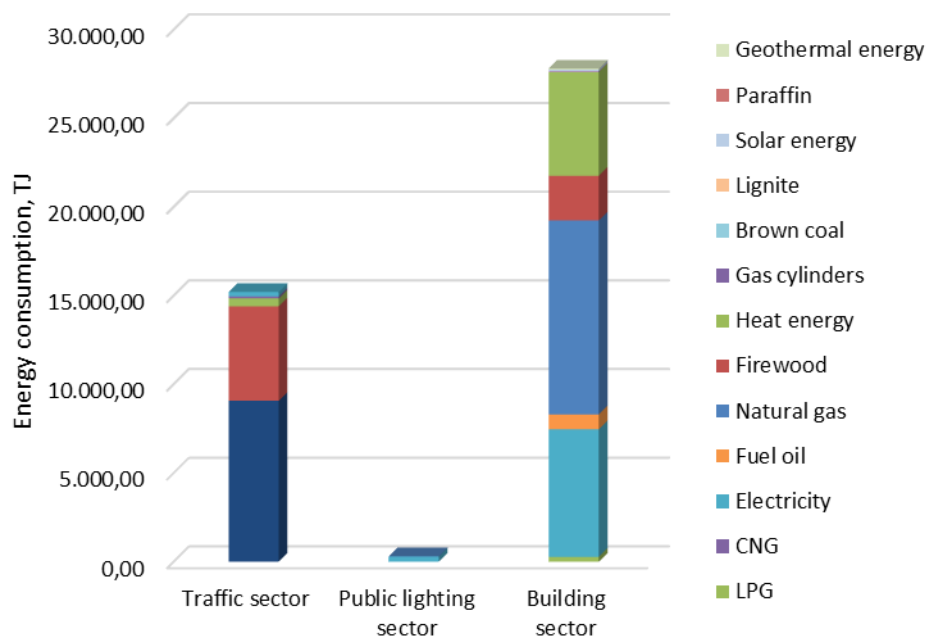


Picture 5.6 Energy consumption by energy sources in 2015

The most utilised energy source was natural gas. Natural gas consumption in 2015 amounted to 10,959.95 TJ, or 25.31 % of the overall energy consumption.

The overall energy consumption in the monitored sectors of the City of Zagreb amounted to 43,305 TJ, 27,800 TJ of which were consumed in the building sector and 15,202 TJ of which were consumed in the traffic sector (Picture 4.5).

Picture 5.7 indicates the overall energy consumption, by energy sources, in the City of Zagreb sectors.



Picture 5.7 Overall sectorial energy consumption by energy sources

The building sector consumed the most energy (64.20%) and is followed by the traffic sector (35.10%). Natural gas (10,949.53 TJ) and electricity (7,205.84 TJ) were the most used energy sources in the building sector, while diesel (9,079.38 TJ) and petrol (5,312.56 TJ) were the most used energy sources in the traffic sector.

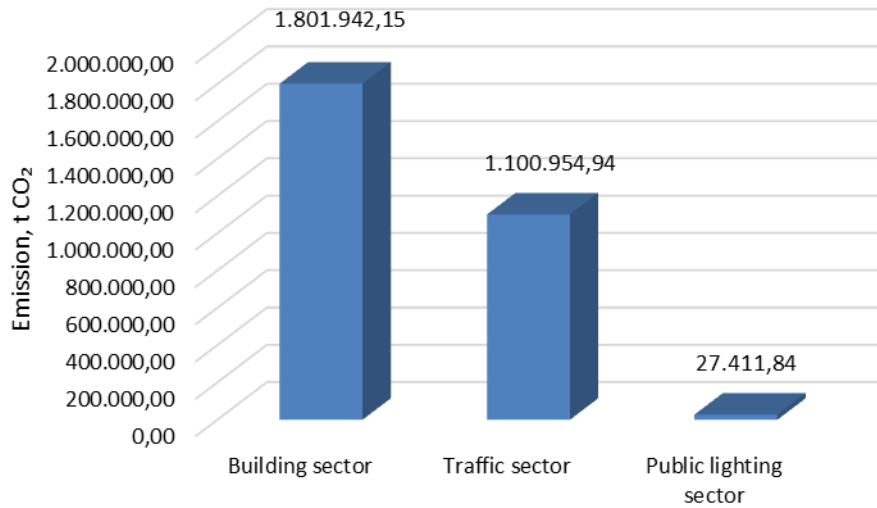
5.4.2 City of Zagreb CO₂ Emissions – Monitoring Emission Inventory

The overall MEI of the City of Zagreb indicates that in 2015 2,930 kt of CO₂ emissions were generated in the analysed sectors, as shown in Table 5.6.

Table 5.6 CO₂ emissions by sectors and energy sources, 2015 MEI

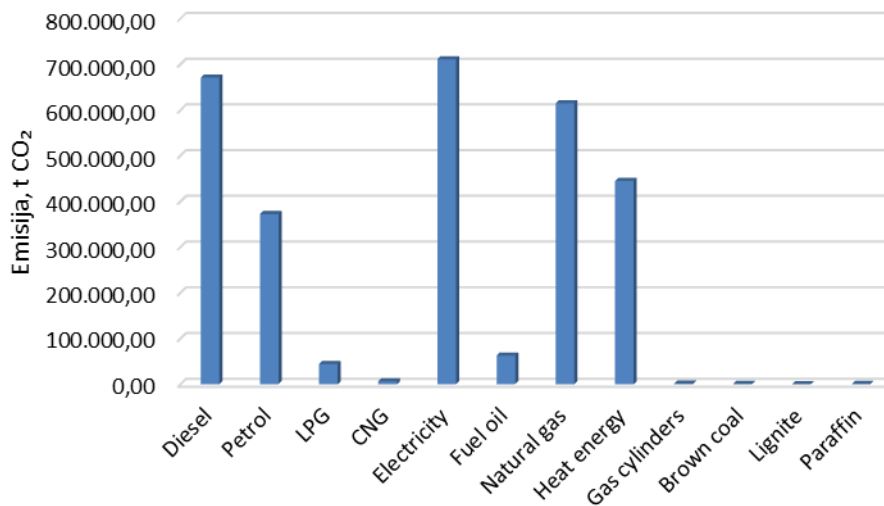
Energy source	Emission, t CO ₂				%
	Traffic sector	Public lighting sector	Building sector	Total energy source consumption	Share in the overall energy consumption
Diesel	671,042.61			671,042.61	22.90 %
Petrol	372,278.01			372,278.01	12.70 %
LPG	28,042.65		16,507.98	44,550.63	1.52 %
CNG	6,165.62			6,165.62	0.21 %
Electricity	23,426.05	26,827.02	660,535.68	710,788.75	24.26 %
Fuel oil			62,517.27	62,517.27	2.13 %
Natural gas		584.82	614,390.70	614,975.52	20.99 %
Heat energy			444,668.42	444,668.42	15.17 %
Gas cylinders			1,658.73	1,658.73	0.06 %
Brown coal			657.40	657.40	0.02 %
Lignite			436.80	436.80	0.01 %
Paraffin			569.17	569.17	0.02 %
TOTAL	1,100,954.94	27,411.84	1,801,942.15	2,930,308.93	100.00 %
%	37.57 %	0.94 %	61.49 %		100.00 %

Picture 5.8 indicates the MEI data on total sectorial emissions. Picture 5.9 indicates the MEI data for emissions generated by consumption of individual energy sources. Picture 5.10 provides an overview of both the sectorial emissions and data for emissions generated by consumption of individual energy sources.



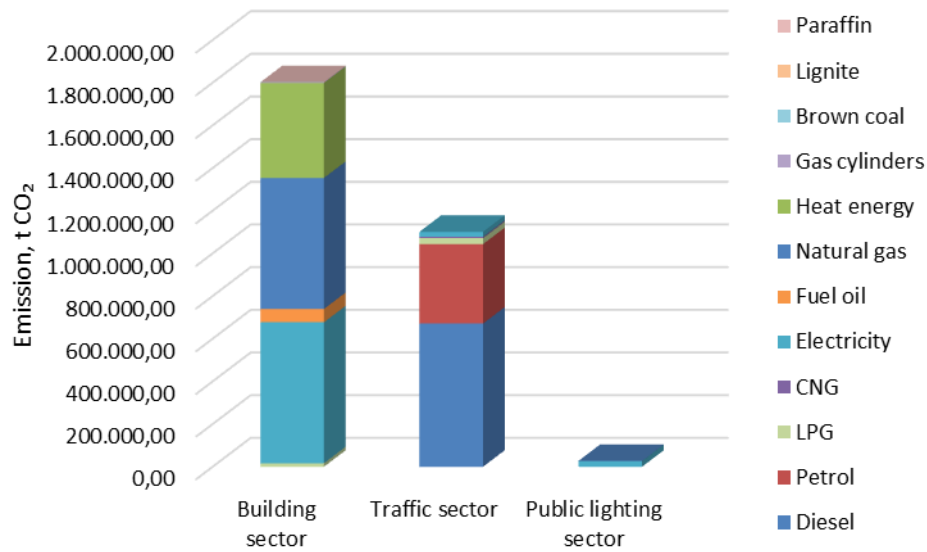
Picture 5.8 Monitoring Emission Inventory by sectors for 2015

The 2015 MEI indicates that the total CO₂ emissions amounted to 2,930,000 t. The largest emitter, as well as energy consumer, was the building sector, which emitted 1,802,000 t of CO₂, and is followed by the traffic sector, which emitted 1,101,000 t of CO₂.



Picture 5.9 Monitoring Emission Inventory by energy sources for 2015

The CO₂ emissions generated by electricity consumption amounted to 711 kt in 2015, or 24.26% of the total emission amount. Electricity consumption is followed by diesel (671,000 t), natural gas (615,000 t) and heat energy (444,000 t) consumption. Over 80% of CO₂ in the City of Zagreb was emitted by the consumption of the above mentioned energy sources.



Picture 5.10 Monitoring Emission Inventory by sectors and energy sources for 2015

According to the 2015 MEI, the building sector emitted the most CO₂ (61.49 %) and is followed by the traffic sector (37.57 %). In the building sector, electricity (661,000 t) and natural gas (614,000 t) consumption generated the most emissions, whereas diesel (671,000 t) and petrol (372,000 t) consumption emitted the most CO₂ in the traffic sector.

6 Comparison between the Baseline and the Monitoring Emission Inventory

Table 6.1 indicates the 2008 BEI data by sectors and consumption of individual energy sources, whereas Table 6.2 indicates the 2015 MEI data.

Table 6.1 Baseline Emission Inventory by sectors and energy sources for 2008

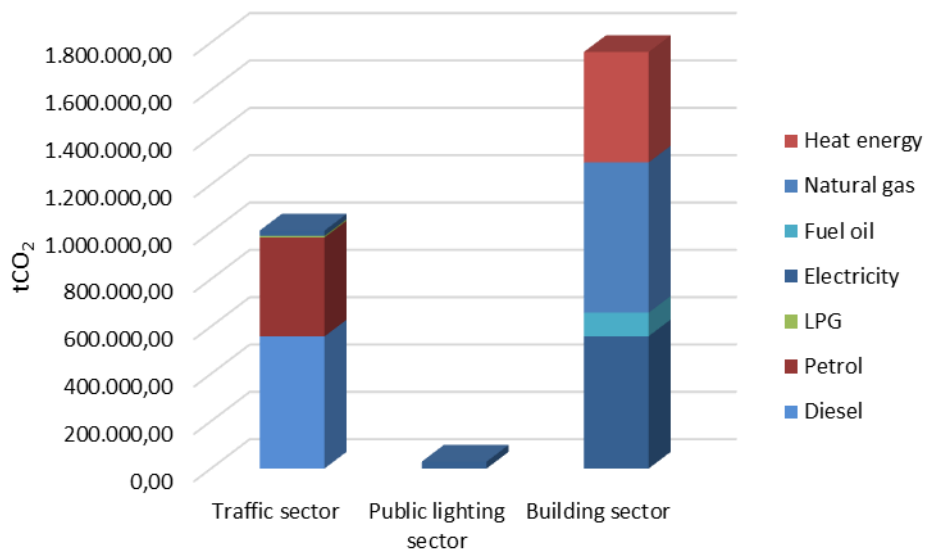
Energy source	Emission, t CO ₂				%
	Traffic sector	Public lighting sector	Building sector	Total energy source consumption	Share in the overall energy consumption
Diesel	558,037.30			558,037.30	19.97 %
Petrol	417,817.80			417,817.80	14.96 %
LPG	6,688.70		58.80	6,747.50	0.24 %
Electricity	22,474.00	29,102.30	559,132.00	610,708.30	21.86 %
Fuel oil			99,316.30	99,316.30	3.55 %
Natural gas	90.10	71.80	634,876.60	635,038.50	22.73 %
Heat energy			466,137.10	466,080.70	16.68 %
TOTAL	1,005,107.90	29,174.10	1,759,520.80	2,793,746.40	100.00 %
Individual sector's share, %	35.98 %	1.04 %	62.98 %	100.00 %	

Table 6.2 Monitoring Emission Inventory by sectors and energy sources for 2015

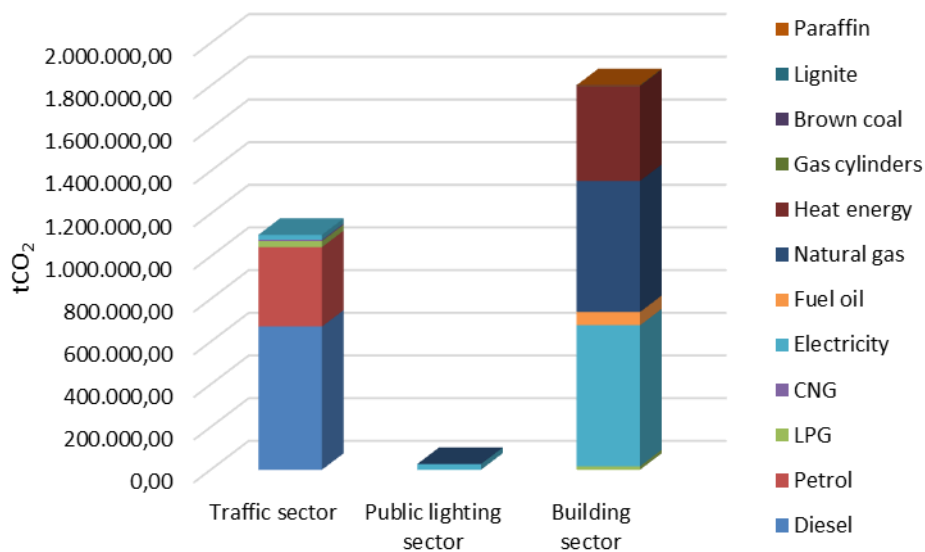
Energy source	Emission, t CO ₂				%
	Traffic sector	Public lighting sector	Building sector	Total energy source consumption	Share in the overall energy consumption
Diesel	671,042.61			671,042.61	22.90 %
Petrol	372,278.01			372,278.01	12.70 %
LPG	28,042.65		16,507.98	44,550.63	1.52 %
CNG	6,165.62			6,165.62	0.21 %
Electricity	23,426.05	26,827.02	660,535.68	710,788.75	24.26 %
Fuel oil			62,517.27	62,517.27	2.13 %

Energy source	Emission, t CO ₂				%
	Traffic sector	Public lighting sector	Building sector	Total energy source consumption	Share in the overall energy consumption
Natural gas		584.82	614,390.70	614,975.52	20.99 %
Heat energy			444,668.42	444,668.42	15.17 %
Gas cylinders			1,658.73	1,658.73	0.06 %
Brown coal			657.40	657.40	0.02 %
Lignite			436.80	436.80	0.01 %
Paraffin			569.17	569.17	0.02 %
TOTAL	1,100,954.94	27,411.84	1,801,942.15	2,930,308.93	100.00 %
%	37.57 %	0.94 %	61.49 %	100 %	100.00 %

According to the 2015 MEI, the total amount of CO₂ emissions equalled **2,930,000 t**, which represents a **5%** increase in comparison with the 2008 BEI (Picture 6.1 and Picture 6.2).

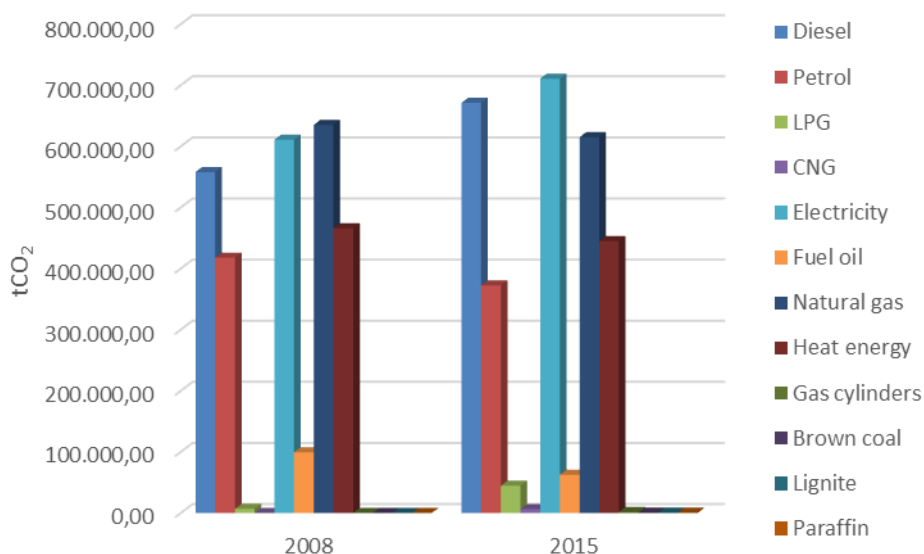


Picture 6.1. Baseline Emission Inventory by sectors and energy sources for 2008



Picture 6.2 Monitoring Emission Inventory by sectors and energy sources for 2015

The amount of CO₂ emissions generated by diesel consumption grew the most, by approximately 20% compared to 2008, whereas the amount of CO₂ emissions generated by fuel oil consumption and petrol decreased the most, by approximately 37% and 10%, respectively (Picture 6.3).



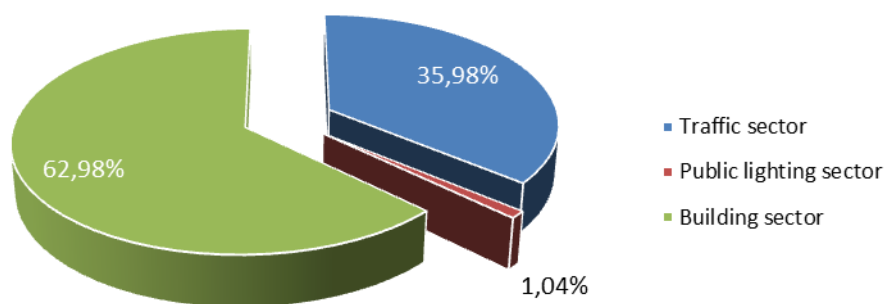
Picture 6.3. Comparison between the 2008 BEI and the 2015 MEI, by energy sources

It can be surmised that the structure of the sectorial shares in generating CO₂ emissions changed slightly compared to 2008 since the traffic sector's share grew from 36% to 38%, meaning that the other sectors' shares marginally decreased.

The increase in the share of the traffic sector was expected since that sector is currently one of the largest energy consumers in the Republic of Croatia and the rapid growth of that sector's energy consumption share, compared to other sectors', is expected to continue in the future.³

Picture 6.4. and Picture 6.5.

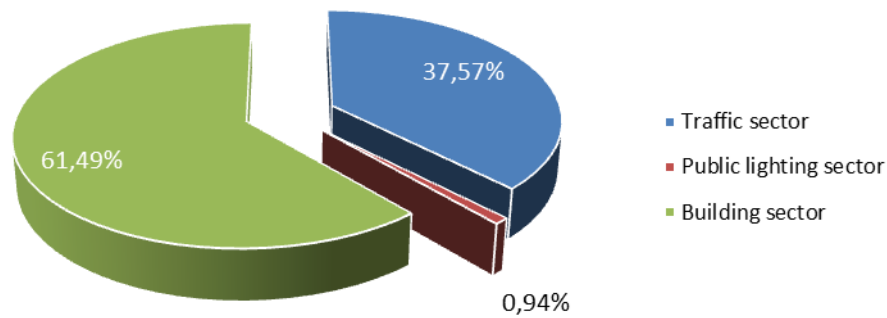
Sectorial Baseline Emission Inventory



Picture 6.4. Baseline Emission Inventory by sectors for 2008

³Energy in Croatia 2014

Sectorial Monitoring Emission Inventory

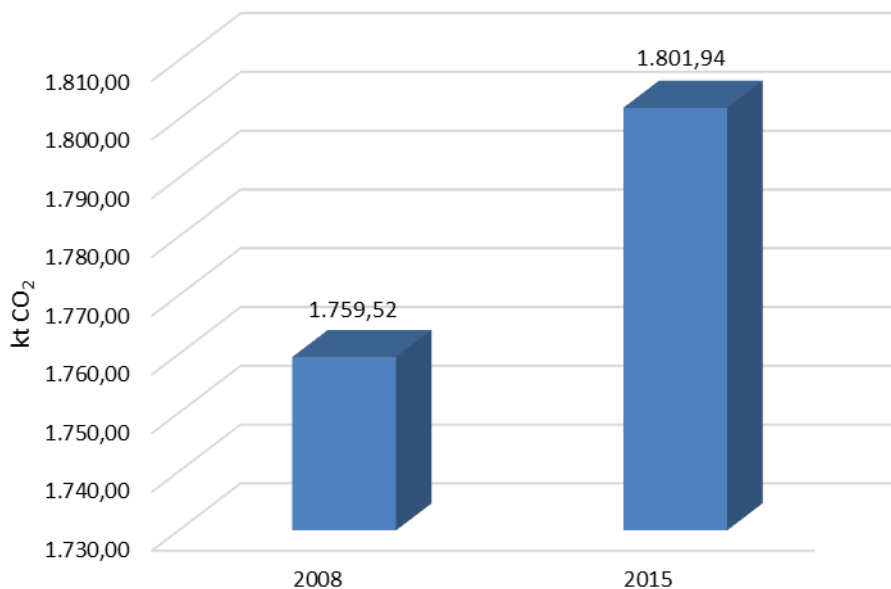


Picture 6.5. Monitoring Emission Inventory by sectors for 2015

6.1 Indicators in the comparison between the 2008 BEI and the 2015 MEI

Energy consumption, on the basis of which the CO₂ emission calculations are made, is affected by various factors other than the implementation of energy efficiency measures, such as climate impact and changes in economic structure and lifestyle (e.g. increasing household and commercial space areas). With that in mind, the comparison between the 2008 BEI and the 2015 MEI for the building, traffic and public lighting sectors shall be explained with the help of indicators.

Picture 6.6 indicates the comparison between the emission inventories with regards to the building sector.



Picture 6.6. Comparison between the 2008 BEI and the 2015 MEI, building sector

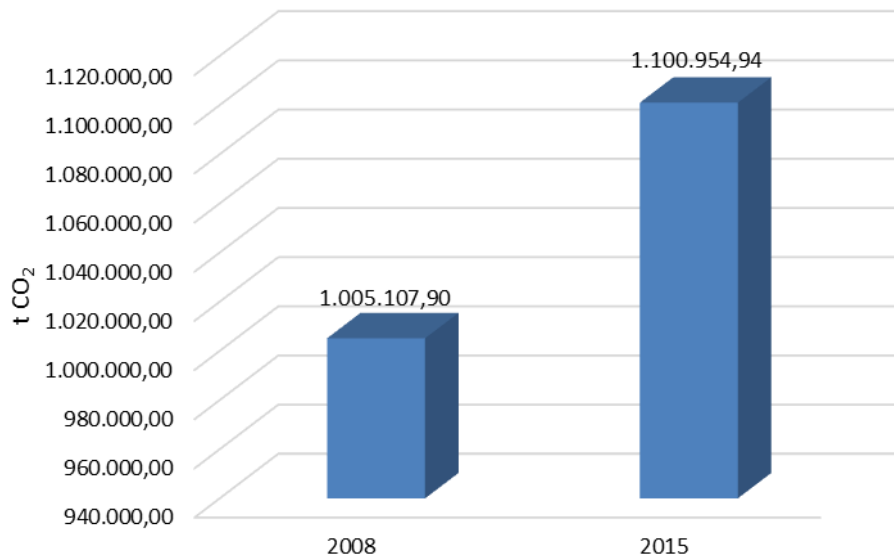
According to the 2015 MEI, the total amount of CO₂ emissions generated by the building sector equalled **1,802,000 t**, which represents a **2%** increase in comparison to the 2008 BEI. The areas of the residential buildings (households) and the commercial spaces significantly increased in the analysed period, by 2,416,882 m², which represents a 29.04% expansion.

Comparison of emission-to-area (residential and commercial) ratios of the building sector for 2008 and 2015:

- 0.0610 t CO₂/m² (of heated area, 2008);

- 0.0458 t CO₂/m² (of heated area, 2015).

Picture 6.7 indicates the comparison between the emission inventories with regards to the traffic sector.

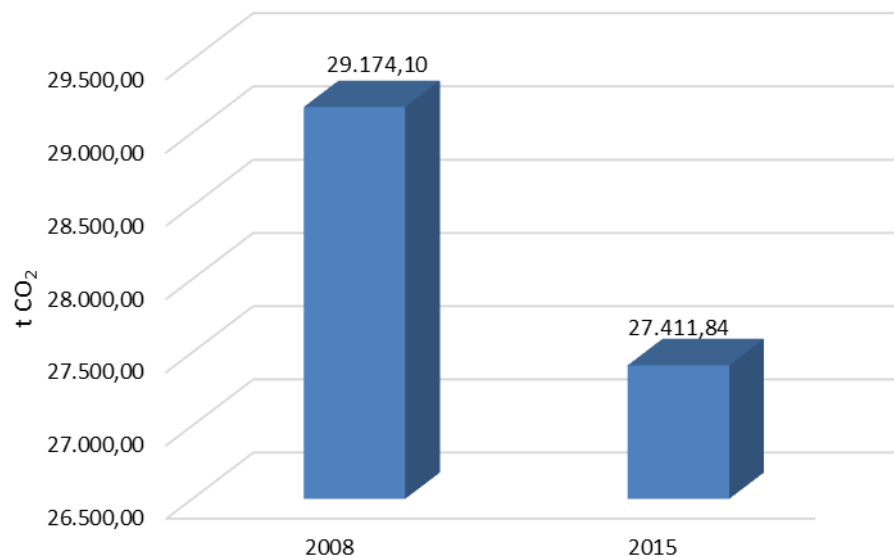


Picture 6.7. Comparison between the 2008 BEI and the 2015 MEI, traffic sector

According to the 2015 MEI, the total amount of CO₂ emissions generated by the traffic sector equalled **1,102,000 t**, which represents a **10%** increase in comparison with the 2008 BEI.

The inventory grew due to the fact that the COPERT III software was used in 2008 SEAP calculations. That software does not encompass the consumption of inter-city buses, whereas COPERT IV, which was later developed by the EEA and used in conducting the 2015 MEI, does.

Picture 6.8 indicates the comparison between the emission inventories with regards to the public lighting sector.



Picture 6.8. Comparison between the 2008 BEI and the 2015 MEI, public lighting sector

According to the 2015 MEI, the total amount of CO₂ emissions generated by the public lighting sector equalled **27,411.84 t**, which represents a **6%** decrease in comparison to the 2008 BEI. The decrease in the total amount of emissions generated by the public lighting sector was caused by the implemented measures of modernisation and management of the public lighting system (details can be found in Chapter 9).

Table 6.3 contains the data on the ratios of the amount of the CO₂ emissions generated by the public lighting sector and the number of public lighting fixtures in 2008 and 2015.

Table 6.3 Ratio of the amount of CO₂ emissions generated by the public lighting sector and the number of public lighting fixtures, t CO₂/lighting fixture

Ratio of the amount of CO₂ emissions generated by the public lighting sector and the number of public lighting fixtures, t CO₂/lighting fixture	
2008	2015
0.2210	0.2167

Table 6.4 contains summary data on the comparison between the emission inventories.

Table 6.4 Summary comparison between the 2008 BEI and the 2015 MEI

Summary comparison between the 2008 BEI and the 2015 MEI	
Date of joining the Covenant of Mayors	30/10/2008
Date of ratification by the City Assembly of the City of Zagreb	20/04/2010
Indicative goal of CO₂ emission reduction by 2020 (%)	21 %
Indicative goal of CO₂ emission reduction by 2020 (t CO₂)	587,170.69
Baseline year in which energy analyses and emission inventories were conducted	2008
Monitoring year in which energy analyses and emission inventories were conducted	2015
Overview of the 2008 indicators	
Number of households	280,354
Area of households (m ²)	18,533,107
Number of commercial structures	19,893
Area of commercial structures (m ²)	8,041,291
Overview of the 2015 indicators	
Number of households	360,601
Area of households (m ²)	25,979,962
Number of commercial structures	27,452
Area of commercial structures (m ²)	10,377,926
Overview of the 2008 energy analysis	
• Energy consumption in the building sector (MWh)	7,443,455
• Energy consumption in the traffic sector (MWh)	3,909,237
• Energy consumption in the public lighting sector (MWh)	90,458
• Overall energy consumption (MWh)	11,443,150
• Building sector CO ₂ emissions (kt CO ₂)	1,760
• Traffic sector CO ₂ emissions (kt CO ₂)	1,005
• Public lighting sector CO ₂ emissions (kt CO ₂)	29
• Overall CO ₂ emissions (kt CO ₂)	2,794
Overview of the 2015 energy analysis	
• Energy consumption in the building sector (MWh)	7,722,299
• Energy consumption in the traffic sector (MWh)	4,222,812
• Energy consumption in the public lighting sector (MWh)	84,189
• Overall energy consumption (MWh)	12,029,300
• Building sector CO ₂ emissions (kt CO ₂)	1,802
• Traffic sector CO ₂ emissions (kt CO ₂)	1,101
• Public lighting sector CO ₂ emissions (kt CO ₂)	27
• Overall CO ₂ emissions (kt CO ₂)	2,930
Performance analysis, accomplished reduction of CO₂ emissions (kt CO₂)	303
Share in the set CO₂ emission goal, %	51.60

6.2 SEAP implementation Performance Analysis and conclusion

The conducted Performance Analysis encompassed all the measures and activities performed by 31 December 2015.

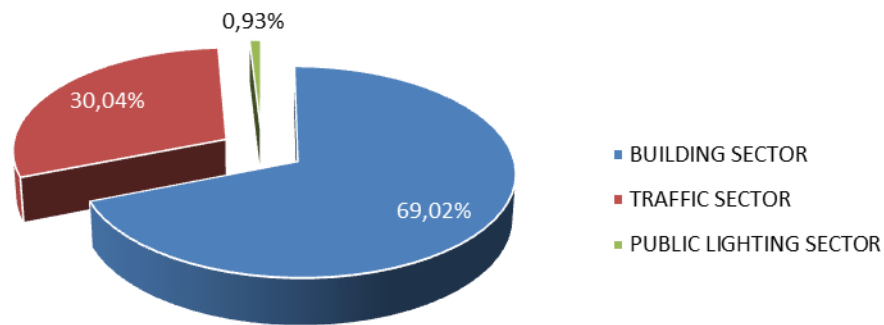
What follows is an overview of the main conclusions of the analysis, but a detailed overview of the analysis by sectors can be found in *Annex 6 – The City of Zagreb Sustainable Energy Action Plan Revision*.

The analysis has shown that, as a result of the implemented measures and activities, the amount of CO₂ emissions was reduced by 303,000 t, or 51.6 % of the emission reduction target for 2020, which amounted to **587,170.69 t** (Table 6.5).

Table 6.5. SEAP implementation Performance Analysis results overview

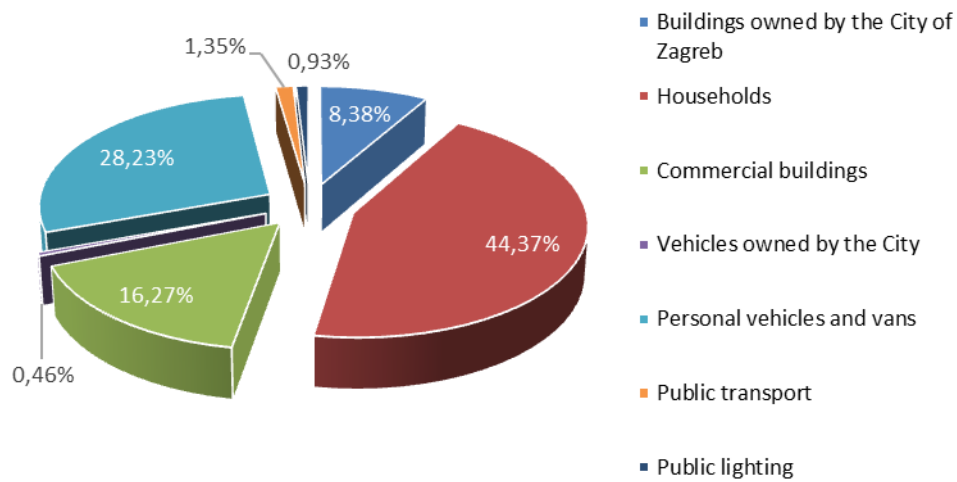
SECTOR	Accomplished reduction of CO ₂ emissions, t CO ₂
BUILDING	209,115.86
TRAFFIC	91,018.51
PUBLIC LIGHTING	2,830.33
TOTAL	302,964.70

Picture 6.9 and Picture 6.10 indicate shares of individual sectors in the overall reduction of CO₂ emissions.



Picture 6.9. Shares of individual sectors in the overall reduction of CO₂ emissions

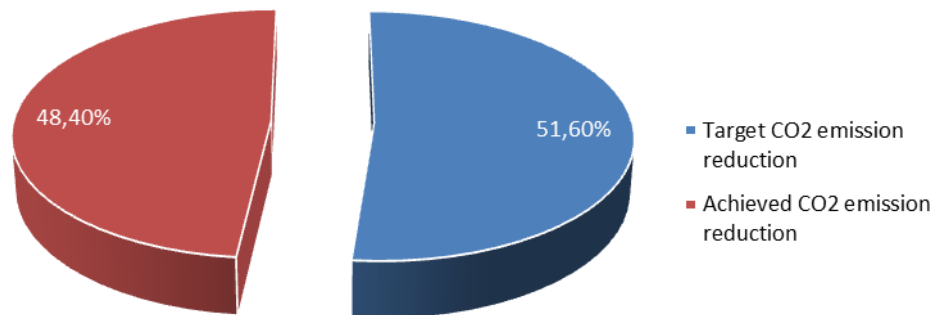
The building sector contributed to the reduction the most (69.02%) and is followed by the traffic (30.04%) and public lighting (0.93%) sectors.



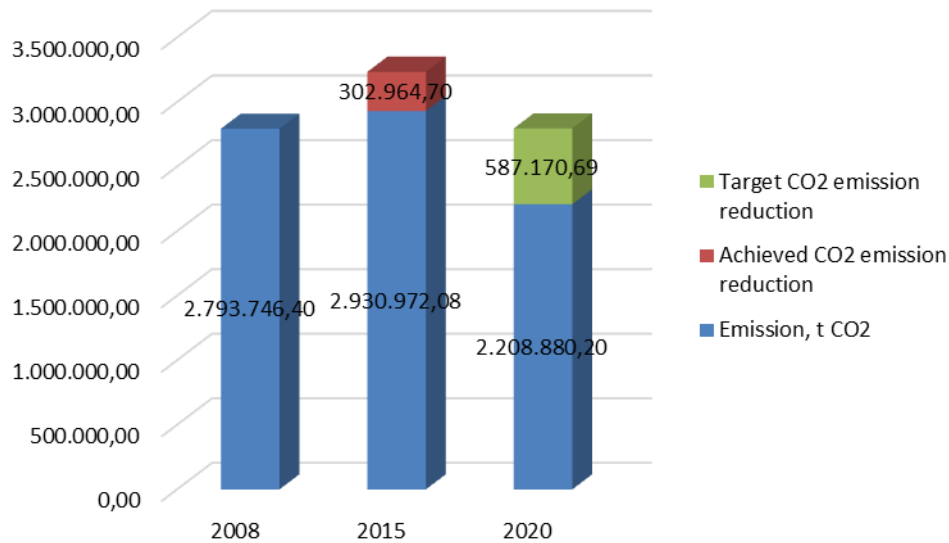
Picture 6.10. Shares of individual sub-sectors in the overall reduction of CO₂ emissions

In the category of sub-sectors, the residential buildings (households) sub-sector contributed to the reduction the most (44.37%).

Picture 6.11 and Picture 6.12 provide an overview of SEAP implementation Performance Analysis data.



Picture 6.11. Share of the overall achieved reduction of CO₂ emissions in the target CO₂ emission reduction for 2020



Picture 6.12. Comparison between the achieved CO₂ emission reduction and the target CO₂ emission reduction for 2020

The previous picture indicates that the difference between the achieved and the target CO₂ emission reduction for 2020 amounts to approximately 284,000 t.

7 CLIMATE CHANGE MITIGATION – Plan of priority measures aimed at mitigating climate change

Climate change mitigation implies active prevention of effects of climate change on the local community, achieved through reducing CO₂ emissions in order to prevent further atmospheric warming.

Climate change mitigation includes implementation of solutions contributing to better energy efficiency, increased use of renewable energy sources and of solutions which contribute to creating a sustainable society.

Utilisation of renewable energy sources, such as wind, solar, geothermal or water power stations, represents one of the main strategies aimed at reducing atmospheric greenhouse gas emissions. Renewable energy source use technologies are facing obstacles having to do with capital expenses (expenses of preparing projects and of the construction and maintenance of power stations), financing, public perception and long-term dependence of the market and institutions on fossil fuels. In spite of that, the IPCC's Third Assessment Report states that numerous renewable energy source technologies have become more cost-effective and efficient, and that their effects on reducing air pollution and in providing energy security outmatch the possible shortcomings.

Climate change mitigation also includes active education and measures aimed at citizen behaviour change, as well as implementation of sustainable management practices or sustainable consumer behaviour.

7.1 Measures aimed at reducing CO₂ emissions generated in the building sector

In this point, measures aimed at reducing greenhouse gas emissions generated in the building sector are summarily discussed. The measures are divided into the following groups:

- Promotion, education and behaviour change;
- Public buildings;
- Residential buildings (households);
- Commercial buildings.

The priority measures are outlined in their corresponding tables, along with the following parameters:

- Stakeholders involved in the implementation;
- Implementation time frame;
- Entity responsible for the implementation;

- Estimate of energy savings;
- Estimate of the level of CO₂ emissions reduction;
- Possible sources of funding;
- Short description of the measure and the manner of implementation.

For simplicity, each measure has been summarily outlined in its corresponding table. Possible sources of funding the implementation of each measure were determined on the basis of the overview which can be found in Chapter 11 – Mechanisms for funding the implementation of the Sustainable Energy and Climate Action Plan.

7.1.1 Promotion, education and behaviour change

All activities and measures which are to be implemented as part of the Action Plan are dedicated to the welfare of the community and the population, as the end users. In order for the measures to take root and the projects developed by these measures to succeed, it is vital that they be recognised and accepted by the community. That is why exquisite efforts and funds are being invested in the activities of promotion, education and raising awareness of matters relative to energy efficiency, sustainable development and climate change.

Programmes such as these fulfil the preconditions for the implementation of projects and interventions in space aimed at neutralising the risks of the NIMBY effect (Not In My Back Yard) and at including various stakeholders into the processes of planning and preparing the project. It is important to identify the target population, which would be directly affected by the project, and enable experience and knowledge exchange.

When initiating the project, it is vital to include the end-implementers of change in order to acquaint them with the importance and the ultimate goal of the project. In certain cases that would include the development of promotional campaigns and canvassing, while, in other cases, it would include focusing on the employees of a specific economic operator within which changes are to be made.

Education projects, consisting of developing education programmes, help the market to develop and expand in order to train new generations of energy efficiency experts. In this way the generation of new knowledge and trade crafts fuels the transition towards a sustainable society.

In the field of climate change mitigation, the Action Plan is focused on the education measures and measures for promoting energy efficiency, which are both aimed at the citizens, as well as on the integration of the energy and urban planning, which should aid the decarbonisation process.

According to the Ordinance on the System for Monitoring, Measuring and Verification of Energy Savings, energy savings are not calculated on the basis of these measures. However, some sources, as well as Covenant guidelines, estimate that these measures generate up to additional 5% savings annually, in comparison to the previous energy consumption data.

Measure no	1
Measure/activity	Educating about and promoting energy efficiency and informing citizens on climate change effects
Activity promoter	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection
Implementation partners	<ul style="list-style-type: none"> • City offices, institutes and services; • Zagrebački holding d.o.o; • Regional Energy Agency (REGEA).
Other involved stakeholders	<ul style="list-style-type: none"> • Civil society associations; • Environmental Protection and Energy Efficiency Fund (FZOEU).
Start/end of implementation (year)	Continuous implementation throughout the whole period
Savings estimate (MWh)	According to the Ordinance on the System for Monitoring
Estimate of the level of reduction of CO₂ emissions (t CO₂e)	Measuring and Verification of Energy Savings, energy savings are not calculated on the basis of this measure.
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • European structural and investment funds; • EU programmes.
Short description / comment	The goal of this measure is to raise citizen awareness of energy efficiency and climate change adaptation. The promotional campaign should raise awareness in target groups of the benefits and possibilities of implementing energy efficiency measures via energy services, inform and educate the public on

	<p>the benefits of investing in energy efficiency, possibilities of (co)financing, specific procedures and available consultation services.</p> <p>Specific activities include:</p> <ul style="list-style-type: none"> • Establishing a one-stop shop dedicated to potential users and aimed at providing independent information on energy audits, technical requirements for energy efficiency renovations and for installing renewable energy source facilities, possibilities for funding, available subsidies etc; • Zagreb Energy Week; • Developing a Communication and Dissemination Strategy; • Utilising an upgraded version of the Moj Zagreb portal as the main source of contact and information on energy efficiency and climate change adaptation; • Actively implementing measures aimed at creating “green jobs” for craftspeople.
--	--

Measure no	2
Measure/activity	Developing a platform for implementing solutions aimed at increasing energy efficiency and reducing greenhouse gas emissions in urban planning processes
Activity promoter	<ul style="list-style-type: none"> • City Institute for Physical Planning.
Implementation partners	<ul style="list-style-type: none"> • City Office for the Strategic Planning and Development of the City; • City Office for Economy, Energetics and Environment Protection; • Regional Energy Agency (REGEA).
Other involved stakeholders	<ul style="list-style-type: none"> • Civil society associations.
Start/end of implementation (year)	Development from 2020 to 2022, continuously after that
Savings estimate (MWh)	0, savings are to be accomplished through other measures
Estimate of the level of reduction of CO₂ emissions (t CO₂e)	0, savings are to be accomplished through other measures
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • EU programmes.
Short description / comment	<p>Integrative energy planning implies the integration of the energy aspects of urbanism and the planning process, i.e. systematically contemplating both energy supply and demand from the very beginning (of the plan). All the pertinent stakeholders should be included in the planning process from the very beginning, whereas the infrastructure should be contemplated in an integrative manner.</p> <p>Within the scope of this measure:</p> <ul style="list-style-type: none"> • Guidelines for long-term energy planning shall be outlined; • Short-term goals shall be defined; • A set of indicators shall be established (sustainability – a connection with the climate and environmental indicators should be made); • A body responsible for energy planning and monitoring should be founded; • Binding goals shall be introduced into urban development plans; • The indicators and the efficiency of the measure shall be regularly reviewed and improvements shall be suggested and implemented.

Measure no	3
Measure/activity	Education and change in behaviour of operators / employees / users of the buildings owned by the City of Zagreb
Activity promoter	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection.
Implementation partners	<ul style="list-style-type: none"> • City offices/institutes or services, budget users and branches of Zagrebački holding that use the building(s); • Regional Energy Agency (REGEA).
Start/end of implementation (year)	Continuously.
Savings estimate (MWh)	According to the Ordinance on the System for Monitoring
Estimate of the level of reduction of CO₂ emissions (t CO₂e)	Measuring and Verification of Energy Savings, energy savings are not calculated on the basis of this measure.
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • EU programmes; • Environmental Protection and Energy Efficiency Fund (FZOEU).
Short description / comment	<p>This measure encompasses an array of educational activities that are carried out regularly:</p> <ul style="list-style-type: none"> • Educational workshops on efficient use of energy; • Creation and distribution of educational materials (flyers, brochures, posters, stickers etc.); • Education of building operators on the use of the newly implemented technologies.

7.1.2 Building sector

a. Public buildings

Public buildings possess large potential for energy savings and reducing CO₂ emissions, which is why they can serve as an example for engaging in the process of reduction of CO₂ emissions. The local community's implementation of energy and climate policies is exemplified most properly in the practices it applies to asset management. That is exactly why the public buildings are the backbone of the process of implementing energy efficiency measures and, therefore, of the process of mitigating climate change.

Measure no	4
Measure/activity	Introducing a system for automated monitoring and individual metering of energy and water consumption in the public buildings
Activity promoter	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection.
Other stakeholders involved in the implementation	<ul style="list-style-type: none"> • City offices/institutes or services, budget users and branches of Zagrebački holding that use the building(s);
Other involved stakeholders	<ul style="list-style-type: none"> • Vodoopskrba i odvodnja d.o.o; • Gradska plinara Zagreb d.o.o; • HEP Toplinarstvo d.o.o; • HEP Elektra d.o.o; • Regional Energy Agency (REGEA).
Start/end of implementation (year)	2021 – 2030
Savings estimate (MWh)	According to the Ordinance on the System for Monitoring
Estimate of the level of reduction of CO₂ emissions (t CO₂e)	Measuring and Verification of Energy Savings, energy savings are not calculated on the basis of this measure.

Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • Croatian Bank for Reconstruction And Development (HBOR); • European Skills, Competences, Qualifications and Occupations (ESCO); • Environmental Protection and Energy Efficiency Fund (FZOEU).
Short description / comment	<p>Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency introduced the smart readiness indicator which should be used to measure the capacity of buildings to use information and communication technologies and electronic systems to adapt the operation of buildings to the needs of the occupants and the grid and to improve the energy efficiency and overall performance of buildings. The methodology for rating the smart readiness of buildings shall take into account features such as smart meters, building automation and control systems, self-regulating systems and systems for the regulation of indoor air temperature, recharging points for electric vehicles, energy storage and the interoperability of these systems.</p> <p>The measure encompasses installation of real-time energy consumption meters which can be read remotely, automated data collection and analysis and the implementation of measures for increasing energy efficiency. Systematic collection of the data on the consumption of electricity, heat energy, gas and water encourages energy efficient behaviour and opens up the possibility for additional 5% energy savings.</p> <p>Specific activities include:</p> <ul style="list-style-type: none"> • Establishing a system for remote readings of energy source (gas, electricity and heat energy) consumption; • Establishing a system for remote readings of water consumption; • Automatization of consumption analysis and control and identification of unwanted, excessive and irrational consumption; • Systematic (automated) notifying of responsible persons about critical results of analyses; • Undertaking specific measures aimed at increasing energy efficiency and reducing water consumption.

Measure no	5
Measure/activity	Implementation of cost-effective activities which carry low capital intensity and provide quick energy savings
Activity promoter	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection.
Implementation partners	<ul style="list-style-type: none"> • City offices/institutes or services, budget users and branches of Zagrebački holding that use the building(s); • Regional Energy Agency (REGEA).
Start/end of implementation (year)	2021 – 2030
Savings estimate (MWh)	11.092,30
Estimate of the level of reduction of CO ₂ emissions (t CO ₂ e)	1.848,60
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • Zagrebački holding Budget; • Budgets of the City-owned companies; • Environmental Protection and Energy Efficiency Fund (FZOEU).
Short description / comment	There are various activities with low capital intensity which can

	<p>be implemented without causing larger hindrances to the usual functioning of the buildings exist. Energy savings achieved in this way can be significant. This measure should be implemented continuously, since it includes maintenance of all the buildings' systems and parts.</p> <p>Buildings should be analysed in detail in the first phase, so that the targets of the specific activities outlined below could be identified. It is recommended that the analysis also be performed successively, during the energy certificate audit. The database should be continuously maintained. This measure is directly connected to the measure for introducing the automated monitoring and individual metering of energy and water consumption in the public buildings.</p> <p>Specific activities include:</p> <ul style="list-style-type: none"> • Consumption control: precise metering of electricity, water and heat energy consumption is the basis for an efficient consumption control; • Maintaining an adequate room temperature: One of the factors which is relatively simple to control is room temperature. Energy consumption in buildings depends mostly on the room temperature; a 1°C increase in temperature generates a 6% increase in consumption; • Regular maintenance of mechanical ventilation systems: Even the simpler technological systems contain numerous components which should be regularly maintained in order for them to function optimally; • Reducing water consumption: Faucets and toilet tanks should be regularly checked for leaks and serviced accordingly. Water-saving devices should be installed as part of energy efficiency renovations; • Adequate water heating: Water heating, storing and distribution require energy. The optimal temperature is considered to be 60°C; • Efficient lighting: Lighting fixtures in many buildings are old and inefficient, they lack a central management system and the lights are turned on and off by numerous users. The very users could largely contribute to electricity savings by proper and careful use; • Maintaining the recommended levels of lighting of individual rooms (DIN EN 12464); • Isolating heating pipes in the rooms which are not heated; • Properly utilising thermostatic valves; • Reducing energy consumption of devices that are in stand-by mode by using distribution devices with switches.
--	---

Measure no	6
Measure/activity	Implementation of the programme of integral energy efficiency renovation of the buildings owned by the City of Zagreb and city companies, aimed at achieving the NZEB target
Activity promoter	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection.
Implementation partners	<ul style="list-style-type: none"> • City offices/institutes or services, budget users that use the building(s); • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • City Office for Financing; • City Office for EU programmes and projects; • City Institute for Physical Planning; • Regional Energy Agency (REGEA).

Other involved stakeholders	<ul style="list-style-type: none"> • Ministry of Regional Development and EU Funds; • Ministry of Construction and Physical Planning; • Environmental Protection and Energy Efficiency Fund (FZOEU).
Start/end of implementation (year)	2021 – 2030
Savings estimate (MWh)	77.142,60
Estimate of the level of reduction of CO₂ emissions (t CO₂e)	16.046,10
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State Budget; • European Structural and Investment Funds; • Public-private partnerships (PPPs) / ESCO; • European Investment Bank; • Croatian Bank for Reconstruction and Development (HBOR); • Programmes for technical assistance; • Horizon 2020; • Commercial banks.
Short description / comment	<p>Since buildings consume the most energy and generate 36% of the EU CO₂ emissions, implementing this measure will contribute to the EU goals for a sustainable, safe and decarbonised energy sector for 2050, which includes indicative national milestones and actions for energy efficiency to achieve the short-term (2030) objectives. Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency demands high energy efficiency and a decarbonised building sector. This measure includes measurable, targeted activities which will contribute to reduction in heating/cooling energy demand. Considering the fact that the amended Directive orders a Strategy for Renovating the National Building Stock to be drafted, this specific measure will considerably contribute to accomplishing that strategy's targets, taking into consideration the share of the buildings owned by the City of Zagreb. The scope of the activities is broad and the measure carries large capital intensity, which is why it is important to anticipate the use of financial mechanisms, aids from structural funds and inclusion of financial institutions and private capital in the implementation. The project should also be developed as a strategic one in cooperation with the competent national institutions in the process of programming the 2021 – 2028 financial perspective. The implementation of the measure should be performed through sectorial programmes (e.g. the Integral Energy Efficiency Renovations of Schools Programme, the Integral Energy Efficiency Renovations of Healthcare Institutions Programme etc.).</p> <p>The measure is aimed at achieving a cost-effective transformation of buildings to the NZEB (Near-Zero Energy Buildings) level through the implementation of the following activities:</p> <ul style="list-style-type: none"> • Energy audits and building certifications; • Renovating building envelopes – improving the level of thermal protection the envelope offers by adding, renovating or replacing those parts of the building that are part of the envelope of the heated or cooled part of the building, such as windows, doors, transparent elements of the facade, thermal insulation of the floors, walls, ceilings, flat, sloped and arched roofs, coverings and

	<p>waterproofing;</p> <ul style="list-style-type: none"> • Installing a new, highly efficient heating system or improving the existing one; • Replacing the existing system for the preparation of sanitary hot water with a system that uses renewable energy sources; • Replacing the existing one with or establishing a highly efficient cooling system or improving the existing one; • Replacing the existing one with or establishing a highly efficient ventilation system or improving the existing one; • Replacing the existing lighting system with an energy efficient one; • Installing photovoltaic modules for producing electricity from renewable energy sources; • Establishing a system for building automatization and management; • Designing and installing smart equipment, in accordance with the smart readiness indicator; • Installing sensors and equipment for smart energy consumption management. <p>This measure is connected with the measure for introducing a system for automated monitoring and individual metering of energy and water consumption in the public buildings and with the climate change adaptation measures related to the analysis of possibilities and actual implementation of green technologies in building renovations.</p>
--	--

b. The residential buildings (households) sub-sector

Family houses and multi-residential buildings are part of the sector within which significant reduction of CO₂ emissions can be achieved by integral renovations and energy efficiency renovations aimed at achieving the NZEB level. The local authorities can encourage improvements in this sector by developing educational and financial measures, as well as measures aimed at raising awareness of energy savings.

Measure no	7
Measure/activity	Integral energy efficiency renovation of multi-residential buildings programme, aimed at achieving the NZEB level
Activity promoter	<ul style="list-style-type: none"> • Gradsko stambeno-komunalno gospodarstvo d.o.o. and other building operators.
Implementation partners	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection. • City Office for the Strategic Planning and Development of the City; • City Institute for Physical Planning; • Regional Energy Agency (REGEA).
Other involved stakeholders	<ul style="list-style-type: none"> • Ministry of Construction and Physical Planning; • Ministry of Regional Development and EU Funds; • Environmental Protection and Energy Efficiency Fund (FZOEU).
Start/end of implementation (year)	2021 – 2030
Savings estimate (MWh)	635.649
Estimate of the level of reduction of CO₂ emissions (t CO₂e)	126.405
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State Budget; • European Structural and Investment Funds; • Public-private partnerships (PPPs) / ESCO; • European Investment Bank; • Croatian Bank for Reconstruction and Development (HBOR);

	<ul style="list-style-type: none"> • Programmes for technical assistance; • Horizon 2020; • Commercial banks; • Co-owners' and users' own funds.
Short description / comment	<p>The scope of the activities is broad and the measure has large capital intensity, which is why it is important to anticipate the use of financial mechanisms, aids from structural funds and inclusion of financial institutions and private capital in the implementation. The project should also be developed as a strategic one in cooperation with the competent national institutions in the process of programming the 2021 – 2027 financial perspective.</p> <p>In the first phase, the residential building sector should be analysed and priorities should be set in accordance with the condition the buildings are in, whereas the buildings should be cost-effectively transformed into NZEB-level structures in the second phase, which includes:</p> <ul style="list-style-type: none"> • Urban development and energy analysis of residential neighbourhoods; • Energy audits and building certifications; • Renovating building envelopes – improving the level of thermal protection the envelope offers by adding, renovating or replacing those parts of the building that are part of the envelope of the heated or cooled part of the building, such as windows, doors, transparent elements of the facade, thermal insulation of the floors, walls, ceilings, flat, sloped and arched roofs, coverings and waterproofing; • Installing a new, highly efficient heating system or improving the existing one; • Replacing the existing system for the preparation of sanitary hot water with a system that uses renewable energy sources; • Replacing the existing one with or establishing a highly efficient cooling system or improving the existing one; • Replacing the existing one with or establishing a highly efficient ventilation system or improving the existing one; • Replacing the existing indoor lighting system with an energy efficient one; • Installing photovoltaic modules for producing electricity from renewable energy sources; • Establishing a system for building automatization and management; • Designing and installing smart equipment, in accordance with the smart readiness indicator. <p>This measure is connected with the measure for introducing a system for automated monitoring and individual metering of energy and water consumption in the public buildings and with the climate change adaptation measures related to the analysis of possibilities and actual implementation of green technologies in building renovations.</p>

Measure no	8
Measure/activity	Integral energy efficiency renovation of family houses programme
Activity promoter	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection.
Implementation partners	<ul style="list-style-type: none"> • City Institute for Physical Planning; • City Office for the Strategic Planning and Development of

	<p>the City;</p> <ul style="list-style-type: none"> • Regional Energy Agency (REGEA).
Other involved stakeholders	<ul style="list-style-type: none"> • Ministry of Construction and Physical Planning; • Ministry of Regional Development and EU Funds; • Environmental Protection and Energy Efficiency Fund (FZOEU).
Start/end of implementation (year)	2021 – 2030
Savings estimate (MWh)	635.649
Estimate of the level of reduction of CO₂ emissions (t CO₂e)	126.405
Possible sources of funding	<ul style="list-style-type: none"> • State Budget; • European Structural and Investment Funds; • European Structural and Investment Funds / Public-private partnerships (PPPs) / ESCO; • European Investment Bank / Croatian Bank for Reconstruction and Development; • Commercial banks; • Co-owners' and users' own funds.
Short description / comment	<p>The general objective consists in achieving energy savings by reducing energy consumption in family houses through integral energy efficiency renovations and, where available, by using renewable energy sources. The integral energy efficiency renovation of family houses programme should be elaborated in order for this goal to be achieved. Significant savings are achievable if a comprehensive approach to urban development is applied, meaning that a part of a neighbourhood should be perceived as a whole.</p> <p>Specifically, the programme should enable home-owners to perform energy efficiency renovations of their structures by providing support:</p> <ul style="list-style-type: none"> • In the energy audit phase (energy certification); • In designing the integral renovation. <p>The integral renovation activities include:</p> <ul style="list-style-type: none"> • Renovating building envelopes – improving the level of thermal protection the envelope offers, thermal insulation of the floors, walls, ceilings, flat, sloped and arched roofs, coverings and waterproofing; • Installing a new, highly efficient heating system or improving the existing one; • Replacing the existing system for the preparation of sanitary hot water with a system that utilises renewable energy sources; • Replacing the existing one with or establishing a highly efficient cooling system or improving the existing one; • Replacing the existing one with or establishing a highly efficient ventilation system or improving the existing one; • Replacing the existing lighting system with an energy efficient one; • Installing photovoltaic modules for producing electricity from renewable energy sources; • Establishing a system for building automatization and management. <p>The scope of the activities is broad and the measure carries large capital intensity, which is why it is important to anticipate the use of financial mechanisms, aids from structural funds and inclusion of financial institutions and private capital in the implementation. The project should also be developed as a strategic one in cooperation with the competent national institutions in the process of programming the 2021 – 2028</p>

	financial perspective.
--	------------------------

c. Commercial buildings sub-sector

Commercial buildings possess large potential for reducing CO₂ emissions. The suggested measures are aimed at conducting an analysis of the scope and the manner in which the local community can encourage the sustainability of this sector. The measure aimed at establishing a system for monitoring the energy efficiency renovations of commercial buildings is important because these renovations contribute to the reduction of the local community's emission and are taken into account when calculations for status reports concerning the obligations arising from the Covenant of Mayors are made.

Measure no	9
Measure/activity	Establishment of a system for monitoring energy efficiency renovations of commercial buildings
Activity promoters (coordinators)	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection.
Other involved stakeholders	<ul style="list-style-type: none"> • Companies that operate non-residential commercial buildings (building operators); • Ministry of Environmental Protection and Energy; • Croatian Real Estate Agency (APN).
Start/end of implementation (year)	2021 – 2023
Savings estimate (MWh)	717.348
Estimate of the level of reduction of CO₂ emissions (t CO₂)	131.342
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State Budget; • European Structural and Investment Funds.
Short description / comment	<p>In the City of Zagreb area, the share of the commercial buildings in the total building stock is significant, making that sub-sector an important factor in the total energy consumption and total CO₂ emission. In order for the building sector energy consumption and CO₂ emissions to be comprehensively and efficiently monitored, a system for monitoring and reporting should be established.</p> <p>The measure should be implemented in the following phases:</p> <ul style="list-style-type: none"> • Determining a parameter on the basis of which commercial buildings would be included in the system for monitoring and reporting; • Establishing a registry of companies included in the system for monitoring and reporting; • Establishing a system for monitoring and reporting; • Regular monitoring and reporting. <p>By performing the above-mentioned activities, changes could be timely monitored and a comprehensive overview of energy consumption and emissions generated in the building sector of the City of Zagreb would be gained.</p>

Measure no	10
Measure/activity	Analysis of possibilities of encouraging installation of renewable energy source systems in non-residential commercial buildings
Activity promoter (coordinators)	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection.
Implementation partners	<ul style="list-style-type: none"> • Regional Energy Agency (REGEA).
Other involved stakeholders	<ul style="list-style-type: none"> • Ministry of Physical Planning and Construction; • Ministry of Economy, Entrepreneurship and Crafts; • Ministry of Tourism;

	<ul style="list-style-type: none"> • Ministry of Environmental Protection and Energy; • Ministry of Regional Development and EU Funds.
Start/end of implementation (year)	2021 – 2023
Savings estimate (MWh)	214.866
Estimate of the level of reduction of CO₂ emissions (t CO₂)	58.089
Possible sources of funding	<ul style="list-style-type: none"> • State Budget; • European structural and investment funds; • Budget of the City of Zagreb.
Short description / comment	<p>In the City of Zagreb area, the share of the commercial buildings in the total building stock is significant, making that sub-sector an important factor in the total energy consumption and total CO₂ emission.</p> <p>The measure includes an analysis of possibilities and a potential elaboration of a programme for encouraging installations of renewable energy source systems in non-residential commercial buildings, which should be conducted in cooperation with the State.</p> <p>The specific systems encompassed by the programme include:</p> <ul style="list-style-type: none"> • Solar collector systems for heating and preparation of sanitary hot water; • Photovoltaic systems for electricity production; • Biomass-fuelled systems for heating and preparation of sanitary hot water; • Energy efficiency class A heat pump systems for preparation of sanitary hot water, heating and cooling; • Wind turbine and accumulator systems for electricity prosumption.

7.2 Traffic

The traffic sector, as analysed in this document, actually integrates the measures and activities outlined in other sectorial documents, such as the Traffic System Master Plan. The Master Plan of the Traffic System of the City of Zagreb, Zagreb County and Krapina-Zagorje County was not fully implemented at the time this document was being drafted. Only its first phase, the analytic one, was completed. The second phase of the Traffic System Master Plan will significantly affect the SECAP, which is why the traffic sector shall be reviewed in this document upon the adoption of the Second Phase of the Traffic System Master Plan. Measures which should bring about a reduction in energy consumption and greenhouse gas emissions, according to the available data and insights, shall be discussed in this section.

Measures aimed at reducing greenhouse gas emissions generated in the traffic sector of the City of Zagreb shall now be summarily discussed. The measures are divided into the following groups:

- Public transport;
- City of Zagreb vehicle fleet;
- Personal and commercial vehicles;
- Taxi, e-taxi, car sharing;
- Cycling traffic.

7.2.1 Public transport

Measure no	11
Measure/activity	Introducing an integrated passenger transport system
Activity promoter	<ul style="list-style-type: none"> • Integrirani promet zagrebačkog područja d.o.o.
Implementation partners	<ul style="list-style-type: none"> • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • City Office for Economy, Energetics and Environment Protection; • ZET d.o.o.; • HŽ Infrastruktura d.o.o.; • HŽ Putnički prijevoz d.o.o.;

	<ul style="list-style-type: none"> • Providers of transport-on-demand services (taxi); • Providers of car sharing services;
Other involved stakeholders	<ul style="list-style-type: none"> • Ministry of Maritime Affairs, Transport and Infrastructure.
Start/end of implementation (year)	2021 – 2030
Savings estimate (MWh)	82,027.8
Estimate of the level of reduction of CO₂ emissions (t CO₂)	20,999.5
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State Budget; • European Structural and Investment Funds; • ZET d.o.o.; • HŽ Infrastruktura d.o.o.; • HŽ Putnički prijevoz d.o.o.; • Providers of transport-on-demand services (taxi); • Providers of car sharing services; • European Investment Bank / Croatian Bank for Reconstruction and Development; • European Bank for Reconstruction And Development (EBRD); • Commercial banks.
Short description / comment	<p>Integrated passenger transport system has to include all participants which provide public transport services, first and foremost providers of transport by bus, train or tram, but also other service providers, such as providers of transport-on-demand services, car sharing systems and similar. Specific measures for establishing an integrated public passenger transport system include:</p> <ul style="list-style-type: none"> • Establishing a uniform timetable and tariff system; • Alignment of transport supply with the demand; • Creating a uniform payment and ticket sale system for the urban public passenger transport system; • Introducing a system for informing of passengers and route planning; • Introducing a single ticket system. <p>Specific goals of the measures:</p> <ul style="list-style-type: none"> • To reduce the average travel duration; • To establish a single, functional traffic system consisting of railway, tram and bus public transport systems; • To achieve a significant increase in the modal split of public transport and sustainable transport utilisation; • To achieve a 30% increase in the number of passengers utilising railway transport, a 15% increase in the number of passengers utilising tram transport, to optimise the routes of the suburban bus lines and to abolish the parallel system; • To start managing the traffic system and fully implement automated traffic management, primarily in the narrow City of Zagreb area (the area covered by the General Urban Development Plan of the City of Zagreb) in the next five (5) years; • To align the price of the transport service with the frequency of use. <p>This measure contributes to the achievement of the goals of the Transport Development Strategy of the Republic of Croatia (Objective 4: Improvement of the passenger accessibility to and within the main urban agglomerations – especially 4a Improvement of passenger accessibility – Zagreb node; Objective 6: Improvement of the Transport System Organisational and Operational setup to ensure the efficiency</p>

	<p>and sustainability of the system – especially 6c Improvement of the system operational setup, 6d Improvement of the safety of the transport system, 6e Reduction/mitigation of the environmental impact, 6f Improvement of the energy efficiency and 6g Financial sustainability of the transport system), and of the Competitiveness and Cohesion Operational Programme. The proposed project is in concordance with the measures outlined in another City of Zagreb strategic document, the City of Zagreb Development Strategy for the Period up to 2020 (G4.P4-M3 Improving public passenger transport; G4.P4-M6 Improving bicycle traffic; and G4.P4-M8 Improving safety for participants in traffic).</p> <p>The goal of this measure is in compliance with the Competitiveness and Cohesion OP specific objective 7ii2 – Developing and improving environmentally-friendly (including low-noise) and low-carbon transport systems and it should increase the number of transported passengers in urban public transport, as well as reduce the share of personal vehicles used in the total number of journeys in the City of Zagreb area, while increasing the general public transport quality, traffic safety and citizen mobility.</p> <p>The system for informing users of public city passenger transport services is the key channel of communication between the service provider and end users. Passenger and driver information systems provide pre-travel and in-travel passenger information services, by using static and dynamic information. The biggest benefit of the implementation of this system is the provision of timely and correct information to the passenger and increased reliability of travel duration estimates, which significantly improves the quality of public transport service, resulting in an increase in the number of users and reduction in the use of personal vehicles. The perception of care for and treatment of the passengers will thereby be improved and the duration of waiting time will be perceived as shorter, i.e. the negative effect of potential delays of public transport vehicles will be minimised.</p> <p>The single ticket system enables the user to buy a single passenger ticket for transport service for travelling from the starting to the final point. Such a ticket can be used for services offered by one or more operators of public city transport. The system should be easily applicable to other means of transport, so that the current mechanisms of ticket issue, sale and use can be transparently applied to other means of transport.</p> <p>A special stress needs to be put on the modern sales channels which include the sale of tickets and service payment via mobile applications and web. Moreover, it is recommended that the support for the implementation of this service include a passenger counting system in public city transport vehicles, which would enable detailed analyses of individual public city transport lines' use, service optimisation, as well as the creation of a basis for revenue distribution among service providers according to the actual number of transported passengers.</p> <p>This measure contributes to the achievement of the goals of the Transport Development Strategy of the Republic of Croatia (Objective 4: Improvement of the passenger accessibility to and within the main urban agglomerations – especially 4a Improvement of passenger accessibility – Zagreb node; Objective 6: Improvement of the Transport System Organisational and Operational setup to ensure the efficiency</p>
--	--

	<p>and sustainability of the system – especially 6c Improvement of the system operational setup, 6d Improvement of the safety of the transport system, 6e Reduction/mitigation of the environmental impact, 6f Improvement of the energy efficiency and 6g Financial sustainability of the transport system), and of the Competitiveness and Cohesion Operational Programme. The proposed project is in concordance with the measures outlined in another City of Zagreb strategic document, the City of Zagreb Development Strategy for the Period up to 2020 (G4.P4-M3 Improving public passenger transport; G4.P4-M6 Improving bicycle traffic; and G4.P4-M8 Improving safety for participants in traffic).</p> <p>The goal of this measure is in compliance with the Competitiveness and Cohesion OP specific objective 7ii2 – Developing and improving environmentally-friendly (including low-noise) and low-carbon transport systems and it should increase the number of transported passengers in urban public transport, as well as reduce the share of personal vehicles used in the total number of journeys in the City of Zagreb area, while increasing the general public transport quality, traffic safety and citizen mobility.</p>
--	--

Measure no	12
Measure/activity	Introducing a system for informing of passengers and route planning as part of the integrated passenger transport
Activity promoter	<ul style="list-style-type: none"> • Integrirani promet zagrebačkog područja d.o.o.
Implementation partners	<ul style="list-style-type: none"> • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • City Office for Economy, Energetics and Environment Protection; • ZET d.o.o.; • HŽ Infrastruktura d.o.o.; • HŽ Putnički prijevoz d.o.o.
Other involved stakeholders	<ul style="list-style-type: none"> • Ministry of Maritime Affairs, Transport and Infrastructure.
Start/end of implementation (year)	2021 – 2023
Savings estimate (MWh)	82,027.8
Estimate of the level of reduction of CO₂ emissions (t CO₂)	20,999.5
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State Budget; • European structural and investment funds; • ZET d.o.o.; • European Investment Bank (EIB) / Croatian Bank for Reconstruction and Development (HBOR); • European Bank for Reconstruction and Development (EBRD); • Commercial banks.
Short description / comment	<p>The system for informing users of public city passenger transport services is the key channel of communication between the service provider and end users. Passenger and driver information systems include passenger information services via pre-travel and travel information services, by using static and dynamic information. The biggest benefit of the implementation of this system is the provision of timely and correct information to the passenger and increased reliability of travel duration estimates, which significantly improves the quality of public transport service, resulting in an increase in the number of users and reduction in the use of personal vehicles. The perception of care for and treatment of the passengers will thereby be</p>

	<p>improved and the duration of waiting time will be perceived as shorter, that is, the negative effect of potential delays of public transport vehicles will be minimised.</p> <p>This measure contributes to the achievement of the goals of the Transport Development Strategy of the Republic of Croatia (Objective 4: Improvement of the passenger accessibility to and within the main urban agglomerations – especially 4a Improvement of passenger accessibility – Zagreb node; Objective 6: Improvement of the Transport System Organisational and Operational setup to ensure the efficiency and sustainability of the system – especially 6c Improvement of the system operational setup, 6d Improvement of the safety of the transport system, 6e Reduction/mitigation of the environmental impact, 6f Improvement of the energy efficiency and 6g Financial sustainability of the transport system), and of the Competitiveness and Cohesion Operational Programme. The proposed project is in concordance with the measures outlined in another City of Zagreb strategic document, the City of Zagreb Development Strategy for the Period up to 2020 (G4.P4-M3 Improving public passenger transport; G4.P4-M6 Improving bicycle traffic; and G4.P4-M8 Improving safety for participants in traffic).</p> <p>The goal of this measure is in compliance with the Competitiveness and Cohesion OP specific objective 7ii2 – Developing and improving environmentally-friendly (including low-noise) and low-carbon transport systems and it should increase the number of transported passengers in urban public transport, as well as reduce the share of personal vehicles used in the total number of journeys in the City of Zagreb area, while increasing the general public transport quality, traffic safety and citizen mobility.</p>
--	--

Measure no	13
Measure/activity	Introducing a single ticket system as part of the integrated passenger transport
Activity promoter	<ul style="list-style-type: none"> • Integrirani promet zagrebačkog područja d.o.o.
Implementation partners	<ul style="list-style-type: none"> • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • City Office for Economy, Energetics and Environment Protection; • ZET d.o.o; • HŽ Infrastruktura d.o.o; • HŽ Putnički prijevoz d.o.o.
Other involved stakeholders	<ul style="list-style-type: none"> • Ministry of Maritime Affairs, Transport and Infrastructure.
Start/end of implementation (year)	2021 – 2023
Savings estimate (MWh)	82,027.8
Estimate of the level of reduction of CO₂ emissions (t CO₂)	20,999.5
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State Budget; • European structural and investment funds; • ZET d.o.o; • European Investment Bank (EIB) / Croatian Bank for Reconstruction and Development (HBOR); • European Bank for Reconstruction and Development (EBRD); • Commercial banks.
Short description / comment	The single ticket system enables the user to buy a single passenger ticket for transport service for travelling from the

	<p>starting to the final point. Such a ticket can be used for services offered by one or more operators of public city transport. The system should be easily applicable to other means of transport, so that the current mechanisms of ticket issue, sale and use can be transparently applied to other means of transport.</p> <p>A special stress needs to be put on the modern sales channels which include the sale of tickets and service payment via mobile applications and web. Moreover, it is recommended that the support for the implementation of this service include a passenger counting system in public city transport vehicles, which would enable detailed analyses of individual public city transport lines' use, service optimisation, as well as the creation of a basis for revenue distribution among service providers according to the actual number of transported passengers.</p> <p>This measure contributes to the achievement of the goals of the Transport Development Strategy of the Republic of Croatia (Objective 4: Improvement of the passenger accessibility to and within the main urban agglomerations – especially 4a Improvement of passenger accessibility – Zagreb node; Objective 6: Improvement of the Transport System Organisational and Operational setup to ensure the efficiency and sustainability of the system – especially 6c Improvement of the system operational setup, 6d Improvement of the safety of the transport system, 6e Reduction/mitigation of the environmental impact, 6f Improvement of the energy efficiency and 6g Financial sustainability of the transport system), and of the Competitiveness and Cohesion Operational Programme. The proposed project is in concordance with the measures outlined in another City of Zagreb strategic document, the City of Zagreb Development Strategy for the Period up to 2020 (G4.P4-M3 Improving public passenger transport; G4.P4-M6 Improving bicycle traffic; and G4.P4-M8 Improving safety for participants in traffic).</p> <p>The goal of this measure is in compliance with the Competitiveness and Cohesion OP specific objective 7ii2 – Developing and improving environmentally-friendly (including low-noise) and low-carbon transport systems and it should increase the number of transported passengers in urban public transport, as well as reduce the share of personal vehicles used in the total number of journeys in the City of Zagreb area, while increasing the general public transport quality, traffic safety and citizen mobility.</p>
--	---

Measure no	14
Measure/activity	Improving the tram electricity system with the purpose of improving the public service
Activity promoter	<ul style="list-style-type: none"> • ZET d.o.o.
Implementation partners	<ul style="list-style-type: none"> • Integrirani promet zagrebačkog područja d.o.o; • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • City Office for Economy, Energetics and Environment Protection.
Start/end of implementation (year)	2021 – 2025
Savings estimate (MWh)	2,500
Estimate of the level of reduction of CO₂ emissions (t CO₂)	273.7
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State Budget; • European structural and investment funds;

	<ul style="list-style-type: none"> • EU programmes; • Environmental Protection and Energy Efficiency Fund (FZOEU).
Short description / comment	<p>For the tram traffic to be conducted efficiently, a sufficient pulling energy is required. In order for the long tradition of quality of the tram transport service of the City of Zagreb to continue, the electricity system should be upgraded. The analysis has shown that the following parts of the system need to be upgraded:</p> <ul style="list-style-type: none"> • Rectifier and transformer stations with their corresponding equipment; • Networks of feed (+) and return (-) overhead lines; • Tram contact networks (sectors of the tram contact network, the corresponding contact network poles and consoles, cathodic lightning arresters and feed points, transmission equipment, switching devices and turn signalisation); • Tram switches (devices for automated control of the switch points, powered point lock devices, devices for regulating switch heating and switch heaters, signal devices and system for detecting arriving tram vehicles on the contact network). <p>In addition to the system being upgraded, the Supervisory Control and Data Acquisition (SCADA) system also needs to be implemented.</p> <p>The following positive effects will be accomplished by implementing this measure:</p> <ul style="list-style-type: none"> • Reduction in energy consumption and CO₂ emissions; • Increase in transport capacity and average speed of tram travel; • Reduction of costs related to pulling energy and reduction of maintenance costs; • Increase in the popularity of tram transport and increase in the number of passengers transported by kilometre. <p>This measure is compliant with the City of Zagreb Development Strategy for the Period up to 2020 in its Goal 4 – Improving urban quality and city functions, Priority 4 – Improving traffic systems, Measure 3 – Improving public passenger transport. By carrying out the specific activities, the share of passengers using public transport will increase and, at the same time, the share of personal vehicles as means of transport in the total number of travels in the City of Zagreb area will decrease, the general quality of the public transport will improve, the safety of traffic participants will increase and the citizens will become more mobile.</p>

Measure no	15
Measure/activity	Use of innovative drive systems in the urban public transport
Activity promoter	<ul style="list-style-type: none"> • ZET d.o.o.
Implementation partners	<ul style="list-style-type: none"> • Integrirani promet zagrebačkog područja d.o.o; • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • City Office for Economy, Energetics and Environment Protection.
Start/end of implementation (year)	2021 – 2030
Savings estimate (MWh)	22,861.1
Estimate of the level of reduction of CO₂ emissions (t CO₂)	5,746.3
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb;

	<ul style="list-style-type: none"> • State Budget; • European structural and investment funds; • EU programmes; • Environmental Protection and Energy Efficiency Fund (FZOEU).
Short description / comment	<p>This measure is aimed at all types of mobility which can achieve the transition from fossil fuels to new types of available fuels e.g. electricity or hydrogen drive, and which are used in the urban public transport system. Liquefied petroleum gas is considered a transitional fuel for buses. The transition from traditional drive systems to e.g. electric drive directly contributes to the reduction of air pollutant emissions (CO, NOx), reduction of CO₂ emissions and noise reduction. The existing and the future drive technologies possess a significant potential for radical change and improvement of urban public transport, which still has a very large share in the overall transport structure of the City of Zagreb, in the holistic approach to sustainable traffic system. Within the scope of this measure, e-vehicle charging station infrastructure should be mapped in accordance with the estimated existing and future demand and integrated with the electricity system. The dynamics of this measure depends directly on the technological developments and will directly affect the specific activities.</p> <p>Specific activities include:</p> <ul style="list-style-type: none"> • Carrying out a pilot project of introducing alternative-fuel-powered buses (electricity, hydrogen etc.) on standard lines, with the purpose of attaining key indicators for the preparation of a comprehensive project; • Analysis of the possibilities for introducing alternative-fuel-powered buses (electricity, hydrogen etc.) in the City of Zagreb bus network – includes determining the type of buses and the need for construction of the accompanying infrastructure (network of charging stations, improving the infrastructure etc.); • Planning and successively introducing alternative-fuel-powered buses and the accompanying infrastructure into the City of Zagreb bus network; • Monitoring and optimising the operation of the alternative-fuel-powered vehicle fleet.

7.2.2 City of Zagreb vehicle fleet

Measure no	16
Measure/activity	Eco-driving training for drivers of the vehicles in the City of Zagreb and Zagrebački holding branches' vehicle fleets
Activity promoter	<ul style="list-style-type: none"> • Mayor's Office; • Zagrebački holding d.o.o.
Implementation partners	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection.
Other involved stakeholders	<ul style="list-style-type: none"> • Companies providing eco-driving education and training.
Start/end of implementation (year)	Continuous.
Savings estimate (MWh)	6,058.3
Estimate of the level of reduction of CO₂ emissions (t CO₂)	1,541.1
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • Environmental Protection and Energy Efficiency Fund (FZOEU).
Short description / comment	Eco-driving has been recognised as one of the most efficient measures for encouraging energy efficiency in the European

	<p>Union. Studies have shown that fuel consumption can be reduced by 5-15% in the long-term. By launching an eco-driving campaign aimed at the drivers of the vehicles in the City of Zagreb and Zagrebački holding vehicle fleets, the maximum level of driver awareness of the benefits of this modern, intelligent and eco-friendly driving style could be achieved. Specific activities include active eco-driving training of licensed (existing) drivers of special vehicles and drivers of personal vehicles used for the needs of the City of Zagreb and Zagrebački holding. Special elements should be dedicated to eco-driving education of:</p> <ul style="list-style-type: none"> • Personal vehicle drivers; • Bus drivers; • Drivers of freight vehicles, the mass of which exceeds 3.5 tonnes.
--	--

Measure no	17
Measure/activity	Gradual replacement of the existing vehicle fleet owned by the City of Zagreb and Zagrebački holding with hybrid or electric vehicles
Activity promoter	<ul style="list-style-type: none"> • Mayor's Office.
Implementation partners	<ul style="list-style-type: none"> • Zagrebački holding d.o.o.; • Companies owned by the City of Zagreb.
Start/end of implementation (year)	2020 – 2030
Savings estimate (MWh)	6,469.4
Estimate of the level of reduction of CO₂ emissions (t CO₂)	1,714.2
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • Environmental Protection and Energy Efficiency Fund (FZOEU).
Short description / comment	<p>Hybrid and electric vehicles are more efficient, they pollute less and should gradually be given advantage over fossil fuel powered vehicles in the procedures of procurement of vehicles used for the operative needs of city offices, institutes, services and budget users and of Zagrebački holding.</p> <p>The average energy consumption of electric cars amounts to 15 kWh/100 km, hybrid cars consume 44 kWh/100 km, whereas that value for traditional vehicles equals 67 kWh/100 km.</p> <p>Specific activities include:</p> <ul style="list-style-type: none"> • Analysis of the existing vehicle fleet; • Analysis of the possibilities for implementing the alternative fuel powered vehicles in individual organisational units, accompanied by savings projections; • Gradual replacement of the existing vehicle fleet with alternative fuel powered vehicles; • Continuous monitoring and optimising of the vehicle fleet and proposing of additional possibilities.

Measure no	18
Measure/activity	Development of an infrastructure for the use of alternative, energy efficient fuels in personal vehicles
Activity promoter	<ul style="list-style-type: none"> • Zagrebparking d.o.o.
Implementation partners	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection; • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • City Office for the Local Self-Administration.
Start/end of implementation (year)	2021 – 2030

Savings estimate (MWh)	158,527.8
Estimate of the level of reduction of CO₂ emissions (t CO₂)	44,550.1
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State Budget; • Connecting Europe Facility (CEF); • Horizon 2020; • European structural and investment funds; • European Investment Bank (EIB); • Commercial banks; • Environmental Protection and Energy Efficiency Fund (FZOEU).
Short description / comment	<p>The implementation of this measure includes:</p> <ul style="list-style-type: none"> • The physical component (construction of a network of charging stations); • ICT (system management); • The operative component (developing a business model for operating the system): <p>The measure should be implemented systematically, by:</p> <ul style="list-style-type: none"> • Initially mapping the need for charging stations; • Planning the integration with the electricity system and parking systems; • Determining the type and the number of the required charging stations, taking into consideration both slow and fast charging stations and the possible advanced solutions in terms of stations for e-vehicle battery replacement, all in accordance with the results of the analysis; • Analysing the possibility of integrating the e-vehicle charging stations integrated with public and multi-residential buildings with those buildings' energy management systems (with the purpose of complying with the amended Directive on the energy performance of buildings), with the ultimate goal of accomplishing as low a vehicle charging price for the end users as possible; • Developing an information system through which it will be possible to announce vehicle arrival and, considering the anticipated working conditions of other energy systems in the building, achieving the lowest possible charging prices; • Estimating the possibility of integration with the services of Zagrebparking; • Connecting the information system with the application of the possible service provider and/or charging station operator; • Developing and implementing a business model for system management; • Continuously improving the system, as necessary.

Measure no	19
Measure/activity	Introducing a system of reliefs for e-vehicle owners
Activity promoter	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection.
Implementation partners	<ul style="list-style-type: none"> • Zagrebparking d.o.o; • City Office for Physical Planning, Construction of the City, Utility Services and Transport.
Start/end of implementation (year)	up to 2023
Savings estimate (MWh)	158,555.6
Estimate of the level of reduction of CO₂ emissions (t CO₂)	44,550.1

Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • Connecting Europe Facility (CEF).
Short description / comment	<p>The goal of this measure is to elaborate modalities of encouraging the use of e-vehicles since they directly contribute to the reduction in fossil fuel use and the reduction of CO₂ emissions. In order to take full advantage of the measure relative to the construction of the infrastructure for alternative fuel use, a sufficient number of consumers has to be guaranteed, which can be accomplished by introducing reliefs for e-vehicle owners.</p> <p>Potential measures include free parking, free acquisition of an annual parking ticket, discount prices on using the charging stations operated by the parking service provider etc.</p> <p>The measure has to be elaborated systematically:</p> <ul style="list-style-type: none"> • Funding should be partially derived from the newly instituted fees for entering the city centre and partially from City of Zagreb funds; • Subsidies for buying an e-vehicle in the amount of 10% of the value of the vehicle should be awarded as one-off stimulations. <p>The models of subsidising should be synchronised with the tax policy of the Republic of Croatia.</p>

7.2.3 Cycling and pedestrian traffic

Measure no	20
Measure/activity	Improvement of the cycling and pedestrian traffic
Activity promoter	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection; • ZET d.o.o.
Implementation partners	<ul style="list-style-type: none"> • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • City Institute for Physical Planning; • Integrirani promet zagrebačkog područja d.o.o.
Other involved stakeholders	<ul style="list-style-type: none"> • Companies providing bike sharing services; • Civil society associations.
Start/end of implementation (year)	2020 – 2030
Savings estimate (MWh)	246,027.8
Estimate of the level of reduction of CO₂ emissions (t CO₂)	62,998.6
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • EU programmes; • European Structural and Investment Funds; • Connecting Europe Facility (CEF); • European Investment Bank (EIB) / Croatian Bank for Reconstruction and Development (HBOR); • European Bank for Reconstruction and Development (EBRD); • Commercial banks; • Private companies and investors.
Short description / comment	<p>The goal of this measure is to improve the cycling and pedestrian infrastructure, in a way that generates larger accessibility of cycling lanes, by building new ones or renovating the existing ones, in accordance with the Ordinance on Cycling Infrastructure. Cycling lane and track network should be well interconnected and connected to other forms of transport, and, first and foremost, be safe for use. The network should be connected to national and European cycling routes. Public cycling system, with its parking lots and garages, should follow</p>

	<p>the development of the cycling network and be suited to the users. Special attention should be paid to the availability of free and secured bicycle parking lots at intermodal nodes in order to guarantee uninterrupted journeys when changing means of transport. In order to additionally improve cycling traffic, additional bike sharing system capacities should be employed. The bike sharing system should be integrated into application and transaction solutions (payment) for using all forms of transport, which signals integration with measures 11, 12 and 13. Bike sharing systems are ideal for connecting various forms of transport. In this context, last mile journeys should be specially pointed out. Development of additional services which will enable easier connection to other forms of transport, e.g. the Bike on Bus project, should be encouraged. Pedestrian zones should be expanded and new zones formed. Frequently used pedestrian crossings should be appropriately equipped in order to improve passenger safety.</p> <p>Key activities which are to be carried out are:</p> <ul style="list-style-type: none">• Establishment of a modern, 250 km long network of cycling lanes in the City of Zagreb area, which, according to the Ordinance on Cycling Infrastructure implies:• Cycling traffic ways: cycling roads; cycling paths; cycling lanes; cycling tracks; cycling-pedestrian lanes;• Traffic signalisation and equipment;• Parking areas for bicycles and accompanying equipment;• Bicycle garages;• Public bicycle system;• Establishment of a public bicycle system in the City of Zagreb – 25 public bicycle stations throughout the City and procurement of 300 bicycles for use by the citizens, as part of the public transport system;• System and application for cyclists (information on cycle lanes, bike sharing, route planning and ride duration, traffic, charging stations, pollution etc.);• Better integration of bicycles into public transport (bicycle racks on the fronts or backs of buses, bicycle areas in trams etc.);• Introduction of additional capacities and expansion of system functionality regarding the use of the bike sharing service, which needs to be connected to the application for use of public transport system in real time;• Introduction of electric bicycle system and construction of charging stations for electric bicycles;• Construction and equipping of training centres for cyclists' traffic safety;• Integration of all systems into a uniform system for electric vehicles;• Integration of the cycling system into the Intelligent Transport System (ITS);• Expansion of pedestrian zones;• Expansion of pedestrian pavements;• Removing parking spaces from pedestrian pavements;• Introducing new pedestrian zones in all city districts;• Removing architectural barriers from pedestrian lanes. <p>This measure is compliant with the City of Zagreb Development Strategy for the Period up to 2020 in its Goal 4 – Improving urban quality and city functions, Priority 4 – Improving traffic systems, Measure 3 – Improving public passenger transport.</p>
--	---

7.3 Measures aimed at reducing CO₂ emissions generated in the public lighting sector of the City of Zagreb

Measure no	21
Measure/activity	Energy efficiency renovation of public lighting
Activity promoter	<ul style="list-style-type: none"> • City Office for Physical Planning, Construction of the City, Utility Services and Transport.
Implementation partners	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection; • Regional Energy Agency (REGEA).
Start/end of implementation (year)	<ul style="list-style-type: none"> • Preparatory activities conducted through the RePubLEEC project, 2017 – 2020; • Modernisation of public lighting, 2020 – 2023.
Savings estimate (MWh)	26,881.9
Estimate of the level of reduction of CO₂ emissions (t CO₂)	2,957
Possible sources of funding	<ul style="list-style-type: none"> • European structural and investment funds; • European Investment Bank (technical assistance via the European Local Energy Assistance – ELENA – financial instrument); • Croatian Bank for Reconstruction and Development (HBOR), European Investment Bank (EIB) or commercial banks; • Private financial initiative (PFI).
Short description / comment	In order to improve the energy efficiency level of public lighting, preparatory activities aimed at project elaboration should be carried out, as should the very modernisation of public lighting. A 65% reduction in electricity consumption and a 75% reduction in public lighting system maintenance costs are estimated to be achieved through the above-mentioned activities. The total annual savings in operative costs (electricity and maintenance) are estimated to amount to approximately 5 million euros.

7.4 Measures aimed at reducing CO₂ emissions generated in the district heating system

Measure no	22
Measure/activity	Energy efficient City of Zagreb district heating system – interventions on the hot water supply network
Activity promoter	<ul style="list-style-type: none"> • HEP Toplinarstvo d.o.o.
Implementation partners	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection; • Zagreb Urban Agglomeration (ITI mechanism); • Ministry of Regional Development and EU Funds; • Ministry of Environmental Protection and Energy.
Start/end of implementation (year)	2020 – 2023
Savings estimate (MWh)	0.201708 PJ
Estimate of the level of reduction of CO₂ emissions (t CO₂)	145,079.9
Possible sources of funding	<ul style="list-style-type: none"> • European Structural and Investment funds (ITI mechanism); • HEP Toplinarstvo d.o.o; • European Investment Bank (EIB).
Short description / comment	The hot water supply network is spread at approximately 227.3 km. The age and wear of the system causes large losses. Technical heat losses in the City of Zagreb DHS amounted to 210.28 GWh in 2017, which represents 15.19% of the heat energy entering the distribution system. The 2017 hot water supply system rupture generated the need for additional

	<p>1,235,723 m³ of water in order for the system to be filled. The additional water index for the entire City of Zagreb DHS amounted to 46.19 in 2017. In addition to water loss, ruptures generate the need for emergency interventions on the system, the aim of which is to remedy the damage and provide the end users with uninterrupted heat energy supply. In order to increase supply safety and decrease heat and water losses, as well as the number of emergency interventions, the critical sections of the hot water supply system need to be revitalised in order to improve the existing insulation of the pipeline by installing pre-insulated pipes using the trenchless pipeline construction technique.</p> <p>The ultimate goal of this measure is to reduce heat losses, water losses and network maintenance costs, to increase the availability of heat energy and the operative stability of the entire system, from smaller branches and junctions to the larger main pipelines, as well as to indirectly reduce the amount of CO₂ emissions. The project is aligned with the renovation of the system's production facility in the Žitnjak zone.</p> <p>This measure should generate energy efficiency savings of 0.201708 PJ in the district heating system and a reduction in heat losses in the central heat networks by 3.4 %, which is compliant with measure 3.2.3 - <i>Construction and improvement of communal equipment - public heating system</i> of the Zagreb Urban Agglomeration Development Strategy for the Period up to 2020. The total estimated value of the implementation of this measure amounts to approximately 573 million kuna. The project should be funded by the Integrated Territorial Investments mechanism, in accordance with specific objective 4c3 - <i>Improvement of the efficiency of the district heating system</i>, in the amount of 45 million euros. The deadline for the completion of the project is 2023.</p>
--	---

Measure no	23
Measure/activity	Utilisation of the geothermal potential in the district heating system
Activity promoter	<ul style="list-style-type: none"> • HEP Toplinarstvo d.o.o; • City Office for Economy, Energetics and Environment Protection; • Holder of the concession to the Zagreb geothermal field.
Start/end of implementation (year)	2021 – 2030
Savings estimate (MWh)	150,000
Estimate of the level of reduction of CO₂ emissions (t CO₂)	30,000
Possible sources of funding	<ul style="list-style-type: none"> • Concession holder; • Horizon 2020; • European Investment Bank (EIB).
Short description / comment	<p>Only 3% of the total potential of the Zagreb geothermal field is used. The Zagreb geothermal field is a medium temperature deposit which is not suitable for cost-efficient electricity production, but it possesses the ideal physical parameters for cascade use in district heating, among other applications. The field is reversible and functions on the principle of production of geothermal fluid and reinjection into the deposit. Geothermal energy utilisation is among the top priorities of the Strategic Energy Technology Plan. By synergising with the district heating system, significant energy savings could be achieved in terms of reduction in the consumption of natural gas and reduction of CO₂ emissions.</p>

8 CLIMATE CHANGE ADAPTATION – Plan of priority measures aimed at adapting to climate change

According to the Air Protection Act (Official Gazette 130/11, 47/14, 61/17 and 118/18), climate change adaptation is the process of estimating the harmful climate change effects and undertaking the appropriate measures aimed at preventing or reducing the potential damage.

Climate change adaptation is a mandatory subject in the SECAP. Climate change adaptation activities are aimed at reducing the vulnerability of the natural and societal systems to climate change and increasing their resistance to climate change effects, as well as at utilising the potential positive climate change effects.

Climate change adaptation has, within the Action Plan, been elaborated as part of the plan of measures for climate change adaptation. Climate change adaptation measures are the result of the **Assessment of the Climate and Climate Change in the City of Zagreb** and the **Risk and Vulnerability Assessment of individual sectors**. Both documents can be found in *Annex 8 – Assessment of climate change, risks and vulnerability*.

In that annex, a theoretical foundation regarding climate and climate change is provided, as is the methodology of climate modelling. The City of Zagreb climate change assessments and the corresponding vulnerability risk assessments have been conducted on the basis of those concepts. All analyses, having to do with climate parameters and the pertinent bases for climate change analysis etc. can be found in *Annex 8 – Assessment of climate change, risks and vulnerability*.

8.1 Climate change adaptation measures in the building sector

Change in climate conditions and the accompanying extreme weather events are constantly putting more pressure on the development of and investments in the building sector. Since buildings and their accompanying infrastructure are envisioned as long-term structures and since such developments exert high capital investment, it is of vital importance that they be prepared for and resistant to any future climate change effects.

Climate change especially affects the construction industry due to the expected service life of buildings and the fact that the existing buildings should be renovated in order for them to be able to cope with the climate conditions which are or are going to be different from the ones present at the time of designing and construction of these buildings. The main challenges facing the construction industry and the buildings which should be renovated, and in a relatively short time horizon at that, are:

- Extreme amounts of precipitation, which cause e.g. water leaks, damage to the foundation and underground parts of the building, destruction of the building and the infrastructure etc;
- Extreme heat waves, which cause e.g. wear and accelerated material ageing, reduction in the comfort of living and potential negative effects on human health, consumption of large amounts of cooling energy etc;
- Exposure of buildings to large amounts of snow;
- Soil erosion risk and, depending on the structural stability of buildings, foundation erosion risk could become higher.

Buildings could be vulnerable to climate change due to their design (e.g. in a way that causes low resistance to extreme weather events, such as storms) or due to the location of construction.

Measure no	1
Measure/activity	Mapping the City of Zagreb buildings in order to determine the green technology implementation potential
Activity promoter	<ul style="list-style-type: none"> • City Institute for Physical Planning.
Implementation partners	<ul style="list-style-type: none"> • City Office for the Strategic Planning and Development of the City; • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • City Office for Economy, Energetics and Environment Protection; • Gradsko stambeno komunalno gospodarstvo d.o.o; • Zagrebački holding d.o.o; • Regional Energy Agency (REGEA); • Andrija Štampar Teaching Institute of Public Health.
Other involved stakeholders	<ul style="list-style-type: none"> • University of Zagreb; • Building operators.

Start/end of implementation (year)	2021 – 2023
Cost estimate (per unit or overall per measure)	2,500,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • EU programmes; • European structural and investment funds; • Environmental Protection and Energy Efficiency Fund (FZOEU).
Short description / comment	<p>The goal of this measure is to analyse and document the green technology implementation potential of public, residential and commercial buildings. Mapping should, on the basis of a previous evaluation of microclimate conditions of the structures and locations, show the areas and buildings in which green roof and green facade technologies can be applied. The analysis should encompass a proposal for utilisation of plant species of the lowest allergenic potential which are suitable for the climate conditions in the City of Zagreb and which will most efficiently achieve the optimal effects, information on technical limitations and possibilities and an overview of the effect a green facade would have on individual buildings and accumulative effects for specific areas.</p> <p>Implementing green technologies has been proven to contribute to increasing building energy efficiency, reducing water consumption, storing CO₂ and reducing warming of urban centres. Technologies in this area have already reached technology readiness level 5-7, but it is estimated that they should reach at least level 9 in the time horizon of this document, which should be taken into consideration when conducting the analysis and implementation.</p>

Measure no	2
Measure/activity	Implementation of green roof and green facade technologies in the buildings owned by the City of Zagreb and Zagrebački holding
Activity promoter	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection.
Implementation partners	<ul style="list-style-type: none"> • City offices, institutes and services/institutions, companies owned by the City of Zagreb which operate the buildings; • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • Mayor's Office; • City Office for the Local Self-Administration; • Zagrebački holding d.o.o.; • Gradsko stambeno komunalno gospodarstvo d.o.o.; • Regional Energy Agency (REGEA).
Other involved stakeholders	<ul style="list-style-type: none"> • University of Zagreb.
Start/end of implementation (year)	2022 – 2030
Cost estimate (per unit or overall per measure)	To be determined on the basis of the analysis referred to in Measure 1.
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • EU programmes; • European structural and investment funds; • Environmental Protection and Energy Efficiency Fund (FZOEU).
Short description / comment	On the basis of the mapped possibilities for implementing green technologies, the City of Zagreb will, according to its capabilities, implement the technology in certain buildings it owns. When designing the projects of energy efficiency renovations of the buildings owned by the City of Zagreb, the possibilities for implementing green technologies should be analysed for each

	building.
Measure no	3
Measure/activity	Conceptualisation and implementation of the programme for informing and educating the public on the benefits of climate resistant buildings
Activity promoter	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection.
Implementation partners	<ul style="list-style-type: none"> • City Office for the Strategic Planning and Development of the City; • City Institute for Physical Planning; • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • Zagrebački holding d.o.o; • Gradsko stambeno komunalno gospodarstvo d.o.o; • Regional Energy Agency (REGEA).
Other involved stakeholders	<ul style="list-style-type: none"> • Environmental Protection and Energy Efficiency Fund (FZOEU); • Civil society associations.
Start/end of implementation (year)	2020 – 2022
Cost estimate (per unit or overall per measure)	500,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • EU programmes; • European structural and investment funds; • Environmental Protection and Energy Efficiency Fund (FZOEU).
Short description / comment	The goal consists of creating promotional materials which should provide the framework for the implementation of the climate resistant building concept for new and existing buildings, evaluation of the effect of the measures (energy, financial and environmental savings), a list of institutions competent for implementing the measures and the available models and mechanisms for funding the implementation of measures. A broad spectrum of communication channels should be used in promotion in order for all the relevant stakeholders to be encompassed.

8.2 Traffic infrastructure

Climate change effects are known to negatively affect road, railway and supporting traffic infrastructure. Change in climate conditions is expected to cause frequent extreme weather events, such as strong rainfall in short periods (floods), strong wind (storms) and temperature extremes (heat waves and periods of extremely cold weather). Consequences for railway infrastructure include reduced safety, increased costs of repairs and maintenance and suspension of operation. Road infrastructure, depending on the type of effect, can suffer consequences which include reduced speed and flow of traffic, safety risks, direct material damage and increased maintenance and repair costs.

The risks can be summarily outlined in the following groups:

- Damage to traffic infrastructure caused by extreme weather events (primarily ducts and signalisation);
- Damage to traffic infrastructure caused by landslides;
- Faster wear of road and railway infrastructure caused by increased temperature extremes;
- Need for organising a fast and efficient response to strong and extraordinary disturbances in traffic caused by climate change effects.

Measure no	4
Measure/activity	Analysis of climate change effects on road infrastructure and adaptation plan proposal
Activity promoter	<ul style="list-style-type: none"> • City Office for Physical Planning, Construction of the City,

	Utility Services and Transport.
Implementation partners	<ul style="list-style-type: none"> • Integrirani promet zagrebačkog područja d.o.o; • ZET d.o.o; • Zagrebačke ceste d.o.o.
Other involved stakeholders	<ul style="list-style-type: none"> • Ministry of Maritime Affairs, Transport and Infrastructure; • HŽ Infrastruktura d.o.o.
Start/end of implementation (year)	2021 – 2024
Cost estimate (per unit or overall per measure)	1,500,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State Budget; • Environmental Protection and Energy Efficiency Fund (FZOEU).
Short description / comment	Climate change effects are known to negatively affect road, railway and supporting traffic infrastructure. Change in climate conditions is expected to cause frequent extreme weather events, such as strong rainfall in short periods (floods), strong wind (storms) and temperature extremes (heat waves and periods of extremely cold weather). Consequences for railway infrastructure include reduced safety, increased costs of repairs and maintenance and suspension of operation. Road infrastructure, depending on the type of effect, can suffer consequences which include reduced speed and flow of traffic, safety risks, direct material damage and increased maintenance and repair costs. Therefore, the effects should be adequately contemplated and evaluated and an adaptation plan should be drafted.

Measure no	5
Measure/activity	Introducing the air conditioning standard in the urban public transport vehicles
Activity promoter	<ul style="list-style-type: none"> • ZET d.o.o; • HŽ Putnički prijevoz d.o.o.
Implementation partners	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection; • City Office for Health.
Other involved stakeholders	<ul style="list-style-type: none"> • Andrija Štampar Teaching Institute of Public Health.
Start/end of implementation (year)	2021 – 2026
Cost estimate (per unit or overall per measure)	The measure is to be implemented via other activities, mostly through vehicle fleet upgrades.
Possible sources of funding	<ul style="list-style-type: none"> • ZET d.o.o; • Budget of the City of Zagreb; • European structural and investment funds.
Short description / comment	Heat waves are one of the ways in which climate change manifests itself and they affect numerous aspects of everyday life, which might be especially true for the passengers using the public transport service. Certain studies have shown that vehicle temperatures can be up to 4°C higher than the outside temperature during heat wave peaks, which poses a serious threat to human health. Therefore, the goal of this measure is to equip all public transport vehicles with air conditioning devices. Air conditioning devices should be rationally used since they bring about higher energy consumption and, consequently, generate more CO ₂ emissions. In the colder periods of the day, it is recommended to only use ventilation. However, when it comes to human health, air conditioning devices are considered an acceptable compromise. It is recommended that protocols on use of air conditioning

	devices in public transport vehicles, aimed at ensuring adequate temperature conditions, be drawn up in cooperation with the City Office for Health and the Andrija Štampar Teaching Institute of Public Health.
--	--

Measure no	6
Measure/activity	Equipping urban public transport stations with canopies which provide sun protection
Activity promoter	<ul style="list-style-type: none"> • City Office for Physical Planning, Construction of the City, Utility Services and Transport.
Implementation partners	<ul style="list-style-type: none"> • ZET d.o.o; • City Office for Health.
Other involved stakeholders	<ul style="list-style-type: none"> • Andrija Štampar Teaching Institute of Public Health.
Start/end of implementation (year)	2021 – 2026
Cost estimate (per unit or overall per measure)	5,000,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • ZET d.o.o; • European structural and investment funds.
Short description / comment	Heat waves are one of the ways in which climate change manifests itself and they affect numerous aspects of everyday life, which might be especially true for the passengers utilising the public transport service. Consequently, they pose a threat to human health, which is why the goal of this measure is to provide the users of the public transport service with canopies which offer protection from direct exposure to sunlight. Specific activities include mapping the existing status of the stations and planning a gradual replacement / construction of canopies which provide adequate protection from direct sunlight exposure. When selecting the type of canopies and construction materials, green materials and technologies should be favoured, where applicable.

Measure no	7
Measure/activity	Sustainable management of road surfaces in view of climate change adaptation
Activity promoter	<ul style="list-style-type: none"> • Zagrebačke ceste d.o.o.
Implementation partners	<ul style="list-style-type: none"> • City Office for Physical Planning, Construction of the City, Utility Services and Transport.

Other involved stakeholders	<ul style="list-style-type: none"> • University of Zagreb; • Ministry of the Interior.
Start/end of implementation (year)	2021 – 2030
Cost estimate (per unit or overall per measure)	1,500,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Zagrebačke ceste d.o.o; • Budget of the City of Zagreb; • European structural and investment funds.
Short description / comment	<p>High temperatures and direct exposure to sunlight during heat waves cause structural changes in road (asphalt) surfaces, which can generate negative consequences for traffic circulation, e.g. limitation or even complete restriction of usage of specific sections of traffic ways and disturbances in the operation of urban public transport. Hot road surface increases air temperature, which causes an array of corollary negative effects and adaptation requirements. Asphalt properties, load capacity and wear resistance depend on temperature. Deformations are more likely to occur in temperatures above 30°C.</p> <p>Specific activities include:</p> <ul style="list-style-type: none"> • Analysis of the existing condition of road and pavement surfaces, considering the type of asphalt (composition) and structural status; • Devising an overview of possibilities of utilising other asphalt mixtures which possess higher resistance to structural changes caused by high temperatures and are more reflective, in order to reduce surface warming; • Drafting a plan of adaptation of the existing asphalt surfaces on the basis of the overview of adaptation possibilities; • Devising protocols on the limitation of utilisation of specific sections, with regard to vehicle load capacity; • Continuous monitoring of the condition of asphalt surfaces and timely response in case of temperature extremes; • Connecting the measure with the measures for integration of green infrastructure in order to shade asphalt surfaces.

8.3 Energy sector

Climate change effects, such as increased frequency of extreme weather events, increased precipitation intensity and extreme temperatures will also negatively affect energy production, transmission, distribution and demand. Different seasonal patterns of consumption and direct physical effects of extreme weather events will affect the transmission and distribution systems, the older parts of which are the most vulnerable. The system efficiency of electricity production is vulnerable to e.g. reduced availability of water used in cooling the production facilities. Floods are among the most dangerous threats to energy production facilities, but also to the supporting physical infrastructure. Seasonal energy supply demand will grow, mostly in terms of increased electricity consumption during intense heat waves, which will put a significant load on the entire electricity sector.

The risks can be summarily outlined in the following groups:

- Larger load on the electricity system caused by heat waves;
- Damage to distribution systems brought on by extreme weather events;
- Negative effect of landslides on energy systems;
- Lack of water used in cooling energy production facilities due to drought.

Measure no	8
Measure/activity	Analysis of the existing electricity, natural gas and heat energy distribution systems and strengthening their resistance to climate change effects
Activity promoter	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection (coordinator).
Implementation partners	<ul style="list-style-type: none"> • Regional Energy Agency (REGEA).

Other involved stakeholders	<ul style="list-style-type: none"> • HEP-Operator distribucijskog sustava d.o.o; • HEP Toplinarstvo d.o.o; • Gradska plinara Zagreb d.o.o.
Start/end of implementation (year)	2022 – 2024
Cost estimate (per unit or overall per measure)	1,000,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • HEP-Operator distribucijskog sustava d.o.o; • HEP Toplinarstvo d.o.o; • Gradska plinara Zagreb d.o.o; • Budget of the City of Zagreb; • European structural and investment funds.
Short description / comment	<p>Climate change could affect the amount of consumed electricity and heat energy and the duration of usage.</p> <p>Electricity network is considered to be more vulnerable than the heat energy network, whereas the gas network is the least vulnerable.</p> <p>The goal is to analyse the resistance of the electricity, heat energy and natural gas distribution systems to climate change, primarily to heat waves and to work on strengthening that resistance.</p>

8.4 Water management

Water management poses a special challenge to climate change adaptation considering the fact that water is highly susceptible to climate effects.

The risks can be summarily outlined in the following groups:

- Reduced accessibility of drinking water, due to lengthy droughts;
- Contamination of water pumping sites;
- Increased risk of floods;
- Damage to water supply systems caused by landslides.

If no action is undertaken to combat climate change in water resource hydrology sector, larger and more frequent damages caused by the negative agency of waters, such as floods and erosion in water streams, hydromelioration systems and urban areas, can be expected. Reduced water supply to the population and industry can also be expected due to the lack of fresh water, caused by drought. Summer water shortage is probably going to especially affect agriculture, where water demand is going to grow (due to higher temperatures and evapotranspiration), as a result of reduced abundance of the available water sources. The water sector's vulnerability to climate change has already been recognised in one of the fundamental water management planning documents, the River Basin Districts Management Plan for the 2016 – 2021 Period, which anticipates an increase in the risk of floods, brought on by the change in the duration, intensity and frequency of extreme precipitation in combination with changes in the manner of land use. Another issue that is being raised has to do with the possibility of having to alter the existing approach to flood risk management because of the above-mentioned changes.

According to the Assessment of the Vulnerability of the Population, Material Assets and Cultural Heritage to Disasters and Major Accidents in the City of Zagreb Area, the City of Zagreb water supply system could be vulnerable to lengthy droughts, which would cause a decrease in the level of drinking water in the sources, which might cause a drinking water shortage (especially during the summer months) and a supply shortage. On the other hand, the drainage system could be vulnerable to floods. A continuous increase in the consumption of electricity used for the purpose of pumping underground water at the water pump sites of the City of Zagreb has been noticed in the recent period, which indicates that the water supply system is becoming increasingly less efficient energy-wise.

Very few systematic studies aimed at generating and quantifying the results of the possible climate change effects on the water sector have been conducted, which is why generally available information and conclusions of recent documents and international literature are relevant at the moment. Especially rare are the intersectorial, interdisciplinary studies which research climate change through several domains, e.g. change in water quantity and quality, change in aquatic ecosystems and possible adaptation measures. Therefore, it is vital to launch such intersectorial studies, the goal of which is to provide suitable results which could serve as a basis for reliable estimates of possible adaptation measures.

Measure no	9
Measure/activity	Economic evaluation of underground waters as the basis for the City of Zagreb water supply
Activity promoter	<ul style="list-style-type: none"> • Vodoopskrba i odvodnja d.o.o.
Implementation partners	<ul style="list-style-type: none"> • Hrvatske vode.
Other involved stakeholders	<ul style="list-style-type: none"> • University of Zagreb.
Start/end of implementation (year)	2021 – 2022
Cost estimate (per unit or overall per measure)	3,000,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Vodoopskrba i odvodnja d.o.o; • Hrvatske vode; • Budget of the City of Zagreb.
Short description / comment	<p>An economic evaluation of the functions of underground waters, which are based on pumping of said water for water supply needs, and their environmental functions, especially those that determine the interdependence between the underground and surface waters, should be conducted. Such an evaluation is necessary since it will demonstrate the indicators of financial benefits which will then be compared with the potential expenses caused by underground water pollution or excessive pumping of underground water in order to help determine the most economically advantageous measures aimed at reducing the effects of climate change on water resources.</p> <p>This measure is scientific in nature and shall provide the basis for the implementation of other measures aimed at climate change adaptation.</p> <p>The goal is to perform a cost benefit analysis for the implementation of individual measures or a combination of the most effective and acceptable measures for remedying the consequences of reduction in renewable underground water stock and/or underground water pollution brought on by extreme hydrological events caused by climate change, which can be intensified in combination with anthropogenic agency (e.g. because of uncontrolled development of large infrastructure projects).</p>

Measure no	10
Measure/activity	Impeding and reversing the negative trends of underground water level decrease and ensuring appropriate pumping site capacities for water supply
Activity promoter	<ul style="list-style-type: none"> • Hrvatske vode.
Implementation partners	<ul style="list-style-type: none"> • Vodoopskrba i odvodnja d.o.o; • City Office for the Strategic Planning and Development of the City; • City Office for Economy, Energetics and Environment Protection; • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • City Institute for Physical Planning.
Other involved stakeholders	<ul style="list-style-type: none"> • University of Zagreb.
Start/end of implementation (year)	In phases: <ul style="list-style-type: none"> • Drafting research documentation, 2020 – 2022; • Drafting project documentation, 2022 – 2024; • Project implementation, 2024 – 2030.
Cost estimate (per unit or overall per measure)	Research – approximately 1,500,000 kuna

measure)	Implementation – difficult to estimate
Possible sources of funding	<ul style="list-style-type: none"> • Hrvatske vode; • Vodoopskrba i odvodnja d.o.o; • Budget of the City of Zagreb.
Short description / comment	<p>The goal of this measure is to ensure the pumping capacities required for the supply of the existing and future users of the water supply service, to increase the efficiency of the pumping facilities and, thereby, to achieve the goal of sustainable water resource management.</p> <p>The activities regarding initiating the drafting of the feasibility study, the cost benefit analysis and the estimate of various alternative solutions aimed at stopping and altering the negative trend of the underground water level reduction and at ensuring the pumping facilities' capacities required for satisfying the water supply demand in the City of Zagreb should be launched. The measure should be carried out in an integrated manner, with a special stress on preserving the high quality of underground waters.</p> <p>After the research documentation has been drafted, the project documentation should be drafted and specific project activities should be carried out.</p>

Measure no	11
Measure/activity	Protecting water pumping sites' confluence areas by renovating the sites' sanitary protection zones, including cleaning up the polluted parts of the water pumping sites' confluence areas
Activity promoter	<ul style="list-style-type: none"> • Hrvatske vode.
Implementation partners	<ul style="list-style-type: none"> • Vodoopskrba i odvodnja d.o.o; • City Office for the Strategic Planning and Development of the City; • City Institute for Physical Planning; • City Office for Economy, Energetics and Environment Protection; • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • City Institute for the Conservation of Cultural and Natural Heritage.
Other involved stakeholders	<ul style="list-style-type: none"> • Andrija Štampar Teaching Institute of Public Health.
Start/end of implementation (year)	2021 – 2026
Cost estimate (per unit or overall per measure)	Analysis – 1,500,000 kuna Implementation – tens of millions of kuna
Possible sources of funding	<ul style="list-style-type: none"> • Hrvatske vode; • Vodoopskrba i odvodnja d.o.o; • Budget of the City of Zagreb; • European Structural and Investment Funds.
Short description / comment	<p>The goal of this measure is to protect the underground waters in the confluence areas of the Zagreb water pumping sites and to clean up the pollution in order to ensure safe water supply to the City of Zagreb and to comply with the requirements laid out in EU directives and guidelines, especially in the Water Framework Directive.</p> <p>The measure consists of an analytic part and a part encompassing the implementation of specific sanitary interventions. In the analytic and research part of the measure, the activities regarding the renovation of the sanitary protection zones, i.e. the analysis of the efficiency of the measures aimed at protecting underground waters, which are undertaken in the confluence areas of water pumping sites, in the conditions of increasingly influential climate change effects, should be initiated, the implementation of</p>

	<p>integrated underground water protection instruments and measures undertaken in the confluence areas of water pumping sites should be elaborated and a cost benefit analysis should be performed.</p> <p>The part of the measure which has an adaptive effect encompasses the identification and implementation of the required specific sanitary interventions on the polluted parts of the water supply system, specifically on the confluence areas of water pumping sites, in accordance with the list of priorities.</p>
--	---

Measure no	12
Measure/activity	Identifying the vulnerable groups and critical property at risk of floods
Activity promoter	<ul style="list-style-type: none"> • Hrvatske vode.
Implementation partners	<ul style="list-style-type: none"> • City Office of Emergency Management; • City Office for the Strategic Planning and Development of the City; • City Institute for Physical Planning; • City Office for Economy, Energetics and Environment Protection; • City Office for Physical Planning, Construction of the City, Utility Services and Transport.
Other involved stakeholders	<ul style="list-style-type: none"> • National Protection and Rescue Directorate; • Andrija Štampar Teaching Institute of Public Health.
Start/end of implementation (year)	2021 – 2022
Cost estimate (per unit or overall per measure)	1,000,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Hrvatske vode; • Budget of the City of Zagreb; • European structural and investment funds.
Short description / comment	<p>The goal of this measure is to mitigate human and material losses in the populated and industrial areas of the City of Zagreb which are at great risk of floods. A faster and prepared response of the local community and the institutions competent for flood response is vital in such a process. The response should consist in quickly recognising the needs of the priority groups, in order to facilitate the evacuation of primarily those groups and the protection of their property.</p> <p>The neighbourhoods, houses and housing that are located in the most vulnerable areas, taking into account the vicinity of water surfaces, considering the available infrastructure and the quality of embankments, should be identified. The main economic activities in which the local population, which could potentially be affected by flood, is involved should be analysed in detail. Meteorological and climate data should expedite the identification of the most likely event in the annual schedule of flood events for specific locations (which is pertinent to agriculture), whereas the locations and the characteristics of the most vulnerable and susceptible social groups should be identified more precisely in order for a more efficient flood risk assessment and rescue service interventions in case of floods to be conducted. In the case of unacceptable flood risks and on the basis of a previous identification of the vulnerable groups, the competent institutions should organise educational programmes aimed at informing the part of the population which is the most vulnerable to floods and prepare them for protecting their properties from floods. The materials should encompass the recommended type of construction and/or adaptation of household, agricultural and industrial infrastructure in case of floods.</p>

Measure no	13
Measure/activity	Sava river streambed renovation
Activity promoter	<ul style="list-style-type: none"> • Hrvatske vode.
Implementation partners	<ul style="list-style-type: none"> • City Office for the Strategic Planning and Development of the City; • City Institute for Physical Planning; • City Office for Economy, Energetics and Environment Protection; • City Office for Physical Planning, Construction of the City, Utility Services and Transport.
Other involved stakeholders	<ul style="list-style-type: none"> • National Protection and Rescue Directorate.
Start/end of implementation (year)	2021 – 2030
Cost estimate (per unit or overall per measure)	10,000,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Hrvatske vode; • European structural and investment funds; • Budget of the City of Zagreb.
Short description / comment	The goal of this measure is to level the streambed and renovate the existing and build additional embankments in order to prevent floods at those areas that are currently at highest risk of high water level of the Sava river. A status analysis and a feasibility study of landscaping and utilising the Sava river should be conducted, while specific measures aimed at levelling the streambed and renovating the existing and building new embankments and measures aimed at reconstructing and building new sections of channels should be carried out.

Measure no	14
Measure/activity	Reducing water losses in the water supply network of the City of Zagreb – network reconstruction
Activity promoter	<ul style="list-style-type: none"> • Vodoopskrba i odvodnja d.o.o.
Implementation partners	<ul style="list-style-type: none"> • Zagrebački holding d.o.o.; • City Office for Economy, Energetics and Environment Protection; • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • City Office for the Local Self-Administration; • City Institute for the Conservation of Cultural and Natural Heritage.
Other involved stakeholders	<ul style="list-style-type: none"> • Hrvatske vode; • Zagrebačke otpadne vode d.o.o.
Start/end of implementation (year)	2020 – 2030
Cost estimate (per unit or overall per measure)	Over 1,000,000,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Vodoopskrba i odvodnja d.o.o.; • Budget of the City of Zagreb; • European structural and investment funds.
Short description / comment	Water is one of the resources that are vulnerable to climate change effects the most, especially in the categories of availability and quality. The availability is becoming increasingly problematic, which is why every activity which is aimed at preserving water resources is immensely welcome and necessary. The goal of this measure is to increase the efficiency of the water supply system, i.e. to reduce losses and increase supply safety, through a comprehensive reconstruction, so as to comply with the Water Framework Directive (2000/60/EC) and the Drinking Water Directive (98/83/EC), with the ultimate goal of ensuring adequate

	<p>quantities of water which is safe for humans and increasing the share of the population connected to the public water supply systems. The implementation of specific activities will contribute to the accomplishment of the Competitiveness and Cohesion Operational Programme specific objective <i>6ii1 – Improvement of the public water supply system with the purpose of assuring quality and safety of drinking water supply</i>, by developing and reconstructing the water supply system. It will also contribute to the fulfilment of the obligations assumed during the negotiation process for the accession of the Republic of Croatia to the European Union which are contained in the Treaty of Accession of the Republic of Croatia to the European Union and have been embedded into the Multi-Annual Programme for the Construction of Water Utility Facilities for the 2014 – 2023 Period. The specific activities which should be carried out include drafting of the research and project documentation and the implementation of physical interventions of reconstruction and installation of equipment for smart monitoring of the water supply system.</p>
--	---

Measure no	15
Measure/activity	Raising public awareness of the importance of water consumption in households and of climate change impact on water as a component of the environment
Activity promoter	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection.
Implementation partners	<ul style="list-style-type: none"> • Vodoopskrba i odvodnja d.o.o.; • City Office for Health; • City Office for Education.
Other involved stakeholders	<ul style="list-style-type: none"> • Andrija Štampar Teaching Institute of Public Health; • Hrvatske vode.
Start/end of implementation (year)	2020 – 2030 (continuously)
Cost estimate (per unit or overall per measure)	500,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • Hrvatske vode; • Environmental Protection and Energy Efficiency Fund (FZOEU); • EU programmes.
Short description / comment	<p>Water is one of the resources that are affected by climate change effects the most, especially in the categories of availability and quality. The availability is becoming increasingly problematic, which is why every activity that is aimed at raising the awareness of rational utilisation and the way climate change affects waters is immensely welcome and necessary.</p> <p>The available communication channels, systems and infrastructure should be utilised in the implementation of this activity and new ones should be developed.</p>

Measure no	16
Measure/activity	Reducing the consumption of water used in the maintenance of green public surfaces, nurseries and sports and recreational surfaces
Activity promoter	<ul style="list-style-type: none"> • Zagrebački holding d.o.o. – the Zrinjevac branch; • Zagrebački holding d.o.o. – the Čistoća branch; • Vodoopskrba i odvodnja d.o.o.; • Institution for Sports Facilities Management.
Implementation partners	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection;

	<ul style="list-style-type: none"> • City Office for the Local Self-Administration; • City Office for Agriculture and Forestry; • City Office for Sport and Youth; • Regional Energy Agency (REGEA).
Start/end of implementation (year)	2020 – 2030 (continuously)
Cost estimate (per unit or overall per measure)	500,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • Environmental Protection and Energy Efficiency Fund (FZOEU); • EU programmes.
Short description / comment	The goal of this measure is to accomplish rational consumption of water used in the maintenance and cleaning of public surfaces, maintenance of green public surfaces, nurseries and sports structures and recreational surfaces. The first phase should encompass an analysis of the possibilities of utilisation of precipitation water. Such an analysis should include proposals for the construction of infrastructure which would facilitate the utilisation of precipitation and waste water, as well as proposals regarding the adaptation of processes and the equipment of the utility companies in order to rationalise the consumption of drinking water used for this purpose. The analysis should also encompass the possibilities for utilising wells for pumping the water for this purpose.

Measure no	17
Measure/activity	Rationalising the water consumption in the buildings owned by the City of Zagreb
Activity promoter	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection; • Mayor's Office.
Implementation partners	<ul style="list-style-type: none"> • Vodoopskrba i odvodnja d.o.o; • Regional Energy Agency (REGEA).
Start/end of implementation (year)	2022 – 2030 (continuously)
Cost estimate (per unit or overall per measure)	500,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • European structural and investment funds.
Short description / comment	Water is one of the resources that are affected by climate change effects the most, especially in the categories of availability and quality. Its availability on the international, as well as on the lower levels, is becoming increasingly problematic, which is why it is necessary to continuously undertake activities aimed at rationalising water usage. In the structures it owns or uses, the City of Zagreb should carry out the measures aimed at rationalising and reducing water consumption. The first phase consists of a water consumption analysis, based on the available data, which should elaborate the status of the existing water consumption infrastructure, the manner of usage and the potential infrastructural and improvements in the behavioural pattern of users. The second phase consists of the implementation of specific activities, such as the planning and installation of smart meters which can be remotely read.

Measure no	18
Measure/activity	Analysis of the possibilities for recycling and reusing waste water and collecting precipitation water
Activity promoter	<ul style="list-style-type: none"> • Vodoopskrba i odvodnja d.o.o.
Implementation partners	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection; • Regional Energy Agency (REGEA).
Start/end of implementation (year)	2022 – 2030 (continuously)
Cost estimate (per unit or overall per measure)	750,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • EU programmes.
Short description / comment	<p>Water recycling is an adaptation measure aimed at preserving resources by reusing non-drinking water. Water used in households could be utilised to various ends, e.g. for flushing toilets, garden irrigation etc. Industrial processes could be devised in such a way to utilise water in closed temperature control systems. Two types of water re-usage exist, the direct and indirect one. The direct type uses treated waste water, which is introduced into the water supply system without having been previously mixed with the water from natural sources. The indirect type implies mixing of waste water with water from another source. This measure can contribute to the reduction in total water consumption and to cost reductions. Its goal is to conduct an analysis of possibilities for recycling in the water supply and drainage system of the City of Zagreb.</p> <p>Furthermore, the possibilities for collection and use of precipitation water and the potential integration with the water supply system of the City of Zagreb should also be analysed.</p>

Measure no	19
Measure/activity	Devising an analysis and a plan of implementation of the integral concept of precipitation water drainage
Activity promoter	<ul style="list-style-type: none"> • Vodoopskrba i odvodnja d.o.o.
Implementation partners	<ul style="list-style-type: none"> • Hrvatske vode; • City Institute for Physical Planning; • Zagrebačke otpadne vode d.o.o.; • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • City Office for Economy, Energetics and Environment Protection; • City Office for the Local Self-Administration.
Other involved stakeholders	<ul style="list-style-type: none"> • University of Zagreb.
Start/end of implementation (year)	2022 – 2030 (continuously)
Cost estimate (per unit or overall per measure)	750,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • European structural and investment funds.
Short description / comment	<p>The precipitation water drainage systems in urban areas are mostly executed in the traditional hydrotechnical way. Such drainage concepts are ridden with disadvantages, which is why new concepts have been devised to satisfy the modern drainage systems' needs, such as the integral precipitation water drainage concept, green infrastructure or water sensitive urban design, which is based on the concept of constructing water sensitive urban entities that practice an integral and decentralised</p>

	<p>approach to drainage and that protect and reuse water resources. In addition to these sustainability concepts, modern technical solutions should be applied in designing the drainage system and the existing, inadequate drainage systems should be replaced with modern ones. The City of Zagreb Development Strategy identified <i>Climate change effects on parts of the existing drainage system</i> as a development problem. The existing surface water drainage system should be analysed and measures aimed at retaining precipitation water as close as possible to the place where it congregates should be proposed.</p>
--	---

8.5 Spatial planning and land management

Urban and spatial planning holds a key role in infrastructure development. Climate resistant infrastructure is not only limited to technical design, but it also encompasses quality spatial planning, i.e. the selection of the location and, potentially, of the required compensatory measures. Analyses of options regarding possible climate change effects on individual locations are extremely important. The wiring and piping can be situated differently, as a result of the local climate effects, without generating additional expenses for investors. Green infrastructure and other protective measures can significantly contribute to increased resistance to climate change effects, which is why the possibilities for increasing the share of green infrastructure should be analysed. Green infrastructure generally requires low starting investment and it generates low maintenance costs. If it is properly planned and executed, green infrastructure offers numerous benefits, for instance, it reduces the heat island effect, contributes to buildings' energy efficiency, affects human health positively and it contributes to the reduction in greenhouse gas emissions.

Measure no	20
Measure/activity	Integration of the green infrastructure concept into spatial and strategic planning processes
Activity promoter	<ul style="list-style-type: none"> • City Institute for Physical Planning.
Implementation partners	<ul style="list-style-type: none"> • City Office for the Strategic Planning and Development of the City; • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • City Office for Economy, Energetics and Environment Protection; • City Institute for the Conservation of Cultural and Natural Heritage; • Regional Energy Agency (REGEA); • Croatian Meteorological and Hydrological Service.
Other involved stakeholders	<ul style="list-style-type: none"> • Civil society associations.
Start/end of implementation (year)	2020 – 2030
Cost estimate (per unit or overall per measure)	500,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • Environmental Protection and Energy Efficiency Fund (FZOEU); • EU programmes.
Short description / comment	<p>The green infrastructure concept must be integrated into the spatial planning processes. When amending the documents such as the City of Zagreb Development Strategy and the City of Zagreb Spatial Plan, as well as when drafting general urban development plans, special attention should be paid to green infrastructure, as an element of spatial organisation.</p> <p>The goal of this measure is to strategically plan and systematically develop green infrastructure in the City of Zagreb area, especially at the critical points where it is underdeveloped, primarily in order to reduce the effect of the existing and prevent the occurrence of new heat islands in the City of Zagreb area and in</p>

	order to synchronise the development planning and infrastructure adaptation with the predicted climate change effects. The green infrastructure elements should be integrated by means of special construction conditions included in the process of permit issue.
--	--

Measure no	21
Measure/activity	Analysis of the possibilities for mitigating the urban heat island effect in the City of Zagreb by using green infrastructure
Activity promoter	<ul style="list-style-type: none"> • City Institute for Physical Planning.
Implementation partners	<ul style="list-style-type: none"> • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • City Office for the Strategic Planning and Development of the City; • City Office for Agriculture and Forestry; • Zagrebački holding d.o.o. – the Zrinjevac branch; • City Office for Economy, Energetics and Environment Protection; • Regional Energy Agency (REGEA).
Other involved stakeholders	<ul style="list-style-type: none"> • Croatian Meteorological and Hydrological Service; • University of Zagreb; • Andrija Štampar Teaching Institute of Public Health.
Start/end of implementation (year)	2020 – 2022
Cost estimate (per unit or overall per measure)	1,000,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • Environmental Protection and Energy Efficiency Fund (FZOEU); • EU programmes.
Short description / comment	<p>An urban heat island is a phenomenon characterised by significantly higher air temperature in an urban area than in its adjacent rural area.</p> <p>The urban heat island effects pose some of the most serious environmental problems in cities since they cause multiple negative consequences, such as overheated surfaces, climate conditions unpleasant for citizens, increased health risks brought on by high temperatures, increase in water demand and electricity consumption etc. Considering the fact that the urban population is growing fast, two significant consequences which should be addressed occur. Firstly, cities are becoming larger, which increases their impact on urban climate. Secondly, as the urban population grows, the number of people exposed to negative urban heat island effects is increasing.</p> <p>The goal of this measure is to identify the critical urban heat island areas and to plan the implementation of green infrastructure in order to mitigate the urban heat island effect.</p> <p>The first phase of the measure consists of an analysis of the urban areas which exhibit the most intense heat island effects and of an estimate of the areas which would become the most vulnerable in the future, considering the expected changes in climate parameters. The next step, depending on the results of the analysis, would consist of conducting a feasibility study and cost benefit analysis for the implementation of green infrastructure aimed at mitigating the urban heat island effects. The study should be comprehensive and result in specific solutions regarding the construction of green infrastructure, the type of green infrastructure and the method of its maintenance.</p>

Measure no	22
Measure/activity	Carrying out specific measures of construction of green infrastructure at the critical points and monitoring the effects
Activity promoter	<ul style="list-style-type: none"> • City Office for Physical Planning, Construction of the City, Utility Services and Transport; • Zagrebački holding d.o.o. – the Zrinjevac branch.
Implementation partners	<ul style="list-style-type: none"> • City Office for Health; • City Office for the Local Self-Administration; • City Office for Economy, Energetics and Environment Protection; • Regional Energy Agency (REGEA).
Other involved stakeholders	<ul style="list-style-type: none"> • University of Zagreb; • Andrija Štampar Teaching Institute of Public Health.
Start/end of implementation (year)	2022 – 2030
Cost estimate (per unit or overall per measure)	The costs shall be estimated within the scope of measure 22.
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • Zagrebački holding d.o.o.; • Environmental Protection and Energy Efficiency Fund (FZOEU); • EU programmes; • European structural and investment funds.
Short description / comment	The goal of this measure is to install green infrastructure in the areas affected by urban heat island effects in order to mitigate those effects. The selected vegetation should be highly resistant to climate change, in addition to having an adaptive effect. The condition of the green infrastructure should be continuously monitored. If necessary, interventions should be made and the implementation should be modified.

8.6 Environment and biodiversity

Environment and biodiversity represent important property on the basis of which the local community develops tourism and the preconditions for a pleasant life for its citizens. The term biodiversity encompasses plant and animal species in a specific habitat. It is especially vulnerable to climate change. The importance of biodiversity is also mirrored in impacts on agriculture.

The risks which affect the environment and biodiversity sustainability can be divided into the following groups:

- Habitat loss;
- Increase in the share of invasive species;
- Extinction of indigenous plant and animal species;
- Change in the ratio of habitat types;
- Loss of certain habitat types.

Measure no	23
Measure/activity	Analysis of possibilities and drafting of the plan for increasing the share of green surfaces and corridors (habitat aspect)
Activity promoter	<ul style="list-style-type: none"> • City Institute for the Conservation of Cultural and Natural Heritage.
Implementation partners	<ul style="list-style-type: none"> • City Office for Agriculture and Forestry; • City Institute for Physical Planning; • Public Institution Nature Park Medvednica; • Public Institution Maksimir.
Other involved stakeholders	<ul style="list-style-type: none"> • University of Zagreb; • Zagrebački holding d.o.o. – the Zrinjevac branch.
Start/end of implementation (year)	2020 – 2030
Cost estimate (per unit or overall per measure)	1,000,000 kuna

Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • EU programmes.
Short description / comment	<p>Green surfaces often fall victims to urban infrastructure expansion, which causes the fragmentation of natural habitats, some of which are contained to areas surrounded by buildings and traffic infrastructure. Environmental corridors, or links between green surfaces, have been recognised as a method for diminishing the fragmentation effect. New green surfaces and corridors can be formed in most urban areas. An array of techniques which enable green corridors to be implemented in areas with different characteristics, even when the area is limited (e.g. green roofs and facades), exists. An analysis of possibilities should be conducted and a plan for increasing the share of green surfaces and green corridors should be drafted. This measure is connected to some measures from the building sector and spatial planning areas, with the difference here being that environmental indicators (e.g. the occurrence and the number of specific species) should be monitored.</p>

Measure no	24
Measure/activity	Establishing a system for adaptive natural habitat management
Activity promoter	<ul style="list-style-type: none"> • City Institute for the Conservation of Cultural and Natural Heritage.
Implementation partners	<ul style="list-style-type: none"> • City Office for Agriculture and Forestry; • City Institute for Physical Planning; • Public Institution Nature Park Medvednica; • Public Institution Maksimir.
Other involved stakeholders	<ul style="list-style-type: none"> • University of Zagreb.
Start/end of implementation (year)	2020 – 2030
Cost estimate (per unit or overall per measure)	500,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • EU programmes (LIFE).
Short description / comment	<p>Biodiversity is of key importance to the economy and the welfare of the humanity, but the greatest threat to environment is its loss. Preserving biodiversity and maintaining the levels of natural capacities are among the international priorities. Climate change is already affecting biodiversity and is expected to become the largest threat to biodiversity in this century. The direct climate change effects on biodiversity include:</p> <ul style="list-style-type: none"> • Changes in the number and distribution of species; • Changes of habitats inhabited by certain species; • Phenological changes which can lead to breaks in relationships between species; • Changes in the composition of communities; • Changes in ecosystem processes and the functioning of ecosystems; • Loss of habitat and ecosystem space. <p>Adaptive ecosystem management is an inclusive process which encompasses monitored activities, as well as an understanding of the potential climate effects and connected uncertainties, planning of activities aimed at combating climate change effects, monitoring the species vulnerable to climate change and evaluating management efficiency.</p>

8.7 Agriculture and forestry

Agriculture and forestry are exposed to the risk of change in climate parameters. Agriculture is directly vulnerable to weather conditions, that is, to climate change. The intensity of the physical and (bio)chemical processes taking place in the ground, plants and domestic animals is largely dependent on the moisture/water in the soil and air temperature.

The risks can be divided in the following groups:

- Increased frequency of wildfires;
- Reduced availability of arable surfaces;
- Negative extreme weather event effects on woodland communities;
- Lack of irrigation water;
- Reduction in woodland biomass availability;
- Increase in forest management costs;
- Disturbance of the natural structure of woodland communities.

Measure no	25
Measure/activity	Increasing the area of the surfaces intended for urban gardening activities
Activity promoter	<ul style="list-style-type: none"> • City Office for Agriculture and Forestry.
Implementation partners	<ul style="list-style-type: none"> • City Office for the Strategic Planning and Development of the City; • City Institute for Physical Planning; • City Office for Economy, Energetics and Environment Protection.
Other involved stakeholders	<ul style="list-style-type: none"> • University of Zagreb; • Zagrebački holding d.o.o. – the Zrinjevac branch; • Civil society associations; • Citizens.
Start/end of implementation (year)	2020 – 2030
Cost estimate (per unit or overall per measure)	1,000,000 kuna per annum
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • EU programmes.
Short description / comment	<p>Surfaces intended for urban gardening contribute to climate change adaptation, unlike concrete and asphalt surfaces. Additional adaptation is achieved by introducing drought resistant species. Other contributions to climate change adaptation include:</p> <ul style="list-style-type: none"> • Increased soil capacity for water infiltration, brought on by increased presence of vegetation and resulting in better adaptation to future needs, exemplified in precipitation water runoff during storms; • Plants and trees generate a cooling effect in their environment by providing shade, increasing evapotranspiration and transforming sunlight into vegetational material in the photosynthesis processes; • Reduced need for irrigation brought on by using drought resistant plants; • Increased resistance to drought, caused by increased underground water levels brought on by the increased water infiltration capacity; • Urban agriculture and gardening attract various animal species, thereby enriching the local biodiversity. Gardens are also used as recreational areas and public meeting places, which improves the environmental qualities of urban areas. <p>This measure exemplifies continuous good practice in the City of Zagreb and it should be further developed by increasing the area of surfaces intended for urban gardening, educating citizens on</p>

	the benefits of urban gardening and raising citizen awareness of and interest for engaging in urban gardening, not only for food production, but also for the purpose of preserving biodiversity and reducing the negative climate change effects.
--	--

Measure no	26
Measure/activity	Adapting the fire protection plans to climate change effects
Activity promoter	<ul style="list-style-type: none"> • City Office of Emergency Management.
Implementation partners	<ul style="list-style-type: none"> • City Office for the Strategic Planning and Development of the City; • City Institute for Physical Planning; • City Office for Economy, Energetics and Environment Protection.
Other involved stakeholders	<ul style="list-style-type: none"> • University of Zagreb; • Civil society associations; • Citizens.
Start/end of implementation (year)	2020 – 2030
Cost estimate (per unit or overall per measure)	500,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • EU programmes.
Short description / comment	The increased frequency of wildfires is directly caused by climate change, specifically by the reduction in frequency and amount of precipitation and by extreme heat waves, which generates the need for conducting an analysis of the existing fire protection plans, on the basis of which those plans should be upgraded.

8.8 Healthcare sector

The healthcare sector is especially important when it comes to monitoring the climate change effects on the local community. Climate change is going to affect citizen health, which is why it is extremely important to plan activities aimed at protecting it. Climate change is going to cause new health risks and increase the intensity of the existing health issues. Human, animal and plant health is expected to be affected both directly and indirectly. The direct effects are going to be caused by changes in the intensity and frequency of extreme weather events, such as extreme heat waves and floods. The indirect effects are going to include the changes in the occurrence of diseases transmitted vectorially (e.g. diseases transmitted by arthropods such as mosquitoes and ticks) or by rodents, as well as the occurrence of changes in the water, food and air quality.

The risks can be divided in the following groups:

- Negative effects on human health, caused by high temperatures;
- Increase in the frequency of diseases caused by climate change.

Measure no	27
Measure/activity	The City of Zagreb area microclimate modelling
Activity promoter	<ul style="list-style-type: none"> • City Office for the Strategic Planning and Development of the City.
Implementation partners	<ul style="list-style-type: none"> • City Office for Health; • City Office for Economy, Energetics and Environment Protection.
Other involved stakeholders	<ul style="list-style-type: none"> • Croatian Meteorological and Hydrological Service; • Andrija Štampar Teaching Institute of Public Health.
Start/end of implementation (year)	2020 – 2022
Cost estimate (per unit or overall per measure)	400,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • European structural and investment funds.
Short description / comment	<p>The goal of this measure is to improve insights into the current and future City of Zagreb area microclimate in order to facilitate the evaluation of the implementation of measures aimed at climate change adaptation in the area of heat wave protection and the predictive analytics of other extreme weather events. The microclimate conditions should be modelled for specific reference periods, on the basis of the available data and trends. Climate models will largely expedite the planning of other activities aimed at climate change adaptation, as well as provide the data on the basis of which research and project documentation for various areas can be drafted.</p>

Measure no	28
Measure/activity	Implementing the Protocol on Heat Protection Measures and Guidelines
Activity promoter	<ul style="list-style-type: none"> • City Office for Health.
Implementation partners	<ul style="list-style-type: none"> • City Office of Emergency Management; • City of Zagreb Teaching Institute of Emergency Medicine; • Polyclinic for Prevention of Cardiovascular Diseases and Rehabilitation "Srčana"; • Red Cross branch of the City of Zagreb; • Andrija Štampar Teaching Institute of Public Health. • Healthcare and social institutions; • Education institutions; • Croatian Institute of Public Health; • Ministry of Health; • World Health Organisation Country Office in Croatia; • Associations.

Other involved stakeholders	<ul style="list-style-type: none"> • Croatian Meteorological and Hydrological Service; • ZET d.o.o; • City of Zagreb Tourist Board.
Start/end of implementation (year)	2020 – 2030
Cost estimate (per unit or overall per measure)	1,000,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • European structural and investment funds.
Short description / comment	<p>The goal of this measure is to reduce the risks for the population by implementing the measures aimed at mitigating heat wave effects that are defined by the Protocol on Heat Protection Measures and Guidelines.</p> <p>In order to reduce the risks for the population, the following measures aimed at mitigating heat wave effects should be planned:</p> <ul style="list-style-type: none"> • The system for early heat wave warning should be upgraded in order to expedite the flow of information to all social groups; • Persons who require help should be provided with increased care (by family, neighbours, social services); • Staff caring for the elderly should receive special training; • Vulnerable groups of citizens (children, pregnant women, the elderly, chronic patients etc.) should receive special care; • Persons at increased risk or those who require special help should be identified (chronic patients, single persons); • The availability of human resources and healthcare facility capacities in case of a heat wave should be determined; • The urban public transport should be adapted to heat waves by organising more frequent and free lines during heat waves in order to protect citizen health, as well as by ensuring air conditioning in public transport vehicles and sun protection at the stops; • Sources of free drinking water should be installed in frequented public places so that they could be used during heat waves; • The UV index meter network in the City of Zagreb area should be improved; • UV index values should be shown in public transport vehicles, along with the recommended sun protection factors; • The citizens should be educated on healthy behaviour in the sun – teaching materials should be designed in English and Croatian in collaboration with professional associations and the City of Zagreb Tourist Board; • Public health preventive examinations of nevi and skin should be provided in order to prevent malignant skin tumours.

Measure no	29
Measure/activity	Conducting an analysis of the correlation between the increased frequency of diseases and climate change
Activity promoter	<ul style="list-style-type: none"> • City Office for Health.
Implementation partners	<ul style="list-style-type: none"> • City of Zagreb Teaching Institute of Emergency Medicine; • Polyclinic for Prevention of Cardiovascular Diseases and Rehabilitation “Srčana”; • Andrija Štampar Teaching Institute of Public Health.
Other involved stakeholders	<ul style="list-style-type: none"> • Croatian Institute of Public Health;

	<ul style="list-style-type: none"> • Ministry of Health; • Healthcare institutions; • Croatian Meteorological and Hydrological Service.
Start/end of implementation (year)	2020 – 2030
Cost estimate (per unit or overall per measure)	500,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • European structural and investment funds.
Short description / comment	The goal of this measure is to conduct a comprehensive analysis of the correlation between the increased frequency of diseases and climate change, as well as to provide recommendations for mitigating the diseases exacerbated by climate change. All the relevant stakeholders should be involved in the analysis and the results should be timely communicated in order to expedite the process of planning the activities aimed at system preparation.

8.9 Civil protection and crisis situations

Civil protection is the fundamental effort in protecting the local community from extreme conditions. The identified risk caused by climate change can be described as follows:

- Increase in the need for drafting civil protection troops due to extreme weather events.

Measure no	30
Measure/activity	Planning and construction of safe points intended for use in case of extreme meteorological conditions
Activity promoter	<ul style="list-style-type: none"> • City Office of Emergency Management.
Implementation partners	<ul style="list-style-type: none"> • City Office for Health; • City Institute for Physical Planning; • City Office for the Strategic Planning and Development of the City; • City Office for Physical Planning, Construction of the City, Utility Services and Transport.
Other involved stakeholders	<ul style="list-style-type: none"> • Andrija Štampar Teaching Institute of Public Health; • Croatian Meteorological and Hydrological Service.
Start/end of implementation (year)	2020 – 2025
Cost estimate (per unit or overall per measure)	Detailed construction costs are going to be available after the analysis has been conducted. Basic analysis cost – approximately 250,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • European structural and investment funds.
Short description / comment	Microclimate modelling and other analytic documents should provide an overview of the areas in the City of Zagreb most vulnerable to extreme weather events, by type and frequency. The goal of this measure is to plan and construct safe points which would provide citizens with protection and/or reduce the potential consequences to health and safety during extreme weather events.

Measure no	31
Measure/activity	Developing a model for predicting the risk of landslides on the basis of precipitation prognosis and the existing landslide maps
Activity promoter	<ul style="list-style-type: none"> • City Office of Emergency Management.
Implementation partners	<ul style="list-style-type: none"> • City Office for Physical Planning, Construction of the City, Utility Services and Transport.
Other involved stakeholders	<ul style="list-style-type: none"> • Croatian Meteorological and Hydrological Service; • University of Zagreb.

Start/end of implementation (year)	2020 – 2023
Cost estimate (per unit or overall per measure)	500,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • European structural and investment funds.
Short description / comment	<p>The goal of this measure is to develop a system for modelling the probability of landslide occurrence on the basis of static and dynamic data. Static data is derived from cartographic overviews of landslide susceptibility and limit values of critical precipitation. Dynamic data implies real-time predictions of precipitation on the basis of a suitable meteorological model, with an overview of data in the Geographic Information System (GIS). The model of the prognosis of the temporal probability of landslides also should result in a cartographic overview of the temporal probability in a GIS of an adequate resolution. Development of a model which would enable data updates several times a day in order to facilitate landslide probability 24 hours in advance is being planned. The prognosis should come in the form of a description of intensity of the landslide risk, e.g. “very low”, “low”, “medium”, “high” and “very high”, along with a diagram of the data which can be seen via a web application. The model should support potential integration with the early warning system. The ultimate objective consists in producing a dynamic landslide risk prognosis 24 hours in advance, one which would be daily updated and available via an Internet site and the “MojZagreb” application, in order to provide landslide risk data for the hilly and mountainous areas of the City of Zagreb. The primary users of such prognosis would be the civil protection systems (e.g. the City Office of Emergency Management).</p>

8.10 Economy and tourism

Tourism has been identified as one of the sectors which are extremely vulnerable to climate change. The tourism sector is facing new demands for maintaining the quality level, as a consequence of climate change. Some of the ways climate change affects tourism include: increased energy demand due to the need for maintaining the equal level of comfort, brought on by temperature extremes; increased frequency of medical interventions; impact on the appeal of tourist sites and content (air pollution, negative effects on biodiversity and natural landscape maintenance).

Measure no	32
Measure/activity	Encouraging entrepreneurship and the founding of economic operators involved in climate change, energy efficiency, ecological production and sustainable development sectors
Activity promoter	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection.

Implementation partners	<ul style="list-style-type: none"> • Regional Energy Agency (REGEA); • Zagrebački inovacijski centar d.o.o.
Other involved stakeholders	<ul style="list-style-type: none"> • University of Zagreb.
Start/end of implementation (year)	2020 – 2030
Cost estimate (per unit or overall per measure)	Yearly programmes are going to determine the specific cost.
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • European structural and investment funds; • EU programmes; • European Institute of Innovation & Technology – Climate Knowledge and Innovation Community (EIT Climate KIC).
Short description / comment	<p>The activity of encouraging entrepreneurship and the founding of economic operators involved in climate change, energy efficiency, ecological production and sustainable development sectors is a catalyst of sorts for the transition of a carbon society to a sustainable one. Therefore, it is vital to encourage innovations in this area, enable them to be applied in the real sector and to encourage the founding of economic operators which promote the welcome social changes. Thereby, a sustainable image of the city and economic prosperity are being advertised.</p> <p>This measure includes the following activities:</p> <ul style="list-style-type: none"> • Developing a subsidy system / system for innovation tenders – such systems would solve the City of Zagreb priority matters regarding climate change; • Introducing new measures for encouraging start-ups involved and innovating in the field of climate change into the working programmes of the Zagreb Innovation Centre; • Developing subsidies for economic operators involved in sustainability activities.

Measure no	33
Measure/activity	Increasing the tourism sector's climate change resistance
Activity promoter	<ul style="list-style-type: none"> • City of Zagreb Tourist Board.
Implementation partners	<ul style="list-style-type: none"> • City Office for Health; • City Office for Economy, Energetics and Environment Protection; • Andrija Štampar Teaching Institute of Public Health.
Other involved stakeholders	<ul style="list-style-type: none"> • Croatian Chamber of Economy – The Zagreb Chamber.
Start/end of implementation (year)	2020 – 2030
Cost estimate (per unit or overall per measure)	500,000 kuna per annum
Possible sources of funding	<ul style="list-style-type: none"> • City of Zagreb Tourist Board; • Budget of the City of Zagreb; • State budget; • European structural and investment funds.
Short description / comment	<p>Tourism has been identified as one of the sectors which are extremely vulnerable to climate change. The tourism sector is facing new demands for maintaining the quality level, as a consequence of climate change. Some of the ways climate change affects tourism include: increased energy demand due to the need for maintaining the equal level of comfort, brought on by temperature extremes; increased frequency of medical interventions; impact on the appeal of tourist sites and content (air pollution, negative effects on biodiversity and natural landscape maintenance).</p> <p>This measure includes the following activities:</p> <ul style="list-style-type: none"> • Tourism employees should be educated on possible climate change effects on tourism in order to be timely prepared;

	<ul style="list-style-type: none"> • Infrastructure facilitating comfort at city surfaces should be constructed (e.g. installing drinking water points along frequented tourist routes or evaporative coolers); • Developing multilingual educational brochures with recommendations for healthy behaviour in the sun.
--	--

8.11 Other

Measure no	34
Measure/activity	Educating and informing on climate change, energy efficiency and sustainability – using the “MojZagreb” portal
Activity promoter	<ul style="list-style-type: none"> • City Office for Economy, Energetics and Environment Protection.
Implementation partners	<ul style="list-style-type: none"> • City Office for Education; • City Office for Physical Planning, Construction of the City, Utility Services and Transport.
Other involved stakeholders	<ul style="list-style-type: none"> • Ministry of Environmental Protection and Energy; • Environmental Protection and Energy Efficiency Fund (FZOEU).
Start/end of implementation (year)	2021 – 2025
Cost estimate (per unit or overall per measure)	350,000 kuna
Possible sources of funding	<ul style="list-style-type: none"> • Budget of the City of Zagreb; • State budget; • European structural and investment funds; • Education institutions.
Short description / comment	<p>The goal of this measure is to design educational materials available to the public via the “MojZagreb” portal and the supporting promotional campaigns, in order to popularise the portal.</p> <p>The “MojZagreb” portal is the focal point of access to all services that the City of Zagreb offers to its citizens. It was designed as the main digital information hub intended for simplifying the communication between citizens and the public utility department. Therefore, the portal possesses the potential for facilitating dissemination and educational activities from the climate change adaptation area.</p> <p>This measure overlaps and is in synergy with measures 1, 2 and 3 from the Climate change mitigation chapter.</p> <p>The portal should be developed and improved, as should a connected mobile application, which would, in addition to the existing tools, provide:</p> <ul style="list-style-type: none"> • Information on the condition of climate parameters; • Information on the occurrence of extreme weather conditions; • Information on the location of occurrence of extreme climate conditions, via the digital maps of the City of Zagreb which are already available on the portal; • Integration of the Zagreb Ecomap and the data collected by the Andrija Štampar Teaching Institute of Public Health into the “MojZagreb” portal (https://ekokartazagreb.stampar.hr/); • Warning notifications from the mobile application in case of upcoming extreme climate conditions and information on extreme condition forecast for the week, change in air quality, change in water quality and on the occurrence of high concentrations of pollen; • Advice to citizens on the matters regarding climate change adaptation (one-stop shop information service).

9 ESTIMATE OF CO₂ EMISSION REDUCTION GENERATED BY THE OUTLINED MEASURES FOR 2030

9.1 Introductory considerations

Projections of movements of energy consumption and emissions for 2030 have been generated in two scenarios, *with* and *without* the implementation of the measures, in order to facilitate the estimate of CO₂ emission reduction for 2030 generated by the energy efficiency measures for the building, traffic and public lighting sectors of the City of Zagreb, which were outlined in the preceding chapter.

The LEAP software was used in developing the scenarios, as were the methodology described in Chapter 3 – Methodology and the assumptions outlined and explained in *Annex 3 – Assumptions used in modelling scenarios for the City of Zagreb SECAP for the period up to 2030*. The scenario without implementing the measures is the default, business-as-usual (BAU) scenario which predicts an increase in energy consumption, which has been exposed to market developments and consumer habits, caused by the absence of systematic implementation of energy efficiency measures, but one which also accounts for the use of new, technologically advanced products, as they appear on the market.

The scenario which accounts for the implementation of the measures predicts a reduction in energy consumption and the accompanying CO₂ emissions by 2030, caused by said implementation of the identified measures aimed at mitigating and adapting to climate change.

The sectorial CO₂ emission projections are elaborated in *Annex 9 – Estimate of CO₂ emission reduction by 2030, generated by the outlined measures – by sectors*, whereas the complete summary overview of the sectorial CO₂ emission projections follows below.

9.2 Overall CO₂ emission projections

Emission projections have been made for the three end-consumption sectors of the City of Zagreb: traffic, building and public lighting sector. Emission factors identical to those used for the Baseline Emission Inventory were used for the projections, although the factors for determining the indirect CO₂ emissions vary annually, depending on the manner of production of electricity and heat energy. The fact that the Energy Development Strategy of the Republic of Croatia anticipates the construction of two coal-based thermal power plants and one gas power plant by 2020 was not taken into consideration in the projecting of these emissions, which largely affects the emission factor, primarily that of electricity production.

Table 9.1 contains an overview of the overall sectorial emissions for both the scenario including the measures and the business-as-usual scenario. The building sector generates the largest share of emissions in the business-as-usual scenario, which amounts to 56%. The traffic sector generates the largest share (53.4%) of the overall emissions in the scenario which includes the implementation of the measures, whereas its share in the business-as-usual scenario amounts to 43.68%.

Table 9.1 CO₂ emission projections for the business-as-usual and the measure-inclusive scenario

Scenario	Sector	Emission, t CO ₂		%, compared to 2008
		2008	2030	
Business-as-usual scenario	Traffic	1,007,443.07	1,091,901.10	8.38
	Building sector	1,759,432.26	1,400,681.40	-20.39
	Public lighting	29,175.56	7,076.20	-75.75
	TOTAL	2,796,050.89	2,499,658.70	-10.60
Measure-inclusive scenario	Traffic	1,007,443.07	867,528.4	-13.88
	Building sector	1,759,432.26	759,888.70	-56.81
	Public lighting	29,175.56	4,119.20	-85.88
	TOTAL	2,796,050.89	1,631,536.3	-41.65

The total amount of CO₂ emissions in the business-as-usual scenario equals approximately 2,500,000 t, which is a 10.6% reduction in comparison with 2008. The business-as-usual scenario is based on the assumption that, by using new technologies and improved legislature and EU directives, the emission amounts will be reduced in comparison with the baseline year. However, in order to accomplish the indicative goal of a 40% reduction in emissions by 2030, additional effort is required.

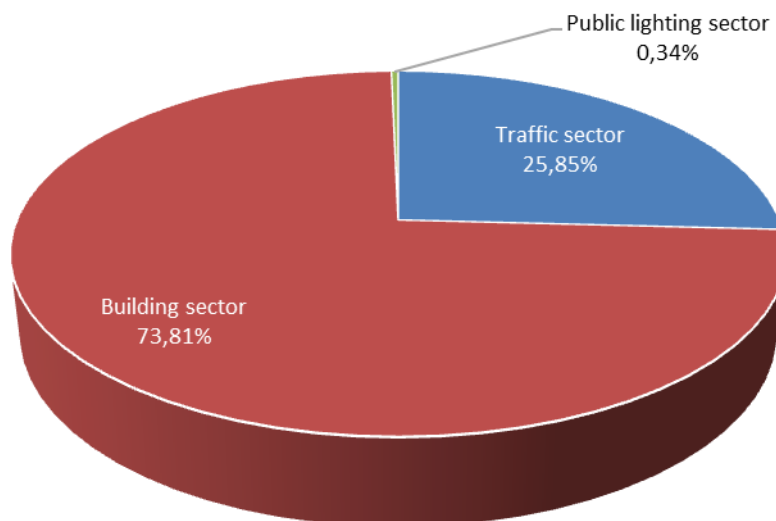
The measure-inclusive scenario projections verify that fact and indicate that the total CO₂ emissions in 2030 would amount to approximately 1,630,000 t, which means that, by implementing the measures aimed at reducing energy consumption and CO₂ emissions, a 41.65% reduction in total emissions, in comparison with the baseline year, would be achieved.

The total sectorial emission reduction potentials are outlined in Table 9.2.

Table 9.2 Total sectorial emission reduction potentials

Sector	Reduction potential	Share in overall potential, %
Traffic sector	224,381.7	25.85
Building sector	640,792.70	73.81
Public lighting sector	2,957.00	0.34
TOTAL	868,131.4	-

Distribution of the total sectorial emission reduction potential

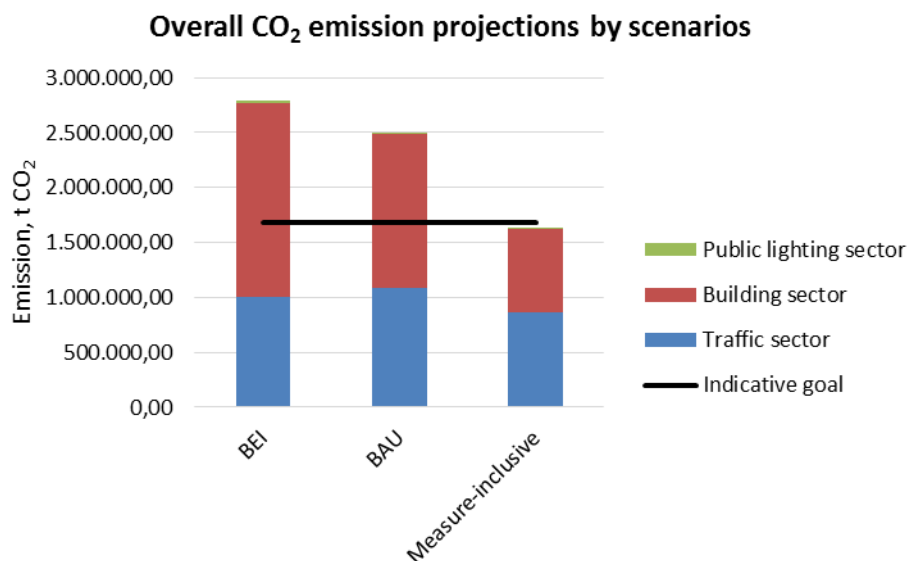


Picture 9.1 Distribution of the total sectorial emission reduction potential (%)

The outlined shares indicate that the building sector possesses the largest potential for reducing CO₂ emissions (Table 9.2 and Picture 9.1). The measure-inclusive scenario for that sector shows a 56.8% reduction in emissions in comparison with 2008. The public lighting sector emission projections indicate an 85.8% reduction, whereas the traffic sector emission projections indicate a 13.88% reduction in comparison with the baseline year. The overall emission reduction in comparison with the baseline year is projected to amount to 41.65%.

The overall potential of 2030 CO₂ emission reduction for the City of Zagreb amounts to 868,131 t. The building sector is the one with the largest potential for CO₂ emission reduction, amounting to 640,792.70 t, or a share of 73.81%. The emission reduction potential of the traffic sector amounts to 224,381.7 t, or a share of 25.85%. The public lighting sector has the lowest share (0.34%) in relation to its total CO₂ emission reduction potential, equalling 2,957 t.

Picture 9.2 indicates the overall CO₂ emissions in 2030 for both the business-as-usual and the measure-inclusive scenario, as well as a comparison with the 2008 emission and the indicative goal.



Picture 9.2 Overall CO₂ emission projections by scenarios

The proposed indicative CO₂ emission reduction objective for 2030 consists in a 40% reduction of emissions in comparison to 2008, or a reduction in the amount of 1,118,420.36 t. According to the set objective, the total 2030 CO₂ emissions should amount to 1,677,630.534 t. That objective is represented by the black line in Picture 9.2.

The overall measure-inclusive scenario emission projections for 2030 amount to 1,631,536.3 t, or 46,094.23 t below the set goal.

Education, promotion and measures aimed at behaviour change were excluded from the scenario calculations since the Ordinance on the System for Monitoring, Measuring and Verifying Energy Savings (Official Gazette no 71/15) does not encompass savings calculations on the basis of those measures. However, some sources, including the Covenant of Mayors for Climate and Energy Reporting Guidelines, estimate that these measures will annually generate additional 5% of the savings, in comparison with the previous energy consumption data. The climate change adaptation measures have not been quantified with regards to energy savings and greenhouse gas emission reduction, but they do contribute to those goals. Therefore, it can be surmised that the actual potential of energy savings and greenhouse gas emission reduction is even larger than was calculated, regarding the increase in energy efficiency.

9.3 Conclusion

By signing the Covenant of Mayors for Climate and Energy, the City of Zagreb entered the European initiative for reducing greenhouse gas emissions and accepted the indicative goal of a 40% reduction in CO₂ emissions (1,677,630,534 t) by 2030, in comparison with 2008.

With the help of the LEAP software and by using the methodology explained in Chapter 3, projections of movements of energy consumption and emissions for 2030 have been generated in two scenarios, *with* and *without* the implementation of the measures, in order to facilitate the estimate of CO₂ emission reduction for 2030 generated by the energy efficiency measures for the building, traffic and public lighting sectors of the City of Zagreb. Climate change adaptation measures have been comprehensively dealt with for the first time in this document. The very proposal of measures clearly indicates that numerous research and analytic activities need to be carried out in order to gain a quality basis for specific periods.

Climate change adaptation measures were not included in the projections of energy savings and CO₂ emission reduction scenarios since the methodology has not been ascertained for these measures, but they definitely contribute to the set goals. Considering the fact that methods for monitoring CO₂ emissions, for certain adaptation measures, will be devised on the basis of some of the suggested measures, the additional savings will be monitored in the monitoring period and will be presented in the reports, accordingly. Education, promotion and measures aimed at behaviour change were excluded from the scenario calculations since the Ordinance on the System for Monitoring, Measuring and Verifying Energy Savings (Official Gazette no 71/15) does not encompass savings calculations on the basis of those measures. However, some sources, including the Covenant of Mayors for Climate and Energy Reporting

Guidelines, estimate that these measures will annually generate additional 5% of the savings, in comparison with the previous energy consumption data.

The conducted analyses indicate that the business-as-usual scenario CO₂ emissions amount to 2,499,658.70 t, that is, 822.03 kt or 49% over the suggested indicative objective, meaning that the suggested goal will not be accomplished without implementing the measures.

The measure-inclusive scenario projections verify that fact and indicate that the total CO₂ emissions in 2030 would amount to 1,631,536.3 t, which means that, by implementing the measures aimed at reducing energy consumption and CO₂ emissions, a 41.65% reduction in total emissions, in comparison with the baseline year, would be achieved.

By implementing all the suggested measures, the 2030 CO₂ emission would exceed the objective by 2.75%, or 46,094.23 t.

10 MECHANISMS FOR FINANCING OF THE IMPLEMENTATION OF THE SUSTAINABLE ENERGY AND CLIMATE ACTION PLAN

10.1 Overview of the possible sources of financing

The implementation of the identified measures will require significant funding. The overview of the potential sources of financing the implementation of the measures referred to in this Action Plan generally encompasses three categories of financial instruments:

- Financial instruments and models available in the Republic of Croatia today;
- Financial instruments and models available in the European Union today, but which have not been used in Croatia;
- Innovative financial models developed in order to satisfy the needs of implementation of certain Action Plan measures.

Table 10.1 contains an overview of the possible sources of funding which the City of Zagreb has at its disposal in order to successfully implement the measures.

Table 10.1. Overview of the possible sources of funding of measures and activities

Source of funding	Type	Maximal amount	Share in total cost, %
City Budget	City funds	-	100
National energy efficiency renovation programmes	Grants / credit facilities	Not determined	Up to 95
Environmental Protection and Energy Efficiency Fund	Grants	Not determined	Up to 80
ESIF	Grants	Separately determined per individual specific objectives – the rest contained in the 2014 – 2020 perspective, potential funding stemming from the 2021 – 2027 perspective	Up to 100
European Fund for Strategic Investments (EFSI)	Security deposits	Not determined	No data available
Croatian Bank for Reconstruction and Development (HBOR)	Credit facilities	Not determined	Up to 75
European Investment Bank (EIB)	Credit facilities / security deposits	Not determined	Up to 50
European Bank for Reconstruction and Development (EBRD)	Credit facilities	5 – 230 million euros per project	Up to 35
European Energy Efficiency Fund (EEEF)	Credit facilities	Not determined	Up to 100
Western Balkans Sustainable Energy Finance Facility II (WeBSEFF II)	Grants / credit facilities	2.5 million euros	Up to 50
Horizon 2020	Grants	Up to 18 million euros	Up to 100
European Territorial Co-Operation programmes	Grants	Up to 5 million euros per project	Up to 85
EIB technical assistance mechanism ELENA	Grants	Not determined	90
Joint Assistance in Supporting Projects in European Regions	Technical assistance	-	-

(JASPERS)			
European Economic Area (EEA) and Norway Grants	Grants	103.4 million euros	Not determined
ESCO	Private capital / credit facilities	-	Up to 100
Public-private partnership (PPP)	Private capital	-	Up to 100

10.1.1 National energy efficiency renovation programmes aimed at the building sector

a. Energy efficiency renovations of public buildings

The Government of the Republic of Croatia adopted the Programme of Energy Efficiency Renovations of Public Buildings for the 2016 – 2020 Period at its session held on 2 March 2017.

The Programme is co-financed by the European Regional Development Fund, within the scope of the 2014 – 2020 Competitiveness and Cohesion Operational Programme (OPCC) Priority Axis 4 – Promoting Energy Efficiency and Renewable Energy Sources; Investment Priority 4c – Supporting energy efficiency, smart energy management and renewable energy use in public infrastructure, including in public buildings, and in the housing sector; Specific Objective 4c1 – Reduction of energy consumption of the public sector buildings. The Ministry of Regional Development and EU Funds is the Managing Authority (MA) competent in managing and implementing the OPCC.

The purpose of the Programme is a comprehensive renovation of buildings accompanied by maximal private capital investments in public buildings and further development of the energy service market. Investments which do not burden the state budget are encouraged and the ESCO model ensures the implementation of energy efficiency measures in public buildings, without added expenses to the budget. The area of the implemented energy efficiency renovations of buildings is expected to increase by between 327,000 m² and 473,000 m² and the expected accumulated primary energy savings are expected to grow by 394 GWh, to 552 GWh by 2020. The Croatian Real Estate Agency is responsible for implementing the Programme, whereas the Environmental Protection and Energy Efficiency Fund will ensure the financing and co-financing of the implementation.

According to the OPCC, 1,110,000,000 kuna has been provided by the ESIF to be used in energy efficiency renovations of public buildings by 2020, within the scope of the Ministry of Construction and Physical Planning Call for Tenders, “Energy Efficiency and Use of Renewable Energy Sources in Public Buildings”. The Call for Tenders encompasses four calls, the last of which was published in September 2018. On 4 February 2019, due to the large number of submissions, the Ministry of Construction and Physical Planning announced on its website that the Call had been closed. Information on potential re-opening of the Call was not available in the period of drafting of this document.

The funds allocated to the implementation of energy efficiency measures in the building sector within the scope of the 2021 – 2027 financial perspective will be made known after the programming process has been finished and the Operational Programmes have been approved by the European Commission. Measures planned by this document have been formed in such a way that they can easily be used in the process of programming of Operational Programmes.

b. Programme of energy efficiency renovations of family houses

On 27 March 2014, the Government of the Republic of Croatia adopted the Programme of Energy Efficiency Renovations of Family Houses for the 2014 – 2020 Period with a Detailed Plan for the 2014 – 2016 Period (Official Gazette 43/14 and 36/15). The goals of the Programme are to determine and analyse energy consumption and energy efficiency of the existing residential building stock of the Republic of Croatia, to determine the possibilities for reducing energy consumption in the existing residential buildings, to elaborate the implementation of measures aimed at encouraging energy efficiency improvements in the existing residential buildings and to evaluate the effect of those measures. The Programme was amended on 26 March 2015, wherein equal opportunities for receiving subsidies were provided to all citizens of the Republic of Croatia, the time window of the implementation of energy efficiency renovations was shortened and the implementation simplified.

The Government of the Republic of Croatia is carrying out the Programme through the Ministry of Construction and Physical Planning and the Environmental Protection and Energy Efficiency Fund, with the help of grants which enable subsidies in the amounts from 40% to 80% of acceptable costs, depending on the location of the applicant. The indicative allocation of ESI funds amounts to 20 million euros by the end of 2020, additional financial participation of the Environmental Protection and Energy Efficiency Fund is expected and, according to the Ministry of Construction and Physical Planning, calls for co-financing energy efficiency renovations of family houses should be published mid-2019. The measures elaborated in this document can serve as a basis for planning the measures and allocation in the 2021 – 2027 Operational Programme.

c. Energy efficiency renovations of multi-residential buildings

The Government of the Republic of Croatia adopted the Programme of Energy Efficiency Renovations of Multi-Residential Buildings for the 2014 – 2020 Period with a Detailed Plan for the 2014 – 2016 Period (Official Gazette 78/14) on 24 June 2014. The goals of the Programme are to determine and analyse energy consumption and energy efficiency of the existing residential building stock of the Republic of Croatia, to determine the possibilities for reducing energy consumption in the existing residential buildings, to elaborate the implementation of measures aimed at encouraging energy efficiency improvements in the existing residential buildings and to evaluate the effect of those measures.

The Programme makes the building co-owners eligible for co-financing of energy audits and certifications, drafting of project documentation for renovation projects and encompasses co-financing of measures aimed at increasing energy efficiency, i.e. energy efficiency renovations of buildings. The indicative allocation of ESIF funds amounts to 80 million euros by the end of 2020 and additional financial participation of the Environmental Protection and Energy Efficiency Fund is expected. The funds allocated to energy efficiency renovations of multi-residential buildings from the 2014 – 2020 Operational Programme Competitiveness and Cohesion have been used up. The allocation can be increased by amending the OP, but the objective now is to utilise the measures outlined in this document in order to plan the new OP in the 2021 – 2027 financial perspective.

d. Programme of energy efficiency renovations of non-residential commercial buildings

The Government of the Republic of Croatia adopted the Programme of Energy Efficiency Renovations of Non-Residential Commercial Buildings for the 2014 – 2020 Period with a Detailed Plan for the 2014 – 2016 Period (Official Gazette 98/14) on 30 July 2014. The Government of the Republic of Croatia subsidises energy efficiency renovations of building envelopes or comprehensive energy efficiency renovations through the Environmental Protection and Energy Efficiency Fund. A comprehensive renovation helps achieve the Nearly Zero Energy Building standard, which implies that such a building is highly energy efficient and produces a significant amount of energy for its own consumption from renewable energy sources (facilities for the production of energy from renewable energy sources could be located on the building or in its vicinity). The amount of funds allocated to the implementation of energy efficiency renovations of non-residential commercial buildings is not known, but the de minimis doctrine, as observed in the EU institutions, should be applied to the maximal subsidy amount (200,000 euros) for economic operators.

e. Environmental Protection and Energy Efficiency Fund (FZOEU)

The Environmental Protection and Energy Efficiency Fund, which was founded by the Environmental Protection and Energy Efficiency Fund Act (Official Gazette 107/03 and 144/12), co-finances environmental protection, energy efficiency and renewable energy source projects through numerous programmes. The funds which finance the Fund's activities are amassed from the Fund's earmarked income from:

- Environment polluter charges;
- Environmental user fees;
- Charges for burdening the environment with waste;
- Special environmental charge for motor vehicles.

Fund subsidies are awarded on the basis of adopted national programmes, that is, public calls, regarding the financial instruments which include interest-free loans, subventions, financial assistance and donations. Beneficiaries can include local and regional self-government units, companies and other legal persons, craft trades and natural persons. Upon the accession of the Republic of Croatia to the European Union, the Funds' resources became a complementary source of funding stemming from the European Structural and Investment Funds.

10.1.2 European Structural and Investment Funds (ESIF)

The European Structural and Investment Funds, which are endowed with over a third of the EU budget, serve the cohesion policy of the EU, the main goal of which is to establish an economic and social cohesion, i.e. a balanced level of development of countries and regions in the European Union.

Together with the European Regional Development Fund (ERDF), the Cohesion Fund is the most important source of funding of national infrastructure projects. A significant increase in the number of projects from the energy sector is expected to occur in the 2014 – 2020 budgetary period. It should be mentioned that the programme also anticipates special funds intended for technical preparation and drafting of project documentation which would generate a base of prepared projects submitted for co-financing.

The ESIF and the Cohesion Fund can provide co-financing in the amount of 100% of the acceptable costs, depending on the development index of the given city or municipality where the investment in

question is to be performed and depending on its financial viability. The rules for co-financing via EU funds forbid the projects that are commercially viable, i.e. generate quick returns on initial investments, to be co-financed by EU funds. On the other hand, the projects that are not likely to generate returns, but that generate positive social and environmental impact on the broader community, are considered fit for receiving EU grants.

The Republic of Croatia is divided into two NUTS II regions for the purposes of use of the ESI funds. The City of Zagreb belongs to the Continental Croatia region. The process of drafting a new NUTS II classification of the Republic of Croatia was on-going in the period of drafting of this document. Considering the level of development and according to available information, the City of Zagreb should become a separate NUTS II region. What effect that will have on project co-financing from the ESIF will be known after the new classification has officially been drafted.

A significantly more generous amount of funds (10.676 billion euros) has been allocated in the current seven-year financial perspective in comparison with the Instruments for Pre-Accession Assistance (IPA). The European Commission has adopted 11 Thematic Objectives within which every Member State has defined its priority sectorial areas for ESIF funding. Encouraging the transition towards low-carbon economy in all sectors was pointed out as one of the main thematic objectives. The Government of the Republic of Croatia anticipated the need for significant funding of projects from the energy sector in the drafting of the 2014 – 2020 Operational Programme Competitiveness and Cohesion. Project co-financing should be provided through the OPCC *Priority Axis 4 – Promoting Energy Efficiency and Renewable Energy Sources*, the total allocation of which amounts to 531,810,805 euros for the seven-year period. This priority axis consists of the following specific objectives:

- 1 Promoting energy efficiency and renewable energy use in enterprises. 100 million euros has been allocated for the implementation of this measure, which is intended for projects aimed at increasing energy efficiency and renewable energy use in the industry and service sectors.
- 2 Supporting energy efficiency, smart energy management and renewable energy use in public infrastructure, including in public buildings, and in the housing sector. 411,810,805 euros has been allocated for the implementation of this measure. Energy efficiency renovations in the public sector have been allocated 211,810,805 euros and 100 million euros has been allocated for renovations of multi-residential buildings and family houses. The remaining 100 million euros has been reserved for the projects aimed at improving the district heating and public lighting systems' energy efficiency.
- 3 Developing and implementing smart electricity distribution systems. Financial allocation for this measure, which will demonstrate the benefits of introducing smart networks in two types of cities (one with a population of over 100 thousand and one with a population of between 40 and 60 thousand), is 20 million euro.

In addition to the implementation on the national level, another system for supporting the carrying out of projects backed by operational programmes, the Integrated Territorial Investments (ITI) mechanism, was introduced with the purpose of strengthening the role of cities as the dynamos of economic development in the 2014 – 2020 period. The ITI mechanism was designed in order to simplify the implementation of activities which converge at a single territorial unit and which can be funded by three different ESI funds: the European Regional Development Fund, the Cohesion Fund and the European Social Fund.

For the purpose of expediting the planning and synchronisation of sustainable urban development and in accordance with the Act on Regional Development of the Republic of Croatia, the Zagreb Urban Agglomeration was established in 2016, with the seat being in Zagreb. The adopted Zagreb Urban Agglomeration Development Strategy enabled the financing of activities which contribute to the following thematic areas:

- Progressive cities – cities that generate economic development;
- Clean cities – cities that combat climate change;
- Inclusive cities – cities that combat poverty.

A total of 126 million euros was allocated for the implementation of the Zagreb Urban Agglomeration projects through the ITI mechanism. Of that, 55.5 million euros was allocated for the purpose of revitalising the district heating system, i.e. for the purpose of increasing energy efficiency.

The time horizon of the SECAP overlaps with both the end of the 2014 – 2020 multi-annual financial period and with the new 2021 – 2027 period. In the financing proposal part of the document, the measures were designed in such a way that the 2014 – 2020 Operational Programme Competitiveness and Cohesion funds could be used, where applicable. They were also designed as a basis for structuring and planning a new operational programme in the 2021 – 2027 perspective.

10.1.3 European Fund for Strategic Investments (EFSI)

The European Fund for Strategic Investments (EFSI) is the backbone of the Investment Plan for Europe. Its goals include solving the problematic lack of trust and investments, which have been brought on by the economic and financial crisis, and using the liquidity of financial institutions, companies and individuals at a time of increasing scarcity of public resources.

The European Commission collaborates with its strategic partner, the European Investment Bank Group. The EFSI supports strategic investments in key areas such as infrastructure, energy efficiency and renewable energy sources, research and innovations, environment protection, agriculture, digital technologies, education, health and social projects. By offering risk financing, it also aids the launching, growth and development of small businesses.

The EFSI is the EU's budgetary guarantee which protects the EIB Group from initial losses, which means that the EIB Group can provide financing for projects which carry higher risk than those it would usually finance. The independent Investment Committee applies strict criteria in deciding if a project is eligible for EFSI support. No quotas exist for sectors nor countries. Funding is based exclusively on demand.

10.1.4 Croatian Bank for Reconstruction and Development (HBOR)

The Croatian Bank for Reconstruction and Development (HBOR) was founded on 12 June 1992 by the Act on the Croatian Credit Bank for Reconstruction (Official Gazette no 33/92), with the objective of financing the reconstruction and development of the Croatian economy. The HBOR was founded and is entirely owned by the Republic of Croatia, which provides guarantees for all arising obligations. The Founder's capital, deriving from the state budget, was prescribed by the Act on the Croatian Bank for Reconstruction and Development (Official Gazette no 138/06 and 25/13) in the amount of 7 billion kuna, the payment schedule of which is determined by the Government of the Republic of Croatia.

Special HBOR facilities, the ESIF Loans for Energy Efficiency and ESIF Loans for Public Lighting, are available to local self-government units and, to some extent, to other public and social institutions. These credit facilities enable investments in energy efficient public buildings and public lighting. An ESIF public sector building energy efficiency loan can range from 100,000 kuna to 60,000,000 kuna, with a payback period of up to 14 years and a 12-month grace period. An ESIF public lighting loan can range from 500,000 kuna to 15,000,000 kuna, with a payback period of up to 10 years and a maximal grace period of 6 months. The interest rates for both types of loans range from 0.1% to 0.5% annually and the loans are processed directly by the HBOR.

10.1.5 European Investment Bank (EIB)

The European Investment Bank (EIB), founded by the Treaty of Rome in 1958, is a financial institution owned by the EU Member States, which specialises in long-term financing of projects which support the EU's development policy.

The goal of the EIB is to finance the projects which contribute to economic development and reduction in regional differences, with its main priorities being:

- Supporting the economic and cohesion policy of the EU;
- Developing the Trans-European Network (TEN);
- Supporting small- and middle-sized enterprises;
- Environment protection;
- Supporting the sustainable development of the energy sector.

The EIB's financial strength is reflected in its excellent credit rating (AAA), which also enables the EIB to obtain funds under favourable conditions. The EIB operates under non-profit principles, which is why the beneficiaries of loans can count on low capital costs and long payback periods with possible grace periods.

The services of the EIB, for both the private and public sector users, are divided into four groups:

- Granting single, intermediated or framework loans;
- Granting loan guarantees;
- Providing technical assistance via special instruments: ELENA, JASPERS;
- Financing projects via funds and special instruments: EIF, JEREMIE, JASMINE, JESSICA.

Single loans are granted for infrastructure projects from the fields of transport, energy, environment protection, industry, service activities, healthcare and education, which are financed directly by the EIB and require investments larger than 25 million euros. Loan amounts are not limited, the payback period for industry projects ranges from 5 to 12 years, whereas for the infrastructure and energy projects, it ranges from 15 to 25 years, and the EIB's standard participation equals 50% of the investment amount.

Interest rates can be fixed and variable and a grace period can be enforced regarding the payback of the principal. The loan must be secured by a bank guarantee or some other first-rate security instrument.

Intermediated loans are mainly granted to small- and middle-sized enterprises and local authorities and are intermediated by a partner bank from the investor's country. Loans range from 40,000 to 25 million euros, with the projects from the fields of industry and service activities, technology modernisation, energy savings, environment protection and infrastructure improvement being funded in their entirety. In those cases where investors cannot fulfil the minimal investment amount condition (25 million euros), a larger number of smaller projects can be grouped together and granted framework loans.

No standard documentation or survey which should be filled in are required for submitting project proposals for EIB loans. However, each project proposal needs to encompass a feasibility study, the required legal permits, technical specifications, relevant investor information, cost estimate, financial analysis and an environmental impact study. The EIB loans can be combined with funds granted by the ESIF.

10.1.6 European Bank for Reconstruction And Development (EBRD)

The European Bank for Reconstruction And Development (EBRD) was founded in 1991 as an international financial institution which helps transition countries to establish a market economy and democracy. The EBRD, whose headquarters are located in London, is owned by 61 countries and two international institutions: the EU and the EIB. Investments take place in 29 countries in Europe and Asia, including Croatia.

The beneficiaries of the funds are mainly in the private sector and unable to obtain suitable sources of financing on the market. The EBRD also closely cooperates with regional banks in financing public sector projects.

The EBRD project financing conditions are the following:

- The project must be carried out in an EBRD Member State;
- The project must have a significant market perspective;
- The investors' financial contribution must be significantly larger than the EBRD's;
- The project must contribute to local economy and private sector development;
- The project must fulfil strict financial and environmental criteria.

The EBRD regularly funds projects from the fields of agriculture, energy efficiency and energy supply, industrial production, local community infrastructure, tourism, telecommunications and transport. EBRD financing is conducted via loans and securities in the 5 to 230 million euros value range. Projects of smaller value can be financed intermediately, via private banks or special development programmes. The loan payback period ranges from one to fifteen years. The EBRD adjusts the financing conditions to the state of the region or the sector in which the project is to be carried out. The EBRD project contribution amounts up to 35%, but it can also exceed that percentage.

10.1.7 European Energy Efficiency Fund (EEEF)

The European Energy Efficiency Fund (EEEF) was founded by the European Commission on 1 July 2008 as a part of the European Energy Programme for Recovery. The Fund supports energy efficiency and renewable energy source projects, with a special stress on projects aimed at urban areas. The Fund provides all types of financial services, including medium-term and long-term loans, issue of guarantees, debt securities, letters of credit and technical assistance. The acceptable investment amount ranges from 5 to 25 million euros, with a 1:20 technical-assistance-to-capital-investment ratio. The share in co-financing the technical assistance for project preparation amounts to 100%.

The primary beneficiaries include units of local and regional self-government, but private companies and ESCO companies can also apply for EEEF funding. The initial Fund budget amounts to 265 million euros, 125 million of which is provided by the EU, 75 million by the EIB, 60 million by the Cassa Depositi e Prestiti SpA and 5 million by the Deutsche Bank, which manages the Fund. Loans granted through this Fund cannot exceed 25 million euros and project implementation must be launched within a three-year time window. The initial Fund budget is estimated to grow to 800 million euros, with private investors' and banks' contribution.

10.1.8 Western Balkans Sustainable Energy Finance Facility II (WeBSEFF II)

A new Western Balkans Sustainable Energy Finance Facility II (WeBSEFF II) was launched in 2013, on the basis of the successful Western Balkans Sustainable Energy Direct Financing Facility (WeBSEDF), founded by the EBRD in 2009. This facility is intended for granting loans to sustainable energy development projects in the Western Balkans countries and is carried out through regional partner banks (Zagrebačka banka d.d.). The Facility's budget amounts to 75 million euros and it is open to both private

and public sector investors. The EU provides the WeBSEFF II with 11,5 million euros worth of grants intended for technical and consulting assistance to the investors, as well as for those projects aimed at achieving significant energy savings.

Incentives in the form of a reduction of the loan principal are approved if the project achieves:

- A 20% reduction in CO₂ emissions by investing in new, energy efficient equipment;
- A 30% reduction in energy consumption achieved through renovations of existing buildings;
- A 15-year investment return period and an internal rate of return of over 10% (for renewable energy source projects).

Project consultants evaluate the cost effectiveness of the investment. Only the projects that are financially sustainable in the long-term are to be selected. The consultants evaluate the compliance of the project with the set criteria and the potential reduction in CO₂ emissions and they provide consulting assistance.

10.1.9 Programmes and special support instruments of the European Union

a. Horizon 2020

The Horizon 2020 is a framework programme for the 2014 – 2020 period which serves the purpose of funding research and innovation projects that were carried out via the Intelligent Energy Europe (IEE) programme and the Seventh Framework Programme (FP7) until 2013. The fundamental goal of the Horizon 2020 is to decrease the European innovation and research gap in comparison with the USA, Japan and China, as well as to reduce further fragmentation of European research and innovations through a more efficient management of funds. The programme should also solve some of the most obvious inadequacies of the existing FP7 and IEE programmes, such as introduce a simplified administrative procedure and financial monitoring of projects. Strong support is also being given to focusing research on societal challenges in the EU, such as climate change, energy security and efficiency, population ageing and efficient use of resources without negative consequences for the environment.

The seven-year period Horizon 2020 budget totals 80 billion euros and is allocated in accordance with the programme's priorities:

- Strengthening research and scientific capacities of the EU (24.6 billion euros);
- Technological development and innovations in the industry sector and simplifying access to sources of financing for small- and middle-sized enterprises (13.7 billion euros);
- Solving societal problems related to climate change, energy supply security, sustainable transport, agriculture and citizen health (31.8 billion euros).

By combining scientific and research activities with incentives for the industry and entrepreneurs, development and commercialisation projects have been unified for the first time, with the goal of bridging the gap between these two sectors.

b. European Territorial Co-Operation programmes

The European Territorial Co-Operation programmes were launched for the purpose of developing partnership in sectors of strategic importance, in order for the territorial, economic and social integration process to be improved and to achieve regional cohesion, stability and competitiveness. The programmes are funded by the ERDF and the Instruments for Pre-Accession Assistance (IPA), depending on whether the applicant is from an EU Member State or not.

The European Territorial Co-Operation programmes are grouped into:

- Cross-border cooperation programmes;
- Transnational cooperation programmes;
- Interregional programmes.

Until 2013, the partners located in the City of Zagreb were able to participate in two transnational programmes: the MED Programme and the South East Europe Transnational Cooperation Programme. The current programme period (2014 – 2020) encompasses four transnational programme:

- Central Europe;
- Interreg MED;
- Danube;
- ADRION (Adriatic-Ionian).

Furthermore, two interregional programmes have been continued:

- URBACT III;
- INTERREG EUROPE.

The cross-border cooperation programme encompasses the neighbouring countries: Slovenia, Bosnia and Herzegovina, Hungary, Serbia, Montenegro and Italy. The City of Zagreb can participate in the Slovenia – Croatia cross-border programme. According to the existing programme rules, activities from the fields of environment protection, promotion of energy efficiency and use of renewable energy sources were co-

financed, as were some smaller pilot projects. Project consortia must include several partners from different countries in the programme area, but the project coordinator must be from an EU Member State. The amount of co-financing of project activities cannot exceed 85% of the acceptable costs.

c. European Local Energy Assistance (ELENA)

ELENA is a technical assistance service jointly launched by the European Commission and the EIB in late 2009. Technical assistance is provided to cities and regions for the purpose of developing energy efficiency projects and attracting additional investments. It encompasses all types of technical support required for the preparation, implementation and financing of the investment programme. The key criterion in project selection is their overall impact on the total reduction of CO₂ emissions. Acceptable projects include construction of energy efficient heating and cooling systems, investments in cleaner public transport, construction etc. The minimal investment amount equals 50 million euros, with a 1:20 technical-assistance-to-capital-investment ratio. The share of grant co-financing amounts to 90%. Considering the very low minimal investment, the European Commission founded other ELENA funds intended for smaller projects (between 30 and 50 million euros), which are operated by the KfW (German Development Bank) and CEB (Council of Europe Development Bank).

d. Joint European Support for Sustainable Investment in City Areas (JESSICA)

The JESSICA initiative promotes sustainable urban development by supporting projects in the following areas:

- Urban infrastructure – including transport, water/waste water, energy;
- Heritage or cultural sites – for tourism or other sustainable uses;
- Redevelopment of brownfield sites – including site clearance and decontamination;
- Creation of new commercial floor space for SMEs, IT and/or R&D sectors;
- University buildings – medical, biotech and other specialised facilities;
- Energy efficiency improvements.

The initiative is carried out in co-operation with the European Investment Bank, Council of Europe Development Bank and commercial banks. EU Member States can decide to invest part of the funds allotted to them from ESI funds into revolving funds in order to contribute to re-utilisation of funds and, thereby, expedite investments in Europe's urban areas. Contributions from the European Regional Development Fund (ERDF) are allotted to Urban Development Funds (UDFs), which invest them into public-private partnerships or into other projects included in an integrated sustainable urban development plan. These investments can take the form of equity, loans and/or guarantees. Alternatively, managing authorities can decide to channel funds to UDFs using Holding Funds (HFs) which are set up to invest in several UDFs. Owing to the revolving nature of the instruments, returns from investments are reinvested in new urban development projects, thereby recycling public funds and promoting the sustainability and impact of EU and national public money. Loan beneficiaries include local and regional authorities, agencies, state administration and private investors.

A special study, on the basis of which the characteristics of the future fund and the financing instruments are determined, is prepared for every Member State interested in establishing a JESSICA fund. 19 JESSICA programmes have mobilised a total of 1.6 billion euros. Croatia has gained the right to establish a JESSICA fund by acceding to the EU and signing the memorandum.

e. Joint Assistance in Supporting Projects in European Regions (JASPERS)

JASPERS is a partnership between the European Commission (Directorate General for Regional Policy), the European Investment Bank (EIB), the European Bank for Reconstruction and Development (EBRD) and Kreditanstalt für Wiederaufbau (KfW). It is a technical assistance facility for the twelve EU countries which joined the EU in 2004 and 2007.

The JASPERS programme is carried out by highly qualified experts headquartered in Luxembourg and regional offices in Central and East Europe, which provide technical assistance in the following areas:

- Improvement of railway, road and inland waterway traffic infrastructure within and outside of the Trans-European Network;
- Intermodal traffic systems and their interoperability;
- Clean urban and public transport;
- Environment protection, energy efficiency and renewable energy source projects;
- Public-private partnership projects.

The technical assistance provided under the JASPERS initiative is prepared jointly by the interested Member States and the European Commission in the form of an annual action plan which focuses on environment protection projects valued at over 25 million euros and traffic infrastructure projects valued at over 50 million euros.

The Republic of Croatia has been a JASPERS beneficiary since 2012.

10.1.10 European Economic Area (EEA) and Norway Grants

The EEA Grants and Norway Grants represent the contribution of Iceland, Liechtenstein and Norway to reducing economic and social disparities and to strengthening bilateral relations with 15 EU countries in Central and Southern Europe and the Baltics, including Croatia.

These EEA countries finance the grants jointly and proportionally to their economic strength. The total amount allocated to the Republic of Croatia for the 2014 – 2021 period equals 103.4 million euros. The operational programme for the utilisation of these funds is being drafted at the moment. Its priorities for financing should reflect the main challenges Europe is facing, which are:

- Innovation, research, education and competitiveness;
- Social inclusion, youth employment and poverty reduction;
- Environment, energy, climate change and greenhouse gas emission reduction;
- Culture, civil society development, good management and basic human rights;
- Justice and home affairs.

This fund has financed projects aimed at increasing energy efficiency of residential buildings in Czechia, Bulgaria, Hungary, Poland, Romania, Slovakia and Slovenia.

A bilateral agreement for the implementation of the programme is expected to be signed between the Republic of Croatia and the EEA and Norway in 2019.

10.1.11 The ESCO model

ESCO is short for Energy Service Company and it is the generic name of a concept in the energy area service market. The ESCO model encompasses development, implementation and financing of projects aimed at increasing energy efficiency and reducing operating and maintenance costs. Every project strives for reducing energy consumption and maintenance costs by promoting the installation of new, energy efficient equipment and by optimising energy systems, which ensures investment returns through achieved savings in a matter of several years, depending on the client and the project.

The risk of achieving the savings is generally undertaken by the ESCO company, in form of guarantees. In addition to innovative projects aimed at increasing energy efficiency and reducing energy consumption, the financial solutions for their implementation are also often provided. When the client is paying back the energy efficiency investment, they pay energy consumption costs equal to those before the project implementation, but separated into the real (reduced) energy cost and the investment payback cost. After the investment has been paid back, the ESCO company exits the project and leaves the benefits to the client. All projects are specially suited for the clients. The projects can be expanded through inclusion of new energy efficiency measures, with an appropriate investment distribution. Thereby, the client is able to modernise their equipment without assuming any investment risk since the risk of accomplishing the savings can be overtaken by the ESCO company. Additionally, after the investment has been paid back, the client will realise positive cash flows in the payback period, as well as long-term savings.

Another benefit of the ESCO model is that, during all project phases, the client works with only one company, in accordance with the one-stop shop principle, instead of working with several companies, which significantly decreases the energy efficiency project costs and the risk of investment into such projects. Furthermore, an ESCO project encompasses all energy systems at a specific location, which enables the optimal selection of measures with a favourable investment-to-savings ratio.

The ESCO service users can also include private and public companies, institutions and local and regional self-government units.

Various variations of ESCO activities exist in Europe, such as Energy Performance Contracting (EPC) and Heat Contracting. The Heat Contracting model was developed and is extensively implemented in Austria, Finland, Sweden and other EU Member States with significant experience in modern usage of biomass from private forests, whereas not a single implementation example exists in Croatia. This model's fundamental principle consists in private enterprises selling heat energy to end users (e.g. public buildings).

10.1.12 Public-private partnership (PPP)

A public-private partnership is a joint, cooperative action of public and private sector in the creation of public products or the provision of public services. As the manufacturer and offeror of cooperation (partner) and of the performance of public activities to the private sector, the public sector contractually defines the types and the scope of activities and services which it intends to transfer to the private sector. The private sector, as a partner, seeks such cooperation if it can achieve its business interest (profit) and it is obliged to perform the contractually transferred and defined activities.

The goal of a public-private partnership is a cost-efficient, effective and more efficient production of public products or services in comparison with the traditional manner of provision of public services.

Public-private partnerships arise in various public administration areas and in various forms, with various deadlines and intensities, but most often when the public administration is not able to directly perform its own public activities for two reasons:

- Due to lack of public administration employees' expertise in specific activities (e.g. regarding medicine, petroleum etc.);
- Due to high costs of performing certain public activities (e.g. provision of construction mechanisation).

PPP project characteristics include:

- Long-term contractual cooperation (maximum of 40 years) between the public and the private sector;
- Real distribution of the business risk of construction, availability and demand (two of the three risks must be assumed by the private partner).

The European Union has adopted the Green Paper on public-private partnerships and Community law on public contracts and concessions, in which the occurrence of PPPs is analysed, primarily in order to classify PPPs so as to determine those forms of that type of partnership which are covered by the EU legislature on public procurement, as well as to determine those that can be contractually defined differently. When it comes to procedures of awarding public procurement contracts and concession contracts in the Republic of Croatia, PPPs are regulated by the Public-Private Partnership Act (Official Gazette no 78/12, 152/14 and 114/18) and the Regulation on the Implementation of Public-Private Partnership Projects (Official Gazette no 88/12 and 15/15), the Concessions Act (Official Gazette no 69/17) and the Public Procurement Act (Official Gazette no 120/16).

The benefit of financing projects via public-private partnerships lies in the fact that such an investment is not viewed as an increase in the public debt. The key condition has to do with the assets elaborated along with the partnership contract. The assets outlined in the contract are not considered city property only if there is firm evidence that the private partner is taking on the most of the partnership risks. In a situation where local and regional self-government units are heavily indebted and public grants are scarce, public-private partnership represents the model which is able to launch a significantly larger volume of projects aimed at energy efficiency renovations.

11 CONCLUSION AND RECOMMENDATIONS

The Sustainable Energy and Climate Action Plan (SECAP) is an ambitious key city document, which, on the basis of the referential data, identifies and provides precise and clear guidelines for the implementation of projects and energy efficiency measures, use of renewable energy sources and climate change adaptation in order to facilitate the accomplishment of the set goals of reducing greenhouse gas emissions. The Action Plan is focused on long-term climate change effects on local community areas, taking into consideration energy efficiency and providing measurable objectives and results related to the reduction of energy consumption and CO₂ emissions. **The main goal of the Action Plan is to, by implementing the suggested measures, achieve a reduction in CO₂ emissions of over 40% by 2030.**

The City of Zagreb is the first city in the Republic Croatia which is to submit its Action Plan to the Covenant of Mayors for Energy and Climate. In comparison with the reference 2008 and in compliance with the set level of emission reduction of 40%, the City of Zagreb should reduce its CO₂ emissions by approximately 1,118 kt, meaning that its emissions ought not exceed 1,677,630.53 t in 2030.

The Baseline Emission Inventory (BEI) of CO₂ emissions was conducted for 2008, on the basis of collected data, and was used in the indicative goal calculations. The Monitoring Emission Inventory (MEI) of CO₂ emissions was conducted for 2015. Both inventories were conducted in accordance with the IPCC protocol. On the basis of the collected data and analyses made available through the BEI and MEI, measures for mitigating and adapting to climate change effects were proposed.

A total of 32 climate change mitigation measures were proposed and the energy savings resulting from them (expressed in MWh) and their potentials for reducing CO₂ emissions (expressed in t CO₂) were quantified. 35 measures aimed at climate change adaptation were proposed. Climate change adaptation measures were not included in the projections of energy savings and CO₂ emission reduction scenarios since the methodology has not been ascertained for these measures, but they definitely contribute to the set goals. Considering the fact that methods for monitoring CO₂ emissions, for certain adaptation sectors, will be devised on the basis of some of the suggested measures, the additional savings will be monitored in the monitoring period and will be presented in the reports, accordingly.

Climate change adaptation measures have been comprehensively integrated in this type of document for the first time. The very proposal of measures indicates that many of them are analytical and research-based, which points to the fact that platforms which would serve the purpose of planning specific

activities in this area in the future need to be developed, despite the fact that a certain share of the activities anticipated by these measures is very clear-cut.

The LEAP (Long-range Energy Alternatives Planning) programme was used in preparing the energy savings and CO₂ emission reductions scenario for 2030, in accordance with the suggested climate change mitigation measures. Both the business-as-usual (BAU), i.e. the scenario not foreseeing the implementation of measures, and the measure-inclusive scenario were drafted in the programme. The conducted analyses indicate that the BAU scenario CO₂ emissions amount to 2,499,658.70 t, that is, 822.03 kt or 49% over the suggested indicative objective, meaning that the suggested goal will not be accomplished without implementing the measures.

The measure-inclusive scenario projections verify that fact and indicate that the total CO₂ emissions in 2030 would amount to 1,631,536.3 t, which means that, by implementing the measures aimed at reducing energy consumption and CO₂ emissions, a 41.65% reduction in total emissions, in comparison with the baseline year, would be achieved.

In 2030, the result of the implementation of the aforementioned suggested measures would be the reduction of CO₂ emission which exceeds the objective by 2.75%, equalling thus 46.094,23 t CO₂.

This document is the strategic document of the City of Zagreb in the area of energy efficiency and adaptation to climate change effects for the period up to 2030. It has been drafted in such a manner that the measure implementation and therefore their effects will be monitorable and reportable, which represents an obligation under the Covenant of Mayors for Climate and Energy. The City of Zagreb plans to use this document as a key document in the process of planning operative energy efficiency and climate change effect adaptation programmes in the following financial period.

CLASS: 021-05/19-01/208
REFERENCE NO: 251-01-02-19-5
Zagreb, 10 June 2019

President
of the City Assembly
prof. dr. sc. Drago Prgomet, m.p.