NET ZERO CITIES

EU MISSION PLATFORM | CLIMATE NEUTRAL AND SMART CITIES

Climate City Contract

2030 Climate Neutrality Action Plan

2030 Climate Neutrality Action Plan of the City of Zagreb - A disruptive vision for mitigation and adaptation synergy!

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Summary

Textual element

Zagreb is committed to becoming a leading example of urban sustainability and climate resilience by integrating climate action into every aspect of city governance. The Climate Action Plan outlines a path to achieve carbon neutrality by 2030. This plan emphasizes a holistic approach that combines both mitigation and adaptation efforts, ensuring the city not only reduces its carbon footprint but also enhances its resilience to climate impacts. Through the Climate City Contract development exercise, Zagreb has recognized the full scope of efforts needed to reach climate neutrality and to integrate the resilience into the processes, highlighting the complexity of execution and the need for a coordinated, cross-sectoral approach. Taking a disruptive path, Zagreb has moved away from traditional business-as-usual models, with a bold strategy that embeds climate considerations into the core of all city operations.

Key Elements of the Climate Action Plan are following:

Climate Goals and Commitments: Zagreb is dedicated to achieving significant reductions in greenhouse gas emissions and reaching carbon neutrality by the target year, aligning with global commitments such as the Paris Agreement, surpassing national targets. This ambition reflects a comprehensive understanding of the challenges ahead, emphasizing the need for integrated mitigation and adaptation strategies that address the complex, interconnected nature of climate action.

Resilience and Adaptation: In response to increasing climate risks, including extreme weather events, flooding, and heatwaves, Zagreb's strategy integrates adaptation into urban planning and infrastructure development. By combining mitigation and adaptation efforts, the city ensures that resilience is embedded in all initiatives, reducing vulnerabilities and preparing the city to cope with the impacts of climate change.

Disruptive Approach to Governance:

Zagreb's approach to the development of the Climate City Contract is distinctly disruptive, moving away from business-as-usual practices. Unlike traditional models that often rely on a separate transition team, Zagreb has made climate action a shared responsibility across all city officials. There is no specific transition team in place; instead, all main city officials are required to incorporate climate-related issues into their agendas and daily operations. This approach ensures that climate action is not siloed but embedded into every decision and process. Notably, the Mayor of Zagreb serves as the Chief Climate Officer, underscoring the city's commitment to making climate action a top priority at the highest level of leadership.

Mainstreaming Climate Action Across All City Processes:

The Climate City Contract exercise revealed the importance of embedding climate considerations into all city functions, ensuring that the city's approach is comprehensive and cohesive:

- Integration into Urban Planning and Zoning: Climate resilience and sustainability are already embedded into urban planning, zoning, and land use regulations up to certain level, but more will be done in future iterations. This ensures that all developments align with the city's combined mitigation and adaptation goals, such as promoting low-carbon transport, energy-efficient buildings, and expanding green spaces to enhance urban cooling and flood management.
- Climate-Oriented Public Procurement: The will revise procurement policies to prioritize climate-friendly and resilient solutions, integrating both mitigation and adaptation considerations. By selecting low-emission vehicles, renewable energy systems, and resilient construction materials, Zagreb supports its broader climate strategy through every purchase.
- Incorporating Climate Risk into Budgeting and Financial Planning: Mainstreaming climate action involves integrating climate risk assessments into budgeting and financial planning processes. This ensures that financial decisions align with the city's combined mitigation and

adaptation objectives, creating a unified approach to addressing the complexity of climate challenges.

- Establishing Climate Action as a Cross-Cutting Priority: A dedicated climate task force will oversee the integration of climate considerations across all city departments, fostering collaboration and ensuring that every policy, program, and project is evaluated for its climate impact and contribution to both mitigation and adaptation goals, maximizing overall effectiveness.

Policy and Regulatory Adjustments: To support the combined approach of mitigation and adaptation, Zagreb is revising its policy and regulatory frameworks. This includes mandating green building standards that not only reduce energy use but also improve resilience to extreme weather, and updating zoning laws to promote climate-smart land use, fully implementing the climate proofing and monetisation aspects. The Climate City Contract has been instrumental in identifying these necessary policy shifts, underscoring the need for regulatory flexibility and innovation.

Enhanced Cooperation with Stakeholders:

- National Ministries: Zagreb's climate strategy involves close collaboration with national ministries, such as the Ministry of Green transition, Ministry of economy, Minstry of Finance, Ministry of transport, Ministry of regional development and EU funds and others to ensure local efforts are supported by national policies and resources. The Climate City Contract process highlighted the critical need for this alignment, enabling cohesive action across governance levels.
- Private Sector Engagement: The private sector plays a pivotal role in driving both emissions reductions and resilience-building. Through partnerships, incentives, and collaboration platforms, Zagreb aims to disrupt traditional business models and advance both mitigation and adaptation, as recognized in the comprehensive scope outlined by the Climate City Contract action plan.
- Citizen and Community Participation: Engaging citizens is central to Zagreb's climate action strategy. The city will actively involve residents in

climate initiatives through education, outreach, and participatory processes, ensuring that the community understands and supports both mitigation efforts and adaptation measures. The Climate City Contract emphasized the importance of this inclusive approach, recognizing the role of citizens in the city's climate journey.

Innovation and Technology: Leveraging innovative technologies that address both mitigation and adaptation needs is a key aspect of Zagreb's strategy. The Climate City Contract process identified opportunities for smart city initiatives, green infrastructure, and advanced energy systems, which are critical to addressing the complexity of achieving climate neutrality.

Social Equity and Inclusion: Ensuring a just transition is fundamental to Zagreb's climate strategy. By focusing on inclusive policies that address social disparities and create opportunities in the green economy, the city aims to ensure that all residents benefit from combined mitigation and adaptation efforts. The Climate City Contract highlighted the need for these efforts to be equitable and inclusive, ensuring that no one is left behind.

Scaling Up Successful Initiatives: To maximize impact, Zagreb will expand successful pilot projects that integrate mitigation and adaptation across the city.

Monitoring, Reporting, and Continuous Improvement: A robust monitoring and reporting framework will track progress on both mitigation and adaptation fronts. This transparent approach allows for continuous learning and adaptation, ensuring that the city's climate actions remain effective and responsive to evolving challenges. The Climate City Contract has provided a roadmap for ongoing evaluation and refinement, essential for navigating the complex path to climate neutrality. We have also developed our own index, index that will allow us to track the mainstreaming effect of mitigation and adaoptation into all governance processes. This innovation will support the disruptive way of considering climate issues.

The Climate City Contract exercise has allowed Zagreb to recognize the full scope of efforts required to reach climate neutrality, highlighting the complexity of execution and the need for a unified, all-encompassing approach. By taking a disruptive path that moves away from business-as-usual models, Zagreb ensures that climate action is not the responsibility of a single team but is woven into the fabric of the city's governance. With the Mayor acting as the Chief Climate Officer, this approach underscores the city's commitment to prioritizing climate action at the highest level.

The next steps involve detailed implementation of the Climate Action Plan, securing funding, and maintaining a focus on innovation and social equity. By embracing a holistic approach that integrates mitigation and adaptation, and by ensuring that all city officials are actively involved in climate efforts, Zagreb is poised to meet its climate goals and set a new standard for comprehensive urban climate action, recognizing the complexity and dedication required to achieve a climate-neutral future.

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Abbreviations and acronyms

Abbreviations and acronyms	Definition
ACR+	Association of Cities and Regions for Sustainable Resource Management
AMI	Advanced metering infrastructure
AV	Autonomous vehicle
AEV	Autonomous electric vehicle
CAB	Climate Awareness Bond
CAPEX	Capital expenditures

CCC	Climate City Contract
DH	District heating
DJF	December January February
DSO	Distribution system operator
EEA	European Economic Area
EIB	European Investment Bank
ELENA	European Local Energy Assistance
EL-TO Zagreb	Elektrana – toplana Zagreb (engl. Power Plant – District Heating Zagreb)
EPC	Energy performance certificate
ES	Equivalent inhabitants
ESCO	Energy service company
ESIF	European Structural & Investment Funds
ETC	Electronic toll collection
EU	European Union
EV	Electric vehicles
FS	Feasibility studies
GDP	Gross domestic product
GDPR	General data protection regulation
GEN	Generation
GHG	Greenhouse gases
GIS	Geographic information system
GmbH	Company with limited liability
GPS	Global positioning system
GWh	Gigawatt - hour
HE	Horizon Europe
HEP	Hrvatska elektroprivreda
HERA	Hrvatska regulatorna energetska agencija
HVAC	Heating, ventilation, and air conditioning
HŽPP	HŽ Putnički prijevoz (engl. HŽ Passenger Transport)
H2020	Horizon 2020
ICAI	Integrated Climate Action Index
IPCC	Intergovernmental Panel on Climate Change
ITI	Information technology industry
ITS	Intelligent transportation systems
JJA	June July August
km	Kilometer
KPI	Key performance indicator
LED	Light-emitting diode

LEZs	Expand low-emission zones
LIFE	Lifestyle for Environment
LPG	Liquefied petroleum gas
MAM	March April May
MEL	Monitoring, evaluation, and learning
mTEO Jakuševec	Modularno termičko energetsko postrojenje Jakuševac (engl. Modular Thermal Energy Plant Jakuševac)
MW	Megawatt
MWe	Megawatt electrical
MWt	Megawatt thermal
NECP	National Energy and Climate Action Plan
NFC	Near-field communication
NGO	Non-governmental organization
nZEB	Nearly-zero energy buildings
PCI-DSS	Payment Card Industry Data Security Standard
PNG	Piped natural gas
PPA	Power-purchase agreements
PPD	Prvo plinarsko društvo (engl. First Gas Company)
PPP	Public-private partnership
PV system	Photovoltaic system
RCP	Representative Concentration Pathway
REGEA	Regionalna energetsko-klimatska agencija Sjeverozapadne Hrvatske (engl. North-West Croatia Regional Energy and Climate Agency)
RES	Renewable energy sources
RFPs	Requests for proposals
ROI	Return on investment
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SCADA	Supervisory control and data acquisition
SECAP	Sustainable Energy and Climate Action Plan
SON	September October November
SPV	Special purpose vehicle
SUMP	Sustainable Urban Mobility Plan
TE-TO Zagreb	Termoelektrana – toplana Zagreb (engl. Thermal Power Plant – District Heating Zagreb)
TIF	Tax increment financing
TOD	Transit-oriented development
TODDs	Transit-oriented development districts

TPES	Total primary energy supply
TSO	Transmission system operator
TVM	Ticket vending machine
TWh	Terawatt-hour
VAT	Value-added tax
V2I	Vehicle-to-infrastructure
ZET	Zagrebački električni tramvaj (engl. Zagreb Electric Tramway)
ZOV	Zagrebačke otpadne vode (engl. Zagreb Wastewater)
ZSK	Zagrebački sunčani krovovi (engl. Zagreb Solar Roofs)
WTE	Waste-to-energy

1 Introduction

Vision

As Mayor of Zagreb, my vision for our city is one where sustainability, resilience, and innovation are not mere aspirations but integral to our daily operations and governance. Our commitment to climate action is both a profound responsibility and a transformative opportunity for our city. The Climate Action Plan, developed through the Climate City Contract exercise, represents a bold step towards a future where Zagreb leads by example in the global effort to combat climate change.

A City Transformed: Embracing a Holistic Climate Strategy

Zagreb's journey towards carbon neutrality by is not just about setting targets; it's about fundamentally reshaping how we operate as a city. Our approach is grounded in a holistic strategy that combines both mitigation and adaptation efforts, ensuring that we address climate challenges comprehensively. This means reducing our greenhouse gas emissions while simultaneously preparing our infrastructure, economy, and communities to withstand and adapt to the impacts of climate change.

Our Climate Action Plan is a testament to our determination to move away from business-as-usual practices. By embracing a disruptive approach, we are embedding climate considerations into every facet of city governance. This is not the responsibility of a single department or team but a shared duty that spans across all levels of city administration. Each city official is tasked with integrating climate-related issues into their agendas and daily operations, reflecting our commitment to making climate action a core priority in all decision-making processes.

Leadership and Innovation: Leading by Example

As Chief Climate Officer, I am committed to leading this transformation with vision and determination. It is imperative that we demonstrate leadership not only in setting ambitious goals but also in pioneering innovative solutions. By adopting a disruptive model, we are breaking down silos and fostering a culture where climate action is seamlessly integrated into urban planning, public procurement, financial planning, and every other aspect of city management.We are leveraging cutting-edge technologies and innovative approaches to address both mitigation and adaptation needs. From smart city initiatives to green infrastructure projects, we are positioning Zagreb as a hub of sustainability and resilience. This approach will not only enhance our city's livability but also set a benchmark for other cities to follow.

Inclusive and Equitable Climate Action

Our vision for Zagreb is inclusive and equitable. We understand that climate action must benefit all residents and address social disparities. As we pursue our climate goals, we are dedicated to ensuring that no one is left behind. By focusing on inclusive policies, we aim to create opportunities for all citizens in the green economy and ensure that vulnerable communities are protected and empowered.

Engaging with citizens is central to our strategy. We will involve our residents in climate initiatives through education, outreach, and participatory processes, ensuring that our climate action plan reflects their needs and aspirations. This collaborative approach will foster a sense of ownership and shared responsibility, making our climate goals a collective endeavor.

Collaborative Approach: National and Global Engagement

To achieve our climate objectives, we must work closely with national ministries, the private sector, and our citizens. Collaboration with national ministries will ensure that our local

actions are supported by national policies and resources, but also serve as an example for national level to undertake more bold initiatives. Engaging with the private sector will drive innovation and investment in climate solutions, while active citizen participation will strengthen our community's resilience and commitment to sustainability.

Our approach is about more than just local actions; it's about contributing to global climate efforts and setting an example for others to follow. By aligning our strategies with national and global frameworks, we are positioning Zagreb as a leader in the international climate community.

A Future of Resilience and Prosperity

The path to climate neutrality is complex, but it is one we must navigate with determination and foresight. Our Climate Action Plan is a comprehensive roadmap that outlines the steps we need to take to build a resilient and sustainable city. It is a testament to our commitment to addressing climate challenges head-on and ensuring that Zagreb remains a vibrant, livable, and prosperous city for future generations.

As we move forward, I am confident that our collective efforts will transform Zagreb into a model of climate action and urban sustainability. Together, we will create a city that not only meets its climate goals but also thrives in the face of change, setting a standard for cities in the region.

This vision reflects our commitment to leading by example, embracing innovation, and fostering inclusive and collaborative climate action. It is a call to action for all city officials, stakeholders, and residents to unite in our shared goal of a climate-neutral and resilient Zagreb.

Mayor,

Tomislav Tomašević

2 Part A – Current State of Climate Action

By uniting two medieval settlements, Kaptol and Gradec, in 1850, the City of Zagreb embarked on a rapid development trajectory. Throughout the 19th century, the population increased tenfold, and from the 1960s onwards, the City began expanding rapidly across the plains along the Sava River.[1]

Today, Zagreb is the Republic of Croatia's capital and **economic and administrative hub**. It hosts key state institutions - legislative, judicial, and executive branches - as well as institutions for finance, defence, healthcare, culture, education, transportation, and others. The City covers an area of 641.24 km^2, comprising 69 settlements and 17 urban districts.

According to the 2021 census[2], the City of Zagreb has **767,131** residents, accounting for **19.8%** of the total population of the Republic of Croatia. This is a **decrease of 2.9% compared to the 2011 census**. The population structure reveals that women constitute 53.3% of the total population, while men comprise 46.7%. The largest demographic group falls within the age bracket of 40-44 (Figure 1), comprising 7.7% of the population.

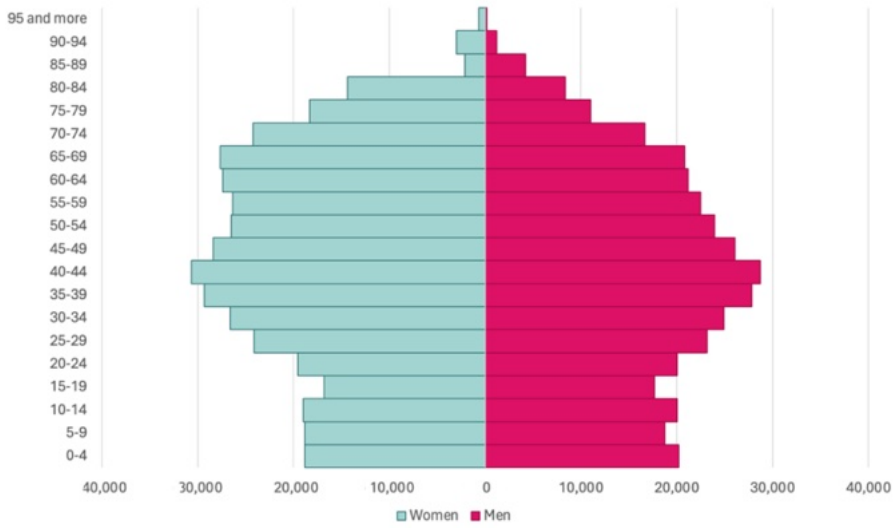


Figure 1 Demographic structure of the City of Zagreb population according to the 2021 census

[1] Tourist Board of the City of Zagreb

[2] Official Website of the City of Zagreb

According to March 2022 data, a significant proportion of the employed population in the City of Zagreb holds educational qualifications from vocational high schools, constituting 46.2% of the total workforce, while 33.3% possess postgraduate degrees (Figure 2). The greatest number of individuals in Zagreb are employed in the wholesale and retail trade, repair of motor vehicles and motorcycles, and manufacturing sectors. As per 2022 data, the registered unemployment rate stood at 3.1%.[3]

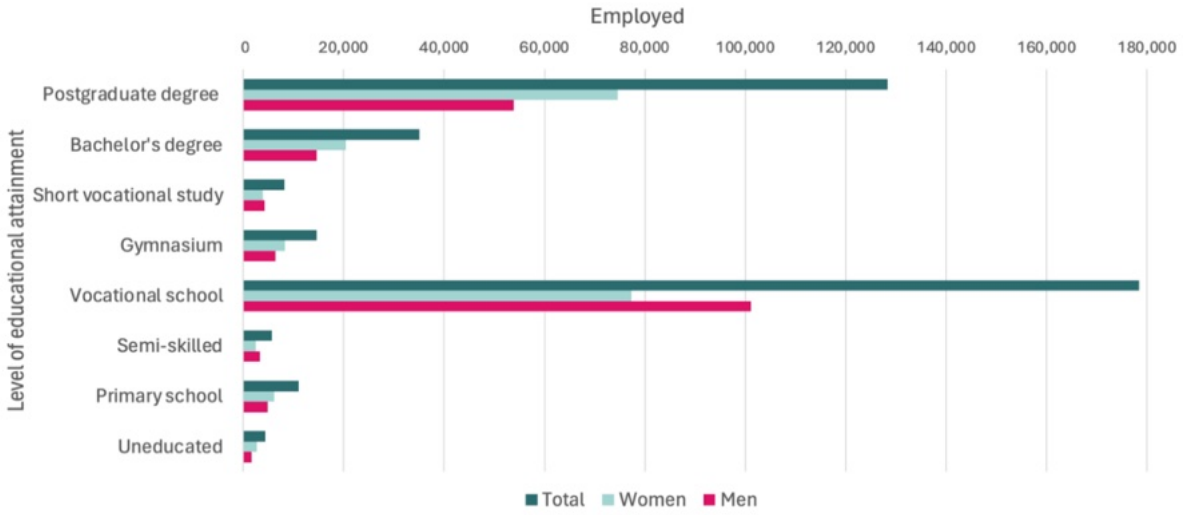


Figure 2 Statistics of employed individuals in legal entities in the City of Zagreb by gender and level of educational attainment

The City of Zagreb, nestled at the foothills and southern slopes of the Medvednica mountain range and along the banks of the Sava River, experiences diverse microclimatic conditions. Zagreb enjoys a humid continental climate due to its location in the southwest part of the Pannonian Basin. However, recent times have witnessed alterations in the Köppen-Geiger climate classification across all meteorological stations within the City. These observations underscore the necessity for vigilant monitoring and adaptation to emerging conditions to ensure the City's resilience and sustainability for the future.

[3] Official Website of the City of Zagreb

2.1 Module A-1 Greenhouse Gas Emissions Baseline Inventory

2.1.1 Infrastructure

2.1.1.1 Built environment

Key statistics on the buildings sector

The City of Zagreb owns over 1,000 buildings. This building stock includes kindergartens, schools, hospitals, health care buildings, social care buildings, cultural sector buildings, and sports and recreation buildings (including several large multi-functional buildings and complexes). The building stock also includes all the buildings of the city utility companies. Most buildings are older than 30 years, have worse energy classes, and generally need renovation. Considering the development plans of the City of Zagreb, adaptation, renovation, reconstruction, extension, revitalisation, change of purpose or demolition with the construction of replacement buildings are planned for a large part of the building stock. In the coming period, the focus is particularly on investments related to kindergartens and schools and implementing capital projects in health, culture, and sports.

In the last 10 years, the City of Zagreb has carried out energy renovation of 80 public buildings, including 37 kindergartens, 18 primary schools, 4 secondary schools, 4 administration buildings / regional offices, 4 homes for the elderly and infirm, 8 health care buildings (health centers and hospital buildings), 2 sports buildings, 2 local self-government buildings. The mentioned buildings have a total area of 213,214 m^2. The energy renovation cost of these buildings is 62 million EUR.

The series of earthquakes in northwestern Croatia in 2020 greatly impacted the building stock in the City of Zagreb, as many buildings were damaged due to the earthquakes. In accordance with the Law on Reconstruction, the City of Zagreb is solely responsible for the reconstruction of public buildings it owns, while the Government of the Republic of Croatia is responsible for the reconstruction of private houses, multi-apartment buildings, and other public buildings. The City of Zagreb prioritised the renovation of kindergartens, schools, and road infrastructure, and then the focus shifted to health and cultural buildings and city administration buildings.

The City of Zagreb contracted 207 renovation projects for buildings it owns, of which 177 are currently completed, which amounts to more than 85%. At the same time, the buildings are not only renovated in solely part regarding construction but completely, which means that other important requirements for the building, including thermal protection and rational use of energy, have also been improved – all according to national regulation. The buildings were renovated with the funds made available to Croatia by the European Union as a sign of solidarity after the earthquakes in 2020. The City of Zagreb managed to use the funds with the great commitment of its city employees, who through eight calls for different types of buildings had to prepare projects according to the strict rules of the Law on Reconstruction and of the European Commission.

Public lighting system

Based on the latest available data - Energy Efficiency Action Plan for the City of Zagreb for the period 2022 – 2024 and Action plan for modernisation of the public lighting system in the City of Zagreb, there are around 120,000 lamps (luminaires) with a total power of around 19 MW. The most represented light sources are high-pressure sodium (81%), LED (9%), adapted high-pressure sodium (replacement for high-pressure mercury) at around 8%, as well as other particular types (2%), all presented in the following table.

Table 1 Public lighting system in the City of Zagreb

Source	Number of lamps	Share in number of lamps (%)	Installed power (kW)	Share in installed power (kW)
High-pressure sodium	97,418	81%	16.432	86%
LED	10,895	9%	722	4%
Adapted high-pressure sodium	9,633	8%	1.588	8%
Other special types	2,000	2%	300	2%
Total	119,946		19.042	

The whole public lighting system works around 4,200 hours every year which results in a total annual electricity consumption of around 78.5 GWh which generates around 9 million euros of annual expenses for electricity.

Since the public lighting system of the City of Zagreb is relatively large, but also outdated, the City of Zagreb recognised the importance and necessity of its public lighting system modernisation several years ago when a project called RePubLEEc was implemented in the period 2018-2021. This project, financed through ELENA (European Local Energy Assistance), had the aim to co-finance preparatory activities (technical and tender documentation) for the reconstruction and modernisation of at least 70% of the entire public lighting system in the City of Zagreb.

Throughout the project, with the great help of REGEA, and due to several limitation factors, the City of Zagreb prepared a tender documentation for an Energy Performance Contract (EPC) for 40% of the public lighting system (around 51,000 luminaires), while the tender was published at the end of 2021.

The total value of this tender was set at around 28 million EUR. However, due to the nature of EPC, the City of Zagreb did not invest its financial funds, but it obliged a private partner to independently design, finance, and conduct work, as well as to guarantee services such as guaranteed energy savings, availability, and luminance. Expected outputs of these activities were creating an EPC contract in 17 years, by which 65% energy savings (25 GWh), 75% savings in maintenance costs (2.7 million EUR), and 5,000 tonnes of CO_2 reduction were achieved. Due to low electricity prices (2021), offers received on the tender procedure were higher than the estimated contract value (investment could not be covered by the energy savings) so the City decided to cancel the tendering procedure and the EPC contract has not been signed.

Except for EPC tender documentation, the City of Zagreb prepared and launched smaller reconstruction projects during 2019 - 2022. These smaller investment projects were primarily focused on older parts of the infrastructure that had to be realised due to other (in parallel) infrastructure modernisation programmes (like holistic reconstruction of streets and infrastructure on public roads). The overall investment of realised smaller investment projects is approximately 1,000,000 EUR.

While a bigger investment project was not implemented, there is still a great need for a major renovation of the public lighting system in terms of not only replacing old luminaires

with LED, but also changing the infrastructure such as lighting poles, electricity cables, as well as to integrate energy management and monitoring system.

2.1.1.2 Energy infrastructure

EL-TO Zagreb

EL-TO Zagreb, operated by *HEP Proizvodnja* Ltd (a daughter company of Croatian Energy Company – HEP Ltd) is a cogeneration heat and power plant built located in the western part of the city center. Initially built in 1907 for the electrification of the City of Zagreb, it operated as a typical thermal power plant, producing electricity only until 1954, when its utilisation in the heating sector started. Over the years, different blocks have been installed at the location, keeping up the energy needs, both in electricity and heat of the major city. As of today, 8 different production blocks are available with a nominal electricity power of 50 MWe and a nominal heat power of 200 MWt. Two blocks are classified as natural gas cogeneration blocks, two blocks are classified as typical thermal electricity production blocks (using natural gas or extra light fuel oil), while the other 4 are used for heating purposes only (using natural gas or extra light fuel oil). Production blocks can also participate in steam production with a nominal capacity of 80 MWt.

As it is a cogeneration power plant, its primary purpose is to produce electricity and heating energy through a complex process of optimisation of different blocks based on energy needs. Apart from these, this power plant is also used as a vital production unit in auxiliary services provided to electricity distribution and transmission operators (tertiary balancing services). On a yearly basis, EL-TO produces around 550 GWh of heating energy, 250 GWh of electricity, and 290,000 tonnes of steam.

It is important to mention that, just as any other cogeneration power plant, EL-TO is defined by its work regime to produce a maximum amount of electric energy, while the heating energy is produced as a byproduct. If there is not enough heating energy to meet the heat demand, blocks mentioned above for the production of heating energy only are activated. This is also one of the reasons why EL-TO Zagreb also has a large water storage, which enables smoother optimisation of production units, especially during the night and in morning hours.

Due to exceeded lifetime of several production blocks, EL-TO is currently in the process of modernisation of its production blocks where a brand new cogeneration block with a nominal electricity power of 150 MWe and a nominal heat power of 114 MWt has been built.

As a part of this modernisation project, a new 32,000 m^3 water storage is planned which will have a thermal capacity of 1,000 MWh and an integrated 150 MW heater.

TE-TO Zagreb

TE-TO Zagreb, operated by *HEP Proizvodnja* Ltd (a daughter company of Croatian Energy Company – HEP Ltd), is also a cogeneration heat and power plant built located in the east part of the City near the Sava River. Initially built in 1962, contrary to EL-TO, its purpose was immediately to meet both the electricity and heating needs of the eastern part of the City of Zagreb, where its nominal production capacity has increased over the years. As of today, 6 different production blocks are available with a nominal electricity power of 300 MWe and a nominal heat power of 508 MWt. Two blocks are classified as natural gas cogeneration blocks, one block is classified as typical thermal electricity production blocks (using natural gas or extra light fuel oil), while the other 4 are used for heating purposes only (using natural gas or extra light fuel oil). Production blocks can also participate in steam production with a nominal capacity of 246 MWt.

As it is a cogeneration power plant, its primary purpose is to produce electricity and heating energy through a complex process of optimisation of different blocks based on energy needs. Apart from these, this power plant is also used as a vital production unit in auxiliary services provided to electricity distribution and transmission operators (tertiary balancing services). On a yearly basis, EL-TO produces around 900 GWh of heating energy, 1,650 GWh of electricity, and 200,000 tonnes of steam.

Just as EL-TO Zagreb, this facility is also defined by its work regime to produce a maximum amount of electric energy, while the heating energy is produced as a byproduct. If there is not enough heating energy to meet the heat demand, the above-mentioned blocks for the production of heating energy only are activated. This is also one of the reasons why TE-TO Zagreb, just as EL-TO Zagreb, has a large water storage, which enables smoother optimisation of production units, especially during night and in morning hours. The thermal capacity of the water storage is 750 MWh, and it also has an integrated 150 MW heater.

Central wastewater management facility

A very important aspect of high-density urban areas is management of waste-water due to an increased load for drainage and purification of sewage water. Having that in mind, the City of Zagreb established a company called *Zagrebačke Otpadne Vode* Ltd (engl. Zagreb Wastewater, ZOV) in 1998, whose integral purpose was to design, finance, build and operate a central waste-water management unit for the whole area of the City of Zagreb.

In 2000, the City of Zagreb signed a concession agreement with ZOV, after which ZOV started to build the central waste-water management facility in July 2002. The first phase of this facility was commissioned in April 2004 when mechanical purification was introduced. In the following years, the facility was improved in 4 different phases with the final result of having 100% biological purification (4th stage), which is still in operation. The total capacity of the facility is 1.5 million ES (equivalent inhabitants), and the wastewater volume is 442,370 m^3/day. Units within this facility are designed to withhold peak hour demand of 37,790 m^3/h and "biological" demand BPK5 of 90,000 kg/day.

It should be mentioned that, as a part of this facility and its development, ZOV also invested in the most complex part of the infrastructure – a wastewater supply pipeline from the city to the facility and a purified water drainage pipeline from the facility to the Sava River. ZOV also participated in the design, finance, and build of the main wastewater supply pipeline (in total 10 km long), which enabled the connection of the whole City of Zagreb to the facility, as well as the design, finance, and build of *Domovinski most* (engl. Homeland Bridge), a crucial bridge over the Sava River under which main wastewater supply pipeline are leading to the facility.

As of today, the company underwent a privatisation process after which companies WTE Wassertechnig GmbH and Westenergie Aqua GmbH have an equal ownership share of 48.5%, while a city-owned company *Vodoprivreda Zagreb* (engl. Water Management Zagreb) has a 3% ownership share. Although the concession agreement should have lasted until 2028, after which the facility would be transferred into the City of Zagreb's ownership, the agreement was canceled in 2024 due to several reasons where the most important one is that the land which was part of the concession agreement could be transferred in City of Zagreb's ownership before 2028 since the main waste management center is planned there.

Integrated PV systems

In the last several years, integrated PV systems have become one of the top priorities of the City of Zagreb's representatives since there were only 21 small-scale systems integrated on public buildings' roofs with a total power of 0.66 MWp. Most of these PV systems were installed to participate in the previous incentive systems (guaranteed purchase price).

To set more ambitious goals, in 2021, the City of Zagreb developed a programme called: Integrated PV systems on public buildings, multi-apartments, family houses, and business sector 2022-2024, which aims to install around 50 MWp out of which 10 MWp are planned to be installed on public buildings' rooftops, 10 MWp on multi-apartments and family houses' rooftops, while the rest (30 MWp) are planned for the business sector which per classification also includes large city-owned companies which should be leaders in this aspect.

The main support to the City of Zagreb in management of this programme is given by REGEA throughout the European project called PVMax. In the programme, it is stated that the City of Zagreb will build those PV systems using various models such as a traditional model (own funds, subsidies, credit lines), incentive systems, but also innovative models such as Power-Purchase Agreements (PPA).

As of today, the City of Zagreb and REGEA prepared technical documentation for around 160 integrated PV systems for mixed purposes (self-consumption and sell-to-market) on public buildings' rooftop with the total power of around 20 MWp, two times more than the programme predicted.

8 PV systems (1.43 MWp) were successfully installed through the EGP mechanism (EEA Grants), 16 PV systems are currently in the process of installation for which PPA was signed (1.7 MWp), while others are in different stages of development (obtaining permits, preparation for tender process or other). It is important to mention that the main factor that hinders this process is rooftops quality and complex administrative procedures.

Apart from public buildings, city-owned company *Zagreb Holding* and *Zagrebački Velesajam* Ltd, as part of the business sector are also contributing to the programme. The *Zagreb Holding* and its connected companies identified 24 projects with a total power of

around 33 MW which alone fulfill the programme's aim for this sector, while *Zagrebački Velesajam* Ltd is in the process of obtaining technical requirements from the electricity distribution company for its 3.3 MW PV system. It is important to mention that 2 PV systems that belong to this group have already been commissioned with a total power of 1 MW, while others will be published in a tender process by the end of this year after *Zagreb Holding* decides on the implementation model and financing schemes.

In 2022, the City of Zagreb established the company *Zagrebački sunčani krovovi* Ltd. (Zagreb Solar Roofs, ZSK) which has the main task of installing PV systems and storage systems, with the final objective to be able to supply green electricity primarily to public buildings owned by the City of Zagreb. The company is currently in the process of installing approximately 1.5 MW of building integrated PVs (planned by mid 2025), while it is planned to increase the capacity to over 20 MW by 2027.

Electricity network

The electricity network is one of the most developed infrastructures in the City of Zagreb, with more than 18,300 km of grid. It provides electricity to more than 570,000 points through 3,800 grid stations (total power 4,850 MVA). Every year, this electricity network is responsible for distributing around 16,900 GWh of electricity to end consumers, while the average distribution losses are around 7%. The reliability of the network, according to two main parameters – number of outages (SAIFI) and duration of outages (SAIDI), is the best among all parts of the country which is mostly due to the very dense and well-developed power distribution network, which enables various alternative power supply chains. However, several parts of the electricity grid are outdated and need to be modernised, while the whole grid is simply not ready for the "smart grid" concept due to a lack of digital measurement units, advanced regulation units and others. According to the investment strategy of the electricity distribution network operator (HEP ODS), most of the investments in the next decade will focus on digitalisation, the introduction of the "smart grid" concept, and an increase in the number of transformation units across the City. Regarding the spare capacity in the grid, for now, no major problems have been reported, which means that the grid can integrate a large share of renewable energy sources.

DH network

The City of Zagreb relies on *HEP Toplinarstvo* Ltd for delivery of heat through its heat distribution network based on the long-term concession agreement. In total, around 100,000 end customers are supplied with high-temperature water or steam through a 227.3 km long heat distribution network. It should be mentioned that heat delivered through this network is produced in EL-TO and TE-TO Zagreb, the two main production units explained earlier. Until a few years ago, heat distribution network conditions were inadequate, with a high share of heat and water losses. In order to change that, *HEP Toplinarstvo* successfully applied for a large-scale EU project, "Revitalisation of district heating network," financed through the ITI mechanism. The project is still in its implementation phase where the final results will be a complete revitalisation of 1/3 of the total length (68.5 km). This project will result in a reduction of water losses by 47%, heat losses by 28%, and a number of urgent interventions by more than 90%. As a part of this project, *HEP Toplinarstvo* is also introducing an advanced management and control system for the heat distribution network to improve the security of supply and the overall energy efficiency of the grid. However, there are still several areas where the heat distribution network is outdated and needs to be revitalised. On the other hand, the biggest problem in the heat distribution network is probably the fact that heat exchanger units located at the site of end-consumers are not in the ownership of *HEP Toplinarstvo* but of those end-consumers. This directly impacts attempts to lower the inlet and outlet temperature in the heat distribution network and consequently decrease energy and water losses. It should also be mentioned that, due to the very long tradition of heat distribution network and district heating in general, there is a lack of individual meters in the system, which causes a very negative public perception since end customers do not pay for what they consume. However, this is a direct problem of current legislation in the heating sector.

Gas network

Gas distribution is operated by a city-owned company, *Gradska Plinara Zagreb* Ltd (engl. City Gasworks Zagreb), based on obtained permits for this activity, but also on a long-term concession agreement with the City of Zagreb. This company has provided gas distribution services since 1862 and is the largest gas distribution company in the country. The gas network is very well developed and covers almost the whole area of the City. In total, there

are around 4,000 km of gas pipelines through which *Gradska Plinara Zagreb* Ltd delivers gas to around 300,000 end consumers. Yearly, around 300,000,000 m^3 of natural gas is distributed through the network. However, most of the gas distribution networks are relatively old and inefficient, with certain losses. This causes high maintenance costs. To back up that, a recent series of earthquakes in the City of Zagreb showed the aforementioned problem of inadequate and old gas network in the city center for which *Gradska Plinara Zagreb* Ltd had to invest major resources and time for reparations. On the other hand, only a few parts of the gas network were enhanced with digital measurement units, while for other parts, employees still had to do field inspections and register the consumption of each measurement unit. Also, several parts of the City have yet to be connected to the gas network due to the relatively high gasification costs.

2.1.1.3 Mobility

Key transport statistics

Registered vehicles and trends

The number of passenger vehicles has been increasing since 1997. The fastest growth in registering new cars occurred between 2005 and 2008. After the financial crisis, the number of newly registered vehicles declined until 2014, when it began to rise again. The reduced number of newly registered vehicles compared to the period before the 2008 financial crisis significantly contributed to the increase in the average age of cars.[4]

In 2022, 442,049 motor vehicles were registered, which is 3.4% more than in 2021. Of the total registered motor vehicles in 2022, 82.6% (364,924) were passenger cars.[5]

Share of transport modes

The results of a study on weekday travel demand show that car traffic is the City's most preferred form of transportation, with a share of 60%. Following car traffic is public transportation, which in the City of Zagreb includes buses, trams, cable car, and funicular,

[4] Phase II of the Master Plan for the Transport System of the City of Zagreb, Zagreb County, and Krapina-Zagorje County

[5] Statistical Yearbook of the City of Zagreb 2023

with a demand share of 37.7%. The lowest demand, with a share of 2.3%, is for bicycle traffic.[6]

Regarding the public transport statistics, in 2023, 158.7 million passengers were transported in the City of Zagreb, which is 7.0% less than in 2022, when 170.7 million passengers were transported. Trams transported 108.1 million passengers in 2023, 7.1% less than in 2022, when 116.3 million passengers were transported. Buses transported 49.7 million passengers, a decrease of 7.1% compared to 2022, when 53.5 million passengers were transported. In 2023, the funicular transported 522,000 passengers, which, compared to 2022, when 536,000 passengers were transported, represents a decrease of 2.7%.[7]

Public transport

Busses

The bus system in the City of Zagreb is under the jurisdiction of *Zagrebački električni tramvaj* (engl. Zagreb Electric Tramway, ZET), a company owned by the City. The City has 110 bus lines, with 241 vehicles deployed on weekdays, 160 on Saturdays, and 120 on Sundays. Most of the bus lines are connected through 29 terminals, but in addition to these, there are several other terminals located within the tram line system where ZET buses operate.

In 2022, the length of the tram lines was 1,538 km, while the number of seats in trams amounted to 45,459. A total of 26,818,000 km were traveled, and 53,484,000 passengers were transported.[8]

Various transport companies operate intercity lines, connecting Zagreb with all major cities in Croatia, in addition to the City's public bus transport.

Trams

Tram traffic for passengers in the City of Zagreb was opened in 1881, and in 1910 the network was electrified. Tram traffic in the City of Zagreb operates as part of the ZET system, and the fleet consists of 263 tram vehicles, 142 of which are low-floor. In the City area, 15 daytime

[6] Phase I of the Master Plan for the Transport System of the City of Zagreb, Zagreb County, and Krapina-Zagorje County
[7] Press Release on Transportation for 2023
[8] Statistical Yearbook of the City of Zagreb 2023

and 4 nighttime lines connect the City center with its eastern, western, and southern parts. The timetable for daytime trams depends on the time of day and season, with the highest frequency during peak rush hour. In addition to the regular daytime tram lines, four nighttime lines with fixed schedules also operate in the City. The nighttime tram lines cover all parts of the City and connect residential areas with the City center.

In 2022, the length of the tram lines was 208 km, while the number of seats in trams amounted to 45,842. A total of 11,849,000 km were traveled, and 116,303,000 passengers were transported.[9]

Trains

The public railway transport system throughout Croatia and in Zagreb is under the jurisdiction of the company *HŽ Putnički prijevoz* (engl. HŽ Passenger Transport, HŽPP). In the 2023/2024 timetable, HŽPP operates 769 trains, of which 725 are in domestic and 44 in international traffic, depending on the season. In the City area, railway transport connects the eastern and western parts of the City, while in the southern part of the City, the existing railway network is used exclusively for freight transport. Within the City, 143.4 km of railway tracks are in use and 16 stops. In terms of tariffs, passenger railway transport within the City is integrated with ZET, allowing passengers to purchase a combined monthly HŽPP and ZET ticket.

International passenger traffic at the Zagreb hub is organized on 9 lines that run daily, with an average occupancy of 33% of international trains.

Alternative transport

Bicycle

Cycling traffic in the City of Zagreb is on a slight rise, with its share amounting to slightly more than 3%. According to 2022 data, the total length of cycling lanes within the traffic network is 320 km, while the length of sports and recreational paths is 187 km.[9]

[9] Statistical Yearbook of the City of Zagreb 2023

The public bike system has been implemented in Zagreb, but it is not sufficiently developed or integrated with other forms of public transport. The public shared bike system has 22 stations where city bikes can be rented and returned. In collaboration with ZET, the City of Zagreb introduced the BoB – Bike on Bus service in October 2014, allowing citizens to transport their bicycles free of charge on three bus lines. The goal was to increase the number of bus and bicycle users and to encourage residents of the foothill areas to use bicycles.

Pedestrian traffic

Pedestrian traffic in Zagreb is important, especially in the city center and historical areas, where many pedestrian streets are adapted. Some of the most prominent pedestrian zones include the city center (Gornji Grad and Donji Grad) and Ban Jelačić Square, the central square of Zagreb. Bridges and underpasses are also adapted for pedestrians, particularly in train stations and major traffic intersections. Many pedestrian paths pass through parks and green areas, such as Maksimir, Zrinjevac, and Jarun, providing a pleasant walking experience in natural surroundings.

Freight transport

Road transport

The road transport of freight predominantly takes place via the motorway network, which enables truck transport to terminals or the final destination. In the area of the City of Zagreb, the following motorway routes are vital:

- A1 Zagreb-Split-Dubrovnik,
- A2 Zagreb-Macelj,
- A3 Bregana-Zagreb-Lipovac,
- A4 Zagreb-Goričan,
- A11 Zagreb-Sisak.

These routes are used for domestic freight transport and have international significance, as most continue towards Central and Eastern Europe.

Zagreb has three road-rail container terminals: Vrapče, Jankomir, and Žitnjak. The Jankomir and Žitnjak terminals are smaller container terminals compared to Vrapče. They are located in industrial zones and are used for receiving, storing, customs clearance, repackaging, and dispatching goods.

In the City of Zagreb in 2023, a total of 16.2 million tons of goods were transported, which is a 4.8% decrease compared to 2022, while compared to 2019, there was an increase of 0.6%, when a total of 16.1 million tons of goods were transported. In domestic transport, 14.1 million tons of goods were transported, a 4.3% decrease compared to 2022, and in international transport, 2.1 million tons of goods were transported, marking a decrease of 8.2%.[10]

Railway transport

Freight railway traffic in the area of the City of Zagreb operates on railway lines located on two international corridors, as well as on local and regional railways. Freight is brought into the Zagreb area via the Mediterranean corridor of the TEN-T network from the direction of Rijeka and Karlovac to Klara and the marshalling yard in Zagreb. A significant route for the delivery and dispatch of goods is the M101 railway line, which is also part of the Mediterranean TEN-T corridor, extending from the border with the Republic of Slovenia to the City of Zagreb.

Air transport

The cargo terminal for air transport, whose primary function is the transshipment of cargo from air transport to road vehicles for further distribution, is located within Franjo Tuđman International Airport. The mentioned airport is a registered IATA cargo agent that provides services for the reception and dispatch of goods and mail and owns and operates its own cargo warehouses.

The total cargo traffic at Zagreb Airport in 2023 amounted to 9,035 tons, a decrease of 3.5% compared to 2022 when the cargo traffic totaled 9,362 tons.[10] The mentioned cargo traffic

[10] Press Release on Transportation for 2023

at Zagreb Airport refers to loaded and unloaded goods and mail in commercial operations, excluding passenger baggage, while cargo in direct transit is not included.

2.1.1.4 Utilities

Gas power plant at landfill Jakuševec

The City of Zagreb, through the city-owned company *Čistoća* Ltd (part of *Zagreb Holding Company* Ltd), is operating the biggest landfill in the Republic of Croatia – landfill Jakuševec. In 2004, *Čistoća* Ltd developed a gas power plant and gas network as a part of the active degassing system at Jakuševec landfill. The primary task of this landfill's active degassing system is the continuous collection and thermal treatment of the generated landfill gas to ensure general safety, environmental protection, and protection from fire, as well as utilisation of its energy for producing electricity from a renewable energy source.

The gas network consists of 137 permanent wells, a 10 km gas distribution network covering the whole landfill area and 5 degassing lines on which waste is disposed daily. On the other hand, a gas power plant called mTEO Jakuševec, developed in phases over the years consists of 3 high-temperature torches with compressors, 3 gas engines and 3 generators. The nominal capacity of the gas power plant is 3 MW. Additionally, in 2021, *Čistoća* Ltd developed an additional gas power plant, mE Jakuševec 2, which consists of 1 gas engine and 1 generator with a nominal capacity of 1.2 MW. Since its beginning of operation, both gas power plants produced around 230 GWh of electricity. This production unit will continue its operation until 2036 when the feed-in tariff, granted in 2021 for 25 years, will end. Under this feed-in tariff, *Čistoća* Ltd is obliged to deliver all produced electricity to the electricity distribution network.

Water distribution network

The main source of drinking water in the City of Zagreb is the underground water of the Sava alluvium. Drinking water is obtained by pumping from the Zagreb aquifer and, for the western part of the City, from the Samobor - Zaprešić aquifer. These two aquifers are connected in one natural unity. After natural filtration, which lasts for weeks and months, the water in the wells is captured by pumps, disinfected preventively with gaseous chlorine, and distributed to consumers through the water supply network. The basic idea of the water supply system is lifting the water into water tanks, along with the distribution of water to

consumers. Such a water supply system in Zagreb has been functioning since 1878 when the flow capacity was 53.2 L/s distributed along around 4km of water pipeline network. Today, water is pumped from 44 wells at 7 water pumping stations: Sašnjak, Žitnjak, Petruševec, Zapruđe, Mala Mlaka, Strmec, and Velika Gorica, with a total storage capacity of around 120,000 m^3 (41% of daily needs), while the flow capacity is around 310,000 m^3/day distributed along 3,900 km of water pipeline network. The water supply system is responsible for delivering fresh water to around 900,000 inhabitants. However, most of the water distribution network is more than 30 years old which results in around alarming 50% distribution losses. Also, the average level of underground water in the two aforementioned aquifers dropped by more than 3m in the last 20 years.

2.1.2 Emissions

This chapter looks closely at energy consumption and greenhouse gas emissions for the City of Zagreb in 2019. It provides an overview of various sectors and energy carriers. Public lighting is not analysed on its own, but it's considered as part of the Services sector. The energy balance is based on the 2021 Energy and Climate Development pathway of the City of Zagreb for 2030 with an outlook for 2050[11].

The total energy consumption of the City of Zagreb in 2019 was 12.424232 TWh. Among the sectors, Households are the largest consumers, accounting for 4.503281 TWh (36%), followed closely by Mobility and Services at 3.839586 TWh (31%) and 2.654058 TWh (22%), respectively. The industry sector contributed to 1.385279 TWh (11%), while the Agriculture sector registered the lowest consumption, amounting to 0.042028 TWh (less than 1%) (Table 2, Figure 3 and Figure 4).

The highest energy consumption was attributed to Natural gas, accounting for 3.069947 TWh (25%). This was closely followed by Diesel and Electricity, contributing 2.869891 TWh (23%) and 2.766336 TWh (22%) respectively. District Heating represented 1.578307 TWh (13%), while Petrol accounted for 0.907917 TWh (7%). The utilisation of additional fuels,

[11] Energy Institute Hrvoje Požar, 'Energy-Climate Development Framework of the City of Zagreb until 2030 with a Perspective to 2050'

including Firewood, Light fuel oil, LPG, Biodiesel, Biomass, Solar, PNG, Geothermal and Coal, collectively constituted the remaining 10% of consumption (Table 2, Figure 3 and Figure 5).

Table 2 Energy consumption of the City of Zagreb in 2019

TWh	Households	Services	Industry	Agriculture	Mobility	Total
Electricity	0.922112	1.294612	0.454695	0.001111	0.093806	2.766336
Natural gas	2.012779	0.813445	0.240834	0.002889	0.000000	3.069947
Petrol	0.000000	0.000000	0.009917	0.001250	0.896751	0.907917
Diesel	0.000000	0.000000	0.223028	0.034417	2.612447	2.869891
Light fuel oil	0.048639	0.189833	0.036361	0.002361	0.000000	0.277195
LPG	0.036472	0.059917	0.009111	0.000000	0.122445	0.227945
Coal	0.000972	0.000000	0.000000	0.000000	0.000000	0.000972
Firewood	0.494000	0.012000	0.001250	0.000000	0.000000	0.507250
Biogas	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Solar	0.024528	0.010500	0.000000	0.000000	0.000000	0.035028
Geothermal	0.000000	0.007139	0.000000	0.000000	0.000000	0.007139
DH	0.906973	0.261250	0.410084	0.000000	0.000000	1.578307
Biomass	0.056806	0.005361	0.000000	0.000000	0.000000	0.062167
LNG	0.000000	0.000000	0.000000	0.000000	0.032889	0.032889
Biodiesel	0.000000	0.000000	0.000000	0.000000	0.081250	0.081250
Total	4.503281	2.654058	1.385279	0.042028	3.839586	12.424232

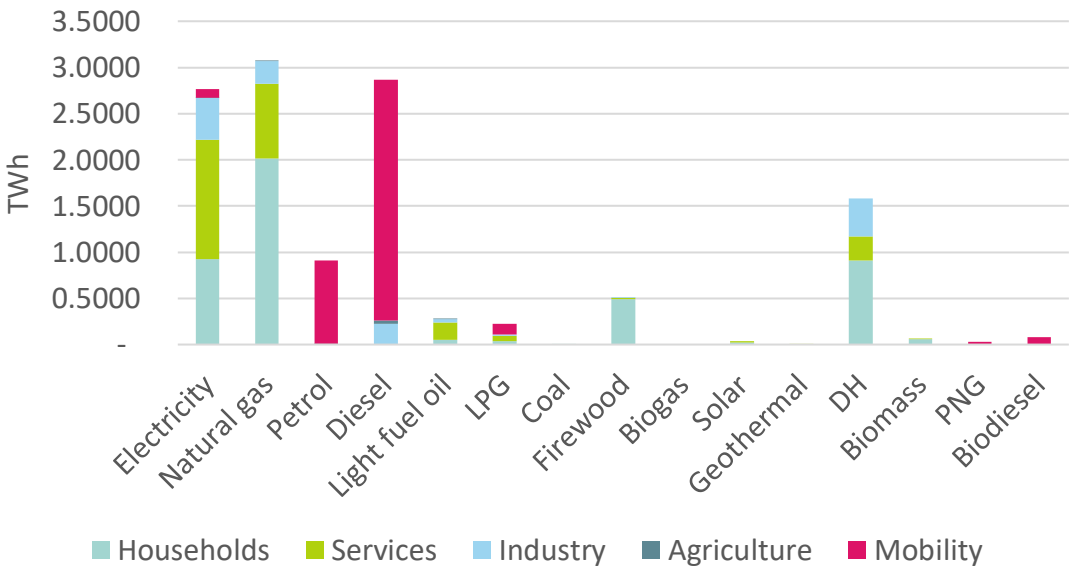


Figure 3 Energy consumption of the City of Zagreb in 2019

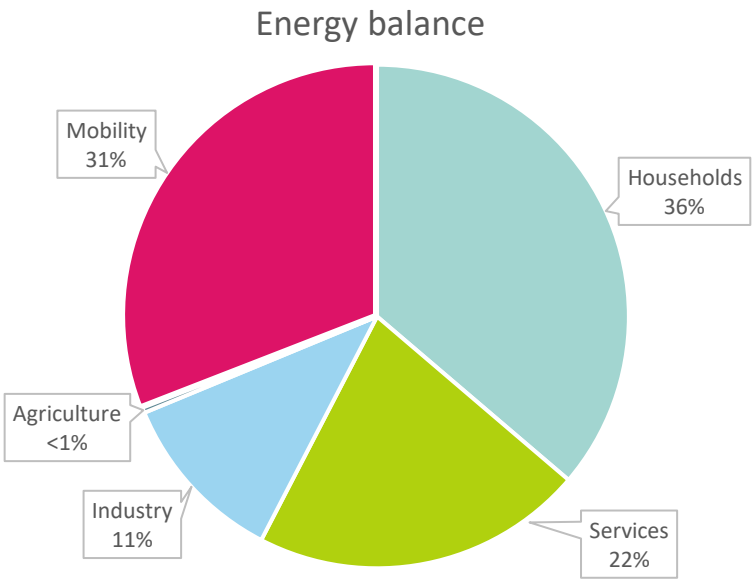


Figure 4 Energy Balance per sector

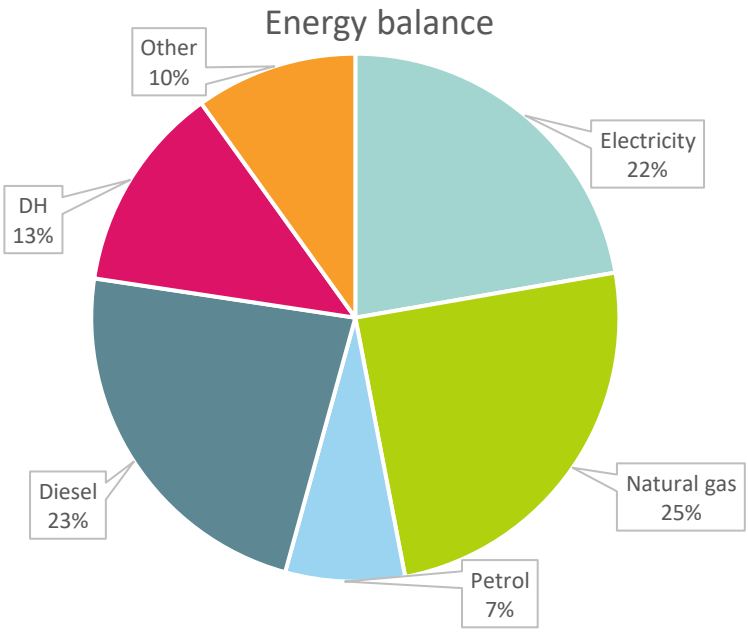


Figure 5 Energy balance per fuel

Emissions were calculated using emission factors from the Guidelines on the methodology for calculating emissions factors and removing greenhouse gas emissions published by the Croatian Ministry of Economy and Sustainable Development in 2022[12].

[12] Ministry of Economy and Sustainable Development, "Guide on the Methodology for Calculating Greenhouse Gas Emission and Removal Factors"

The total GHG emissions of the City of Zagreb in 2019 were 2,927,203.98 tCO_2. Among the sectors, Mobility is the largest emitter, accounting for 1,112,494.44 tCO_2 (38%), followed closely by Households with 916,099.04 tCO_2 (31%). Services and Industry amount to 556,373.30 tCO_2 (19%) and 329,806.94 tCO_2 (11%), while Agriculture contributes 12,430.26 tCO_2 (less than 1%) (Table 3, Figure 6 and Figure 7).

The highest GHG emissions were attributed to Diesel, totalling 875,383.97 tCO_2 (30%). Following were Natural gas and Electricity, contributing 712,554.89 tCO_2 (24%) and 476 386.40 tCO_2 (16%) respectively. District heating accounted for 428,405.82 tCO_2 (15%), while Petrol emissions amounted to 261,724.62 tCO_2 (9%). Additionally, the GHG emissions from additional fuels, including Light fuel oil, LPG, Firewood, PNG, Biomass, and Coal, comprised the remaining 6% of emissions collectively (Table 3, Figure 6 and Figure 8).

The table provides a full baseline in CO2 equivalents meaning that all greenhouse gases have been accounted for. This table is the baseline.

Table 3 GHG emissions of the City of Zagreb in 2019

tCO_2	Households	Services	Industry	Agriculture	Mobility	Total
Electricity	158,795.47	222,943.17	78,302.30	191.34	16,154.12	476,386.40
Natural gas	467,179.35	188,805.96	55,899.05	670.53	0.00	712,554.89
Petrol	0.00	0.00	2,858.67	360.34	258,505.61	c
Diesel	0.00	0.00	68,028.75	10,497.90	796,857.33	875,383.97
Light fuel oil	14,629.22	57,096.56	10,936.41	710.16	0.00	83,372.34
LPG	9,723.26	15,973.39	2,428.96	0.00	32,642.89	60,768.50
Coal	388.68	0.00	0.00	0.00	0.00	388.68
Firewood	16,693.29	405.51	42.24	0.00	0.00	17,141.04
Biogas	0.00	0.00	0.00	0.00	0.00	0.00
Solar	0.00	0.00	0.00	0.00	0.00	0.00
Geothermal	0.00	0.00	0.00	0.00	0.00	0.00
DH	246,183.12	70,912.14	111,310.57	0.00	0.00	428,405.82
Biomass	2,506.66	236.57	0.00	0.00	0.00	2,743.23
PNG	0.00	0.00	0.00	0.00	8,334.48	8,334.48
Biodiesel	0.00	0.00	0.00	0.00	0.00	0.00
Total	916,099.04	556,373.30	329,806.94	12,430.26	1,112,494.44	2,927,203.98

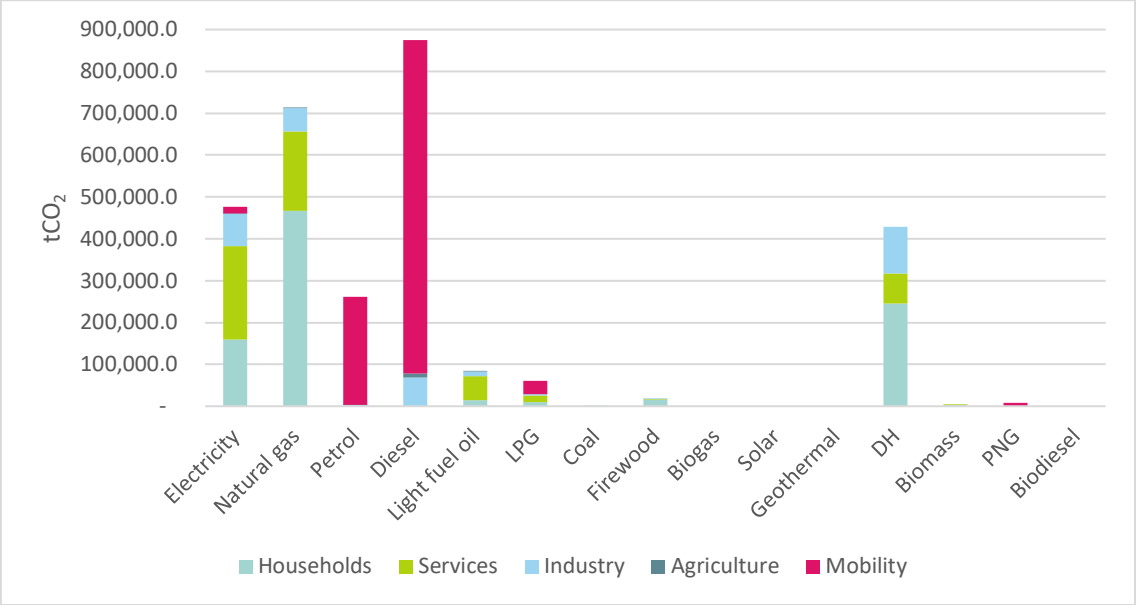


Figure 6 GHG emissions of the City of Zagreb in 2019

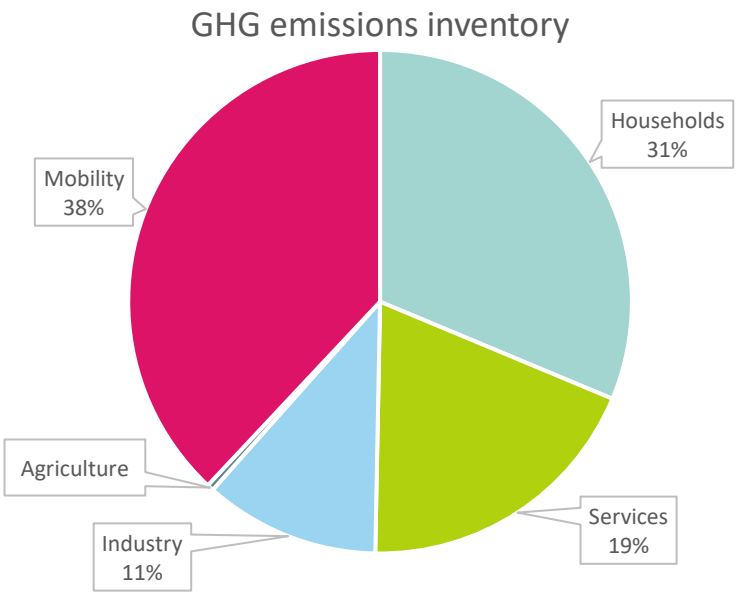


Figure 7 GHG emissions inventory per sector

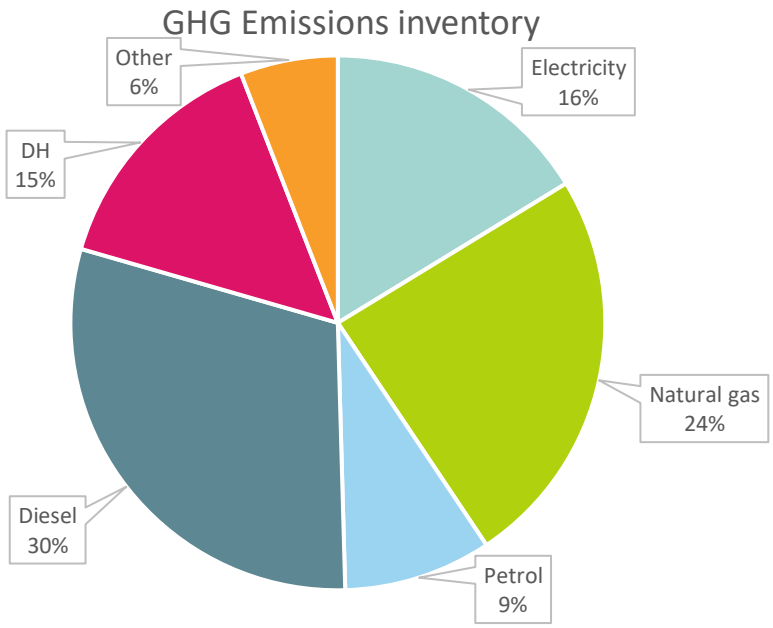


Figure 8 GHG emissions inventory per fuel

The Climate City Contract (CCC) takes a comprehensive approach to its Greenhouse Gas (GHG) inventory, encompassing all emissions within the city's territorial boundaries, including mobility and transport. While the current inventory integrates all available emissions data as CO2 equivalents, the city recognizes the need for further granularity in detailing regions with high energy consumption, areas of intense traffic density, and sector-specific emissions (e.g., CH_4 and N_2O) compared to a baseline.

To address these gaps, the city is committed to enhancing its data collection and analysis capabilities. Efforts will focus on developing mechanisms to reliably map high-energy consumption regions, identify local areas with significant traffic congestion during peak hours, and further disaggregate emissions from transport categories such as cars, motorcycles, light trucks, heavy trucks, and buses.

Although current limitations in data resolution exist, the city plans to strengthen its methodologies and collaborate with relevant stakeholders to ensure accurate, detailed, and actionable insights. This iterative process will support the continuous refinement of the GHG inventory, providing a robust foundation for informed decision-making and targeted climate action in the future.

Zagreb's extensive green infrastructure, which comprises approximately 72% of its urban area or about 46,152 hectares, presents a substantial potential in the context of AFOLU (Agriculture, Forestry, and Other Land Use) strategies for carbon sequestration. This preliminary estimate, suggesting that these green spaces could sequester around 461,520 tonnes of CO2 annually, based on an average of 10 tonnes per hectare per year, highlights the critical role of urban forestry and land use in mitigating climate change. However, this is a rough estimate that necessitates further refinement and more precise data collection to fully integrate these natural resources into Zagreb's Climate City Contract Action Plan. Enhanced monitoring and verification are required to ensure that these green spaces are accurately evaluated for their carbon offset capabilities, aligning with broader environmental sustainability goals. This approach will also support the development of targeted policies and practices that promote effective land management and urban planning strategies within the AFOLU framework.

The current scope of the Climate City Contract (CCC) does not include emissions from Industrial Processes and Product Use (IPPU) or Agriculture, Forestry, and Other Land Use (AFOLU) in detail, only the rough estimate for AFOLU as staeted above. However, the city acknowledges the importance of these sectors in achieving comprehensive climate action.

As part of future iterations of the CCC, a detailed plan to incorporate IPPU and AFOLU emissions into the GHG inventory will be developed. This plan will include:

1. Baseline Data Development: Establishing methodologies for quantifying emissions from IPPU and AFOLU, including identifying key emission sources and determining appropriate data collection processes.
2. Stakeholder Engagement: Collaborating with industry representatives, agricultural stakeholders, and forestry management entities to co-create actionable strategies and ensure accurate data inputs.
3. Rationale and Action Plans: Outlining the rationale for including these sectors and developing targeted action plans to address emissions reduction and sustainable practices in industrial processes, agriculture, and land use management.

4. Policy Integration: Aligning these actions with national and international frameworks to enhance accountability and facilitate resource mobilization.

The inclusion of IPPU and AFOLU will be guided by an iterative approach that builds on existing data while strengthening the city's capacity for comprehensive climate governance. By integrating these sectors, the CCC will advance its mission of fostering a sustainable, climate-resilient city.

2.1.2.1 Households

In the City of Zagreb, Households have the highest share in energy consumption, accounting for 36% of the total, equivalent to 4,503,281 MWh. They also contribute significantly to GHG emissions, representing 31% of the city's emissions at 916,099.04 tCO_2. The largest portion of Household energy expenditure is attributed to Natural gas usage, totalling 2,012,779 MWh, which also generates the highest emissions within the household sector, reaching 467,179.35 tCO_2. Other notable energy consumptions include Electricity (922,112 MWh), District Heating (906,973 MWh), and Firewood (494,000 MWh). Following Natural gas, District Heating has the next highest emissions, amounting to 246,183.12 tCO_2, trailed by Electricity with 158,795.47 tCO_2. Emissions from other fuels remain significantly lower in comparison (Figure 9 and Figure 10).

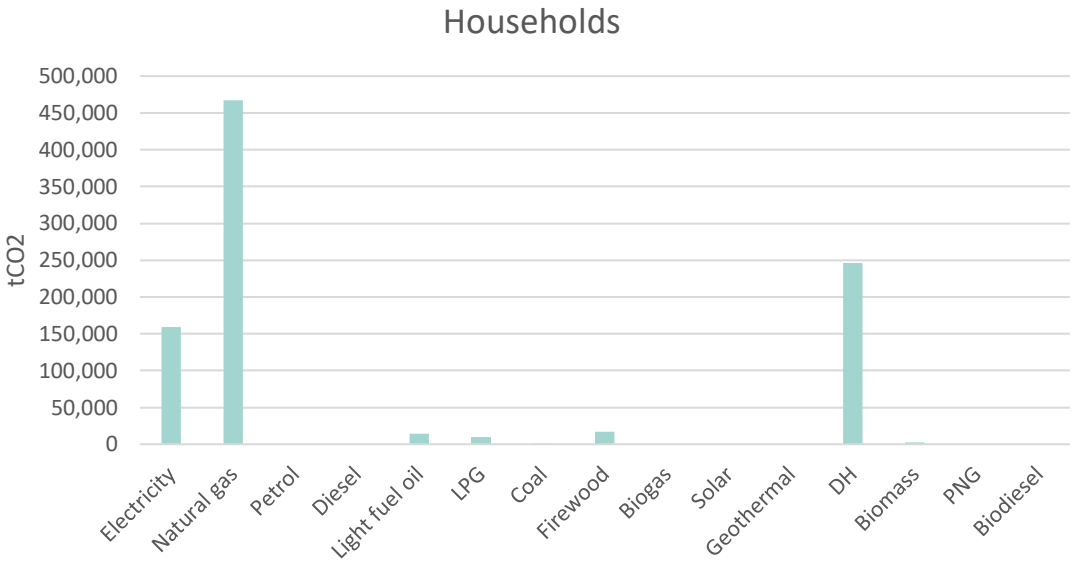


Figure 9 Energy consumption of the Household sector

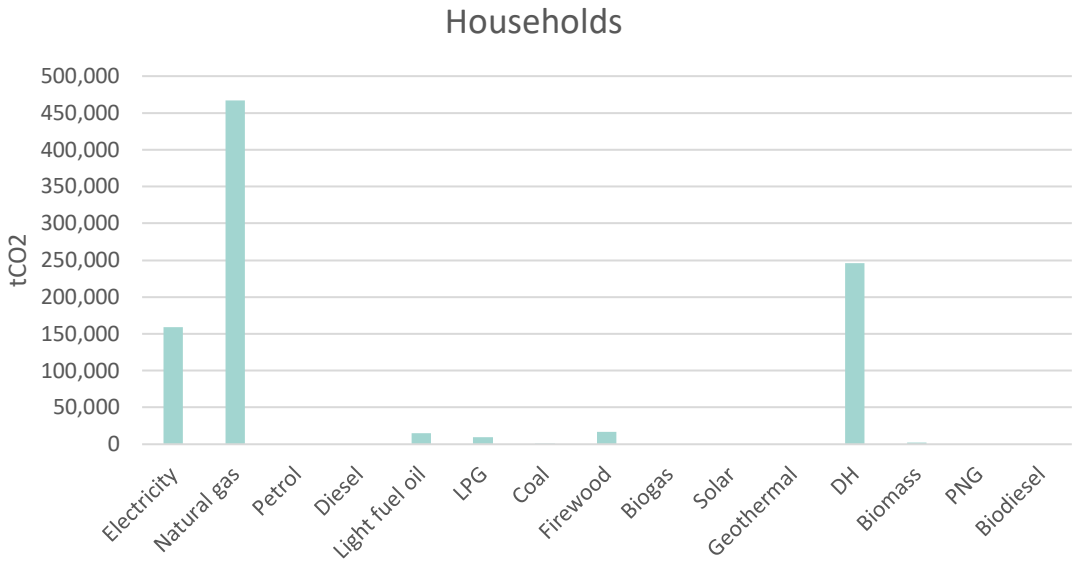


Figure 10 GHG emissions of the Household sector

2.1.2.2 Services

In the City of Zagreb, the Services sector accounts for 22% of total energy consumption and 19% of greenhouse gas emissions, equating to 2,654,057.7 MWh and 556,373.3 tCO2, respectively. Within this sector, Electricity stands out with the highest energy consumption and GHG emissions, with consumption totalling 1,294,612.1 MWh and emissions reaching 222,943.2 tCO2. Following closely behind is Natural gas, responsible for 813,445.1 MWh of energy consumption and emissions of 188,806.0 tCO2. District heating contributes to 261,250.2 MWh of energy consumption and emissions of 70,912.1 tCO2. Other fuels such as Light fuel oil, LPG, Firewood, and Solar make comparatively smaller contributions to both energy consumption and greenhouse gas emissions within the Services sector (Figure 11 and Figure 12).

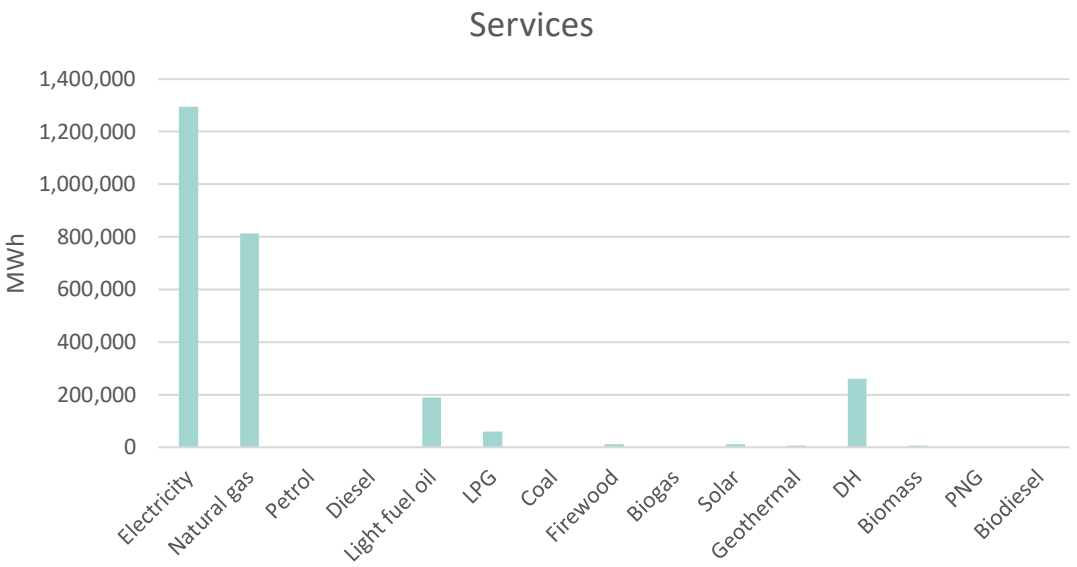


Figure 11 Energy consumption of the Services sector

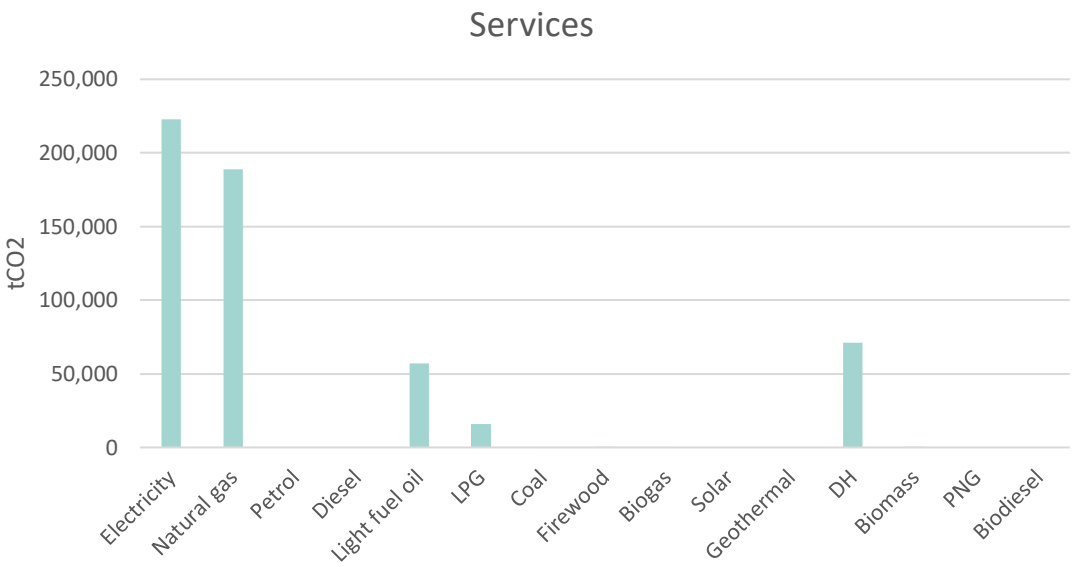


Figure 12 GHG emissions of the Services sector

2.1.2.3 Mobility

Mobility ranks as the second-largest energy consumer in the City of Zagreb, accounting for 31% of total consumption, and the sector with the highest GHG emissions, contributing 38%. This translates to a consumption of 3,839,586.4 MWh and emissions of 1,112,494.4 tCO2. Among the fuels utilised within this sector, Diesel stands out as the most extensively used and the primary contributor to GHG emissions, amounting to 2,612,446.5 MWh of energy consumption and emissions of 796,857.3 tCO2. Following is Petrol, with a consumption of 896,750.7 MWh and emissions of 258,505.6 tCO2. Other fuels such as LPG, Electricity, Biodiesel, and PNG play a considerably smaller role in energy consumption and GHG emissions within the mobility sector (Figure 13 and Figure 14).

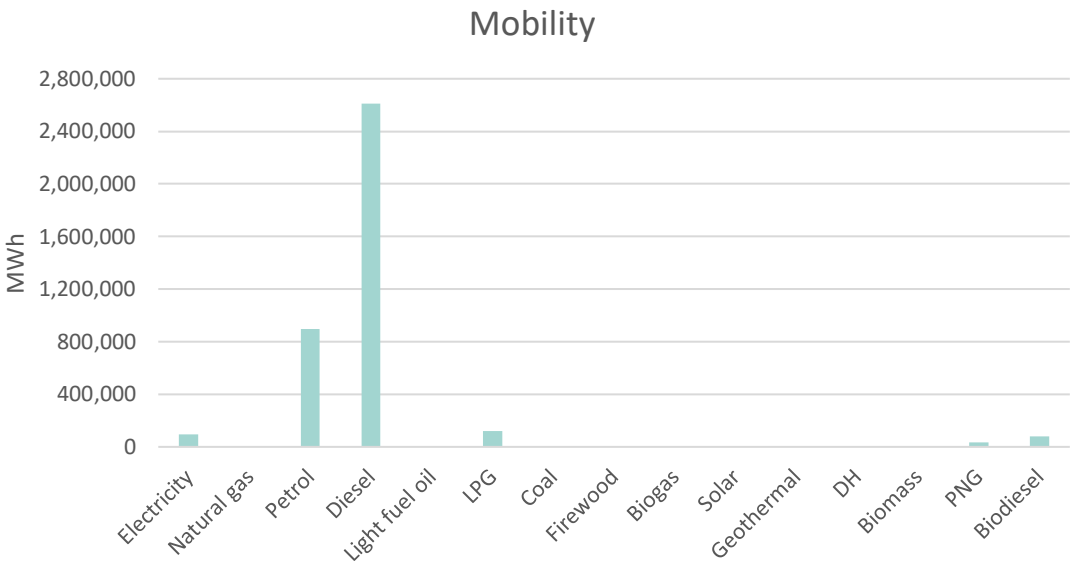


Figure 13 Energy consumption of the Mobility sector

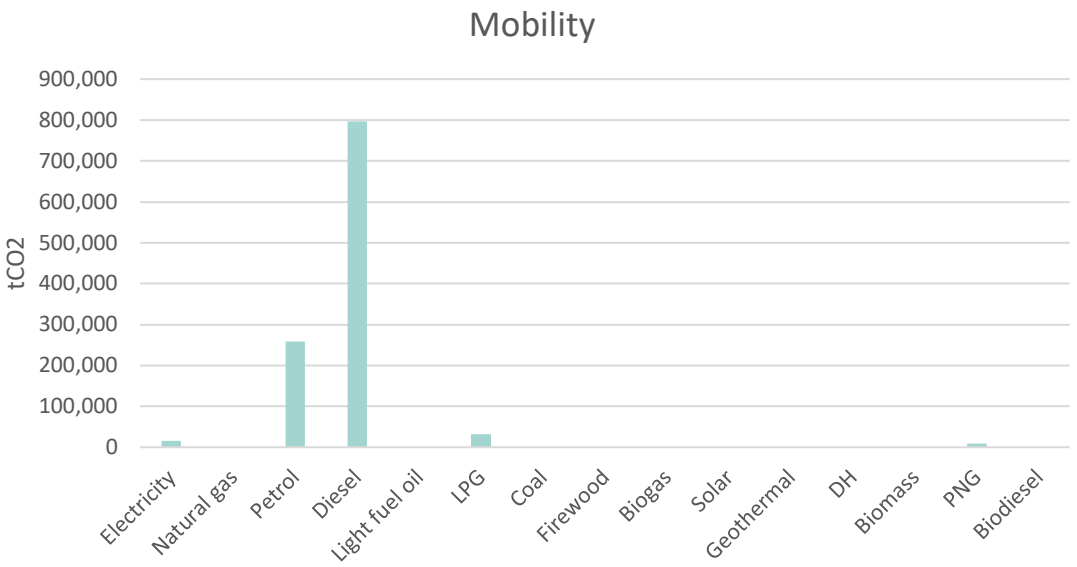


Figure 14 GHG emissions of the Mobility sector

2.1.2.4 Industry

The industry sector in the City of Zagreb exhibits the second-lowest energy consumption and greenhouse gas emissions, each constituting 11% of the total, amounting to 1,385,278.9 MWh and 329,806.9 tCO_2, respectively. Electricity is the primary energy source within this sector, accounting for 454,694.8 MWh of energy consumption, followed by District Heating with 410,083.7 MWh, Natural gas with 240,833.5 MWh, and Diesel with 223,028.0 MWh. In terms of emissions, District Heating leads with 111,310.6 tCO_2, followed by Electricity with 78,302.3 tCO_2, Diesel with 68,028.7 tCO_2, and Natural gas with 55,899.0 tCO_2. Other fuels such as Light fuel oil, Petrol, and LPG play a considerably smaller role in both energy consumption and greenhouse gas emissions within the Industry sector (Figure 15 and Figure 16).

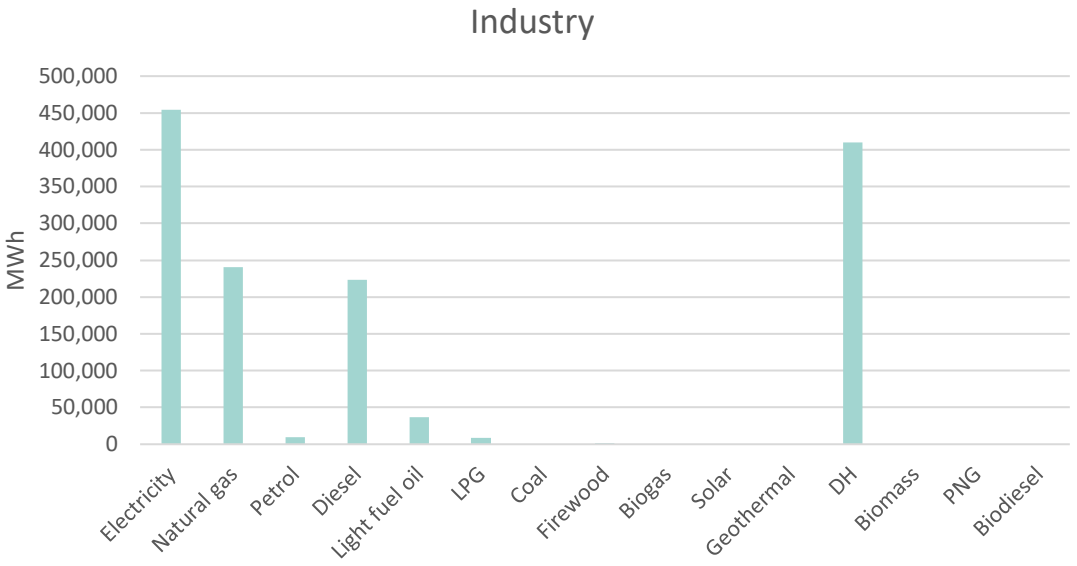


Figure 15 Energy consumption of the Industrial sector

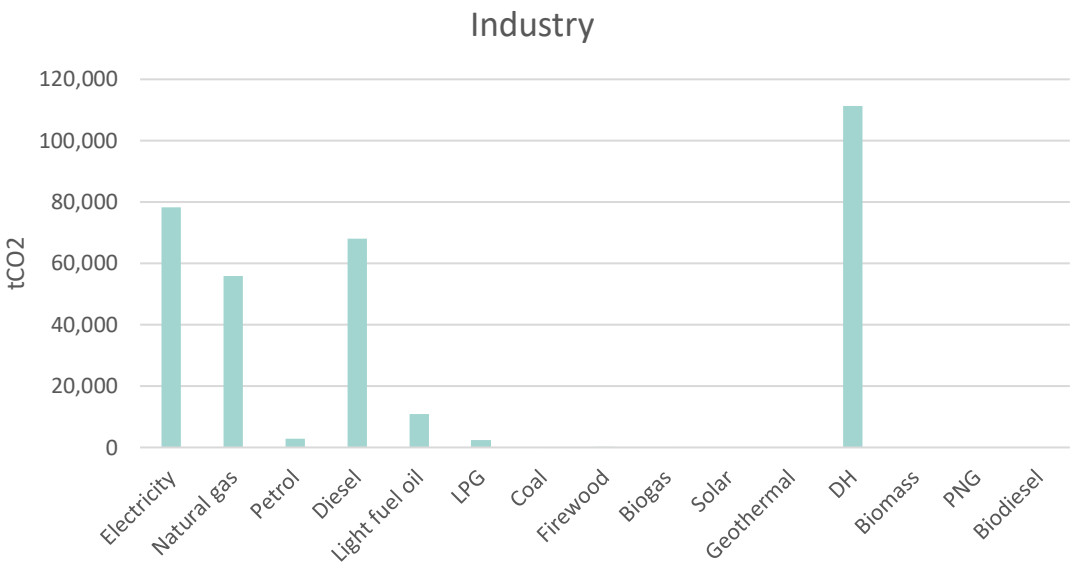


Figure 16 GHG emissions of the Industrial sector

2.1.2.5 Agriculture

The agricultural sector in the City of Zagreb accounts for less than 1% of both energy consumption and GHG emissions, totalling 42,027.8 MWh and 12,430.3 tCO_2, respectively. Diesel is the predominant fuel within this sector, with energy consumption of 34,416.7 MWh and GHG emissions of 10,497.9 tCO_2. Other fuels such as Natural gas, Light fuel oil, Petrol, and Electricity play a significantly smaller role in both energy consumption and GHG emissions within the Agriculture sector (Figure 17 and Figure 18).

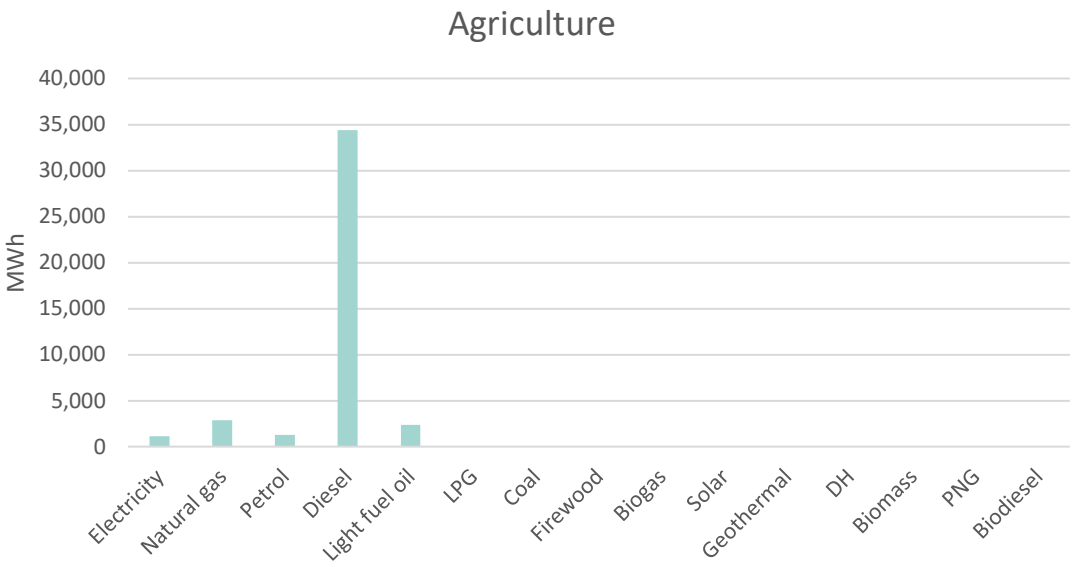


Figure 17 Energy consumption of the Agricultural sector

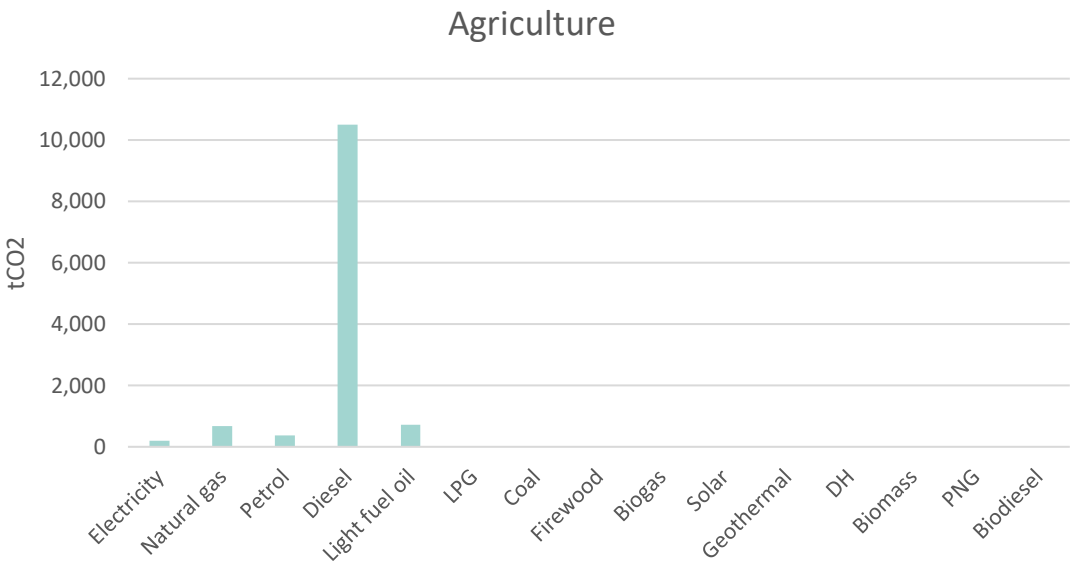


Figure 18 GHG emissions of the Agricultural sector

2.2 Module A-2 Current Policies and Strategies Assessment

At the national level in the Republic of Croatia, there are many laws and regulations governing energy, climate, and mobility. In the sector of energy, the most prominent national laws include the Energy Act, the Electricity Market Act, the Gas Market Act, the Liquefied Natural Gas Terminal Act, the Heat Energy Market Act, the Oil and Oil Derivatives Market Act, the Biofuels for Transport Act, the Energy Activities Regulation Act, the Renewable Energy Sources and High-Efficiency Cogeneration Act, the Energy Efficiency Act, and the Implementation of Council Regulation (EU) 2022/1854 on urgent intervention to address high energy prices Act. These laws form the legal framework guiding activities in the energy sector, ensuring alignment with the EU's energy objectives.

In addition to the array of national laws and regulations, the Republic of Croatia has a Strategy for Energy Development of the Republic of Croatia until 2030, with a perspective towards 2050. This strategy represents a crucial step towards realising the vision of low-carbon energy, ensuring a smooth transition into a new era of energy policy. Central to this strategy is the assurance of an affordable, secure, and high-quality energy supply without imposing additional burdens on the state budget, achieved within the framework of state aid and incentives.

At the national level, legislation concerning climate encompasses a range of laws to mitigate climate change and protect the ozone layer. The Climate Change and Ozone Layer Protection Act delineates climate change mitigation, adaptation, and ozone layer protection responsibilities. It addresses key aspects such as greenhouse gas emission monitoring and reporting, emissions trading systems, aviation activities, substances harmful to the ozone layer, financing for climate mitigation and adaptation, and administrative oversight. Additionally, regulations like the Biofuel Quality Regulation set standards for the quality of biofuels on the domestic market, including assessment and compliance verification criteria. Furthermore, the Distribution plan for greenhouse gas emission quotas in Croatia and numerous other regulations contribute to the comprehensive legal framework to combat climate change and safeguard the environment.

In the mobility sector, The Road Act, Road Traffic Safety Act, Railway Act, Railway Safety and Interoperability Act, Air Traffic Act, and Act on Transport in Regular and Occasional Coastal

Maritime Traffic establish regulatory frameworks to enhance safety, efficiency, and sustainability in transportation. Additionally, the Act on Promoting Clean Vehicles in Road Transport encourages the adoption of low-emission and alternative fuel vehicles, further aligning the transportation sector with climate goals. These laws collectively address various aspects of transportation, including infrastructure development, safety standards, emissions reduction strategies, and promoting sustainable modes of transport, contributing to national efforts in combating climate change.

Regarding local and regional planning and associated responsibilities, the Spatial Planning Act establishes a structured system to ensure coherence and effectiveness in spatial development initiatives. Secondly, the Regional Development Act outlines policies and spatial plans vital for regional growth and sustainability. Additionally, the Act on Local and Regional Self-Government incorporates spatial and urban planning provisions, granting local and regional authorities the authority to manage their territories efficiently. Together, these laws provide a solid framework for spatial development, aligning local and regional plans with national strategies.

Transitioning from national policies to local initiatives and strategies, The City of Zagreb was among the first European capital cities to join the Covenant of Mayors, a significant initiative launched by the European Commission in January 2008. Following a consultation process on the future of the Covenant of Mayors, the European Commission introduced a new integrated Covenant of Mayors for Climate and Energy on October 15, 2015, surpassing the set targets for 2020. The City of Zagreb has developed its Sustainable Energy and Climate Action Plan (SECAP), aligning its efforts with the Covenant's objectives and outlining specific strategies and actions to achieve these ambitious emission reduction targets. The indicative target for reducing CO_2 emissions by 40% compared to 2008 levels was set, amounting to 1,118,000 tons of CO_2 emissions for the City of Zagreb.

Additionally, the City has developed the Energy-Climate Development Framework for the City of Zagreb until 2030, with a perspective towards 2050. This framework encompasses an analysis of two scenarios for developing the City's energy sector. The first scenario, termed the Reference Scenario, delineates future energy flow trends in line with anticipated technological advancements and structural changes in energy consumption and production primarily driven by market principles, with limited proactive involvement from the City of

Zagreb in shaping and implementing energy and climate measures. Conversely, the second scenario, the Climate Neutrality Scenario, assumes the implementation of active policies to support energy transition within the City of Zagreb. This scenario entails a model incorporating eleven elaborated measures across various sectors, each with defined activities. Also, the City of Zagreb is currently developing its Climate adaptation plan.

The progression from the SECAP to the Energy-Climate Development Framework demonstrates the City of Zagreb's evolving commitment to combating climate change and transitioning towards sustainability. With the initial focus on emission reduction targets set by the SECAP, the subsequent Energy-Climate Development Framework broadens the scope to encompass a longer-term vision, extending its perspective to 2050 and outlining proactive strategies for achieving climate neutrality. These documents reflect a growing ambition and dedication to environmental actions, moving from reduction targets to a comprehensive plan with different scenarios.

Within the energy and climate planning framework, spatial planning documentation of the City of Zagreb also plays a significant role. Among these documents is the General Urban Development Plan of the City of Zagreb. It establishes the fundamental spatial organisation, protection of natural, cultural, and historical values, land use and purpose, and proposed conditions and measures for their regulation. Covering an area of approximately 220 km2, the plan encompasses the inner urban area between the Medvednica mountain range and the Zagreb bypass road, including its historical centre. Additionally, other spatial plans contribute to Zagreb's comprehensive spatial management strategy, ensuring alignment between spatial development objectives.

Moreover, the City of Zagreb is a member of several prominent associations committed to sustainable development and climate action. These include the above-mentioned Covenant of Mayors, Energy Cities, Eurocities, and ACR+ (Association of Cities and Regions for Sustainable Resource Management).

In Croatia, the legal and policy landscape governing energy, mobility, and climate actions is predominantly centralized at the national level, leaving local and regional authorities with limited capacity to create and implement their own policies, yet they do, as the SECAPs and

CCC are the examples on how cities are moving forward with ambition. This centralization stems from the overarching role of national legislation in shaping the country's climate, energy, and mobility strategies. Several key national policies, including the Energy Act, Renewable Energy Sources and High-Efficiency Cogeneration Act, and National Energy and Climate Plan (NECP), guide the overall approach to energy transitions and emissions reductions.

National Level Policies and Regulations:

1. Energy Sector:
   Croatia's Energy Act and the Renewable Energy Sources and High-Efficiency Cogeneration Act promote sustainable energy transitions by encouraging renewable energy production, enhancing energy efficiency, and reducing dependency on fossil fuels. The National Energy and Climate Plan (NECP) further drives Croatia's goals of meeting EU climate targets, focusing on increasing the share of renewable energy in the energy mix and promoting energy efficiency measures.
2. Mobility Sector:
   The Act on Promoting Clean Vehicles in Road Transport and regulations such as the Road Traffic Safety Actfocus on reducing emissions from the transportation sector. These regulations support the adoption of low-emission and alternative fuel vehicles while improving infrastructure to meet EU sustainability standards.
3. Climate Change Policy:
   At the national level, the Climate Change and Ozone Layer Protection Act and accompanying regulations outline efforts to monitor and report greenhouse gas (GHG) emissions, implement emissions trading systems, and tackle substances harmful to the ozone layer. The overarching goal is to align national climate actions with EU climate strategies and commitments.

Local and Regional Governance Challenges:

Despite these comprehensive national frameworks, local and regional authorities in Croatia face challenges in driving sectoral change independently. The capacity for local authorities to craft and implement climate policies is limited by:

- Centralized Decision-Making: Most climate and energy policies, including those for mobility and energy efficiency, are dictated by national laws and EU regulations. This reduces the flexibility of local and regional governments to tailor policies to specific regional needs or local contexts.
- Broad Policy Frameworks: National policies, while robust, tend to be broad and generalized. They mostly focus on the energy and mobility sectors, with less emphasis on other domains such as industrial processes or agriculture, which may be relevant for a comprehensive Climate City Contract (CCC). As such, there is little additional localized data or information that can be readily provided for sectors outside of these frameworks.
- Lack of Local Implementation Capacity: Regional and local governments are often tasked with implementing national policies but lack the resources and administrative capacity to enforce them effectively or to develop localized solutions. This makes it challenging for local authorities to make meaningful progress in addressing emissions or to adapt strategies based on specific local needs.

In summary, while Croatia's national policies provide a solid foundation for climate and energy action, local and regional authorities face challenges due to the centralized nature of governance. For the Climate City Contract to be successful, it will focus on leveraging national policies while addressing sector-specific gaps and enhancing local capacity for implementation.

Policy overview:

Climate Policy	Policy Status (Enacted, In Process, Development, etc.)	Description of the policy (sector, targeted audience, etc.)	Intended Outcome for Capital Formation
European green deal (EU LEVEL)	Enacted	The aim of The European Green Deal is sustainable EU's economy and transforming it into a resource-efficient and low-carbon system. It encompasses various policy initiatives and measures to address climate change, promote clean energy, enhance biodiversity, and foster a circular economy.	The goal is to achieve climate neutrality by 2050, meaning the EU aims to balance the amount of greenhouse gases emitted with the amount removed from the atmosphere. The European Green Deal also seeks to create green jobs, improve energy efficiency, and ensure a just transition for regions and industries most affected by the transformation.

			Relevant areas: Energy systems, Mobility & transport, built environment.
Energy efficiency directive (EU LEVEL)	Enacted	Energy Efficiency Directive aims to boost overall energy efficiency, align with the EU's 55% emission reduction target by 2030, and require EU countries, including, to collectively achieve an additional 11.7% reduction in energy consumption by 2030, with a focus on critical sectors.	Under the revised directive, and as part of their energy efficiency obligation schemes, EU countries will be required to achieve an average annual energy savings rate of 1.49% from 2024 to 2030, up from the 2021-2023 requirement of 0.8%, driving energy savings in critical sectors like buildings, industry, and transport. In addition, to underline the exemplary role to be played by the public sector, there is a new annual energy consumption

			reduction target of 1.9% for the public sector as a whole and the annual 3% buildings renovation obligation is being extended to all levels of public administration. Relevant areas: Energy systems
EU hydrogen strategy (EU LEVEL)	Enacted	The EU strategy on hydrogen (COM/2020/301) was adopted in 2020 and suggested policy action points in 5 areas: investment support; support production and demand; creating a hydrogen market and infrastructure; research and cooperation and international cooperation.	While the direct impact of the EU's hydrogen strategy on Zagreb's emissions reduction targets may vary based on the city's specific implementation plans and adoption of hydrogen technologies, integrating hydrogen into the energy mix (included in this Action plan)presents opportunities to

			transition towards cleaner energy sources, contributing to the city's emissions reduction objectives already for 2030. Relevant areas: Energy systems, mobility
National energy and climate plan of the Republic of Croatia (NECP) (National level)	Enacted	Action plan sets key objectives measures and targets by 2030 through five defined dimensions: decarbonisation, energy efficiency, energy security, internal energy market, R&D and competitiveness.	Croatia aims to decrease emissions by 50,2% (ETS) 16,7(Non - ETS), Increase the RES production by 42,5% Relevant areas: Energy systems, Mobility & transport, Built environment.
Climate Change Adaptation Strategy	Enacted	This strategy aims to prepare Croatia to cope with and adapt to the impacts of climate change. It includes measures	Enhancing Croatia's ability to cope with climate-related hazards, reducing potential economic losses

		for mitigation as part of a broader approach to enhance resilience to climate-related hazards.	due to climate impacts, and improving infrastructure resilience.
Croatian Low Carbon Development Strategy	Enacted	This strategy outlines Croatia's framework for achieving significant reductions in greenhouse gas emissions across various sectors. It sets specific emission reduction targets in line with EU commitments and details the transition toward a low-carbon economy.	Supporting the transition to a low-carbon economy, fostering green investments, and driving technological innovation in renewable energy and emissions reduction technologies.
Energy Development Strategy up to 2030 with a View to 2050	Enacted	This strategic document sets forth a vision for the future of energy in Croatia, emphasizing the enhancement of energy independence, sustainability, and competitiveness. It focuses on increasing the share	Increasing the share of renewable energy, improving energy efficiency, and reducing greenhouse gas emissions while ensuring energy security and fostering economic growth through green industries.

		of renewable energy sources, improving energy efficiency, and reducing greenhouse gas emissions.	
Long-term strategy for the restoration of the national building fund until 2050	Enacted	This strategy supports the renovation of residential and non-residential buildings, both public and private, aiming to transform the existing building stock into an energy-efficient and decarbonized fund by 2050. It sets long-term renovation goals and assesses required investments.	Identify effective measures for cost-efficient integral renovation, achieve a 55% reduction in greenhouse gas emissions by 2030 (compared to 1990 levels), and meet the Renovation Wave initiative's goal of reducing emissions from buildings by 60%. Gradually increase the renovation rate from 0.7% to 4% of the total building stock by 2050. Enhance building resilience to seismic activity and integrate energy and seismic renovations.

National Renewable Energy Action Plan	Enacted	This plan details Croatia's targets for increasing the contribution of renewable energies in its total energy mix, a key component in reducing CO2 emissions. It outlines specific actions and measures for the development of solar, wind, biomass, and hydroelectric energy projects.	Reducing CO2 emissions by increasing renewable energy production, driving investments in solar, wind, biomass, and hydropower projects, and supporting local green jobs in these industries.
Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) Regulations	Enacted	These assessments are crucial for ensuring that any plans, programs, or projects that might significantly affect the environment are evaluated and mitigated as necessary, focusing on protecting biodiversity, reducing pollution, and promoting sustainable	Ensuring that development projects consider environmental impacts, leading to more sustainable land use and infrastructure development, and reducing the risk of ecological damage.

		development practices.	
Transport development strategy of the Republic of Croatia for the period from 2017 to 2030	Enacted	This strategy includes provisions for reducing emissions through improved public transport systems, promotion of electric vehicles, and development of cycling infrastructure. It aligns with broader goals of reducing the transport sector's carbon footprint.	Reducing the carbon footprint of the transport sector, fostering the adoption of clean vehicles, and improving public transportation infrastructure, contributing to cleaner, more sustainable urban environments.
Waste management plan of the Republic of Croatia for the period 2023 - 2028	Enacted	While primarily focused on reducing waste and improving recycling rates, this plan contributes to climate change mitigation by reducing methane emissions from landfills and promoting energy recovery from waste.	Reducing methane emissions from landfills, increasing energy recovery from waste, and promoting circular economy practices, driving investments in recycling infrastructure and green waste management technologies.
EU Emissions Trading System (EU ETS) Implementation	Enacted	Croatia adheres to this EU-wide system for trading greenhouse gas	Limiting CO2 emissions by enforcing caps and promoting

		emission allowances. This cap-and-trade system covers the power generation, industrial sectors, and airlines, enforcing caps on CO2 emissions and requiring entities to hold sufficient emission allowances.	investment in cleaner technologies and emissions reduction strategies across covered sectors, contributing to overall emissions reduction targets.
Act on Environmental Protection	Enacted	This act serves as the foundation for environmental protection policies in Croatia, including climate change mitigation. It sets out general principles for environmental management, the responsibilities of public authorities and businesses, and the legal framework for pollution control, waste management, and air quality control.	Supporting the creation of a sustainable environment through pollution control, responsible waste management, and the enforcement of air quality standards, driving investment in green technologies and compliance solutions.
Air Protection Act	Enacted	This act focuses specifically on the regulation of air	Reducing air pollution, improving public

		quality and the reduction of air pollutants, including CO2 emissions. It provides measures for monitoring air quality, establishes emission limits, and outlines the responsibilities of local and national authorities in managing air pollution.	health, and ensuring compliance with national and EU air quality standards, promoting investment in cleaner technologies and monitoring systems.
Act on efficient use of energy in direct consumption	Enacted	Aimed at improving energy efficiency and promoting renewable energy sources, this legislation supports Croatia's commitments to reduce energy consumption and CO2 emissions. It includes provisions for energy audits, energy certification of buildings, and the promotion of energy-saving technologies.	Encouraging the integration of energy-efficient technologies and renewable energy sources in variuos sectors, building designs and industrial processes, supporting long-term energy savings and emissions reductions.

Construction Act	Enacted	This act provides the general legal framework for construction in Croatia, including requirements for building permits, safety standards, and environmental considerations. It indirectly influences CO2 emissions by mandating compliance with energy efficiency standards in building designs.	Promotes investment in energy-efficient construction practices and ensures that new buildings adhere to high standards for environmental sustainability and safety.
Act on Energy Efficiency	Enacted	Directly targets the reduction of energy consumption in buildings, which is a significant component of CO2 emissions. This act includes measures such as the improvement of thermal insulation, installation of energy-efficient heating and cooling systems, and the use	Encourages capital investment in energy-efficient technologies and retrofitting of existing buildings to reduce energy consumption and greenhouse gas emissions.

		of renewable energy sources in buildings.	
Law on renewable energy sources and high-efficiency cogeneration	Enacted	This act establishes the framework for promoting the use of renewable energy and high-efficiency cogeneration. It covers planning and incentives for producing and consuming electricity from renewable sources and high-efficiency cogeneration, including financial support and certification. The act aims to integrate renewable energy into the national grid and achieve sustainability goals.	The intended outcome is to increase the share of renewable energy in the national energy mix, reduce greenhouse gas emissions, and support energy transition projects. It aims to contribute to Croatia's climate goals and EU targets by encouraging investments in renewable energy and efficient technologies.
Regulation on building energy inspection and energy certification	Enacted	Requires that new buildings, or major renovations to existing buildings, obtain an energy performance certificate. This regulation ensures	Improving building energy efficiency, reducing energy consumption, and promoting green building practices, leading to long-

		that buildings adhere to energy efficiency standards and are rated according to their energy consumption and CO2 emissions.	term cost savings and lower
Technical regulation on the rational use of energy and thermal protection in buildings	Enacted	Sets requirements for the thermal insulation of buildings to reduce heating and cooling demands, directly affecting CO2 emissions. It covers aspects such as insulation materials, installation techniques, and performance criteria.	Improving building energy performance, lowering energy bills, and reducing emissions from the building sector, supporting investments in insulation materials and energy-efficient construction techniques.
National Ordinance on Renewable Energy Sources	Enacted	Although broader than just the construction sector, this ordinance promotes the use of renewable energy sources within buildings, such as solar panels, biomass boilers, and geothermal heating	Increasing the share of renewables in building energy use, lowering carbon emissions, and fostering investments in renewable energy technologies for residential and

		systems, which help reduce reliance on fossil fuels and lower CO2 emissions.	commercial properties.
Act on Road Transport	Enacted	Governs the operation of road transport and includes provisions for reducing environmental impact, such as promoting the use of cleaner vehicle technologies and enhancing the efficiency of transport operations.	Reducing emissions from road transport, encouraging the adoption of eco-friendly vehicles, and improving overall transport efficiency, leading to investment in cleaner transportation technologies.
National plan for the development of bicycle transport for the period from 2023 to 2027	Enacted	Aims to develop and expand cycling infrastructure across the country to encourage cycling as a low-carbon mode of transport. This program supports the construction of new bike lanes, bike parking facilities, and other infrastructure improvements to	Expanding bike lanes and infrastructure, reducing traffic congestion, and lowering transport-related emissions, supporting investments in cycling infrastructure and promoting sustainable urban mobility.

		make cycling safer and more accessible.	
Act on Promoting Clean Vehicles in Road Transport	Enacted	This act promotes the adoption of low-emission and alternative fuel vehicles in the road transport sector. It includes measures for developing infrastructure, setting safety standards, and implementing emissions reduction strategies. The act aims to support the transition to sustainable transportation modes.	The intended outcome is to reduce emissions from road transport, enhance infrastructure for clean vehicles, and encourage investments in sustainable transportation technologies. It aligns the sector with broader climate goals and contributes to overall national efforts to combat climate change.
Regulation on the Promotion of Clean and Energy-Efficient Road Transport Vehicles	Enacted	This regulation supports the deployment of low-emission vehicles in road transport by setting minimum procurement targets for public service contracts and public service obligations.	Driving investment in clean transport vehicles and infrastructure, reducing emissions from public services, and encouraging the transition to low-emission mobility solutions.

Climate Change and Ozone Layer Protection Act	Enacted	Addresses climate change mitigation, adaptation, and ozone layer protection responsibilities. Includes greenhouse gas emission monitoring, emissions trading, aviation activities, and substances harmful to the ozone layer.	Mitigate climate change impacts, enhance climate resilience, regulate and reduce harmful emissions, and manage adaptation efforts.
Sustainable Energy and Climate Action Plan (SECAP)	Enacted	Developed in alignment with the Covenant of Mayors, SECAP outlines strategies to reduce CO2 emissions by 40% compared to 2008 levels. It targets the energy, mobility, and building sectors in Zagreb.	Reduction of 1,118,000 tons of CO2 emissions (40% compared to 1990), supporting sustainable urban development and contributing to long-term energy and climate resilience.
Air Protection Program of the City of Zagreb for the Period 2022-2026	Enacted	This program establishes goals, priorities, and measures for improving air quality	The intended outcome is to enhance air quality, reduce emissions, and support sustainable urban

		in Zagreb. It addresses air quality assessments, emission reduction strategies, and continuous monitoring. It also considers current challenges such as the 2020 earthquake and COVID-19 impacts. The program integrates air protection with broader urban and environmental strategies, including transport and energy efficiency measures.	development. It aims to align air protection efforts with broader environmental and climate goals.
Energy-Climate Development Framework for the City of Zagreb until 2030 (with perspective to 2050)	Enacted	This framework proposes two scenarios: the Reference Scenario and the Climate Neutrality Scenario. The latter envisions active policies for energy transition, focusing on energy	Achieve climate neutrality by 2050, increase energy efficiency, and encourage investment in renewable energy and sustainable infrastructure projects.

Climate Adaptation Plan for the City of Zagreb	Development	Currently under development, this plan focuses on adapting the city's infrastructure and services to cope with climate change impacts, including flood management, heatwaves, and other environmental risks.	Improved resilience to climate change, safeguarding public and private investments, and enhancing sustainable urban growth.
General Urban Development Plan of the City of Zagreb	In the process	This plan defines the spatial organization of Zagreb, covering the protection of natural, cultural, and historical values, land use, and urban planning measures. It integrates climate and sustainability goals into the city's urban development policies.	Efficient spatial development supporting sustainable growth, protecting cultural assets, and ensuring long-term urban resilience.

2.3 Module A-3 Systemic Barriers and Opportunities to 2030 Climate Neutrality

2.3.1 Legislative and political

2.3.1.1 Barriers

Notable dependencies and structural intricacies characterise Croatia's energy landscape. With an import dependency rate of 56% in 2021 (57% in 2020)[13], Croatia relies significantly on imports, particularly oil and petroleum products. The national oil and gas company, INA, stands at the centre of Croatia's energy dynamics. Co-owned by the Hungarian oil company MOL and the Croatian government, INA's operational management by MOL underscores Croatia's vulnerability in the production and supply of oil and oil derivatives. Despite possessing active oil and gas fields and refineries, INA has experienced a steady decline in production, particularly evident in the natural gas supply, where INA's position has been supplanted by *Prvo plinarsko društvo* (PPD), operating under a ten-year contract with Gazprom, thereby reinforcing Croatia's energy dependence.

Furthermore, the national electricity and heat supply company, HEP Group, wholly owned by the Croatian government, maintains dominance in installed capacity, electricity production, and wholesale market sales, controlling nearly two-thirds of the total market share. Although Croatia's electricity market underwent formal liberalisation in 2001, the practical outcomes must be improved. Over 90% of electricity supply is still provided by HEP Group, indicating the persistence of state control in the energy sector[14]. Additionally, the transmission system operator (TSO) and distribution system operator (DSO), crucial players in managing the electricity grid, are intertwined within the HEP Group structure. Despite their critical roles, neither TSO nor DSO effectively ensures transparent, fair, and timely grid

[13] 2023 Country Report – Croatia, Commission Staff Working Document

[14] Energy Without Russia: The Consequences of the Ukraine war and the EU Sanctions on the Energy Sector in Europe, Country Report Croatia

access to all potential investors and producers, indicating persistent challenges in achieving a fully competitive energy market.

Following the energy crisis, it is also necessary to examine the role of subsidies, mainly how they influence Croatia's energy sector. High subsidies for energy and fuel pose a significant barrier to the development of renewable energy sources in Croatia. In response to the energy crisis in February 2022, the Croatian government implemented several measures to alleviate energy prices, including reducing VAT rates for heating energy and excise duties on petroleum products. While these measures relieved consumers, they also inadvertently hindered investments in renewable energy, particularly in photovoltaic (PV) power plants. This is primarily due to the artificially low prices of gas and electricity, sustained through subsidies, which do not accurately reflect market conditions. Consequently, there is a diminished incentive for investors to pursue renewable energy projects like PVs, which could contribute to reducing Croatia's energy dependency and enhancing energy security.

In the realm of legislative and political barriers in Croatia's energy sector, several obstacles hinder the seamless transition towards climate neutrality. One significant challenge lies in the underdeveloped energy market, particularly concerning electricity. The absence of a smart grid capable of real-time consumption monitoring constrains the integration of renewable energy sources by disrupting the effective balancing of production. The traditional grid infrastructure, designed primarily for centralised energy distribution, needs more flexibility and resilience to accommodate the decentralised nature of renewable energy generation. This limitation poses a barrier to the widespread adoption of renewables and the realisation of Croatia's renewable energy potential.

Moreover, Croatia faces challenges in transitioning away from natural gas dependency. The well-established gas network, supported by subsidies and historical preferences, has traditionally been a dominant energy source. Yet, this historical reliance substantially challenges Croatia's aspirations of diversifying its energy portfolio and curbing carbon emissions. Although there is increasing acknowledgment of the need for sustainability and environmental responsibility, reducing reliance on natural gas requires significant investments in alternative energy sources and infrastructure upgrades. However, recent regulatory changes and evolving market dynamics, including increasing environmental awareness and EU directives, are reshaping investor sentiments. Despite the attractiveness

of natural gas due to its relatively low cost and convenience, concerns regarding its environmental impact and long-term sustainability are prompting a shift towards cleaner energy alternatives. On the regulatory front, Croatia has taken significant steps to promote sustainable energy practices. Building regulations requiring nearly Zero Energy Buildings (nZEB) for new constructions signify a commitment to energy efficiency and carbon reduction. These regulations mandate that in nZEB buildings, a minimum of 30% of the annual delivered energy must be sourced from renewable energy, preferably generated on-site or nearby.

The unplanned development of the energy network poses an additional barrier and aggravates inefficiencies within Croatia's energy infrastructure. The overlapping infrastructure of gas and district heating systems contributes to mutual competition between the two energy sources. District heating should be favoured in suitable locations to optimise energy usage and promote efficiency. Still, the district heating infrastructure must improve its inefficiencies due to aged infrastructure and insufficient investments, resulting in significant heat losses and increased energy consumption. Addressing these infrastructural challenges requires strategic investments in modernising and optimising energy networks to enhance efficiency and reduce environmental impact. Moreover, in line with EU directives, by 2027, at least 50% of all heat generated from district heating systems must come from renewable energy sources. This directive underscores the urgency of transitioning towards sustainable energy solutions, driving efforts to increase the share of renewables in district heating networks and further aligning energy policies with environmental objectives.

Additionally, the ownership structures of real estate pose another significant barrier. The fragmented ownership of buildings, particularly in residential complexes where different parties own individual apartments, further complicates the decision-making process for energy renovations or investments in renewable energy sources. Achieving consensus among multiple owners for such initiatives becomes exceedingly challenging, impeding progress in sustainable energy transitions. Moreover, the need for unified ownership hampers the implementation of cohesive energy efficiency strategies and the adoption of renewable energy solutions on a larger scale.

In summary, Croatia's energy market presents significant dependencies and structural complexities, characterised by dominant state-owned entities and barriers to renewable

energy development. Addressing these issues will foster a more competitive, resilient, and sustainable energy landscape in Croatia.

2.3.1.2 Opportunities

Amidst the challenges facing Croatia's energy sector, there are significant opportunities at various levels to drive the transition towards sustainability and resilience. Firstly, the European Union's ambitious targets for decarbonisation, as outlined in initiatives like the EU Green Deal, Repower EU, and Fit for 55, provide a clear framework for Croatia to align its energy policies with broader European objectives. These initiatives prioritise the transition to renewable energy sources, energy efficiency improvements, and carbon reduction strategies.

Furthermore, the ongoing revision of Croatia's National Energy and Climate Action Plan (NECP) presents an opportunity to enhance the country's energy transition efforts. While the current NECP provides a foundational framework, there is a need for more ambitious targets, extensive stakeholder engagement and transparency in the revision process. By incorporating feedback from a diverse range of stakeholders, Croatia can ensure that its energy and climate objectives are robust and inclusive.

In addition, Croatia possesses considerable geothermal potential, particularly within the Pannonian basin. While current production and utilisation are limited, there is growing interest and momentum, especially in response to the energy crisis. The Croatian government's plans to increase geothermal energy utilisation and dedicated funding in the National Recovery and Resilience program signal a positive trajectory. Regional and local initiatives, particularly in district heating, balneology, and agriculture, further underscore Croatia's potential in this renewable energy source.

Moreover, Croatia possesses significant untapped potential for photovoltaic (PV) installations, yet its current process is lengthy and complex, hindering progress. Despite recent expansions, PV capacity remains relatively low compared to other EU countries. However, there has been notable progress, with unofficial data suggesting a doubling of capacity in 2022. Expanding PV installations presents a critical opportunity for Croatia to

diversify its energy mix and expedite its transition to renewable energy sources[15]. However, the ongoing legal adjustments and developments have not accelerated the process; rather, they have further slowed it down[16]. Revision and optimisation of the current procedures are still necessary to streamline the process, offering investors greater clarity and confidence in the regulatory framework.

Lastly, Croatia's local and regional authorities, along with energy agencies, are actively engaged in **implementing sustainable energy projects**. These initiatives focus on deep energy/comprehensive renovation buildings and the utilisation of local renewable energy sources. Such grassroots efforts play a crucial role in driving the energy transition at the community level and showcasing the commitment of local stakeholders to sustainability. Within the City of Zagreb, several initiatives underscore its ambition in the energy and climate sphere. **Zagreb's inclusion among the 100 climate-neutral and smart European cities** reflects its commitment to sustainability and innovation. Initiatives such as the energy-efficient renovation of public buildings, installation of solar collectors on various facilities, and efforts to improve energy efficiency in street lighting demonstrate concrete actions towards reducing energy consumption and promoting renewable energy use. These initiatives showcase Zagreb's proactive approach and readiness to embrace sustainable practices at the local level.

2.3.2 Technical

2.3.2.1 Barriers

Old buildings and infrastructure

- **Building Data and Registry** - there is a need to improve the management system of buildings owned by the City in the way of better systematisation, the definition of investment needs and preparation and monitoring of necessary investments. In

[15] Energy Without Russia: The Consequences of the Ukraine war and the EU Sanctions on the Energy Sector in Europe, Country Report Croatia

[16] Position paper: Obstacles in administrative procedures for the preparation and development of renewable energy projects in the Republic of Croatia

many cases, there is not enough necessary data about buildings, and the databases currently used are not sufficiently functional.

- Ownership - barriers connected with ownership and permits, which is a major obstacle. A great amount of the public buildings in the City of Zagreb do not have all legislative/ownership documentation resolved in full, which effectively prevents their renovation through using any form of EU co-financing.

- Reliance on EU grants - low energy costs in the past (before the Ukraine crisis) made renovation (energy renovation) of public buildings financially not viable (i.e., payback periods of over 20 years in the best-case scenarios) without a high level (50% or more) of grants/subsidies. This has been recognised as the most critical barrier, and as a result, within the 2014-2020 financial framework in Croatia, a total of 253,4 million EUR of grants/subsidies for public building renovation have been disbursed (the original allocation in the Croatian Operational Programme was 211 million EUR). The calls for application were closed within days of being open, indicating a very high demand in the public sector for grants/subsidies (i.e., obviously, the total amount of grants/subsidies, even though increased from the original plan, was not nearly sufficient to cover the demand). This directly leads to the following over-reliance of the public sector on grants and subsidies, available mostly through ESIF, leading to a reluctance at all levels (national, regional, local) to implement any other financial model (e.g., ESCO/EPC, energy supply contracting (PPA or similar), public-private partnership (PPP), green/white certificates, financial instruments, etc.) for the renovation of buildings.

- Technical documentation/Project design documentation preparation – Today, in Croatia, there is limited access to financial institutions or national funds to cover the costs of the technical preparation phase. This means that all local or regional authorities must secure funding from their budgets, posing a significant financial barrier. The ELENA assistance is used for the implementation of activities that cannot be implemented by current staff of the City of Zagreb, i.e., preparation of EPC documentation, preparation of Main Project Designs, technical and legal advice, and support in the preparation of the feasibility studies for energy management systems in buildings, etc. Receiving EIB/ELENA funding for this action,

through the ZA-GREEN project will significantly speed up the process of its realisation, which would provide instant benefits for the City of Zagreb (energy and cost savings).

- Lack of construction companies - The main risk related to the actual implementation of the construction works identified based on the current situation and experience with energy/comprehensive renovation of buildings is related to the lack of capacity of the construction industry to implement all planned works within the planned timeframe and budget. In addition, the increase in construction material costs within the last months due to the overall situation in the world (Ukraine crisis, post COVID effects), resulted in several cases where the construction company contracted to implement the works asking for either a contract annex, which would allow for an increase in costs or the cancellation of the contract if the costs cannot be increased.

Reliance on individual gas heating systems

- Although the district heating and its heat distribution network is relatively well-developed in the City of Zagreb, most of the buildings are using individual gas heating systems due to multiple issues. Firstly, the price of heating delivered by district heating systems is heavily regulated by the *Hrvatska energetska regulatorna agencija* (engl. Croatian Regulatory Energy Agency, HERA). This means that HERA directly dictates the selling price of heat to end consumers, at a level that makes district heating systems completely non-competitive in comparison to the individual gas heating system. Secondly, according to the law, the price of gas is subsidies through several mechanisms, which makes it cheap and often the top pick for buildings that are built or renovated. In other words, it completely diminishes any economic feasibility of using any other source of heat but natural gas.

- Reliance of individual gas heating systems can also be ascribed to the fact that investment costs (CAPEX) in those systems are the lowest among all heating options for both new and renovated buildings, no matter the size. Another contributing factor is that, in comparison to district heating systems where the end customer must

pay relatively high connection costs, costs for connection on gas grid is relatively cheap.

- The same situation is observed when comparing individual gas and electric heating systems, as electric heating systems require a large connection power to match the functionality of gas heating systems. This means that end customers must pay for additional connection power to distribution system operators.

- Despite the fact that district heating is probably the only source that could move individual gas heating systems out of the market, it is failing to do so because public opinion is mostly negative about district heating systems for several reasons. That is why end customers often rather choose individual gas heating systems. One of the biggest reasons for the negative public opinion is the fact that end customers in multi-apartment buildings cannot pay for their consumption due to technical limitations, but they pay their share of the energy bill based on various formulas.

2.3.2.2 Opportunities

Existence of an efficient DH system

- As presented above, the City of Zagreb has a relatively large district heating system which, for now, uses favourable heat production units (cogeneration plants). In comparison to all other heating sources, district heating systems are characterised as the most reliant and most environmentally friendly heating options, especially if they use renewable heat such as cogeneration plants, heat pumps, or geothermal energy.

- District heating systems present probably the best option to decarbonise large number of building stock in urban areas such as the City of Zagreb since one needs to replace main production unit instead of numerous individual systems. The same goes for attempts to increase energy efficiency where district heating systems can increase it faster and easier than individual systems. This means that district heating systems can be perceived as a technology for the best uptake of renewable energy and energy efficiency in urban areas.

- Opportunity for end customers can also be found in the fact that, in connection to district heating systems, all maintenance costs become obligatory for the district

heating system operators. Since the optimisation of the whole system will come to one place (district heating system operators), management and control of one central system instead of numerous individual systems presents a massive opportunity in terms of additional energy/financial savings.

- Once the *Law on Thermal Energy Market* is changed and aligned with EU Directives, district heating systems (if decarbonised and sustainable) will become one of the most competitive heating sources in terms of cost.

The existence of a tram infrastructure for public transport

- Potential for renewable and waste energy utilisation (PV, geothermal, waste heat from industry, and energy from waste)

- The City of Zagreb, as the largest city in the country, possesses a great potential for integration of various PV systems. The City of Zagreb has a fair insolation, which can result in a relatively high production of renewable electricity from PV systems (around 1000 kWh/kWp), which is better than most locations in, i.e., France or Germany.

- Apart from the installation of individual integrated PV systems (i.e., for each household or each company), which definitively presents a great way for decarbonisation, according to new EU and Croatian laws, energy communities are more and more popular where numerous incentives are organised among different actors. Croatian legislation identifies three types of energy communities. The most important one for the City of Zagreb is a community dedicated to multi-apartment buildings that foster the integration of PV systems on their rooftops and the sharing of produced electricity among more users.

- Also, perhaps the greatest opportunity for integration of PV systems is a recently changed Law on Electricity Market which introduced the so-called "net-metering" system, favourable for small scale systems installed in households.

2.3.3 Governance

2.3.3.1 Barrier

"The Bureaucracy is expanding to meet the needs of the expanding bureaucracy" – Oscar Wilde

Being a large city can bring significant advantages in terms of resources, capacities, options, and opportunities. The size, however, also brings certain challenges. Large systems require complex mechanisms of control, management, and communication to ensure overall efficiency. These mechanisms grow in complexity with the size of the system. The City of Zagreb is no exception. With numerous departments, offices and companies, vast amounts of land, buildings, infrastructure and vehicles in its territory and in some cases ownership, keeping track of everything, let alone optimising it, is a monumental task.

The City of Zagreb needs to balance the need for tight control and compliance with a desire for agility and efficiency. The current system of governance does not always allow this to happen and will need to be updated and modernised.

2.3.3.2 Opportunities

Despite the aforementioned barriers, the City of Zagreb has several opportunities to pilot positive changes in terms of its governance. The two that are in the focus of this process are the existence of a vast GIS database, the *Zagreb Energy Atlas*, and the initiation of an integrated energy, climate, and spatial planning principle.

Zagreb Energy Atlas is an extensive GIS database that holds georeferenced data on all buildings located within the city, including their size, category, age, number of users, and energy and water consumption data for the past 6 years, alongside data on key energy infrastructure. This database is an invaluable resource for all planning activities as it can bridge the information gap and help assess key areas and fields of intervention.

Likewise, linking energy and spatial planning is an innovative approach enabling the city to not just plan, but also enforce energy and climate measures as spatial plans are executive

documents, alongside being planning ones as well. This integrated planning process provides a direct link between the proposed ambitions and methods to achieve them.

2.4 Climate risks and hazards

Climate change is evident in the City of Zagreb, where a notable alteration in Köppen-Geiger climate classes has been observed over the past six decades (Table 4). Rising temperatures have led to a transition from a **subtropical highland** (Cfb) to **humid subtropical climates** (Cfa) across all Zagreb meteorological stations, highlighting the profound influence of urbanisation on microclimatic variations within the City. This change is attributed to the increase in the average monthly temperature of the warmest month exceeding 22 °C. Additionally, the unique case of the Puntijarka station, a mountainous station near the City, demonstrates how even mountainous regions are not immune to these changes, further underlining the pervasive nature of climate change in both urban and rural areas. There, the Köppen-Geiger class transitioned from a **humid continental climate with severe winters** (Dfb) to a **subtropical highland climate** (Cfb) due to the rise in the average monthly temperature of the coldest month, which no longer falls below -3 °C. Interestingly, alternations in climate classes due to changes in precipitation regimes were not observed during the 60 years under study.[17]

Table 4 Change in Köppen-Geiger climate classification for the City of Zagreb

Meteorological station	1960 - 1989	1988 - 2017	The period in which the change in climate class occurred
Grič	Cfb	Cfa	1978 - 2007
Maksimir	Cfb	Cfa	1978 - 2007
Pleso	Cfb	Cfa	1987 - 2017
Puntijarka	Dfb	Cfb	1964 – 1993

Given the specific geographical location of the City of Zagreb, situated on the banks of the Sava River and the southern slopes of the Medvednica mountain, coupled with its position within a region prone to seismic activity, the City faces many climate hazards. Furthermore,

[17] Nimac, I. (2022) 'Characteristics and Modeling of the Urban Heat Island,' PhD Dissertation, University of Zagreb, Faculty of Science

Zagreb's urban morphology contributes to the development of urban heat islands, exacerbating the effects of rising temperatures. With the growing influence of climate change, these hazards are becoming more pronounced, posing significant challenges for urban planning and resilience efforts.

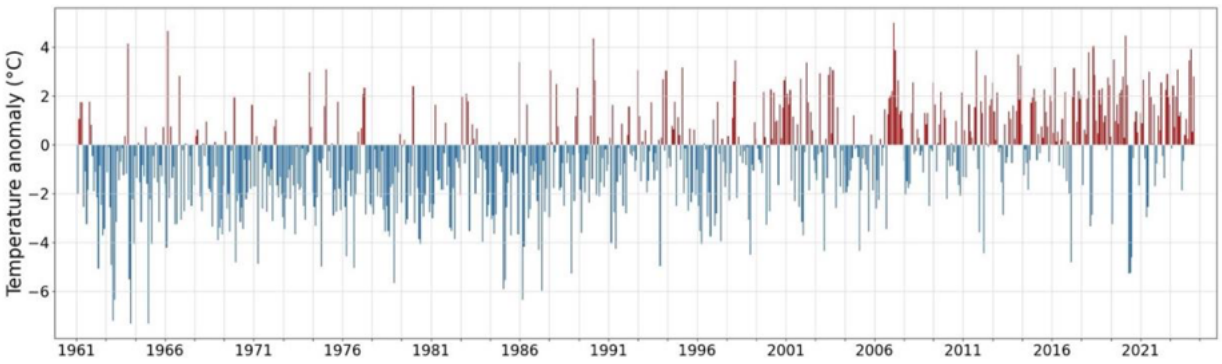
2.4.1 Key hazards

2.4.1.1 Extreme temperatures

According to the Ministry of Economy and Sustainable Development of the Republic of Croatia (2014), Croatia is facing overall warming throughout the country, manifested, among other things, in significant **positive trends in mean, minimum, and maximum temperatures**, which is also noticeable in Zagreb (Figure 19). Anomalies are referenced to the climatological period 1991-2020. The red (blue) colour indicates above-average warm (cold) months.

Warming is also evident in all extreme indices, with **warm temperature indices** (warm days, warm nights, and the warm spell duration) showing a significantly **increasing trend**, while **cold temperature indices** (cold days, cold nights, and the cold spell duration) exhibit a **negative trend**.

Figure 19 Anomalies of mean monthly air temperature in Zagreb (Grič) for the period January 1961 – December 2023



These trends have been observed in Zagreb as well, and their values vary depending on the location of the measuring station (Table 5), reflecting the influence of microclimatic conditions and the urban structure surrounding the stations.

Table 5 Average change in the number of days/nights over 10 years in Zagreb (for the period 1961 - 2023)

	Hot days (Tmax > 30 °C)	Tropical nights (Tmin > 20 °C)	Icing days (Tmax < 0 °C)	Frost days (Tmin < 0 °C)
Grič	+7	+5	-3	-5
Maksimir	+5	+2	-3	-6
Pleso	+5	+1	-3	-5

2.4.1.2 Flash flood

In recent years, we have witnessed increasingly intense weather events that often result in not only hail and strong wind gusts but also significant rainfall within a short period. Such events in urban areas lead to flash (urban) floods. The streams in the Zagreb urban area's foothills often react swiftly to precipitation in their catchment areas, experiencing a sudden rise in water levels characteristic of torrential watercourses. Some of the urban streams have been incorporated into the sewage system of the City of Zagreb, significantly burdening it during heavy rains. According to some estimates, their contribution to the total flow in the sewage system during peak flows is more than 30%. The sewage system is of a combined type, meaning it receives both sanitary and stormwater, and with the City's growth, the proportion of asphalted and waterproof surfaces is increasing, significantly enhancing surface runoff. Lesser amounts of rainfall naturally infiltrate into the ground, and surface water flows more rapidly towards drainage openings, which, often due to lack of maintenance, become impassable. In such situations, the drainage system malfunctions, and in lower parts, pressurised sewage water emerges to the surface, mixing with rainwater.

2.4.1.3 Gale force wind

Figure 20 displays the average annual wind speed, while Figure 21 illustrates the number of days with stormy winds at the Grič station for the period from 1981 to 2023. There is a notable variability in the average wind speed. In the period from 2006 to 2015, there was an increase in the average annual wind speed (from 1.4 to 1.9 Beaufort) and an increase in the annual number of days with gale-force winds. However, from the year 2020 onwards, the figures show a decreasing trend. Despite the downward trends, the possibility of encountering gale-force and hurricane-force winds is not ruled out, as witnessed during the summer season of 2023.

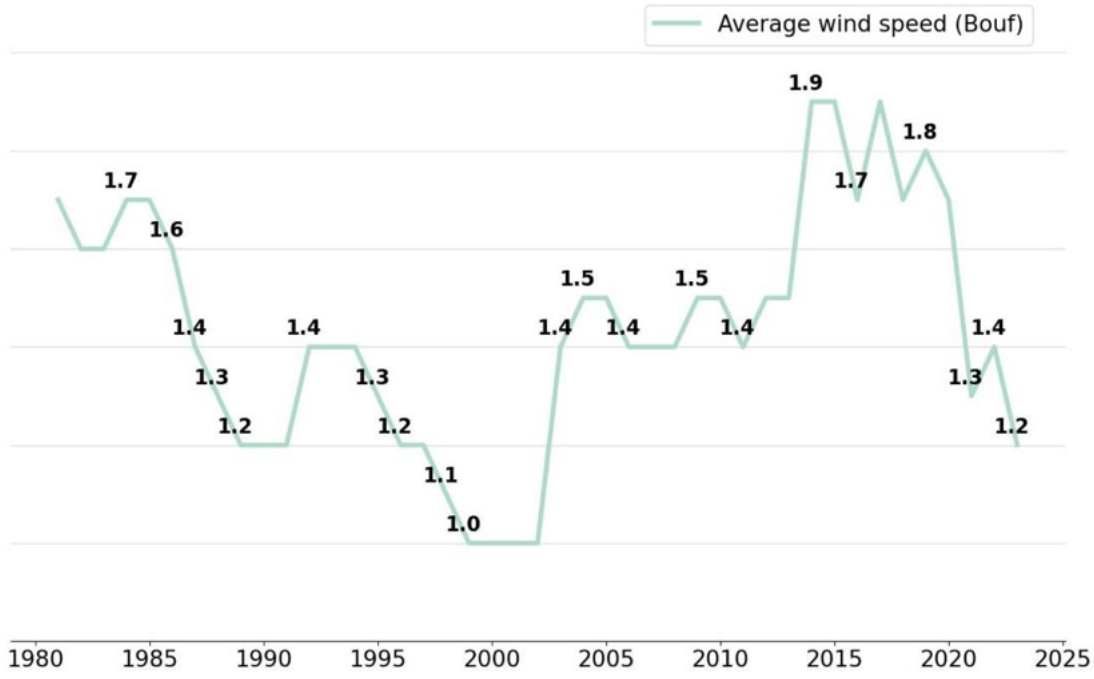


Figure 20 Average annual wind speed (Bouf) in Zagreb (Grič) for the period from 1981 to 2023

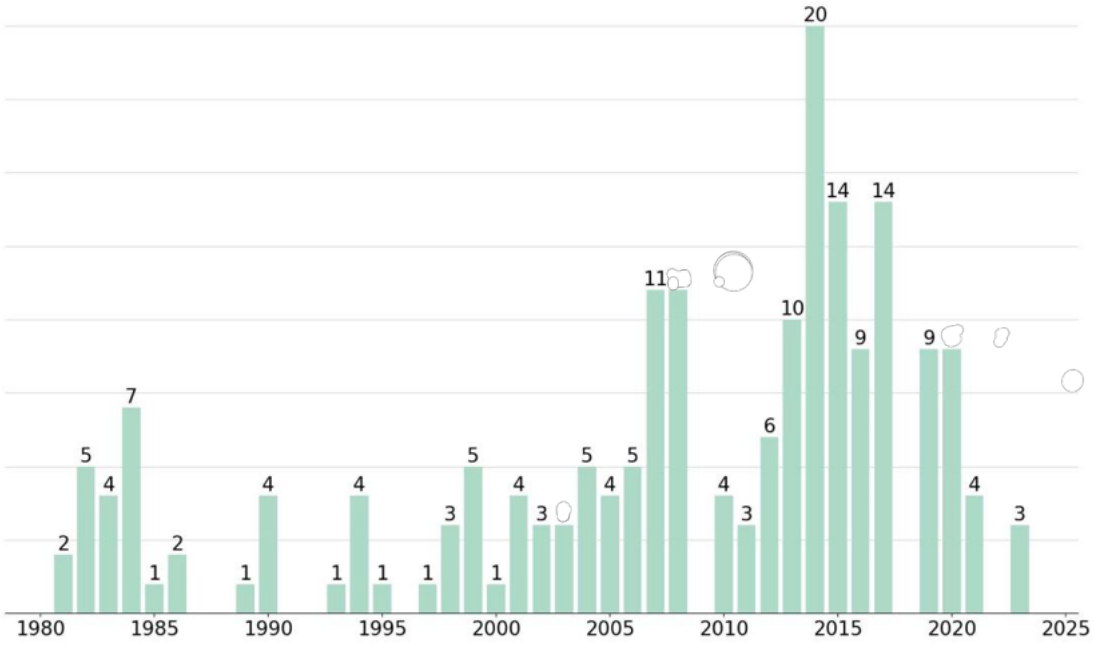


Figure 21 Annual number of days with gale force wind (8 or more Bouf) in Zagreb (Grič) for the period from 1981 to 2023

2.4.1.4 Landslide

Climate conditions play a role in triggering landslides. Increased rainfall, especially after dry periods, can significantly impact soil stability. Intense rains can saturate the soil with water, increasing its weight and reducing friction among soil particles. This reduction in friction can

lead to landslide initiation. Additionally, changes in climate conditions, such as extreme weather events, prolonged rainfall, or snowmelt, can increase the risk of landslides. Rising temperatures can accelerate ice and snow melting, adding extra stress to the soil and the potential for sliding.

Settlements in the City of Zagreb, located on the southern slope of Medvednica, face the risk of landslides and unstable slopes due to specific geological conditions. The threat of active landslides affects approximately 700 buildings in populated areas.

Areas **not prone to landslides** cover an area of **366.4 km²,** or **57.1%** of the City of Zagreb's total area. Regions with a **relatively low landslide density** (number of landslides per km²) occupy an area of **116.2 km²**, accounting for **18.1%** of the City of Zagreb's total area. Areas with a **relatively high landslide density** cover an area of **158.7 km²**, approximately **24.8%** of the City of Zagreb's total area.

The spatial development plan of the City of Zagreb designates a portion of the terrain as predominantly unstable, defined by the Ilica-Jurišićeva-Vlaška-Maksimirska-Dubrava line as the southern boundary and the boundary with the Medvednica Nature Park to the north. Therefore, landslides pose the most significant threat in the urban districts of Gornji grad – Medveščak, Črnomerec, Gornja Dubrava, Maksimir, Podsljeme, Podsused – Vrapče, and Sesvete.[18]

2.4.1.5 River flood

According to the *Risk of Major Disasters Assessment for the Area of the City of Zagreb*, the greatest risk of flooding arises from the potential **breach of the Sava River levee** during periods of high-water levels, as well as the potential **failure of retention systems in the Medvednica area**. Although short-term, heavy rainfall may lead to flash floods, their impact is anticipated to primarily be local, confined to smaller areas affected by stormy weather. This contrasts with a broader area of the City that would be affected by the failure of flood protection infrastructure.

[18] Assessment of Major Accident Risks for the City of Zagreb Area

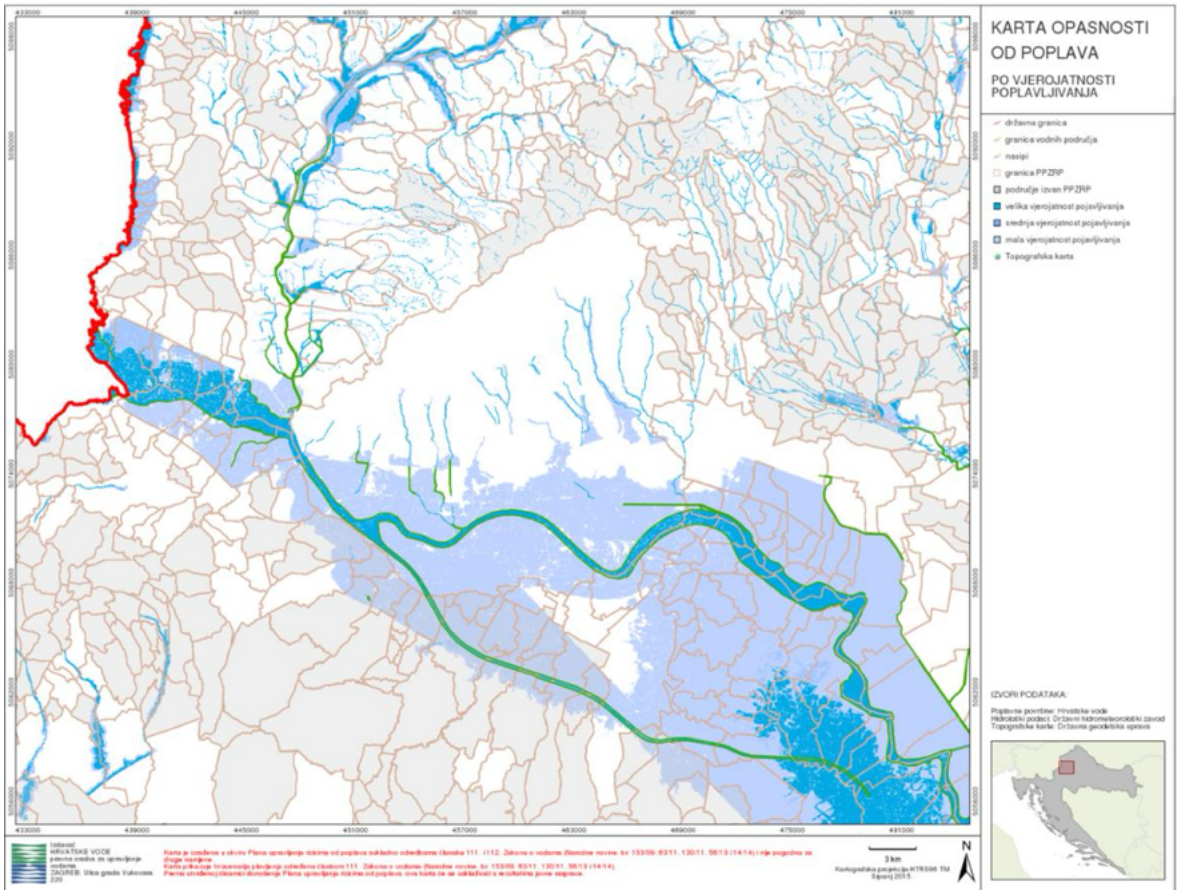


Figure 22 Flood hazard map for the City of Zagreb[19]

2.4.2 Outlook

The provided text outlines the outcomes of climate modeling with a horizontal spatial resolution of 12.5 km for the area of the City of Zagreb, according to the Eighth National Report of the Republic of Croatia under the *United Nations Framework Convention on Climate Change*. Climate projections are provided seasonally for the RCP4.5 climate change scenario for the climate period 2041-2070 (referred to as period P1). Climate change or deviations in climate parameters during the observed climate period are expressed as deviations from the average of these climate parameters in the "reference" period of 1981-2010 (denoted as P0).

Table 6 indicates that global warming in the City of Zagreb will be reflected in the trend of increasing air temperatures (mean annual, minimum, and maximum air temperatures), as well as in the increase in the occurrence of warm temperature extremes (an increase in the

[19] Croatian Waters

number of hot days and nights and the duration of warm periods) and a **decrease in cold temperature extremes** (a decrease in the number of cold days and the duration of cold periods). Climate projections for precipitation indicate a trend of decreasing annual precipitation, a **reduction in the number of rainy periods**, and an **increase in the number of dry periods**.

Table 6 Projections of selected climate parameters for the City of Zagreb according to the RCP4.5 scenario[20]

Climate parameter		Period 2041 – 2070
Precipitation	Dry days (Annual number of days with daily precipitation < 1,0 mm)	The trend of increase is 2-3% annually
	Maximum no of consecutive dry days (Number of consecutive days where R < 1,0 mm)	An increase in the range of 5-10%
	Maximum no of consecutive wet days (Number of consecutive days where R ≥ 1,0 mm)	A reduction in the range of 1-3%
	Highest 1-day precipitation amount (Maximum 1-day value)	An increase of 5-10% annually
	Highest 5-day precipitation amount (Maximum 5-day value)	An increase of 5-10% annually
Temperature	Mean	Annual increase 1.5 – 1.6 °C; seasonal increase: DJF 1.6 – 1.8 °C; MAM 1.1 – 1.2 °C; JJA 2.0 – 2.2 °C; SON 1.5 – 1.6 °C
	Maximum	Annual increase 1.5 – 1.6 °C; seasonal increase: DJF 1.6 – 1.8 °C; MAM 1.1 – 1.2 °C; JJA 2.0 – 2.2 °C; SON 1.5 – 1.6 °C
	Minimum	Annual increase 1.5 – 1.6 °C; seasonal increase: DJF 1.6 – 1.8 °C; MAM 1.1 – 1.2 °C; JJA 1.8 – 2.0 °C; SON 1.5 – 1.6 °C
Extreme weather events	Cold days (Annual number of days with maximum temperature < 10th percentile of daily maximum temperature)	A reduction in the number of days by 4-4.5% compared to the reference period
	Cold spell duration (Annual count of days with at least 6 consecutive days when minimum < 10th percentile)	A reduction of 3 to 4 days on an annual basis

[20] Eighth National Report of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC)

	Warm days (Annual number of days with maximum temperature > 90th percentile of daily maximum temperature.)	Increasing by 10-11% compared to the reference period
	Warm nights (Annual number of days with minimum temperature > 90th percentile of daily minimum temperature)	Increasing by 13-14% compared to the reference period
	Warm spell duration (Annual count of days with at least 6 consecutive days when maximum temperature > 90th percentile)	An increase of 20 to 22.5 days on an annual basis

2.4.3 Impacts

The vulnerability level of Croatia is evident from the fact that agriculture and tourism together accounted for a quarter of the total GDP in 2018. The effects of climate change depend on a wide range of parameters. According to international climate modeling results (IPCC, EEA), the Mediterranean basin has been identified as a 'hot' climate spot with particularly pronounced effects of climate change. Croatia, which largely falls within this region, is certain to feel the consequences of climate change, and its vulnerability is assessed as high. The vulnerability of certain economic sectors is particularly significant: construction, transport, tourism, agriculture, forestry, and energy, as their success largely depends on climatic factors. As a result, the extreme vulnerability of the economy to the effects of climate change can negatively impact overall social development, especially among vulnerable groups of society.

Investing in adaptation measures today will reduce the cost of addressing potential damages in the future and open opportunities for the development of new jobs.

The following table outlines various risks and their potential influence, highlighting the significant challenges climate change poses on infrastructure, public health, water resources, biodiversity, and social vulnerability.

Table 7 Assessment of climate change-induced risks

Risk	Potential impact	Probability	Impact level	Risk level
Extreme weather event	Floods in urban areas	High	High	High
	Buildings and infrastructure damage	High	High	High
	Disruptions in transportation infrastructure functioning	Moderate	High	High
Heat waves	Illnesses and deaths caused by heatwaves	High	High	High
	Increased demand for cooling	High	Moderate	High
Limited water resources/drought	Reduced availability of water for industry and households	High	High	High
	Increased risk of wildfires	High	High	High
Biodiversity loss	Loss of habitats and ecosystem services	High	High	High
	Disruptions in ecosystems and the food web	High	Moderate	High
Social vulnerability	Increased risk for vulnerable populations	High	High	High
	Disruptions in essential services	Moderate	High	High
	Economic impacts on marginalised and vulnerable groups	Moderate	High	High

3 Part B – Pathways towards Climate Neutrality by 2030

The City of Zagreb is dedicated to achieving **net climate neutrality from 2030 onward**, with residual emissions systematically neutralised, and full structural decarbonisation consolidated by 2050. These pathways quantify greenhouse gas (GHG) reductions across key sectors and measures, establishing ambitious but realistic interim targets. The plan aligns with Croatia's Climate Law, the EU Green Deal, and the EU Cities Mission framework.

The city of Zagreb will deliver approximately a **90% reduction in territorial GHG emissions by 2030** (relative to the 2019 baseline of 2.93 $MtCO_2e$), reducing emissions to ~293 $ktCO_2e$. These remaining residuals will be managed through a dedicated **residual emissions and removals strategy** based on local sinks, bio-based construction, and certified removals.

By 2040, residual emissions are expected to shrink to ~158 kt, and by 2050 to ~6 kt. These will continue to be neutralised, ensuring sustained net climate neutrality.

Waste sector is handled separately, on top of baseline emissions workout.

Year	Target Reduction (%)	Target Emissions (tCO_2e)	Residuals neutralised (tCO2e)	Cumulative Reduction (tCO_2e)
2019	Baseline	2,930,000	-	-
2030	90%	293,000	293,000	2,634,000
2040	95%	158,000	158,000	2,772,000
2050	100% - net zero	6,000 residuals	6,000	2,924,000

Note: The City's official 2019 baseline of 2.93 $MtCO_2e$ covers energy-related emissions in buildings, transport, and local industry, plus agriculture. Waste-sector emissions (~85 $ktCO_2e$ in 2019) are reported separately, consistent with SECAP methodology. They are fully addressed in the pathways and residuals strategy but not counted in the 2.93 Mt baseline.

3.1 Module B-1 Climate Neutrality Scenarios and Impact Pathways – summary

In developing Climate Neutrality Scenarios and Impact Pathways, Zagreb focuses on **front-loading reductions by 2030**, closing the ambition gap through a gap-closing portfolio of measures in the **built environment** (deep renovations, heat pumps, district heating decarbonisation, rooftop PV) and **transport** (public fleet electrification, modal shift, private EV adoption, freight decarbonisation).

These mitigation pathways are complemented by adaptation scenarios, ensuring that all major infrastructure transformations are climate-proofed against extreme weather, flooding, heatwaves, and other climate risks.

The integrated pathway ensures that:

Mitigation actions reduce emissions by ~90% by 2030.

Residual emissions (~293 kt in 2030) are neutralised through a **residuals and removals strategy**.

Adaptation measures safeguard infrastructure and communities, embedding resilience into the city's long-term climate neutrality framework.

This approach positions City of Zagreb not only to meet its 2050 neutrality target, but to act as an EU frontrunner city by achieving **net climate neutrality already in 2030**.

Credibility and Achievability of the Scenario

The proposed modelled scenario is grounded in transparent assumptions, sector-specific pathways, and alignment with EU and national decarbonisation frameworks. It reflects realistic adoption dynamics, available technologies, and policy commitments, while integrating financial instruments already accessible to the City of Zagreb (e.g., EIB framework loans, EU funds, national programmes). Sensitivity testing has been applied to key drivers such as technology uptake, behavioural change, and investment pacing, ensuring robustness under different future conditions. Together, these elements confirm

that the scenario is both credible and achievable, providing a resilient pathway to climate neutrality by 2030 in line with the EU Cities Mission.

The following is our approach.

1. Development of Climate Neutrality Scenarios

Baseline Scenario: The baseline reflects current trends and projections for emissions, focusing on the built environment and transport sectors as the key contributors. Local non-ETS industry plays a smaller role, while ETS-covered industry is regulated primarily at the national and EU level. This scenario provides a reference point to understand the magnitude of emission reductions required to achieve neutrality.

2. Mitigation and Adaptation in Synergy

Mitigation Scenarios: Alternative mitigation scenarios outline different pathways toward climate neutrality, targeting a ~90% reduction in emissions by 2030 compared to 2019. These scenarios include ambitious energy efficiency improvements, renewable energy deployment, electrification of transport, and sustainable urban development. A special focus is placed on systemic enabling measures, regulatory, financial, and institutional, which are technically prerequisites for implementation. All scenarios include a residual emissions and removals strategy, ensuring that unavoidable emissions (~293 kt in 2030) are neutralised.

Adaptation Scenarios: To address climate risks to the built environment and transport, adaptation scenarios define measures for resilience: green infrastructure, flood defences, building renovations, and land-use planning. All technical measures are designed to be climate-proofed, embedding resilience into Zagreb's mitigation actions. Zagreb has implemented climate proofing as mandatory for all city projects.

Integrated Scenarios: Zagreb integrates mitigation, adaptation, and residuals management to deliver a holistic pathway. This ensures synergies between emission reduction, resilience-building, and neutralisation through forestry, bio-based construction, blue-green infrastructure, and certified removals.

3. Broad Programmes and Stakeholder Enablement

The action plan presents broad programmes rather than isolated measures. Many decarbonisation actions require delivery by other stakeholders, the private sector, national government, and regional authorities. The city's role is to create enabling frameworks, incentives, and platforms for collaboration. These programmes also structure the gap-closing portfolio that delivers the 90% decarbonization by 2030.

Direct one-to-one attribution between specific actions and city implementation is not always possible, as responsibilities lie with diverse actors. However, by framing the action plan as a portfolio of programmes, the city ensures it catalyses action, facilitates coordination, and tracks progress.

4. Connection to Investment Plan

The action plan includes a detailed description of how emissions reductions are linked to capital-intensive measures in the investment plan. These measures, deep building renovations, district heating decarbonisation, public fleet electrification, renewable rollout and new Waste treatment Facility are scaled to deliver the ~90% emissions cut by 2030. Residual emissions are managed via the removals strategy, ensuring the broader programmes are connected to specific, measurable, and financeable actions.

Systemic measures – applicable to all sectors, the horizontal measures!

Governance and Policy – Early adoptions (1-2 years)

Early adoptions (1-2 years)					
Field of action	Systemic leaver	Action	Adresses (mitigation/ adaptation/ both)	Direct impacts	Indirect impacts
Horizontal	Governance and policy	Spatial development plan revision that has energy transition and climate change adaptation standards built in	Both	Decrease of GHG emissions, increase of adaptive capacity	Better quality of life, better health prospects

		Introduction of building standards that overcome existing standards (above national level) for renovation and/or reconstruction of existing buildings and construction of new buildings	Both	Decrease of GHG emissions, increase of adaptive capacity, introduction of sustainable buildings standards	Better quality of life, better health prospects
		Developed and implemented Green Deal Project Guidelines for drawing up technical documentation for construction and/or renovation of buildings	Both	Decrease of GHG emissions, introduction of principles for sustainable buildings, increase of adaptive capacity	Better quality of life, better health prospects
		Developed and implemented Climate proofing methodology for infrastructure projects reconstruction and development	Both	Primarily increased resilience towards climate change effects on infrastructure	Decreased potential loses and damage due to climate change caused impacts

Explanation:

Implementing early policy adoptions via a horizontal approach is crucial for mainstreaming climate action and setting a strong foundation for both mitigation and adaptation efforts. These policies integrate climate considerations across all aspects of urban development, ensuring that sustainability becomes a core component of city planning and operations. For instance, adopting stringent building codes and energy performance standards not only reduces greenhouse gas emissions but also enhances the resilience of buildings to climate impacts, making them more energy-efficient and better prepared for future extreme weather events.

Implementing urban green spaces and zoning policies contributes to urban resilience by reducing the heat island effect, increasing biodiversity, and providing natural buffers against climate-related impacts as well as improving population's well-being. Offering incentives for renewable energy installations, such as tax credits and subsidies, promotes the widespread adoption of clean energy solutions, reducing the city's reliance on fossil fuels and lowering overall emissions. Developing comprehensive climate action plans ensures that climate goals are integrated into all city projects and initiatives, providing a clear roadmap for coordinated and effective climate action.

These early policy measures will collectively mainstream climate action into the city's governance framework, creating a supportive regulatory environment that encourages sustainable urban development, reduces emissions, and enhances resilience to climate impacts. By embedding climate considerations into the city's core operations and planning processes, these policies ensure long-term sustainability and resilience, benefiting both the environment and the community.

Later adoptions (3 + years)					
Field of action	**Systemic leaver**	**Action**	**Adresses (mitigation/adaptation/both)**	**Direct impacts**	**Indirect impacts**
Horizontal	**Governance and policy**	City budget - climate monetised and climate proofed	Both	GHG savings, resilient investments, clear ownership and accountability	No more silos
		Redesigned City development strategy - no separate climate related action plans. Full mainstreaming achieved	Both	GHG savings, resilient investments, clear ownership and accountability,	No more silos, everybody "talks" climate language and acts as an agent of change

Governance and Policy – Later adoptions (3+ years)

Explanation:

By implementing later adoptions using the horizontal approach, we are focusing on mainstreaming climate action through governance and policy innovations. By climate-proofing the city budget and redesigning the city development strategy to fully integrate climate considerations, these measures ensure that all investments and development activities contribute to greenhouse gas savings and enhanced resilience. Our fiscal policies arent designed to enable planning and tracking the climate related spendings. We will pilot this in cooperation with the Ministry of finance to setup that system in the program of so called green budgeting. The program involves stakeholder engagement, policy review,

training, pilot projects, and continuous monitoring and evaluation. These actions aim to achieve significant GHG savings, resilient investments, clear ownership and accountability, and a unified approach to climate action eliminating silos and fostering a culture where everyone participates as agents of change.

3.1.1 Impact Pathways – Built environment

Initial overview

Type	2019 baseline	2030 (tCO2e)	2040 (tCO2e)	2050 (tCO2e)
Policy	-	130,000	130,000	130,000
Technical	-	1,195,000	1,250,000	1,342,000
Total	**1,472,000**	**1,325,000**	**1.380,854**	**1.472,000**
Residual emissions		**147,000**	**100,000**	**0**

The built environment is Zagreb's largest emitting sector, with a 2019 baseline of 1,472,517 tCO_2e. By 2030, the sector will deliver ~1.33 $MtCO_2e$ of gross reductions, equivalent to a 90% decrease from baseline levels.

This transformation is enabled through a balanced portfolio of policy measures (≈130 $ktCO_2e$) and technical measures (≈1.20 $MtCO_2e$). Policy measures include advanced building standards, spatial development plan revisions, mandatory climate proofing, and incentive frameworks. Technical measures comprise deep building renovations, district heating decarbonisation, electrification of heating with large-scale deployment of heat pumps, rooftop PV with storage, water system modernisation, and nature-based runoff management.

Even with these ambitious measures, ~147 $ktCO_2e$ of residual emissions remain in 2030. These are linked to transitional reliance on fossil backup in district heating, segments of the building stock that are harder to renovate, and lagging technology uptake. They represent around 10% of the sector's baseline.

All residuals are **fully neutralised** under Zagreb's **Residual Emissions and Removals Strategy**, through urban and peri-urban forestry, bio-based construction materials, soil carbon improvements, blue-green infrastructure, and, if required, certified removals. This ensures that **net emissions in the built environment are zero from 2030 onwards**.

By 2040, as renovation reaches nearly the entire building stock and district heating fully transitions, residuals decline to ~100 $ktCO_2e$. By 2050, the sector is effectively **fully decarbonised**, with gross reductions equal to the baseline and no residuals remaining.

The built environment thus becomes the **cornerstone of Zagreb's climate neutrality**, delivering early, deep reductions, driving systemic change across energy, water, and spatial systems, and sustaining net zero from 2030 forward.

Summary of Actions and Implementation Environment

Strategic Vision: The Built Environment as the Foundation of Climate Neutrality and Resilience

The City of Zagreb is pursuing a comprehensive transformation of its built environment, recognising it not only as a source of emissions but also as a structural lever for systemic change. Buildings represent long-lived infrastructure that shapes energy demand, water use, mobility patterns, and vulnerability to climate impacts. For this reason, the pathway to climate neutrality places the built environment at its centre, treating it as a complex system that integrates spatial, social, and technical dimensions.

The city's strategy combines direct emissions reductions with enabling infrastructure and regulatory measures. It addresses buildings, energy and water systems, and citizen behaviour, underpinned by a governance and investment framework that is already being deployed and scaled up.

A Phased, Resilient, and Accelerated Pathway

The built environment pathway is designed to:

- Accelerate impact by 2030, achieving ~90% gross reductions (~1.33 $MtCO_2e$) relative to the 2019 baseline.
- Sustain progress into 2040, reducing residuals to ~100 $ktCO_2e$ as district heating fully transitions and renovation reaches the bulk of the building stock.
- Consolidate full decarbonisation by 2050, with gross reductions equalling the baseline and all residuals eliminated.

This transformation is driven by a diverse but coherent portfolio of measures:

- Comprehensive renovation of public, residential, and service buildings, eliminating fossil fuel use and improving efficiency through envelope upgrades, digital controls, and advanced standards.
- Expansion and decarbonisation of district heating, shifting to geothermal, solar thermal, industrial-scale heat pumps, and waste heat, supported by network revitalisation and user switching from individual gas boilers.
- Electrification of heating with the large-scale rollout of heat pumps, particularly in gas-dependent buildings, supported by financial incentives and workforce capacity building.
- Public lighting modernisation, converting the entire stock to smart LED systems, with IoT-readiness for systemic sensor deployment.
- Installation of rooftop solar PV and on-site storage, prioritising public facilities and large rooftops, scaling to at least 150 MWp by 2030.
- Deployment of district cooling systems in dense urban areas to address rising cooling demand sustainably.
- Revitalisation of the urban water system, with pump upgrades, energy recovery, efficiency measures, and integration of solar power.
- Nature-based runoff management, including green roofs, permeable surfaces, and retention basins, reducing flood risk and energy demand in drainage systems.
- Smart energy and water management systems, enabling real-time monitoring, efficiency optimisation, and demand response.

- **Behavioural and awareness campaigns**, promoting energy and water efficiency, low-carbon lifestyles, and citizen participation.
- **Green urban development strategy actions**, reinforcing building measures through spatial planning, regulatory tools, and participatory governance.

Residual Emissions and Modelling Assumptions

Even after full deployment of these measures, ~147 $ktCO_2e$ of **residual emissions** remain in 2030, primarily from transitional district heating and hard-to-abate segments of the building stock. These are **fully neutralised** through Zagreb's Residual Emissions and Removals Strategy, ensuring net zero in 2030.

All measures are grounded in emission reduction modelling, based on Croatia's **Long-Term Renovation Strategy**, Zagreb's **SECAP**, **district heating decarbonisation plans**, and supporting EU technical studies.

Spatial planning as a structural enabler of 90% by 2030

The transformation of Zagreb's built environment is anchored in the revision of the **General Urban Development Plan (GUP)**. The new "**Green GUP**" structurally embeds mitigation, adaptation, and residuals management into the city's spatial and regulatory frameworks. It provides the long-term certainty and alignment required to reach **~90% emission reductions in the built environment by 2030**. Specifically, the Green GUP will:

- Integrate energy and climate objectives directly into zoning, density, and mobility frameworks;
- Reserve space for **district heating expansion** and **renewables infrastructure** (solar, geothermal, heat pumps);
- Designate **green belts, permeable areas, and blue-green corridors** as verified carbon sinks to neutralise residual emissions;
- Restrict development in **climate-sensitive areas** such as floodplains;
- Mandate **green-blue infrastructure** and **passive cooling strategies** for new developments and major retrofits;
- Enable **compact, walkable, mixed-use urban form** that reduces energy demand from transport and buildings.

By mainstreaming climate action into urban planning, the city unlocks synergies between land use, infrastructure, and decarbonisation, ensuring that spatial governance underpins both mitigation and the Residual Emissions and Removals Strategy.

Green Deal–aligned standards and climate-proof design

Zagreb has adopted Green Deal Design Guidelines for new construction and for the renovation of existing buildings. These guidelines exceed minimum national standards and are fully aligned with the EU Energy Performance of Buildings Directive (EPBD) recast and the Renovation Wave. They establish:

- A sustainable building approach, incorporating passive design and resilient construction;
- Integration of on-site renewables, nature-based solutions, and circular construction methods that lock carbon into materials;
- Mandatory climate proofing and "Do No Significant Harm" (DNSH) assessments for all projects.

These guidelines are mandatory for municipal projects and promoted to the private sector through permitting and technical assistance. They are a critical driver of the scaled renovation and technology deployment needed to close the ~736 kt gap to 90% reductions by 2030.

Climate proofing and adaptation co-benefits

All technical measures are designed not only to cut emissions but also to strengthen resilience against climate impacts. Climate proofing is embedded in design, construction, and operations, ensuring durability and protection of investments. Buildings and infrastructure are systematically adapted to:

- Heatwaves, through passive design (natural ventilation, solar shading, reflective surfaces, green roofs) that reduce indoor temperatures and cooling demand;
- Urban and pluvial flooding, via stormwater management, permeable pavements, vegetated swales, and rain gardens;

- Water scarcity, through greywater reuse, rainwater harvesting, and efficient appliances;
- Extreme weather, with stronger facades, roofs, and glazing against wind, hail, snow, and heat stress.

Many of these measures contribute directly to the Residual Emissions Strategy e.g., green roofs, permeable surfaces, and blue-green infrastructure are counted as verified local sinks.

Implementation risks and systemic responses

Achieving 90% emission reductions by 2030 requires rapid scaling of renovations, technology deployment, and financing. Zagreb recognises key risks but is addressing them through systemic solutions:

- Workforce shortages: Accelerated curricula, certification, and training with vocational schools, chambers, and universities to expand capacity in renovation, heat pump installation, energy auditing, and adaptive design.
- Low renovation uptake in multi-owner buildings: Expansion of one-stop-shop models offering legal, financial, and technical support to homeowner associations and cooperatives, streamlining procedures and procurement.
- Technology performance and investor hesitancy: Post-renovation monitoring and verification of energy savings, comfort, and resilience, supported by feedback loops to strengthen investor and resident confidence.
- Affordability and financing barriers: Integration with national subsidies, RRF and Cohesion Policy funds, and deployment of ESCOs, revolving funds, and performance-based PPPs to unlock private capital.
- Procurement inefficiencies: Adoption of framework agreements and cluster-based procurement to aggregate demand and reduce transaction costs.

These measures turn risks into drivers of green jobs, innovation, and inclusion, supporting a just transition.

Opportunity-driven transition

The built environment transition is not only an emissions reduction effort but also a driver of social and economic change. It is expected to:

- Create new skilled jobs in **renovation, renewable technologies, smart systems, and green materials**;
- Stimulate SME growth in construction and energy services;
- Foster youth reskilling into future-fit green professions;
- Improve comfort, health, and safety for residents, particularly in low-income communities.

Institutional architecture and stakeholder engagement

Zagreb's governance model recognises that decarbonisation is a **city-wide endeavour**, requiring joint ownership by municipal institutions, utilities, building owners, private companies, and civil society. The City coordinates strategy, regulations, and public investment, while stakeholders lead implementation:

- **Public building owners and operators** implement deep renovation and apply design guidelines.
- **District heating operators (HEP Toplinarstvo)** and **electricity distributors** decarbonise and expand thermal and power grids.
- **Water utilities** modernise systems and integrate renewables.
- **Homeowner associations and cooperatives** unlock large-scale renovations in multi-residential buildings.
- **ESCOs, contractors, and technology providers** deliver projects under innovative frameworks.
- **Universities and vocational institutions** build workforce capacity and co-design solutions.
- **Civil society** engages communities, ensuring inclusiveness, equity, and acceptance.

Flagship projects such as **Zagrebački Sunčani Krovovi ("Zagreb Solar Roofs")**, developed with REGEA, demonstrate this governance model in practice, installing municipal PV capacity while catalysing private rooftop investment through a digital solar mapping platform.

Financial and institutional readiness

Zagreb demonstrates robust financial and institutional capacity. Key pillars include:

- **EIB framework loans**, already financing public building renovations, system modernisation, and integrated climate investments. These loans enable programmatic delivery, bundling projects, phasing investments, and ensuring compliance with EU green finance standards.
- **Alignment with national and EU funding** (RRF, Cohesion Policy 2021–2027) for energy efficiency, DH decarbonisation, resilience, and circular construction.
- **Innovative finance**, such as aggregated renovation models, ESCO contracts, revolving funds, and green loan facilities.

This **layered financing strategy** ensures diversification, scalability, and resilience of funding streams, directly linked to the delivery of **90% emission reductions by 2030** and the **neutralisation of residuals** through verified local sinks and removals.

Overview of emissions reduction per measure till full decarbonization in 2030 is given in the table below, without residuals – 90% decrease.

Measure	Type	Total Reduction in 2030 (tCO2e)
Comprehensive renovation of public buildings	Technical	105.705
Comprehensive renovation of service buildings	Technical	183.067
Comprehensive renovation of residential buildings	Technical	369.545
District heating system expansion	Technical	86.621

District heating decarbonization (geothermal/heat pumps/solar PV)	Technical	51.972
Increased RES production - PV	Technical	112.500
Heat pumps installation	Technical	83.700
Public lighting modernization	Technical	34.648
Electrical energy storage	Technical	51.971
District cooling systems	Technical	25.986
Upgrade to high-efficiency pumps and motors (water)	Technical	21.656
Solar PV in water sector	Technical	17.325
Comprehensive water system revitalization	Technical	30.317
Nature-based runoff management	Technical	7.650
Spatial development plan revision	Policy	25.986
Improved water usage regulation	Policy	8.550
Promotion of water conservation and reuse	Policy	8.280
Public awareness campaigns	Policy	8.663
Green urban development strategy actions	Policy	17.325
Green Deal Project Guidelines	Policy	31.500
Advanced Building Standards	Policy	30.600
Climate Proofing Infrastructure	Policy	11.700
	Total	1.325.266

Despite achieving ~90% gross reductions in the built environment by 2030, approximately **147,000 tCO_2e** of **residual emissions** remain. These residuals are primarily linked to transitional reliance on fossil-based backup in district heating systems, segments

of the building stock that are technically or financially harder to renovate by 2030, and lagging uptake of new heating technologies. Rather than being left unmanaged, these emissions are addressed through Zagreb's **Residual Emissions and Removals Strategy**, which combines verified local sinks (urban and peri-urban forestry, soil carbon improvements, blue-green infrastructure), carbon-storing construction materials, and, if needed, certified EU removals. This ensures that residuals are fully neutralised and that the built environment reaches **net zero already in 2030**, while continuing to shrink residuals to ~100 kt by 2040 and eliminating them entirely by 2050.

Assumptions and data sources

The emissions reduction model for Zagreb's built environment is based on sector-specific mitigation measures and reflects the city's accelerated pathway towards a **90% reduction by 2030**, followed by the progressive elimination of residual emissions by 2050. The modelling combines technical interventions, policy instruments, investment estimates, and projected decarbonisation impacts across all building segments.

For **public buildings**, covering around 2.7 million m^2, the model assumes that by 2030 the stock will undergo deep renovation, achieving energy savings of at least 80 kWh per m^2 per year. At least 70% of energy demand in these buildings is expected to be supplied from renewable sources, setting a benchmark for the wider sector. In the **service sector**, which includes approximately 6.2 million m^2 of commercial and institutional space, at least half of the stock is assumed to be renovated by 2030 to medium- or deep-renovation standards, delivering energy savings of 50–70% depending on depth. The **residential sector**, which comprises 36.6 million m^2 of housing, is assumed to achieve deep renovation of 40–50% of its total area by 2030, with savings ranging from 50–70%. By 2050, the full stock is expected to meet nZEB or higher standards.

In parallel with demand reduction, the model assumes a large-scale transformation of **energy supply systems**. The district heating (DH) network expands significantly, connecting around 50% of households and service buildings currently using individual gas boilers by 2030. At the same time, DH decarbonisation progresses rapidly, with 80–90% of current fossil-based generation replaced by industrial heat pumps, geothermal, solar, and

waste heat. By 2040, DH is expected to be fully decarbonised. The model also assumes large-scale **heat pump deployment**, with around 200,000 households switching to electric heating by 2030. In addition, at least 150 MWp of **rooftop solar PV** is installed by 2030, with integrated storage deployed across public and service facilities.

Despite these ambitious measures, **residual emissions of about 147 $ktCO_2e$** are expected to remain in 2030, primarily from transitional use of fossil fuels in district heating and hard-to-renovate building segments. These residuals are explicitly integrated into the model and are neutralised through Zagreb's Residual Emissions and Removals Strategy, which combines verified local sinks (urban forestry and soils), carbon-storing construction materials, blue-green infrastructure, and certified removals. By 2040, residuals are projected to fall to ~100 $ktCO_2e$ and are eliminated completely by 2050.

The baseline year for the modelling is 2019, with emissions calculated from energy consumption by source — electricity, natural gas, diesel, and other fuels — across households, services, and local industry. Reduction impacts are estimated per measure, drawing on Croatia's **Long-Term Renovation Strategy (2020)**, the **Sustainable Energy and Climate Action Plan (SECAP) for Zagreb**, studies by the Croatian Energy Institute, data and plans from **HEP Toplinarstvo**, geothermal potential mapping, district heating planning documents, and outputs from EU-funded projects such as **D2Heat**. Costs are estimated per tonne of CO_2 equivalent reduced, including both capital and operational expenditures.

Detailed overview of measures

Technology and assets – Early adoptions (1-2 years)

Early adoptions (1-2 years)					
Field of action	**Systemic leaver**	**Action**	**Adresses (mitigation/ adaptation/ both)**	**Direct impacts**	**Indirect impacts**
Built environment	**Technology /Innovation**	Phasing-out the natural gas (gradually)	Mitigation	Decrease of GHG emissions	Better quality of life, better health prospects
		Energy/Comprehensive renovation and reconstruction of existing buildings	Both	Decrease of GHG emissions, increase of adaptive capacity, increased resilience of buildings and infrastructure, introduction of principles for sustainable buildings and circular management of space and buildings	Better quality of life, better health prospects

		District heating system as a primary source of heat - shift from individual gas boilers to district heating system	Mitigation	Decrease of GHG emissions	Better quality of life, better health prospects
		Increased production of electrical energy from RES - Photovoltaics primarily	Both	Primarily increased resilience towards climate change	Decreased potential loses and damage due to climate change caused impacts
		Heat pumps installations programme deployment	Mitigation	Decrease of GHG emissions	Better quality of life, better health prospects
		Public lightninig modernisation	Both	Decrease of GHG emissions, decrease of light pollution	Better quality of life, better health prospects, positive influence on environment and biodiversity, smart city aspects

Explanation:

Implementing early adoptions in the built environment, focusing on technology and innovation, is crucial for mainstreaming climate action and achieving long-term sustainability and resilience. These measures include phasing out natural gas, energy/comprehensive renovation and reconstruction of buildings (applying the principles of sustainability and circular management, when possible), transitioning to district heating systems, increasing renewable energy production, deploying heat pumps, and modernising public lighting. Each action directly reduces greenhouse gas emissions and enhances energy efficiency while indirectly improving air quality, health outcomes, and urban liveability. By integrating these

climate mitigation and adaptation strategies into city planning and operations, these initiatives lay a strong foundation for a sustainable and resilient urban environment, benefiting both the community and the environment.

Technology and assets – Later adoptions (3 + years)

Later adoptions (3 + years)					
Field of action	**Systemic leaver**	**Action**	**Adresses (mitigation /adaptation/both)**	**Direct impacts**	**Indirect impacts**
Built environment	**Technology/Innovation**	Phasing-out the natural gas - gradual - continuation	Mitigation	Decrease of GHG emissions	Better quality of life, better health prospects
		Energy/Comprehensive renovation and reconstruction of existing buildings- continuation	Both	Decrease of GHG emissions, increase of adaptive capacity, increased resilience of buildings and infrastructure, Introduction of principles for sustainable buildings and circular management of space and buildings	Better quality of life, better health prospects

		District heating system as a primary source of heat - shift from individual gas boilers to district heating system	Mitigation	Decrease of GHG emissions	Better quality of life, better health prospects
		District heating system - heat production decarbonisation, utilisaton of geothermal and solar energy	Both	Decrease of GHG emissions	Better quality of life, better health prospects
		Electrical energy produced from RES storage capacities development	Mitigation	Decrease of GHG emissions	Better quality of life, better health prospects, positive environmental aspects
		Introduction of district cooling systems	Both	Decrease of GHG emissions	Better quality of life, better health prospects, positive environmental aspects

Explanation:

Continuing the integration of advanced technology and innovation in the built environment is essential for maintaining momentum in mainstreaming climate action over the long term. Measures such as phasing out natural gas, energy/comprehensive renovation of buildings, and the expansion of district heating systems significantly reduce greenhouse gas emissions and enhance energy efficiency. Introducing geothermal and solar energy for district heating, alongside developing storage capacities for renewable energy sources, ensures a stable and sustainable energy supply. Additionally, implementing district cooling systems provides efficient cooling solutions that mitigate heatwave impacts and improve urban resilience.

These initiatives collectively enhance the built environment's sustainability, contributing to better air quality, improved health outcomes, and a higher quality of life for residents while ensuring the city's infrastructure is robust and adaptable to future climate challenges.

Water supply sector

Governance and policy – Early adoptions (1-2 years)

Early adoptions (1-2 years)					
Field of action	**Systemic leaver**	**Action**	**Adresses (mitigation/ adaptation/ both)**	**Direct impacts**	**Indirect impacts**
Water supply sector	**Governance and policy**	Promote water conservation and reuse practices	Both	Reduced demand on water resources, lower energy use	Decreased water treatment costs, increased public awareness
		Improved water usage regulation	Both	Reduced water consumption, enhanced resource managemen t	Promotes sustainable water use behaviors, reduces overexploitation
		Implementation of the actions from the Strategy for green urban development	Both	Increased adoption of green solutions, reduced stormwater runoff	Enhanced urban aesthetics, increased biodiversity

		Public Awareness Campaigns	Both	Increased public knowledge and engagement	Encourages community involvement and support for water management initiatives

Explanation:

Continuing the integration of advanced technology and innovation in the water sector is essential for maintaining momentum in the long-term mainstreaming of climate action. Measures such as phasing out inefficient water practices, comprehensive water infrastructure refurbishments, and the expansion of water reuse systems significantly reduce water waste and enhance water efficiency. Introducing advanced wastewater treatment technologies and rainwater harvesting, alongside developing storage capacities for reused water, ensures a stable and sustainable water supply. Additionally, implementing smart water management systems provides efficient solutions that mitigate the impacts of droughts and water scarcity, improving urban resilience. These initiatives collectively enhance water sustainability, contributing to better water quality, improved health outcomes, and a higher quality of life for residents while ensuring the city's water infrastructure is robust and adaptable to future climate challenges.

Technology and assets – Early adoptions (1-2 years)

Early adoptions (1-2 years)					
Field of action	**Systemic leaver**	**Action**	**Adresses (mitigation/ adaptation/ both)**	**Direct impacts**	**Indirect impacts**
Water supply sector	**Technology /Innovation**	Upgrade to high-efficiency pumps and motors	Mitigation	Reduced energy consumption and greenhouse gas emissions	Lower operational costs, decreased strain on energy infrastructure
		Installation of renewable energy systems - solar PV	Mitigation	Reduced reliance on fossil fuels, lower CO_2 emissions	Enhanced energy security, potential revenue from excess energy
		Comprehensive water supply system revitalisation	Both	Decreased water loss, reduced energy for water treatment	Extended lifespan of water infrastructure, savings on water bills
		Programe for usage of nature based solutions in runoff water management	Adaptation	Reduces stormwater runoff, enhances infiltration	Decreases urban heat island effect, improves urban biodiversity

Explanation:

Continuing to integrate advanced technology and innovation in the water sector is essential for maintaining momentum in mainstreaming climate action over the long term. Measures such as upgrading high-efficiency pumps and motors, installing renewable energy systems like solar PV, revitalising comprehensive water supply systems, and implementing nature-

based solutions for runoff water management significantly reduce water waste and enhance energy efficiency. Introducing advanced technologies and infrastructure improvements ensures a stable and sustainable water supply while reducing greenhouse gas emissions. Additionally, implementing smart water management systems provides efficient solutions that mitigate the impacts of droughts and water scarcity, improving urban resilience. These initiatives collectively enhance water sustainability, contributing to better water quality, improved health outcomes, and a higher quality of life for residents while ensuring the city's water infrastructure is robust and adaptable to future climate challenges.

3.1.2 Transport Sector – impact pathways

The **transport sector baseline in 2019** was approximately **1.11 $MtCO_2e$**. Under Zagreb's accelerated climate neutrality pathway, the sector will deliver **~1.01 $MtCO_2e$ of gross reductions by 2030**, equal to a **90% cut from baseline levels**. The remaining **~102 $ktCO_2e$** represent residual emissions, primarily from freight and logistics, lagging private fleet decarbonisation, and a share of municipal utility vehicles. These residuals are **fully neutralised** through Zagreb's Residual Emissions and Removals Strategy, ensuring the transport sector reaches **net zero in 2030**. Residuals are expected to fall to ~50 kt by 2040 and be eliminated by 2050.

Strategic vision. Zagreb is redefining its mobility system as clean, integrated, and people-centred, treating transport not only as a source of emissions but as a structural lever that shapes urban form, public health, and resilience. Public transport is repositioned as the backbone of the mobility system, embedded within compact, walkable neighbourhoods that reduce car dependency.

Decarbonisation pathway. The core driver of reductions is the **electrification and modernisation of public transport**, including the procurement of new low-floor trams and electric buses, depot upgrades with rooftop solar PV, and smart charging systems. Together, these measures deliver over half of total sectoral reductions by 2030. Complementary measures include:

- **Low-Emission Zones (LEZs)** expanded and enforced, reducing fossil vehicle traffic in key areas;
- **Sustainable Urban Mobility Plan (SUMP) actions**, integrating land-use reform with mobility planning to reduce travel demand;
- **Green transit corridors** and priority bus lanes, improving speed and reliability of collective modes;
- **Shared mobility platforms** integrated with public transport ticketing;
- **Smart multimodal hubs** at key interchange points;
- **Municipal fleet electrification**, including vans, waste collection, and utility vehicles.

Private fleet decarbonisation remains the largest structural challenge. While the city cannot directly mandate vehicle turnover, it creates enabling conditions for rapid electrification: restricting parking in central zones, expanding charging infrastructure, integrating shared e-mobility services, and advocating for stronger national EV incentives. The strategy anticipates **300,000–400,000 private EVs in circulation by 2030**, supported by compact urban development and stronger alternatives to car use.

Active mobility is mainstreamed through safe cycling corridors, bicycle superhighways linking peripheral areas to the centre, expanded e-bike sharing, and pedestrianisation. These measures provide co-benefits of reduced congestion, better air quality, and improved public health.

Climate proofing is embedded throughout: heat-resilient buses and trams, flood-protected charging substations, permeable paving and bioswales in corridors, and PV-powered depots with battery backup. These interventions ensure service continuity under extreme weather and protect the long-term emission reduction gains.

Governance and just transition. The transformation of Zagreb's transport system is coordinated through a **multi-actor governance model**. At its core:

- **ZET** leads public fleet and service upgrades;
- **IPZP (Integrated Transport Authority)** ensures synchronisation across modes (trams, buses, cycling, shared mobility, regional rail) and levels of government, aligning operations, ticketing, and planning under a single integrated framework;
- **Urban planning and SUMP teams** align mobility and spatial planning;
- **REGEA and HEP** support energy integration and renewable deployment;
- **Universities and vocational institutions** drive workforce reskilling;
- **Civil society and NGOs** ensure inclusiveness and community participation.

The transition is designed to be **socially just**: electrification programmes prioritise underserved areas, free public transport is secured for youth and the elderly, and tiered pricing protects affordability. Green jobs are created across maintenance, smart mobility, and infrastructure, while participatory budgeting ensures investments match community needs.

2030 milestone. By 2030, transport emissions are reduced by ~1.01 $MtCO_2e$, leaving ~102 kt of residuals. Through the residuals strategy, these are neutralised, delivering **net zero transport** two decades ahead of EU-wide targets. By 2040 residuals are halved, and by 2050 transport is fully decarbonised.

Full measures decarbonization contributions are given in the table below

Measure	Type of measure	2030 total reduction (tCO2e)
Full Decarbonization of Private Vehicle Fleet	Technical	497.644
Expansion of Low-Emission Zones	Policy	18.000
Smart City Transport Systems/smart grids and smart energy management	Technical	27.000
Green Corridors & Public Transit Lanes	Technical	36.000
Sustainable Urban Mobility Plans (SUMPs) and transit oriented development	Policy	7.200
Bike-sharing & E-scooter Programs	Technical	10.800
Dynamic Road Pricing	Policy	13.500
Urban Logistics Zones	Technical/Policy	9.000
Electrification of Bus Fleet	Technical	135.000

Deployment of Energy-Efficient Trams	Technical	85.500
Solar Panels on Depots and Rooftops	Technical	101.250
Modernisation of Tram Energy Network	Technical	16.200
Decarbonization of the City fleet (utility vehicles)	Technical	20.250
Comprehensive EV Charging Network	Technical	22.500
Integrated Ticketing Systems	Technical/Policy	8.100
Smart Grids & Energy Management	Technical	27.000
	Total	1.034.099

Assumptions and data sources: Foundations of Zagreb's transport emissions reduction modeling

The transport emissions reduction pathway developed by the City of Zagreb is built on a robust foundation of technical realism, operational experience, and international methodological standards. Each measure is modeled using data-driven assumptions grounded in existing or planned municipal initiatives, validated through sectoral benchmarks, and refined using inputs from actual procurements and implementation experience. Rather than being speculative, the model reflects the city's current transformation efforts, enhanced by conservative estimates for scaling and emissions performance.

At the heart of the model is the transition to an electrified and modernised **public transport fleet**, a process already well underway in Zagreb. The **bus fleet electrification** scenario is directly based on ZET's procurement pipeline, which includes 70 electric buses currently being acquired, supported by the EU's Recovery and Resilience Facility. The model assumes

a phased deployment of up to 500 e-buses, aligning with operational projections and city fleet planning. Emissions savings per vehicle are estimated using published values from the IEA Global EV Outlook and urban fleet case studies, assuming average operational hours, energy efficiency improvements, and Zagreb's electricity grid decarbonisation trajectory.

Similarly, the assumption of deploying **100 energy-efficient low-floor trams** is drawn from the city's ongoing fleet renewal with Končar Electric Vehicles. These new-generation trams are expected to deliver significant energy savings and improved lifecycle emissions performance, based on manufacturer data and validation from UITP's fleet benchmarking reports. The model integrates realistic estimates of emissions savings per tram unit, calibrated against current usage patterns, line densities, and vehicle retirement schedules in Zagreb's public transport network.

To support and amplify the benefits of electrified public transport, the model incorporates measures to prioritise collective mobility within the city fabric. One such measure is the development of **over 100 km of green public transit corridors**, including tram and bus lanes, which are designed to increase system reliability, reduce travel times, and attract modal shift from private vehicles. Assumptions for emissions reductions in these corridors are drawn from data provided by the EU Urban Mobility Observatory and UITP case comparisons. Average emissions avoided are calculated per vehicle-kilometre reduced and adjusted for likely ridership increases.

Beyond fleet and infrastructure, the model integrates a set of **policy and spatial planning measures** that enable long-term behavioural shifts. A key example is the **expansion of low-emission zones (LEZs)**, from the current single zone, covering high-traffic and high-pollution areas. Emissions reduction assumptions for this measure are based on empirical studies of similar schemes, including London's ULEZ (cited via ICCT 2021) and other European examples. Expected outcomes are scaled for Zagreb's fleet composition, urban form, and anticipated regulatory compliance rates.

The integration of **smart city mobility systems**, including adaptive traffic signals, AI-based traffic routing, and city-wide sensor networks, is modeled based on assumptions in the European Commission's Smart Mobility 2030 Strategy. Emissions reductions are calculated

by estimating improvements in traffic flow efficiency, reduced idling time, and lower stop-start frequency, particularly during peak congestion periods.

Spatial planning measures are also central to the model, with **Sustainable Urban Mobility Plans (SUMPs)** and **transit-oriented development (TOD)** treated not as standalone policies but as structural enablers of system-wide emissions reductions. The model assumes the integration of TOD principles at key nodes, particularly where new tram or bus infrastructure intersects with residential and commercial development. Emissions impacts are derived from shifts in trip length, vehicle kilometres travelled, and mode share, based on ELTIS Urban Planning Guidelines and validated urban mobility studies.

A key pillar of the pathway is the **active mobility component**, encompassing both infrastructure and behavioural enablers. The model assumes the citywide rollout of a **bike-sharing and e-scooter programme**, over a 10-year horizon. Emissions reduction assumptions are based on modal substitution for short trips (less than 5 km), derived from ICLEI's Mobility Atlas and EU cycling modal share studies. These programs are supported by the expansion of safe, segregated **cycling corridors** and connected **pedestrian infrastructure**, modeled as emissions-reducing through avoided car trips and increased access to public transport stations.

Further assumptions address emerging areas of urban transport transformation. The model includes a scenario for **dynamic road pricing**, applied to two zones within the city, inspired by Stockholm's congestion pricing framework. Emissions impacts are calculated using elasticity estimates for vehicle use reduction and time-of-day pricing incentives. Similarly, **urban logistics zones** and consolidation hubs are modeled to reduce last-mile delivery vehicle activity in the inner city, based on the EU's Smart Urban Logistics guidelines and local pilot projects.

The single largest source of modeled reductions is the **decarbonisation of the private vehicle fleet**, an area not directly controlled by the city but critically important to its climate goals. The model estimates the transition of approximately 292,500 vehicles to electric powertrains by 2050, referencing IEA's Global EV Outlook 2023 and national projections for EV adoption. Emissions reductions are calculated using fleet turnover rates, average emissions factors for conventional vehicles, and Zagreb's urban driving profile. While the city does not set

national standards or subsidies, this measure is included to represent the importance of enabling infrastructure, behavioural incentives, and advocacy for national support.

Across all measures, the modeling approach adheres to principles of technical realism, institutional capacity alignment, and policy coherence. Where possible, assumptions are validated against actual procurement processes, operational data, or city planning documents. Where no local precedent exists, European comparators and peer-reviewed guidelines are used to ensure conservative and credible estimates.

The primary sources of data used in constructing the assumptions include:

- City of Zagreb and ZET procurement records and implementation reports, particularly for bus and tram fleet upgrades and depot modernization;
- IEA Global EV Outlook 2023, UITP performance benchmarks, and national transport decarbonisation strategy documents;
- EU Smart Mobility 2030 Strategy, Urban Mobility Observatory, ELTIS, and ICLEI publications for behavioral and spatial impact parameters;
- London ULEZ (via ICCT), Stockholm congestion pricing, and EU cycling and walking infrastructure data for policy interventions and modal shift;
- Technical documentation from Končar Electric Vehicles, operational experience with shared mobility platforms (e.g., Nextbike), and pilot projects in low-emission logistics.

This layered, evidence-based modeling framework ensures that Zagreb's transport pathway is not only ambitious, but replicable, verifiable, and grounded in the city's real capacity to deliver transition outcomes by 2030 and beyond.

NOTE: Zagreb airport, eventhough it is called Zagreb airport, is not situated in Zagreb admisnistrative area, but outside of it! That is why it is not considered in the CCC workout.

Governance and Policy – Early adoptions (1-2 years)

Early adoptions (1-2 years)					
Field of Action	Systemic Lever	Action	Addresses (Mitigation/ Adaptation/ Both)	Direct Impacts	Indirect Impacts
Transport	Regulation and Planning	Development of integrated public transportation plans	Both	Enhanced public transport network, reduced GHG emissions	Increased mobility, reduced traffic congestion, better access to services
		Establishment of policies to promote active transport (cycling and walking)	Both	Reduced GHG emissions, decreased traffic congestion	Improved public health, enhanced urban livability, reduced healthcare costs
		Enforcement of green procurement policies for city fleets	Mitigation	Reduced GHG emissions from municipal vehicles	Leadership in sustainability, economic savings, setting a community example
		Strategy for City owned company public transport company transformation	Both	Reduced GHG emissions from municipal vehicles	Leadership in sustainability, economic savings, setting a community example

Explanation:

These early adoption policy actions in the transport sector focus on regulation and planning to integrate climate change mitigation and adaptation into transportation planning and operations. Each policy initiative is designed to reduce greenhouse gas emissions, improve air quality, and enhance the resilience of the city's transport infrastructure. By implementing these policies, the city can create a more sustainable, efficient, and health-promoting transportation system, benefiting both the environment and the community.

Governance and Policy – Late adoptions (3+ years)

Late adoptions (3+ years)					
Field of Action	**Systemic Lever**	**Action**	**Addresses (Mitigation / Adaptation / Both)**	**Direct Impacts**	**Indirect Impacts**
Transport	**Regulation and Planning**	Expansion of the low-emission zones to cover larger urban areas	Mitigation	Further reduction in GHG emissions, improved air quality	Enhanced urban living conditions, better health outcomes
		Implementation of comprehensive smart city transportation systems	Both	Optimised traffic flow, reduced congestion, decreased emissions	Improved efficiency of public transport, enhanced commuter experience
		Introduction of green corridors and dedicated lanes for public transit	Mitigation	Increased public transport usage, reduced private vehicle emissions	Enhanced public transport reliability, reduced travel times
		Mandate for all new city vehicles to be electric or hybrid	Mitigation	Significant reduction in GHG emissions from municipal operations	Leadership in clean transport, setting a precedent for private sector adoption
		Development and enforcement of sustainable urban mobility plans (SUMPs)	Both	Integrated transport planning, reduced emissions, increased resilience	Improved urban mobility, better coordination between transport modes

		Establishment of comprehensive bike-sharing and e-scooter programs	Both	Reduced dependence on private vehicles, lower emissions	Increased active transport options, improved public health, reduced urban congestion
		Introduction of dynamic road pricing based on real time congestion data	Mitigation	Decreased traffic congestion, reduced emissions	More efficient use of road networks, increased use of public and active transportation modes
		Creation of urban logistics zones for efficient, low-emission goods delivery	Mitigation	Reduced emissions from freight transport	Improved air quality, enhanced efficiency of urban logistics
		Promotion of transit-oriented development (TOD)	Both	Reduced need for car travel, increased public transport use	Higher-density, mixed-use developments, improved access to amenities

Explanation:

These mid-term policy and governance interventions focus on further embedding climate change mitigation and adaptation into the transport sector's framework. They aim to expand existing initiatives and introduce new strategies to enhance the sustainability and resilience of urban transportation systems. By broadening the scope and impact of low-emission zones, integrating smart technologies, and promoting sustainable urban mobility plans these actions will lead to significant reductions in greenhouse gas emissions and improvements in air quality. Additionally, initiatives like transit-oriented development and support for telecommuting will contribute to a more efficient, resilient, and livable urban environment.

Technology and assets – Early adoptions transport sector (1-2 years)

Early adoptions transport sector (1-2 years)					
Field of Action	**Systemic Lever**	**Action**	**Addresses (Mitigation / Adaptation / Both)**	**Direct Impacts**	**Indirect Impacts**
Transport	**Technology and assets**	Electrification of Bus Fleet	Mitigation	Further reduction in GHG emissions, improved air quality	Enhanced urban living conditions, better health outcomes
		Deployment of Energy-Efficient Trams	Both	Reduced energy consumption, lower operational costs	Enhanced reliability of public transport, longer lifespan of assets
		Installation of Solar Panels on Bus and Tram Depots	Both	Generation of renewable energy, reduced operational costs	Reduced carbon footprint of public transport facilities, demonstration of renewable energy use
		Implementation of Real-Time Passenger Information Systems	Both	Improved efficiency of public transport, better passenger experience	Increased public transport usage, reduced waiting times, enhanced commuter satisfaction

		Introduction of Contactless Payment Systems	Both	Increased convenience for passengers, faster boarding times	Reduced fare evasion, increased revenue, improved passenger data collection
		Installation of Energy Storage Systems (e.g., batteries) at Tram Stations	Both	Enhanced resilience to power outages, optimised energy use	Improved reliability of tram services, reduced energy costs
		Implementation of Smart Traffic Signal Priority for Buses and Trams	Both	Reduced travel times, increased punctuality	Improved public transport efficiency, enhanced commuter satisfaction
		Deployment of Electric Charging Infrastructure for Buses	Mitigation	Increased adoption of electric buses, reduced GHG emissions	Improved air quality, reduced dependence on fossil fuels
		Establishment of Maintenance Programs for Energy Efficiency	Both	Improved energy efficiency of transport assets, reduced operational costs	Longer lifespan of vehicles, improved reliability of public transport services
		Modernisation of Energy Network Supplying Trams	Both	Increased energy efficiency, reduced transmission losses	Enhanced reliability and resilience of tram network, reduced operational costs

		Increase the climate hazards resilience of the network	Adaptation	Improved reliability and durability of rail and power systems	Reduced service disruptions, enhanced safety, and long-term sustainability

Explanation:

Implementing these early adoption measures in the transport sector is essential for several reasons. Firstly, transitioning to electric buses and deploying energy-efficient trams significantly reduce greenhouse gas emissions, directly combating climate change. The installation of solar panels and energy storage systems at depots and tram stations not only cuts operational costs but also enhances resilience to power outages, ensuring uninterrupted service. Real-time passenger information systems and contactless payment methods improve efficiency and user experience, encouraging greater public transport use, which further reduces emissions. Additionally, smart traffic signal priority and comprehensive maintenance programs enhance the reliability and longevity of transport assets, optimising their performance. Modernising the energy network for trams and increasing the resilience of the rail and electricity network ensure the infrastructure can withstand future climate impacts, reducing service disruptions and enhancing safety. Collectively, these measures create a more sustainable, efficient, and resilient urban transport system, improving the overall quality of life and setting a strong foundation for future climate action.

Technology and assets – Late adoptions (3 + years)

Late adoptions (3+ years)					
Field of action	**Systemic leaver**	**Action**	**Addresses (Mitigation/ Adaptation/ Both)**	**Direct Impacts**	**Indirect Impacts**
Transport	**Technology and assets**	Expansion of Electrified Public Transport Fleet	Mitigation	Further reduction in GHG emissions,	Improved air quality, reduced noise pollution,

				improved air quality	better health outcomes
		Development of a Comprehensive Electric Vehicle (EV) Charging Network	Mitigation	Increased adoption of electric vehicles, reduced GHG emissions	Improved air quality, reduced dependence on fossil fuels, economic benefits from increased EV usage
		Implementation of Integrated Ticketing Systems	Both	Enhanced efficiency and convenience for passengers, increased public transport usage	Reduced traffic congestion, lower emissions, better public transport accessibility
		Upgrade and Expansion of Public Transport Infrastructure	Both	Increased public transport capacity, reduced travel times, decreased GHG emissions	Enhanced urban mobility, economic growth through improved transport links, increased property values along transit corridors
		Adoption of Autonomous Electric Public Transport Vehicles	Both	Reduced operational costs, enhanced safety,	Improved public transport efficiency, innovative urban transport solutions,

				reduced GHG emissions	attraction of tech investments
		Resilient Transport Infrastructure Projects	Adaptation	Increased resilience to extreme weather events, reduced infrastructure damage	Enhanced safety and reliability, lower long-term maintenance costs, continuity of service during climate events
		Deployment of Smart Grids and Energy Management Systems	Both	Optimised energy consumption, reduced operational costs, lower emissions	Improved grid stability, enhanced integration of renewable energy, demonstration of advanced energy technologies
		Promotion of Low-Emission Zones and Green Corridors	Both	Reduced traffic emissions, enhanced air quality, increased public transport and active transport use	Improved urban livability, better public health outcomes, increased green space

Explanation:

Implementing these mid-term measures in the transport sector focuses on leveraging advanced technologies and assets to enhance sustainability and resilience. Expanding the electrified public transport fleet and developing a comprehensive EV charging network will significantly reduce greenhouse gas emissions and improve air quality. Integrated ticketing systems and upgraded infrastructure will increase efficiency and convenience, promoting higher public transport usage. Autonomous electric vehicles and resilient infrastructure projects will enhance safety and reliability. Smart grids and energy management systems will optimise energy use, while low-emission zones and green corridors will further reduce emissions and improve urban livability. These measures collectively support a more efficient, environmentally friendly, and resilient urban transport system.

As part of Zagreb's commitment to reducing greenhouse gas (GHG) emissions and promoting sustainable urban mobility, the Climate City Contract outlines a comprehensive strategy to transform the transport sector. Through a combination of regulatory measures, infrastructure investments, technological innovation, and public engagement, these initiatives will create a modern, low-carbon, and resilient transportation system.

3.1.3 Waste – From Liability to Circular Asset

Strategic vision: waste as part of climate neutrality

Although waste is not included in Zagreb's official baseline inventory (2.93 $MtCO_2e$ in 2019), the city is proactively addressing ~85 $ktCO_2e$ of landfill and wastewater emissions through the development of the new Waste Management Centre (CGO Resnik) and the Zagreb Water Supply and Wastewater improvement project (UPOV). By 2030, this will reduce waste-sector residuals to ~25 $ktCO_2e$, which are fully integrated into the Residual Emissions and Removals Strategy. These residuals are **fully neutralised** through Zagreb's Residual Emissions and Removals Strategy, ensuring the waste sector emissions are eliminated by 2050.

Waste accounts for a smaller share of Zagreb's territorial GHG emissions compared to buildings and transport, but it remains strategically important due to its link to methane (CH_4) emissions from landfilling of biodegradable municipal waste and wastewater sludge. In 2019, total waste-sector emissions were ~85,000 tCO_2e. If added to the baseline inventory, this would correspond to ~3% of citywide emissions. These emissions derive mainly from landfill methane at Jakuševec (~70,000 tCO_2e as the landfill has an active gas recovery and cover but not perfect capture), wastewater treatment (~15,000 tCO_2e), and smaller contributions from waste collection and treatment facilities.

Without intervention, these emissions would persist, as methane generation from legacy landfilled waste continues for decades. The planned **Centar za gospodarenje otpadom Zagreb (CGO Resnik)** – Waste management centre is therefore critical for Zagreb's climate neutrality pathway, as it replaces reliance on Jakuševec landfill with a modern **Recovery and recycle facility** (**mechanical-biological treatment (MBT) and recycling centre)**, fully enclosed and compliant with EU standards.

Future Integration of Waste Sector Emissions

While the waste sector is currently treated separately from Zagreb's official baseline and target, the city recognises the importance of ensuring consistency across all emitting sectors. In future iterations of the Climate City Contract, **waste-sector emissions will be fully**

embedded in the baseline inventory and treated on equal footing with buildings, transport, and industry. This will strengthen transparency, improve comparability, and ensure that waste-related reductions directly contribute to Zagreb's overall climate neutrality pathway.

Mitigation impact and residuals

Based on design concepts presented in the **public hearing and EIA documentation**, the CGO Zagreb is expected to handle up to **~400,000 tonnes/year** of municipal waste at 2030 (both for City of Zagreb and neighbouring Zagreb County), with:

- **~58,000 tonnes/year biowaste** treated through composting/anaerobic stabilisation;
- **~50,000 tonnes/year bulky waste** sorted and processed;
- **~250,000 tonnes/year recyclables and mixed fractions** processed via mechanical separation and recovery;
- **RDF/SRF** produced from non-recyclable residues.

The mitigation effects are estimated as:

- **Avoided landfill methane**: ~45,000–55,000 tCO_2e/year by diverting organics and stabilising residuals.
- **Improved landfill gas capture**: ~5,000–8000 tCO_2e/year from upgrading collection at Jakuševec.
- **Material/energy recoverycredits**: ~5,000–20,000 tCO_2e/year from recycling and SRF displacing fossil fuels.

Net impact: **50,000–70,000 tCO_2e/year avoided**, reducing waste-sector emissions by ~70%.

By **2030**, waste-sector residual emissions are projected at **~20,000–35,000 tCO_2e**, mostly coming from wastewater CH_4/N_2O and minor fugitives from composting. These residuals are integrated into Zagreb's **Residual Emissions and Removals Strategy**, neutralised through blue-green infrastructure, soil carbon enhancement, and certified removals if required.

Climate proofing is embedded in the preparation of waste and wastewater treatment projects, ensuring long term service continuity and environmental protection under future extreme weather conditions.

Assumptions and data sources

The waste-sector model is based on:

- **2019 baseline**: derived from IPCC waste-sector inventory methods and Croatia's national GHG inventory, scaled to Zagreb's waste generation (~400,000 tonnes MSW/year).
- **Methane emissions**: estimated using first-order decay (FOD) factors for biowaste fractions, consistent with IPCC 2006 Guidelines. Local analysis indicates **~127,680 tCO_2e methane potential** from Zagreb's biowaste; with 50% LFG capture, net is ~63,800 tCO_2e — consistent with reported landfill emissions.
- **CGO Resnik design parameters**: drawn from the public EIA documentation (2025 hearing), including treatment capacities for biowaste, bulky waste, and recyclables.
- **Capture efficiency**: landfill gas capture increases from ~50% today to 80% post-CGO integration.
- **Recycling and SRF credits**: calculated conservatively using EU LIFE project benchmarks, assuming displacement of virgin materials and fossil fuels at 0.3–0.5 tCO_2e/tonne of recovered fraction.
- **Operational footprint**: CGO electricity and logistics estimated at ~2,000 tCO_2e/year, assuming grid factors in line with Croatia's 2030 electricity mix.

Governance and planning integration

The Zagreb Waste Management Center is coordinated as a joint recovery and recycling facility of the City of Zagreb and Zagreb County, as required by the National Waste Management Plan adopted by the Government of the Republic of Croatia. Both City of Zagreb and Zagreb County will implement behavioural and awareness campaigns promoting waste reduction, proper separation and recycling, circular economy practices, and active citizen participation in sustainable waste management.

The CGO Zagreb is embedded in the Green General Urban Plan (GUP) as strategic infrastructure and integrated with peri-urban green belts, wetlands, and agro-ecological corridors, ensuring coherence between waste management and land-based neutralisation. Its development is being conducted transparently, with a public hearing (2025) and formal EIA procedures.

Financing and circular economy role

The CGO will be financed through EU Cohesion Policy 2021–2027, the RRF, and potential EIB support. By producing compost, recyclables, and SRF, CGO Zagreb advances the circular economy, turning waste from a liability into a resource.

Residuals strategy for waste and Outlook

- 2030: Waste-sector residuals are reduced to ~25,000 tCO_2e, ensuring alignment with the city's overarching net-zero commitment. The residuals strategy follows a tiered approach, integrating both nature-based and technological solutions tailored to the sector's unique emission profile. The allocation is as follows:
    - Forestry and Soils: Used to absorb emissions from waste decomposition processes and legacy landfill sites, leveraging natural carbon sinks.
    - Blue-Green Infrastructure: Integrated into urban and peri-urban waste treatment facilities, such as composting sites and anaerobic digestion plants, to enhance climate resilience and provide additional carbon capture.
    - Circular Economy and Bio-Based Systems: The city will prioritize upstream measures—minimizing waste generation, promoting reuse, and expanding compostable and recyclable material streams—to reduce the volume of residuals and embed carbon in long-lived materials.
    - Certified EU Removals: Utilized only as a last resort for emissions that cannot be addressed through local or nature-based means, maintaining credibility and transparency.
- 2040: Waste residuals decline below ~15,000 tCO_2e, through wastewater upgrades and further recycling. However, the significance of the sector extends beyond emissions reductionsm as waste management is increasingly recognized as a lever for circular economy innovation, resource efficiency, and green job creation.

Zagreb's strategic approach will align its waste policies with EU and SDG frameworks, transforming waste flows into value chains through innovation in sorting, recovery, and bio-based material cycles.

2050: Waste sector effectively climate-neutral, with residuals balanced entirely by local sinks.

3.1.4 Industry – reflection

Strategic vision: Industry as both a challenge and an opportunity

Although Zagreb's industrial sector is smaller in emissions compared with the built environment and transport, it remains a critical component of the city's climate neutrality pathway. Industry is simultaneously a source of residual emissions and an enabler of solutions that benefit other sectors, such as district heating decarbonisation, circular construction, and renewable integration. The city's strategy is therefore not to treat industry as a marginal problem, but to elevate it as a strategic pillar of climate action, green growth, and resilience.

Baseline and residual challenge

In 2019, industrial emissions accounted for an estimated ~330,000 tCO_2e, of which most were covered under national or EU regulation. By 2030, industry in Zagreb is projected to deliver ~298,000 tCO_2e in gross reductions, leaving approximately 32,000 tCO_2e as residual emissions. These residuals arise primarily from non-ETS processes, smaller facilities, and sectors with slower technology turnover. They are explicitly integrated into the city's Residual Emissions and Removals Strategy, ensuring that industry also reaches net zero by 2030.

Regulatory and corporate foundations

Zagreb's industrial pathway builds on strong regulatory foundations: the EU ETS and the Industrial Emissions Directive (IED) create a carbon pricing and BAT framework, while Croatia's NECP and circular economy strategies provide additional incentives. However, corporate climate strategies are increasingly the driving force of change. Teva,

Končar, Dalekovod, and MOL/INA have all adopted science-based targets, ESG reporting, and decarbonisation roadmaps, which are directly shaping investment decisions in Zagreb. These companies are not just reducing their own emissions but also delivering low-carbon solutions to other sectors: trams, smart grids, renewables, and circular products.

City as an active enabler

Even though the city has limited regulatory powers over industry, it plays a **proactive enabling role**:

- The Green General Urban Plan (GUP) reserves zones for clean industry, renewables, and logistics hubs.
- **Industrial waste heat recovery** is being integrated into the district heating decarbonisation programme.
- **SME support mechanisms**, co-designed with REGEA, the Chamber of Economy, and universities, provide audits, transition roadmaps, and access to EU funds.
- Innovation ecosystems such as living labs and Horizon Europe pilots create testbeds for industrial circularity and low-carbon technologies.

Through these levers, Zagreb aims not only to facilitate compliance but also to **accelerate industrial transformation beyond minimum legal requirements**.

Industry as a driver of circularity and innovation

Zagreb's industrial actors are already central to the city's circular and green economy transition:

- **Circular material flows**: packaging recovery, industrial symbiosis, and green chemistry.
- **District heating support**: harvesting waste heat from industrial processes.
- **Clean logistics**: adoption of electric delivery fleets and participation in urban low-emission zones.
- **Green manufacturing**: Končar's electrification systems and Dalekovod's renewable integration projects.

These actions show that industry is not only a source of emissions but a **provider of solutions** for Zagreb's climate neutrality.

Residuals strategy for industry

By 2030, the **~50 $ktCO_2e$ of industrial residuals** will be fully neutralised. The allocation is designed as follows:

- **Forestry and soils**: absorbing process emissions that cannot yet be avoided.
- **Blue-green infrastructure**: integrated into industrial zones, providing carbon sinks and climate resilience.
- **Bio-based construction materials and circular production**: embedding carbon storage in buildings and supply chains.
- **Certified EU removals**: deployed only if necessary as a last resort.

This ensures that industry plays its part in the **citywide residuals strategy (293 kt total)** and does not compromise Zagreb's 2030 net-zero commitment.

Outlook: focus on industry as a strategic pillar

By 2040, industrial residuals are expected to fall to ~30 kt, and by 2050 they are eliminated. But the importance of industry goes beyond its own emissions. It is a **driver of green jobs, technology development, and competitiveness**. Zagreb's forward-looking approach is to make industry not just compliant but **climate-leading**, aligning it with SDGs and EU Mission Cities ambitions.

In sum, Zagreb's industrial pathway combines national law, corporate ambition, municipal enabling, and residuals neutralisation. The city will place **greater focus on industry** in the next phase of its transition, ensuring that this sector is both a **net-zero contributor by 2030** and a **catalyst for innovation, circularity, and green growth**.

Industrial Emissions and Credibility of the Pathway

In 2019, Zagreb's industrial sector emitted approximately 330 $ktCO_2e$, stemming mainly from large installations covered by the EU ETS (refining and petrochemicals, pharmaceuticals, electrical equipment, and heavy manufacturing), which account for the

majority of emissions. A further 20–25% arises from medium and small facilities outside ETS, primarily food processing, light manufacturing, and logistics, while a smaller share (<10%) is linked to industrial processes and product use (IPPU) such as solvents, chemicals, and refrigerants. This mix highlights the need to clarify whether the city's industrial accounting covers only stationary energy emissions or also includes IPPU and F-gases, as this materially affects the baseline and targets.

The projected -85% reduction by 2030 is considered credible because most reductions will result from EU ETS compliance and the Industrial Emissions Directive, which enforce decarbonisation trajectories on large emitters. Major industrial actors in Zagreb - Teva, Končar, Dalekovod, MOL/INA are already implementing science-based targets, ESG reporting, and low-carbon investment programmes, which reinforce the delivery of reductions and also provide solutions for other sectors, such as district heating, renewable integration, and circular construction materials. The city complements these regulatory and corporate drivers with enabling measures: zoning for clean industry, integrating waste heat into district heating, providing SME transition support, and fostering innovation through living labs and EU pilot projects.

By 2030, residual industrial emissions are expected to fall to around 50 $ktCO_2e$, mainly from non-ETS facilities and slower-turnover processes. These are explicitly integrated into the Residual Emissions and Removals Strategy, where they will be neutralised through forestry and soils, blue-green infrastructure, bio-based materials, and certified EU removals as a last resort. Taken together, these elements provide a coherent, credible, and achievable pathway for Zagreb's industry to reach net zero by 2030, while positioning the sector as a driver of green jobs, innovation, and competitiveness.

3.1.5 Agriculture

Agriculture and climate neutrality: small footprint, systemic significance

Agriculture in Zagreb accounts for a modest share of the city's greenhouse gas emissions – around 12,000 tCO_2e in 2019– but its role in the climate transition is disproportionately important. Emissions come primarily from livestock methane, nitrous oxide from fertilisers, and diesel use in machinery. While the sector is numerically small compared with transport or buildings, it is uniquely tied to land stewardship, food security, peri-urban resilience, and carbon sequestration potential.

By 2030, agricultural emissions are expected to remain at ~12 $ktCO_2e$, reflecting the hard-to-abate nature of biological methane and nitrous oxide. These are treated as residual emissions, explicitly included in Zagreb's citywide residuals pool (~293 $ktCO_2e$ in 2030). Unlike other sectors, however, agriculture also acts as a provider of neutralisation capacity, through soil carbon sequestration, agroforestry, and nature-based practices that can offset residuals from buildings, transport, and industry.

Legislative and governance framework

Agricultural emissions are governed primarily by Croatia's Law on Climate Change and Protection of the Ozone Layer (2025), the National Energy and Climate Plan (NECP 2021–2030), and the Sustainable Agriculture Strategy (2020–2030). These are complemented by the CAP Strategic Plan, which links subsidies and eco-schemes to climate performance.

Within this framework, the City of Zagreb plays an enabling role. Through the Green General Urban Development Plan (GUP), the city protects peri-urban farmland and green belts from urban encroachment, conserving soil carbon sinks and maintaining ecological corridors in areas such as Brezovica, Sesvete, and the Sava corridor. Land-use planning is used to safeguard carbon-rich agricultural areas and integrate them with the city's broader green-blue infrastructure strategy.

Enabling practices and partnerships

Although Zagreb cannot directly regulate agricultural emissions, it actively supports **farmers and cooperatives** in adopting climate-smart practices that reduce emissions and increase removals, including:

- **No-till and reduced tillage** to preserve soil carbon;
- **Organic amendments and composting**, replacing synthetic fertilisers;
- **Improved manure management**, reducing methane leakage;
- **Agroforestry and hedgerows**, boosting sequestration and biodiversity;
- **Efficient irrigation and water reuse**, building resilience to drought.

These practices are supported by partnerships with the **Faculty of Agriculture**, the **Zagreb Development Agency**, and farmer associations, ensuring access to EU eco-schemes and technical expertise.

Agriculture in the circular economy and resilience agenda

Agriculture connects directly to Zagreb's **circular economy** by transforming residues into compost, biogas, and soil enhancers, closing nutrient loops and linking peri-urban farms to urban metabolism. Agricultural landscapes provide **adaptation co-benefits**, buffering floods, enhancing biodiversity, and securing local food production. In this way, agriculture is not only a small emitter but a **systemic enabler of resilience and sustainability**.

Residuals strategy for agriculture

By 2030, Zagreb's agriculture will emit ~12 $ktCO_2e$, all of which are **residuals**. These are neutralised through:

- **Soil carbon sequestration** (cover crops, organic amendments, carbon farming);
- **Agroforestry and peri-urban tree planting** integrated with farmland;
- **Wetland restoration** and blue-green infrastructure;
- **EU carbon farming schemes** providing financial support and MRV systems.

This dual role, as both a **source of residuals** and a **provider of removals**, makes agriculture strategically significant. By 2040, residuals are projected to decline to ~8 kt, and by 2050 the sector balances its emissions fully, becoming a **net sink**.

Outlook

Agriculture's contribution is therefore not measured in tonnes alone but in its ability to link **urban and rural systems**, provide **land-based neutralisation**, and reinforce **resilience and food security**. By aligning with national legislation, leveraging CAP eco-schemes, protecting farmland through spatial planning, and promoting carbon farming, Zagreb ensures that agriculture supports both **residual management** and the city's broader **net-zero commitment by 2030**.

3.1.6 Residual emissions and removals outline – A structural component of Zagreb's climate pathway

Residuals as a systemic challenge, not a side issue

Zagreb's pathway to climate neutrality is built on deep, front-loaded reductions: by 2030 the city cuts ~90% of emissions relative to the 2019 baseline, leaving **~293 $ktCO_2e$ of unavoidable residual emissions**. These residuals are not random "leftovers," but the structural result of technological, economic, and biological constraints: transitional fossil back-up in district heating, incomplete private fleet turnover, industrial processes beyond city control, biological methane and nitrous oxide in agriculture, and methane from legacy waste management.

If unmanaged, these emissions would undermine the credibility of the 2030 neutrality target. For this reason, Zagreb treats residuals as a **strategic category in their own right**, not as an afterthought. Residuals are explicitly embedded into the **Green General Urban Development Plan (Green GUP)**, the **Green Deal Building Design Standards**, and the city's governance architecture, ensuring that neutralisation is spatially planned, technically standardised, and institutionally anchored.

Anchoring residuals in spatial planning (Green GUP)

The revision of the General Urban Development Plan (GUP) is a cornerstone of the residuals strategy. The new "Green GUP" operationalises neutrality by:

- **Designating green belts, agroforestry zones, and peri-urban corridors** as verified carbon sinks. These areas serve both as buffers against urban sprawl and as active carbon-absorbing landscapes.
- Embedding **nature-based solutions** (green roofs, permeable pavements, retention basins, wetland restoration) directly into land-use rules, so that every new development contributes to carbon sequestration and resilience.
- **Reserving space for bio-based industries and materials banks**, linking industrial land use with carbon storage in construction materials.

- Integrating soil carbon management into zoning for peri-urban agriculture, ensuring that CAP eco-schemes and carbon farming projects are spatially aligned with the city plan.

Through these instruments, residual neutralisation is literally "written into the map" of Zagreb's future.

Standards as guarantors of permanence and quality

Residual management is also codified in Zagreb's Green Deal Design Guidelines. These go beyond national minimum standards and require:

- Mandatory climate proofing of all new projects, ensuring resilience and preventing "lock-in" of new emissions.
- Integration of on-site carbon sinks (timber structures, green roofs, passive vegetation) as standard design elements.
- Circular construction and bio-based materials, turning the building stock into a carbon storage asset rather than a source.
- Do No Significant Harm (DNSH) and EU taxonomy alignment, ensuring that removals will be permanent, verifiable, and financially credible.

These standards ensure that neutralisation is not speculative but embedded into regulated construction, renovation, and infrastructure practice.

Institutional architecture and governance

Residuals are governed through the city's Climate Cockpit. Residuals are not outsourced but integrated into the city's monitoring, reporting, and verification (MRV) system, ensuring:

- Annual residual emissions inventories by sector (built environment, transport, industry, agriculture, waste).
- MRV protocols for removals aligned with the forthcoming EU Carbon Removal Certification Framework.

- Cross-departmental ownership: spatial planning, utilities, waste operator, environment, and finance all share accountability.
- Public transparency: residuals and removals tracked on a **public dashboard** alongside emissions reductions.

This governance model ensures **no "hidden offsets"**, but transparent, accountable neutralisation of residuals.

Financing residuals through mainstream investment

Residual management is financed as an **integral part of Zagreb's climate investment strategy**, not as an add-on:

- **EIB framework loans** include financing for urban greening, waste infrastructure, and nature-based measures.
- **Cohesion Policy 2021–2027 and RRF funds** support carbon farming, wetlands, and the new CGO Resnik.
- **Private capital and ESCO models** are mobilised for bio-based construction and materials banks.
- Farmers and cooperatives benefit from **CAP eco-schemes and carbon farming pilots**, with the city facilitating uptake.

Residual neutralisation is thus **structurally financed through the same channels as mitigation**, ensuring permanence.

Social and economic co-benefits

Neutralising residuals delivers more than carbon balance:

- **Jobs**: forestry, agroforestry, regenerative farming, timber construction, waste-to-resource value chains, and nature-based solutions create local employment.
- **Resilience**: green corridors, wetlands, and permeable surfaces reduce flood and heat risks.
- **Equity**: peri-urban farmers gain new income streams from carbon farming; communities benefit from reduced landfill impacts and modern waste services.

- Urban quality: new green infrastructure improves health, biodiversity, and provides recreational opportunities.

Outlook: phasing down residuals, phasing up local removals

Residuals are not permanent. By 2040, they shrink to ~158 kt; by 2050, only ~6 kt remain. At the same time, local removal capacity grows as forestry, soils, bio-based materials, waste valorisation, and blue-green infrastructure mature. By mid-century, Zagreb aims to cover all residuals within its own territory, phasing out reliance on certified EU removals.

Future Detailing of the Residual Emissions and Removals Strategy

The City of Zagreb acknowledges that the Residual Emissions and Removals Strategy must continue to evolve to ensure long-term credibility. In future iterations of the Climate City Contract, the City will make explicit that all residual emissions will be fully compensated by 2030 and will provide a quantified assessment of each neutralisation option, including the expected potential of tree planting, kilometres of green belts, hectares of agroforestry zones, and other nature-based solutions. Timelines, responsible actors, and safeguards against carbon reversals (including design buffers and conservative accounting rules) will also be detailed. Finally, the City will clarify the circumstances under which certified removals may be used, ensuring transparency, permanence, and consistency with EU frameworks.

This ensures that neutrality is not only achieved in 2030 but sustained long-term, with residuals managed in a way that is spatially anchored, socially just, and institutionally credible.

Sector	2019 baseline	2030 gross reductions (tCO2e)	2030 residuals (tCO2e)	Neutralization lever applied
Built environment	1,472,517	1,325,265	147,000	Forestry & soils; bio-based construction; blue and green infrastructure, certified EU removals (if needed)
Transport	1,112,494	1,010,494	102,000	Forestry & soils; bio-based construction; blue and green infrastructure, certified EU removals (if needed)
Industry	330,000	298,000	32,000	Forestry & soils; bio-based construction; blue and green infrastructure, certified EU removals (if needed)
Agriculture	11,200	0 (hard to abate)	12,000	Soil carbon sequestration; agroforestry; blue-green infrastructure
Waste – outside of emissions baseline	85,000	60,000	25,000	Waste diversion (CGO Resnik); compost & SRF; blue-green infrastructure; circular economy; certified EU removals (if needed)
Total (without waste)	2,930,204	2,637,752	293,000	

Sector	2019 baseline	2030 gross reductions (tCO2e)	2030 residuals (tCO2e)	Neutralization lever applied
Total (with waste)	3,011,211	2,693,759	318,000	

3.2 Module B-2 Climate Neutrality Portfolio Design

3.2.1 Horizontal measures portfolio - Policy developments – early stages (Years 1-2) – setting the enabling conditions

The City of Zagreb recognises that several actions in this Climate City Contract are currently described at a programmatic level. In future iterations, the City will enhance the **maturity and specificity** of each action by defining concrete measures, spatial scope (e.g. number of buildings renovated, kilometres of transport corridors developed, locations of blue-green infrastructure etc.), implementation timelines, and responsible actors. This will ensure that quantified reductions are transparently linked to verifiable, place-based interventions, strengthening the credibility of the scenario and enabling robust monitoring of progress.

A) Urban Development Plan Revision with Energy Transition and Climate Change Adaptation Standards – All Levels of Application

Objective	To integrate energy transition and climate change adaptation standards into the urban development plan to reduce greenhouse gas emissions and enhance adaptive capacity
Programme Components	
Stakeholder Engagement	Engage local government, urban planners, developers, and the community in the revision process through workshops and public consultations
Policy Review and Integration	Analyse existing policies and integrate advanced energy transition and climate adaptation standards into the urban development plan
Training and Capacity Building	Provide training for urban planners and developers on the new standards and their implementation
Pilot Projects	Implement pilot projects to demonstrate the benefits of the revised standards and gather feedback for improvement
Monitoring and Evaluation	Establish mechanisms to monitor and evaluate the effectiveness of the revised urban development plan in achieving emission reductions and increased adaptive capacity

B) Introduction of Building Standards Above National Level for Renovation, Reconstruction of Existing Buildings, and Construction of New Buildings

Objective	Introduce building standards that exceed national levels to reduce GHG emissions to introduce principles for sustainable buildings and increase adaptive capacity
Programme Components	
Regulatory Framework	• Develop regulations that mandate higher building standards • Provide guidelines for renovation, reconstruction of existing buildings, and construction of new buildings
Incentives and Subsidies	• Offer financial incentives, grants, and tax benefits to encourage compliance • Develop subsidy programs for and renovation of existing buildings
Technical Support and Guidance	• Provide technical support to architects, engineers, builders, and developers • Develop detailed guidelines for implementing new standards
Certification and Compliance	• Establish a certification process to ensure compliance • Conduct regular inspections and audits
Public Awareness Campaign	• Launch a campaign to educate the public about the benefits of higher standards • Encourage acceptance and support through community outreach
Timeline	Year 1: Develop a regulatory framework, establish incentives, and start a public awareness campaign Year 2: Roll out technical support and certification processes

C) Developed and Implemented Green Deal Guidance for Building and Reconstruction

Objective	Develop and implement Project Guidelines for drawing up technical documentation for construction and/or renovation of buildings aligned with EU Green Deal
Programme Components	
Guidance Development	• Formulate detailed guidelines documents based on the principles of the EU Green Deal as well as the EU Framework for sustainable buildings • Focus on sustainability, energy efficiency, and resilience

Stakeholder Collaboration	• Work with industry expert, policymakers, professionals from the construction sector (architects, engineers, designers, etc.) and community representatives • Ensure that guidelines are comprehensive and practical
Training Programs	• Conduct training sessions for builders, architects, engineers and local authorities • Develop online resources and toolkits
Pilot Projects	• Implement pilot projects using the Green Deal Project Guidelines • Monitor and evaluate benefits and gather insights
Feedback and Revision	• Collect feedback from pilot projects and stakeholders • Refine and improve the Green Deal Project Guidelines
Timeline	Year 1: Develop guidelines, initiate stakeholder collaboration, and start training programs Year 1/2: Implement pilot projects and gather feedback

D) Developed and Implemented Climate-Proofing Methodology for Infrastructure Project Reconstruction and Development

Objective	Create and apply a climate-proofing methodology for infrastructure projects to ensure resilience to climate change impacts
Programme Components	
Methodology Development	• Develop a comprehensive climate-proofing methodology • Include risk assessments, design standards, and resilience measures
Capacity Building	• Provide training for engineers, architects, and planners • Develop online training modules and resources
Integration into Planning	• Embed the climate-proofing methodology into planning and approval processes • Ensure all infrastructure projects follow the methodology
Demonstration Projects	• Implement demonstration projects to showcase climate-proofing measures. • Monitor and document outcomes.
Monitoring and Evaluation	• Develop KPIs to measure resilience and compliance. • Regularly review and adjust the methodology based on outcomes.

Timeline	**Year 1:** Develop methodology, start capacity building, and integrate it into planning **Year 1/2:** Launch demonstration projects begin monitoring and evaluation

3.2.1.1 Policy developments – setting the enabling conditions!

A) City Budget - Climate Monetised and Climate Proofed

Objective	Integrate climate considerations into the city's budgeting process to ensure that all investments are climate-resilient and contribute to GHG savings
Programme Components	
Stakeholder Engagement	Engage key stakeholders, including city officials, financial planners, financial sector, private capital holders, and community representatives, to ensure broad support and understanding. Create connections with the National level platform on sustainable finance, led by the Ministry of Finance. • Conduct workshops and public consultations to gather input and build consensus • Establish a climate budgeting task force to oversee implementation
Policy Review and Integration	Analyse current budgeting policies and integrate climate monetisation and proofing. • Review existing budgeting policies and processes • Develop guidelines for climate-proofing investments • Integrate climate risk assessments into the budgeting process
Training and Capacity Building	Equip city officials and financial planners with the skills needed to implement climate monetisation and proofing. • Organise training sessions on climate risk assessments and climate finance • Develop online resources and toolkits
Pilot Projects	Demonstrate the benefits of climate-proofing the budget through pilot projects. • Select a few city projects to apply climate-proofing guidelines • Monitor and evaluate the financial and environmental outcomes

Monitoring and Evaluation	Track the effectiveness of the climate-proofed budgeting process. • Develop key performance indicators (KPIs) to measure GHG savings and resilience, in-line with the proposed indicators for the CCC • Regularly review and adjust the process based on feedback and outcomes
Timeline	Year 1: Stakeholder engagement, policy review, initial training sessions Year 2: Implement pilot projects and start monitoring and evaluation Year 3-4: Full integration of climate-proofing into the city budget, continuous monitoring, and improvement

B) Redesigned City Development Strategy - Full Mainstreaming Achieved

Objective	Fully integrate climate considerations into the city's development strategy, eliminating the need for separate climate action plans and ensuring that all development activities contribute to climate goals
Programme Components	
Stakeholder Engagement	Engage city officials, planners, developers, and the community to ensure support and alignment. • Conduct workshops and public consultations to gather input and build a consensus • Form a strategy revision committee to oversee the process
Policy Review and Integration	Analyse current budgeting policies and integrate climate monetisation and proofing. • Review existing budgeting policies and processes • Develop guidelines for climate-proofing investments • Integrate climate risk assessments into the budgeting process
Training and Capacity Building	Equip city officials, planners, and developers with the skills needed to implement the revised strategy. • Organise training sessions on integrated planning and climate action • Develop online resources and toolkits
Pilot Projects	Demonstrate the benefits of the revised development strategy through pilot projects. • Select a few development projects to apply the revised strategy • Monitor and evaluate the outcomes

Monitoring and Evaluation	Track the effectiveness of the revised development strategy. • Develop key performance indicators (KPIs) to measure GHG savings, resilience, and mainstreaming success • Regularly review and adjust the strategy based on feedback and outcomes
Timeline	**Year 1:** Stakeholder engagement, policy review, and initial training sessions **Year 2**: Implement pilot projects and start monitoring and evaluation **Year 3-4**: Full integration of the revised development strategy, continuous monitoring, and improvement

3.2.2 Programme for the decarbonisation of the built environment

3.2.2.1 Technology and assets – Early adoptions (1-2 years)

A) Phasing out the Natural Gas

Objective	Gradually eliminate the use of natural gas to reduce greenhouse gas (GHG) emissions and improve public health
Programme Components	
Stakeholder Engagement	**Objective**: Ensure broad support and participation **Activities**: • Conduct technical workshops and public consultations with residents, businesses, and energy providers • Establish a task force to oversee the phase-out process, comprising technical experts and key stakeholders
Policy Development	**Objective**: Create policies to support the phase-out **Activities**: • Develop technical regulations to limit new natural gas connections • Introduce incentives for switching to alternative energy sources, focusing on electrification and renewable energy systems

Infrastructure Development	**Objective**: Prepare the infrastructure for alternative energy sources **Activities**: • Upgrade existing energy infrastructure to support electrification, including the expansion of electrical grids and substations • Provide subsidies for the installation of electric heating systems, such as heat pumps and advanced electric boilers • Modernise and expand the district heating network
Public Engagement and Communication	**Objective**: Educate the public about the benefits and process of phasing out natural gas **Activities**: • Launch campaigns to raise awareness of alternative energy options, including detailed technical brochures and online resources • Provide information on available subsidies and technical support for the transition
Monitoring and Evaluation	**Objective**: Track progress and adjust strategies as needed **Activities**: • Develop key performance indicators (KPIs) to measure reductions in GHG emissions and monitor the transition to alternative energy sources • Regularly review and update the phase-out plan based on technical performance data and feedback from stakeholders
Timeline	**Year 1**: Stakeholder engagement, policy development, start infrastructure upgrades **Year 2**: Continue infrastructure upgrades, public awareness campaign, begin monitoring and evaluation

B) Energy/Comprehensive Renovation and/or Reconstruction of Existing Buildings

Objective	Improve energy efficiency and resilience of buildings through energy/comprehensive renovation and/or reconstruction while applying principles of sustainability and circular management when possible
Programme Components	

Asset Management System Improvements and Building Analyses	**Objective**: Assess current energy performance and condition of buildings in general and identify improvement opportunities **Activities**: • Improve building data management, acquire needed data to perform audits and analyses and for drawing up technical documentation • Conduct detailed energy audits and analyses for building improvements for residential, commercial, and public buildings, utilising advanced energy modelling software and thermal imaging technologies • Provide customised renovation recommendations based on the results of the analyses
Policy and Incentives	**Objective**: Support and incentivise renovation and reconstruction of buildings **Activities**: • Align with the Green Deal Project Guidelines and regularly update it • Develop technical regulations requiring energy performance improvements in existing buildings • Offer financial incentives, grants, and low-interest loans for renovations, focusing on high-impact areas such as insulation, HVAC systems, and renewable energy integration
Technical Support and Training	**Objective**: Equip stakeholders with the necessary skills and knowledge **Activities**: • Provide Minimum Output Project Specifications for drawing up technical documentation for energy/comprehensive renovation and reconstruction of buildings aligned with Green Deal Project Guidelines • Provide training programs for contractors, builders, and building managers on advanced principles, technologies, and best practices of energy efficiency, sustainability, and circular management of buildings • Develop detailed technical guidelines and support resources, including installation manuals and online training modules • Preparation and drawing up of design and technical documentation

Implementation of Renovations	**Objective**: Carry out the recommended renovations **Activities**: • Install high-performance insulation, energy-efficient windows, and advanced HVAC and lighting systems • Integrate renewable energy sources such as solar panels and geothermal systems where feasible • Perform, when possible, comprehensive renovation upgrading essential requirements for buildings
Monitoring and Evaluation	**Objective**: Ensure the effectiveness of renovations **Activities**: • Monitor energy performance improvements using smart meters and energy management systems • Evaluate the impact on GHG emissions and adaptive capacity through regular performance reviews
Timeline	**Year 1:** Conduct energy audits and analyses, develop policies and incentives, start training programs, draw up the technical documentation **Year 2:** Begin implementation of renovations, monitor and evaluate progress

C) District Heating System as a Primary Source of Heat

Objective	Shift from individual gas boilers to a centralised district heating system to reduce emissions
Programme Components	
Feasibility Study	**Objective**: Assess the feasibility and benefits of district heating **Activities**: • Conduct a feasibility study using energy modeling and simulation tools, including technical, economic, and environmental assessments
Stakeholder Engagement	**Objective**: Secure buy-in from key stakeholders **Activities**: • Engage local government, utility companies, and residents through consultations and information sessions, presenting technical data and case studies

Policy and Incentives	**Objective**: Support the transition to district heating **Activities**: • Develop policies to encourage connection to the district heating system • Provide financial incentives for households and businesses to switch, including subsidies for connection costs and infrastructure upgrades in cooperation with the district heating network operator and in cooperation with relevant national level ministries
Infrastructure Development	**Objective**: Modernise and expand the district heating infrastructure **Activities**: • Modernise the heat production utilising the RES and distribution networks using advanced technologies for energy efficiency and emissions control • Retrofit existing buildings to connect to the district heating system, ensuring compatibility with existing heating systems
Monitoring and Evaluation	**Objective**: Track system performance and benefits **Activities**: • Monitor energy savings and emission reductions using smart grid technologies • Evaluate user satisfaction and system efficiency through regular surveys and technical assessments
Timeline	**Year 1:** Conduct feasibility study, stakeholder engagement, policy development **Year 2 onwards:** infrastructure development, offer incentives, start monitoring and evaluation

D) Increased Production of Electrical Energy from RES - Photovoltaics Primarily

Objective	Increase the production of renewable energy, primarily through solar photovoltaics, to enhance resilience and reduce emissions
Programme Components	
Site Identification and Assessment	**Objective**: Identify suitable sites for photovoltaic installations **Activities**: • Conduct site assessments using GIS mapping and solar potential analysis for rooftops, public buildings, and open spaces - usage of the tool developed in cooperation with the GDi company

Regulatory Framework	**Objective**: Develop regulations to support renewable energy production **Activities**: • Create policies that mandate or incentivise the installation of solar panels on new and existing buildings • Streamline permitting processes for renewable energy projects
Financial Incentives and Support	**Objective**: Encourage investment in renewable energy **Activities**: • Provide grants, tax credits, and low-interest loans for photovoltaic installations, launch green bonds for own project, enable citizen participation • Develop public-private partnerships to fund large-scale projects, leveraging financing from green bonds and investment funds • Support citizen investments through models such as energy communities and energy cooperatives
Technical Support and Training	**Objective**: Equip stakeholders with the skills needed for installation and maintenance **Activities**: • Provide technical and legal guidelines and support for system design, installation, and maintenance
Monitoring and Evaluation	**Objective**: Ensure the effectiveness and sustainability of installations **Activities**: • Monitor energy production and system performance using smart meters and remote monitoring technologies • Evaluate the impact on energy resilience and GHG emissions through regular performance reviews and technical assessments
Timeline	**Year 1:** Site identification, regulatory framework development, start financial incentives **Year 1/2:** Begin installations, develop investment programme of city-owned company *Zagrebački sunčani krovovi Ltd.*, provide technical and legal support and training, monitor and evaluate

E) Heat Pumps Installations Programme Deployment

Objective	Deploy heat pumps to improve energy efficiency and reduce GHG emissions in heating and cooling systems of public buildings, as a part of the energy/comprehensive renovation of buildings
Programme Components	

Feasibility Study	**Objective**: Assess the feasibility and benefits of heat pump installations as a secondary solution, after the district heating usage **Activities**: • Conduct a feasibility study using energy modelling and simulation tools, including technical, economic, and environmental assessments
Policy and Incentives	**Objective**: Support and incentivise the adoption of heat pumps **Activities**: • Develop regulations to encourage the use of heat pumps in residential and commercial buildings • Provide financial incentives, grants, and low-interest loans for heat pump installations, focusing on high-impact areas in cooperation with national level ministries, synergising with their programmes
Pilot Projects	**Objective**: Demonstrate the benefits of heat pump installations **Activities**: • Implement pilot projects in various building types, using advanced heat pump technologies • Monitor and evaluate performance and benefits through detailed technical assessments
Monitoring and Evaluation	**Objective**: Ensure the effectiveness and sustainability of heat pump installations **Activities**: • Monitor energy savings and system performance using smart meters and remote monitoring technologies • Evaluate the impact on GHG emissions and user satisfaction through regular surveys and technical assessments
Timeline	**Year 1:** Conduct feasibility studies, develop policies and incentives **Year 1/2:** Implement pilot projects, begin widespread installations, monitor and evaluate

F) Continuation of Public Lighting Modernisation

Objective	Modernise public lighting systems to improve energy efficiency, reduce emissions, and decrease light pollution
Programme Components	

Audit and Assessment	**Objective**: Assess current public lighting systems and identify improvement opportunities **Activities**: • Conduct a comprehensive audit of the existing non-modernised part of public lighting infrastructure using advanced lighting assessment tools • Identify areas for modernisation and efficiency improvements
Policy Development	**Objective**: Create policies to support the modernisation of public lighting **Activities**: • Develop regulations requiring the adoption of energy-efficient public lighting technologies • Introduce incentives for municipalities to upgrade lighting systems, focusing on LED technology and smart lighting controls, coupling it with the advanced IoT and 5th GEN technologies
Technology Selection and Procurement	**Objective**: Choose the best technologies for modernisation **Activities**: • Evaluate and select energy-efficient lighting technologies (e.g., LED, smart controls) based on performance and cost-effectiveness • Procure the necessary equipment and materials through competitive bidding processes, or use the advanced contracting processes
Implementation and Installation	**Objective**: Upgrade public lighting systems **Activities**: • Replace existing lighting with energy-efficient alternatives, focusing on high-traffic and public areas • Install smart lighting controls to optimise energy use and reduce light pollution
Monitoring and Evaluation	**Objective**: Track the performance and benefits of the upgraded systems **Activities**: • Monitor energy consumption and savings using smart meters and lighting control systems • Evaluate the impact on emissions, light pollution, and user satisfaction through regular surveys and technical assessments
Timeline	**Year 1:** Conduct audit, develop policies, select technologies **Year 2:** Begin implementation, monitor and evaluate performance

3.2.2.2 Technology and assets – Later adoptions (3+ years)

A) District Heating System - Heat Production Decarbonisation, Utilisation of Geothermal and Solar Energy

Objective	Decarbonise heat production in the district heating system by utilising geothermal and solar energy, reducing GHG emissions and improving public health
Programme Components	
Feasibility Study	**Objective**: Assess the technical and economic feasibility of integrating geothermal and solar energy into the district heating system **Activities**: • Conduct geological surveys to identify additional geothermal potential • Perform solar potential assessments using GIS mapping and solar radiation data
Policy and Incentives	**Objective**: Develop supportive policies and incentives for decarbonising district heating **Activities**: • Create regulations promoting the use of renewable energy in district heating • Initiate additional cooperation with the district heating service provider and with the national-level ministries to trace a path for the full decarbonisation of the service
Infrastructure Development	**Objective**: Build and upgrade infrastructure to support geothermal and solar energy integration **Activities**: • Create cooperation agreement with the concession rights owner and district heating system operator for existing wells and fields, engage in talks with the National Hydrocarbon Agency for additional geothermal investigation plots, drill new wells, and build heat exchangers and supporting infrastructure • Install solar thermal collectors and integrate them into the district heating network • Upgrade existing distribution networks to accommodate new energy sources

Technical Support and Training	**Objective**: Equip stakeholders with the necessary skills and knowledge **Activities**: • Develop technical guidelines for system design, installation, and maintenance
Monitoring and Evaluation	**Objective**: Track the performance and benefits of the decarbonised district heating system **Activities**: • Monitor energy production and system efficiency using smart meters and sensors • Evaluate the impact on GHG emissions and public health through regular assessments
Timeline	**Year 1:** Conduct a feasibility study, develop policies, and start infrastructure planning **Year 2:** Begin infrastructure development **Year 3-4:** Complete infrastructure development, monitor and evaluate performance

B) Electrical Energy Produced from RES Storage Capacities Development

Objective	Increase the production and storage of renewable energy to reduce GHG emissions and improve public health and environmental outcomes
Programme Components	
Site Identification and Assessment	**Objective**: Identify suitable sites for renewable energy storage installations **Activities**: • Conduct site assessments using GIS mapping and environmental impact studies • Identify optimal locations for battery storage systems and other energy storage technologies
Regulatory Framework	**Objective**: Develop regulations to support renewable energy storage **Activities**: • Create policies that mandate or incentivise the installation of energy storage systems • Streamline permitting processes for renewable energy storage projects

Financial Incentives and Support	**Objective**: Encourage investment in renewable energy storage **Activities**: • Provide grants, tax credits, and low-interest loans for energy storage installations • Develop public-private partnerships to fund large-scale storage projects
Monitoring and Evaluation	**Objective**: Ensure the effectiveness and sustainability of energy storage installations **Activities**: • Monitor energy production, storage capacity, and system performance using smart meters and remote monitoring technologies • Evaluate the impact on energy resilience, GHG emissions, and environmental outcomes through regular performance reviews and technical assessments
Timeline	**Year 1:** Site identification, regulatory framework development, start financial incentives **Year 2:** Begin installations, provide technical support and training, monitor and evaluate

C) Introduction of District Cooling Systems

Objective	Introduce district cooling systems to improve energy efficiency, reduce GHG emissions, and enhance public health and environmental outcomes
Programme Components	
Feasibility Study	**Objective**: Assess the technical and economic feasibility of district cooling systems **Activities**: • Conduct a feasibility study using energy modeling and simulation tools, including technical, economic, and environmental assessments
Policy and Incentives	**Objective**: Develop supportive policies and incentives for district cooling systems **Activities**: • Create regulations promoting the adoption of district cooling systems in urban areas

Infrastructure Development	**Objective**: Build and upgrade infrastructure to support district cooling systems **Activities**: • Construct central cooling plants and distribution networks using advanced technologies for energy efficiency • Energy/comprehensive renovation of existing buildings to connect to the district cooling system, ensuring compatibility with existing cooling systems
Monitoring and Evaluation	**Objective**: Track the performance and benefits of the district cooling systems **Activities**: • Monitor energy savings and system performance using smart meters and sensors • Evaluate the impact on GHG emissions, public health, and environmental outcomes through regular assessments • Connect the service to the City of Zagreb Energy Atlas
Timeline	**Year 1:** Conduct feasibility study, develop policies, and start infrastructure planning **Year 2:** Begin infrastructure development **Year 3-4:** Complete infrastructure development, monitor and evaluate performance

3.2.3 Programme for decarbonisation of water supply sector

3.2.3.1 Governance and Policy early adoptions

A) Promote Water Conservation and Re-Use Practices

Objective	Encourage efficient water use and the adoption of water reuse practices to conserve water resources and enhance sustainability
Programme Components	

Needs Assessment and Feasibility Study	**Objective**: Conduct a thorough assessment to identify current water usage patterns, infrastructure gaps, and feasibility of implementing conservation and reuse practices **Activities**: • Evaluate existing water supply and wastewater infrastructure, including storage, distribution, and treatment systems • Analyse water demand patterns, usage efficiency, and potential areas for water savings • Assess technological advancements and innovative solutions for water conservation and reuse, such as greywater recycling and rainwater harvesting
Technology and Infrastructure Upgrade	**Objective**: Upgrade water infrastructure to support modern conservation and reuse practices **Activities**: • Replace outdated water distribution and treatment systems with modern, efficient models equipped with advanced control systems – the Zagreb project • Implement water-saving technologies, such as low-flow faucets, showerheads, and toilets in public and private buildings • Install rainwater harvesting systems and greywater recycling systems to promote water reuse in non-potable applications like irrigation and flushing
Deployment of Smart Water Management Systems	**Objective**: Implement smart water management systems for efficient water usage and operational optimisation **Activities**: • Deploy smart meters and sensors to monitor water consumption, flow rates, and system performance in real-time • Implement predictive analytics and demand response systems to optimise water usage, reduce peak demands, and improve system stability • Establish communication networks and data analytics platforms to enable remote monitoring, proactive maintenance, and rapid response to water supply disruptions

Safety and Regulatory Compliance	**Objective**: Ensure compliance with safety standards and regulatory requirements during the implementation of water conservation and reuse practices **Activities**: • Conduct safety assessments and risk analyses to identify potential hazards associated with new technologies and practices • Coordinate with regulatory authorities and utility providers to obtain necessary permits, approvals, and compliance certifications • Train water utility staff, maintenance personnel, and emergency responders on safety protocols, equipment operation, and emergency procedures related to the upgraded water infrastructure
Integration with Existing Water Supply and Management Systems	**Objective**: Seamlessly integrate new water conservation and reuse practices with existing water supply and management systems **Activities**: • Collaborate with water utility operators and maintenance teams to ensure compatibility and interoperability between upgraded infrastructure and existing operations • Implement remote monitoring and diagnostic capabilities to enhance water supply management, scheduling efficiency, and predictive maintenance of water infrastructure • Integrate water management systems with other city management software and public information systems to optimise water usage, enhance transparency, and improve service reliability
Performance Monitoring and Evaluation	**Objective**: Monitor performance metrics and evaluate the impact of water conservation and reuse practices on overall water management **Activities**: • Establish key performance indicators (KPIs) such as water savings, efficiency improvements, and cost savings • Conduct regular audits, performance assessments, and water usage audits to track progress towards goals and identify areas for further optimisation • Solicit feedback from water utility operators, residents, and stakeholders to assess satisfaction levels and gather insights for continuous improvement of water conservation and reuse practices

Public Awareness and Stakeholder Engagement	**Objective**: Engage stakeholders and raise awareness about the benefits of water conservation and reuse practices **Activities**: • Launch public outreach campaigns, community forums, and educational workshops to inform residents, businesses, and local communities about the environmental and economic benefits of water conservation and reuse • Collaborate with environmental organisations, advocacy groups, and civic leaders to advocate for sustainable water management solutions and support for conservation projects • Foster partnerships with academic institutions, research centers, and industry associations to promote knowledge-sharing, innovation, and best practices in water conservation and reuse
Timeline	**Year 1:** Conduct needs assessment, feasibility study, and technology evaluation **Year 2:** Begin infrastructure upgrades and deployment of smart water management systems. (if possible, already in year 1, as a part of maintenance programme) **Year 3-4:** Complete implementation efforts, integrate with existing water supply systems, and monitor performance for continuous improvement

B) Improved Water Usage Regulation

Objective	Enhance water management through stricter regulations and monitoring to ensure sustainable usage and efficient resource allocation
Programme Components	
Needs Assessment and Feasibility Study	**Objective**: Conduct a thorough assessment to identify current water usage patterns, regulatory gaps, and the feasibility of new regulations – monitoring could be done using the Energy Atlas **Activities**: • Evaluate existing water usage data, including residential, commercial, industrial, and agricultural sectors • Analyse current regulatory frameworks and identify areas for improvement • Assess technological advancements and best practices in water regulation and management from other regions

Regulatory Framework Development	**Objective**: Develop a comprehensive regulatory framework to promote efficient and sustainable water usage **Activities**: • Draft new regulations that set water usage limits, enforce conservation practices, and mandate efficient technologies • Include provisions for water reuse, rainwater harvesting, and greywater recycling • Develop guidelines for the implementation of water-saving measures in new constructions and retrofits
Monitoring and Enforcement Systems	**Objective**: Implement robust monitoring and enforcement systems to ensure compliance with new regulations **Activities**: • Install advanced metering infrastructure (AMI) to monitor water usage in real-time • Develop a centralised database to collect and analyse water usage data from various sectors • Implement automated systems for detecting and addressing non-compliance, including fines and penalties for excessive water use
Incentives and Support Programs	**Objective**: Encourage compliance and support stakeholders in adopting efficient water usage practices **Activities**: • Provide financial incentives, such as rebates or tax credits, for installing water-saving devices and technologies • Offer technical assistance and resources to help businesses and households transition to more efficient water usage practices • Launch grant programs for community projects that promote water conservation and reuse
Public Awareness and Stakeholder Engagement	**Objective**: Engage the public and stakeholders to foster a culture of water conservation and support for regulatory changes **Activities**: • Conduct public awareness campaigns using various media to educate about the importance of water conservation and the new regulations • Organise community workshops, forums, and training sessions to explain the benefits and requirements of the new regulations • Establish a feedback mechanism to gather input from residents, businesses, and other stakeholders on the effectiveness of the regulations

Performance Monitoring and Evaluation	**Objective**: Track the impact of new regulations on water usage and make necessary adjustments **Activities**: • Establish key performance indicators (KPIs) such as water savings, compliance rates, and reduction in water waste • Conduct regular audits and assessments to evaluate the effectiveness of the regulations • Use data analytics to identify trends and areas needing further regulatory adjustments or support
Safety and Regulatory Compliance	**Objective**: Ensure that all water usage practices comply with safety standards and regulatory requirements **Activities**: • Conduct safety assessments and risk analyses to identify potential hazards associated with water-saving technologies • Coordinate with regulatory authorities and utility providers to ensure alignment with safety and compliance standards • Train water utility staff, maintenance personnel, and emergency responders on safety protocols related to the new regulations
Timeline	**Year 1:** Conduct needs assessment, feasibility study, and draft regulatory framework **Year 2:** Implement monitoring and enforcement systems and develop incentives and support programs **Year 3-4:** Launch public awareness campaigns, monitor performance, and make regulatory adjustments as needed

3.2.3.2 Water sector technology and assets measures

A) Upgrade to High-Efficiency Pumps and Motors

Objective	Improve water and energy efficiency in the water supply system by upgrading to high-efficiency pumps and motors
Programme Components	

Needs Assessment and Feasibility Study	**Objective**: Assess current pump and motor systems to identify inefficiencies and feasibility of upgrades **Activities**: • Evaluate existing pump and motor specifications, energy consumption, and operational performance • Analyse water flow requirements, pressure levels, and system capacity to determine upgrade needs • Conduct cost-benefit analysis to justify investment in high-efficiency equipment
Technology and Infrastructure Upgrade	**Objective**: Replace outdated pumps and motors with high-efficiency models to reduce energy consumption and operational costs **Activities**: • Procure and install high-efficiency pumps and motors that meet or exceed energy efficiency standards • Upgrade control systems and automation to optimise pump and motor operation based on real-time demand and energy usage • Retrofit existing infrastructure to accommodate new equipment and ensure compatibility with upgraded systems
Implementation and Integration	**Objective**: Seamlessly integrate upgraded pumps and motors into the existing water supply system for enhanced reliability and performance **Activities**: • Collaborate with engineering teams and contractors to oversee installation and commissioning of new equipment • Conduct thorough testing and adjustments to ensure optimal performance and energy savings • Implement monitoring and maintenance protocols to track equipment performance and address any operational issues promptly
Performance Monitoring and Optimisation	**Objective**: Monitor and optimise the performance of upgraded pumps and motors to maximise energy efficiency and water conservation **Activities**: • Deploy monitoring tools, such as flow meters and energy meters, to track energy consumption and water flow rates in real-time • Analyse data to identify opportunities for further efficiency improvements and operational optimisations • Implement preventive maintenance schedules and predictive maintenance techniques to minimise downtime and extend equipment lifespan

Training and Capacity Building	**Objective**: Provide training for operational staff on the use, maintenance, and troubleshooting of high-efficiency pumps and motors **Activities**: • Develop training programs and materials covering equipment operation, energy efficiency principles, and safety protocols • Conduct hands-on workshops and simulations to enhance skills and knowledge among maintenance personnel • Foster a culture of continuous improvement by encouraging staff participation in ongoing training and skills development initiatives
Public Awareness and Stakeholder Engagement	**Objective**: Raise awareness among stakeholders about the benefits of high-efficiency pumps and motors for water conservation and sustainability **Activities**: • Communicate project goals, achievements, and energy savings through public outreach campaigns and community engagement events • Collaborate with local authorities, water utility boards, and environmental organisations to promote best practices in water management and conservation • Solicit feedback from stakeholders to gauge satisfaction, address concerns, and identify opportunities for future enhancements in water infrastructure
Timeline	**Year 1:** Conduct needs assessment, feasibility study, and equipment procurement **Year 2:** Implement equipment upgrades and integration into the water supply system **Year 3-4:** Monitor performance, optimise operations, and provide ongoing training and public

B) Installation of Renewable Energy Systems - Solar PV

Objective	Integrate solar photovoltaic (PV) systems to generate clean energy for sustainable operations
Programme Components	

Feasibility Assessment	**Objective**: Evaluate the suitability and potential benefits of solar PV installation **Activities**: • Assess available rooftop or ground space for solar panel installation • Analyse solar irradiance levels and shading factors to determine energy generation potential • Conduct financial analysis including cost-benefit and return on investment calculations
System Design and Engineering	**Objective**: Develop detailed plans and specifications for the solar PV system **Activities**: • An engineer designs the system layout • Determine the optimal configuration of panels, inverters, and storage (if applicable) • Ensure compliance with local building codes, permits, and regulatory requirements
Procurement and Installation	**Objective**: Procure high-quality solar PV equipment and execute installation **Activities**: • Source solar panels, inverters, mounting structures, and necessary electrical components • Manage contractor selection, bidding processes, and contract negotiations • Oversee installation activities, quality assurance checks, and safety protocols
Grid Connection and Interconnection	**Objective**: Connect the solar PV system to the existing electrical grid **Activities**: • Coordinate with utility companies to secure interconnection agreements • Install meters and monitoring systems for real-time energy production and consumption tracking • Ensure compliance with grid connection standards and safety regulations

Commissioning and Testing	**Objective**: Validate the functionality and performance of the solar PV system **Activities**: • Conduct comprehensive commissioning tests to verify system operation and efficiency • Optimise system settings and configurations for maximum energy output • Address any operational issues or adjustments needed during the testing phase
Operation and Maintenance	**Objective**: Implement a proactive maintenance plan to ensure long-term performance **Activities**: • Schedule regular inspections, cleaning, and performance assessments of solar panels • Monitor system performance through data analytics and remote monitoring tools • Train staff on routine maintenance tasks and troubleshooting procedures
Monitoring and Performance Evaluation	**Objective**: Monitor energy production and evaluate system performance over time **Activities**: • Utilise monitoring software and tools to track daily energy generation and savings • Analyse performance data to assess ROI, energy savings, and environmental benefits • Generate periodic reports to stakeholders on system performance and financial metrics
Public Awareness and Education	**Objective:** Raise awareness about the benefits of solar PV and promote sustainable practices **Activities:** • Launch educational campaigns and workshops for staff, residents, and stakeholders • Share success stories and case studies through newsletters, social media, and community events • Collaborate with local organisations and schools to educate the community on renewable energy

Timeline	**Year 1:** Conduct feasibility assessment, system design, and procurement **Year 2:** Install and commission solar PV system, including grid connection **Year 3-4:** Monitor performance, conduct maintenance, and promote public awareness

C) Comprehensive Water Supply System Revitalisation

Objective	Enhance the efficiency, reliability, and sustainability of the water supply system through comprehensive revitalisation efforts
Programme Components	
Needs Assessment and System Evaluation	**Objective**: Assess current infrastructure and identify areas needing improvement **Activities**: • Evaluate the condition of water treatment plants, pumping stations, pipelines, and storage facilities • Conduct hydraulic modelling and analysis to understand water flow dynamics and pressure zones • Identify vulnerabilities, bottlenecks, and areas prone to leaks or system losses
Infrastructure Rehabilitation and Upgrades	**Objective**: Upgrade and rehabilitate key components of the water supply system **Activities**: • Repair or replace aging pipelines and distribution networks to reduce water losses and improve reliability • Upgrade pumping stations with energy-efficient pumps and automation systems for optimal operation • Modernise water treatment facilities to meet current regulatory standards and increase treatment capacity • Implement advanced technologies for leak detection, pressure management, and remote monitoring

Integration of Smart Water Management Systems	**Objective**: Implement smart technologies for enhanced water management and operational efficiency **Activities**: • Deploy sensors and meters to monitor water quality, pressure levels, and flow rates in real-time • Utilise data analytics and predictive modelling to optimise water distribution and minimise waste • Implement SCADA (Supervisory Control and Data Acquisition) systems for centralised monitoring and control • Integrate GIS (Geographic Information System) for asset management and spatial analysis
Water Quality and Environmental Protection	**Objective**: Improve water quality standards and protect water resources **Activities**: • Enhance water treatment processes to ensure compliance with drinking water quality regulations • Implement measures for watershed protection and source water management • Promote sustainable practices for agricultural and industrial water use to minimise pollution and contamination • Collaborate with environmental agencies and stakeholders to address water conservation and ecosystem health
Community Engagement and Public Awareness	**Objective**: Engage stakeholders and raise public awareness about water conservation and system revitalisation efforts **Activities**: • Conduct outreach programs, workshops, and educational campaigns on water conservation and efficient use • Establish partnerships with local communities, schools, and businesses to promote sustainable water practices • Solicit feedback from residents and stakeholders to ensure transparency and accountability in water management initiatives

Capacity Building and Training	**Objective**: Build institutional capacity and train personnel for effective water system management **Activities**: • Provide technical training for water utility staff on new technologies, maintenance practices, and emergency response • Develop contingency plans and emergency preparedness strategies for water supply disruptions or natural disasters • Foster collaboration with universities and research institutions to advance knowledge and innovation in water management
Regulatory Compliance and Governance	**Objective**: Ensure compliance with water regulations and improve governance of the water supply system **Activities**: • Review and update water policies, regulations, and tariffs to promote equitable and sustainable water management • Engage with regulatory authorities and stakeholders to address legal and institutional barriers to system revitalisation • Enhance governance structures for transparent decision-making, financial management, and accountability
Timeline	**Year 1:** Conduct needs assessment, system evaluation, and planning **Year 2:** Initiate infrastructure rehabilitation and smart technology integration **Year 3-4:** Complete upgrades, monitor system performance, and engage stakeholders for ongoing support and improvement

D) Programme for the Usage of Nature-Based Solutions in Runoff Water Management

Objective	Implement nature-based solutions to effectively manage runoff water, reduce flooding risks, and enhance ecosystem resilience
Programme Components	
Needs Assessment and Site Selection	**Objective**: Identify areas prone to runoff water issues and assess the feasibility of nature-based solutions **Activities**: • Conduct hydrological assessments to understand runoff patterns, flood risks, and water quality impacts • Evaluate potential sites for implementing nature-based solutions based on ecological suitability and community needs • Engage with local stakeholders, including residents and businesses, to gather input and support for the program

Design and Implementation of Nature-Based Solutions	**Objective**: Design and implement green infrastructure projects to manage runoff water effectively **Activities**: • Design bio-swales, rain gardens, green roofs, and permeable pavements to capture and infiltrate stormwater (integrated into the new guidelines for buildings design) • Restore or create wetlands, floodplains, and riparian buffers to enhance natural flood control and water filtration • Install check dams, retention ponds, and vegetated channels to slow down and detain runoff flows • Integrate native vegetation and landscaping practices that enhance water absorption and biodiversity
Community Engagement and Participation	**Objective**: Engage and involve the community in the planning and implementation of nature-based solutions **Activities**: • Conduct public workshops, educational programs, and outreach campaigns to raise awareness about runoff water management • Collaborate with residents, schools, and community groups to participate in planting and maintenance activities • Establish partnerships with non-profit organisations, environmental groups, and businesses to support project funding and volunteer efforts
Monitoring and Performance Evaluation	**Objective**: Monitor the effectiveness and performance of nature-based solutions in managing runoff water **Activities**: • Implement monitoring systems to track water quality, flow rates, and infiltration rates in green infrastructure • Collect data on flood mitigation, reduction in pollutant loads, and improvement in local ecosystem health • Conduct regular assessments and evaluations to measure the success of implemented projects and identify areas for improvement

Policy Integration and Institutional Support	**Objective**: Integrate nature-based solutions into local policies and secure institutional support for sustainable water management **Activities**: • Advocate for policy changes and zoning regulations that prioritise green infrastructure and runoff water management • Work with municipal authorities and planning departments to include nature-based solutions in urban development plans • Secure funding and grants from government agencies, foundations, and private donors to support long-term maintenance and expansion of green infrastructure
Capacity Building and Knowledge Sharing	**Objective**: Build local capacity and share knowledge on nature-based solutions for runoff water management **Activities**: • Provide training and workshops for landscape architects, engineers, and city planners on designing and implementing green infrastructure • Facilitate knowledge exchange forums, conferences, and study tours to showcase successful projects and lessons learned • Develop educational materials, guidelines, and best practices manuals for stakeholders interested in replicating nature-based solutions
Timeline	**Year 1:** Conduct needs assessment, site selection, and stakeholder engagement **Year 2:** Design and implement nature-based solutions, initiate monitoring programs **Year 3-4:** Monitor performance, evaluate effectiveness, and scale-up implementation based on results and community feedback

E) Demarcation of Rainwater Sewage System from Canalisation (Sanitary) Sewage System

Objective	Establish distinct systems for rainwater and sanitary sewage to improve water management, reduce pollution, and mitigate flooding risks
Programme Components	

Hydrological Assessment and Mapping	**Objective**: Assess the existing sewer infrastructure and map out separate systems for rainwater and sanitary sewage **Activities**: • Conduct hydrological studies to analyse rainfall patterns, runoff characteristics, and drainage basin conditions • Map out the existing canalisation (sanitary) sewage system and identify areas where rainwater and sanitary sewage are currently mixed • Identify critical points of overlap and areas prone to flooding or pollution due to combined sewage systems
Infrastructure Planning and Design	**Objective**: Design and plan infrastructure upgrades to separate rainwater and sanitary sewage systems **Activities**: • Develop engineering designs for separate drainage networks, including pipes, culverts, and storage facilities • Determine optimal locations for rainwater collection points, retention basins, and infiltration zones • Ensure compatibility with existing urban infrastructure and land use planning considerations
Construction and Implementation	**Objective**: Construct and implement the demarcated rainwater and sanitary sewage systems **Activities**: • Install new pipelines and infrastructure for rainwater collection and management • Retrofit existing canalisation systems to separate rainwater and sanitary sewage flows • Implement green infrastructure solutions such as permeable pavements and bioswales to enhance rainwater infiltration and treatment
Regulatory Compliance and Permitting	**Objective**: Obtain necessary permits and ensure compliance with regulatory standards for sewage system demarcation **Activities**: • Coordinate with local authorities and environmental agencies to secure permits for construction and operation • Comply with environmental regulations and standards related to water quality, stormwater management, and pollution control • Conduct environmental impact assessments and address any potential ecological concerns or community impacts

Monitoring and Maintenance	**Objective**: Establish monitoring protocols and maintenance procedures for the separated sewage systems **Activities**: • Implement monitoring systems to track water quality, flow rates, and system performance • Conduct regular inspections and maintenance of infrastructure to ensure optimal operation and prevent system failures • Train local personnel and stakeholders on maintenance practices and emergency response procedures
Public Awareness and Stakeholder Engagement	**Objective**: Educate and engage the community on the benefits of separate rainwater and sanitary sewage systems **Activities**: • Launch public awareness campaigns, workshops, and educational programs to inform residents and businesses • Collaborate with local communities, schools, and civic organisations to promote sustainable water management practices • Foster partnerships with stakeholders, including property owners, developers, and environmental groups, to support system implementation and maintenance
Timeline	**Year 1:** Conduct hydrological assessment, mapping, and initial planning **Year 2:** Design infrastructure upgrades and obtain necessary permits **Year 3-4:** Implement construction, monitor system performance, and engage in ongoing maintenance and community outreach

3.2.4 Programme for the decarbonisation of mobility

3.2.4.1 Early adoption policy measures (1-3 years)

A) Subsidies and Incentives for Electric Vehicle (EV) Purchases

Objective	Promote the adoption of electric vehicles (EVs) to reduce greenhouse gas emissions, improve air quality, and support sustainable urban mobility
Programme Components	

Infrastructure Development	**Objective**: Build and upgrade the necessary infrastructure to support EV adoption **Activities**: • Install public charging stations in strategic locations such as parking lots, shopping centers, and residential areas • Develop fast-charging networks along major highways and urban centers • Support the installation of home charging stations through grants or rebates
Policy and Regulatory Support	**Objective**: Create a supportive policy framework to encourage EV adoption **Activities**: • Implement low-emission zones where only EVs and other low-emission vehicles are allowed
Public Awareness and Education	**Objective**: Raise public awareness and understanding of the benefits of EVs **Activities**: • Conduct public information campaigns highlighting the environmental and economic benefits of EVs • Organise events such as EV fairs and test drive opportunities to allow potential buyers to experience EVs firsthand • Develop educational programs and materials for schools and community organisations
Partnerships and Collaborations	**Objective**: Foster collaboration between government, industry, and other stakeholders to support EV adoption **Activities**: • Encourage public-private partnerships to develop charging infrastructure and other supportive services • Collaborate with local governments and communities to identify and address barriers to EV adoption
Monitoring and Evaluation	**Objective**: Track the effectiveness and impact of subsidies and incentives for EV adoption **Activities**: • Monitor the uptake of EVs and usage patterns of charging infrastructure • Evaluate the impact of EV adoption on greenhouse gas emissions, air quality, and overall urban mobility • Adjust and refine subsidy programs and incentives based on feedback and data collected

Timeline	Year 1: Begin infrastructure planning and start public awareness campaigns Year 2: Start infrastructure development, continue public awareness efforts, and implement policy support Year 3-4: Complete infrastructure projects, foster partnerships, and conduct ongoing monitoring and evaluation

B) Development of Integrated Public Transportation Systems – an Update

Objective	Create comprehensive and seamless public transportation systems to enhance urban mobility, reduce traffic congestion, lower greenhouse gas emissions, and improve quality of life
Programme Components	
Feasibility Study and Needs Assessment	Objective: Understand the current transportation landscape and identify gaps and opportunities for integration Activities: • Conduct comprehensive surveys and data collection on current public transportation usage, traffic patterns, and commuter needs • Identify key areas where integration can improve efficiency and accessibility
Planning and Design	Objective: Develop a detailed plan for an integrated public transportation system Activities: • Design an integrated network that connects various modes of transportation, including buses, trams, trains, bike-sharing, and pedestrian pathways • Ensure the inclusion of accessible routes and facilities for people with disabilities • Plan for future expansion and scalability of the transportation network

Infrastructure Development	**Objective**: Build and upgrade infrastructure to support the integrated transportation plan **Activities**: • Construct and upgrade transportation hubs that facilitate easy transfers between different modes of transport • Develop dedicated lanes for buses and bicycles to improve speed and safety • Install real-time information systems and smart ticketing solutions to enhance user experience
Policy and Regulatory Support	**Objective**: Establish supportive policies and regulations to facilitate the implementation of the transportation plan **Activities**: • Create zoning and land-use policies that support transit-oriented development. Already tackled through the new General urbanistic plan of land development, will be worked out in the lower level plans • Implement regulations that encourage the use of public transportation, such as reduced fares and parking restrictions in congested areas • Develop policies that promote the use of sustainable and clean energy sources in public transportation
Public Engagement and Education	**Objective**: Ensure public support and awareness of the integrated transportation plan **Activities**: • Conduct public consultations and workshops to gather feedback and build community support • Develop educational campaigns to inform the public about the benefits and usage of the integrated transportation system • Engage with schools, businesses, and community groups to promote public transportation use

Funding and Financing	**Objective:** Secure funding for the development and maintenance of the integrated transportation system **Activities:** • Identify and apply for grants and funding opportunities from national and international sources • Explore public-private partnerships to share the costs and benefits of transportation projects • Implement fare structures and subsidies that balance affordability for users with financial sustainability
Monitoring and Evaluation	**Objective:** Track the performance and impact of the integrated transportation system **Activities:** • Monitor usage patterns, service reliability, and user satisfaction through regular surveys and data analysis • Evaluate the impact on traffic congestion, greenhouse gas emissions, and urban mobility • Use feedback and data to continuously improve and adapt the transportation plan
Timeline	**Year 1**: Conduct feasibility study and needs assessment, begin planning and design, and secure initial funding **Year 2**: Start infrastructure development and implement initial policy and regulatory changes **Year 3-4**: Complete major infrastructure projects, launch public engagement and education campaigns, and start monitoring and evaluation

C) Establishment of Policies to Promote Active Transport (Cycling and Walking)

Objective	Encourage active transport modes such as cycling and walking to reduce traffic congestion, lower greenhouse gas emissions, improve public health, and enhance urban liveability
Programme Components	

Infrastructure Development	**Objective**: Build and upgrade infrastructure to support cycling and walking **Activities**: • Develop dedicated bike lanes, pedestrian pathways, and crosswalks to ensure safe and accessible routes • Install bike-sharing stations and bike racks throughout the city to promote cycling • Improve lighting, signage, and safety features along walking and cycling routes
Policy and Regulatory Support	**Objective**: Establish policies and regulations that encourage active transport **Activities**: • Implement policies that prioritise the development and maintenance of cycling and pedestrian infrastructure • Introduce regulations that limit car access in certain areas, creating car-free zones to encourage walking and cycling – connected to land use and congestion pricing • Provide incentives for businesses to support active transport, such as bike storage facilities and shower/changing rooms for employees
Public Awareness and Education	**Objective**: Raise public awareness and understanding of the benefits of active transport **Activities**: • Conduct public campaigns highlighting the health, environmental, and economic benefits of cycling and walking • Organise events such as "Bike to Work" days, walking tours, and community cycling workshops to promote active transport • Develop educational materials and programs for schools to encourage children to walk or cycle to school
Incentives and Support Programmes	**Objective**: Provide incentives to encourage the use of active transport **Activities**: • Offer subsidies or grants for the purchase of bicycles and related equipment • Implement reward programs for frequent cyclists and pedestrians, such as discounts at local businesses • Provide free or subsidised bike repair services to encourage regular bike maintenance and usage

Integration with Public Transportation	**Objective**: Integrate active transport modes with public transportation systems **Activities**: • Ensure easy and safe access to public transportation hubs for cyclists and pedestrians • Install bike racks and storage facilities at train and bus stations • Develop multimodal transport apps that include options for cycling and walking routes along with public transportation schedules
Monitoring and Evaluation	**Objective**: Track the performance and benefits of policies promoting active transport **Activities**: • Monitor usage patterns of cycling and walking infrastructure using counters and surveys • Evaluate the impact on traffic congestion, greenhouse gas emissions, and public health outcomes through regular assessments • Adjust policies and infrastructure development plans based on feedback and data collected
Timeline	**Year 1**: Conduct initial feasibility studies, develop policies, and start infrastructure planning **Year 2**: Begin infrastructure development and launch public awareness campaigns **Year 3-4**: Complete major infrastructure projects, implement incentive programs, and start monitoring and evaluation

D) Enforcement of Green Procurement Policies for City Fleets

Objective	Implement green procurement policies to ensure that city fleets are environmentally friendly, reducing greenhouse gas emissions and promoting sustainability in urban transportation
Programme Components	

Policy Development and Implementation	**Objective**: Create and enforce green procurement policies for city fleets **Activities**: • Develop policies that mandate the purchase of low-emission or zero-emission vehicles for all new city fleet acquisitions • Establish criteria and guidelines for evaluating the environmental performance of vehicles, including fuel efficiency, emissions, and lifecycle impacts • Implement regulations requiring regular upgrades to the existing fleet to meet new environmental standards
Incentives and Financial Support	**Objective**: Provide financial incentives to support the adoption of green vehicles in city fleets **Activities**: • Allocate budget and grants for the procurement of electric or hybrid vehicles • Provide financial assistance for retrofitting existing vehicles with cleaner technologies – towards the utility companies owned by the city
Infrastructure Development	**Objective**: Develop infrastructure to support the operation of green city fleets **Activities**: • Install electric vehicle (EV) charging stations at municipal buildings, depots, and other strategic locations • Ensure maintenance facilities are equipped to handle the servicing of green vehicles • Develop refueling infrastructure for alternative fuels, such as hydrogen or biofuels
Training and Capacity Building	**Objective**: Train city staff and fleet operators on the use and maintenance of green vehicles **Activities**: • Conduct training programs for fleet managers and drivers on the benefits and operation of green vehicles • Develop workshops and courses on vehicle maintenance, safety, and energy-efficient driving practices • Provide resources and guidelines on best practices for managing a green fleet

Monitoring and Evaluation	**Objective**: Track the performance and environmental impact of green city fleets **Activities**: • Monitor fleet composition, usage, fuel consumption, and emissions using data collection and reporting tools • Evaluate the impact on greenhouse gas emissions, air quality, and operational costs through regular assessments • Use the data collected to refine and improve green procurement policies and practices
Public Engagement and Reporting	**Objective**: Engage the public and ensure transparency in the implementation of green procurement policies **Activities**: • Publish regular reports on the progress and outcomes of green fleet initiatives • Conduct public outreach campaigns to highlight the environmental benefits of green procurement policies • Engage with community groups, businesses, and stakeholders to gather feedback and build support for green initiatives
Timeline	**Year 1**: Develop and finalise green procurement policies, allocate budget, and start training programs **Year 2**: Begin procurement of green vehicles and infrastructure development **Year 3-4**: Continue vehicle procurement, complete major infrastructure projects, and conduct ongoing monitoring and evaluation

E) Strategy for City Owned Public Transport Company Transformation

Objective	Transform the city-owned public transport company to improve efficiency, sustainability, service quality, and financial viability. This process has already started via the utilisation of the EIB technical assistance
Programme Components	

Governance and Organisational Restructuring	**Objective**: Modernise the governance structure and operational model of the public transport company **Activities**: • Implement a new governance framework that promotes transparency, accountability, and stakeholder engagement • Restructure the organisation to enhance efficiency, reduce bureaucracy, and streamline decision-making processes • Introduce performance-based management and key performance indicators (KPIs) to monitor progress and outcomes
Service Improvement and Customer Focus	**Objective**: Enhance the quality and reliability of public transport services to meet the needs of users **Activities**: • Conduct comprehensive customer satisfaction surveys and engage with the community to understand their needs and preferences • Improve service frequency, reliability, and coverage, ensuring timely and convenient connections • Upgrade and maintain vehicles and infrastructure to provide a comfortable and safe travel experience
Sustainability and Environmental Responsibility	**Objective**: Promote sustainability in operations to reduce the environmental impact of public transport **Activities**: • Transition to a fleet of low-emission or zero-emission vehicles, in the first phase to electric and in the second phase to hydrogen-powered buses • Implement energy-efficient practices and renewable energy sources in depots and administrative buildings • Promote initiatives that encourage public transport usage, such as reduced fares for students, seniors, and low-income residents, which is already in place
Financial Sustainability and Revenue Generation	**Objective**: Ensure the financial viability of the public transport company through diversified revenue streams **Activities**: • Develop a comprehensive financial plan that includes budgeting, cost control measures, and financial forecasting • Explore alternative revenue sources, such as advertising, partnerships, and government grants • Implement dynamic pricing models and fare optimisation strategies to maximise revenue without compromising accessibility

Technology and Innovation	**Objective**: Leverage technology and innovation to enhance operational efficiency and customer experience **Activities**: • Implement advanced ticketing systems, such as contactless payments and mobile ticketing apps • Utilise real-time data and analytics to optimise routes, manage fleet operations, and improve service planning • Invest in smart transportation infrastructure, such as intelligent traffic management systems and connected vehicle technology
Workforce Development and Training	**Objective**: Equip the workforce with the skills and knowledge required for the transformation **Activities**: • Provide training and development programs for staff to enhance their technical and professional skills • Foster a culture of innovation, collaboration, and continuous improvement within the organisation • Ensure workforce diversity and inclusion through equitable hiring practices and supportive workplace policies
Stakeholder Engagement and Collaboration	**Objective**: Engage stakeholders and foster collaboration to support the transformation process **Activities**: • Establish regular communication channels with government agencies, private sector partners, and community groups • Create advisory boards or committees that include representatives from various stakeholder groups • Collaborate with academic institutions, research organisations, and technology providers to drive innovation
Monitoring and Evaluation	**Objective**: Track the progress and impact of the transformation strategy **Activities**: • Implement a robust monitoring and evaluation framework to assess performance against defined KPIs • Conduct regular reviews and audits to ensure compliance with standards and identify areas for improvement • Use feedback from customers and stakeholders to inform ongoing adjustments and enhancements to the strategy

Timeline	Year 1: Develop and finalise the transformation strategy, initiate governance restructuring, and begin stakeholder engagement Year 2: Launch service improvement initiatives, start fleet transition to low-emission vehicles, and implement technology upgrades Year 3-4: Continue infrastructure development, expand customer-focused services, enhance financial sustainability measures, and conduct ongoing monitoring and evaluation

3.2.4.2 Late adoption policy measures (3+ years)

F) Expansion of the Low-Emission Zones to Cover Larger Urban Areas

Objective	Expand low-emission zones (LEZs) to reduce air pollution, improve public health, and encourage the use of sustainable transportation options in larger urban areas, based on the provisions of the spatial plans
Programme Components	
Feasibility Study and Area Assessment	Objective: Identify and assess potential areas for the expansion of low-emission zones Activities: • Conduct air quality monitoring and data analysis to identify areas with high levels of pollution, the network of existing monitoring stations needs to be upgraded and made denser • Evaluate traffic patterns, population density, and the presence of sensitive receptors (e.g., schools, hospitals) to prioritise areas for LEZ expansion • Assess the potential impact on local businesses and residents to ensure a balanced approach
Policy and Regulatory Framework	Objective: Develop a comprehensive policy and regulatory framework to support the expansion of LEZs Activities: • Establish clear criteria for vehicle emissions standards and access restrictions within LEZs • Develop enforcement mechanisms, including the use of cameras and sensors to monitor compliance • Implement legal and administrative processes to manage fines and penalties for non-compliance

Infrastructure Development	**Objective**: Build and upgrade infrastructure to support the expanded LEZs **Activities**: • Install signage and information systems to clearly delineate the boundaries of LEZs and inform drivers of restrictions • Develop and enhance public transportation options to provide alternatives to driving in LEZs • Install charging stations for electric vehicles (EVs) and promote the use of clean energy transportation
Public Awareness and Engagement	**Objective**: Raise public awareness and gain support for the expansion of LEZs **Activities**: • Conduct public information campaigns to educate residents and businesses about the benefits of LEZs and the new regulations • Engage with community groups, local businesses, and stakeholders through consultations and public meetings • Provide resources and support for residents and businesses to transition to low-emission vehicles and sustainable transportation options
Incentives and Support Programs	**Objective**: Provide incentives to encourage compliance and support the transition to low-emission transportation **Activities**: • Offer subsidies and grants for the purchase of low-emission and zero-emission vehicles • Implement tax incentives and rebates for retrofitting existing vehicles to meet LEZ standards • Develop support programs for businesses to adapt their logistics and transportation operations
Monitoring and Evaluation	**Objective**: Track the performance and impact of the expanded LEZs **Activities**: • Monitor air quality and traffic patterns within and around the LEZs using sensors and data analysis • Evaluate the impact on public health, traffic congestion, and local economy through regular assessments • Use feedback and data to make necessary adjustments and improvements to the LEZ policies and infrastructure

Timeline	Year 1: Conduct feasibility study, develop policy framework, and start public engagement Year 2: Begin infrastructure development and implement initial LEZ expansions Year 3-4: Continue expanding LEZ coverage, enhance public transportation options, and conduct ongoing monitoring and evaluation
Implementation Steps	1. Initial Planning • Establish a task force or committee to oversee the LEZ expansion project • Develop a detailed project plan with milestones, responsibilities, and budget allocations 2. Stakeholder Engagement • Conduct workshops and meetings with stakeholders, including local government, businesses, and community groups • Gather input and address concerns to build consensus and support for the LEZ expansion 3. Policy Development • Draft and finalise the regulatory framework, including emissions standards, enforcement mechanisms, and incentives • Secure approval and adoption of the policies by relevant authorities 4. Infrastructure Development • Roll out signage, information systems, and monitoring technology in the expanded LEZ areas • Enhance public transportation and install EV charging infrastructure 5. Public Awareness Campaign • Launch a comprehensive public information campaign to inform residents and businesses about the LEZ expansion • Provide resources and support for transitioning to low-emission transportation options

	6. Implementation and Enforcement • Begin enforcing the new LEZ regulations, monitoring compliance, and issuing fines for violations • Offer ongoing support and resources to help residents and businesses adapt to the changes 7. Monitoring and Evaluation • Continuously monitor air quality, traffic patterns, and other relevant metrics • Conduct regular evaluations to assess the impact and effectiveness of the LEZ expansion • Make data-driven adjustments to policies and infrastructure as needed to ensure the success of the LEZ expansion

G) Implementation of comprehensive smart city transportation systems

Objective	Implement smart city transportation systems to enhance efficiency, safety, sustainability, and overall urban mobility
Programme Components	
Integrated Data Management	Objective: Establish a centralised data management system to integrate and analyse transportation data Activities: • Develop a unified platform for collecting, storing, and analysing data from various transportation modes (e.g., buses, trains, bikes) • Integrate real-time data feeds from sensors, cameras, and GPS devices to monitor traffic flow, vehicle locations, and passenger demand • Ensure data security and privacy protocols are in place to protect sensitive information

Intelligent Transportation Systems (ITS)	**Objective**: Deploy ITS technologies to optimise traffic management and improve transport efficiency **Activities**: • Implement adaptive traffic signal control systems to prioritise buses and emergency vehicles and optimise traffic flow • Introduce dynamic route planning and navigation systems to provide real-time information on traffic conditions and alternative routes • Utilize predictive analytics to forecast traffic patterns and optimise resource allocation
Smart Parking Solutions	**Objective**: Improve parking management and reduce urban congestion through smart parking solutions **Activities**: • Implement sensor-based parking systems to provide real-time information on parking availability and pricing • Develop mobile apps and digital platforms for drivers to locate and reserve parking spaces in advance • Introduce variable pricing models and incentives to encourage off-peak and shared parking solutions
Electric and Autonomous Vehicles Integration	**Objective**: Promote the integration of electric and autonomous vehicles (AVs) into the transportation network – connection with the RIMAC self-driving taxi project **Activities**: • Expand EV charging infrastructure and implement incentives for the adoption of electric vehicles • Develop AV testing zones and pilot projects to demonstrate safety and efficiency benefits • Collaborate with automakers and technology firms to integrate AV technologies into public transportation and ride-sharing services
Public Transit Enhancement	**Objective**: Enhance public transit systems to increase ridership and improve accessibility **Activities**: • Upgrade bus and rail fleets with smart technologies for real-time tracking, automated fare collection, and passenger information systems • Integrate multimodal transportation options, including bike-sharing programs and last-mile connectivity solutions

	• Implement mobile ticketing apps and digital payment platforms to streamline the passenger experience
Sustainable and Resilient Infrastructure	**Objective**: Develop sustainable and resilient infrastructure to support smart transportation systems **Activities**: • Retrofit existing infrastructure with energy-efficient lighting, EV charging stations, and green spaces • Integrate renewable energy sources, such as solar panels to power transportation facilities • Implement resilience measures to withstand and recover from natural disasters and climate change impacts – connection to the adaptation part via the climate proofing exercise prescribed in the horizontal measures
Public Engagement and Education	**Objective**: Educate and engage the public on the benefits and usage of smart city transportation systems **Activities**: • Launch public awareness campaigns through media channels, community events, and educational workshops • Conduct pilot projects and demonstrations to showcase the capabilities and benefits of smart transportation technologies • Solicit feedback and input from residents, businesses, and stakeholders to ensure inclusivity and address concerns
Policy and Regulatory Framework	**Objective**: Establish supportive policies and regulations to enable the implementation and operation of smart transportation systems **Activities**: • Develop guidelines for data sharing and privacy protection to facilitate collaboration among stakeholders • Implement regulations to promote the safety and reliability of autonomous vehicles and other emerging technologies • Create incentives and funding mechanisms to support innovation and investment in smart city transportation initiatives
Monitoring and Evaluation	**Objective**: Monitor performance metrics and evaluate the impact of smart city transportation systems **Activities**: • Establish key performance indicators (KPIs) to track system efficiency, safety, sustainability, and user satisfaction • Conduct regular audits and reviews to assess compliance with regulatory requirements and achievement of goals

	• Use data analytics and feedback mechanisms to continuously improve and optimise smart transportation services
Timeline	Year 1: Develop a comprehensive smart transportation strategy and secure funding for initial projects Year 2: Pilot test smart transportation technologies and begin infrastructure deployment Year 3-4: Scale up deployment, expand coverage, and integrate additional smart city initiatives

I) Introduction of Green Corridors and Dedicated Lanes for Public Transit

Objective	Implement green corridors and dedicated lanes to enhance the efficiency, reliability, and sustainability of public transit systems
Programme Components	
Planning and Design	Objective: Develop a strategic plan for creating green corridors and dedicated lanes Activities: • Conduct feasibility studies and corridor assessments to identify suitable routes for green corridors and dedicated transit lanes • Engage urban planners, transportation experts, and stakeholders to design integrated transit networks in alignment with spatial plans • Ensure alignment with city development plans and sustainability goals
Infrastructure Development	Objective: Build and upgrade infrastructure to support green corridors and dedicated transit lanes Activities: • Construct dedicated lanes for buses, trams, or other forms of public transit to prioritise transit vehicles and reduce congestion • Designate green corridors with enhanced pedestrian amenities, bike lanes, and landscaping to promote sustainable transportation options • Implement traffic management systems, signal prioritisation, and smart technologies to optimise transit flow and reduce travel times

Policy and Regulatory Support	**Objective**: Establish supportive policies and regulations to facilitate the implementation of green corridors and dedicated transit lanes **Activities**: • Develop zoning regulations and land-use policies that support transit-oriented development along green corridors • Implement regulations to restrict private vehicle access or parking in dedicated transit lanes to ensure their effectiveness • Introduce incentives for businesses and developers to locate near transit corridors and promote mixed-use developments
Public Engagement and Community Outreach	**Objective**: Engage the public and stakeholders to build support and awareness for green corridors and dedicated transit lanes **Activities**: • Conduct public consultations, workshops, and community meetings to gather feedback and input from residents and businesses • Provide educational campaigns and information sessions to promote the benefits of sustainable transit options • Collaborate with local organisations and advocacy groups to advocate for transit-oriented policies and initiatives
Integration with Public Transportation	**Objective**: Integrate green corridors and dedicated lanes with existing public transportation networks **Activities**: • Enhance connectivity between transit lines and modes of transport (e.g., buses, light rail, bike-sharing) within green corridors • Implement multimodal transit hubs with seamless transfers and amenities for passengers • Develop real-time information systems and mobile apps to inform travellers about transit schedules, routes, and services
Environmental and Social Benefits	**Objective**: Maximise environmental sustainability and improve quality of life along green corridors **Activities**: • Plant trees, vegetation, and green infrastructure to improve air quality, reduce urban heat island effects according to the already executed heat mapping, and enhance aesthetics • Promote active transportation options such as walking and cycling through dedicated lanes and safe pedestrian crossings • Monitor and evaluate the impact of green corridors on carbon emissions, air pollution, and public health outcomes

Monitoring and Evaluation	**Objective**: Track the performance and effectiveness of green corridors and dedicated transit lanes **Activities**: • Collect data on ridership, travel times, congestion levels, and environmental metrics to assess impact and identify improvements • Conduct regular reviews and assessments to measure compliance with transit lane regulations and policies • Use feedback from stakeholders and residents to adjust strategies and optimise the design and operation of green corridors
Timeline	**Year 1**: Conduct planning and feasibility studies, engage stakeholders, and develop initial designs for green corridors **Year 2**: Begin construction of dedicated transit lanes and green infrastructure, launch public engagement campaigns **Year 3-4**: Complete infrastructure development, integrate with public transportation networks, and conduct ongoing monitoring and evaluation

J) Mandate for all New City Vehicles to be Electric or Hybrid

Objective	Implement a mandate requiring all new city vehicles to be electric or hybrid, aiming to reduce emissions, promote sustainability, and set an example for the community
Programme Components	
Policy Development and Adoption	**Objective**: Establish a clear policy framework mandating the adoption of electric or hybrid vehicles for all new city vehicle purchases **Activities**: • Draft legislation or ordinances outlining the requirements and timeline for transitioning to electric or hybrid vehicles • Obtain approval and support from the City Council • Coordinate with fleet managers and procurement departments to ensure compliance with the new mandate
Fleet Assessment and Transition Plan	**Objective**: Assess the current city vehicle fleet and develop a phased transition plan to integrate electric and hybrid vehicles **Activities**: • Conduct an inventory of existing city vehicles, including their age, type, and emissions profiles • Evaluate infrastructure readiness for electric vehicle charging stations and maintenance facilities

	• Develop a procurement strategy that includes timelines, budget allocations, and supplier partnerships for acquiring electric and hybrid vehicles
Infrastructure Development	**Objective**: Build and expand infrastructure to support the operation and maintenance of electric and hybrid city vehicles **Activities**: • Install electric vehicle charging stations at city facilities, depots, and public locations accessible to city vehicles • Upgrade maintenance facilities to accommodate electric vehicle servicing and repair needs • Coordinate with utility providers to ensure sufficient electrical capacity to support charging infrastructure
Financial Incentives and Support	**Objective**: Provide financial incentives and support mechanisms to facilitate the adoption of electric and hybrid vehicles towards the budgetary users (city owned companies) **Activities**: • Allocate funding for subsidies, grants, or tax incentives to offset the higher upfront costs of electric and hybrid vehicles • Establish partnerships with financial institutions to offer favorable financing options for city departments purchasing electric vehicles • Explore opportunities for cost-sharing arrangements with private sector partners or neighboring municipalities to leverage resources
Training and Capacity Building	**Objective**: Train city staff and fleet operators on the operation, maintenance, and benefits of electric and hybrid vehicles **Activities**: • Develop training programs and workshops covering vehicle technology, charging protocols, and safety procedures • Provide ongoing education and certification opportunities to ensure staff proficiency and competence in managing electric and hybrid fleets • Foster a culture of sustainability and environmental stewardship among city employees through awareness campaigns and recognition programs

Public Outreach and Communication	**Objective**: Engage residents, businesses, and community stakeholders to build support and awareness for the electric and hybrid vehicle mandate **Activities**: • Launch public awareness campaigns highlighting the environmental, economic, and health benefits of electric and hybrid vehicles • Organise informational sessions, town hall meetings, and demonstrations to showcase the city's commitment to sustainability • Collaborate with local media outlets, schools, and civic organisations to amplify messaging and encourage community participation
Timeline	**Year 1**: Develop and adopt policy framework, conduct fleet assessment, and begin infrastructure planning **Year 2**: Initiate procurement of electric and hybrid vehicles, commence infrastructure installation, and launch training programs **Year 3-4**: Complete fleet transition, expand charging infrastructure, monitor performance, and evaluate program effectiveness
Implementation Steps	1. **Policy Development**: Draft and finalise legislation mandating electric and hybrid vehicles for new city purchases 2. **Fleet Assessment**: Inventory current city vehicles and assess readiness for electric and hybrid transitions 3. **Infrastructure Planning**: Plan and install charging stations and upgrade maintenance facilities 4. **Financial Support**: Allocate funds and establish incentives to support vehicle procurement and infrastructure development 5. **Training and Capacity Building**: Educate staff on vehicle operation and maintenance, ensuring readiness for electric and hybrid fleets 6. **Monitoring and Reporting**: Track progress, measure impact, and report outcomes to stakeholders and the public 7. **Public Outreach**: Engage the community, build support, and promote the benefits of electric and hybrid vehicles

K) Development and Enforcement of Sustainable Urban Mobility Plans (SUMPs)

Objective	Implement sustainable urban mobility plans (SUMPs) to improve transportation efficiency, reduce environmental impact, enhance accessibility, and promote sustainable development in urban areas
Programme Components	
Policy Development and Stakeholder Engagement	**Objective**: Develop comprehensive policies and engage stakeholders in the formulation of SUMPs **Activities**: • Conduct assessments of current urban mobility challenges, including traffic congestion, emissions, and accessibility issues • Establish partnerships with local government agencies, transportation authorities, businesses, and community groups • Define goals and objectives for sustainable mobility, incorporating input from residents and experts
Data Collection and Analysis	**Objective**: Gather and analyse data to inform decision-making and prioritise interventions **Activities**: • Collect data on transportation patterns, modal split, travel behavior, and infrastructure usage through surveys, sensors, and GPS tracking • Utilise Geographic Information System (GIS) mapping and data visualisation tools to identify hotspots and areas needing improvement • Conduct mobility audits to assess the performance and efficiency of existing transport systems
Multimodal Transportation Integration	**Objective**: Integrate various modes of transportation to provide seamless connectivity and reduce reliance on private vehicles **Activities**: • Develop integrated networks for walking, cycling, public transit, and shared mobility services (e.g., bike-sharing, car-sharing) • Design multimodal hubs and transfer points to facilitate smooth transitions between different transport modes • Implement policies and infrastructure improvements to prioritise pedestrian safety and accessibility

Promotion of Sustainable Transport Options	**Objective**: Promote the use of sustainable transport modes, such as public transit, cycling, and walking **Activities**: • Expand public transit networks with efficient routes, increased frequency, and improved accessibility for all users • Implement measures to encourage active transportation, including bike lanes, pedestrian-friendly infrastructure, and traffic calming measures • Provide incentives and subsidies for using sustainable modes of transport, such as fare discounts, bike-sharing memberships, and park-and-ride facilities
Infrastructure Development and Maintenance	**Objective**: Develop and maintain infrastructure that supports sustainable urban mobility goals **Activities**: • Upgrade roads, bridges, and intersections to accommodate increased pedestrian and cyclist traffic • Install dedicated lanes for buses, trams, and other public transit vehicles to improve efficiency and reduce congestion • Introduce smart transportation technologies, such as adaptive traffic signals and real-time information systems, to optimise traffic flow
Policy Implementation and Monitoring	**Objective**: Implement SUMPs through effective policies, regulations, and monitoring mechanisms **Activities**: • Enact zoning and land-use policies that support compact, mixed-use development and transit-oriented development (TOD) • Establish regulations for emissions standards, vehicle access restrictions, and parking management to reduce environmental impact – also described in other measures • Monitor progress towards SUMP objectives through performance indicators, data analytics, and regular evaluations

Financial Planning and Resource Allocation	**Objective**: Secure funding and allocate resources to support the implementation of SUMPs **Activities**: • Identify funding sources, including government grants, public-private partnerships, and European Union (EU) funding programs, development banks, EIB loans and technical assistance • Develop budgets and financial plans for infrastructure investments, operational costs, and maintenance of sustainable transport initiatives • Advocate for sustainable mobility funding at regional, national, and international levels to support long-term implementation
Public Engagement and Awareness	**Objective**: Engage residents, businesses, and stakeholders to build support and awareness for SUMPs **Activities**: • Conduct public consultations, workshops, and outreach campaigns to gather feedback and educate the community about sustainable mobility options • Foster partnerships with schools, universities, and community organisations to promote sustainable transport behavior and advocate for SUMPs • Use digital platforms, social media, and community events to communicate SUMP objectives, progress, and benefits to the public
Timeline	**Year 1**: Initiate data collection, stakeholder engagement, and policy development for SUMPs **Year 2**: Formulate and finalise SUMP strategies, including multimodal integration and infrastructure plans **Year 3-4**: Implement infrastructure improvements, promote sustainable transport options, monitor performance, and evaluate SUMP effectiveness

L) Introduction of Dynamic Road Pricing Based on Real Time Congestion Data

Objective	Implement dynamic road pricing to manage congestion, reduce traffic emissions, optimise road capacity, and encourage sustainable transportation choices, in line with other suggested policies and infrastructure developments
Programme Components	

Feasibility Study and Data Analysis	**Objective**: Conduct a feasibility study to assess the implementation of dynamic road pricing based on real-time congestion data **Activities**: • Gather and analyse traffic data, including congestion patterns, traffic volume, and peak hours using sensors, GPS data, and traffic management systems • Evaluate the economic and environmental impacts of congestion on urban mobility and air quality • Use simulation models and traffic flow analysis to predict the effectiveness of dynamic road pricing strategies
Policy Development and Regulatory Framework	**Objective**: Develop policies and regulatory frameworks to support the implementation of dynamic road pricing **Activities**: • Draft legislation or ordinances to authorise the introduction of dynamic road pricing schemes • Define pricing mechanisms, including peak-hour surcharges, variable toll rates, and exemptions for low-emission vehicles • Establish enforcement measures and penalties for non-compliance with road pricing regulations
Technology and Infrastructure Implementation	**Objective**: Deploy technology and infrastructure to support dynamic road pricing systems **Activities**: • Install tolling gantries, cameras, and electronic toll collection (ETC) systems at entry points to designated zones or congestion-prone areas • Develop backend systems for real-time data processing, billing, and enforcement of road pricing charges • Integrate with existing transportation management systems and traffic monitoring infrastructure to ensure seamless operation
Public Awareness and Stakeholder Engagement	**Objective**: Engage stakeholders and the public to build support and awareness for dynamic road pricing initiatives **Activities**: • Conduct public consultations, workshops, and information sessions to educate stakeholders about the benefits of road pricing • Address concerns related to equity, affordability, and potential impacts on different socioeconomic groups • Collaborate with local businesses, community organisations, and transportation agencies to gather feedback and input

Monitoring and Evaluation	**Objective**: Monitor the performance and evaluate the impact of dynamic road pricing on congestion reduction and transportation efficiency **Activities**: • Monitor traffic flow, travel times, and congestion levels in real-time using data analytics and performance metrics • Assess changes in traffic patterns, modal shift, and use of alternative transportation modes (e.g., public transit, cycling) • Conduct regular reviews and evaluations to measure the effectiveness of road pricing strategies and adjust as needed
Financial Planning and Revenue Allocation	**Objective**: Plan for the financial sustainability of dynamic road pricing systems and allocate revenues for transportation improvements **Activities**: • Develop a financial plan that outlines revenue projections, cost recovery strategies, and investment priorities for transportation infrastructure • Allocate funds generated from road pricing to support public transit enhancements, active transportation infrastructure, and sustainable mobility initiatives • Ensure transparency and accountability in the use of road pricing revenues through regular reporting and public disclosure
Timeline	**Year 1**: Conduct feasibility study, develop policy framework, and engage stakeholders **Year 2**: Pilot test dynamic road pricing systems in selected zones or corridors, gather feedback **Year 3-4**: Scale up implementation, expand coverage, and optimise road pricing strategies based on monitoring and evaluation results
Implementation Steps	1. **Feasibility Study**: Analyse congestion data and assess the economic and environmental impacts 2. **Policy Development**: Draft regulations and pricing mechanisms, obtain approval from relevant authorities 3. **Technology Deployment**: Install tolling infrastructure and backend systems for data processing and enforcement 4. **Public Engagement**: Educate stakeholders, gather feedback, and address concerns through consultation 5. **Monitoring and Evaluation**: Monitor traffic conditions, evaluate effectiveness, and adjust pricing strategies as necessary

	6. **Financial Planning**: Plan for revenue management and allocation to support sustainable transportation initiatives

M) Creation of Urban Logistics Zones for Efficient, Low-Emission Goods Delivery

Objective	Establish urban logistics zones to optimise goods delivery, reduce congestion, improve air quality, and promote sustainable urban mobility
Programme Components	
Site Selection and Planning	**Objective**: Identify suitable locations and plan urban logistics zones to support efficient and low-emission goods delivery **Activities**: • Conduct spatial analysis and stakeholder consultations to determine optimal sites based on proximity to commercial centres, transportation hubs, and residential areas • Evaluate existing infrastructure and land use to ensure compatibility with logistics operations and minimise environmental impact • Designate zones with access to multimodal transport options, including rail, road, and potentially waterways for freight transport
Infrastructure Development	**Objective**: Develop infrastructure within urban logistics zones to support sustainable goods delivery **Activities**: • Construct loading/unloading bays, consolidation centres, and distribution facilities optimised for efficient goods handling and reduced traffic congestion • Install charging stations for electric delivery vehicles (EVs), as well as facilities for managing low-emission vehicle fleets • Implement smart technologies for real-time tracking, scheduling, and optimisation of logistics operations

Regulatory and Policy Framework	**Objective**: Establish regulations and policies to govern operations within urban logistics zones and promote sustainable practices **Activities**: • Develop zoning regulations and land-use policies to designate areas for logistics activities and minimise conflicts with residential or sensitive land uses • Introduce incentives or requirements for businesses to use low-emission vehicles, adopt efficient delivery practices, and adhere to noise and emissions standards • Collaborate with local authorities and transport agencies to align logistics policies with broader urban planning and sustainability goals
Public-Private Partnerships	**Objective**: Foster partnerships between public agencies, private enterprises, and logistics providers to optimise resources and expertise **Activities**: • Form alliances with logistics companies, retailers, and delivery service providers to pilot sustainable delivery models within urban logistics zones • Facilitate knowledge-sharing and collaboration on technological innovations, last-mile delivery solutions, and operational best practices • Leverage private sector investment and expertise to enhance the efficiency and sustainability of logistics operations
Monitoring and Performance Evaluation	**Objective**: Monitor the effectiveness of urban logistics zones in achieving sustainable transport and environmental goals **Activities**: • Establish key performance indicators (KPIs) such as reduction in traffic congestion, improvement in air quality, and increase in delivery efficiency • Conduct regular audits and assessments of logistics operations, vehicle emissions, and compliance with sustainability standards • Use data analytics and feedback mechanisms to continuously optimise logistics processes and infrastructure within the zones

Public Engagement and Awareness	**Objective**: Engage residents, businesses, and stakeholders to build support and awareness for urban logistics zones **Activities**: • Organise community forums, workshops, and outreach campaigns to educate the public about the benefits of sustainable goods delivery • Seek input from local communities and businesses to address concerns related to noise, traffic, and environmental impacts • Highlight success stories and case studies of efficient and low-emission logistics practices to inspire broader adoption
Financial Planning and Resource Allocation	**Objective**: Secure funding and allocate resources to develop and maintain urban logistics zones **Activities**: • Identify funding sources such as government grants, private investments, and EU funding programs to support infrastructure development and technology adoption • Develop budgets for ongoing maintenance, operational costs, and technological upgrades within the logistics zones • Explore innovative financing mechanisms and revenue generation opportunities through logistics services and value-added activities
Timeline	**Year 1**: Conduct site selection, planning, and regulatory framework development for urban logistics zones **Year 2**: Begin infrastructure development and establish public-private partnerships for pilot projects **Year 3-4**: Expand infrastructure, implement operational logistics solutions, monitor performance, and evaluate impact

N) Promotion of Transit-Oriented Development (TOD)

Objective	Foster transit-oriented development to create vibrant, walkable neighbourhoods centred around public transit hubs, reducing dependency on private vehicles and promoting sustainable urban growth
Programme Components	

Planning and Zoning Policies	**Objective**: Develop and implement land-use policies that encourage compact, mixed-use development around transit stations, especially on the level of detailed urbanistic plans of development **Activities**: • Conduct land-use assessments and transit accessibility analyses to identify suitable sites for TOD • Update zoning regulations to allow for higher densities, diverse housing options, and commercial amenities within walking distance of transit nodes • Integrate TOD principles into comprehensive urban development plans and neighbourhood designs
Infrastructure Investment	**Objective**: Invest in transportation infrastructure to enhance connectivity and accessibility within TOD areas – it is assessed through other measures **Activities**: • Upgrade and expand public transit networks with new routes, increased frequency, and improved reliability to serve TOD zones effectively • Develop pedestrian and cycling infrastructure, including sidewalks, bike lanes, and shared paths, to promote active transportation options – combined with other measures • Implement streetscape improvements, public spaces, and green infrastructure to create attractive, pedestrian-friendly environments
Mixed-Use Development	**Objective**: Encourage a mix of residential, commercial, retail, and recreational facilities within TOD zones to support diverse community needs **Activities**: • Facilitate partnerships between developers, investors, and local authorities to incentivise mixed-use projects near transit stations • Provide density bonuses or tax incentives for developers who incorporate affordable housing, green building standards, and sustainable design practices • Foster a vibrant street-level environment with shops, restaurants, and cultural amenities that enhance the quality of life for residents and visitors

Affordable Housing and Equity	**Objective**: Ensure equitable access to affordable housing and amenities in TOD areas, minimising displacement and supporting inclusive development **Activities**: • Implement inclusionary zoning policies to mandate affordable housing units or contributions from developers within TOD projects • Establish housing funds, subsidies, or land trusts to preserve affordability and prevent gentrification pressures in transit-accessible neighborhoods • Engage community stakeholders and advocacy groups to address social equity concerns and prioritise the needs of vulnerable populations
Public Engagement and Community Outreach	**Objective**: Engage residents, businesses, and stakeholders in the planning and implementation of TOD initiatives **Activities**: • Conduct public forums, workshops, and charrettes to gather input and preferences from local communities on TOD development • Collaborate with neighbourhood associations, schools, and civic organisations to build consensus and support for TOD projects • Educate the public about the benefits of transit-oriented living, including reduced commuting times, improved air quality, and enhanced access to amenities
Policy Incentives and Financing	**Objective**: Provide financial incentives and policy support to catalyse TOD investments and projects **Activities**: • Offer grants, loans, or tax increment financing (TIF) to offset infrastructure costs and incentivise private sector investment in TOD • Establish transit-oriented development districts (TODDs) with streamlined permitting processes and regulatory flexibility for developers • Leverage public-private partnerships and innovative financing mechanisms to fund TOD infrastructure improvements and community amenities

Monitoring and Evaluation	**Objective**: Monitor progress and evaluate the outcomes of TOD initiatives to ensure alignment with sustainability and liveability goals **Activities**: • Establish performance metrics, such as transit ridership, mode share, and greenhouse gas emissions reductions, to measure the impact of TOD • Conduct periodic assessments and reviews to track development patterns, affordability metrics, and community satisfaction with TOD outcomes • Use data-driven insights to refine TOD strategies, adapt policies, and optimise future investments in transit-oriented development
Timeline	**Year 1**: Initiate TOD planning, policy development, and stakeholder engagement activities **Year 2**: Begin infrastructure investments, zoning updates, and mixed-use development projects in targeted TOD areas **Year 3-4**: Expand TOD implementation, monitor performance metrics, and evaluate the social, economic, and environmental impacts of transit-oriented development

3.2.4.3 Early adoption technological measures

A) Electrification of Bus Fleet

Objective	Transition the city's bus fleet from fossil fuel-powered vehicles to electric buses to reduce emissions, improve air quality, and promote sustainable urban transportation
Programme Components	
Feasibility Assessment and Planning	**Objective**: Conduct a feasibility study to assess the transition to electric buses and develop a strategic electrification plan – already in progress via the EIB technical assistance **Activities**: • Analyse the current bus fleet composition, routes, and operational needs to determine suitable electrification options • Evaluate the technical feasibility, economic viability, and environmental benefits of electric buses compared to conventional diesel, gasoline and LPG buses • Develop a roadmap with milestones and timelines for phased implementation of electrification across the bus fleet

Procurement and Fleet Expansion	**Objective**: Procure electric buses and expand the fleet with zero-emission vehicles **Activities**: • Issue requests for proposals (RFPs) or bids from bus manufacturers and suppliers for electric bus procurement • Negotiate contracts for the purchase or lease of electric buses, considering factors such as vehicle performance, charging infrastructure requirements, and maintenance agreements • Coordinate with financing institutions, government grants, or funding programs to secure financial support for bus electrification
Charging Infrastructure Deployment	**Objective**: Install charging infrastructure to support the operation of electric buses throughout the city **Activities**: • Conduct site assessments to identify optimal locations for charging stations based on bus routes, depot locations, and electricity grid capacity • Install fast chargers at bus depots, transit hubs, and strategic points along routes to ensure reliable and efficient charging capabilities. • Implement smart charging technologies and management systems to optimise energy use, minimise operational costs, and integrate renewable energy sources • Conduct climate proofing for all infrastructure
Training and Capacity Building	**Objective**: Train personnel and build institutional capacity to support the operation and maintenance of electric buses **Activities**: • Provide training programs for bus drivers, mechanics, and maintenance staff on electric vehicle (EV) operation, safety protocols, and maintenance procedures • Equip depots with necessary tools, diagnostic equipment, and spare parts for servicing electric buses • Establish partnerships with educational institutions and industry experts to facilitate ongoing skills development and knowledge sharing in EV technology

Public Awareness and Stakeholder Engagement	**Objective**: Engage stakeholders, including residents, businesses, and transit users, to build support for electrification of the bus fleet **Activities**: • Conduct public outreach campaigns, workshops, and community forums to educate the public about the benefits of electric buses • Collaborate with environmental organisations, advocacy groups, and local media to raise awareness about air quality improvements and emissions reduction • Solicit feedback from transit riders and community members to address concerns and preferences related to electric bus deployment
Monitoring and Evaluation	**Objective**: Monitor the performance and evaluate the impact of electric buses on operational efficiency, air quality, and greenhouse gas emissions **Activities**: • Establish performance metrics, such as energy consumption per mile, maintenance costs, and emissions reductions, to assess the effectiveness of electric buses • Conduct regular inspections and data analysis to track bus fleet performance, battery life, and charging infrastructure reliability • Use feedback from drivers, passengers, and maintenance staff to identify opportunities for improvement and optimise electric bus operations
Policy Support and Funding	**Objective**: Advocate for policies and secure funding to support the electrification of the bus fleet **Activities**: • Collaborate with state government to access funding opportunities, grants, and financing mechanisms for sustainable transportation initiatives • Participate in industry forums, policy dialogues, and legislative sessions to influence transportation policies and promote sustainable mobility solutions
Timeline	**Year 1**: Conduct feasibility study, develop electrification plan, and secure funding commitments **Year 2**: Procure electric buses, deploy charging infrastructure, and commence driver training programs **Year 3-4**: Expand electric bus fleet, monitor performance metrics, and evaluate impact on air quality and operational efficiency

B) Deployment of Energy-Efficient Trams

Objective	Introduce energy-efficient trams to enhance public transportation, reduce greenhouse gas emissions, and promote sustainable urban mobility
Programme Components	
Feasibility Assessment and Planning	**Objective**: Conduct a feasibility study to assess the deployment of energy-efficient trams and develop an implementation plan **Activities**: • Analyse existing tram infrastructure, routes, and passenger demand to determine suitable locations for energy-efficient tram deployment- already being done via the technical assisstance of the EIB for decarbonisation of the fleet • Develop a phased implementation strategy with timelines, milestones, and budget estimates for tram fleet renewal
Procurement and Fleet Modernisation	**Objective**: Procure energy-efficient trams and modernise the existing fleet with sustainable vehicles **Activities**: • Issue requests for proposals (RFPs) or tenders to tram manufacturers for energy-efficient tram procurement • Negotiate contracts for the purchase or lease of energy-efficient trams, considering factors such as performance specifications, energy efficiency ratings, and lifecycle costs • Coordinate with financing institutions, government grants, or funding programs to secure financial support for tram modernisation and fleet expansion
Infrastructure Upgrades and Charging Facilities	**Objective**: Upgrade tram infrastructure and develop charging facilities to support energy-efficient tram operations **Activities**: • Retrofit tram depots and stations with modern infrastructure, including overhead charging systems or on-board battery charging facilities • Install renewable energy sources, such as solar panels, to power tram charging stations and reduce carbon footprint – up to the level of feasibility – use of virtual power plants • Implement smart grid technologies to optimise energy use and manage tram fleet charging schedules efficiently

Training and Capacity Building	**Objective**: Train personnel and build institutional capacity to operate and maintain energy-efficient trams **Activities**: • Provide specialised training programs for tram drivers, maintenance technicians, and operational staff on the operation and maintenance of energy-efficient tram technologies • Equip tram depots with necessary tools, diagnostic equipment, and spare parts for servicing energy-efficient trams • Establish partnerships with educational institutions and industry experts to promote knowledge sharing and continuous skills development in tram technology
Public Awareness and Stakeholder Engagement	**Objective**: Engage stakeholders, including residents, businesses, and transit users, to build support for energy-efficient tram deployment **Activities**: • Launch public information campaigns, workshops, and community forums to educate the public about the environmental benefits and operational advantages of energy-efficient trams • Collaborate with environmental organisations, advocacy groups, and local media to raise awareness about air quality improvements and emissions reduction through tram modernisation • Solicit feedback from tram passengers and community members to address concerns and preferences related to energy-efficient tram deployment
Monitoring and Evaluation	**Objective**: Monitor the performance and evaluate the impact of energy-efficient trams on energy consumption, emissions reduction, and operational efficiency **Activities**: • Establish key performance indicators (KPIs) such as energy efficiency ratings, maintenance costs, and passenger satisfaction levels to assess the effectiveness of energy-efficient tram deployment • Conduct regular inspections and data analysis to track tram fleet performance, reliability of charging infrastructure, and adherence to sustainability targets • Use feedback from tram operators, maintenance teams, and passengers to identify opportunities for improvement and optimise energy-efficient tram operations

Policy Support and Funding	**Objective**: Advocate for policies and secure funding to support the deployment of energy-efficient trams **Activities**: • Advocate for subsidies, or mandates that promote the adoption of energy-efficient tram technologies and reduce reliance on fossil fuels • Collaborate with state government to access funding opportunities, grants, and financing mechanisms for sustainable transportation initiatives • Participate in industry forums, policy dialogues, and legislative sessions to influence transportation policies and promote sustainable mobility solutions
Timeline	**Year 1**: Conduct feasibility study, develop deployment plan, and secure funding commitments **Year 2**: Procure energy-efficient trams, upgrade infrastructure, and commence training programs **Year 3-4**: Deploy energy-efficient trams, monitor performance metrics, and evaluate impact on energy consumption and emissions reduction

C) Installation of Solar Panels on Bus and Tram Depots

Objective	Install solar panels on bus and tram depots to generate renewable energy, reduce carbon footprint, and promote sustainable practices in public transportation
Programme Components	
Feasibility Assessment and Site Selection	**Objective**: Conduct a feasibility study to assess the installation of solar panels on bus and tram depots **Activities**: • Evaluate the energy consumption and peak demand of bus and tram depots to determine the optimal size and capacity of solar panel systems • Conduct site assessments to identify suitable locations for solar panel installation based on roof space availability, orientation, and shading factors • Analyse the economic viability, return on investment (ROI), and environmental benefits of solar energy compared to conventional energy sources

Design and Engineering	**Objective**: Design solar panel systems tailored to the specific energy needs and structural characteristics of bus and tram depots **Activities**: • Develop engineering plans and specifications for solar panel installation, considering load-bearing capacity, electrical integration, and safety standards • Optimise system layout and configuration to maximise solar energy generation and efficiency, considering local climate conditions and solar irradiance levels • Incorporate smart technologies for monitoring energy production, optimising performance, and integrating with existing depot infrastructure
Procurement and Installation	**Objective**: Procure solar panels and components and install solar energy systems on bus and tram depots **Activities**: • Select vendors based on qualifications, experience, and cost-effectiveness, ensuring compliance with quality standards and regulatory requirements • Coordinate logistics, construction timelines, and site preparation to minimise disruption to depot operations during installation
Integration with Energy Management Systems	**Objective**: Integrate solar panel systems with depot energy management systems for efficient energy use **Activities**: • Install inverters, energy storage solutions (if applicable), and grid connection equipment to manage solar energy production and consumption • Implement demand response strategies and peak shaving techniques to reduce electricity costs and enhance energy efficiency • Configure monitoring and control systems for real-time performance tracking, fault detection, and remote maintenance of solar panel arrays

Training and Capacity Building	**Objective**: Train depot staff on solar panel operation, maintenance practices, and safety protocols **Activities**: • Provide technical training and workshops for maintenance personnel, electricians, and facility managers on solar panel system operation and troubleshooting • Establish maintenance schedules and procedures for regular inspections, cleaning, and performance testing of solar panels and associated equipment • Foster collaboration with renewable energy experts, industry partners, and educational institutions to support ongoing skills development and knowledge sharing
Public Awareness and Stakeholder Engagement	**Objective**: Engage stakeholders, including employees, community members, and transit users, to build support for solar panel installations **Activities**: • Conduct outreach campaigns, public tours, and educational workshops to raise awareness about the environmental benefits and cost savings of solar energy • Collaborate with local schools, environmental organisations, and media outlets to showcase the depot's commitment to sustainability and renewable energy • Solicit feedback and input from stakeholders to address concerns, gather suggestions for improvement, and foster community engagement in sustainable transportation initiatives
Monitoring and Evaluation	**Objective**: Monitor the performance of solar panel systems and evaluate their impact on energy savings, carbon emissions reduction, and operational efficiency **Activities**: • Establish performance metrics, such as energy production, cost savings, and greenhouse gas emissions avoided, to assess the effectiveness of solar panel installations • Conduct regular inspections, data analysis, and performance audits to ensure optimal functioning and reliability of solar energy systems • Use feedback from depot managers, energy analysts, and environmental consultants to identify opportunities for system optimisation, efficiency improvements, and future expansion

Policy Support and Funding	**Objective**: Advocate for policies and secure funding to support the installation of solar panels on bus and tram depots **Activities**: • Advocate for regulatory incentives, grants, or rebates that promote the adoption of renewable energy technologies and support depot sustainability initiatives • Collaborate with government agencies, utilities, and renewable energy associations to access funding opportunities and financing mechanisms for solar panel projects • Participate in policy dialogues, industry forums, and legislative advocacy efforts to influence energy policy and promote sustainable practices in public transportation
Timeline	**Year 1**: Conduct feasibility assessment, design solar panel systems, and secure funding commitments **Year 2**: Procure solar panels, execute installation, and integrate with depot energy management systems **Year 3-4**: Monitor performance metrics, conduct training and capacity building, and engage stakeholders in public awareness activities

D) Implementation of Real-Time Passenger Information Systems

Objective	Implement real-time passenger information systems to enhance public transit efficiency, improve user experience, and promote a shift towards sustainable transportation options
Programme Components	
Technology Assessment and Planning	**Objective**: Conduct a technology assessment and develop a comprehensive plan for implementing real-time passenger information systems **Activities**: • Evaluate available technologies, such as GPS tracking, mobile applications, and digital signage, to determine the most suitable solution for real-time information delivery • Assess integration requirements with existing transit infrastructure, fleet management systems, and communication networks • Develop a phased implementation strategy with milestones, timelines, and budget estimates for deploying real-time passenger information systems across the transit network

System Procurement and Deployment	**Objective**: Procure necessary equipment and deploy real-time passenger information systems across transit vehicles and stations **Activities**: • Select vendors based on technical capabilities, reliability, cost-effectiveness, and compatibility with existing transit operations • Install GPS tracking devices, communication hardware, passenger information displays, and mobile app interfaces on buses, trams, and at transit stops
Data Integration and Information Management	**Objective**: Integrate real-time data sources and manage information to provide accurate and reliable passenger updates **Activities**: • Establish data interfaces and protocols to collect, process, and transmit real-time information from vehicles, sensors, and transit management systems • Develop algorithms and predictive models to anticipate arrival times, service disruptions, and transit schedules based on real-time data inputs • Implement cloud-based platforms or centralised databases for storing and managing real-time passenger information, ensuring data security and accessibility
User Interface and Accessibility	**Objective**: Design user-friendly interfaces and ensure accessibility of real-time passenger information for all transit users **Activities**: • Develop mobile applications, websites, and digital displays that provide intuitive access to real-time transit updates, route maps, and service alerts • Incorporate features such as multilingual support, audio announcements, and text-to-speech functionalities to enhance accessibility for diverse user groups • Conduct usability testing and gather feedback from passengers to optimise interface design and functionality based on user preferences and needs

Training and Capacity Building	**Objective**: Tram and bus, cable car transit operators, maintenance staff, and customer service personnel on the use and management of real-time passenger information systems **Activities**: • Provide comprehensive training programs and workshops on system operation, troubleshooting, and customer service protocols related to real-time information delivery • Equip transit staff with technical skills and knowledge to monitor system performance, address user inquiries, and respond to service disruptions effectively • Establish continuous learning opportunities and knowledge-sharing platforms to support ongoing skill development and adaptation to new technologies
Public Awareness and Stakeholder Engagement	**Objective**: Engage passengers, stakeholders, and the community to promote awareness and utilisation of real-time passenger information systems **Activities**: • Launch marketing campaigns, demonstrations, and outreach activities to educate the public about the benefits of real-time transit updates and improved service reliability • Collaborate with community organisations, advocacy groups, and local media to encourage adoption of digital tools for transit information • Solicit feedback from passengers and stakeholders to identify usability issues, service gaps, and opportunities for enhancing real-time information services
Monitoring and Evaluation	**Objective**: Monitor system performance and evaluate the impact of real-time passenger information on transit operations and user satisfaction **Activities**: • Establish performance metrics, such as customer satisfaction ratings, on-time performance, and use of digital platforms, to assess the effectiveness of real-time information systems • Conduct regular audits, surveys, and usability tests to gather quantitative and qualitative data on passenger experiences and preferences • Use feedback and data analytics to make improvements, optimise system functionality, and address operational challenges in real-time information delivery

Policy Support and Funding	**Objective**: Advocate for policies and secure funding to support the implementation and sustainability of real-time passenger information systems **Activities**: • Advocate for grants, or funding programs that prioritise investments in digital infrastructure and transit technology enhancements • Collaborate with government agencies, transit authorities, and private sector partners to access funding opportunities and financing mechanisms for system deployment • Participate in policy dialogues, industry forums, and legislative advocacy efforts to influence transportation policies and promote the adoption of digital innovations in public transit
Timeline	**Year 1**: Conduct technology assessment, develop implementation plan, and secure funding commitments **Year 2**: Procure equipment, deploy real-time passenger information systems, and integrate data management solutions **Year 3-4**: Expand system coverage, enhance user interfaces, monitor performance metrics, and engage stakeholders in public awareness campaigns

E) Introduction of Contactless Payment Systems

Objective	Implement contactless payment systems across public transportation networks to enhance convenience, efficiency, and user experience for passengers
Programme Components	

Feasibility Assessment and Planning	**Objective**: Conduct a feasibility study to assess the introduction of contactless payment systems **Activities**: • Analyse current fare collection methods, passenger demographics, and payment preferences to determine the feasibility and benefits of contactless payment • Evaluate technological options, such as smart cards, mobile payment apps, and near-field communication (NFC) technology, for seamless integration with existing fare collection infrastructure • Develop a phased implementation strategy with milestones, timelines, and budget estimates for deploying contactless payment systems across the transit network
System Procurement and Deployment	**Objective**: Procure necessary equipment and deploy contactless payment systems on buses, trams, and at transit stations **Activities**: • Issue requests for proposals (RFPs) or bids to technology vendors and service providers for system procurement and installation • Select vendors based on technical capabilities, reliability, cost-effectiveness, and compatibility with existing fare collection systems • Install contactless payment validators, readers, and backend systems to enable seamless transactions and integration with fare management databases
Integration with Fare Collection Infrastructure	**Objective**: Integrate contactless payment systems with existing fare collection infrastructure and backend processing systems **Activities**: • Develop APIs and data interfaces to connect contactless payment devices with fare calculation, validation, and revenue management systems • Ensure interoperability with multiple payment methods, including bank cards, mobile wallets, and digital transit passes • Implement secure payment protocols and encryption standards to protect passenger data and prevent fraud during transactions

User Education and Adoption	**Objective**: Educate passengers on how to use contactless payment systems and promote adoption across diverse user groups **Activities**: • Launch public information campaigns, tutorials, and demonstrations to familiarise passengers with contactless payment options and benefits • Provide training materials and customer support services to assist passengers in setting up and using contactless payment methods • Collaborate with local businesses, community organisations, and schools to increase awareness and encourage adoption of digital payment technologies
Monitoring and Performance Evaluation	**Objective**: Monitor system performance and evaluate the impact of contactless payment on fare collection efficiency and passenger satisfaction **Activities**: • Establish performance metrics, such as transaction volumes, processing times, and user feedback, to assess the effectiveness of contactless payment systems • Conduct regular audits and data analysis to track revenue generation, fare evasion rates, and operational costs associated with contactless payments • Use passenger surveys, focus groups, and usability tests to gather insights into user experiences, preferences, and areas for improvement
Policy Support and Stakeholder Engagement	**Objective**: Advocate for policies and secure stakeholder buy-in to support the implementation and adoption of contactless payment systems **Activities**: • Collaborate with transit agencies, government authorities, and regulatory bodies to advocate for regulatory incentives, standards, and guidelines that facilitate contactless payment adoption • Engage with financial institutions, payment providers, and technology partners to establish partnerships and secure funding for system deployment and infrastructure upgrades • Participate in industry forums, policy discussions, and public consultations to address concerns, gather feedback, and build consensus on digital payment innovations in public transportation

Timeline	Year 1: Conduct feasibility assessment, develop implementation plan, and secure funding commitments Year 2: Procure equipment, deploy contactless payment systems, and integrate with fare collection infrastructure Year 3-4: Expand system coverage, enhance user interfaces, monitor performance metrics, and engage stakeholders in public awareness campaigns

F) Installation of Energy Storage Systems (e.g., batteries) at Tram Stations

Objective	Implement energy storage systems, such as batteries, at tram stations to enhance energy efficiency, optimise power usage, and support sustainable urban transportation
Programme Components	
Feasibility Assessment and Planning	Objective: Conduct a feasibility study to assess the installation of energy storage systems at tram stations Activities: • Evaluate tram station energy consumption patterns, peak demand periods, and grid connection capacity to determine the optimal size and type of energy storage system • Analyse the potential benefits of energy storage, including load balancing, peak shaving, and integration of renewable energy sources • Develop a detailed implementation plan with technical specifications, cost estimates, and timelines for deploying energy storage systems at tram stations
Technology Selection and Procurement	Objective: Select appropriate energy storage technology and procure necessary equipment for installation Activities: • Assess available energy storage technologies, such as lithium-ion batteries, flow batteries, or supercapacitors, based on performance, lifecycle costs, and compatibility with tram station infrastructure • Issue requests for proposals (RFPs) or bids to energy storage providers and technology vendors for system procurement • Collaborate with suppliers to finalise design specifications, installation requirements, and integration with existing tram station infrastructure

Installation and Integration	**Objective**: Install energy storage systems and integrate them with tram station operations and electrical systems **Activities**: • Coordinate construction activities and ensure compliance with safety regulations and environmental standards during installation • Configure energy storage systems to optimise charging and discharging cycles, aligning with tram station energy demand and grid supply fluctuations • Integrate smart grid technologies and monitoring systems to manage energy flows, optimise system performance, and maximise energy savings
Testing and Commissioning	**Objective**: Conduct testing and commissioning to ensure the reliability and functionality of energy storage systems **Activities**: • Perform system tests, including performance validation, stress testing, and safety checks, to verify operational readiness and compliance with technical specifications • Conduct simulated load scenarios and grid outage simulations to assess the resilience and backup capabilities of energy storage systems • Train tram station staff on system operation, maintenance procedures, and emergency response protocols related to energy storage technology
Operational Monitoring and Maintenance	**Objective**: Monitor energy storage system performance and implement regular maintenance to optimise efficiency and reliability **Activities**: • Establish monitoring protocols and remote diagnostics tools to track energy storage system performance, battery health, and energy savings • Conduct routine inspections, preventive maintenance, and battery testing to extend operational lifespan and ensure system reliability • Implement contingency plans and emergency protocols for rapid response to system failures, grid disruptions, or unforeseen operational challenges

Public Awareness and Stakeholder Engagement	**Objective**: Engage stakeholders, including tram passengers, local communities, and regulatory bodies, to promote awareness and acceptance of energy storage systems **Activities**: • Launch public information campaigns, workshops, and community forums to educate stakeholders about the benefits of energy storage technology in tram stations • Collaborate with environmental organisations, advocacy groups, and local media to highlight sustainability initiatives and energy efficiency improvements • Solicit feedback from tram users and community members to address concerns, gather suggestions, and foster support for sustainable transportation solutions
Policy Support and Funding	**Objective**: Advocate for policies and secure funding to support the installation and operation of energy storage systems at tram stations **Activities**: • Advocate for grants, or financing mechanisms that encourage investment in energy storage technology and support sustainable infrastructure projects • Collaborate with government agencies, transit authorities, and energy regulators to navigate permitting processes, regulatory approvals, and compliance with local energy codes • Participate in policy dialogues, industry forums, and legislative advocacy efforts to influence energy policies and promote the integration of energy storage in public transportation
Timeline	**Year 1**: Conduct feasibility assessment, select technology, and finalise procurement arrangements **Year 2**: Install and integrate energy storage systems, conduct testing and commissioning, and begin operational monitoring **Year 3-4**: Implement maintenance protocols, engage stakeholders, and optimise energy storage system performance

G) Implementation of Smart Traffic Signal Priority for Buses and Trams

Objective	Implement smart traffic signal priority systems to optimise traffic flow, reduce congestion, and improve transit efficiency for buses and trams
Programme Components	

Feasibility Assessment and Planning	**Objective**: Conduct a feasibility study to assess the implementation of smart traffic signal priority systems **Activities**: • Analyse current traffic patterns, bus/tram routes, and signal timings to identify intersections with potential congestion and delays • Evaluate technological solutions, such as GPS-based signal priority, vehicle-to-infrastructure (V2I) communication, and adaptive traffic control systems • Develop a detailed implementation plan with cost estimates, timelines, and performance metrics for deploying smart traffic signal priority across key transit corridors
Technology Selection and Procurement	**Objective**: Select appropriate technology and procure necessary equipment for implementing smart traffic signal priority **Activities**: • Assess available signal priority technologies, including hardware (sensors, controllers) and software (algorithms, communication protocols), based on performance, scalability, and compatibility with existing traffic infrastructure • Issue requests for proposals (RFPs) or bids to technology vendors and service providers for system procurement • Collaborate with suppliers to customise solutions, integrate hardware/software components, and conduct pilot testing to validate system functionality
Installation and Integration	**Objective**: Install smart traffic signal priority systems and integrate them with existing traffic management infrastructure **Activities**: • Coordinate construction activities and ensure compliance with traffic safety regulations and environmental standards during installation • Deploy signal priority equipment, such as detectors, transmitters, and communication devices, at selected intersections and transit priority corridors • Integrate smart traffic signal systems with traffic management centres, transit dispatch systems, and onboard vehicle equipment to enable real-time data exchange and coordination

Testing and Optimisation	**Objective**: Conduct testing, optimisation, and performance evaluation of smart traffic signal priority systems **Activities**: • Perform field tests and simulations to validate signal priority algorithms, optimise signal timing adjustments, and assess system reliability under varying traffic conditions • Monitor traffic flow, travel times, and transit schedule adherence to measure the effectiveness of signal priority interventions • Fine-tune system parameters, adjust priority settings, and analyse data analytics to improve operational efficiency and transit service reliability
Training and Capacity Building	**Objective**: Train traffic engineers, transit operators, and maintenance staff on the use and management of smart traffic signal priority systems **Activities**: • Provide technical training and workshops to familiarise stakeholders with system operation, performance monitoring, and troubleshooting procedures • Equip traffic management personnel with tools and resources for real-time decision-making, coordination with transit agencies, and response to traffic incidents • Establish knowledge-sharing platforms, communities of practice, and collaboration networks to facilitate continuous learning and innovation in traffic signal management
Public Awareness and Stakeholder Engagement	**Objective**: Engage stakeholders, including transit riders, motorists, and local communities, to build support for smart traffic signal priority initiatives **Activities**: • Conduct public outreach campaigns, informational sessions, and community forums to educate stakeholders about the benefits of signal priority for transit reliability and traffic congestion reduction • Collaborate with transportation advocacy groups, business associations, and civic organisations to advocate for smart mobility solutions and sustainable transportation practices • Solicit feedback from transit users, residents, and businesses to address concerns, gather input on priority corridors, and prioritise future signal optimisation efforts

Policy Support and Funding	**Objective**: Advocate for policies and secure funding to support the implementation and expansion of smart traffic signal priority systems **Activities**: • Advocate for regulatory incentives, grants, or funding programs that prioritise investments in smart traffic management technologies and transit priority measures • Collaborate with government agencies, transit authorities, and transportation planning bodies to align policy frameworks, traffic regulations, and investment priorities with smart mobility initiatives • Participate in policy dialogues, stakeholder consultations, and legislative advocacy efforts to influence transportation policies and promote the adoption of innovative traffic signal technologies
Timeline	**Year 1**: Conduct feasibility assessment, select technology, and finalise procurement arrangements **Year 2**: Install and integrate smart traffic signal priority systems, conduct testing and optimisation, and begin operational monitoring **Year 3-4**: Implement maintenance protocols, enhance system performance, and expand signal priority deployment to additional transit corridors

H) Deployment of Electric Charging Infrastructure for Buses

Objective	Implement electric charging infrastructure to support the transition of buses to electric propulsion systems, reducing emissions and promoting sustainable urban transportation
Programme Components	
Feasibility Assessment and Planning	**Objective**: Conduct a feasibility study to assess the deployment of electric charging infrastructure for buses **Activities**: • Evaluate existing bus routes, fleet operations, and energy consumption patterns to determine the optimal locations for charging infrastructure • Analyse technological options, such as overhead charging (pantograph), plug-in charging stations, and depot-based charging solutions • Develop a comprehensive implementation plan with cost estimates, timelines, and performance metrics for deploying electric charging infrastructure across bus routes and depots

Technology Selection and Procurement	**Objective**: Select appropriate charging technology and procure necessary equipment for electric buses **Activities**: • Assess available charging technologies, including rapid chargers, slow chargers, and fast chargers, based on compatibility with bus fleet requirements and operational needs • Issue requests for proposals (RFPs) or bids to charging infrastructure providers and technology vendors for system procurement • Collaborate with suppliers to customise charging solutions, integrate hardware/software components, and ensure compliance with safety standards and environmental regulations
Installation and Integration	**Objective**: Install electric charging infrastructure and integrate it with existing bus depots and transit operations **Activities**: • Coordinate construction activities and ensure adherence to electrical codes, zoning regulations, and environmental permits during installation • Deploy charging stations at strategic locations, such as bus depots, transit hubs, and along key routes, to support seamless operation and efficient charging cycles • Integrate charging infrastructure with fleet management systems, scheduling software, and energy management platforms to optimise bus deployment and charging schedules. • Conduct climate proofing for all infrastructure measures to be deployed
Testing and Optimisation	**Objective**: Conduct testing, optimisation, and performance evaluation of electric charging infrastructure for buses **Activities**: • Perform interoperability tests, charging efficiency assessments, and grid impact analyses to validate system reliability and performance • Monitor energy consumption, charging times, and battery health metrics to optimise charging protocols and maximise operational uptime for electric buses • Implement predictive maintenance strategies, remote monitoring capabilities, and real-time data analytics to proactively manage charging infrastructure and minimise downtime

Training and Capacity Building	**Objective**: Train bus operators, maintenance staff, and depot personnel on the use and management of electric charging infrastructure **Activities**: • Provide technical training programs, workshops, and certification courses to educate stakeholders on safe handling practices, charging procedures, and emergency protocols • Equip maintenance teams with diagnostic tools, troubleshooting techniques, and battery management strategies to ensure optimal performance and longevity of electric bus fleets • Establish knowledge-sharing networks, online resources, and collaboration platforms to facilitate continuous learning and best practices in EV technology adoption
Public Awareness and Stakeholder Engagement	**Objective**: Engage stakeholders, including bus passengers, local communities, and regulatory bodies, to build support for electric bus deployment and charging infrastructure **Activities**: • Launch public education campaigns, informational workshops, and community events to raise awareness about the benefits of electric buses, such as reduced emissions and improved air quality • Collaborate with environmental groups, advocacy organisations, and civic leaders to advocate for sustainable transportation policies, incentives, and funding opportunities • Solicit feedback from transit users, residents, and businesses to address concerns, gather input on charging infrastructure locations, and prioritise future expansion efforts
Policy Support and Funding	**Objective**: Advocate for policies and secure funding to support the deployment and expansion of electric charging infrastructure for buses **Activities**: • Advocate for regulatory incentives, grants, or financial mechanisms that promote investments in EV infrastructure, charging technologies, and sustainable transit solutions • Collaborate with government agencies, ministries, transit authorities, and energy regulators to align policy frameworks, permitting processes, and funding priorities with electric bus deployment goals • Participate in policy dialogues, stakeholder consultations, and legislative advocacy efforts to influence transportation policies and accelerate the adoption of zero-emission vehicles in public transit

Timeline	Year 1: Conduct feasibility assessment, select technology, and finalise procurement arrangements Year 2: Install and integrate electric charging infrastructure, conduct testing and optimisation, and begin operational deployment Year 3-4: Expand charging network, enhance system performance, and integrate additional electric buses into the fleet

I) Modernisation of Energy Network Supplying Trams

Objective	Upgrade and modernise the energy network supplying trams to improve reliability, efficiency, and sustainability of tram operations – already ongoing
Programme Components	
Needs Assessment and Feasibility Study	Objective: Conduct a thorough assessment to identify current infrastructure gaps and feasibility of modernisation – partially already done Activities: • Evaluate existing tram energy network infrastructure, including substations, overhead lines, and power distribution systems • Analyse energy demand, voltage stability, and capacity constraints to determine upgrade requirements • Assess technological advancements and innovative solutions for tram energy supply, such as renewable energy integration and smart grid technologies
Technology and Infrastructure Upgrade	Objective: Upgrade energy network infrastructure to support modern tram operations Activities: • Replace outdated substations with modern, efficient models equipped with advanced control systems • Upgrade overhead lines and catenary systems to enhance reliability and accommodate increased tram fleet size and energy demand • Implement voltage optimisation technologies and power quality improvements to reduce energy losses and improve system efficiency • Integrate renewable energy sources, such as solar or wind power, into the tram energy network to reduce carbon footprint and enhance sustainability

Deployment of Smart Grid Technologies	**Objective**: Implement smart grid technologies for efficient energy management and operational optimisation **Activities**: • Deploy smart meters and sensors to monitor tram energy consumption, voltage levels, and grid performance in real-time • Implement predictive analytics and demand response systems to optimise tram energy usage, reduce peak loads, and improve grid stability • Establish communication networks and data analytics platforms to enable remote monitoring, proactive maintenance, and rapid response to energy network disruptions
Safety and Regulatory Compliance	**Objective**: Ensure compliance with safety standards and regulatory requirements during modernisation efforts **Activities**: • Conduct safety assessments and risk analyses to identify potential hazards associated with energy network upgrades • Coordinate with regulatory authorities and utility providers to obtain necessary permits, approvals, and compliance certifications • Train tram operators, maintenance staff, and emergency responders on safety protocols, equipment operation, and emergency procedures related to the upgraded energy network
Integration with Tram Fleet and Operations	**Objective**: Seamlessly integrate modernised energy network with tram fleet operations and management systems **Activities**: • Collaborate with tram operators and maintenance teams to ensure compatibility and interoperability between upgraded infrastructure and tram operations • Implement remote monitoring and diagnostic capabilities to enhance fleet management, scheduling efficiency, and predictive maintenance of tram vehicles • Integrate energy management systems with tram dispatching software and passenger information systems to optimise tram routes, energy consumption, and service reliability

Performance Monitoring and Evaluation	**Objective**: Monitor performance metrics and evaluate the impact of energy network modernisation on tram operations **Activities**: • Establish key performance indicators (KPIs) such as energy efficiency gains, reliability improvements, and cost savings • Conduct regular audits, performance assessments, and energy audits to track progress towards goals and identify areas for further optimisation • Solicit feedback from tram operators, passengers, and stakeholders to assess satisfaction levels and gather insights for continuous improvement of energy network performance
Public Awareness and Stakeholder Engagement	**Objective**: Engage stakeholders and raise awareness about the benefits of modernised tram energy networks **Activities**: • Launch public outreach campaigns, community forums, and educational workshops to inform residents, businesses, and local communities about the environmental and economic benefits of energy network modernisation • Collaborate with environmental organisations, advocacy groups, and civic leaders to advocate for sustainable transportation solutions and support for tram modernisation projects • Foster partnerships with academic institutions, research centres, and industry associations to promote knowledge-sharing, innovation, and best practices in tram energy supply modernisation
Timeline	**Year 1**: Conduct needs assessment, feasibility study, and technology evaluation **Year 2**: Begin infrastructure upgrades and deployment of smart grid technologies **Year 3-4**: Complete modernisation efforts, integrate with tram operations, and monitor performance for continuous improvement

J) Increase the climate hazards resilience of the network – mitigation meets adaptation!

All parts of the traffic infrastructure need to be climate proofed to make them resilient to climate change effects.

To increase the climate hazards resilience of a network, whether it's transportation, energy, or another critical infrastructure, several key strategies and components can be implemented:

Vulnerability Assessment	• Conduct a comprehensive assessment to identify vulnerable points in the network concerning climate hazards such as floods, extreme temperatures and storms, as those are the greatest risks in the City of Zagreb
Risk Management and Planning	• Develop risk management plans that include strategies for mitigating identified vulnerabilities and adapting to potential climate impacts • Integrate climate resilience ideas into long-term planning processes, infrastructure development projects, and policy frameworks
Infrastructure Resilience Enhancements	• Renovate existing infrastructure to withstand climate hazards, such as reinforcing bridges and embankments against floods or improving drainage systems to manage increased precipitation • Utilise climate-resilient construction materials and designs for new infrastructure projects
Adaptive Capacity Building	• Enhance the adaptive capacity of the network's operators and stakeholders through training, workshops, and simulation exercises • Foster partnerships with emergency response agencies, local communities, and relevant stakeholders to coordinate responses to climate-related events
Early Warning Systems	• Implement and enhance early warning systems for climate hazards to provide timely alerts and enable proactive responses • Integrate weather forecasting technologies and climate monitoring systems into network operations and decision-making processes
Natural Infrastructure and Green Solutions	• Incorporate natural infrastructure and green solutions into network resilience strategies, such as green roofs, urban green spaces, and permeable pavements to mitigate flood risks and heat island effects to the traffic related infrastructure • Restore and protect natural buffers like wetlands and forests that can provide natural resilience against climate impacts

Community Engagement and Awareness	• Engage with local communities and stakeholders to raise awareness about climate hazards and resilience measures • Foster community involvement in resilience planning, emergency preparedness, and response efforts
Investment in Technology and Innovation	• Invest in innovative technologies such as smart sensors, predictive analytics, and remote monitoring systems to enhance network resilience and improve real-time decision-making capabilities • Explore sustainable energy solutions like renewable energy integration and energy storage to enhance network reliability during climate events
Policy and Regulatory Frameworks	• Develop and enforce policies and regulations that promote climate resilience in infrastructure planning, design, and maintenance • Incentivise private sector investment in climate-resilient infrastructure through regulatory measures and financial incentives
Monitoring and Evaluation	• Establish robust monitoring and evaluation mechanisms to assess the effectiveness of resilience measures • Regularly review and update resilience strategies based on acquired knowledge, evolving climate risks, and technological advancements

3.2.4.4 Late adoption technological measures (3+ years)

K) Further Expansion of Electrified Public Transport Fleet

Further expansion of an electrified public transport fleet involves several key components and strategies to ensure successful implementation:

Needs Assessment and Planning	• Conduct a comprehensive assessment of current public transport demand, routes, and fleet conditions to determine the scope and scale of electrification needed – will be assessed in the spatial planning documents as well as in the study of modernisation of public transport of the City of Zagreb, currently supported by the EIB • Develop a strategic plan outlining goals, targets, and timelines for expanding the electrified fleet

Technology Selection and Procurement	• Evaluate available EV technologies as well as hydrogen ones, including buses and trams, based on performance, range, charging infrastructure compatibility, and operational requirements • Procure electric and/or hydrogen vehicles through competitive bidding processes or partnerships with manufacturers, ensuring compliance with local regulations and emission standards
Charging Infrastructure Deployment	• Establish a network of charging infrastructure to support the expanded fleet, including depot charging stations and on-route fast chargers • Coordinate with utility providers and local authorities to optimise charging infrastructure locations and grid capacity
Fleet Deployment and Integration	• Integrate new electric buses or trams as well as hydrogen fuelled vehicles into existing transport operations, ensuring seamless transition and minimal disruption to service • Provide training for drivers, maintenance personnel, and operational staff on electric vehicle operation, charging protocols, and safety procedures
Financial and Regulatory Support	• Secure funding sources and financial incentives, such as grants, subsidies, or low-interest loans, to support the acquisition and deployment of electric and/or hydrogen powered vehicles • Advocate for supportive policies and regulatory frameworks that promote electrification, including incentives for renewable energy use and emissions reductions
Performance Monitoring and Optimisation	• Monitor the performance and efficiency of electrified and/or hydrogen powered vehicles and charging infrastructure through data collection and analysis • Implement maintenance protocols and predictive analytics to optimise vehicle uptime, battery life, and overall fleet efficiency
Public Awareness and Stakeholder Engagement	• Engage with stakeholders, including transit riders, local communities, and environmental groups, to build support for alternative fuels powered public transport • Educate the public about the benefits of electric and hydrogen vehicles, such as reduced emissions, improved air quality, and noise reduction

Scaling Up and Expansion	• Plan for future expansion of the electrified and hydrogen fleet based on demand growth projections and technological advancements • Continuously assess and update fleet decarbonisation strategies to incorporate new innovations and best practices in sustainable transportation
Environmental Impact and Sustainability	• Measure and report on the environmental benefits of electrified and or hydrogen powered public transport, including reductions in greenhouse gas emissions and contributions to local air quality improvement • Incorporate life-cycle assessments and sustainability criteria into fleet procurement and operations
Collaboration and Knowledge Sharing	• Foster partnerships with industry stakeholders, research institutions, and peer cities to share the acquired knowledge, best practices, and innovative solutions in electrified and/or hydrogen powered public transport

L) Implementation of Integrated Ticketing Systems

Objective	Introduce an integrated ticketing system to streamline ticketing processes, enhance passenger convenience, and improve operational efficiency in public transportation to raise the usage of public transport
Programme Components	
Needs Assessment and Planning	Objective: Conduct a comprehensive assessment to understand current ticketing challenges and requirements Activities: • Analyse existing ticketing systems across different modes of public transport (bus, tram, rail) • Identify user needs, such as ticket types, fare structures, and payment preferences • Develop a roadmap and implementation strategy outlining goals, timelines, and budget considerations

Technology Selection and Procurement	**Objective**: Select appropriate technology solutions for the integrated ticketing system **Activities**: • Evaluate available technologies, including smart cards, mobile apps, contactless payment systems, and fare collection devices • Conduct procurement processes, including vendor selection, contract negotiations, and system customisation • Ensure compatibility with existing transport infrastructure and regulatory requirements
Development of Sales and Payment Infrastructure	**Objective**: Establish a robust sales and payment infrastructure for seamless ticketing transactions **Activities**: • Deploy ticket vending machines (TVMs) and self-service kiosks at key transport hubs and stations • Integrate mobile ticketing apps and online platforms for ticket purchase and validation • Implement contactless payment systems and electronic fare collection devices to support diverse payment methods
System Integration and Operational Processes	**Objective**: Integrate the integrated ticketing system with existing transport management systems **Activities**: • Ensure interoperability and data exchange between ticketing, scheduling, and passenger information systems • Develop APIs and data interfaces for seamless communication between different components of the transport network • Train staff on system operation, maintenance, and troubleshooting to ensure smooth implementation and ongoing support
Security and Data Protection	**Objective**: Implement robust security measures to protect passenger data and ensure transaction security **Activities**: • Adopt encryption protocols and secure data transmission channels to safeguard sensitive information • Comply with data protection regulations (e.g., GDPR) and industry standards for payment card security (PCI DSS) • Conduct regular security audits and vulnerability assessments to identify and mitigate potential risks

User Training and Support	**Objective**: Provide comprehensive training and support for passengers and transport staff **Activities**: • Offer user education programs to familiarise passengers with new ticketing options and procedures • Provide training for transport staff on ticketing system operation, troubleshooting, and customer service • Establish customer support channels (e.g., helpdesk, online support) to assist passengers with ticketing issues and inquiries
Performance Monitoring and Evaluation	**Objective**: Monitor system performance and evaluate the impact of the integrated ticketing system **Activities**: • Define key performance indicators (KPIs) such as transaction speed, ticketing accuracy, and customer satisfaction • Conduct regular audits and performance reviews to assess system reliability, efficiency, and user feedback • Use data analytics and passenger feedback to identify areas for improvement and optimise system functionality
Public Awareness and Stakeholder Engagement	**Objective**: Raise awareness and engage stakeholders in the benefits of the integrated ticketing system **Activities**: • Launch marketing campaigns and promotional activities to inform passengers about new ticketing options and benefits • Collaborate with local authorities, transport operators, and community groups to garner support and feedback • Solicit input from stakeholders through surveys, focus groups, and public consultations to shape future enhancements and improvements
Timeline	**Year 1**: Conduct needs assessment, technology selection, and planning **Year 2**: Procure and customise technology solutions, establish infrastructure, and begin system integration **Year 3**: Deploy integrated ticketing system, conduct user training, and monitor initial performance **Year 4**: Evaluate system effectiveness, optimise operations, and continue to enhance user experience and functionality

M) Adoption of autonomous electric public transport vehicles

Objective	Introduce autonomous electric vehicles (AEVs) into the public transport system to enhance efficiency, reduce emissions, and promote sustainable urban mobility
Programme Components	
Feasibility Assessment and Planning	**Objective**: Conduct a feasibility study to assess the viability of adopting AEVs in public transport **Activities**: • Evaluate technological readiness and regulatory requirements for autonomous driving and electric vehicle integration • Analyse potential routes and operational scenarios suitable for AEV deployment • Develop a strategic plan outlining goals, timelines, and budget considerations for AEV adoption
Technology Selection and Procurement	**Objective**: Select and procure AEV technologies that meet operational and safety requirements **Activities**: • Assess available AEV models and technologies from manufacturers and suppliers • Conduct pilot testing and demonstration projects to evaluate performance and reliability • Negotiate contracts and agreements with AEV providers for procurement and deployment
Infrastructure Development	**Objective**: Build and adapt infrastructure to support AEV operations and charging requirements **Activities**: • Install charging stations and infrastructure along designated routes and depots • Upgrade communication networks and sensors to support autonomous navigation and vehicle-to-infrastructure (V2I) communication • Retrofit existing public transport facilities to accommodate AEV maintenance and charging needs

Regulatory and Safety Compliance	**Objective**: Ensure compliance with regulatory frameworks and safety standards for AEV deployment **Activities**: • Collaborate with transportation authorities and regulatory bodies to establish guidelines and safety protocols for AEV operations • Obtain necessary permits, licenses, and approvals for autonomous vehicle testing and commercial deployment • Implement cybersecurity measures and risk assessment strategies to safeguard AEV operations and passenger safety
Training and Workforce Development	**Objective**: Train personnel and stakeholders on AEV operations, maintenance, and emergency response procedures **Activities**: • Provide specialised training for AEV operators, maintenance technicians, and emergency responders • Educate passengers and the public on AEV features, safety protocols, and benefits of autonomous public transport • Foster collaboration with educational institutions and vocational training programs to develop skills for AEV-related careers
Performance Monitoring and Evaluation	**Objective**: Monitor AEV performance and evaluate operational efficiency and passenger satisfaction **Activities**: • Establish performance metrics such as reliability, energy efficiency, and vehicle utilisation rates • Conduct regular audits and assessments to track AEV performance against benchmarks and KPIs • Collect feedback from passengers and stakeholders to identify areas for improvement and optimise AEV operations

Public Awareness and Stakeholder Engagement	**Objective**: Raise awareness and engage stakeholders in the benefits of AEV adoption in public transport **Activities**: • Launch public information campaigns and community outreach programs to educate the public about AEV technology and its advantages • Collaborate with local governments, businesses, and community groups to build support for AEV initiatives and sustainable mobility solutions • Organise demonstrations, tours, and events to showcase AEV capabilities and gather feedback from the community
Timeline	**Year 1**: Conduct feasibility assessment, select technology, and develop a strategic plan **Year 2**: Procure AEV technologies, upgrade infrastructure, and commence regulatory compliance **Year 3**: Deploy AEVs in pilot projects, conduct training, and monitor performance **Year 4**: Expand AEV fleet, evaluate scalability, and optimise operations based on feedback and performance data

3.3 Module B-3 Indicators for Monitoring, Evaluation and Learning

The performance will be tracked through a robust set of indicators for **Monitoring, Evaluation, and Learning (MEL)** in our Climate City Contract. That is essential for several reasons. Firstly, these indicators provide a systematic way to track progress towards climate goals, ensuring that the city remains on course to meet its commitments to greenhouse gas reduction, energy efficiency, and renewable energy adoption, as well as to increase resilience. Secondly, they enable the identification of gaps and areas for improvement, allowing for timely interventions and adjustments to strategies and policies, as the CCC is a "living" type of document. Thirdly, by monitoring adaptation efforts, the indicators help the city enhance its resilience to climate impacts, protecting both infrastructure and vulnerable communities. Moreover, governance and community engagement indicators ensure that climate action is inclusive, transparent, and backed by strong institutional support and public participation. Lastly, the continuous monitoring and reporting facilitated by these indicators

foster a culture of accountability and learning, helping the city to document successes, share best practices, and scale up effective solutions. In essence, these indicators are vital for turning climate commitments into tangible actions and measurable outcomes, driving sustained progress towards a sustainable and climate-resilient future.

The Climate City Contract (CCC) recognizes the importance of establishing both qualitative and quantitative indicators to effectively track the progress of the impact pathways and associated actions. Currently, while the outcomes and impacts identified in the CCC are not explicitly connected to specific actions or indicators, the direct and indirect impacts are provided for each individual measure.

The actions and measures outlined in the CCC are aggregated into short-term and long-term categories for a reason. For each action, a timeline is provided, ensuring clear milestones and deadlines for achievement. However, specific target values for indicators are not yet fully defined, and metadata for these indicators is still under development.
In future iterations, the city will continue to enhance these elements by associating each impact pathway with detailed, measurable indicators to track both early and late outcomes. The city will also define target values for each indicator, integrating the direct and indirect impacts more effectively into the monitoring and evaluation framework. The timelines for achieving these targets will be refined to allow for more precise tracking and accountability of the city's progress towards its climate goals.

Indicators for Monitoring, Evaluation, and Learning (MEL), the data behind the ICAI

1. Mitigation Indicators

Indicator group	Indicator	Metric
Greenhouse Gas Emissions (GHG)	Total GHG emissions	tCO_2
	Annual GHG emissions reduction	tCO_2/year
	GHG emissions per capita	tCO_2/capita
	Annual GHG emissions reduction per capita	tCO_2/capita/year
Energy Efficiency	Total Primary Energy Supply (TPES)	TWh
	TPES per capita	TWh/capita
	Annual TPES reduction	TWh/year
	Annual TPES reduction per capita	TWh/capita/year
	Uptake of energy renovation	m^2 renovated
Adoption of Renewable Energy Sources (RES)	Total production of energy from RES	MWh/year
	Total production of energy from RES per capita	MWH/year/capita
	Installed capacity of RES	MW
	Installed capacity of RES per capita	MW/capita
	Share of RES in total electricity supply	%
	Share of RES in total heating supply	%
Transport	Total GHG emissions from transport	tCO_2
	Total GHG emissions from transport per capita	tCO_2/capita
	Uptake of public transport	Active users
	Use of personal motorised vehicles	Vehicles/capita
	Number of public EV charging stations	EV stations

2. Adaptation Indicators

Indicator group	Indicator	Metric
Infrastructure	Number of climate proofed infrastructure projects	Number
Green infrastructure	Area of new green spaces	Ha
	Number of new trees planted	Number
	Number of new shrubs planted	Number
Heatwaves	Cooling centres established	Number
	Number of buildings with heat mitigation measures	Number
Flood prevention	New natural retention areas established	Ha
	Rain gardens implemented	Number
	Number of buildings with rainwater utilisation measures	Number

3. Community Engagement Indicators

Indicator group	Indicator	Metric
Public awareness	Number of climate awareness campaigns conducted	Number
Community participation	Number of citizens participating in public climate initiatives	Number
	Number of community-led climate projects	Number

4. Monitoring and Reporting Indicators

Indicator group	Indicator	Metric
Data	Number of monitored and metered climate and energy parameters	Number
	Frequency of data collection	Qualitative
Reporting	Frequency of reporting	Qualitative
	Number of stakeholder engagement sessions	Number
	Number of stakeholders consulted	Number

Implementing the Indicators:

Baseline Assessment: A baseline will be established for each indicator to measure progress against initial conditions.

Data Sources: Reliable data sources will be identified for each indicator, such as municipal records, surveys, and external data providers.

Frequency of Measurement: The frequency of data collection and reporting for each indicator (e.g., quarterly, annually) will be defined.

Stakeholder Involvement: Stakeholders in the monitoring and evaluation process will be identified to ensure transparency and accountability.

Adjustments: The results of the monitoring and evaluation process will be used to make informed adjustments.

These indicators provide a comprehensive framework for tracking progress, evaluating outcomes, and facilitating continuous learning and improvement in implementing a Climate City Contract.

Integrated Climate Action Index - ICAI

The essence of our approach is the mainstreaming effect, so we will develop The Integrated Climate Action Index (ICAI) that should provide a comprehensive measure of how well climate change considerations are mainstreamed into city governance and practices. By assessing policy integration, budget allocation, institutional capacity, project implementation, public engagement, and monitoring and reporting, the ICAI should capture the multifaceted nature of mainstreaming climate action. This indicator will help us to identify strengths and areas for improvement, promoting a holistic approach to building climate resilience and reducing emissions.

Integrated Climate Action Index (ICAI)

The Integrated Climate Action Index (ICAI) measures the extent to which climate change mitigation and adaptation actions are embedded across various sectors and levels of city governance, policies, and practices. The following segments and specific elements will be monitored to quantitatively and qualitatively determine the development of the city's energy and climate policies. To this end, data will be gathered from municipal records, policy documents, budget reports, project evaluations, and stakeholder surveys. Progress reports will be developed based on the collected data, and conclusions on the overall process will be derived from them.

Integrated Climate Action Index (ICAI): Operationalizing climate mainstreaming across Zagreb's governance system

The city of Zagreb is advancing a bold transformation toward climate neutrality, but the pathway to 2050 cannot be defined solely by infrastructure and emissions figures. It must also be supported by a governance architecture that embeds climate action across all city functions. This recognition lies at the heart of the Integrated Climate Action Index (ICAI), a framework developed to measure, monitor, and drive the mainstreaming of climate mitigation and adaptation into the city's operational core.

Unlike conventional metrics focused solely on project outcomes or emissions inventories, the ICAI is designed to answer a more structural question: to what extent is climate action integrated into the everyday machinery of city planning, policy, finance, and public engagement? The ICAI captures this by tracking performance across six dimensions: policy integration, budget allocation, institutional capacity, project implementation, public

engagement, and monitoring and reporting. Together, they provide a comprehensive picture of how climate considerations are operationalised, not just adopted, within the governance system.

This governance-level approach directly supports Zagreb's Climate City Contract (CCC) and aligns with emerging EU methodologies that place increasing emphasis on mainstreaming. It also reflects Zagreb's active participation (through REGEA) in European initiatives like the NECPlatform and INPLAN, both of which emphasize systemic governance transformation as a condition for effective local climate action.

Mainstreaming through policy and planning Instruments: The INPLAN Framework

Zagreb's ICAI is explicitly shaped by the principles of the INPLAN project, a European initiative coordinated by REGEA (North-West Croatia Regional Energy and Climate Agency), aimed at supporting local and regional governments in integrating energy and climate objectives into spatial planning processes. INPLAN recognises that without binding spatial, financial, and sectoral instruments, climate plans risk remaining aspirational.

The ICAI builds on this logic. It tracks the number of city policies and regulations that include explicit climate mitigation and adaptation targets, and how these are reflected in Zagreb's urban development plan (GUP), transport strategies, housing codes, and public procurement rules. It also monitors whether energy and climate goals are cross-referenced in land-use documents, aligning with INPLAN's emphasis on vertical coherence between SECAPs and formal planning.

Zagreb has committed to ensuring that climate action is no longer treated as a standalone document or department, but as a cross-cutting obligation embedded into all levels of planning, reflected in how zoning decisions are made, where infrastructure is built, and how resilience is mapped into city growth.

Financial governance and budget Alignment: EU Taxonomy in Practice

One of the ICAI's most strategic functions is to connect climate action with municipal finance. As public investments grow in size and ambition, especially under the EU Green Deal and Mission framework, Zagreb is using the ICAI to track the share of city budgets dedicated to climate-related priorities, and whether they are aligned with the principles of the EU Taxonomy for Sustainable Activities. It is going to be in focus from 2026 – 2028 to fully test it in cooperation with Ministry of finance.

This alignment ensures that public funds are not only spent with environmental objectives in mind, but also meet the evolving regulatory standards that define what is considered "green" at the EU level. The ICAI thus acts as a bridge between the city's capital planning and the EU's climate-aligned finance mechanisms. This is particularly important as Zagreb increasingly draws on blended financing models, including EIB framework loans, RRF funds, and other innovative means of financing.

By tracking climate-tagged expenditures and applying a taxonomy lens, Zagreb ensures its investments are future-proof, bankable, and aligned with investor expectations for climate performance. This also supports mainstreaming at the budgetary level, reinforcing climate as a criterion not only for what projects are done, but how they are selected, appraised, and justified.

Institutional capacity and system learning: NECPlatform as a Catalyst

Zagreb's commitment to mainstreaming climate governance is further strengthened through its involvement in the NECPlatform project through REGEA, which supports the development of national energy and climate planning platforms through multilevel coordination. The NECPlatform approach is rooted in the belief that cities must be equal partners in national climate strategies, and that policy alignment across governance levels is essential to successful implementation.

The ICAI reflects this by measuring not only the presence of climate teams within city departments, as well as the tranisition team, but also the frequency of interdepartmental coordination, the presence of climate focal points, and the number of staff receiving climate-related training. These are key institutional conditions for delivering integrated climate

action, and the basis for participating meaningfully in national and EU platforms like NECPlatform.

Additionally, the ICAI includes monitoring and reporting functions that reflect NECPlatform's push for robust, multi-level data ecosystems. It tracks the city's production of integrated climate action reports, performance reviews, and its contributions to national and EU-level monitoring. This strengthens Zagreb's ability to communicate its progress, influence upstream policies, and ensure its local achievements are reflected in broader climate reporting frameworks such as the EU's Governance Regulation (Regulation 2018/1999).

Social ownership, public engagement, and institutional reflexivity

Mainstreaming cannot happen without social legitimacy. The ICAI thus places special emphasis on public engagement, recognising that climate policy must be co-owned by citizens and stakeholders. It tracks the number and diversity of consultations on integrated climate action, and evaluates the quality of citizen participation in areas like mobility transition, energy use, green space planning, and climate adaptation.

By capturing both quantitative outreach metrics and qualitative dimensions of public trust and empowerment, the ICAI helps the city ensure that climate mainstreaming is not only a technocratic process, but a democratic one. It supports new forms of participatory governance, from living labs to digital co-design tools, reinforcing the CCC principle that climate transformation must be inclusive and just.

From governance gaps to institutional strength: A mainstreaming diagnostic tool

Ultimately, the Integrated Climate Action Index serves as both a diagnostic tool and a learning system. It enables Zagreb to assess where climate action is strong, where it is still siloed, and where deeper integration is required. Its indicators provide actionable feedback on how climate goals are embedded into the planning, budgeting, staffing, and public engagement practices of the municipality.

More than a compliance mechanism, the ICAI supports a governance transformation, one that aligns climate ambition with institutional practice. Through its connection to EU Taxonomy finance rules, INPLAN's spatial integration guidelines, and NECPlatform's multi-

level policy coherence, the ICAI ensures that Zagreb's climate governance is not only well-intentioned, but also operational, scalable, and verifiable.

By building this governance infrastructure for climate mainstreaming, Zagreb is not only enhancing its ability to deliver on its Climate City Contract, it is becoming a European frontrunner in systemic climate governance.

ICAI segment	Specific element
Policy integration	Percentage of city policies and regulations that include explicit climate mitigation and adaptation goals
	Number of sectors (e.g., transportation, housing, energy, water) with integrated climate action plans
Budget Allocation	Percentage of the municipal budget dedicated to climate-related projects and initiatives
Institutional Capacity	Number of city departments with dedicated climate action teams or focal points
	Frequency of climate-related training programs for municipal staff
Project Implementation	Number of infrastructure projects that incorporate both mitigation and adaptation measures
	Percentage of new developments that comply with the City implemented New Green Deal Guidance for reconstruction and development of the infrastructure
Public Engagement	Number of public consultations and stakeholder meetings focused on integrated climate action
	Level of public awareness and participation in climate initiatives that address both mitigation and adaptation
Monitoring and Reporting	Frequency and comprehensiveness of integrated climate action reports
	Number of performance reviews that assess the effectiveness of combined mitigation and adaptation strategies

These indicators provide a comprehensive framework for tracking progress, evaluating outcomes, and facilitating continuous learning and improvement in the implementation of a Climate City Contract.

4 Part C – Enabling Climate Neutrality by 2030

4.1 Module C-1 Governance Innovation Interventions

Mainstreaming mitigation and adaptation activities into our governance processes is essential for effectively addressing climate change and building resilience. By integrating climate considerations into urban planning, policymaking, and decision-making at all levels, we will ensure that climate actions become embedded within the fabric of municipal governance. We will focus on the following strategies for mainstreaming mitigation and adaptation activities into our city governance and driving systemic transformation towards sustainability and resilience.

Institutional Integration

We will create a supporting Climate Action Core group: a dedicated climate action task force within the municipal government structure that will have a role to support sectorial departments in their responsibility for climate initiatives and will ensure coherent and coordinated action across departments. These Core groups will oversee the development and implementation of climate policies, coordinate interdepartmental collaboration, and provide technical expertise and support to all departments. However, climate change mitigation and adaptation are the responsibility of all sectorial heads of departments, and the ultimate responsibility lies with the mayor.

Climate Impact Assessments and climate proofing: Integrating climate impact assessments into the decision-making processes of city departments ensures that climate considerations are systematically evaluated and incorporated into policy development and project planning. By assessing the potential climate risks and opportunities associated with proposed actions, we will make sure that we can make informed decisions that enhance resilience and reduce vulnerability.

Policy Integration

Climate Action Plan is in constant iterations, as is the Climate City Contract: Developing comprehensive climate action plans that outline mitigation and adaptation strategies across all sectors of city governance provides a roadmap for mainstreaming climate action into municipal policies and programs. These plans set clear targets, prioritise actions, and identify the roles and responsibilities of different city departments in achieving climate goals. We have them in place already, but our approach is that as soon as we finish one, we start over again. Climate is changing rapidly – so should we and our work, in a disruptive manner that will help us adapt to climate change and mitigate its effects.

Climate-Smart Regulations: Embedding climate-smart regulations into city ordinances, development strategies, urban development plans, zoning codes, and building standards ensures that new development projects adhere to sustainability principles and resilience standards. By incorporating requirements for energy efficiency, green infrastructure, and climate resilience into regulatory frameworks, cities can promote sustainable urban development and reduce emissions. We are introducing above national level standards, as the national ones are insufficient to get where we want.

Financial Integration

Climate Budgeting: Allocating dedicated funding streams for climate mitigation and adaptation activities within city budgets will ensure that resources are available to support climate action initiatives. Climate budgeting integrates climate considerations into financial planning processes, prioritises investments in climate-resilient infrastructure, and enhances accountability for achieving climate goals. Our goal is not to have separate budget lines for climate actions, but rather for all our budget lines to be assessed in relation to greenhouse gas emissions and climate proofed. Only that will allow us to break the silos and allow for full climate change mainstreaming. Typical current budget rules are limiting, so we will, in cooperation with the national level, develop new classifications with incorporated monitoring and evaluation mechanisms.

Innovation in finance

Financing climate action in cities is a critical challenge that requires innovative approaches to acquire the necessary resources for mitigation and adaptation initiatives. Traditional

funding mechanisms will not be sufficient to meet the scale of investment needed to effectively address climate change. We will have to undertake innovative financing mechanisms that will enable us to finance climate action projects, accelerate implementation, and achieve our sustainability and resilience goals.

We will explore and further utilise:

European structural and investment funds: We have successfully been using these funds, both in a centralised and decentralised manner. Allocations on the national level for energy transition and climate change adaptation are sustainable so there is a strong potential to leverage our fund in a blending manner.

Funds of Investment and Development Banks: As we are in the process of developing the Climate City Contract, we are also arranging the first tranche of the EIB framework loan, which will dominantly be directed to decarbonisation and climate change adaptation activities. The European Investment Bank (EIB) is a major financial institution that provides loans, guarantees, and technical assistance to support projects that contribute to EU policy objectives, including climate action. On top of using the loans we are analysing options to utilise Climate Awareness Bonds (CABs) and Green Bonds, the EIB finances projects aimed at reducing greenhouse gas emissions, promoting renewable energy, improving energy efficiency, and enhancing climate resilience. These bonds are issued to raise funds specifically earmarked for climate-related projects, allowing investors to support sustainable development initiatives while generating financial returns.

Green Bonds and Climate Bonds

Green Municipal Bonds: Issuing green municipal bonds will allow us to raise capital specifically earmarked for financing climate-related projects, such as renewable energy infrastructure, energy-efficient buildings, and public transportation systems, as well as adaptation projects. We believe that these bonds will attract socially responsible investors seeking opportunities to support sustainable development and climate mitigation efforts. We already have strong signals for that, as we are preparing for the first tranche.

Climate Bonds: Climate bonds as fixed-income financial instruments will help us fund projects that contribute to climate mitigation or adaptation objectives. Certified by

independent standards such as the Climate Bonds Initiative, these bonds provide transparency and assurance to investors regarding the environmental integrity of the financed projects, thus mobilising capital for climate-resilient infrastructure. Creating a portfolio of certified projects is the first step. Therefore, we are working on a methodology to label our projects as climate-friendly and resilient.

Public-private partnerships (PPPs)

Performance-Based Contracts: Performance-based contracts between cities and private sector entities incentivise climate services and outcomes rather than pure ideas. Through mechanisms such as energy performance contracts and resilience service agreements, private partners assume the upfront costs of implementing climate solutions and are remunerated based on the achievement of predefined performance targets. We have experience with such contracting, and we will be utilising it on a larger scale.

Climate Funds and Financial Instruments

Climate Resilience Funds: Establishing dedicated climate resilience funds provides cities with flexible financing mechanisms to address climate risks and vulnerabilities. These funds pool resources from various sources, including government budgets, philanthropic contributions, and international financing mechanisms, to support adaptation measures, disaster preparedness, and community resilience initiatives.

Green Revolving Funds: We plan to set up a Green revolving fund that will enable us to invest in energy efficiency and sustainability projects by recycling savings generated from the implementation of previous projects. As investments generate returns through cost savings or revenue generation, these funds replenish themselves, creating a self-sustaining mechanism for financing ongoing climate action initiatives.

Innovative Financing Platforms – bringing citizens on board

Crowdfunding Platforms: We will offer certain projects through the Crowdfunding platforms that will enable us to raise capital from a large number of individual donors or investors to finance specific climate projects or initiatives, for example, for the photovoltaics projects on public buildings, which will also be covered through the mechanism we call the solar bonds.

By tapping into community support and social networks, it is our idea to mobilise financial resources and engage citizens in the co-financing and co-creation of climate solutions.

Innovations in financing climate action are essential for unlocking the financial resources needed to address climate change effectively. By leveraging green bonds, public-private partnerships, climate funds, and innovative financing platforms, we will mobilize capital, accelerate the implementation of climate projects, and achieve sustainability and resilience goals. These innovative financing mechanisms will not only provide us with access to additional funding sources but also catalyse private sector investment, and citizens' participation and foster collaboration, driving the systemic transformation towards a low-carbon, climate-resilient future.

Community Engagement

Community-Based Planning: Engaging communities in the planning and decision-making processes of climate action initiatives ensures that local knowledge and priorities are reflected in governance processes. We are already undertaking community-based planning approaches, and are planning to increase them in the future, as they empower residents to co-design and co-implement climate solutions, foster social cohesion, and build trust between citizens and government.

Climate Education and Awareness: We don't know a lot; we learn every day, and it is essential to raise awareness and educate citizens about climate change and its impacts. That will foster public support for climate action and encourage individual behaviour change. Climate education programs, public outreach campaigns, and community events will provide platforms for dialogue, knowledge sharing, and collective action on climate issues.

Mainstreaming mitigation and adaptation activities

Mainstreaming mitigation and adaptation activities into city governance processes is essential for catalysing transformative change towards sustainability and resilience. By institutionalising climate considerations, integrating climate policies into city planning and regulations, aligning financial resources with climate goals, and engaging communities in decision-making processes, we will be able to effectively address climate change and build a more sustainable future for all.

Ecosystem development – mission-based approach

Innovations and cooperation are at the core of our approach. The City of Zagreb is a signatory of both missions related to climate because we see mitigation and adaptation as two sides of the same coin. Unfortunately, there has been a significant period when methods, tools and actions that were developed through different innovation projects were not serving any purpose, we lacked the follow-up. We have lately established a system in which we use the EU programmes (H2020, HE, LIFE etc.), technical assistance of the EIB ELENA and similar types of funding as leverage to develop and test the solutions that are embedded into our processes and upscaled, as they become the core of the transformational processes. They are the basis of our pathway towards climate neutrality and increased resilience. On that path, we have established successful cooperation with the national level ministries, through different projects and initiatives. We have successfully managed to create a national platform for dialogue on the National Energy and Climate Action Plan, a project led by our supporting agency – the North-West Croatia Regional Energy and Climate Agency. It is a platform that gathers national-level ministries, cities and counties, academic communities, the NGO sector, and financial institutions and currently represents one of the best cases in Europe. As a result of the work and meetings on that platform, under the leadership of the Ministry of Finance Croatia, a national platform for sustainable finance of energy and climate actions has been set up. That platform will serve as a catalysing agent for innovation in finance for energy transition and climate change adaptation.

4.2 Module C-2 Social Innovation Interventions

Recent developments in The City of Zagreb exemplify a concerted effort to involve a diverse array of stakeholders and the general public in the decision-making process, indicating an increasing dedication to tackling city challenges through collaborative and innovative approaches. Initiatives such as the eTransparency[21] application have emerged as tools for enhancing governance transparency and accountability. By providing citizens with access to information about public spending, this application cultivates greater trust in public institutions and promotes citizen engagement. Furthermore, the Open Data Portal of the

[21] eTransparency

City of Zagreb[22] plays a pivotal role in advancing transparency and innovation. Serving as a centralised platform for gathering, organising, and disseminating open data from the City of Zagreb and its affiliated entities, this portal facilitates collaboration and innovation while driving positive social change and contributing to the city's holistic development.

The Climate City Contract (CCC) emphasizes a dynamic and ongoing approach to stakeholder engagement as an integral part of its development and implementation processes. For each individual measure outlined within the CCC, a dedicated portfolio of actions and stakeholders has been carefully identified and is actively being executed. This approach ensures that relevant actors are not only consulted during the initial planning phases, nor is this process solely connected to the development of the CCC, but are continuously involved throughout the lifecycle of the actions.

As highlighted on page 197, the establishment of a shared vision for a sustainable and climate-resilient city is central to the CCC. This vision, co-created with diverse stakeholder input, reflects the values and priorities of the community. Although specific examples of participants and mechanisms are not detailed in the document, it is important to underline that the process of engagement is iterative and adaptive. Stakeholders are engaged at multiple stages—planning, implementation, and monitoring—to ensure that their insights and expertise shape and refine each measure effectively over time.

By maintaining this continuous dialogue and collaboration, the CCC fosters accountability, inclusivity, and resilience in addressing the complex challenges of climate adaptation and sustainability.

We have added a description of one of the processes, the revision of the General Urbanistic plan (so called Green General Urbanistic plan), one of the cornerstones of our approach in horizontal measures on the page 73, in the section on explanation. We could do this for each measure and each action of the CCC AP, but the approach is always the same.

As an add on to the CCC development, City has parallelly been working on the development of the legally binding Plan for GHG emissions reduction, adaptation to climate change and ozone layer protection. This plan and the CCC are in the core the same, when it comes to measures, stakeholders and governance, with the main difference that CCC is much more ambitious in the level of decarbonization. The afore mentioned Plan has undergone

[22] Open Data Portal of the City of Zagreb

significant stakeholders consultation processes, including the public hearing and public consultations and was approved by the competent Ministry in charge for climate that also strengthens the position of the CCC.
In the discussions with relevant stakeholders (especially on the national level) it has come to the attention of the decision makers that CCC approach will be considered as a standard on national level for cities, as it brings huge innovation, especially in the domain of the economics and the investment plan, which our legally binding documents lack.

Our journey in the creation of the Climate City Contract is an evolving process that began with the establishment of a shared vision for a sustainable, climate-resilient Zagreb. This vision is continuously co-created with input from diverse stakeholders, reflecting the values and priorities of our community over time. Below are specific mechanisms and examples of ongoing stakeholder involvement:

1. Digital Engagement Platforms: The Zagreb Smart City Hub serves as a dynamic forum where stakeholders can continuously engage, share ideas, and provide feedback on the evolving needs of our city's climate initiatives.
2. Participatory Budgeting Sessions: Through our e-service platform, we conduct regular participatory budgeting sessions, allowing residents and local businesses to have an ongoing influence on how climate resilience projects are funded and prioritized. This continuous dialogue helps integrate evolving community priorities into our climate action framework.
3. Expert and Stakeholder Conferences: Annual conferences, such as the 2024 energy transition and 2025 conference on green infrastructure, serve as key moments for reflection and co-creation. These conferences synthesize inputs from ongoing workshops and forums, ensuring that our action plans remain relevant and effective.
4. Community Workshops and Forums: We hold workshops and forums across the city districts on a regular basis. These events are designed to capture a wide range of community inputs over time, ensuring that the voices of all community members, including underrepresented groups, are heard and considered in an ongoing manner.

5. Surveys and Public Consultations: We deploy surveys and public consultations periodically to gauge shifting public opinion and gather new suggestions on specific elements of the climate action plan. The continuous feedback received through these channels allows us to adapt and refine our strategies to meet emerging challenges and opportunities.
6. This description underscores our commitment to a participatory approach, demonstrating that the CCC is not a static document but a living agreement that evolves through constant stakeholder engagement. Our aim is to ensure that the CCC remains a collective covenant, co-created with the ongoing participation of the people of Zagreb.

In addition to these engagement strategies, we prioritize ongoing cooperation with key infrastructure stakeholders, including utility companies, transportation agencies, and urban planning entities. This partnership is critical as it ensures that our climate resilience initiatives are integrated with essential city infrastructure developments. Regular coordination meetings and joint planning sessions are held to align infrastructure projects with our climate action goals, allowing for seamless integration and mutual reinforcement of efforts. This continuous collaboration not only enhances the effectiveness of our initiatives but also ensures that our infrastructure evolves in a way that supports sustainable and resilient urban living.

The essence of transformation!

In the face of escalating climate change impacts, Zagreb has recognised the increasing and urgent need for transformative action to mitigate greenhouse gas emissions and enhance resilience. A holistic approach to climate action involves systemic transformation, addressing interlinked social, economic, and environmental challenges through integrated strategies. We have recognised that the creation of a Climate City Contract, a collaborative agreement between local governments, stakeholders, and citizens to pursue ambitious climate goals, is an effective mechanism to drive such a transformation.

Understanding the Transformation!

We understand that systemic transformation entails fundamental changes across multiple interconnected systems, including governance structures, economic models, infrastructure, and societal behaviours. Rather than focusing on isolated solutions or incremental changes, systemic transformation targets the root causes of climate change and seeks to reorient societies towards sustainability and resilience. This approach recognises the complex interactions between human activities and natural systems, emphasising the need for integrated, long-term strategies that address systemic barriers to change.

The Core Values of our Climate City Contract are:

1. Shared Vision and Goals:

Our journey in the creation of the Climate City Contract begins with the establishment of a shared vision for a sustainable, climate-resilient city. This vision is co-created with input from diverse stakeholders, reflecting the values and priorities of the community. Clear, measurable goals are then set to guide the city's climate action efforts, aligning with international agreements such as the Paris Agreement and the Sustainable Development Goals.

2. Participatory Governance:

We believe that effective governance structures are essential for driving systemic transformation. The Climate City Contract promotes participatory decision-making processes that engage citizens, businesses, civil society organisations, and local governments, all rounded around the Penta helix approach. By fostering collaboration and inclusivity, cities can leverage all stakeholders' collective expertise and resources to implement climate solutions. Several processes were, time-wise, aligned with the development of the Climate City Contract, the most important among them being the Development Strategy of the City and the new General Urban Development plan. In all these processes participatory governance was assured.

3. Integrated Planning and Implementation:

Systemic transformation requires integrated approaches to urban planning, policy-making, and infrastructure development. The vision of our Climate City Contract is to integrate

climate-related considerations into all aspects of city planning and decision-making, from land use and transportation to energy and waste management. We don't want to create more separate processes, our idea is to mainstream all aspects related to climate into all processes, thus breaking down the silos and fostering cross-sectorial collaboration that should enable synergies and co-benefits across different areas of action.

4. Innovation and Adaptability:

We will embed innovation and experimentation into our processes, and impose a disruptive way of working as business as usual will not work. That will allow us to navigate the complexities of systemic transformation. For years, we have been nurturing the culture of innovation, and now, this innovation will support the development and adoption of cutting-edge technologies, policies, and practices to achieve climate goals. At the same time, we will be working on increasing our adaptive capacity and responsiveness to evolving climate risks and uncertainties, building resilience into our planning and decision-making processes.

5. Equity and Social Justice:

Systemic transformation must prioritise equity and social justice to ensure that the benefits of climate action are equitably distributed across all segments of society. Our Climate City Contract promotes policies and programs that address systemic inequalities and empower marginalised communities, recognising that climate change disproportionately impacts vulnerable populations. We will build a more inclusive and resilient community by centering equity in climate action.

Active engagement with citizens and civil society organisations in the decision-making process regarding laws, regulations, policies, and strategic documents is facilitated through public consultation. Citizens can submit their proposals and feedback on draft regulations and strategic documents via online forms, thereby facilitating open dialogue and ensuring accountability. Coordinators for Consultation with the Interested Public oversee this process, ensuring effective communication between the government and the public.

Moreover, applications such as the Energy Atlas of the City of Zagreb[23] and the Energy Info Centre of the City of Zagreb[24] make significant contributions to the city's social innovation landscape. The Energy atlas focuses on promoting energy efficiency by providing information about natural gas, electricity, district heating, and water expenditure per year in the city districts. Similarly, the Energy Info Center of the City of Zagreb advocates for widespread solar panel installation, enabling citizens to easily evaluate the potential energy production from rooftop solar panels. This aids citizens in determining whether to proceed with installing solar panels on their rooftops, making the decision process faster and getting things done quicker.

In conclusion, the social innovation landscape in Zagreb showcases a dynamic interplay between stakeholders, policies, and practices, offering abundant opportunities to address city challenges. By fostering collaboration, transparency, and responsiveness to citizen needs, Zagreb can continue to drive positive social change and cultivate a more inclusive and sustainable urban environment.

[23] Energy Atlas of the City of Zagreb

[24] Energy Information Center of the City of Zagreb

5 An overview of catalytic Systemic Transformation Core Activities

5.1 National-level systemic actions

5.1.1 The NECPlatform project

Why? – In the first iterations of the NECP of Croatia, cities were not a part of the process, and a significant volume of activities is and will be carried out by them.

Systemic transformation contribution – Stakeholders around Penta helix (cities and regions, National level ministries, academia, NGO sector, business sector, and finance sector) are jointly gathered around the platform for dialogue.

Impact – cooperation that resulted in better versions of NECP, increased knowledge sharing activities, increased awareness of all stakeholders, identified gaps and concrete actions taken (Setup of National platform for sustainable financing).

Stakeholders – coordinated by North-West Croatia Regional Energy and Climate Agency, cities, ministries, academic and research organisations, NGO sector, and the finance sector.

5.1.2 National-level platform for sustainable finance

Why? – One of the key messages that came out as a result of the discussions within the NECPlatform for dialogue was that Croatia would have a significant gap in financing the energy transition and climate change adaptation and that that could have significant repercussions on the treasury in the years to come.

Systemic transformation contribution – Setup by the Decision of the National Government under the Ministry of Finance, with the support of the North-West Croatia Regional Energy and Climate Agency, the platform operates in a way that connects the stakeholders that are in need to finance their projects in the energy transition and climate change adaptation with the private capital institutions, development and commercial banks, investment funds, etc.

It is a place for cooperation and building of trust. It also connects other relevant ministries so the horizontal cooperation necessary for systemic transformation is present.

Impact – So far, it has managed to connect the stakeholders in need of project funding with the fund's holders, and the future impacts could be substantial. Investors will gain trust in project pipelines as they will be qualitatively assessed.

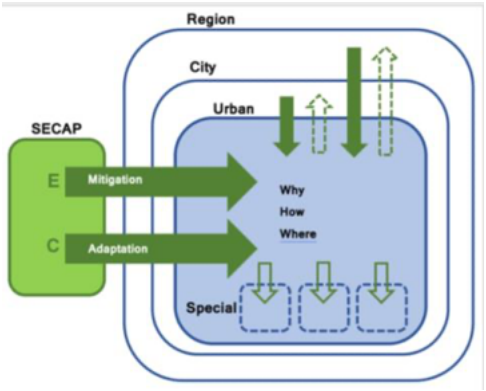
Stakeholders – Coordinated by the Ministry of Finance in cooperation with North-West Croatia Regional Energy and Climate Agency, finance institutions, investors, Croatian National Bank, Croatian Development Bank, commercial Banks associations, cities, ministries, and academia.

5.1.3 City of Zagreb's systemic transformation activities

5.1.3.1 The INPLAN project

Why? – Spatial plans are a tool in the hands of local and regional governance that is a driving force for the energy transition and climate change adaptation.

Systemic transformation contribution – In the ecosystem in which national-level standards for energy transition and climate change adaptation are not as ambitious as needed, cities are using the improvements in spatial plans. They are executive-level documents that can impose the above national-level standards, thus allowing and enabling decarbonisation and resilience build-up. Spatial plans can, for example, ban the usage of natural gas in certain areas – an actual thing that happened in one district in Zagreb. That is a game changer with an enormous impact on GHG emissions removal. When appropriately paired with regulation for construction and reconstruction, the impact is significant, as it creates enabling conditions and removes barriers.



Impact – Potentially the most significant one as it can impose above national-level standards. Facts like banning natural gas usage, usage of renewable energy for new build and reconstructions, mandatory amounts of green infrastructure etc. are executed through spatial plans of all levels.

Stakeholders – City of Zagreb, expert developers, academia, business sector, NGO, and citizens.

5.1.3.2 The CROSS project

Why? – We needed a systemic approach to building refurbishment through the setup of a functional OSS.

Systemic transformation contribution – we have developed the so-called "Green Deal Guidance" for building refurbishment and new buildings. The guidance is a follow-up on the work done through the interventions in spatial plan development. The guidance incorporates all EU standards and is aligned with the New Green Deal stipulations. It has financing and climate-proofing criteria built in. On top of the New Green Deal guidelines in the technical part, we are developing the buildings registry and feasibility studies, in the financial part we are aggregating projects and bringing in the innovation in financing through blending and usage of financial instruments. Innovation is developed in the public procurement domain as well, and green procurement will be the choice.

Impact – Possible significant impact and huge scale-up potential. The above national level standards are introduced, upgrade mechanisms are built, as well as financing criteria and climate proofing of projects – first in Croatia. The direct impact of the project is above 50 million EUR of investments, and indirectly, through the scaling-up process, the potential impact rises significantly.

Stakeholders – City, developers, companies, financial institutions, academia, and various experts.

5.1.3.3 The ZAGREEN project

Why? – Renewable energy sources coupled with integral energy refurbishment are rounding up the decarbonisation pathways.

Systemic transformation contribution – Building energy refurbishment coupled with on-site renewable energy production is a significant contributor to the decarbonisation process. We are using the technical assistance of the European Investment Bank through the ELENA facility and will be producing models and blueprints of tendering documentation (FS studies for energy management and EPC models, development of technical documentation for PV plants, and battery storage).

Impact – The direct impact of the project is above 85 million EUR of investments, 14,5 GWh of annual energy savings, and indirectly, through the scaling-up process, the potential impact rises significantly.

Stakeholders – City, developers, companies, financial institutions, academia, and various experts.

5.1.3.4 The digital Energy atlas of the City of Zagreb – where digitalisation meets energy transition

Why? – Data is crucial for energy transition and climate change adaptation, and when accompanied by the systemic GIS-based tool, it turns into a huge decision-making tool.

Systemic transformation contribution – The tool is GIS-based and contains a significant amount of data on various types of energy usage, physical characteristics, types, and number of users, among others. As such, it represents a powerful tool for planning and monitoring and a significant decision-making tool usage. The next step in the development of the tool is to upgrade it to the process of spatial planning and as a tool for systemic planning of green and blue infrastructure. This tool is an excellent example of the mitigation and adaptation synergy.

Impact – Direct impact is currently for the processes of energy monitoring and planning, but in the future, it will be developed into a decision-making tool that will also address climate change adaptation. Replication is possible and envisaged.

Stakeholders – City, developers, companies, academia, various experts, and development agencies.

5.1.3.5 PV Max project – significant deployment of PV powerplants

Why? – A couple of years back, the amount of energy produced by RES on public buildings was almost insignificant. There were different obstacles, ranging from legal barriers and administrative issues to undeveloped markets and a lack of capacities on all levels.

Systemic transformation contribution – It is an EIB ELENA project that tackles all issues of the significant PV power plant programme development, namely, technical, legal, procurement, and market-related ones. The approach has systemically transformed the process, and the rate of PV power plant installations on public buildings in Zagreb is growing significantly. It led to the setting up of an SPV owned by the City, with the only task of deploying as many PV power plants as possible.

Impact – Significant, both directly and indirectly.

Stakeholders – City, REGEA, *Zagrebački sunčani krovovi*, technical design and development companies, and market companies.

5.1.3.6 ActGreen – Activating green courtyards for carbon neutrality

Why? – Greening activities for public urban spaces should also be accompanied by greening activities for private/semi-private ownership areas, which constitute a significant portion of the city's territory.

Systemic transformation contribution – Involving a wide range of stakeholders in the process of expanding the green space system in the city, through the greening of residential and commercial building courtyards. Depending on the possibilities of each location, interventions in courtyards will include: removing impermeable surfaces and creating permeable areas (green spaces, permeable paving), installing reflective pavements, planting native trees and low shrubs, landscaping lawns, rain gardens, and biodiverse flower meadows, preparing beds for growing vegetables and herbs, installing green pergolas, seating elements, playground equipment, composters, solar-powered lighting, and insect/bird hotels/nesting boxes, as well as collecting rainwater for the maintenance of green spaces.

Impact – Expand the green system and carbon sink capacity in the city, improve the quality of life in areas with a pronounced heat island effect, and strengthen participatory approaches to climate activities.

Stakeholders – City, academia, various experts, business sector, development agencies, and citizens.

5.1.3.7 Climate proofing of infrastructure projects

Why? – The infrastructure we build or reconstruct now will remain for an extensive period. As climate change's effects will only worsen, we must ensure its sustainability.

Systemic transformation contribution – We have developed a methodology for climate proofing that is embedded into the strategic development processes and in the project development (design). In that way, we can ensure that our infrastructure will be resilient as the design and execution will reflect the climate risks and hazards. The process combines and unites climate change mitigation and adaptation. The systemic part lies in the scope and approach.

Impact – Direct impact will be seen through the increase of the resilience of the infrastructure and indirect impacts via the avoided losses and damage.

Stakeholders – City, developers, companies, academia, various experts, and development agencies.

6 Outlook and next steps

As Zagreb commits to a sustainable and resilient future, our vision extends beyond merely reducing greenhouse gas emissions to creating a more livable, equitable, and prosperous city for all residents. Our climate action efforts align with global targets, such as those set out in the Paris Agreement, and aim to position Zagreb as a leader in urban sustainability and climate resilience in Croatia and the broader European region, particularly in the SEE.

Commitment to Climate Goals: Zagreb is dedicated to achieving carbon neutrality by 2030 as described in this document and in the Investment plan, to significantly reduce emissions and improve air quality. This commitment reflects our ambition to transition towards the energy refurbisher building sector, renewable energy, sustainable mobility, and circular economy principles.

Enhanced Resilience: Recognizing the impacts of climate change, including increasing temperatures, severe storms, and flooding, Zagreb is focused on enhancing its resilience. Our approach integrates climate adaptation strategies into urban planning, prioritizing the protection of vulnerable communities and critical infrastructure and combines mitigation and adaptation.

Collaboration and Partnerships: The successful implementation of our climate action plan depends on strong partnerships across government, business, academia, innovative community and civil society. By fostering a collaborative environment, Zagreb will leverage diverse expertise and resources, ensuring that all stakeholders play a role in our climate transition.

Innovation and Technology: Zagreb is committed to embracing innovative solutions and technologies to drive climate action. From smart city initiatives to green infrastructure, the city will continue to explore new ways to improve energy efficiency and promote sustainable urban mobility.

Social Equity and Inclusion: Ensuring a just transition is at the heart of Zagreb's climate strategy, as signatory of the Paris charter. We aim to create opportunities for all residents,

especially vulnerable and marginalized groups, by focusing on inclusive policies that promote social equity and economic resilience.

6.1 Next Steps

1. **Implementation of Action Plans:** The next phase involves the detailed implementation of our Climate Action Plan. This includes setting specific milestones, timelines, and roles for each stakeholder group to ensure accountability and progress.

2. **Monitoring and Reporting:** Establishing a robust framework for monitoring and reporting will be critical. This includes regular assessments of progress towards emission reduction targets, resilience, and adaptation efforts. Transparency will be maintained through public reporting and engagement.

3. **Securing Funding:** Achieving our climate goals requires substantial investment. Zagreb will explore diverse funding sources, including national and EU grants, public-private partnerships, and innovative financing mechanisms such as green bonds.

4. **Policy and Regulatory Adjustments and Mainstreaming Climate Action:**

   To effectively integrate climate action into city processes, Zagreb will undertake comprehensive policy and regulatory adjustments, emphasizing mainstreaming climate considerations across all city functions:

   - **Integration into Urban Planning and Zoning:** Climate resilience and sustainability principles will be embedded into all aspects of urban planning, including zoning regulations, land use planning, and building codes. This will ensure that future developments are aligned with our climate goals, such as prioritizing low-carbon transport, energy-efficient buildings, and green spaces.
   - **Climate-Oriented Public Procurement:** The city will revise procurement policies to prioritize climate-friendly goods and services. This includes adopting criteria that favor low-emission vehicles, renewable energy solutions, and sustainable construction materials in all municipal contracts.

- Mandating Green Building Standards: Updates to building codes will mandate energy efficiency, renewable energy integration, and climate resilience measures in new constructions and major renovations. Incentives for retrofitting existing buildings to meet these standards will also be introduced.
- Incorporating Climate Risk into City Budgeting: Mainstreaming climate action will require integrating climate risk assessments into the city's budgeting and financial planning processes. This will ensure that investments are resilient to climate impacts and aligned with our emissions reduction targets.
- Establishing Climate Action as a Cross-Cutting Priority: Climate action will be a cross-cutting priority across all city departments. This involves creating a climate task force to oversee integration efforts and ensure that all city policies, programs, and projects consider their climate impact and align with our broader climate strategy.
- Regular Policy Reviews and Updates: To remain adaptive and responsive to new challenges, the city will implement a cycle of regular reviews of policies and regulations, updating them as necessary to incorporate the latest climate science, technological advances, and best practices in urban sustainability.

5. Enhanced Cooperation with National Ministries, Private Sector, and Citizens:

- Collaboration with National Ministries: Zagreb will work closely with national ministries, such as the Ministry of Green Transition, Ministry of Economy, Ministry of Finance, Ministry of Construction, Ministry of Regional Development and EU Funds, and Ministry of Transport, to ensure alignment of local actions with national climate policies and to leverage national resources and expertise. This cooperation will include joint initiatives, sharing of data and best practices, and aligning regulatory frameworks to create a cohesive approach to climate action. This will build upon the national platform for dialogue on the National Energy and Climate Plan.
- Engagement with the Private Sector: The private sector plays a crucial role in successfully implementing climate strategies. Zagreb will actively engage with businesses to promote investment in green technologies, sustainable

business practices, and innovative solutions. Incentives for green investments, partnerships for technology development, and creating platforms for knowledge exchange will be key elements of this collaboration.

- Citizen Participation and Engagement: Engaging citizens is vital to ensure the success of our climate initiatives, as a big part of actions and investments lies on citizens. The city will implement comprehensive outreach programs to raise awareness, educate, and involve residents in climate action. This includes creating participatory platforms where citizens can contribute ideas, provide feedback, and participate in decision-making processes. Special emphasis will be placed on engaging youth and community leaders to foster a culture of climate responsibility.

6. Scaling Up Successful Initiatives: Building on pilot projects and successful programs, Zagreb will scale up initiatives that have demonstrated effectiveness, as shown in previous sections of this document. This may include expanding renewable energy projects, enhancing public transportation systems, and increasing the availability of green spaces and digital solutions like the energy atlas already in place.

7. Resilience and Adaptation Measures: Implementing specific adaptation measures will continue to be a priority, but we aim to connect the adaptation and mitigation. This includes improving flood management systems, enhancing green and blue infrastructure, and developing heat mitigation strategies to protect residents and ecosystems.

As Zagreb moves forward, the city remains committed to continuous improvement and learning. By adapting our strategies based on new data and emerging best practices, we will ensure that Zagreb not only meets its climate goals but also serves as a model for sustainable urban development in the region and spills over in the country to other non-mission cities!

NET ZERO CITIES

EU MISSION PLATFORM | CLIMATE NEUTRAL AND SMART CITIES

2030 Climate Neutrality Commitments

The City of Zagreb

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1 Introduction

As the City of Zagreb, we are deeply committed to leading the way in climate change mitigation and adaptation. Our decision to join the mission on 100 climate-neutral and smart cities reflects our dedication to addressing the pressing challenges of climate change, which we recognize as not only an environmental imperative but also an opportunity to enhance the livability and sustainability of our urban environment.

Climate change mitigation and adaptation are at the forefront of our efforts. Through participation in this program, we aim to not only reduce our environmental impact but also to prepare our city for the inevitable changes and challenges brought about by a shifting climate. This mission allows us to access crucial resources and funding that enable us to implement state-of-the-art solutions and infrastructure improvements that are resilient to climate impacts.

The Climate City Contract provided by this mission offers us a comprehensive framework to align our local actions with broader European goals under the European Green Deal. This contract acts as a roadmap, guiding our initiatives and ensuring that every step we take towards becoming a climate-neutral city is measured and aligned with our overall strategy. It facilitates structured planning, implementation, and monitoring of our actions, ensuring that we are not only efficient but also effective in our approach.

Engaging in this mission also enhances our ability to share knowledge and collaborate with other leading European cities. By learning from others and exchanging best practices, we can overcome common challenges more efficiently and innovate more effectively. This collaborative approach is vital, as it allows us to leverage collective insights and experiences to accelerate our progress towards climate neutrality.

Moreover, this initiative underscores the importance of inclusive and participatory governance. We are committed to engaging our local communities in our climate action plans, ensuring that every voice is heard and that the benefits of our green transformation are shared equitably across all sections of society. From enhancing

green spaces to improving public transport and reducing emissions, our goal is to create a city that not only survives but thrives in the face of climate challenges.

In summary, our participation in the 100 climate-neutral and smart cities mission is a clear declaration of our commitment to making Zagreb a leader in climate action. The Climate City Contract provides us with the necessary framework to plan, execute, and monitor our initiatives, ensuring that we remain on the path to achieving our ambitious goals of sustainability and resilience. As we move forward, we are excited about the possibilities that lie ahead and are determined to transform challenges into opportunities for growth and innovation.

Zagreb is committed to becoming a leading example of urban sustainability and climate resilience by integrating climate action into every aspect of city governance. The Climate Action Plan outlines a path to achieve carbon neutrality by 2050, with interim targets for 2030. This plan emphasizes a holistic approach that combines both mitigation and adaptation efforts, ensuring the city not only reduces its carbon footprint but also enhances its resilience to climate impacts. Through the Climate City Contract development exercise, Zagreb has recognized the full scope of efforts needed to reach climate neutrality and to integrate the resilience into the processes, highlighting the complexity of execution and the need for a coordinated, cross-sectoral approach. Taking a disruptive path, Zagreb has moved away from traditional business-as-usual models, with a bold strategy that embeds climate considerations into the core of all city operations.

Disruptive Approach to Governance:

Zagreb's approach to the development of the Climate City Contract is distinctly disruptive, moving away from business-as-usual practices. Unlike traditional models that often rely on a separate transition team, Zagreb has made climate action a shared responsibility across all city officials. There is no specific transition team in place; instead, all main city officials are required to incorporate climate-related issues into their agendas and daily operations. This approach ensures that climate action is not

siloed but embedded into every decision and process. Notably, the Mayor of Zagreb serves as the Chief Climate Officer, underscoring the city's commitment to making climate action a top priority at the highest level of leadership.

Mainstreaming Climate Action Across All City Processes:

The Climate City Contract exercise revealed the importance of embedding climate considerations into all city functions, ensuring that the city's approach is comprehensive and cohesive:

- Integration into Urban Planning and Zoning: Climate resilience and sustainability are already embedded into urban planning, zoning, and land use regulations up to certain level, but more will be done in future iterations. This ensures that all developments align with the city's combined mitigation and adaptation goals, such as promoting low-carbon transport, energy-efficient buildings, and expanding green spaces to enhance urban cooling and flood management.

- Climate-Oriented Public Procurement: We will revise procurement policies to prioritize climate-friendly and resilient solutions, integrating both mitigation and adaptation considerations. By selecting low-emission vehicles, renewable energy systems, and resilient construction materials, Zagreb supports its broader climate strategy through every purchase.

- Incorporating Climate Risk into Budgeting and Financial Planning: Mainstreaming climate action involves integrating climate risk assessments into budgeting and financial planning processes. This ensures that financial decisions align with the city's combined mitigation and adaptation objectives, creating a unified approach to addressing the complexity of climate challenges.

- Establishing Climate Action as a Cross-Cutting Priority: A dedicated climate task force will oversee the integration of climate considerations across all city

departments, fostering collaboration and ensuring that every policy, program, and project is evaluated for its climate impact and contribution to both mitigation and adaptation goals, maximizing overall effectiveness.

Policy and Regulatory Adjustments: To support the combined approach of mitigation and adaptation, Zagreb is revising its policy and regulatory frameworks. This includes mandating green building standards that not only reduce energy use but also improve resilience to extreme weather and updating zoning laws to promote climate-smart land use, fully implementing the climate proofing and monetisation aspects. The Climate City Contract has been instrumental in identifying these necessary policy shifts, underscoring the need for regulatory flexibility and innovation.

Enhanced Cooperation with Stakeholders:

- National Ministries: Zagreb's climate strategy involves close collaboration with national ministries, such as the Ministry of Green transition, Ministry of economy, Minstry of Finance, Ministry of transport, Ministry of regional development and EU funds and others to ensure local efforts are supported by national policies and resources. The Climate City Contract process highlighted the critical need for this alignment, enabling cohesive action across governance levels.

- Private Sector Engagement: The private sector plays a pivotal role in driving both emissions reductions and resilience-building. Through partnerships, incentives, and collaboration platforms, Zagreb aims to disrupt traditional business models and advance both mitigation and adaptation, as recognized in the comprehensive scope outlined by the Climate City Contract action plan.

- Citizen and Community Participation: Engaging citizens is central to Zagreb's climate action strategy. The city will actively involve residents in climate initiatives through education, outreach, and participatory processes, ensuring that the community understands and supports both mitigation efforts and

adaptation measures. The Climate City Contract emphasized the importance of this inclusive approach, recognizing the role of citizens in the city's climate journey.

Innovation and Technology: Leveraging innovative technologies that address both mitigation and adaptation needs is a key aspect of Zagreb's strategy. The Climate City Contract process identified opportunities for smart city initiatives, green infrastructure, and advanced energy systems, which are critical to addressing the complexity of achieving climate neutrality.

Social Equity and Inclusion: Ensuring a just transition is fundamental to Zagreb's climate strategy. By focusing on inclusive policies that address social disparities and create opportunities in the green economy, the city aims to ensure that all residents benefit from combined mitigation and adaptation efforts. The Climate City Contract highlighted the need for these efforts to be equitable and inclusive, ensuring that no one is left behind.

Scaling Up Successful Initiatives: To maximize impact, Zagreb will expand successful pilot projects that integrate mitigation and adaptation across the city.

Monitoring, Reporting, and Continuous Improvement: A robust monitoring and reporting framework will track progress on both mitigation and adaptation fronts. This transparent approach allows for continuous learning and adaptation, ensuring that the city's climate actions remain effective and responsive to evolving challenges. The Climate City Contract has provided a roadmap for ongoing evaluation and refinement, essential for navigating the complex path to climate neutrality. We have also developed our own index, index that will allow us to track the mainstreaming effect of mitigation and adaptation into all governance processes. This innovation will support the disruptive way of considering climate issues.

The Climate City Contract exercise has allowed Zagreb to recognize the full scope of efforts required to reach climate neutrality, highlighting the complexity of execution

and the need for a unified, all-encompassing approach. By taking a disruptive path that moves away from business-as-usual models, Zagreb ensures that climate action is not the responsibility of a single team but is woven into the fabric of the city's governance. With the Mayor acting as the Chief Climate Officer, this approach underscores the city' s commitment to prioritizing climate action at the highest level.

The next steps involve detailed implementation of the Climate Action Plan, securing funding, and maintaining a focus on innovation and social equity. By embracing a holistic approach that integrates mitigation and adaptation, and by ensuring that all city officials are actively involved in climate efforts, Zagreb is poised to meet its climate goals and set a new standard for comprehensive urban climate action, recognizing the complexity and dedication required to achieve a climate-neutral future.

2 Goal: Climate neutrality by 2030

As the City of Zagreb embarks on its ambitious journey toward climate neutrality by 2030, outlined in our Cities Mission Expression of Interest, we are committed to transforming our urban landscape into a model of sustainability and resilience. Our 2030 climate neutrality goal is comprehensive, encompassing the entire administrative territory of Zagreb without any exclusion areas. This ensures that every district and community within the city boundary is involved in and benefits from our climate action initiatives.

Our commitment aligns fully with the climate neutrality definition pursued by the Cities Mission. This means striving for net-zero greenhouse gas emissions through a balanced approach of reducing emissions, enhancing energy efficiency, and implementing sustainable energy solutions. We have incorporated rigorous measures to cut down on emissions across all sectors, integrate renewable energy sources extensively, and improve our energy infrastructure.

The pursuit of climate neutrality is expected to yield significant co-benefits for Zagreb, enhancing the overall quality of life for all residents. Some of the anticipated co-benefits include:

1. **Improved Air Quality:** Reducing reliance on fossil fuels and increasing the use of renewable energy sources will significantly decrease air pollution, leading to better health outcomes for the city's residents.

2. **Economic Opportunities**: The transition toward a green economy is expected to spur job creation, particularly in the renewable energy sector, green building, and sustainable transportation industries. This economic shift will also attract investments and foster innovation in green technologies.

3. **Enhanced Urban Livability:** Investing in green infrastructure such as parks, green roofs, and urban trees will not only help absorb CO2 but also enhance the urban aesthetic, reduce heat islands, and increase biodiversity, making the city more livable and attractive.

4. **Energy Security**: By diversifying energy sources and reducing dependency on imported fossil fuels, relying more on RES in future Zagreb will enhance its energy security and resilience to global energy market fluctuations.

5. **Social Equity:** Our climate action plans and other policies are designed to be inclusive, ensuring that benefits such as access to green spaces, sustainable public transport, and improved air quality are equitably distributed across all communities, thereby addressing historical disparities.

In summary, Zagreb's goal for 2030 is to achieve climate neutrality across the entire city, in line with the stringent criteria set by the Cities Mission. This comprehensive approach not only positions Zagreb as a leader in climate action but also ensures that our transition to a sustainable future brings about widespread and lasting benefits for all residents, fostering a healthier, more sustainable, and economically vibrant city.

3 Key priorities and strategic interventions

Our approach is on a disruptive side, as we believe that in the first phase, we need to do a significant work on mainstreaming the climate related actions into all governance processes that would allow us to avoid the creation of clima silo. Implementing early policy adoptions via a horizontal approach is crucial for mainstreaming climate action and setting a strong foundation for both mitigation and adaptation efforts. These policies integrate climate considerations across all aspects of urban development, ensuring that sustainability becomes a core component of city planning and operations. For instance, adopting stringent building codes and energy performance standards not only reduces greenhouse gas emissions but also enhances the resilience of buildings to climate impacts, making them more energy-efficient and better prepared for extreme weather events.

By climate-proofing the city budget and redesigning the city development strategy to fully integrate climate considerations, these measures ensure that all investments and development activities contribute to greenhouse gas savings and enhanced resilience. The program involves stakeholder engagement, policy review, training, pilot projects, and continuous monitoring and evaluation. These actions aim to achieve significant GHG savings, resilient investments, clear ownership and accountability, and a unified approach to climate action eliminating silos and fostering a culture where everyone participates as agents of change. These early policy measures will collectively mainstream climate action into the city's governance framework, creating a supportive regulatory environment that encourages sustainable urban development, reduces emissions, and enhances resilience to climate impacts. By embedding climate considerations into the city's core operations and planning processes, these policies ensure long-term sustainability and resilience, benefiting both the environment and the community.

The core disruptive measures developed to mainstream the climate actions into all governance processes are:

- Spatial development plan revision that has energy transition and climate change adaptation standards built in;
- Introduction of building standards that overcome existing standards (above national level) for renovation and/or City budget - climate monetised and climate proofed reconstruction of existing buildings and construction of new buildings;
- Developed and implemented Green Deal Project Guidelines for drawing up technical documentation for construction and/or renovation of buildings;
- Developed and implemented Climate proofing methodology for infrastructure projects reconstruction and development;
- Redesigned City development strategy - no separate climate related action plans. Full mainstreaming achieved

The core technical measures are within the built environment, energy and transport domain and include:

- Systemic refurbishment of the building sector in terms of decarbonization and climate proofing;
- Decarbonization of the district heating sector and making it primary source of heat;
- Increased production of energy from RES;
- Decarbonization of the public trasnport.

4 Principles and process

In the City of Zagreb, we have undertaken a holistic and integrated approach to our Climate City Contract (CCC), ensuring that climate action permeates all levels of municipal operations and aligns with broader sustainability goals.

Starting with building a strong mandate, we've integrated the responsibility for climate action across all municipal departments, ensuring every sector contributes to our overarching climate objectives. **The Mayor serves as the Chief Climate Officer**, emphasizing climate action as a priority at the highest levels of city governance. We've fostered a multi-actor coalition by engaging diverse local stakeholders such as businesses, NGOs, academia, and community groups in collaborative dialogue and decision-making processes, but not solely for the purpose of development of CCC. This inclusive approach helps us ensure that a variety of perspectives and expertise are considered in shaping our climate strategy. Furthermore, we maintain a shared understanding and cohesive action plan with municipal, regional, national, and EU stakeholders through regular strategic dialogues and alignment with broader environmental policies like the EU's Green Deal.

In the co-design of our portfolio, we have meticulously integrated existing policies and programs with new or accelerated interventions by reviewing current initiatives and identifying gaps and opportunities for enhancement. As we take action, multiple initiatives have been launched following the CCC. These include projects aimed at reducing emissions, enhancing green infrastructure, and improving energy efficiency, climate proofing, decarbonization of the district heating, new efficient buses and trams etc. The implementation of these actions is under continuous review to assess their effectiveness and adjust as necessary to meet our climate goals.

For learning and reflecting, we have established robust monitoring and review processes within the CCC framework. These processes are designed to measure the effectiveness of our actions, facilitate regular updates, and ensure that our strategies remain responsive to emerging challenges and opportunities. **One that must be**

highlighted is the ICAI - The essence of our approach is the mainstreaming effect, so we will develop The Integrated Climate Action Index (ICAI) that should provide a comprehensive measure of how well climate change considerations are mainstreamed into city governance and practices, as described in the CCC AP. By assessing policy integration, budget allocation, institutional capacity, project implementation, public engagement, and monitoring and reporting, the ICAI should capture the multifaceted nature of mainstreaming climate action. This indicator will help us to identify strengths and areas for improvement, promoting a holistic approach to building climate resilience and reducing emissions.

Lastly, to make it a new normal, we are committed to embedding new approaches and innovations into the ongoing iterations of the CCC. This ensures that successful practices are institutionalized and form the basis for continuous improvement in our climate action strategies, helping Zagreb move towards becoming a climate-neutral city. We will review our commitments and actions on the yearly basis.

This comprehensive approach underscores our dedication not just to meet but to exceed our commitments to climate neutrality, ensuring that Zagreb is a sustainable, resilient, and thriving city for current and future generations.

5 Signatory on behalf of the City of Zagreb

On behalf of the City of Zagreb,

Mayor

Tomislav Tomašević

Date of signature 16 SEP 2024

Signature

Other signatories have expressed their commitment and support with the letters which are presented in the continuation of this document

5 Contract with signatures

Name of the institution	Sector/Area	Legal form	Name of the responsible person	Position of the responsible person
Ministry of Economy	National level/Ministry	Ministry/National Government	Vedran Špehar	State Secretary
Hep Toplinarstvo Ltd.	District heating operator	National utility operator	Tomislav Brnadić	Managing director
Faculty of electrical engineering and computing	Academia	Faculty	Prof. dr. sc. Vedran Bilas	Dean
Energy Institute Hrvoje Požar	National Energy Institute	Institute	Dražen Jakšić	Managing director
Croatian Chamber of Economy	Chamber of economy	Chamber	Josip Zaher	President
Zagreb holding	Utility company	Holding	Ivan Novaković	President of the Management board
Vodoopskrba I odvodnja d.o.o.	Water utility company	Water utility company	Marko Blažević	Director
Gradska ljekarna Zagreb,	Health	Business	Marijo Vukušić	Director

Gradska plinara Zagreb	Utility, gas supply	Utility company	Davor Mayer	CEO
Gradska plinara Opskrba Ltd	Utility, gas distribution company	Utility company	Jeronim Tomas	Director
Gradsko stambeno komunalno gospodarstvo Ltd	Housing, property management	Company	Marko Šarić	CEO
Zagreb Area Integrated Transport authority	Transport/mobility	LLC, Trasnport authority	Josip Miletić	Director
North-West Croatia Regional Energy and Climate Agency	Energy/Climate agency	Agency	Julije Domac, PhD	Managing director
Croatian Chamber of Economy	Business	Chamber	Josip Zaher	President
Croatian Employer's Association	Business	Association	Irena Webber	Managing director
Institute of Physical Planning of the City of Zagreb	Spatial planning	Institute	Nikša Božić	Managing director

Teaching Institute of Public Health Andrija Štampar	Public health	Institute	Prof.prim.dr.sc. Branko Kolarić, dr.med.	Managing director
Society for Sustainable Development Design	Sustainable development.	NGO	Miljenka Kuhar	Director
Development Agency Zagreb for Coordination and Encouragement of Regional Development	National level development agency	Development agency	Kornelija Mlinarević	Director
Zagreb fair, Ltd	Business/Fair	Fair	Renata Suša	Director
Zagrebački električni tramvaj, d.o.o.	Transport	Transport operator	Luka Matošić Marko Bogdanović	Member of the Management board President of the Management board
Zagreb Innovation Centre, Ltd	Business/Startup	Innovation centre/business support	Frane Šesnić	Director
WWF Adria	Nature conservation	Fund	Nataša Kalauz	Director
Zagrebački sunčani krovovi, d.o.o.	Energy/PV	Business	Velimir Šegon	Director
MI-Maris	Engineering/RES	Business	Tomislav Magić	CEO

Solaris Pons d.o.o.	Engineering/PV/Energy storage	Business	Jurica Gorup	CEO
Zagreb Chamber of trades and crafts	Trades and crafts	Business	Antun Trojnar	President
Zagreb ZOO	Nature	Nature conservation institution	Ivan Cizelj	Managing director
Zagreb City Nature – Public Institution for management of natural values of the City of Zagreb	Nature protection/Biodiversity	Institution	Nika Dolenc	Managing director