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 Trikala

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Summary

Within the framework of the Horizon Europe 2021-2027 research and innovation program, the European Missions (EU Missions) were established, aiming to address some of the major challenges currently faced by the EU. Among these missions is the Cities Mission, which aims to create 100 climate-neutral and smart cities by 2030. These cities will serve as research and innovation hubs and will act as examples to be emulated by the rest of the EU. The city of Trikala has also taken part in this mission and the Climate City Contract is drawn up to achieve the goals of climate neutrality.

The Action plan is a very important and integral part of the Climate City Contract that Trikala has signed to achieve climate neutrality by 2030. Specifically, is a comprehensive strategic plan developed to confront the challenge of climate change, addressing the urgent issue of GHG emissions and guiding towards a climate-neutral future. To create it, first of all, the data required for the inventory of pollutants was collected. The initial step in the development of the climate contract involves the inventory of GHG emissions. An inventory estimates the quantity of GHG emissions produced by activities taking place within the city boundaries. Emissions are calculated for each activity over a specific timeframe, referred to as the reporting year.Once the inventory of pollutants was completed, the drafting of the Action plan began. Activities taking place within a city can generate GHG emissions that occur either within or outside the city boundaries. The emissions are categorised into three categories based on the location where they occur: Scope 1 emissions, Scope 2 emissions, and Scope 3 emissions.

Essentially, the Action plan analyses how to address the gap between the City's current baseline GHG inventory and all existing and planned climate actions and the 2030 climate neutrality goal. The Action Plan is designed to be a dynamic and iterative document, allowing for updates and revisions to be made periodically until 2030.

The Action plan is divided into 3 main parts. First, Part A defines and summarises the current baseline inventory of GHG emissions from the different sectors (Stationary energy (Built environment & Energy system), Mobility & transport, AFOLU, IPPU, Waste), the assessment of existing policies and strategies of the country and the European Commission, and the systemic barriers to implementation in the city of Trikala.

Part B is essentially the core of the detailed climate neutrality roadmap by 2030, it describes the proposed and selected action strategies to achieve the climate neutrality goal, the impact pathways that will encounter, the indicators that should be monitored, the indicators that should be evaluated and the learning indicators and, above all, detailing the actions chosen in each of the action areas and then detailing the individual action separately, the way it is proposed to be implemented, the interested parties involved in the action, the competent bodies, etc.

Part C contains guidance on the 2030 Climate Neutrality Action Plan analysing the factors from the perspective of governance, social innovation and financing and considering them as critical conditions for the final realisation of real action. The intervention types are detailed, including the objectives, stakeholders/authorities involved, timing, results and reporting on the impact pathway selected. Finally, a description of the funding need for the implementation of the portfolio of actions and the relative impact is made.

Annex 1 comprises a comprehensive list and description of all activities conducted within the citizen engagement initiative. Furthermore, photographic documentation of these activities is also provided within the annex.

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Abbreviations and acronyms

Abbreviations and acronyms	Definition
AFOLU	Agriculture, Forestry and Land Use
EU	European Union
EV	Electric Vehicle
GHG	Greenhouse gases
GPC	Global Protocol for Community-Scale (GPC) Greenhouse Gas Inventories
HEDNO	Hellenic Electricity Distribution Network Operator
IPCC	International Panel on Climate Change
IPPU	Industrial Process and Product Use
NECP	National Energy and Climate Plan
NHWMP	National Hazardous Waste Management Plan
NWMP	National Waste Management Plan
NZEB	Nearly Zero Energy Buildings
PEB	Pre-engineered building
RES	Renewable Energy Sources
SUD	Sustainable Urban Development
SUMP	Sustainable Urban Mobility Plan

ZEB	Zero Energy Building
AMS	Alternative Management Systems
GP	Green Points
RC	Recycling Corners

1. Introduction

The Municipality of Trikala is a pioneering Municipality in Greece. In 2004, Trikala has been labelled as Greece's "1st digital city" and henceforth made significant effort in smart interventions by becoming a testbed for state-of-the-art solutions. That nurtured a culture within the city and its ' stakeholders around the necessity of digital transformation and further on provided insights for smart, socially responsible, and sustainable growth through advanced technologies, which we believe will help the city proceed toward its' 2030 climate neutrality targets.

Trikala has consistently embraced commendable practices and strategic initiatives aimed at enhancing the city's environmental profile, including endeavors such as the Smart City Strategic Plan, the Sustainable Energy and Climate Action Plan, the Local Waste Management Plan, and the Sustainable Urban Mobility Plan of the Municipality of Trikala (SUMP). The incorporation of the Action Plan to attain climate neutrality represents a transformative initiative that is anticipated to garner strong support from both citizens and stakeholders. The municipality is poised to wholeheartedly commit to the success of this endeavor, demonstrating the same level of dedication that has contributed to the success of previous projects. Trikala's motivation and pledge to climate actions is further presented in the Commitments document.

The government and the Municipality of Trikala must take the initiative in implementing policies and programs to reduce emissions and adapt to climate change and provide support and resources. The Environmental Development Company of Western Thessaly (PADYTH SA), which is the inter-municipal body for Recycling & Waste Management, plays an important role. In the energy sector, an equally important actor is ‑HEDNO S.A. (Hellenic Electricity Distribution Network Operator S.A.) which is involved in the distribution of electricity throughout the country. The work of the Technical Chamber of Greece (TEE) is extremely important and plays a major role in the implementation of the actions, as do universities, scientific bodies in general and research institutes, which must provide expertise on best practices and contribute to the development of innovative solutions.

Trikala city is committed to ensuring that the objectives and actions of Climate City Contract (CCC) are supported by a robust mandate, derived from co-creation with a diverse range of stakeholders. The city recognizes the importance of engaging with various entities, including public bodies, non-governmental organizations (NGOs), private actors, universities, and stakeholders at both regional and national levels.

One key mechanism through which the CCC seeks to involve stakeholders is through ad-hoc consultations. These consultations are designed to gather insights, feedback, and perspectives from a wide array of participants, ensuring a comprehensive understanding of the challenges and opportunities associated with climate change mitigation and adaptation.

In this context and during the first elaboration of the CCC, Trikala created a network of stakeholders from different sectors to co-create their strategy. In the energy sector, the University of Western Macedonia provided their expertise. In the transport sector, the contribution of the Institute of Communication and Computer Systems (ICCS) was significant, while in waste and circular economy the guidance from the Environmental Development Agency of Western Thessaly SA (PADYTH SA) was important. Finally, all the actions and especially the actions of the built environment were co-created with the cooperation of various services of the Municipality. Trikala created a first stakeholder transition team with

its closest partners in order to create the CCC. The team held frequent consultations on the creation and development of the CCC, with each stakeholder adding expertise in their field. The city aims to expand its stakeholder network and simplify the co-creation processes using digital technology and platforms.

On the same note, citizen engagement plays a crucial role in the entire plan, in order for community empowerment and inclusion to be possible. The shift towards a governance model centered on citizens is a fundamental and systemic priority for Trikala, representing a significant change in the city's approach to civic engagement and public administration. This model prioritizes the needs, preferences, and aspirations of residents in decision-making processes, promoting a more inclusive and participatory style of governance. Trikala envisions a city where citizens actively contribute to shaping policies, programs, and urban development initiatives, fostering a sense of shared responsibility and community ownership. By adopting this citizen-centric model, Trikala aims to establish a transparent and accountable governance structure that not only addresses the diverse needs of its population but also nurtures a culture of trust and collaboration between local authorities and residents.

The engagement of both citizens and stakeholders is a cornerstone in directing Trikala's transition toward climate neutrality. The city is committed to ensuring that its entire community is well-informed about climate initiatives and actively participates in shaping and implementing them. Trikala plans to actively engage citizens and stakeholders through initiatives such as regular public consultations and workshops, where the city can host citizen gatherings focused on specific aspects of the CCC, seeking valuable insights and local expertise. Additionally, educational campaigns will be implemented to instill a culture of environmental responsibility among citizens and various stakeholders. These campaigns may encompass workshops, seminars, and awareness programs, aiming to educate the public on topics like climate neutrality, sustainability, and the significance of collaborative efforts among diverse stakeholders.

So far, within the framework of citizen engagement, several workshops were organized, attended by representatives of the stakeholders who were invited. Some participants in the workshops included representatives from the Municipality, PADYTH SA, various associations (medical association, commercial association, youth association), representatives from banks, representatives from the Technical Chamber of Greece (TEE), and additionally, some citizens who were interested in the initiative and responded to the open invitation. The municipality also conducted workshops in schools, including 1.200 students. Trikala has also conducted consultations and surveys in the form of a digital questionnaire, allowing citizens to participate and evaluate the significance of actions in each sector, as well as to express their thoughts, ideas, or concerns. A comprehensive overview of the workshops and all citizen engagement actions can be found in Annex 1, which includes both photos and descriptions for reference.

The city of Trikala aimed to implement a more intensive program of actions regarding citizen participation. However, due to natural disasters that occurred and affected the region, as well as the preceding municipal elections, the actions related to citizen engagement that were planned were ultimately postponed.

Nevertheless, the city plans to intensify citizen engagement in the coming years. Through the implementation of various practices, it aims to arrive at the optimal model of citizen engagement concerning the frequency of actions and the manner in which they should take place. Citizen engagement models and actions that the city of Trikala is going to implement are:

- Public consultations and workshops: These gatherings provide opportunities for citizens, businesses, and organizations to express their concerns and ideas related to the city's climate strategy. As an example, the city may organize regular town hall meetings that focus on specific aspects of the CCC, aiming to gather valuable insights and local knowledge.
- Co-creation of climate policies: This initiative ensures that the measures implemented align with local needs. Trikala will establish a platform for citizen participation, where individuals or organizations can collaborate and communicate to create and refine climate policies. This approach fosters a sense of commitment among participants.
- Educational campaigns: Establishing a culture of environmental responsibility begins with the launch of educational campaigns targeting both citizens and stakeholders. These campaigns may encompass workshops, seminars, and awareness programs designed to educate the public about climate neutrality, sustainability, and the significance of collaboration among different stakeholders.
- Feedback through digital platforms: In addition to the citizen participation platform, Trikala may utilize other channels such as social media and online forums to maintain constant and direct communication with the community.
- Incentive programs: Trikala may introduce programs aimed at encouraging active participation in climate actions by citizens and businesses. This could involve recognition for sustainable practices, rewards for energy-efficient or zero-waste buildings, or funding for innovative climate projects.

The actions included in the Action Plan are categorised in six main sectors, which are Energy systems, Mobility & Transport, Waste & Circular economy, Built environment, Green infrastructure & Nature-based solutions and Smart city actions. Some of the actions that are included in the city’s climate portfolio and are going to be further explained later on are:

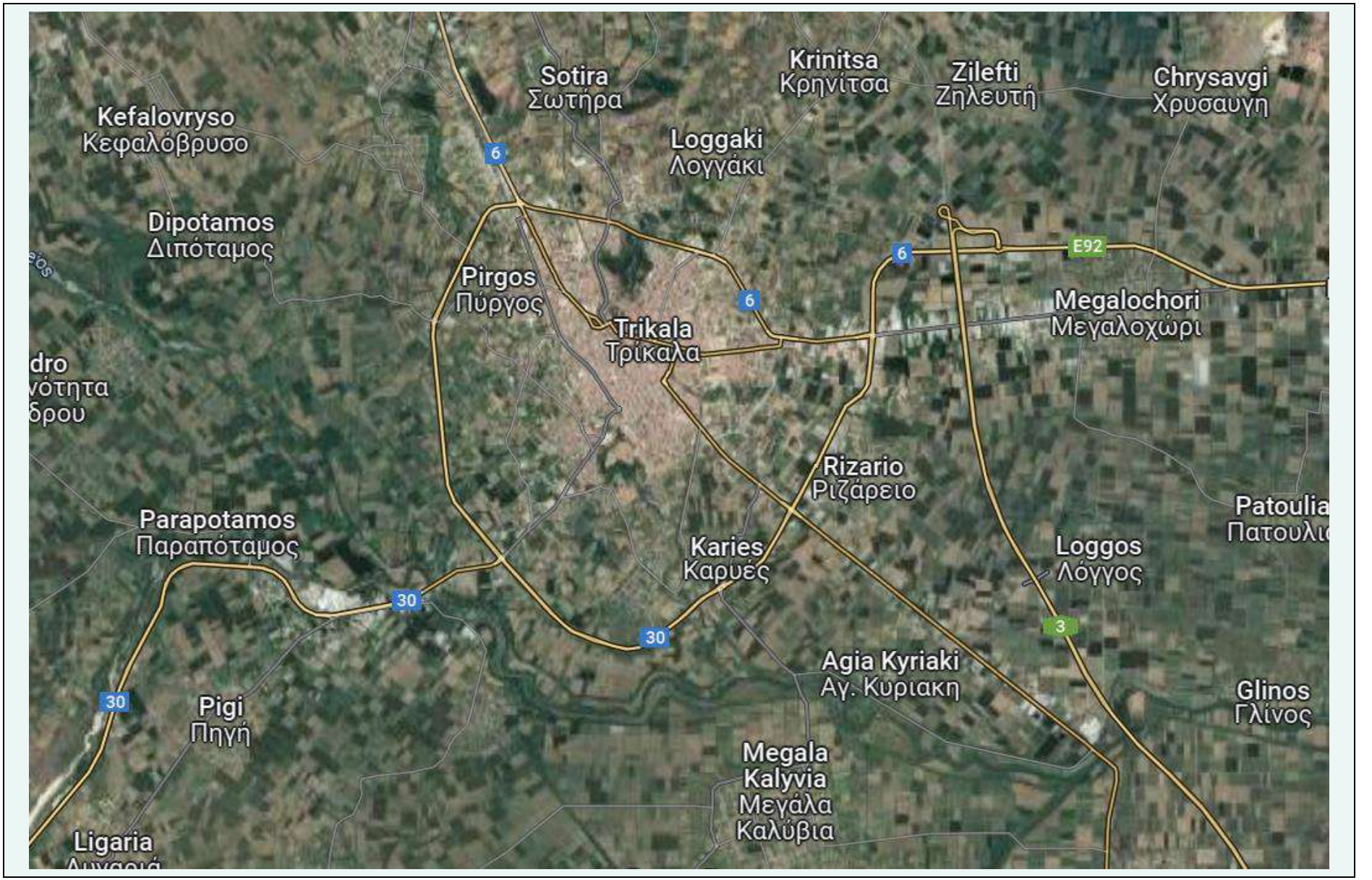
- Electrification of cars, motorcycles and buses
- Shift to public and non-motorised transport (Behavioural shift to public transport, walking and cycling, Maas, Enhancement of e-powered micro mobility, Development of DRT)
- Commercial and residential buildings electrification
- Decarbonising electricity generation (Development of a joined and smart RES management system, Photovoltaics, Virtual power plants)

- Optimised logistics and electrification of trucks (Electrification of trucks, Fleet management, Improvement of logistics and urban freight transport, Eco-driving)
- Building renovations
- Integrated energy systems

Following the submission of the Climate City Contract, the city's primary objective is to establish a robust task force within the Municipal authority, the Trikala Climate Team. This team will play a pivotal role in facilitating the implementation of the Action Plan, overseeing its general progress, and monitoring and evaluating the implementation process.

As a next step, the Municipality aspires to establish a Climate Neutrality Hub, which will serve as the focal point for all climate neutrality actions. Managed by the Trikala Climate Team, this hub will be enriched with more experts in each domain of intervention. Initially, the hub will primarily focus on decarbonizing the stationary energy sector in the city. It will offer services such as a One-Stop shop for energy renovations, responsible for informing, educating, and facilitating the community in energy efficiency measures, a Greenhouse Gas Measurement Platform providing real-time data on GHG emissions in the city, and a Climate Neutrality Observatory serving as the main monitoring mechanism to measure the city's progress during the implementation of specific projects outlined in the Action Plan. The proposal for such a structure represents an organizational intervention outlined in Part C.

Table I-1.1: Climate Neutrality Target by 2030			
Sectors	**Scope 1**	**Scope 2**	**Scope 3**
Stationary energy	Included	Included	-
Transport	Included	Included (not occurring)	-
Waste/wastewater	Included (not occurring)	Not applicable	Included
IPPU	Included	Not applicable	-
AFOLU	Included	Not applicable	-
Geographical boundary	**Same as city administrative boundary**	**Smaller than city administrative boundary**	**Larger than city administrative boundary**
(Tick correct option)		✓	
Specify excluded/additional areas		Municipality of Trikala consists of 8 municipal geographical units. Trikala unit that is basically the city of Trikala gathers 80% of inhabitants of the municipality in total, rendering it the only urban center in the municipality's administrative boundary. Trikala unit has a population density of 886,6 inhabitants/km^2, while the 7 remaining units altogether account for 100 inhabitants/km^2. Therefore, only Trikala municipal unit could be considered as an urban area to be examined for interventions.	
Map			


Sotira
Σωτήρα
Krinitsa
Κρηνίτσα
Zilefti
Ζηλευτή
Chrysavgi
Χρυσαυγή
Kefalovryso
Κεφαλόβρυσο
Loggaki
Λογγάκι
Dipotamos
Διπόταμος
Pirgos
Πύργος
Trikala
Τρίκαλα
Megalochori
Μεγαλοχώρι
E92
6
Rizario
Ριζάρειο
Parapotamos
Παραπόταμος
Karies
Καρυές
Loggos
Λόγγος
Patoulia
Πατουλιά
30
3
Agia Kyriaki
Αγ. Κυριακή
Glinos
Γλίνος
Pigi
Πηγή
Megala
Kalyvia
Μεγάλα
Καλύβια
Ligaria

2. Part A – Current State of Climate Action

This chapter will report on the baseline data and visualization of the most recent GHG inventory for the city of Trikala, describe the assessment of the most recent GHG inventory, including a description of the current status for each of the relevant sectors. It also quantifies the emissions gap between the 2019 emissions baseline and the 2030 climate neutrality goal. In addition, a comprehensive discussion of all pertinent policies, strategies, concepts, regulations, etc. available, as well as regional and national legislation that affect all of the selected climate actions individually is provided. Implementation targets and strategies will be outlined for planning across sectors, along with the emissions implementation gap net of reductions addressed by existing climate action plans. Key components of the system, such as infrastructure, capacities, processes, alliances, and funds, impacting the trajectory toward achieving the 2030 climate neutrality target, will be detailed. Furthermore, a full account is given of all relevant policies, strategies, concepts, regulations, etc. available, as well as regional and national legislation affecting all the climate actions selected individually. Implementation targets and concepts are set, relevant to planning in all sectors, and the emissions implementation gap minus reductions already addressed through existing climate action plans is indicated. It lists key system elements such as infrastructure, capacities, processes, alliances, funds, etc. that affect the pathway to achieve the climate neutrality target by 2030. For all actions, a detailed description of the barriers and opportunities of the system that may have been identified is provided and the participatory model for the city, including the stakeholder ecosystem, partnerships with stakeholders, with other levels of government, with the private sector, with citizens, etc., will be highlighted.

2.1. Module A-1 Greenhouse Gas Emissions Baseline Inventory

A-1.1: Final energy use by source sectors				
Base year	2019			
Unit	MWh/year			
	Scope 1	**Scope 2**	**Scope 3**	**Total**
Buildings	**840.032,5**	**537.204,9**	**0**	**1.377.237,40**
Natural gas	128.290,20	0	0	128.290,20
Liquid gas	12.802,10	0	0	12.802,10

Diesel oil	146.107,90	0	0	146.107,90
Biomass	552.832,30	0	0	552.832,30
Grid-supplied electricity	0	537.204,90	0	537.204,90
Transport	**174.368,70**	**0**	**0,00**	**174.368,70**
Fuel mix	174.368,70	0	0	174.368,70
Waste				
There is no use of fuels or energy in the Waste sector regarding the city of Trikala.*				
Industrial Process and Product Use (IPPU)				
There is no use of fuels or energy in the IPPU sector regarding the city of Trikala.**				
Agricultural, Forestry and Land Use (AFOLU)				
There is no use of fuels or energy in the AFOLU sector regarding the city of Trikala.***				

*All waste is managed outside the city limits, so there is no energy or fuel consumption within it.

**There is no fuel or energy consumption in this sector within city boundaries, only product use.

***There is no fuel or energy consumption in this sector within city boundaries.

A-1.2: Emission factors applied			
Base year	2019		
For calculation in t or MWh of primary energy			
Methodology of the Intergovernmental Panel on Climate Change (IPCC) and the Covenant of Mayors for Climate and Energy			
Primary energy/ energy source	**Carbon Dioxide (CO_2)**	**Methane (CH_4)**	**Nitrous Oxide (N_2O)**
Natural gas	56.100 kg/TJ or 0,202 tn/MWh (IPCC 2006)	1 kg/TJ or 0,000004 tn/MWh (IPCC 2006)	0,1 kg/TJ or 0,0000004 tn/MWh (IPCC 2006)
Liquid gas	63.100 kg/TJ or 0,227 tn/MWh (IPCC 2006)	8,02 kg/TJ or 0,000029 tn/MWh (IPCC 2006)	1,36 kg/TJ or 0,000005 (IPCC 2006)
Diesel oil	74.100 kg/TJ or 0,267 tn/MWh (IPCC 2006)	0,7 kg/TJ or 0,0000025 tn/MWh (IPCC 2006)	0,4 kg/TJ or 0,0000014 tn/MWh (IPCC 2006)
Motor gasoline	69.300 kg/TJ or 0,249 tn/MWh (IPCC 2006)	22,43 kg/TJ or 0,00008 tn/MWh (IPCC 2006)	1,72 kg/TJ or 0,0000062 tn/MWh (IPCC 2006)
Biomass	0,300 t/MWh (National)	-	-
Grid-supplied electricity	0,606 t/MWh (National)	-	-
Transportation fuel mix	0,00236531 t/lt (Local)	-	-
Passenger cars and motorcycles	155 g/km	-	-

Buses	1455 g/km	-	-
Light duty trucks (<3,5 t)	216 g/km	-	-
Heavy duty trucks (>3,5 t)	374 g/km	-	-
Heat production (local heating)	127 g/KWh	-	-

A-1.3: Activity by source sectors			
Base year		**2019**	
	Scope 1	**Scope 2**	**Scope 3**
Buildings (Heating & Electricity)			
Heating demand (space heating & domestic hot water)	920,61 GWh/y		
Electricity demand within city boundaries		537,2 GWh/y	
Transport			
Passenger cars and motorcycles	153,14 million passenger kms/y		
Buses	4,87 million passenger kms/y		

Trains/metro	0,25 million passenger kms/y		
Light duty trucks (<3,5 t)	18 million passenger kms/y		
Heavy duty trucks (>3,5 t)	20 million passenger kms/y		
Waste			
Collected solid waste within city boundaries			25.275,73 t
Industrial Process and Product Use (IPPU)			
Product Use			
Lubricant use in vehicles	2.419,46 t CO_2e		
Paraffin wax use			
Urea use as a catalyst			
Product uses as substitutes for ODS			

A-1.4a: GHG emissions by source sector							
Base year	2019						
Unit	tn CO_2equivalent/year						
	Scope 1	**Scope 2**	**Scope 3**	**Other scope 3**	**Total**	**% Total**	**CO_2(b)**
Buildings	67.957,99	325.546,17	IE	-	393.504,16	84,13%	165.850,18

Transport	45.198,83	-	-	-	45.198,83	9,66%	-
Waste	-	-	26.599,46	-	26.599,46	5,69%	-
Industrial Process and Product Use (IPPU)	2.419,46	-	-	-	2.419,46	0,52%	-
Agricultural, Forestry and Land Use (AFOLU)	-7,26	-	-	-	-7,26	-	-
Total	**115.569,02**	**325.546,17**	**26.599,46**	**0,00**	**467.721,91**	**100,00%**	**165.850,18**

A-1.4b: GHG emissions by source sector (from economic case)							
Base year	Business as Usual (BAU) 2030						
Unit	tn CO_2equivalent/year						
	Scope 1	**Scope 2**	**Scope 3**	**Other scope 3**	**Total**	**% Total**	**CO_2(b)**
Buildings	60.543,77	336.028,76	IE	-	396.572,53	85,64%	154.240,67
Transport	39.317,11	-	-	-	39.317,11	8,49%	-
Waste	-	-	24.764,10	-	24.764,10	5,35%	-
Industrial Process and Product Use (IPPU)	2.419,46	-	-	-	2.419,46	0,52%	-

Agricultural, Forestry and Land Use (AFOLU)	-7,26	-	-	-	-7,26	-	-
Total	**102.273,08**	**336.028,76**	**24.764,10**	**0,00**	**463.073,19**	**1,00**	**154.240,67**

As evident in Table A-1.4a, the GHG inventory of Trikala is based on the year 2019, amounting to a total of 467,7 kt CO2e. The GHG inventory includes all five crucial emission sectors, as it is shown, and the gases that are accounted are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and fluorinated gases (IPPU). During the compilation of the GHG inventory, greenhouse gas (GHG) emissions were documented in metric tonnes and categorized by gas types (CO_2, CH_4, N_2O, Fluorinated gases) as well as by their equivalent in CO_2 (CO_2e). The determination of CO_2 equivalent involves multiplying each gas emission by its respective global warming potential (GWP100). Specifically, the GWP coefficients utilized were derived from the IPCC Fifth Assessment Report. So carbon dioxide's GWP is 1, methane's is 28 and nitrous oxide's is 265.

The fluorinated gases derive from the use of certain products within the city, like paraffin wax or lubricants. Unfortunately, we were unable to locate specific data regarding the utilization of such products within the city boundaries. Nonetheless, greenhouse gas emissions stemming from these sources are documented in Greece's national inventory. Our approach to procuring data in the IPPU sector involved scaling down from national to local level. Specifically, for emissions resulting from the usage of lubricants and urea catalyst, we employed the vehicle count for scaling down; for paraffin wax usage, we utilized the population figure; and for solvent and substitute usage for ODS, we relied on the number of buildings. The values derived from the national inventory were directly in terms of carbon dioxide equivalents.

Regarding the transportation sector, only Scope 1 emissions are considered. Official data indicates that until 2019, there were no electric or hybrid vehicles detected in Trikala. We attribute this primarily to the absence of adequate charging infrastructure for such vehicles. It's worth noting that Trikala, being a relatively small town, lacks a metro or tram system. However, within the city limits, there is a 4.8 km railway section that forms part of the national railway network. The trains operating on this line are still diesel-powered, hence their emissions are categorized as Scope 1. Nevertheless, it's important to acknowledge that the frequency of services is relatively low, with annual emissions estimated to be around 3 tn CO_2e.

As for the waste sector, as shown in the table, all emissions are included in Scope 3. All waste management facilties are located outside the city boundaries, as according to national environmental legislation they are required to have a certain distance from settlements. Thus it follows that there is no waste being treated/managed within the city boundaries.

For the purpose of formulating the Action Plan, a Business As Usual (BAU) approach for the year 2030 was employed. The BAU projection takes into account population growth and the natural replacement of various equipment (such as cars, buses, trucks, heating systems, etc.) over the specified period.

In the context of urban development, population growth typically results in increased carbon emissions. However, this effect is mitigated to a significant extent by the ongoing replacement of older fossil fuel-based equipment with newer, more energy-efficient counterparts. This dynamic is essential for understanding the overall impact of emissions in a growing city.

It is noteworthy that Trikala has experienced a negative population growth trend, with a decrease of 6.9% during the decade from 2011 to 2021. This demographic shift is a crucial factor in the calculation of the BAU scenario for the year 2030. The Economic Model was utilized for this calculation, providing a comprehensive analysis of the city's future trajectory.

According to the BAU 2030 approach, GHG emissions in the city would amount to 463 kt CO_2e. In other words, if the city were to implement no climate action measures, its emissions would exhibit a slight decrease. This reduction is attributed to both internal and external factors, such as demographic issues. Therefore, the anticipated emissions level represents a baseline scenario, highlighting the potential impact of inaction on climate mitigation in the absence of targeted measures.

For additional details regarding the methodology of the model, please refer to the following link:

https://netzerocities.app/group-capabilitybuildingprogrammebuildingastrongeconomiccase

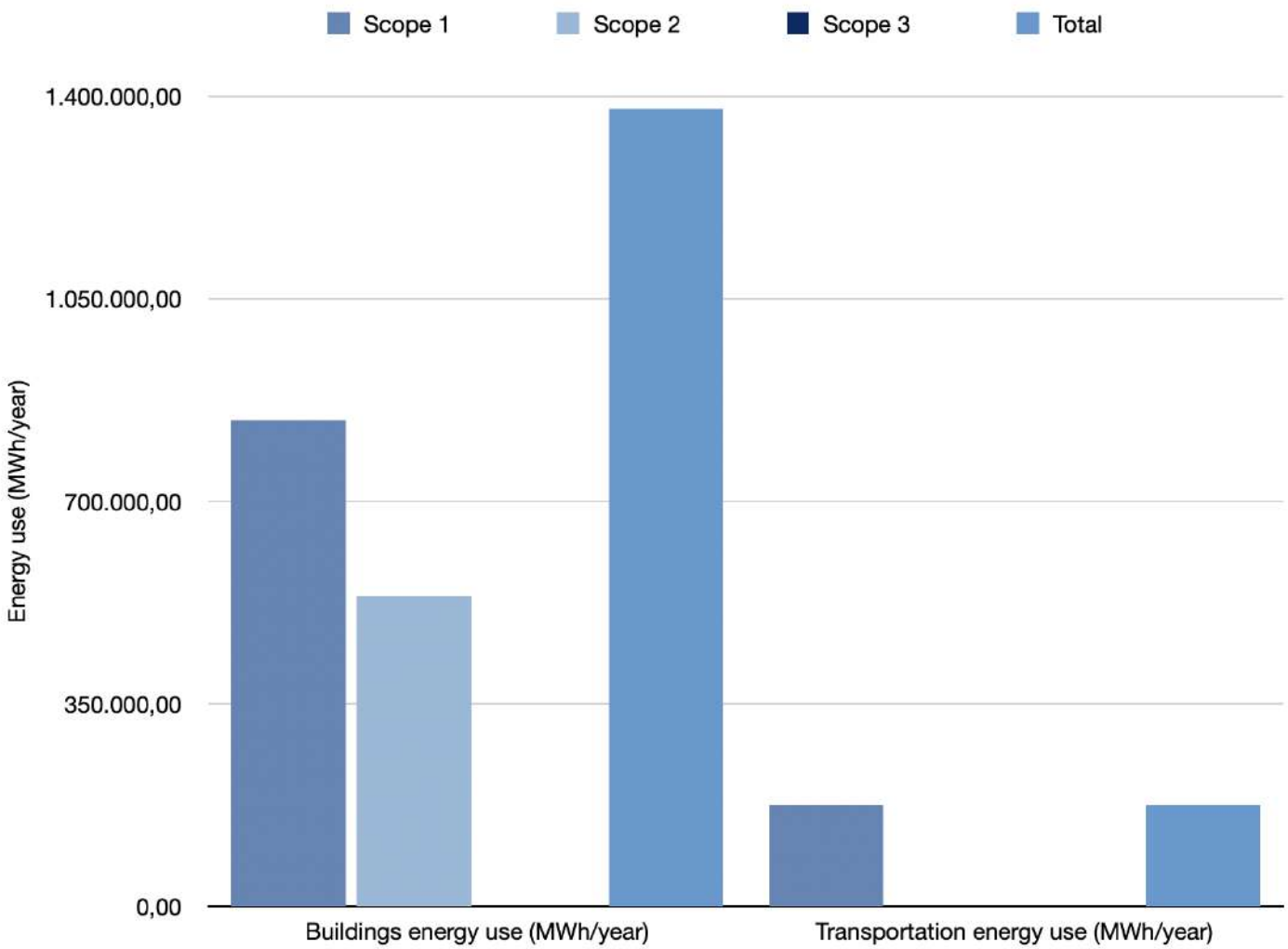


Figure 1. Energy use in Trikala city per sector and scope in 2019.

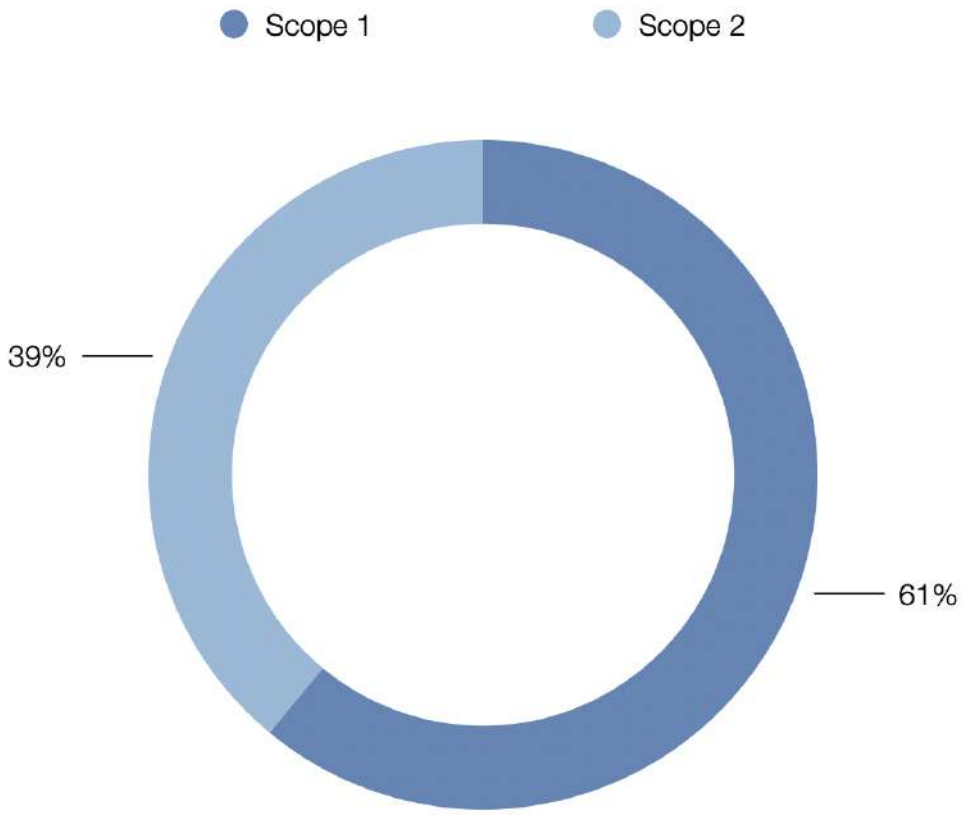


Figure 2. Energy use in Trikala's Buildings sector in 2019.

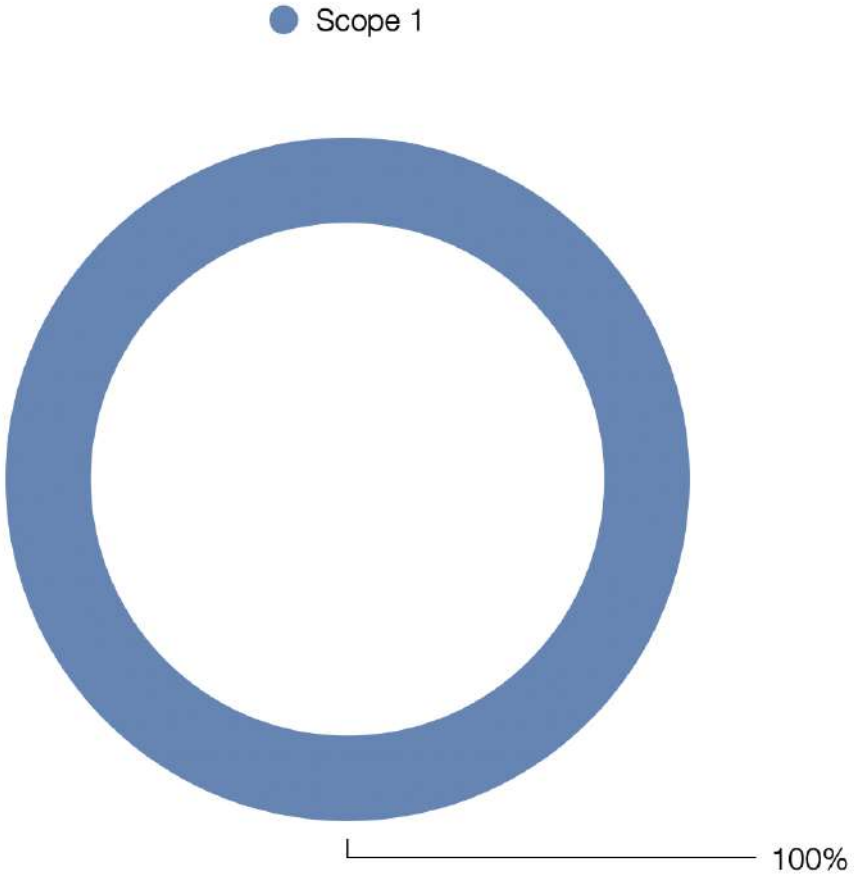


Figure 3. Energy use in Trikala's Transportation sector in 2019.

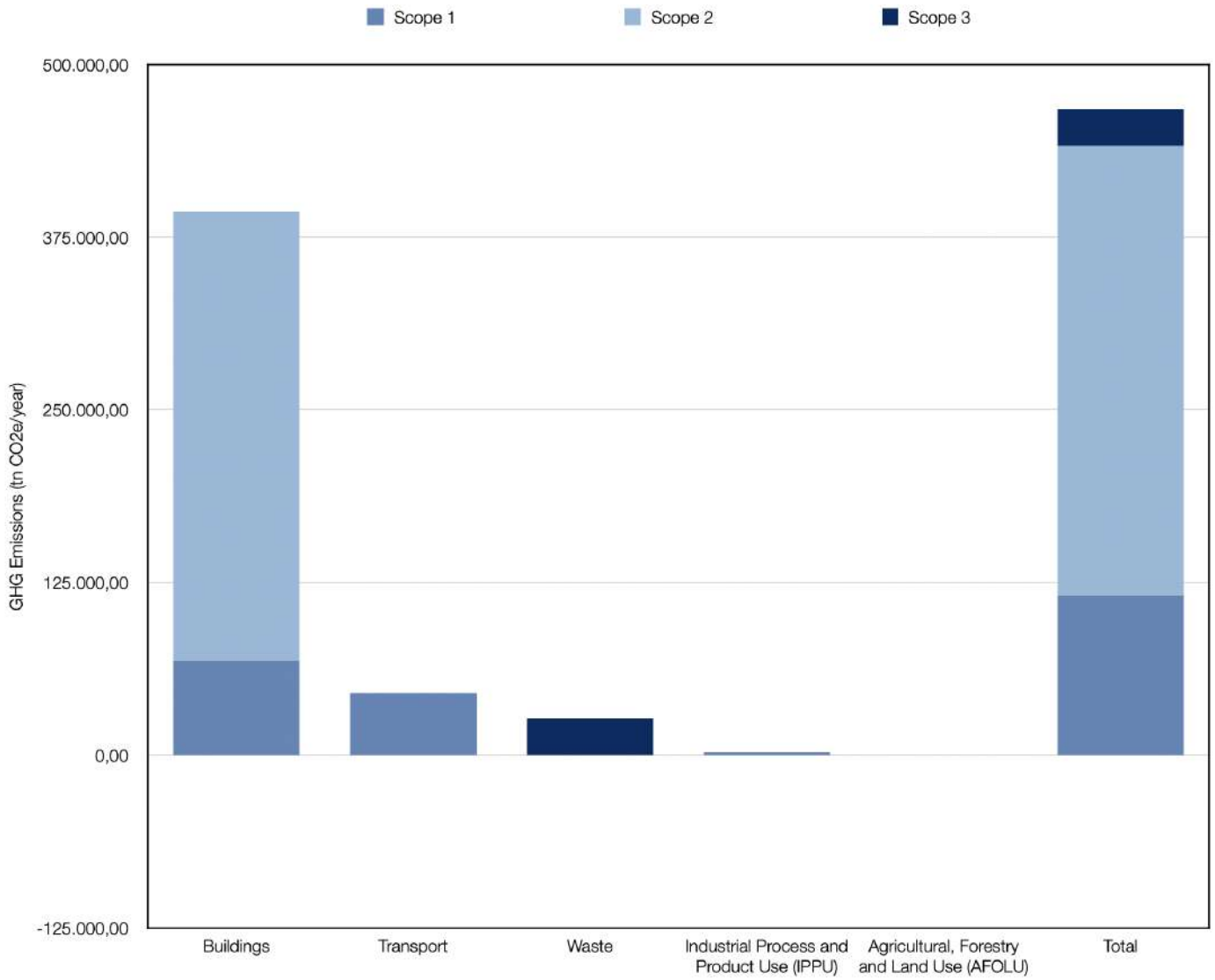


Figure 4. Greenhouse gases emissions per sector and scope in Trikala city in 2019.

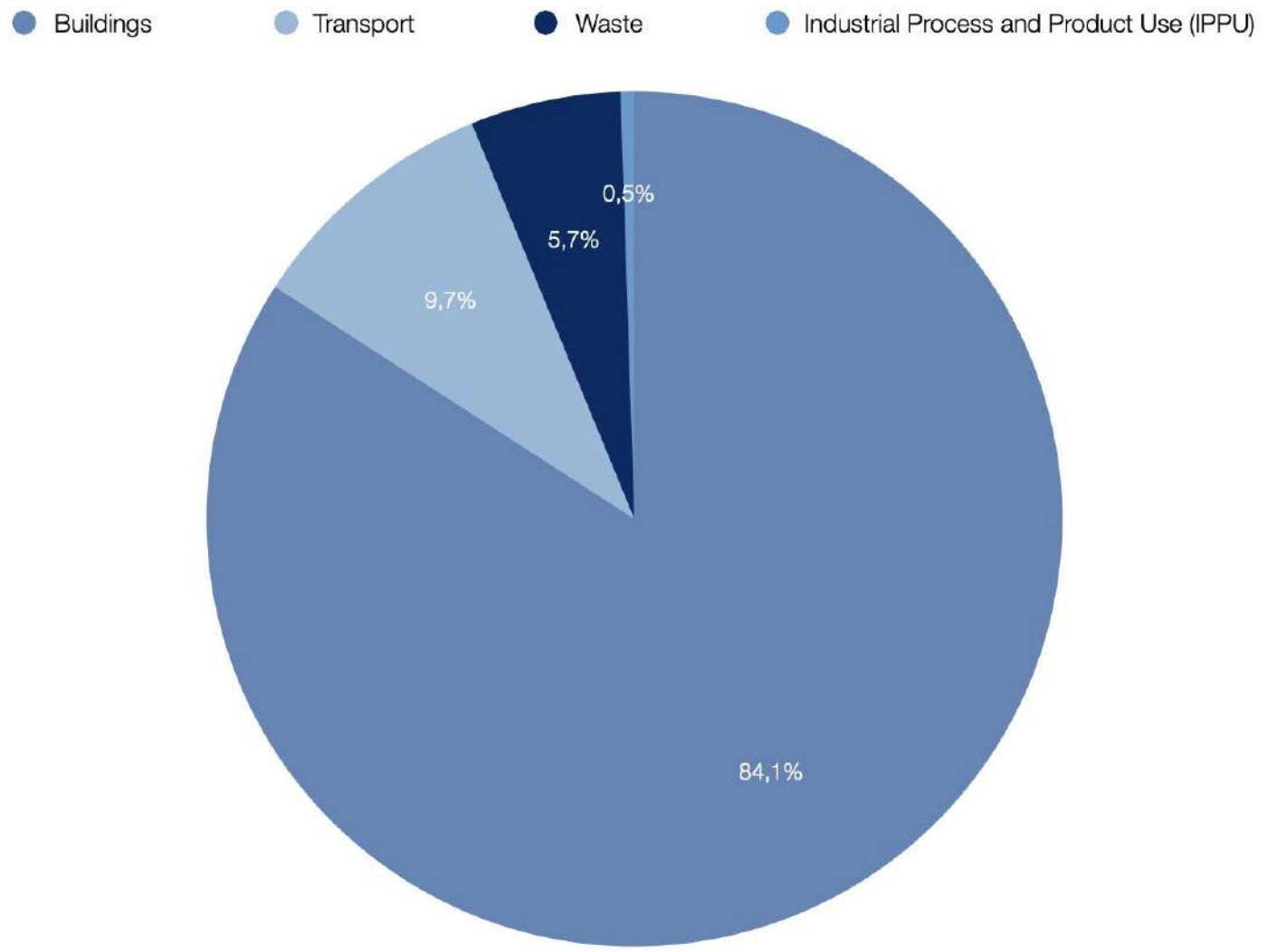


Figure 5. Greenhouse gases emissions per source sector (%).

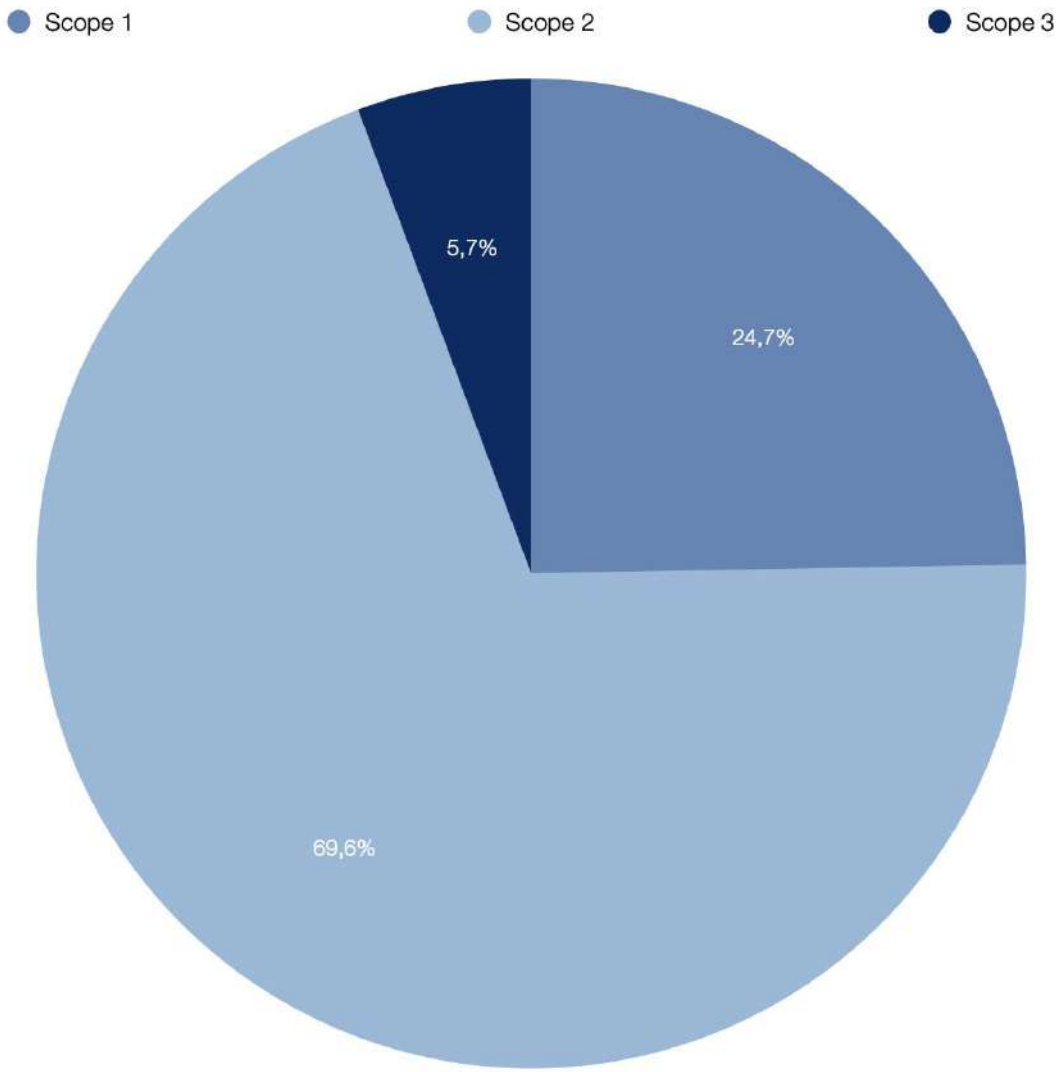


Figure 6. Greenhouse gases emissions per scope (%).

The Municipality of Trikala had an inventory for 2019 which was used at the Expression of Interest (EoI) document. That inventory was compiled using the 2006 IPCC Guidelines for National Greenhouse Gas Inventories standard and it accounted GHG emissions for the whole municipality's administrative boundaries. It covered the sectors of Stationary Energy, Transportation and Waste and the gases carbon dioxide (CO_2) and methane (CH_4).

According to the Mission's Info Kit for Cities, the sectors/sources of emissions covered by the target boundary are Scope 1 and Scope 2 from Stationary Energy, Transportation, Waste (including in this case Scope 3, i.e. at point of disposal/treatment), IPPU and AFOLU. One of the acceptable methodologies for a city's accounting of GHG emissions is the Global Protocol for Community-Scale (GPC) Greenhouse Gas Inventories, which is a global standard for the calculation and reporting of city-wide GHG emissions, consistent with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

The geographic boundary that corresponds to the 2030 climate neutrality target is smaller than the city's administrative boundary, meaning the whole Municipality, and is restricted to the Trikala city boundary. Based on this and the Info Kit's directions, the city of Trikala proceeded to draft a new GHG inventory. The inventory's baseline year is still 2019 and it was selected because it is the year with the most accurate and complete data available. However, this inventory is compiled using the GPC protocol and the Info Kit's directions. In most cases, data quality for activity data is medium to high. Data quality for emission factors is considered low, because the default emission factors from 2006 IPCC Guidelines were used, as they were the only available ones. High data quality on emission factors is detected in grid-supplied electricity and waste.

The latest 2019 GHG Inventory for Trikala city shows that the total emissions (as applicable to the Mission) equal to 467.714,66 tn CO_2e. In addition, there are 165.850 tn CO_2e from the burning of biomass, which are considered biogenic emissions and are not included in emission totals. As it is evident in Table A-1.4a, there is also a small carbon sink located within the city boundary, which is the artificial pine forest of Lofon Kastrou and Ailia, removing 7,26 CO_2e.

Table A-1.1 and Figure 1 show the Energy Use in MWh/year in the Buildings and Transportation sectors. The majority of consumed energy in both sectors is included in Scope 1, meaning it is produced by fossil fuel combustion. The Buildings sector also consumes Scope 2 energy in the form of grid-supplied electricity. Figures 2 and 3 show the distribution of energy use between scopes for the above sectors. In the Waste sector, all of the disposal and treatment activities occur outside the city boundary, therefore there is no use of fuels or energy in Scope 1 and Scope 2 within the city. There is no use of fuels or energy in the IPPU and AFOLU sectors, too.

Figure 4 presents the total GHG emissions per source sector and scope. As it becomes even more obvious with Figures 5, the Stationary Energy sector is responsible for most of the GHG emissions contributing at 84,1%. Up next is the Transport sector with 9,7% while the Waste and IPPU sectors emit less than 10% of the total Trikala's GHG emissions. At the same time, 69,6% of GHG emissions are included in Scope 2, thus they are produced due to grid-supplied electricity consumption. Scope 1 accounts for 24,7% of total GHG emissions. Going back to Table A-1.1 and Figure 1 it can be noted that energy consumption (MWh) in Scope 1 is bigger than in Scope 2. Taking also into consideration the emission factors used from the 2006 IPCC Guidelines and national sources, it is clear that the energy mix of electricity generation in Greece leads to considerable

larger amounts of GHG emissions that the territorial combustion of fossil fuels. Last but not least, Scope 3 accounts for 5,7% of total GHG emissions. Scope 3 emissions are produced totally from solid waste disposal and wastewater treatment in plant located outside the city boundary.

The economic crisis that hit Greece, coupled with the escalation in the cost of living, particularly in terms of energy expenses, has had a profound impact on the composition of heating fuels in use. Historically, the prevalent method for heating buildings in Greece involved the utilization of diesel oil. The prevailing setup includes central boilers servicing multiple units, with the associated fuel costs shared among the respective apartments or businesses. This conventional heating model experienced a considerable setback during the financial crisis, as numerous households and businesses suddenly found themselves unable to afford the elevated costs associated with heating through expensive fuels, such as diesel oil.

Consequently, a gradual transition unfolded, with many buildings forsaking oil-based heating in favor of electricity. This shift was motivated by both the comparatively lower cost of electricity and the flexibility offered by domestic heating devices, such as air conditioners and radiators, which can be individually controlled by each household or business in terms of usage timing.

The municipality of Trikala aspires to advance the electrification of energy production, albeit in a manner distinct from the current approach. Key considerations include the fact that the electricity generation mix in Greece has yet to embrace a substantial proportion of renewable energy sources (RES). This reliance on electricity results in elevated greenhouse gas emissions, primarily stemming from the combustion of fossil fuels, notably lignite. Additionally, a significant portion of the buildings in the city dates back to the 1980s and 1990s, characterized by low energy efficiency. Moreover, the presence of outdated and inefficient electrical heating devices further exacerbates energy consumption for residential and commercial establishments. Collectively, these factors contribute to the categorization of a significant portion of emissions within the Stationary Energy and Scope 2 sectors.

2.2. Module A-2 Current Policies and Strategies Assessment

A-2.1: List of relevant policies, strategies & regulations					
Type	**Level**	**Name & Title**	**Description**	**Relevance**	**Need for action**
General policies					
Strategy	EU	Green Deal (2019)	The European Green Deal is a package of policy initiatives that aims to put the EU on track towards a green transition, with the ultimate goal of achieving climate neutrality by 2050. It supports the transformation of the EU into a just and prosperous society with a modern and competitive economy.	The European Green Deal is very important for achieving climate neutrality as it sets flagship targets and actions to make Europe climate neutral by 2050.	Some of the actions & targets that European Green Deal sets are: • Reducing emissions from industry, transport & other sectors • Strengthening the Circular Economy • Funding the green transition • Building a sustainable food system (Farm to Fork strategy) • Conserving biodiversity
Action Plan	National	National Energy and Climate Plan (NECP) (2019)	The National Energy and Climate Plan (NECP) is a Strategic Plan for Climate and Energy issues and presents a detailed roadmap for achieving specific Energy and Climate Targets by 2030. The NECP	The NECP has a direct impact on the climate transition, as through its targets and actions, which focus on the areas of GHG emissions, fossil fuel consumption etc. it	• Reducing greenhouse gas emissions by more than 42% • Targeting a minimum participation in the gross • final energy consumption share of 35%

			presents and analyses Policy Priorities and Measures across a wide range of development and economic activities for the benefit of Greek society, making it the reference document for the next decade.	promotes the effort to achieve climate neutrality.	• Active and definitive reduction of the share of lignite in electricity generation • Quantitative target for final energy consumption in 2030 to be lower than 2017 • RES share in the national energy mix at 80% until 2030
Regulation	National	National Climate Law (4936/2022)	National Climate Law - Transition to climate neutrality and adaptation to climate change, urgent provisions to address the energy crisis and protect the environment. The purpose of this law is to create a coherent framework to improve the country's adaptive capacity and climate resilience and ensure the country's gradual transition to climate neutrality by 2050 in the most environmentally sustainable, socially equitable and cost-effective way.	National Climate Law is considered to be one of the most influential in achieving climate neutrality. The policies and measures adopted to mitigate climate change aim to reduce emissions and increase removals, enhance legal certainty for investors and citizens, and ensure a smooth transition of the economy and society to climate neutrality.	In order to achieve the long-term climate neutrality objective, interim climate targets are established for the years 2030 and 2040 to reduce net anthropogenic GHG emissions by at least 55% and 80%, respectively, compared to 1990 levels, taking into account the projections of the National Energy and Climate Plan (NECP).

Action plan	National	National Action Plan for the promotion of Green Public Procurement (2020 - 2023)	The process by which public authorities seek to procure goods and services with a lower environmental impact throughout their life cycle than goods and services performing the same primary function.	Contracting products, services and projects with a lower environmental impact throughout their life cycle, compared to products, services and projects that perform the same primary function is another step towards climate neutrality. This is what this process achieves.	The objectives of the action plan relate to the rational use of resources through sustainable consumption and production of goods in the context of the Circular Economy and climate change adaptation and mitigation.
Strategy	Local	Sustainable Energy and Climate Action Plan	It's an important strategic program, part of the Municipality's broader strategy for the transition to a low-carbon economy.	Taking 2019 as a baseline year, 30,1% reduction of emissions by 2030	• Energy savings in buildings and facilities • Renewable electricity generation • Sustainable transport • Awareness and information
Action Plan	EU	Covenant of Mayors/ Sustainable Energy Action Plan of Trikala Municipality (2010 - 2020)	The Covenant of Mayors focuses on climate change mitigation as well as on safe, sustainable and affordable energy.	The initiative complements the EU's broader efforts to address climate change and promote sustainable energy practices. By increasing energy	• Reduction of GHG emissions • Promotion of RES • Monitoring and reporting the implementation of the action plan, ensuring the

				efficiency and the use of RES in the areas participating in the Covenant of Mayors, CO_2 emissions are reduced. Taking 1990 as baseline year, 40% reduction of CO_2 emissions until 2030.	achievement of their targets
Action Plan	Local	Trikala Strategic Plan	The definition of a strategic document with a 10-year planning for the city of Trikala, Greece, with priorities and measures that secure the city's future against challenges like urbanism and climate change.	The main air pollutants concerning the Municipality of Trikala, are from the various combustion processes for heating or cooling, from transportation, from waste disposal and from industrial activity	• Green roofs in Municipal Buildings • NZEB, ZEB and PEB • Adoption of the principles of the Covenant of Mayors and SUD • Adoption of the Passive Building standard for energy upgrade of all public buildings • Adoption of a green policy in the management of energy consumption
Strategy	Local	Restrart mAI City (2022)	A smart city uses the multiple potentials of technology to improve the daily life of the citizens while optimising internal processes.	A smart city aims at a more efficient use of resources and reduction (mitigation) of emissions by providing better operations in several sectors.	• Smart pillars for street lightening • Monitoring of electricity consumption • System for measuring environmental conditions • Fleet mangement

					• Installation of energy-saving infrastructure in municipal buildings • Installation of energy storage systems in hydrogen fuel cells
Strategy	EU	Paris Agreement (2016)	The Paris Agreement is an agreement under the United Nations Framework Convention on Climate Change (UNFCCC), dealing with emission reductions, adaptation and its economic modalities.	The long-term objective is to keep the global temperature increase well below 2°C, above pre-industrial levels, and to continue efforts to keep it below 1.5°C in order to avoid the catastrophic consequences of climate change	• Reducing GHG emissions: limiting global temperature increase to below 2 degrees Celsius, trying to keep it to 1.5 degrees. • National Targets (Binding Climate Targets): submission of national emission reduction targets, renewed every 5 years • Adaptation to Climate Change: promoting programs and initiatives to adapt countries to the expected impacts of climate change. • International Finance: financial support to developing countries for adaptation and emission reductions •

Stationary energy policies					
Action plan	Regional	Fair Development Transition Plan for Lignite Areas (2020)	Within the NECP, the target of complete de-lignification by 2028 was incorporated to decouple the energy mix and the economy from lignite, in line with the EU's climate neutrality ambitions and the standards of the European Green Deal.	The Fair Development Transition Plan for Lignite Areas (2020) is one of the most important action plans that are related to and can contribute to the transition to climate neutrality. The action plan is based on five development pillars: • Green energy, • smart agriculture, • sustainable tourism, • crafts and industry, • digital economy and education.	• Restructuring the energy identity and rationalising the use and exploitation of environmental resources. • Promoting urban regeneration and Sustainable Urban Mobility.
Strategy	Local	Energy transition strategy for Trikala city (2022)	Strategy for the transition to a carbon neutral city within the next decade. The strategy highlights the priorities and the potential of the city in terms of energy efficiency.	Taking into account that the Stationary Energy attributes the most GHG emissions in Trikala city, the strategy for energy transition can play a huge role in achieving climate neutrality.	• Reduction in final energy consumption and an increase in energy efficiency in all sectors of the economy • Elimination of all fossil fuels and their replacement by RES • Substitution of natural gas by renewable gases

					• Promotion of electromobility • Promotion of sustainable urban mobility • Improving the carbon footprint of buildings and infrastructure • Reducing GHG emissions from waste management
Regulation	EU	Renewable Energy Directive	The new Directive sets new targets and measures for energy efficiency and tackling energy poverty, putting consumers at the forefront.	A central element of the new Directive is to significantly increase the percentage of RES in the total energy consumption of the EU, i.e. to 42.5% by 2030. An additional provision allows for an indicative increase of 2.5%, potentially pushing the overall target to 45%.	• EU countries should also promote local heating and cooling schemes in large municipalities with a population of more than 45000 inhabitants. • Creation of one-stop services for technical and financial assistance and consumer protection through out-of-court dispute resolution mechanisms between customers and energy suppliers. • EU countries should also report on the volume of energy efficiency investments to improve accountability and transparency.

Waste policies					
Regulation - Action plan	National	New National Waste Management Plan - National Hazardous Waste Management Plan (NWMP - NHWMP) 2020 - 2030 (2020)	Defines the strategy, policies and objectives, measures and actions for waste management at national level. A key principle of the new NWMP is the transition from the current management regime to a circural model by setting ambitious but realistic targets, in compliance with the relevant EU legislation, both for waste as a whole and for the individual major specific streams.	The waste sector does not contribute a lot to the GHG emissions when its compared with the Stationary Energy of Transportation sectors. However it is important for Trikala to adopt circular practices and comply with national waste policies in order to minimize waste emissions and move to climate neutrality.	The main actions proposed by the NWMP 2020-2030 for waste are source separation and separate collection. New targets for recycling and reuse are also proposed. A target worth mentioning is the reduction of MSW disposal in landfills to under 10% until 2030.
Regulation - Action plan	National	New National Waste Generation Prevention Strategic Plan (2021)	Under the plan, 4 waste streams (Food waste, Paper, Packaging materials, Waste of Electrical and Electronic Equipment) were selected for specific quality objectives, based on the existing situation, the quantities generated, the synergy with other statutory objectives and the hazardousness of the waste.	This action plan also has an influence on the effort of climate transition, since targets are set for the organization and coordination of actions that will contribute to the reduction of Excavation, Construction & Demolition Waste production.	Reduction of waste production and establishment of priority waste streams: • food waste, • paper, • packaging materials, • Waste of Electrical & Electronic Equipment

Regulation	National	New Recycling Law (2021)	With this bill, incentives and disincentives are given to citizens and municipalities to produce less waste and recycle more and measures are taken to promote separate waste collection. Also, separate collection of paper, glass, plastics, metals and bio-waste is promoted.	By preventing waste generation, reducing the negative impacts of waste generation and management, increasing recycling, reducing the overall impact of resource use and improving resource efficiency, the transition to a Circular Economy and climate neutrality is made easier. With this regulation the protection of the natural environment is promoted and spatial, urban and energy regulations are carried out that in the future contribute to climate neutrality.	• Separate waste collection. • Separate collection of paper, glass, plastics, metals and bio-waste. • Waste production reduction. • Increased recycling & reuse.
Action Plan	EU	New EU Action Plan for the Circular Economy (2020)	The aim is to help European businesses and consumers achieve the transition to a stronger and more Circular Economy, in which resources are used in a more sustainable way. The proposed actions will	The new Action Plan supports the transition towards a sustainable development model with clear objectives and actions to achieve the	• Ecodesign, eco-certification, industrial symbiosis, tax exemptions • Sustainable consumption (e.g. promotion of green

			contribute to closing the life cycle of products through more recycling and reuse, and will bring benefits to both the environment and the economy.	Circular Economy and climate neutrality.	public procurement, repair services, reuse) • Less waste with more value
Action plan	Local	Local Waste Action plan (2020-2025)	Sustainable waste management relies on the waste management hierarchy, a system that focuses on prevention, reduction, reuse, recycling and treatment. Aiming to avoid waste disposal in landfills.	While the primary focus of local waste action plans is to address waste-related issues, the inclusion of climate neutrality targets demonstrates an awareness of the significant impact of waste management on GHG emissions and the role in achieving overall climate goals.	• Reduce GHG emissions associated with waste disposal in landfills, waste incineration and transportation of waste to disposal facilities. • Increase recycling rates and diverting waste from landfills • Segregate at source organic waste and promote composting of organic waste as it mitigates the methane emissions from landfills. • Incorporate Circular Economy principles into waste management
Transport policies					
Strategy	Local	Sustainable Urban Mobility Plan of	Upgrading of infrastructure and services related to the transportation of citizens (and goods) within the city of Trikala.	Reducing air pollutants and GHG emissions from vehicle's movement is crucial for improving air	• Improving road infrastructure • Motorised traffic mitigation

		Municipality of Trikala (SUMP) (2021 - 2024)		quality and achieving climate neutrality.	• Upgrade public transport • Upgrade the safety and accessibility of clement mobility infrastructure • Educate drivers about eco-friendly driving • Public awareness and education about the environmental and health impacts of vehicle emissions and the importance of choosing cleaner transportation options.
Strategy	Local	Electric Vehicle Charging Plan (2021)	The Electric Vehicle (EV) Charging Plan concerns the development of a network of publicly accessible EV charging stations for the service/recharging of the various types of electric vehicles (passenger cars, two-wheelers, bicycles, buses, etc.) that are expected to circulate in the Municipality.	Transport sector is responsible for a big amount of GHG emissions. Specifically, it is responsible for a quarter of CO_2 emissions. Electromobility has become a vital part of the EU's strategy for achieving emission reduction (40% reduction in GHG emissions	• Replacing older vehicles with hybrid and pure electric vehicles. • Increasing the existing 0.33% share of electric vehicles in Greek market to at least 8.7% of new registrations within a 5-year period (2020-2024) • Public awareness and education

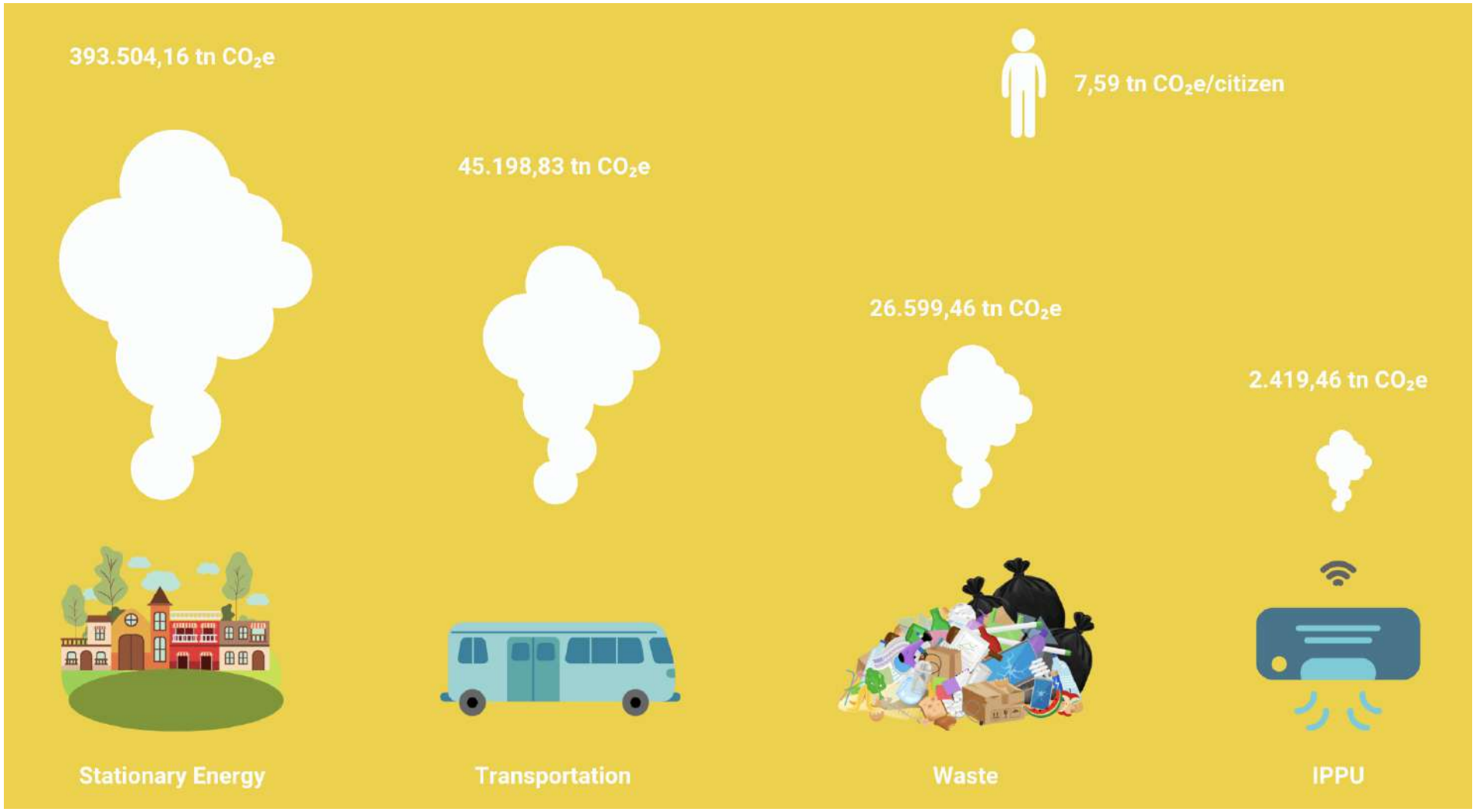
		from 1990 levels by 2030 and 60% by 2050). Thus, the Union is promoting electromobility through policies aimed at integrating electric vehicles into the transport system.	

Legislation, policies and strategies play a critical role in the green transition and are important tools for combating climate change and achieving climate neutrality. Laws relating to the environment and climate change set various emission reduction targets and establish penalties for violations. Compliance with all these laws is essential for achieving climate targets.

Sectors such as agriculture, energy, transport and others linked to emissions are directly affected by policy decisions and economic incentives that may be adopted by governments. Policies such as the development of and investment in renewable energy technologies, carbon taxes, etc. can help to reduce emissions. Also, to achieve climate goals, there are strategies that promote emission reductions, the use of sustainable materials and better energy efficiency.

The EU has set ambitious targets to promote sustainability and create a sustainable future. The areas covered by these objectives are climate change, environmental protection, the economy, etc. One of the European strategies for achieving climate neutrality is the European Green Deal. The European Green Deal is a package of policy initiatives that aims to put the EU on track towards a green transition, with the ultimate goal of

achieving climate neutrality by 2050. It supports the transformation of the EU into a just and prosperous society with a modern and competitive economy. The European Green Deal holds significant importance in the pursuit of climate neutrality by 2050 by establishing key objectives and initiatives as the cornerstone for this ambitious endeavor. The European Green Deal establishes several actions and objectives, which include:



Firstly, minimizing emissions across various sectors, including industry and transportation and reinforcing the concept of a Circular Economy. Also, providing financial support for the transition to a more sustainable future, developing a resilient and eco-friendly food system through the Farm to Fork strategy and preserving and safeguarding biodiversity.

The Green Deal influences Trikala in many ways, as it places significant emphasis on environmental sustainability, reducing GHG emissions, and adapting to climate change. The initiative promotes the creation of green infrastructure, parks, and recreational areas, offering the residents of Trikala an improved quality of life. It encourages sustainable transportation methods such as the use of bicycles, electric vehicles, and the improvement of transportation infrastructure. The transition to RES and increased energy efficiency in the residential and industrial sectors is also promoted. Additionally, the initiative supports innovation and the development of entrepreneurial ideas that promote green growth. It strengthens public participation in decision-making processes, encouraging active involvement of citizens in decisions affecting their environment. Many of the actions proposed within the framework of the CCC, such as integrating renewable energy sources into the grid, developing a unified and intelligent system for managing renewable energy sources, supporting remote work and online services, promoting a shift in behavior towards using public transport, walking, and cycling (including infrastructure improvements), electrifying cars, motorcycles, and buses, implementing separate collection of various waste streams, investing in green infrastructure like green walls, roofs, and pavements, as well as nature-based solutions, decarbonizing heating generation by transitioning energy sources in buildings from fossil fuels to electricity, and renovating buildings for improved energy efficiency, all align with the principles advocated by the European Green Deal.

Another one is the Covenant of Mayors/ Sustainable Energy Action Plan of Trikala Municipality (2010 - 2020). The Covenant of Mayors places its emphasis on addressing climate change by mitigating its effects and promoting the use of secure, sustainable, and cost-effective energy solutions. The initiative aligns with the European Union's broader endeavors to combat climate change and encourage sustainable energy practices. By enhancing energy efficiency and adopting RES in regions engaged in the Covenant of Mayors, it leads to a decrease in CO_2 emissions, aiming for a 40% reduction by 2030 compared to the 1990 baseline year. The plan promotes enhancing energy efficiency in the city by making improvements to buildings, transportation, and other infrastructures. It includes initiatives for sustainable urban planning, incorporating green spaces, eco-friendly transportation, and other aspects of urban design. The implementation of the plan involves the participation of the local community, educating and informing citizens about the importance of sustainability and the actions they can take.

The Local Waste Action Plan provides backing for the shift towards a sustainable development framework, outlining specific goals and measures to attain both the Circular Economy and climate neutrality. The objective is to assist European businesses and consumers in transitioning toward a more robust Circular Economy, where resources are employed in a sustainable manner. The suggested measures will support the idea of "closing the loop" for products, promoting increased recycling and reuse, and delivering advantages to both the environment and the economy. The plan supports initiatives to promote the Circular Economy by encouraging recycling and the reuse of resources. Its implementation includes awareness and education programs for citizens, fostering their participation in waste management. Additionally, improvements in infrastructure for the collection, processing, and recycling of waste are foreseen. Among the goals is the promotion of sustainability through practical waste management practices, providing the city with more incentives to create a sustainable urban environment. Regarding the actions concerning

waste management and the circular economy included in the CCC, there is a prediction for the separate collection and sustainable management of various waste streams, a goal of municipal waste prevention (10%) and a goal for reduction in landfill under 10%.

The Circular Economy Action Plan include actions such as: Eco-design: design principles that prioritize product longevity, reusability, and recyclability. Eco-certification: Developing and promoting certification standards for environmentally friendly products and services.Industrial Symbiosis: reduce waste and collaboration between the companies. Tax Incentives: tax breaks or incentives to businesses that adopt Circular Economy practices. Green Public Procurement: Choosing of environmentally sustainable products and services by governments and public institutions. Reuse Programs: Facilitate the reuse of products and materials. Waste Reduction: Measures to reduce waste generation and promote recycling. The Circular Economy Action Plan promotes the general application of circular economy principles, such as designing products with an emphasis on reuse and recycling. It also encourages the creation of green businesses that adhere to circular economy principles and seek to reduce waste. Furthermore, the implementation of awareness and education programs for citizens becomes more accessible, aiming to increase their participation in waste management. This adoption of practices aligns with the proposed actions of the CCC.

The Paris Agreement is an agreement under the United Nations Framework Convention on Climate Change (UNFCCC), dealing with emission reductions, adaptation and its economic modalities. The overarching goal is to maintain the rise in global temperatures significantly below 2°C compared to pre-industrial levels, and to persistently strive to limit it to below 1.5°C to prevent the severe repercussions of climate change. By limiting the temperature rise below two degrees Celsius, GHG emissions are reduced. Also, through the promotion of country programs and adaptations, adaptation to climate change is achieved and national emission reduction targets are submitted. With the Paris Agreement, clear and ambitious goals for the reduction of greenhouse gas emissions and adaptation to climate change have been established. The Agreement encourages local authorities, including the Municipality of Trikala, to take more intensive actions to achieve climate goals. This policy promotes emission reduction, prompting the Municipality to implement measures to reduce greenhouse gas emissions. Additionally, the Municipality is developing adaptation plans to protect the local community from the negative impacts of climate change. Various awareness campaigns are also being conducted to inform and sensitize residents.

The National Energy and Climate Plan (NECP) is a strategic blueprint that outlines specific targets and a comprehensive plan for addressing climate and energy-related matters, with a focus on achieving particular goals by 2030. The NECP exerts a direct influence on the climate transition by advancing the endeavor to reach climate neutrality through its specified objectives and measures in areas such as GHG emissions and fossil fuel usage. By reducing the utilization of mineral resources and mitigating CO_2 emissions, we ultimately achieve a reduction in GHG emissions. This endeavor entails a concerted effort to minimize the reliance on non-renewable resources and curtail the release of carbon dioxide into the atmosphere. The goals of the NECP promoting practices that can be adopted by Trikala, while simultaneously adopting practices to address the adverse effects of climate change. By promoting and implementing all these measures proposed by the NECP, Trikala can actively contribute to the national effort to address climate challenges and more easily secure funding for achieving climate neutrality. It is important to highlight that the latest amendment of the NECP sets the generation of 80% of national electricity from RES until 2030 as a primary target.

The National Climate Law as a continuation of the European Climate Law is the first law that strengthens the targets and refers exclusively to climate independence. The National Climate Law aims to establish a unified structure for enhancing the nation's ability to adapt to climate change and bolster climate resilience. Additionally, it seeks to facilitate the gradual shift toward climate neutrality by 2050, prioritizing environmental sustainability, social equity, and cost-effectiveness. The policies and measures adopted to tackle climate change aim to reduce emissions and increase the capacity of the environment to absorb them. They also seek to ensure legal certainty for investors and citizens and to ensure a smooth transition of the economy and society towards climate neutrality. To achieve the long-term goal of climate neutrality, interim climate targets are set for the years 2030 and 2040 as follows: Reduction of net anthropogenic GHG emissions by at least 55% in 2030 and 80% in 2040 compared to 1990 levels. To achieve the targets, the National Energy and Climate Plan (NECP) is taken into account. It establishes clear targets and action plans for reducing greenhouse gas emissions and adapting to climate change. It strengthens the commitment of the region to achieve climate neutrality goals and promotes practices that contribute to sustainable development. Furthermore, the law provides guidelines for the development of practices that encourage the circular economy, waste reduction, and the protection of biodiversity. Through the implementation of these measures, Trikala can contribute to the national effort to address climate challenges and enhance its economic and social resilience.

A key pretext of the new NWMP is the transition from the existing management system to an environmentally sustainable model, with the setting of ambitious but realistic targets. These targets must comply with the relevant EU legislation, both for total waste and for important specific waste streams. These targets must comply with the relevant EU legislation, both for total waste and for important specific waste streams. The NWMP mainly concerns the waste sector. Although the waste sector does not contribute significantly to GHG emissions compared to the stationary energy and transport sectors, it is important for Trikala to implement Circular Economy practices and comply with national waste policies. This will help to minimise waste emissions and support their efforts to achieve climate neutrality. By reducing waste and avoiding its diversion from landfill, gas and methane emissions are reduced. Climate neutrality can be achieved through the reduction of waste and its diversion from landfills, effectively lowering emissions from landfills. Transitioning towards a circular economy, where the traditional model of produce-consume-discard is replaced by recycling and reusing, plays a pivotal role. By embracing this circular model, we not only reduce the environmental impact associated with waste but also proactively prevent additional GHG emissions that would arise from adhering to a linear economic model. In this sustainable paradigm, waste management is transformed, emphasizing recycling and conscious consumption choices. By choosing to recycle and reuse materials, we contribute to a substantial decrease in GHG emissions compared to the emissions generated by adhering to a linear economic model. The shift towards a circular economy encourages responsible resource utilization, mitigates environmental degradation, and fosters a more sustainable and eco-conscious society.

Essentially, the NWMP influences Trikala by establishing clear goals and action plans for reducing GHG emissions and adapting to climate change. It strengthens the commitment of the region to achieving climate targets and promotes practices that contribute to sustainable development. Actions concerning waste management and the circular economy, as included in the CCC, focus on the separate collection and sustainable management of various waste streams, and set the objectives of achieving a 10% reduction in municipal waste and reducing landfill usage by less than 10%.

Actions concerning waste management and the circular economy included in the CCC, are for the separate collection and sustainable management of various waste streams, a goal of municipal waste prevention (10%) and a goal for reduction in landfill under 10%. By implementing these measures, Trikala can actively contribute to the national effort to address climate challenges and enhance their economic and social resilience. Through the reduction of waste and the promotion of the circular economy, they contribute to lowering emissions from waste, thus advancing the goal of climate neutrality.

The New National Waste Generation Prevention Strategic Plan also plays a role in advancing the climate transition by establishing goals for organizing and coordinating initiatives aimed at decreasing the production of Waste. Establishing goals within the building sector is instrumental in diminishing emissions associated with stationary energy use, facilitating a smoother trajectory towards achieving climate neutrality. This targeted approach acknowledges the significance of the built environment in the overall carbon footprint and emphasizes the need for strategic interventions to enhance energy efficiency, promote renewable energy adoption, and ultimately contribute to the broader goal of climate neutrality. It affects Trikala by setting goals for the reduction of waste generation in specific sectors, such as excavation, construction, and demolition waste. As mentioned above, the CCC has set the objective of separate collection of waste streams (organic, paper, glass, metals, plastic, bulky, greens, WEEE, SQHW, edible fats) and the goal of municipal waste prevention by 10%.

The Fair Development Transition Plan for Lignite Areas (2020) is one of the most important action plans that are related to and can contribute to the transition to climate neutrality. The main objective is to provide support to local communities and to support economic recovery after the closure of the lignite mines. At the same time, it seeks to reduce GHG emissions and adapt to new sustainable economic activities. The transition away from lignite is a key component of broader efforts to decarbonise the economy and mitigate the impacts of climate change. To achieve climate neutrality, there is a need to shift towards RES. Specifically, this shift includes the development of a joined and smart RES management system, integrating RES energy through grid, transitioning energy sources in buildings from fossil fuels to electricity (electrification of buildings), implementing Virtual power plants (VPP), installing solar thermal power systems on buildings, and establishing photovoltaics on buildings and in municipal photovoltaics parks. The transition plan allocates resources to support the development of renewable energy projects in lignite-dependent areas. This not only contributes to reducing greenhouse gas emissions but also positions these regions as contributors to the clean energy transition. The extraction and use of lignite often have environmental consequences, including land degradation. The transition plan includes provisions for environmental rehabilitation, focusing on restoring ecosystems affected by lignite mining. This aligns with broader climate goals by promoting sustainable land use and biodiversity. The plan is designed to align with national climate objectives and strategies. By integrating regional transition plans into the broader national climate framework, there is a cohesive and coordinated effort to achieve climate neutrality at the national level. The transition plan greatly affects the national energy mix, thus the emissions occurring due to the consumption of grid-supplied energy. Trikala's Scope 2 emissions can be significantly affected by the changes in lignite areas.

By using the New Recycling Law, the protection of the natural environment is promoted and spatial, urban planning and energy regulations are implemented that will contribute to achieving climate neutrality in the future. This can be achieved by attaining a transition to a Circular Economic Model, recycling, reducing the negative impacts of waste production and management, reducing waste production, etc. Separate collection of

paper, glass, plastics, metals and bio-waste is promoted and municipalities and citizens are encouraged to reduce waste production. As previously emphasized, the reduction in waste production and the implementation of separate waste collection divert a substantial quantity of waste from landfill disposal. Consequently, this not only diminishes emissions from landfill sites but also aligns with broader environmental objectives. The strategic emphasis on waste reduction, coupled with the implementation of comprehensive separate collection practices, significantly contributes to the overall reduction of emissions from landfill sites. By fostering a culture of waste reduction and responsible waste management, communities play a pivotal role in mitigating environmental impacts and advancing the collective pursuit of climate neutrality. Furthermore, the law provides guidelines for promoting a more sustainable approach to waste management, including practices that encourage the circular economy and reduce negative environmental impacts. The implementation of these practices in the city of Trikala can have broader economic, environmental, and social implications, enhancing the sustainability of the local community and contributing to the national goal of sustainability and climate neutrality. The CCC includes actions concerning the separate collection of recyclable waste streams such as paper, glass, plastics, metals and bio-waste.

In addition, National Action Plan for the promotion of Green Public Procurement is another step towards climate neutrality. In essence, contracting for products, services and projects that have a lower environmental impact throughout their life cycle than products, services and projects that serve the same essential function. The National Action Plan for the promotion of the Green Public Procurement is an essential step towards climate independence, as it is closely linked to the reduction of GHG emissions. This approach contributes to reducing the environmental footprint and saving resources in various sectors. Firstly, the promotion of Green Public Procurement is gearing public procurement towards the purchase of products, services and projects with a lower environmental footprint. This includes giving preference to products and services produced using sustainable materials, with low energy consumption and with processes that reduce CO2 emissions during production. The preference for these products and services in public procurement leads to support for companies and producers that incorporate sustainable practices. It thus encourages the development of the market for sustainable products and services, helping to reduce emissions associated with the production and use of these products. These measures are closely tied to efforts for climate neutrality, ensuring that local markets and the economy actively contribute to the reduction of greenhouse gas emissions.

The Municipality of Trikala is a pioneer in environmental issues and focuses on innovations and actions aimed at a sustainable future for the improvement of everyday activities for the citizens. The Municipality has at its disposal numerous plans and strategies, many of which have not been implemented; nevertheless, whatever is available forms the foundation for the specific undertaking of the CCC. Primarily, the plans that are at the local level have been put into practice. Additionally, many actions outlined in other plans have been integrated into the CCC and serve as steppingstones for this initiative. Specifically, the actions of the "Restart MAi City" strategy have been incorporated as smart city initiatives, with some of them further integrated into other action areas, such as the implementation of Demand-Responsive Transport (DRT) in the transportation and mobility sector. Despite the fact that numerous plans remain unrealized, the existing groundwork, coupled with the alignment of actions across various projects, contributes significantly to the overall success of the CCC. With its actions, "Restart MAi City" contributes to shaping a more sustainable and smart urban environment in Trikala. Some of the smart city actions included in the CCC are: the establishment of Smart City Executive Management Centre, Integrated service, information and citizen awareness infrastructures for a smart city ecosystem, implementation

of protection plan against physical / logical system / information breach and drafting of an open data policy for the Municipality, Installation of intelligent traffic signalling and control infrastructure, development of smart citizen wellness support infrastructure, installation of infrastructure for remote management, remote control and telemetry of distribution boards (pillars) of municipal infrastructure of public space (street lighting), installation of emergency detection and management infrastructure, installation of smart consumption and water quality meters in the water supply network, creation of a waste management platform, alternative waste management systems and information-awareness actions.

At the local level, various strategic initiatives and action plans are in place to advance sustainability objectives. Notably, the Action Plan for Sustainable Energy and Climate stands out, emphasizing the imperative of energy conservation within buildings and facilities, the promotion of energy generation from renewable sources, and the advocacy for sustainable transportation practices. These concerted efforts contribute significantly to the reduction of emissions in the building sector, aligning with the overarching goal of progressing towards climate neutrality. In addition, apart from the Local Waste Action Plan (2020-2025), which focuses on the avoidance, reduction, reuse, recycling and treatment of waste in order to avoid the disposal of waste in landfills (thus reducing methane emissions and, by extension, GHG emissions), there is also the Sustainable Urban Mobility Plan of the Municipality of Trikala. The essence of the plan is that in order to achieve climate neutrality, it is vital to improve air quality, and in order to achieve this improvement, it is essential to reduce emissions of air pollutants and GHG from vehicle traffic. Some of the ways proposed in the plan are: improving road infrastructure, upgrading public transport, training drivers to drive in an environmentally friendly way, etc. Similar actions regarding the emissions reduction from transportation are included in CCC. Specifically, behavioural shift to public transport, walking and cycling, support of remote working and online services, Zero Emission Zones, Mobiity as a Service (MaaS) etc

Another initiative by the Municipality of Trikala is the Strategic Plan of Trikala (2022-2027), which sets out priorities and measures to address challenges like urbanisation and climate change. Since the main pollutants affecting the atmosphere in the Municipality of Trikala come from various combustion processes for heating or cooling, from vehicle traffic, from waste disposal and from industrial activities, in order to lead the Municipality to climate neutrality it is possible to create green roofs on municipal buildings, NZEB, adopt the passive building standard for the energy upgrade of all public buildings, adopt a green policy for the management of energy consumption, etc.

The transport sector is responsible for a very large amount of GHG emissions, about a quarter of CO_2 emissions. In this context, the Electric Vehicle (EV) Charging Plan was developed, which involves the development of a network of publicly accessible EV charging stations to serve/charge the different types of electric vehicles (passenger cars, motorcycles, bicycles, buses, etc.) expected to circulate in the Municipality, through actions such as the replacement of older vehicles with hybrid and pure electric vehicles. With these initiatives, emissions of greenhouse gases are significantly reduced, as the introduction of such vehicles, as replacements for conventional ones, substantially diminishes emissions related to transportation. Consequently, transportation ceases to constitute as substantial a percentage of emissions. This paradigm shift towards eco-friendly vehicles not only contributes to mitigating the environmental impact of transportation but also aligns with a broader commitment to sustainability and reduced GHG emissions. The transition to electric vehicles can contribute to reducing fuel costs for consumers, as the cost of charging is usually lower than the cost of gasoline or diesel. The plan encourages a more sustainable approach to mobility, thus contributing to

the creation of a more environmentally friendly urban environment. In these ways, the Electric Vehicle Charging Plan contributes to the transition to a more sustainable, environmentally friendly, and energy-efficient mobility in Trikala.

Furthermore, in 2022 the city also planned the “Restart MAI City" strategy. A smart city aims to use resources more efficiently and reduce (mitigate) emissions by providing better services in various city sectors. For example, by creating smart pillars for street lighting, monitoring electricity consumption, fleet management, installing energy-saving infrastructure in municipal buildings, monitor environmental conditions in city level and inform citizens, educate citizens in environmentally friendly practices etc.

Equally important is the Energy transition strategy for Trikala city (2022), which highlights the priorities and potential of the city in terms of energy efficiency, with actions such as eliminating all fossil fuels and replacing them with renewable energy sources, promoting electromobility, reducing GHG emissions from waste management, reducing final energy consumption and increasing energy efficiency in all sectors of the economy, etc. By strategically implementing this approach, a tangible outcome is the notable reduction of greenhouse gas emissions. The discernible shift towards such sustainable practices not only aligns with environmental stewardship but also substantiates a steadfast commitment to the overarching goal of minimizing GHG impacts.

Although, the introduction of many strategies and legislation (such as the National Climate Law) is a good start towards achieving climate neutrality, some gaps and shortcomings identified make it necessary to change, modify or strengthen some of them. For example, in the National Climate Law, in addition to the decarbonisation of lignite, no specific and binding deadlines are set for the general decarbonisation of hydrocarbons, with the exception of some more specific cases, such as the burning of fuel oil on islands and oil-fired boilers in buildings. Furthermore, there is no mention of the need for public consultation on critical elements such as sectoral budgets. There is a restriction on the online climate dialogue site.

Importantly, there is also a lack of accountability for fining non-compliers and a corresponding lack of incentives for more green investments. It is therefore obvious that the strengthening of some legislation or even its modification is necessary to achieve climate neutrality.

A-2.2: Emissions gap (kt CO2e)									
	Baseline emissions (BAU 2030)	**Emissions Reduction Resulting from CNAP**		**Remaining Emissions**		**Residual Emissions Offsetting**		**Emissions gap (amount necessary to achieve net-zero)**	
Buildings	396,57	331,73	83,65%	64,84	16,35%	64,84	16,35%	0	0%
Transport	39,32	23,07	58,68%	16,25	41,32%	16,25	41,32%	0	0%

Waste	24,76	21,38	86,34%	3,38	13,66%	3,38	13,66%	0	0%
Industrial Process and Product Use (IPPU)	2,42	0,00	0,00%	2,42	100,00%	2,42	100,00%	0	0%
Agriculture, Forestry and Land Use (AFOLU)	-0,01	-	-	-	-	-	-	0	0%
Total	**463,07**	**376,19**	**81,24%**	**86,89**	**18,76%**	**86,89**	**18,76%**	0	0%

The city of Trikala has formulated strategic plans encompassing initiatives to address climate change, such as the Sustainable Urban Mobility Plan (SUMP) and the Sustainable Energy and Climate Action Plan (SECAP). Nevertheless, given the non-implementation of these actions, it is deemed more practical for the Action Plan of the city to include not only new climate-related measures but also existing actions derived from current plans. For this reason, the assessment of greenhouse gas (GHG) emissions reduction resulting from all actions is incorporated within the scope of "Emission reductions Resulting from CNAP".

As depicted in Table A-2.3, the baseline emissions for the Business As Usual (BAU) scenario in 2030 amount to 463.07 kt CO2. The cumulative impact of the Action Plan's initiatives leads to a reduction in emissions by 376.16 kt CO2e (81.24%). Consequently, the expected residual GHG emissions stand at 86.9 kt CO2e, representing a reduction of 18.76%, a percentage that aligns with the mission objectives (aiming for less than 20%).

The subsequent section provides a detailed presentation of the Action Plan's initiatives and the strategy for addressing the remaining emissions.

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

A-3.1: Systems & stakeholder mapping				
System description	**Stakeholders involved**	**Network**	**Influence**	**Interest**
		Systemic Barriers		
Bureaucracy - Public sector System	Municipality, Government	Bureaucracy can drive citizens away from the decision-making process. This can reduce their participation and the effectiveness of policies. The government and the municipalities usually operate with the same systems, so it is necessary to simultaneously modernize and promote the most effective actions towards climate neutrality.	Bureaucracy is characterised by a hierarchical structure, strict rules and procedures and a standardised set of procedures.It is a slow process. It is necessary to modernise the public sector system and find flexible and innovative approaches. Climate change is an urgent global challenge that requires rapid action. Bureaucracy and slow decision-making processes can hinder the timely implementation of climate policies and projects, delaying critical actions needed to mitigate the effects of climate change.	Modernising the system and working together between different stakeholders will accelerate climate action and promote a more effective response to the climate crisis.

Understaffing of municipalities-Public sector System	Municipality, Government	Understaffing in government and municipalities can negatively affect environmental policy, climate action and adaptation to climate change, with an impact on the sustainability and resilience of regions to climate challenges.The decisions for the recruitment of new executives in municipalities come from the Central Government, therefore the Reduced recruitment that eventually takes place in the municipalities resulting in the inability to develop and implement new sustainable technologies has the starting point of the government.	Municipalities play a crucial role in implementing and enforcing policies, programs and initiatives that address climate change at local level. When these agencies are understaffed, their ability to respond effectively to challenges posed by climate change can be hampered. Indicatively, some problems that arise are: Difficulty in responding immediately to challenges, inability to develop and implement projects, insufficient monitoring and data collection, reduced approach and awareness of the community, etc.	When the municipality is adequately staffed, it can respond promptly and effectively to any challenges that may arise. It will now be easier to develop and implement new projects, raising awareness and approaching people will be easier as there will be no staff restrictions, there will be staff who will be able to analyze and monitor data as well as possible funding that may exist from time to time for actions to tackle climate change.

Institutional capacity - Public sector system	Municipality, Government	Civil servants within the Municipality without expertise in climate change may make ineffective task prioritization, lead in lack of dedicated portfolios with climate mitigation actions and projects, may lack the right skills to evaluate the effectiveness of specific climate mitigation actions, be unable to communicate successfully the importance of such actions or the positive results for the society.	The public administration must lead by example. As municipalities implement policy to reduce the effects of climate change, they must enact practices that will be adopted by society at large. Local level civil servants have a formidable sphere of influence to enact change through supporting the government in developing and implementing well-designed, targeted and effective policies which prioritize public engagement, ensuring credible policies back up ambitious targets, and providing the clear policy signals needed to incentivize and catalyze low carbon markets and accelerate private sector buy-in.	Enhancing technical capacity within municipalities to raise public awareness of climate change issues, enhancing collaboration among climate change experts, improving and enhancing access to research opportunities, consolidating inter-institutional cooperation on climate change, enhancing stakeholder engagement on adaptation measures, making collaborative climate projects more sustainable and considering climate research findings in policymaking and decision-making;

Financial scarcity-Economic System	Government, Municipality, Private companies-investors	The government can create funding programs for Municipalities that demonstrate significant climate action. At the same time, it can create the right incentives for private sector companies to invest in the climate.	Financing the transition to renewable energy and sustainable practices can be expensive, and Trikala city may struggle to access the necessary funds for climate mitigation and adaptation.	To effectively address climate change, Trikala needs to recognise the interconnections between economic barriers and environmental challenges and develop coherent policies and programs to address both aspects.It is obvious that by addressing economic obstacles, the implementation of actions against climate change and the transition to a climate-neutral city becomes immediately easier.
Interest & awareness of citizens - Social System	Government, Municipality, Citizens	Raising awareness and informing citizens is not only a personal responsibility, but also a responsibility of both the government and the municipality. The cooperation and action of the government and the municipality is essential to	The lack of awareness among citizens directly affects climate change. There is indifference, apathy towards environmental actions and no social pressure on governments to take effective climate protection measures.	Information, education and enhanced community participation are key to ensuring that the actions needed to protect the environment are taken in a timely and effective manner.

		ensure that citizens understand the importance of climate change and the need for action to address it. This is achieved through the promotion of environmental initiatives, the implementation of educational programs, but also through information through various media.	Citizens do not have a sufficient understanding of the effects of climate change, refrain from participating in environmental actions and do not perceive the worsening of the climate crisis in the future. Therefore, the problem of climate change is getting worse and worse.	
Political Instability- Political System	Government, Municipality	Government changes, party disputes, social unrest and economic insecurity are some of the characteristics of political instability. All these are obstacles to the implementation of actions to tackle climate change and the government must transition to a stable situation that will be ready to take decisions and accept the future progress and development of the country. Same applies to the local level of government.	Climate change requires long-term planning and commitment. The constant change of governments does not allow for proper and long-term planning. This can lead to delayed or insufficient action on climate issues.	Overcoming political instability can create many opportunities to tackle climate change and promote sustainable development. These opportunities include: • Extensification of climate action • Strengthening political will • Strengthening international cooperation • Prosperity and job creation • Promoting innovation

Technological Limitations - Economic System	Government, Market, Industry, Universities	Cooperation and coordination between actors is critical to address technological limitations and promote clean and sustainable technologies to tackle climate change. Government can provide the framework and policies that encourage investment in research and development, while industry and the market can contribute by producing and adopting clean technologies. Research and innovation in universities, on the other hand, can promote new technologies and practices that respond to climate challenges.	Technological limitations can affect tackling climate change in a number of ways. Some of the limitations that need to be addressed are: • Insufficient/high technology costs: Some emission reduction technologies may still be in development or costly. This may limit their ability to be implemented on a large scale or be accessible to all. • Coal dependence: Traditional coal-based energy sources are still cheap and widely available in many regions. This dependency can delay the transition to renewable and sustainable energy sources. • Complex technological solutions: Some climate change technologies can be complex to implement or require a high level of	Addressing the technological limitations and developing efficient and clean technologies are major challenges in tackling climate change. Investment in research, innovation and international cooperation are key to overcoming these barriers and promoting green technology and practices for the future.

expertise. This may limit their adoption by the general public or by regions with limited technological capabilities.

- Impact on other sectors: Some emission abatement technologies may have an impact on other sectors, such as employment, the economy and social structures. This may generate resistance and political controversy over their adoption.

Fossil Fuel Lobbying - Economic System	Government, Market, Industry, Private sector	The limited technological support for RES and the financial constraints for the development of research in this field, cause the repeated choice to use mineral resources. The government is not investing as much as it should in RES and the market is not properly prepared for the final and imposing integration of RES. Also, the fossil fuel industry has a strong influence in many areas. One of them is politics. Political decision-making in many countries is affected, as this industry generates huge profits and thus often serves political interests and hinders the use of RES over fossil fuels.	The fossil fuel industry has significant influence over policymakers, which can hinder the implementation of climate-friendly policies and investments in renewable energy.	If RES are developed and the pressure to use fossil fuels is reduced, new paths are opened. The transition from fossil fuels to RES has wide-ranging and long-term benefits for the environment, the economy and society. • The transition to RES reduces GHG emissions and helps tackle the climate crisis. • Switching to clean alternative energy sources can significantly improve air quality • RES are unlimited and available almost everywhere, while fossil resources are limited and in some cases concentrated in a few countries • The transition to RES promotes sustainability

Social & Cultural Factors - Social System	Citizens, Municipality	The project team within the Municipality needs to identify any social and cultural factors that pose a barrier to climate action and characterise the citizens or certain groups of them. The Municipality will have to design targeted workshops and actions in order to overcome these behaviours.	Cultural norms, values, and behaviors can influence patterns of activities, consumption and waste generation, making it challenging to shift to more sustainable lifestyles. It is obvious that people's behaviour and treatment of climate change issues are not appropriate. The transition to climate neutrality clearly also depends on the social background of citizens. In addition, many of the changes - actions required to tackle climate change are linked to the perceptions and habits of citizens that should change. For example, people who consider that the car is a sign of wealth find it difficult to use public transport, as they believe that this damages their social image.	The city is its own ecosystem where every member plays a special part in the road to climate neutrality. Overcoming social and cultural factors and changing outdated behaviours and mindsets can have crucial results in Trikala’s journey towards climate neutrality. The support and engagement of the citizens is one of the most important and wanted outcomes of the Cities Mission.

Citizens with different background	Citizens, Municipality, Universities	The Municipality can more easily identify the economic and social groups into which its citizens are divided, using surveys and collected data. Universities can provide valuable assistance by conducting training seminars on climate neutrality.	Ensuring the successful and rapid progress towards climate neutrality requires the support and participation of all citizens. Failure to design a climate plan that is fair and mitigates social and economic disparities can negatively impact the city's climate action.	Some of the key principles of Trikala's climate planning are equity, justice and inclusion. The recognition of the social and economic groups within the city is necessary in order to incorporate the appropriate actions in planning that will ensure the above principles and guarantee a path towards climate neutrality that will take everyone into account.
Interconnection of the HEDNO network with RES installations	Municipality, HEDNO, Industry, Government, Universities, Private sector	The government sets the regulatory framework and policies that shape the integration of renewables into the grid. The government can provide financial incentives, subsidies or tax breaks to encourage both public and private investment in renewable energy infrastructure. The Municipality grants permits	HEDNO needs to invest and upgrade its infrastructure to accommodate the integration of RES. This includes network expansion, smart grid technologies and the development of energy storage systems. It also needs to manage the variability and intermittent renewable energy generation and monitor in real time, control systems	Collaboration and communication among these stakeholders are essential to address challenges and promote the effective integration of renewable energy into the electricity distribution network. This involves aligning policies, streamlining regulatory processes, investing in infrastructure, and fostering

		for the construction of renewable energy facilities. The HEDNO is responsible for the electricity distribution network. The industry's cooperation with the HEDNO is essential to connect to the grid and meet technical standards.Universities contribute to the development of innovative technologies and solutions for the integration of RES into the grid. Private companies, including energy developers, investors and service providers, are vital for the financing, construction and operation of RES projects.	and grid balancing to ensure stability.	innovation through research and development.
Systemic Opportunities				
Climate Policy Advancements	Government, Municipality	Tightening energy and climate laws is a good opportunity for government and municipalities to accelerate and intensify actions to help tackle the climate crisis.	Progress in policies to tackle the climate crisis and the tightening of energy and climate-related legislation can bring about huge changes and ultimately enable the transition to	Implementing strong and comprehensive climate policies, such as carbon pricing, renewable energy standards, and emission reduction targets, can create regulatory certainty and spur

			climate neutrality to take place. It is a fact that pressure from legislation is a serious incentive for municipalities and citizens. Mainly with the influence of European legislation and then with their adoption in Greek legislation, tackling the climate crisis becomes more accessible.	investments in clean technologies.
Renewable Energy Transition - Infrastructure System	Government, Municipality, Industry, Universities	The transition to RES concerns not only government and Municipalities, but also the markets, industry and research. Without the necessary research, it is not possible to overcome technological difficulties and without the necessary funding from the government, neither universities nor Municipalities can be supported by executives to implement sustainable practices. Moreover,	Shifting from fossil fuels to RES like solar, wind, hydro, and geothermal power presents a significant opportunity to reduce GHG emissions and foster sustainable economic growth. Greece, which has been using fossil fuels for years, is making great strides to change its energy mix and transition to climate neutrality.	The transition to RES has huge and long-term benefits for the environment, the economy and society. Some of the benefits are: • Tackling climate crisis • Improving public health • Sustainability, • Abundant availability of resources

		industry and the market rely heavily on fossil fuels, which requires proper preparation for the energy transition. It is obvious that in order to tackle the climate crisis, it is necessary for everyone to work together for a sustainable society.		
Green Finance & Investment - Economic System	Government, Banks, Private sector, Industry, Universities	Government and private companies are potentially the largest climate investors. At the same time, banks are a source of financing. The government can, through the provision of policy and financial incentives, enhance green investment. Industry and universities can function as research and innovation hubs regarding green technologies, through funding from economic establishments.	Allocating resources to research and development of eco-friendly technologies has the potential to trigger significant advancements in energy efficiency, carbon capture, sustainable agriculture, and other areas. This, in turn, can hasten the shift towards a low-carbon economy.	The development of green technologies and the possibility of leaving the laboratory and applying them on a full scale, can make them competitive with conventional practices and fossil fuels, creating the conditions for achieving climate neutrality.

Youth Movements - Social System	Municipality, Citizens	The Municipality must support the creation and action of youth movements regarding the climate and quality of life in the city. It is important to develop partnerships to raise the awareness of all citizens.	Involving and empowering the younger generation can inspire creative thinking, activism, and promotion of ambitious climate policies and initiatives.	The participation of citizens plays a decisive role in the implementation and success of climate actions. Cooperation with youth groups can speed up the awareness process of the rest of the population as well.
Corporate Social Responsibility - Economic/Social System	Municipality, Private sector	The connection between corporate social responsibility (CSR) and climate neutrality planning lies in their shared goal of addressing environmental and social concerns. In the context of CSR and the development of a green profile, collaboration between the Municipality and private companies is promoted for the design and implementation of climate actions.	Private companies have the necessary financial and human resources and perhaps the know-how to support the city on the path to climate neutrality.	Cooperation between the public and private sectors is a prerequisite for achieving climate neutrality. The city can benefit financially and knowledgeably from private companies.

On the path towards climate neutrality, various barriers and opportunities arise simultaneously. One significant obstacle encountered is bureaucracy, characterized by a slow, hierarchical structure with strict rules and standardized procedures. This bureaucratic setup can distance citizens from the decision-making process, posing a challenge to timely action on climate change—a pressing global issue requiring rapid responses. The slow decision-making process associated with bureaucracy can impede the timely implementation of climate policies and projects, delaying crucial actions needed to mitigate climate change impacts. Interventions like the OnevStop Shop for Energy Renovation on Buildings aim to simplify bureaucratic processes, reducing administrative burdens for property owners and streamlining energy renovation projects. Similarly, the establishment of a Municipal climate team (Trikala Climate Team) centralizes energy-related initiatives within municipalities, addressing bureaucratic hurdles and ensuring coordinated efforts with efficient resource allocation. Moreover, citizen engagement interventions such as forums and co-creation platforms offer direct engagement channels with policymakers. These platforms enable the identification and streamlining of bureaucratic processes that hinder progress towards climate goals. Through these collaborative efforts, communities can navigate bureaucratic challenges more effectively and accelerate progress towards climate neutrality.

Institutional capacity refers to the ability of organizations, institutions, or systems to effectively carry out their functions, fulfill their mandates, and achieve their objectives. It encompasses various elements, including human resources, organizational structures, policies and procedures, technical expertise, financial resources, and stakeholder relationships. In the context of climate change, institutional capacity is crucial for developing and implementing climate policies and initiatives, conducting research and analysis, managing natural resources, coordinating stakeholders, and responding to climate-related risks and impacts. A lack of resources and qualified personnel poses a significant barrier to effective environmental policy, resulting in delays in the implementation of essential programs and projects aimed at environmental protection. To effectively address climate change at the local level, it is essential for governments and municipalities to implement and enforce policies, programs, and initiatives. However, when these authorities are understaffed, their ability to respond efficiently to climate change challenges is compromised. Co-creation platforms play a crucial role in fostering collaboration among diverse stakeholders, technology experts, policymakers and authorities. By leveraging collective expertise, these platforms can help compensate for municipal understaffing and enhance institutional capacity for sustainable initiatives.

Financial constraints and the state of the economic system in general are undoubtedly a major obstacle to tackling the burning issue of climate change. The transition to sustainable technologies and practices often requires large investments. Since the city of Trikala may find it difficult to access the necessary funds for mitigation and adaptation to climate change, the financial component is too important to achieve the goal. Therefore, the government should create funding programs for municipalities that demonstrate significant climate action. At the same time, it can also create appropriate incentives for private companies, so that they can more easily invest in climate. Incentive programs encourage participation in sustainability efforts by offering financial rewards or subsidies, alleviating financial constraints and promoting the implementation of sustainable projects despite limited budgets.

The lack of public awareness is a critical issue that directly impacts efforts to address climate change. Often, there is apathy and indifference among citizens towards environmental actions, making it difficult to exert social pressure on governments to take effective measures against

climate change. Citizens may lack sufficient knowledge about the short-term and long-term impacts of climate change and may abstain from participating in environmental actions. Raising awareness and educating citizens is not solely an individual responsibility but also a duty of both the government and local municipalities. Collaboration and action from both levels of government are essential to ensure that citizens understand the significance of climate change and the need for action to address it. This can be achieved through educational campaigns and programs, as well as providing information through various channels. Educational campaigns sensitize people to the systemic factors of climate change and the importance of collective action. By providing information and resources, these campaigns empower citizens to make informed choices and support policy changes that address underlying systemic obstacles such as unsustainable consumption patterns and dependence on fossil fuels. Educational campaigns could be conducted through citizen forums and digital platforms focusing on climate crisis issues, thereby increasing interest and encouraging citizen participation in sustainable initiatives.

Political instabilities, partisan disputes, and social unrest make it more challenging to implement actions to address climate change. These issues divert attention and resources away from the need to adopt and implement crucial environmental policies. To address these challenges, efforts must be made to promote political stability and dialogue among all stakeholders in governance. Transparency, cooperation, and open communication are essential for the development and implementation of effective policies against the climate crisis. In this regard, stakeholder forums and platforms for collaboration play a crucial role as spaces for constructive dialogue and commitment to sustainability goals.

Cooperation and coordination between agencies is crucial to address technological constraints and promote clean and sustainable technologies. Government can provide the framework and policies that encourage investment in research and development, while industry and the market can contribute by producing and adopting clean technologies. Research and innovation in universities, on the other hand, can promote new technologies and practices that respond to climate challenges.

Technological constraints present significant hurdles in addressing the climate crisis. Some emission reduction technologies are either still in the developmental stage or too costly, limiting their widespread adoption. This challenge is compounded by the continued affordability and accessibility of traditional carbon-based energy sources, hindering the transition to renewable energy. The fossil fuel industry wields considerable influence across various sectors, particularly in politics. Consequently, it shapes policy decisions in many countries, driven by its substantial profits and alignment with political interests. As a result, the advancement of renewable energy sources often faces obstacles and resistance in favor of fossil fuels. Moreover, the complexity of renewable energy technologies and the specialized expertise required can further hinder public adoption. To tackle these challenges, co-creation platforms facilitate collaboration among technology experts, policymakers, and stakeholders, fostering innovation and addressing technological barriers to sustainability. Additionally, citizen and stakeholder forums play a pivotal role in amplifying the voices of advocates for sustainable practices. By countering the influence of fossil fuel lobbying, these forums advocate for alternative, environmentally friendly policies and initiatives.

The project team within the Municipality must identify social and cultural factors that hinder climate action and design targeted workshops and actions to address them. Many of the changes necessary to combat climate change are intertwined with citizens' perceptions and habits, which

need to evolve. Cultural norms, values, and behaviors significantly influence activities, consumption patterns, and waste generation, making the transition to sustainable lifestyles challenging. It's evident that people's attitudes and behaviors toward climate change are inadequate. Achieving climate neutrality also hinges on citizens' social backgrounds. For example, individuals who view car ownership as a status symbol may resist switching to public transportation due to concerns about social status. In a city like Trikala, every resident plays a crucial role in moving toward climate neutrality. Overcoming social and cultural barriers and changing outdated attitudes and behaviors are essential steps in this journey. Citizen forums offer inclusive platforms where residents from diverse backgrounds can share their perspectives and contribute to decision-making. By ensuring that policies and initiatives reflect community needs and values, these forums play a vital role in Trikala's efforts to achieve climate neutrality.

Another significant obstacle is the diverse backgrounds of citizens, including differences in cognition, economics, and social status. Municipalities can better understand the economic and social groups within their jurisdiction through surveys and data collection. Universities can also play a crucial role by offering training seminars on achieving climate neutrality. However, failing to develop a climate plan that addresses social and economic disparities can undermine the effectiveness of the city's climate action efforts. In Trikala's climate planning, fundamental principles such as fairness, justice, and inclusivity are paramount. Recognizing the diverse social and economic landscape within the city is essential for integrating appropriate measures into the planning process. This ensures adherence to these principles and paves the way for climate neutrality while considering the needs of all residents.Citizen and stakeholder forums serve as inclusive platforms where individuals from various backgrounds can voice their opinions and contribute to decision-making processes. These forums play a vital role in ensuring that policies and initiatives are inclusive and representative of the community's diverse needs and perspectives

The interconnection of the HEDNO network with RES installations is pivotal for advancing the transition to a low-carbon energy system, bolstering grid flexibility, fostering energy independence, driving economic growth, and enhancing environmental sustainability. To achieve this, HEDNO must invest in and upgrade its infrastructure to accommodate the integration of renewable energy sources. Additionally, effective collaboration and communication among stakeholders are vital to facilitate the seamless integration of renewable energy into the electricity distribution network. Stakeholder forums serve as a key platform for fostering such collaboration. By bringing together energy providers, regulators, and renewable energy stakeholders, these forums play a crucial role in overcoming obstacles related to the interconnection of the HEDNO network with RES installations. Through stakeholder forums, initiatives promoting the integration of renewable energy sources into the grid can gain momentum, thereby reducing reliance on fossil fuels and propelling the transition toward a more sustainable energy system.

Strengthening energy and climate regulations presents a favorable chance for governments and local authorities to expedite and enhance efforts aimed at addressing the climate emergency. Enforcing robust and all-encompassing climate measures, including carbon pricing, mandates for renewable energy adoption, and goals for reducing emissions, can establish regulatory clarity and stimulate investments in clean technologies. It is a fact that pressure from legislation is a serious incentive for municipalities and citizens. Mainly with the influence of European legislation and then with their adoption in Greek legislation, tackling the climate crisis becomes more accessible.

The transition to RES involves not only the government and Municipalities but also markets, industry, and research. Without essential research, it is impossible to overcome technological challenges, and without necessary government funding, neither universities nor Municipalities can support professionals to implement sustainable practices. Furthermore, industry and the market heavily rely on fossil fuels, which necessitates proper preparation for the energy transition. It is evident that addressing the climate crisis requires a collective effort from all stakeholders towards a sustainable society. Greece, which has been relying on fossil fuels for many years, is taking significant strides to shift its energy mix and transition towards climate neutrality.

When it comes to Green Finance and Investment, the reasonable allocation of resources towards research and development of environmentally sound technologies can have significant implications in many areas. This approach can promote energy efficiency, carbon reduction, the practice of sustainable agriculture and other related sectors. This, for its part, can accelerate the transition towards an economy that produces less carbon dioxide emissions. It's evident that both the government and private corporations have the capacity to be significant contributors to climate-related investments. At the same time, banks can serve as funding sources. The government can boost and reinforce investments in eco-friendly ventures by offering policy incentives and financial encouragement. Industry and universities can serve as hubs for research and innovation in green technologies, with funding from financial institutions. The development of green technologies and the ability to be widely applied can make them competitive with traditional practices and the use of fossil fuels. Incentive programs can alleviate financial constraints by offering grants, subsidies, or tax incentives for sustainable initiatives, while stakeholder forums can advocate for increased funding and resource allocation to address sustainability challenge.

Citizen participation is a crucial factor in the implementation and success of environmental initiatives. Working with young groups can speed up the awareness process and positively influence the rest of the population. Engaging and empowering the younger generation can enhance creative thinking, promote activism and encourage support for ambitious policies and initiatives to tackle climate change. Young people are perhaps a little more aware of the seriousness of the problem and are willing to take action. Youth movements can easily focus on raising public awareness of climate change and its consequences. This can be achieved by organizing events, protests and campaigns, in order to promote the issue and inform the public. Also, it is possible to put more pressure on the political leaders and the government to take concrete measures to limit the emission of greenhouse gases and the general management of the climate crisis. More knowledge and exposure in the field of environment, best practices for environmental conservation and climate science are some of the possibilities that young people have and can offer. in environmental protection and emission reduction, since they have more friction with science, perhaps fresher ideas and willingness. The youth movement represents a force that struggles to deal with the crisis and can create changes for perspective and change. Citizen forums provide a platform for open dialogue and discussion on climate-related issues. By facilitating conversations among young people, forums can help identify systemic barriers and develop collaborative solutions. Additionally, forums promote transparency and accountability in decision-making processes, ensuring that the concerns and priorities of citizens are addressed.

Engaging local communities in climate action initiatives builds social cohesion and resilience, addressing systemic barriers such as social inequality and lack of access to resources. Community-led projects and initiatives empower residents to implement solutions that are tailored to their specific needs and circumstances, driving systemic change from the ground up.

Businesses can help reduce GHG emissions by adapting more sustainable and environmentally friendly processes and technologies. Also, cooperation between the public and private sectors is a necessary condition for achieving climate neutrality. Therefore, businesses can work with local communities to support environmental protection programs, promote recycling, and offer financial support for the implementation of sustainability programs. Moreover, the need to address climate change creates opportunities for businesses that develop and sell green technologies and products that reduce emissions and create green jobs.

Citizen engagement actions and interventions play a crucial role in addressing systemic barriers to climate neutrality by empowering individuals and communities to take collective action and drive meaningful change. Educational campaigns empower citizens to make informed choices and advocate for policy changes that address underlying systemic barriers. Moreover, citizen forums provide a platform for open dialogue and discussion on climate-related issues, facilitating conversations among diverse stakeholders to identify and address systemic barriers effectively. In addition to educational campaigns and citizen forums, co-creation platforms serve as valuable tools for collaboration between technology experts, policymakers, and stakeholders. These platforms foster the development and implementation of innovative solutions to overcome technological barriers hindering progress towards climate neutrality. By facilitating dialogue and knowledge-sharing, co-creation platforms enable stakeholders to collectively devise strategies for integrating renewable energy sources into existing infrastructure and reducing reliance on fossil fuels. Furthermore, stakeholder forums play a critical role in promoting collaboration between energy providers, regulators, and renewable energy stakeholders. These forums facilitate discussions on challenges related to the interconnection of energy grids with renewable energy installations, thereby promoting the seamless integration of renewable energy sources into the grid. Through collaborative efforts, stakeholders can address regulatory hurdles and technical challenges, paving the way for a more sustainable energy future. Overall, citizen engagement actions, including educational campaigns, citizen forums, co-creation platforms, and stakeholder forums, are essential for identifying and addressing systemic barriers to climate neutrality. By fostering collaboration and dialogue among diverse stakeholders, these initiatives empower communities to drive meaningful change and accelerate progress towards a sustainable and resilient future.

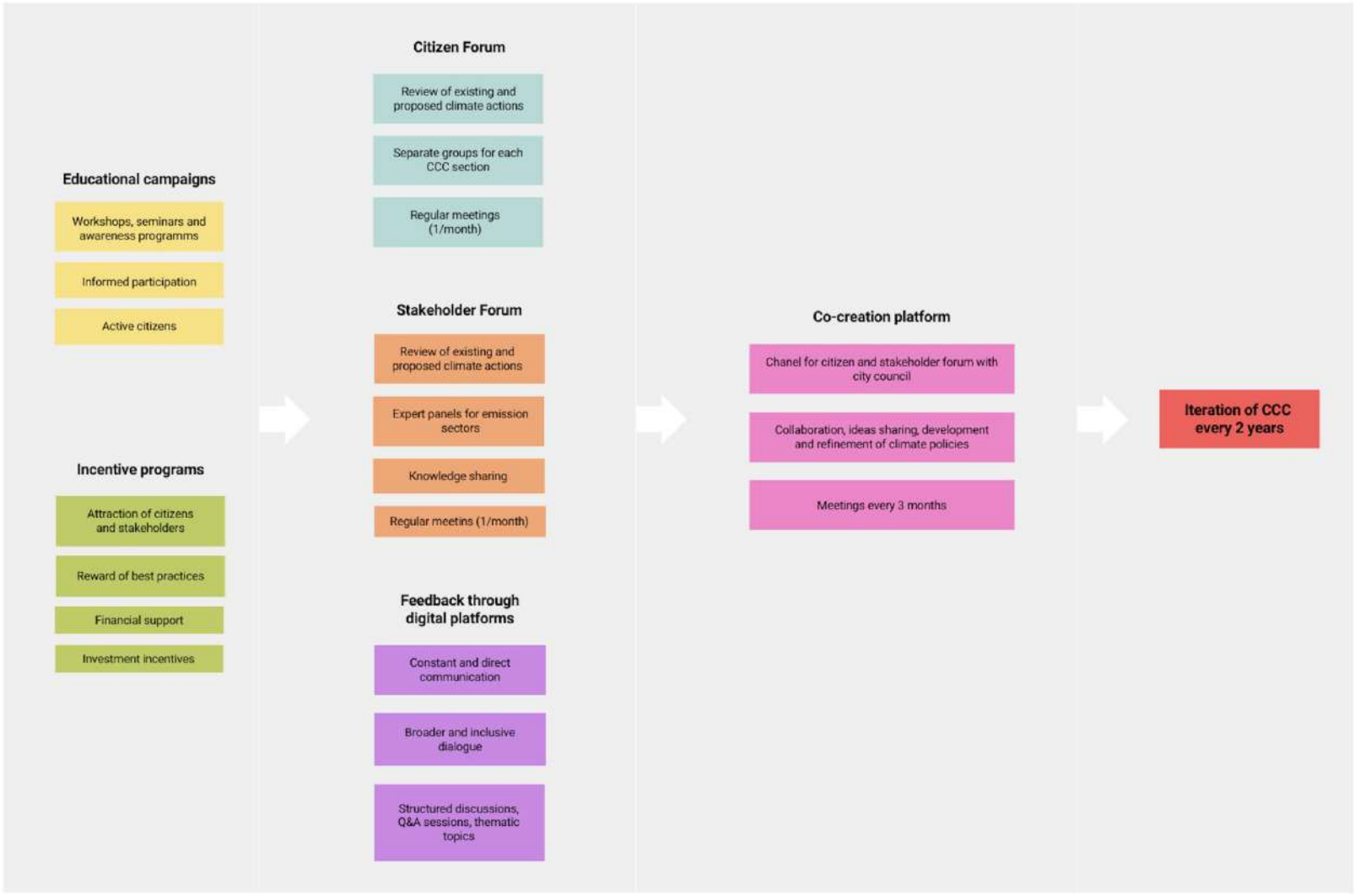


Figure 7. Participatory model for the city climate neutrality

3. Part B – Pathways towards Climate Neutrality by 2030

Part B represents the core of the Action Plan, shaped by local authorities, local businesses and stakeholders, comprising of the most essential elements: scenarios, strategic objectives, impacts, action portfolios and indicators for monitoring, evaluation and learning.

3.1. Module B-1 Climate Neutrality Scenarios and Impact Pathways

B-1.1: Impact Pathways

Fields of action	Systemic levers	Early changes (1-2 years)	Late outcomes (3-4 years)	Direct impacts (Emission reductions)	Indirect impacts (co-benefits)
Energy systems	Technology & Infrastructure	• Renewable Energy Integration • Smart grids and energy management systems • Efficiency improvement • Consumer empowerment	• Decentralised energy production and distribution • Advanced Metering Infrastructure (AMI) • Diverse Energy Mix • Energy storage innovation • Resilience enhancement • Integration of Virtual Power Plants	Decarbonising electricity generation: 251,65 kt CO_2e	• Energy security • Green jobs • Financial savings • Independence from energy market
			•Carbon pricing		• Energy security

Government & Policy	•Energy subsidies and incentives •Energy efficiency standards •Net metering policies •Electrification initiatives •Strict emissions regulations •Green Procurement	•Renewable energy deployment •Research and innovation funding •Energy security measures •Developing codes and standards for energy efficiency	• Green jobs • Financial savings • Independence from energy market • Equity • Justice
Social innovation	•Community engagement •Local energy initiatives •Crowdsourced solutions •Civic collaboration •Cross-sector collaboration	•Behavioural change and cultural shift •Energy poverty mitigation •Capacity building •Policy influence •Community ownership	• Equity • Justice • Financial savings • Energy security • Capacity building • Participation • Independence from energy market
Democracy & Participation	•Transparency and accountability •Informed decision-making •Citizen engagement	•Development of long-term energy strategies •Policy innovation •Public funding allocation	• Equity • Justice • Financial savings • Energy security

		•Education and awareness			• Capacity building • Participation • Independence from energy market
	Finance & Funding	•Renewable energy expansion •Inclusive finance •Energy transition planning •Green entrepreneurship	•Technology innovation •Market transformation •Green infrastructure development •Carbon pricing and trading •Green job creation		• Well-being • Financial savings • Energy security • Green jobs • Capacity building • Economic development • Independence from energy market
	Learning & Capabilities	•Workforce development •Informed decision-making •Community empowerment	•Behavioural change and cultural shift •Policy advocacy •Regulatory compliance		• Equity • Justice • Green jobs • Capacity building • Participation • Economic development
Mobility & transport	Technology & Infrastructure	•Mobility as a Service (Maas)	•Electrification of transportation	Reduced motorised passenger transportation need:	• Health • Financial savings • Green jobs

		•E-Mobility infrastructure •Last-Mile Delivery innovations •Shared mobility platforms •Micromobility establishment	•Intelligent Transportation Systems (ITS) •Vehicle to Grid (V2G) Integration •Infrastructure for active transportation (walking and cycling) •Data-driven decision making •Alternative fuels infrastructure	5,54 kt CO_2e Shift to public & non-motorised transport: 2,59 kt CO_2e Increased car pooling: 0,51 kt CO_2e Electrification of cars & motorcycles: 1,60 kt CO_2e Electrification of buses: 0,38 kt CO_2e	• Air quality • Active lifestyle • Reduced traffic
	Government & Policy	•Promotion of public transportation •Incentives for Electric Vehicles (EVs) •Vehicle emissions standards •Parking policies •Active transportation plans •Inclusive accessibility	•Zoning and urban planning •Zero-Emission Zones •Integration of mobility services	Electrification of trucks & Optimised logistics: 9,04 kt CO_2e	• Health • Financial savings • Air quality • Active lifestyle • Reduced traffic
	Social innovation	•Collaborative ride-sharing	•Community-led transportation initiatives		• Physical and mental health • Financial savings

	•Cycling and walking initiatives •Sustainable and inclusive mobility solutions for vulnerable social groups	•Demand-Responsive Transport (DRT) •Youth-Led initiatives	• Air quality • Active lifestyle • Reduced traffic • Participation
Democracy & Participation	•Transportation equity •Transparency and accountability •Public hearings and consultations •Transit user feedback platforms	•Citizen-driven transport planning •Public funding allocation •Empowered local government	• Well-being • Equity • Justice • Financial savings • Participation
Finance & Funding	•Mobility infrastructure investments •Research and development •Green mobility initiatives	•Public transport and fleet upgrade •Electrification of transportation •Public-private partnerships •Affordable fare programs	• Well-being • Financial savings • Green jobs • Capacity building • Economic development • Equity
Learning & Capabilities	•Capacity building and skilled workforce	•Eco-driving integration •Behavioural change and cultural shift	• Equity • Justice • Green jobs

		•Safety and security awareness •Integration of new mobility services	•Regulatory and policy understanding		• Capacity building • Participation • Economic development
Waste & Circular Economy	Technology & Infrastructure	•Waste management digitalisation •Repairing and refurbishment centres creation •Waste services upgrade (separate collection, smart bins, frequent collection)	•Sustainable and more efficient waste management plants •Circular supply chains •Waste-to-Energy conversion •Resource sharing through digital platforms •Circular housing solutions	Increased waste recycling and landfill minimisation: 21,38 kt CO_2e	• Public health • Financial savings • Green jobs • Capacity building • Economic development • Aesthetic upgrade
	Government & Policy	•Extended Producer Responsibility (EPR) •Tax incentives for recycling and Circular Economy practices •Green Procurement •Strict waste management city regulation	•Subsidies for circular businesses •Local Circular Economy plans		• Public health • Financial savings • Aesthetic upgrade

Social innovation	•Community-led waste management initiatives •Repair cafes •Waste education in schools •Circular Economy workshops •Citizen science projects	•Sharing and swapping platforms •Circular design competitions •Plastic-free communities •Community-led innovation hubs	• Public health • Financial savings • Aesthetic upgrade • Capacity building • Participation
Democracy & Participation	•Waste audits by citizens •Local food waste programs •Waste management transparency •Stakeholder inclusion in policy formulation	•Consumer preferences for circular products •Participatory budgeting for waste initiatives	• Well-being • Equity • Justice • Financial savings • Participation
Finance & Funding	•Circular business startups •Waste reduction incentives •Circular product subsidies	•Circular infrastructure development •Research and innovation funding •Innovation competitions •Public-private partnerships	• Well-being • Financial savings • Green jobs • Capacity building • Economic development

	Learning & Capabilities	•Waste upcycling projects •Capacity building and skilled workforce	• Behavioural change and cultural shift		• Equity • Green jobs • Capacity building • Participation • Economic development
Green infrastructure & Nature-based solutions	Technology & Infrastructure	•Remote sensing and data analysis •GIS use and spatial analysis •Simulation and modelling •Smart irrigation and water management	•Greenery and habitat restoration •Innovative green infrastructure integration	Carbon sequestration: 5,14 kt CO_2e	• Physical and mental health • Well-being • Financial savings • Aesthetic upgrade • Air quality • Active lifestyle • Biodiversity support
	Government & Policy	•Tax incentives for the integration of green infrastructure on buildings •Zoning and land use policies	•Urban greening targets •Mandatory integration of green infrastructure in new constructions		• Physical and mental health • Well-being • Financial savings • Aesthetic upgrade • Air quality • Active lifestyle • Biodiversity support

Social innovation	•Creation of groups for outdoors/nature activities •Cooperation with the municipal social grocery	•Green spaces access increase •Creation of urban farming groups •Collective gardens	• Physical and mental health • Well-being • Financial savings • Aesthetic upgrade • Air quality • Active lifestyle • Biodiversity support • Equity • Participation
Democracy & Participation	•Greater citizen interest in the city's policies •Citizen informing and consulting	•Developing a sense of trust in the city authorities •Citizen empowerment through co-deciding	• Well-being • Equity • Justice • Participation
Finance & Funding	•Green infrastructure investments •Green infrastructure & Nature-based solutions initiatives	•Public-private partnerships •Green city spaces for recreation and food production	• Well-being • Financial savings • Green jobs • Capacity building • Physical and mental health

					• Aesthetic upgrade • Air quality • Active lifestyle • Biodiversity support • Equity • Participation
	Learning & Capabilities	•Skill development for professionals and citizens •Citizen engagement and education	•Targeted and meaningful citizen participation •Collaboration between different business sectors •Resilience and adaptation •Behavioural change and cultural shift		• Well-being • Equity • Green jobs • Capacity building • Participation • Economic development
Built environment	Technology & Infrastructure	•Energy efficiency and sustainability •Smart buildings increase •RES building integration	•Creation of smart and connected city districts •Development of resilient buildings with adaptable functions and systems	Building renovations: 6,37 kt CO_2e New energy efficient buildings: 0,16 kt CO_2e Efficient lighting & appliances:	• Well-being • Public health • Financial savings • Green jobs • Energy security • Capacity building

		•Circular Economy and materials adaptation •Innovative technologies integration	58,32 kt CO_2e Decarbonising heating generation: 15,23 kt CO_2e	• Independence from energy market • Aesthetic upgrade
Government & Policy	•Development of green buildings standards •Incentives for smart and green buildings •Zoning and land use policies •Circular buildings and materials policies •Incentives for sustainable renovation in buildings	•Affordable sustainable housing policies •Mandatory sustainable standards for new constructions		• Public health • Well-being • Financial savings • Aesthetic upgrade • Equity • Justice • Energy security • Independence from energy market
Social innovation	• Community owned RES plants for buildings electrification	• Affordable sustainable social housing		• Well-being • Financial savings • Equity • Justice • Energy security • Independence from energy market • Participation

			• Capacity building
Democracy & Participation	•Greater citizen interest in the city's policies •Citizen informing and consulting •Development of digital platform for citizen engagement for spatial and building decision-making	•Developing a sense of trust in the city authorities •Citizen empowerment through co-deciding	• Well-being • Equity • Justice • Participation • Capacity building
Finance & Funding	•Public infrastructure projects development	•Revitalisation and upgrade of city areas	• Well-being • Financial savings • Green jobs

		•Accelerating the energy retrofitting of buildings	•Public-private partnerships •Community schemes investment •Research and innovation funding	• Capacity building • Aesthetic upgrade • Equity • Participation • Energy security • Economic development • Independence from energy market
	Learning & Capabilities	•Skilled workforce •Citizen engagement and education •Sustainable practices adaptation	•Targeted and meaningful citizen participation •Collaboration between different business sectors •Resilience and adaptation •Behavioural change and cultural shift	• Well-being • Equity • Green jobs • Capacity building • Participation • Economic development

Smart City Actions	Technology & Infrastructure	• Improved data collection and integration • Real-time traffic monitoring • Optimised public transportation routes • Smart grid implementation • Energy consumption monitoring • Early warning systems & environmental monitoring • Smart water metering & leak detection • Smart waste collection • Waste management - recycling tracking • Digital infrastructure development	• Enhanced city-wide connectivity • Reduced traffic congestion • Lower carbon emissions • Enhanced transportation infrastructure • Increased energy efficiency • Integration of RES • Improved disaster response • Environmental sustainability • Efficient water management - reduced wastage • Water conservation measures • Increased recycling and reduced landfilling	• Physical and mental health • Well-being • Cost savings • Economic development • Job creation • Reduced carbon footprint • Resilience • Inclusivity • Equity and justice

	• Expanded broadband access • IoT device connectivity	• Cleaner urban environment • Improved communication networks • Support for emerging technologies	
Government & Policy	• Streamlined data sharing among government departments • Improved inter-agency collaboration • Implementation of smart transportation policies	• Enhanced governance efficiency • Data-driven decision making • Improved public services	• Well-being • Cost savings • Economic development • Increased accountability • Data-driven decision making

- Data-driven traffic management
- Integration of health data for policy planning
- Targeted social interventions
- Implementation of smart energy policies
- Promotion of RES
- Integration of smart technologies in disaster response planning
- Smart water management policies
- Regulations for efficient water use
- Implementation of smart waste management policies
- Adoption of policies supporting digital infrastructure
- Policies promoting citizen engagement
- Optimised urban mobility and transportation safety
- Informed public health policies
- Increased energy efficiency and reduced GHG emissions
- Sustainable energy policies
- Data-informed environmental policies
- Conservation policies
- Sustainable water management
- Increased recycling and minimisation of landfilling
- Improved waste management practices
- Sustainable urban development policies
- Business-friendly environment
- Equity and justice
- Policy innovation
- Public satisfaction
- Job creation

	• Policies to enhance broadband access and support for IoT infrastructure	• Strengthened community-government relations • Support for emerging • technologies	
Social innovation	• Remote health monitoring and digitalisation of services • Data-driven social services • Improved communication and collaboration among diverse community groups • Enhanced accessibility for all citizen, including people with disabilities • Energy awareness campaigns • Citizen led environmental initiatives	• Proactive social interventions • Better healthcare accessibility • Strengthened social networks • Increased citizen engagement • Inclusive decision making • Reduced social disparities in mobility • Empowered communities in sustainable energy practices • Reduced energy poverty • Environmental conscious behaviour • Community resilience	• Physical and mental health • Well-being and quality of life • Equity and justice • Participation • Inclusivity • Community empowerment • Resilience

	• Education on responsible water use • Sustainable waste management and waste reduction campaigns	• Awareness of water issues and collective efforts for sustainable water management • Community-driven circular economy initiatives	
Democracy & Participation	• Citizen engagement platforms • Participatory budgeting • Increased transparency in government operations • Community involvement in city's strategic planning	• Strengthened community ties • Improved trust in local government • Informed and engaged citizens • Enhanced digital inclusion • Participatory decision-making processes • Responsive and accountable local governance	• Well-being • Equity and justice • Participation • Empowerment • Informed community

Finance & Funding	• Improved financial data management • Increased revenue from smart transportation systems • Cost savings in traffic management • Data-driven healthcare resource allocation • Cost savings from energy efficiency technologies • Cost savings in water distribution • Cost savings in waste collection and management	• Increased economic productivity • Enhanced business environment • Optimised resource allocation • Improved creditworthiness • Revenue streams from mobility services • Optimised social and healthcare service spending • Lower energy costs and revenue from sustainable energy initiatives • Reduced financial losses from disasters • Increased funding for resilience projects • Increased revenue from circular economy initiatives	• Well-being • Financial savings • Job creation • Economic development • Resilience • Financial sustainability • Innovation ecosystem • Private sector engagement • Investor confidence
Learning & Capabilities	• Data and digital literacy among city	• Organisational agility	• Well-being • Equity and justice

	employees and professionals • Upskilling of professionals • Education on health data privacy • Capacity building programs • Education on disaster preparedness • Training programs for city officials in participatory governance • Public education on civic engagement	• Culture of continuous learning • Skilled workforce proficient in technology and digital services • Increased innovation • Community resilience • Informed and engaged city administration • Public capability in participation and decision making processes	• Job creation • Capacity building • Participation • Economic development • Innovation culture • Collaboration • Empowerment

There are six fields of action identified; Energy Systems, Mobility & Transport, Waste & Circular Economy, Green infrastructure & Nature-based solutions, Built environment and Smart City solutions. The list of impact pathways is selected from the NetZeroCities Theory of Change and it includes several systemic levers that are addressed in the above table. The systemic levers in question are: Technology & Infrastructure, Government & Policy, Social innovation, Democracy & Participation, Finance & Funding and Learning & Capabilities.

Regarding the Energy Systems field, some of the early changes are RES integration, efficiency improvement and consumer empowerment. These contribute to immediate reductions in carbon footprint, fostering a foundation for sustainable energy practices. Late outcomes like decentralised energy production and diverse energy mix, ensure long-term resilience and a diversified energy portfolio, reducing dependence on traditional energy sources. The early changes align with the identified barriers by addressing current inefficiencies, while the late outcomes tackle long-term issues, such as energy security and innovation funding, identified in the current state analysis. Early changes address immediate concerns, while

late outcomes ensure a sustainable progress towards climate neutrality. Early changes provide quick wins, giving the city and the stakeholders a boost to continue their strategic efforts. Late outcomes are connected with long-term priorities, such as renewable energy deployment and research funding, that can contribute to an actual systemic change within the city's operations.

Decarbonisation of electricity and heating generation is one of Trikala's key priorities. Decarbonisation initiatives entail an increased reliance on renewable energy sources. This transition to renewables fosters the development of a sustainable energy system that aligns with the goals of climate neutrality. This key priority is directly linked to impact pathways regarding Energy systems and Built environment, because it has to do with the way the city meets its energy demand and operates its buildings. Early changes identifies in the impact pathways are immediate actions that can kickstart the decarbonisation process. For instance, integrating RES, implementing smart grids and energy management systems, creating subsidies and incentives, establishing energy efficient and green buildings standards and promoting energy efficiency improvements are all actions that directly contribute to reducing carbon emissions in electricity and heating production. Late outcomes are basically the long-term goals and achievements resulting from sustained efforts through early changes in decarbonisation. Outcomes such as decentralised energy production, advanced metering infrastructure, diverse energy mix, development of resilient buildings with adaptable functions and systems and innovative technologies integration are all aligned with the overarching goal of achieving climate neutrality in electricity and heating generation. On top of that, there are additional positive outcomes that result from decarbonisation efforts. The co-benefits include aspects such as energy security, green job creation, financial savings, and equity. By prioritizing decarbonisation, Trikala can not only mitigate climate change but also foster local economic growth, improve energy security, and promote social equity. The city's key priority is connected to the impact pathways by ensuring that changes and outcomes will lead to the ultimate goal of achieving climate neutrality.

At the Mobility and Transport field, early changes include MaaS, e-mobility infrastructure and micromobility promotion. These changes are linked to actions promoting direct shifts towards sustainable transportation practices. While the city implements climate actions, it sets the foundation for late outcomes like electrification of transportation and alternative fuels infrastructure, which contribute to a sustainable, accessible, low-carbon transportation ecosystem. Currently, Trikala faces challenges in the transport field like the fossil fuel motorised fleet that is old and frequent car use from citizens. Early changes including incentivising EVs and promoting public transportation, are addressing these challenges. Late outcomes contribute to long-term goals, like data-driven decision making regarding transport systems. Early changes essentially provide quick improvements and immediate shifts in behavior, contributing to short-term commitments and plans of the city. At the same time these changes pave the way for late outcomes and systemic changes, addressing the establishment of the necessary infrastructure for sustainable transportation. The identified impact pathways focusing not only in infrastructure but also in other systemic levers, like policy and social innovation, are expected to lead the city's shift to public and non-motorised transport realising another one of the city's key priorities.

The Waste & Circular economy field in Greece faces a lot of problems, mostly because of infrastructure and education lacking. Taking this into consideration, early changes have to address the immediate challenges. For example the digitalisation of waste management provides the city with robust data to plan its strategies, while the establishment of repair cafes aims to raise citizen awareness and at the same time reduce waste. Systemic changes, like the implementation of circular supply chains, are considered late outcomes that contribute significantly to long-term

sustainability. Early changes are directed at small scale challenges like improving waste management practices and efficiency, while the late outcomes contribute to the long-term vision of a circular economy, supporting circular businesses, reducing overall waste and promoting sustainability. All the information and awareness actions combined with stricter policies, circular solutions and waste management infrastructure are going to promote the city's key priority for sustainable waste management and circular economy practices adoption.

Green infrastructure and Nature-based solutions absorb carbon overtime and Trikala will use them as natural sinks, while gaining from their many co-benefits. This field includes the creation of green urban spaces with integration of technologies like remote sensing and smart irrigation (as early changes) for the improvement of green infrastructure. The stable increase of urban green spaces will lead to late outcomes such as greenery restoration and innovative green infrastructure, establishing the foundations for sustainable and resilient urban ecosystem. Early changes are aiming to the immediate solution of challenges (smart irrigation, spacial data analysis) and the implementation of suggested actions. The long-term goal is for green infrastructure integration to be mandatory in new constructions. Late outcomes due to green infrastructure and nature-based solutions contribute to the vision of sustainable urban ecosystems, addressing climate resilience and citizen well-being.

Trikala places a significant emphasis on prioritising energy renovation and the efficient utilisation of its building stock as part of its strategy towards achieving climate neutrality. Recognising the pivotal role of the Built Environment sector in climate action planning, the city aims to address building emissions, which are a primary contributor to greenhouse gas emissions. Early changes coming from implemented actions include energy efficiency and RES integration, controlled by smart systems. The development and implementation of building standards can also support the city's plan for resource efficiency and urban sustainability. Late outcomes establish a foundation for a resilient built environment. Buildings identify as the biggest contributor to GHG emissions within the city. Early changes will face current challenges, while the late outcomes aim to systemically change the building sector of the city, integrating sustainability. By addressing building emissions and promoting sustainable practices, the city aims to create a resilient and environmentally conscious community in its pursuit of climate neutrality.

The successful implementation of actions and accelerated development of all the changes and outcomes listed above can only be possible with the integration of various smart systems within the city's operations. The monitoring and control of existing and future actions, as well as the collection of robust data, is a great tool in the journey towards climate neutrality. From early changes including data-driven decision and policies to late outcomes like upgraded public services, economic productivity and transparency, smart city actions are the glue that connects all of Action Plan's elements.

Trikala's prioritisation of its "Restart mAI city" initiative is closely intertwined with its Smart City actions impact pathways. Over the next two years, the city intends to implement its smart plan, focusing on crucial early changes such as enhancing data collection and integration, instituting real-time monitoring systems, incorporating Internet of Things (IoT) technologies, fostering better collaboration among agencies, and transitioning to a participatory governance model. These initial steps are fundamental in laying the groundwork for broader transformations.

As Trikala progresses towards its digital evolution, it anticipates achieving late outcomes including city-wide connectivity, heightened energy efficiency, data-informed decision-making processes, optimized delivery of city services and operations, and notably, a reduction in carbon

emissions. These outcomes are pivotal in reshaping and revitalizing the city, positioning it firmly on the path towards climate neutrality. Moreover, the concerted efforts towards digital transformation are poised to generate additional co-benefits, such as improved well-being among residents, greater equity and justice in access to resources and services, enhanced citizen participation and empowerment in civic matters, stimulation of economic development through innovation and technology, and bolstering financial sustainability through optimized resource allocation. By harnessing the power of technology and fostering collaboration and participation, the city not only aims to mitigate its environmental footprint but also seeks to create a more resilient, inclusive, and prosperous community for its residents.

Together, Restart mAI city and the citizen-centric governance model stand as the foremost priorities for Trikala. We firmly believe that these initiatives serve as pivotal levers capable of instigating profound systemic changes essential for our journey towards climate neutrality. As highlighted in our impact pathways analysis, social innovation and participation emerge as critical systemic drivers across all action fields. This underscores the significance of community engagement, collaboration, and inclusive decision-making processes in driving transformative change. Initiatives such as public hearings, consultations, feedback platforms, and community-led projects, established at an early stage, are poised to reshape our city's governance model over time.

Late outcomes are anticipated to manifest in various forms, including policy innovation, citizen-driven planning, empowered communities, and participatory budgeting. By fostering an environment where residents are actively involved in decision-making processes and policy formulation, we aim to cultivate a sense of ownership and responsibility among all stakeholders. The engagement of the entire city ecosystem is paramount in our pursuit of climate neutrality. Through collective efforts and sustained commitment, we are confident in our ability to gradually transition towards a more sustainable and resilient future for Trikala and its residents.

In summary, the selected impact pathways across various sectors address both short-term and long-term priorities by incorporating early changes for immediate improvements and late outcomes for establishing foundations for sustained climate action and resilience. They align with the current state analysis and the city's 2030 Climate Neutrality Commitments, providing a comprehensive and adaptive approach to addressing climate challenges.

Key Strategic Priorities

The city of Trikala utilizes the outlined definition of impact pathways and systemic levers to identify specific outcomes and co-benefits, which in turn inform its key strategic priorities. These priorities are represented as city-wide challenges that Trikala is steadfastly committed to accomplishing on its path towards climate neutrality. Additionally, the action portfolio is heavily influenced by the impact pathways and key strategic priorities, with each component interconnected and mutually influencing one another. Trikala’s six key strategic priorities are:

1. Citizen-centric governance model

The transformation towards a citizen-centric governance model stands as a systemic strategic priority in Trikala, reflecting a fundamental shift in the city's approach to civic engagement and public administration. This model places the needs, preferences, and aspirations of the residents at the forefront of decision-making processes, emphasizing a more inclusive and participatory form of governance. Trikala envisions a city where citizens actively contribute to shaping policies, programs, and urban development initiatives, fostering a sense of shared responsibility and community ownership. By embracing a citizen-centric model, Trikala seeks to establish a transparent and accountable governance structure that not only responds to the diverse needs of its population but also cultivates a culture of trust and collaboration between local authorities and residents.

The adoption of a citizen-centric governance model in Trikala involves not only a structural reconfiguration of administrative processes but also a cultural transformation that values the input of citizens in the co-creation of public policies. This approach entails leveraging technology to enhance communication channels, facilitating real-time feedback mechanisms, and promoting citizen participation in decision-making forums. Trikala recognizes that a citizen-centric model is instrumental in building resilient and sustainable communities, as it ensures that the city's development aligns closely with the collective aspirations of its inhabitants. This strategic shift reaffirms the city's commitment to democratic principles, social inclusion, and the creation of a vibrant urban environment that reflects the shared vision and values of its diverse population.

Actions: Citizen engagement in Part C

2. Trikala - Restart mAI city

Cities represent dynamic spaces that undergo continuous changes, interacting with both endogenous and exogenous factors. Within the context of these transformations, the internal processes of cities are directly impacted, resulting in the emergence of challenges across the city's functions that require addressing. Trikala faces numerous challenges such as energy efficiency, climate change, employment, economic development, migration, social cohesion, and environmental pollution, while also grappling with the competition from other cities in attracting investors, new residents, and visitors. In the midst of the Fourth Industrial Revolution and the rapid growth of digital technology, Trikala is called upon to play a distinctive role. It is tasked with becoming a leader in devising and implementing solutions that creatively and effectively address the contemporary problems of urban governance.

The digitisation of city processes at the governance, mobility, healthcare, social care, natural resources, civil protection, and other levels stands as a fundamental strategic priority for the city. This commitment is reflected through the actions of the Restart mAI city (smart city actions) initiative. In this new era and amid the exponential growth of digital technology, Trikala is positioning itself as a pioneer in leveraging these advancements to enhance the efficiency, responsiveness, and overall quality of urban governance.

Digitisation supports climate neutrality actions by providing real-time data and analytics, enabling cities like Trikala to make informed decisions on energy consumption, emissions reduction, and resource management. Additionally, smart technologies facilitate the implementation of targeted interventions, optimising urban systems and processes for more sustainable and efficient practices.

Actions: Smart city

3. Decarbonising electricity & heating generation

The decarbonisation of electricity and heating generation plays a pivotal role in the pursuit of climate neutrality, as it addresses a significant contributor to greenhouse gas emissions. This is evident from the city's inventory, where the Stationary Energy sector, particularly Scope 2 emissions stemming from grid-supplied energy, emerges as the primary contributor to greenhouse gas emissions. This is attributed to the extensive use of electricity for heating/cooling, coupled with energy-inefficient buildings and appliances.

The fundamental objective of decarbonising electricity and heating generation is to shift away from sources responsible for greenhouse gas emissions. Greenhouse gases, notably carbon dioxide (CO2), are major contributors to global warming and climate change. Decarbonising electricity and heating generation contributes to mitigating these impacts by reducing the release of greenhouse gases into the atmosphere. The commitment to decarbonise electricity and heating generation serves as a catalyst for research and development in clean energy technologies.

Decarbonisation initiatives entail an increased reliance on renewable energy sources. This transition to renewables fosters the development of a sustainable energy system that aligns with the goals of climate neutrality.

Actions: Energy Systems & Build Environment

4. Shift to public and non-motorised transport

Public and non-motorized transportation alternatives, encompassing buses, bicycles, and pedestrian modes, typically exhibit lower carbon footprints in comparison to individual conventional vehicles. Buses, for instance, possess the capacity to transport a considerable number of individuals with a relatively lower energy consumption per passenger when contrasted with private cars. This heightened efficiency contributes significantly to the establishment of a more sustainable and environmentally conscious transportation system.

Moreover, the advocacy for non-motorized transportation options, specifically walking and cycling, not only fosters eco-friendly commuting practices but also advocates for healthier and more active lifestyles. This paradigm shift aligns seamlessly with broader sustainability objectives, promoting human well-being and concurrently diminishing the environmental impact linked to sedentary and motorized living patterns. Encouraging the adoption of these alternatives represents a strategic approach in achieving a more sustainable and climate-resilient urban mobility landscape.

Actions: Mobility & Transport

5. Energy renovation and efficient utilisation of building stock

Energy renovation and the efficient utilization of the building stock constitute critical components in the journey toward climate neutrality. In Trikala, akin to many urban centers, the building sector stands out as the primary contributor to greenhouse gas emissions. In Greece, a prevailing challenge lies in the accurate documentation of the building stock. As part of its commitment to climate neutrality, Trikala places a strategic emphasis on comprehensively inventorying the entire building stock, incorporating essential data such as the year of construction, usage patterns, ownership status, and overall condition.

This meticulous inventorying process serves a dual purpose. Firstly, it facilitates the precise identification and subsequent reduction of greenhouse gas emissions, enabling targeted and effective interventions. Secondly, it lays the groundwork for the formulation of a strategic plan dedicated to the enhancement and retrofitting of existing buildings. The concurrent pursuit of energy upgrades for buildings, coupled with the overarching objective of decarbonizing electricity and heat production, is poised to yield the most significant impact on Trikala's carbon footprint. This comprehensive approach is expected to result in an exponential reduction in emissions, marking a substantial leap toward the city's climate neutrality objectives.

Actions: Build Environment

6. Sustainable management of waste & promotion of circular economy

The sustainable management of waste emerges as a pivotal factor in the pursuit of climate neutrality, primarily through the attenuation of methane emissions emanating from landfills, and the advocacy for recycling and the circular economy paradigm. Landfills, renowned as substantial sources of methane, a potent greenhouse gas, are targeted for mitigation through the adoption of sustainable waste management practices, prominently including recycling and composting. These practices not only divert significant quantities of waste away from landfills but concurrently curtail the release of methane emissions, thus aligning with climate neutrality objectives.

The incorporation of a circular economy framework, exemplified by recycling initiatives, plays a dual role in fostering climate neutrality. Primarily, the recycling process diminishes the demand for raw material extraction and manufacturing, activities inherently linked to greenhouse gas emissions. Secondly, by extending the life cycle of materials through recycling, a pivotal contribution is made to resource conservation, concurrently mitigating the carbon footprint associated with the production of new commodities. This approach underscores the symbiotic relationship between sustainable waste management practices, the circular economy, and the overarching objective of climate neutrality.

Actions: Waste and Circular Economy

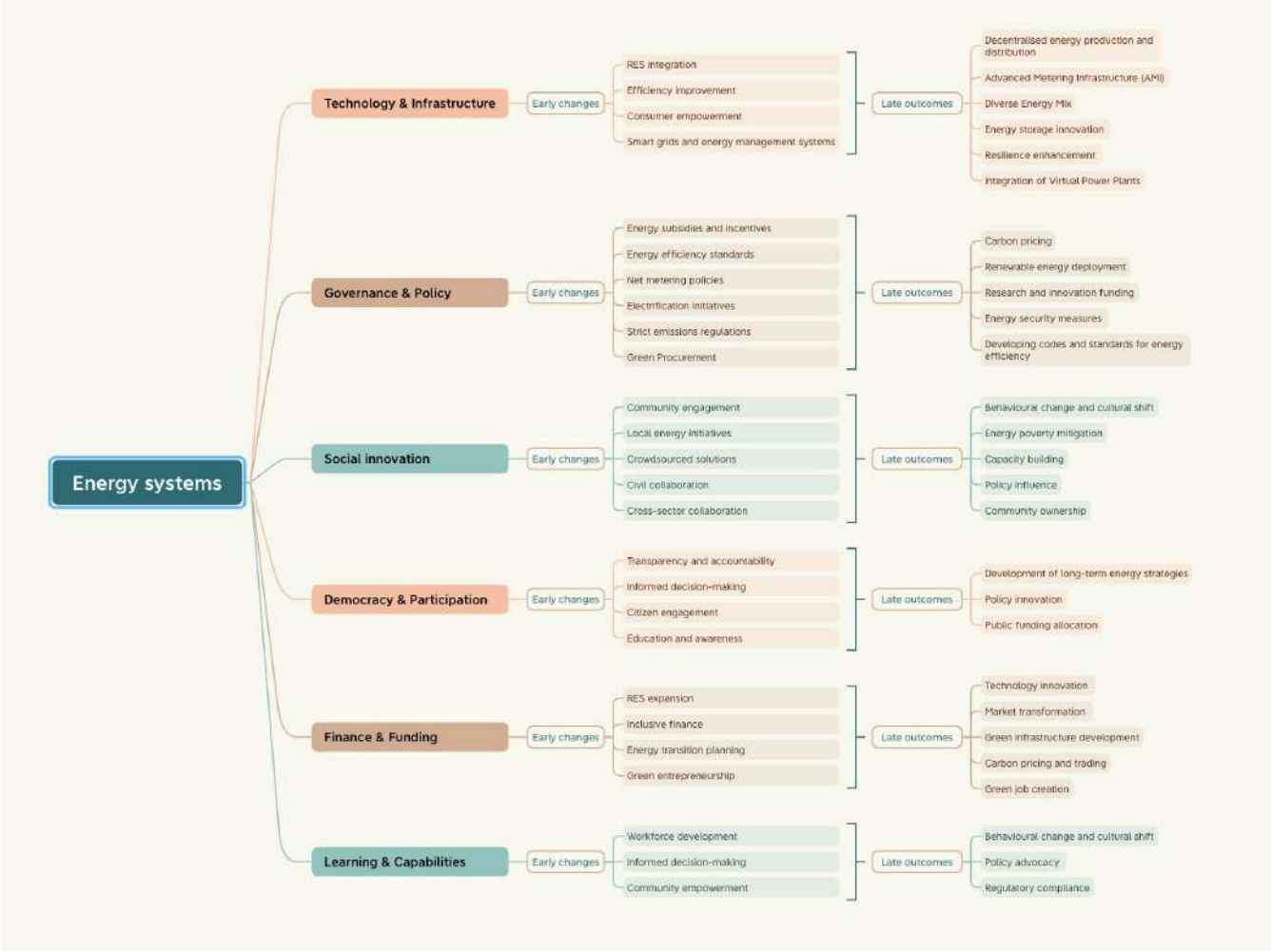


Figure 8. Impact pathways in Energy systems

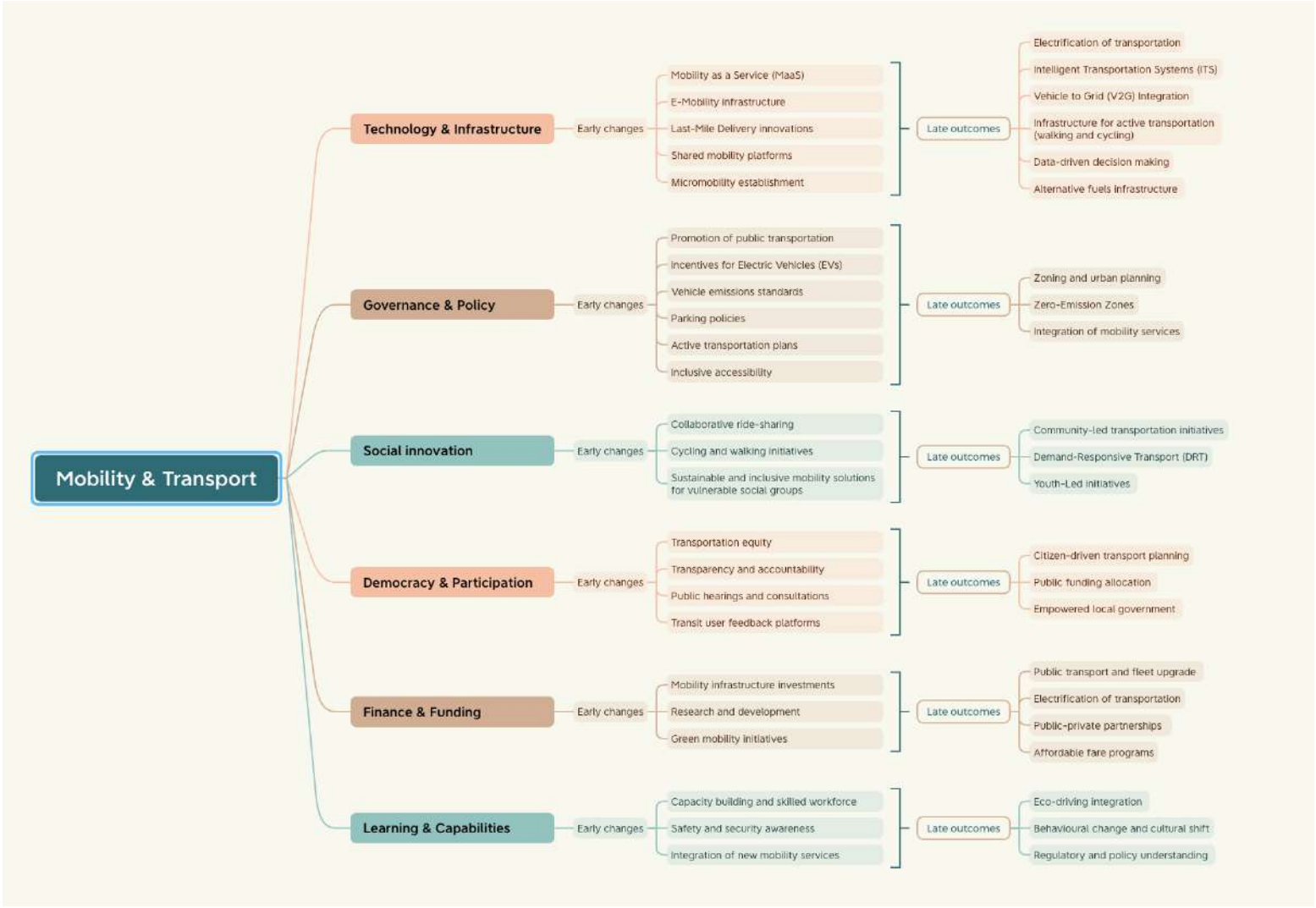


Figure 9. Impact pathways in Mobility & Transport.

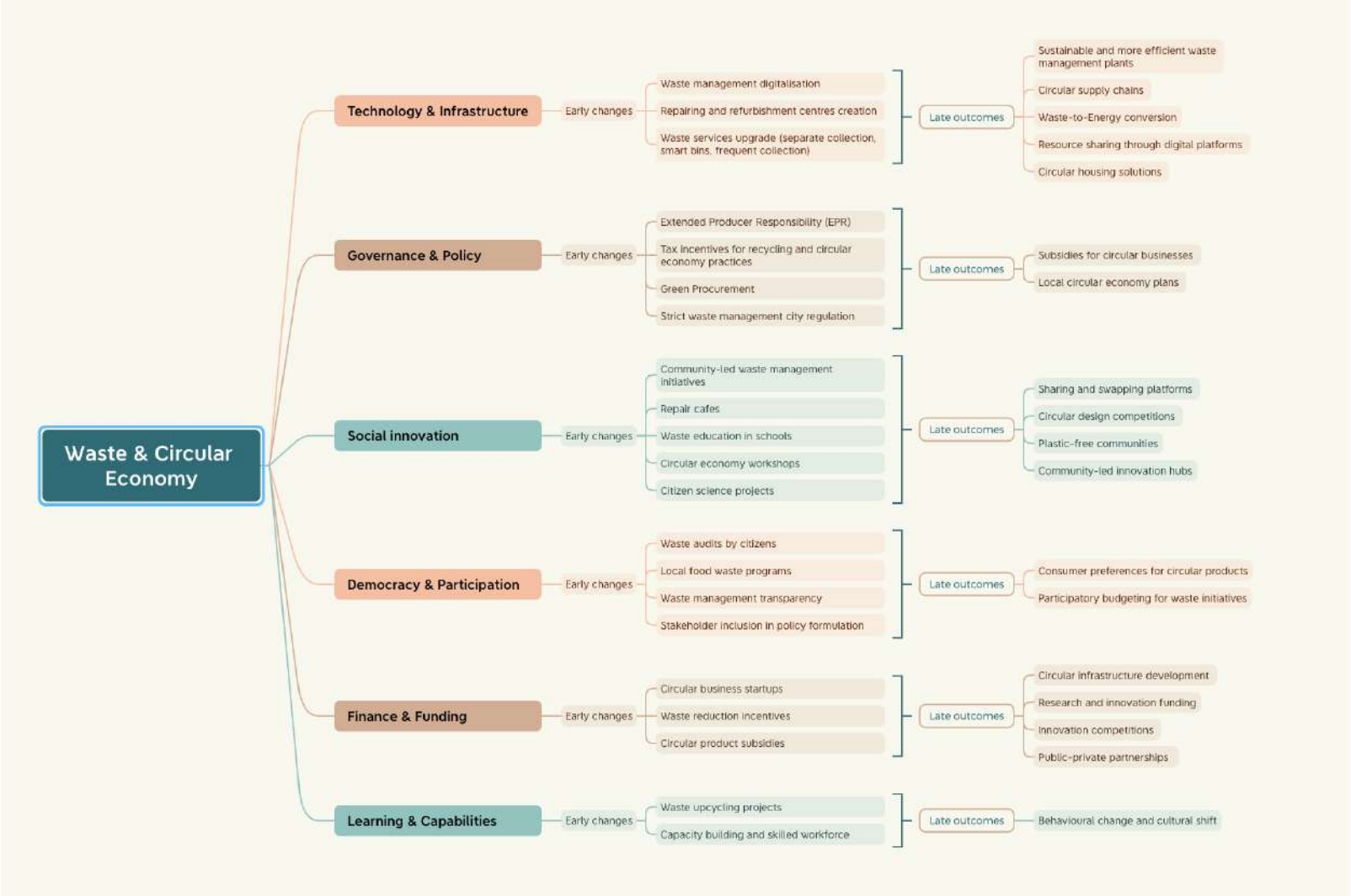


Figure 10. Impact pathways in Waste & Circular Economy.

Figure 11. Impact pathways in Green infrastructure & nature based solutions.

3.2. Module B-2 Climate Neutrality Portfolio Design

B-2.1: Description of action portfolios - textual or visual		
Fields of action	**Portfolio description**	
	List of actions	**Descriptions**
Energy systems	**Decarbonising electricity generation**	
	Photovoltaic on buildings	Buildings with photovoltaic systems can generate their own electricity, reducing their reliance on centralized power grids. This reduces the reliance on fossil fuels for electricity generation, which is a major source of carbon emissions. By using solar energy, buildings can reduce their carbon footprint, helping to mitigate climate change.
	Municipal photovoltaic parks	Photovoltaic (PV) systems, also known as solar panels, generate electricity from sunlight and are considered a clean and renewable energy source. Photovoltaic (PV) installations in cities contribute to mitigating climate change. Photovoltaic systems generate electricity from sunlight without emitting GHG or other harmful pollutants, making them a clean and renewable energy source.
	RES energy through grid	RES energy integrated into the grid displaces electricity generated from fossil fuels, thereby reducing GHG emissions. This substitution leads to a decrease in the amount of carbon dioxide and other pollutants released into the atmosphere. As a result, the use of RES energy helps mitigate climate change by reducing the overall GHG emissions.

	Development of a joined and smart RES management system	The development of a joined and smart RES management system plays a vital role in accelerating the transition to a climate-neutral society. It involves creating an integrated platform that efficiently manages and optimises the generation, distribution and consumption of renewable energy from various sources. Specifically: • Optimizes resource allocation, • integrates multiple energy sources, • promotes demand response, • enhances grid stability, • reduces carbon emissions The contribution of a joined and smart RES management system is significant to the reduction of carbon emissions. The usage of RES, decreases reliance on fossil fuels, which are major contributors to GHG emissions. This transition to clean energy helps in achieving climate neutrality goals. Stakeholder engagement is crucial for the successful implementation of RES. Stakeholders may include local communities, government agencies, environmental groups, businesses, and residents.
	Solar thermal power systems on buildings	In contrast to energy sources based on fossil fuels, solar thermal power systems utilize the Sun's energy to generate heat and produce electricity without releasing GHG emissions into the atmosphere. By harnessing renewable energy from the Sun, these systems contribute to reducing dependance on fossil fuels, which significantly contribute to climate change. The main stakeholder included in the project are building owners, residents, local government authorities, energy providers, and environmental organizations. Each stakeholder group may have different interests and concerns.

	Virtual power plants (VPP)	Virtual power plants are networks of small energy-producing or storage devices, like solar panels and batteries, that are pooled together to serve the electricity grid. Virtual power plants can play a significant role in achieving climate neutrality. Specifically, they provide optimized capabilities of diverse distributed energy resources (DERs) and enable efficient management, trading, and dispatch to provide grid services, stabilize the electrical grid, and optimize energy generation and consumption.
	Power through RES the water pumping and distribution system	The overall pumping and distribution of water resources requires large consumptions of energy. The installation of RES (preferably Photovoltaics) will reduce absolute dependence on traditional forms of electrification and enhance resilience.
Mobility & transport	**Reduced motorised passenger transportation need**	
	Zero Emission Zones	Legislative measures such as the establishment of zero-emission zones can significantly limit the entry of internal combustion engine vehicles into urban areas. This will be also supported by the design and enhancements of specific parking areas outside the city center dedicated to shared mobility services such as bike sharing and car-pooling.
	Support of remote working and online services	New technologies and business models such as teleworking, online shopping and e-health can reduce the total number of trips and significantly reduce emissions.
	Shift to public and non-motorised transport	

	Behavioural shift to public transport, walking and cycling (inc. infrastructure)	Promoting public transport, cycling and walking can accelerate the shift to clean modes of transport, with additional benefits in terms of health, congestion, accidents and noise. By ensuring adequate cycling infrastructure, lowering speed limits and enhancing digital infrastructure and connectivity especially in major intersections of the city where safety is considered, more people can cycle and commute. In addition, cycle network must be upgraded and widened to cover more urban areas.
	Mobiity as a Service (MaaS)	New solutions for micromobility and Mobility-as-a-Service (MaaS) could under certain conditions reduce the carbon footprint of mobility and spur innovation. Mobility as a Service (MaaS) is a transformative concept in transportation that seeks to simplify how people plan, pay for, and use various modes of transportation. It addresses challenges related to urbanization, congestion, environmental concerns, and the proliferation of transportation options. It covers as many as possible means of transportation and provides multi-modal journeys for its users. In addition, MaaS offers personalized recommendations based on user preferences and real-time information about the status of transportation services.
	Enhancement of E-powered Micromobility	As the number of vehicles keep increasing appreciably, e-powered micromobility provides an effective approach in changing people's mode of transport to lesser energy demanding modes. Municipality of Trikala will continue on upgrading and widening the bicycle and micro mobility rental system of the city, as well as the cycling physical and digital infrastructure.

	Provision of DRT (Demand - Responsive Transport) services	The development and provision of Demand-Responsive Transport (DRT) services is to provide efficient public transportation in areas of low passenger demand where other means of transportation is not considered to be financially viable, such as rural and peri-urban areas. DRT services will be integrated to the city's MaaS platform, thus contributing to a unified, complete and sustainable service to the city and citizens.
	Increased car pooling	
	Development of apps and initiatives for vehicle sharing	New technologies or business models for urban transport can also help shift demand towards options with lower carbon footprints. For example, apps that support shared bikes, electric cars, or electric mopeds can provide solutions to many mobility needs and help avoid car ownership. App development for vehicle owners or rental businesses to provide transportation for other residents/users.
	Electrification of cars and motorcycles	
	Clean and efficient vehicles (electric)	The transition from traditional fuel consumption methods to carbon-free or carbon neutral alternatives would directly reduce emissions from a technological standpoint. This can be achieved through the use of electric vehicles, as well as tramways, trolleybuses, and suburban trains. Additionally, hydrogen and fuel cells, or synthetic fuels are viable options for achieving this reduction, as long as the energy used to produce electricity or alternative fuels has a low carbon content. It is necessary to promote using clean and efficient vehicles through information actions across the Municipality of Trikala. Furthermore, the transition can be achieved through economic measures from the Municipality such as the exemption from municipal fees

	Electrification of buses	
	Clean public transport	A potential solution to reduce CO2 emissions in the realm of public transportation is to switch to fully carbon-neutral urban trains and busses, while simultaneously improving their quality of service. This alternative could encourage people to opt for public transportation instead of using passenger cars It is important to alter the existing municipal fleet with new technology vehicles by 2030. Further, both administrative staff and residents should be informed about the benefits of eco-driving. In addition, several initiatives via research and innovation actions will test the integration of automated fleets to the public transportation serving deprived areas in order to complement the current and future public transportation services. Finally, the existing routes must be improved in terms of efficiency and management of the municipal fleet.
	Optimised logistics & electrification of trucks	
	Electrification of trucks	Trucks and city freight transport in general are a significant contributor to GHG emissions. Therefore, the transition to electric trucks holds immense importance in limiting the environmental impact of freight transport. By embracing electric-powered trucks, the city can eliminate tailpipe emissions and fossil fuel dependency. Electric trucks also contribute to less noise and better air quality within the city. Furthermore, the electrification of trucks promotes technological innovation through the development of more sustainable and efficient transportation solutions.

	Fleet management application for the municipal fleet and public transport	Software development to accumulate, store, process, monitor, report on and export information, that can be imported from external sources such as gas pump processors, territorial authorities for managing vehicle registration, financial institutions, insurance databases, vehicle specification databases, mapping systems and from internal sources such as HR and Finance.
	Improvement of logistics and urban freight transport	To make logistics and urban freight transport more eco-friendly, several strategies and technologies can be employed. For instance, intracity freight offers eco-friendly last-mile delivery options, including electric van or cargo bike deliveries. In essence, the goal is to reduce environmental impacts, such as emissions, congestion, and noise pollution, in urban freight and logistics by embracing cleaner vehicles, optimizing delivery processes, and exploring innovative solutions like autonomous vehicles and consolidation centers. These efforts require collaboration between businesses, local governments, and technology providers to create a more sustainable and efficient urban logistics ecosystem.
	Eco-driving workshops and application (especially for professional drivers)	Establish driver-training programs to enhance education, driving regulations, methods, skills, and other relative driving knowledge to boost eco-driving.

Waste & circular economy	Separate collection and sustainable management of organic municipal waste	Circular Economy treats waste as resource and used to create value. Organic waste can be processed through composting and produce nutrient-rich compost. By segregate organic waste at source communities can reduce their environmental footprint and contribute to a more sustainable waste management system. It involves the systemic separation of organic waste materials, such as food scraps, yard waste and other biodegradable materials, from the general waste stream. Collaborate with public and private entities, such as waste management companies, composting facilities, and local agricultural associations, to optimize organic waste management processes. Contribute to climate neutrality by reducing methane emissions. Methane is a potent GHG, and its release into the atmosphere significantly contributes to global warming. By capturing methane from organic waste and converting it into biogas, these power plants prevent its direct release, effectively reducing GHG emissions.
	Separate collection and sustainable management of paper municipal waste	Implementing a separate collection system for paper waste has several environmental and economic benefits. Separating paper waste makes it easier to recycle. Recycled paper can be processed into new paper products, reducing the demand for virgin wood pulp and conserving forests.
	Separate collection and sustainable management of glass municipal waste	Glass is a high recyclable material. By separating glass from other waste streams it can directed to recycling facilities where it is processed to new glass products. This process reduces the carbon footprint associated with glass production. Furthermore, recycling glass also helps conserve natural resources such as sand, soda ash and limestone. Separate collection of glass promotes climate neutrality by reducing energy consumption, GHG emissions, and the use of virgin materials.

	Separate collection and sustainable management of metals municipal waste	By separating metals from other waste materials, it becomes easier to recycle them. Metal production from recycled materials generally requires less energy compared to the production from virgin materials. By separating and recycling metals, we can significantly reduce the energy consumption and associated carbon emissions in the manufacturing process. Metals, such as aluminum, require large amounts of electricity during primary production, which often comes from fossil fuel-based power plants. By recycling these metals, we can avoid the need for new production and the associated GHG emissions.
	Separate collection and sustainable management of plastic municipal waste	Plastic is one of the most harmful materials for the environment. The implementation of a separate collection system for plastic waste has many environmental and economic benefits. Fossil resources and a large amount of energy are used to create plastic, so recycling it results in lower gas emissions and large energy savings. European and Greek legislation set targets for the separate collection of plastic, which, if citizens, municipality and government work together, can be achieved and bring positive results.
	Separate collection and sustainable management of bulky municipal waste	Reducing the amount of bulky waste that ends up in landfills reduces environmental pollution and GHG emissions. Recycling, material recovery and bulk reuse saves resources and reduces the need of using new materials and creating new products. For the implementation of this action, the cooperation of various bodies, such as government, citizens and the educational sector, is necessary.

	Separate collection and sustainable management of green municipal waste	The sustainable management of green waste (yard trimmings, leaves etc) contribute to climate neutrality by reducing methane emissions and promoting carbon sequestration. Green waste emits methane gas when they sent to landfills. Methane is a GHG that contributes to climate change. Composting green waste allows organic materials decompose naturally, releasing carbon dioxide (CO_2) in the process.
	Municipal waste prevention 10%	Waste prevention is the first choice to minimise waste management cost and maximise the environmental benefits and life quality. Benefits of waste prevention; • Saving resources and energy • Reducing environmental impacts • Decreasing waste management cost • Ensuring compliance with legal obligations
	Separate collection and sustainable management of WEEE municipal waste	Waste of Electrical and Electronic Equipment (WEEE) refers to household-originated WEEE that comes from households, as well as commercial, industrial, institutional, and other sources, whose nature and quantity are similar to those of WEEE originating from households and the WEEE that may be used by both private households and users other than private households, which are considered household-originated WEEE. Recycling and material recovery of WEEE saves resources and reduces the need of using new materials and creating new products. Furthermore, reduces CO2 emissions and the amount of waste that sent to landfills. Success of this goal, will come after a cooperation between government, Municipality and citizens.

	Separate collection and sustainable management of SQHW municipal waste	SQHW is the Small Quantities of Hazardous Waste contained in Municipal Solid Waste. This category usually includes hazardous construction materials (e.g. paints, varnishes), chemical waste (e.g. disinfectants, pesticides), waste such as printer ink, toners, etc. Separate collection of SQHW is important as they contain components that may be harmful to the environment. Same cooperation with the separate collection of WEEE needs for the SQHW's separate collection, too.
	Separate collection and sustainable management of Edible fats and oils municipal waste	Proper separation and recycling of edible fats and oils prevent them from being disposed in landfills or wastewater systems. When these fats and oils decompose, they release methane, a potent GHG. By diverting them from waste streams, we can reduce methane emissions and their impact on climate change.
	Reduction in landfill under 10%	Alternative waste management refers to innovative approaches for handling waste, avoiding traditional methods such as landfilling. Since waste generation is directly tied to the cost, individuals and businesses have a financial incentive to reduce waste by recycling and composting organic materials. The reduction of the amount of waste sent to landfills, can lead to cost savings and mitigate environmental impact.

Green infrastructure & Nature-based solutions	Green walls and green roofs	Planted walls and roofs are sustainable architectural elements that incorporate living plants to cover vertical surfaces or roofs, providing environmental benefits such as; • Improving air quality: carbon dioxide and other gases which planted walls and rooms absorb during photosynthesis, helping to improve air quality and reduce air pollution. • Insulation and energy savings: Planted walls can act as natural insulators, help buildings keeping warm. • Improving aesthetics: Green walls add natural beauty to the urban landscape, improving the aesthetics and the beauty of the city. • Reducing the temperature of the city: Green walls can help reduce the "urban heat island" effect, as the planted surface reflects less heat than the hard surfaces of buildings. Bodies that should cooperate for the implementation of the action are municipality, construction industry, governmental bodies, educators and environmental awareness organizations and social participation.
	Green pavements	Green pavements are eco-friendly pavements designed to reduce heat absorption, manage rainwater, and improve urban sustainability by incorporating permeable materials and vegetation. Promoting the use of green pavements will reduce the use of vehicles and other means of transport, and therefore gas emissions. This action requires the cooperation of Municipality, citizens, government and construction industry.

	Planting 23,000 trees inside the city and on its outskirts	Urban areas with green spaces and trees offer many advantages, such as improved air quality, leisure options, temperature control, promotion of biodiversity and enhancement of residents' mental well-being. The implementation of the action is feasible and quickly effective, without such a great financial cost. Effective cooperation between municipal authorities, government agencies and the construction sector is imperative to achieve these benefits.
Built environment	**Building renovations**	
	Energy renovation/retrofit of existing buildings	The energy renovation of existing commercial and residential buildings is beneficial for achieving climate neutrality in the city. Stationary Energy GHG emissions coming from thermal and electrical needs in buildings is the biggest GHG source usually in every city, including Trikala. Achieving energy upgrading reduces energy consumption, improves indoor comfort and achieves environmental sustainability by reducing carbon dioxide emissions. There are also economic benefits and a strengthening of the local economy as, despite the cost of the investment, energy savings lead to a reduction in energy bills for building owners in the long term. The achievement of this goal requires the cooperation of many factors, such as government, Municipalities, companies and banks.
	Nearly Zero Energy Buildings (NZEBs) (renovation of existing buildings)	The conversion of existing buildings to nZEB is an important effort to achieve sustainable cities and environmental sustainability as energy upgrading will reduce energy costs and emissions. Energy upgrading will increase property values, technological development and energy awareness. The cooperation to achieve this objective involves government agencies, construction companies, Municipalities, banks, energy experts, etc.

	Integrated Energy Systems	Integrated energy systems in buildings refer to holistic approaches that optimize the management and use of various energy sources, technologies and components to improve efficiency, reliability and sustainability in the built environment. The positive effects that the installation of Integrated Energy Systems in buildings will bring about include: • the saving of energy and money • the reduction of GHG emissions • the improvement of the quality of life • the conservation of natural resources • the promotion of sustainable development For the success of this goal, cooperation is required between government, Municipality, banks and construction companies.
	Efficient lighting and appliances	The shift to efficient lighting and appliances can significantly contribute to energy conservation, reducing GHG emissions and resulting in financial savings. Energy-efficient lighting, like LED bulbs, and high energy performance appliances consume considerably less electricity, thus resulting in lowered carbon footprint.

	New energy-efficient buildings	The build environment contributes the most to cities' GHG emissions, thus introducing energy-efficiency standards to new buildings is a foundational cornerstone in the pursuit of climate neutrality. Energy-efficient buildings have integrated innovative technologies and sustainable materials and result in reduced energy consumption and environmental impact. By integrating innovative insulation, efficient heating, ventilation, air conditioning systems, and smart design strategies, energy-efficient buildings drastically decrease the demand for non-renewable resources and lower greenhouse gas emissions. Their implementation not only reduces operational energy costs but also fosters healthier indoor environments. Furthermore, these buildings serve as living examples, showcasing the potential for sustainable, low-carbon infrastructure.
	Decarbonising heating generation	
	Commercial and residential buildings electrification	Building electrification is the transition of energy sources in buildings from fossil fuels to electricity. This transition is often achieved by replacing traditional heating and cooking systems with electric alternatives, such as using RES, to reduce GHG emissions. The implementation of the action is important as the replacement of fossil resources achieves reduction of energy costs and CO2 emissions, improvement of energy efficiency, saving resources, promotion of RES, and also independence from electricity prices and promotion of technology. The successful electrification of existing buildings requires cooperation between government, Municipality, banks, research centers and universities, consumers, construction companies, etc.

	Citizen and renewable energy communities	Energy Community is an association that produces and shares renewable energy, generating and managing cost-effective green energy autonomously, reducing CO2 emissions and energy waste. Renewable energy communities contribute to a significant reduction in GHG emissions as they s empower individuals, increase renewable energy generation, educate the public, reduce carbon emissions, and stimulate local economies. Renewables produce minimal or no carbon emissions during operation, unlike fossil fuels. This shift towards cleaner energy sources helps combat climate change by mitigating the release of carbon dioxide and other harmful pollutants into the atmosphere. Effective stakeholder engagement involves regular communication, consultation, and collaboration. With the participation of a wide range of stakeholders (citizens, local government, non governmental organizations, business and industry, educational institutions, financial groups), they can benefit from the resources and support needed to thrive and have a positive impact on the environment and society as a whole.
Smart city	**Horizontal actions**	
	Establishment of Smart City Executive Management Centre	Development of a fully organised Executive Management Centre of the city's smart ecosystem. Its role will involve monitoring the city 24/7 in real time through the smart infrastructure, in order to minimize problem detection time and optimize the coordination of their resolution. The action will include reconfiguring space for use as a smart city control center by appropriately adapting an existing municipal space to accommodate its function and installing communication, monitoring and control equipment for the city's smart city ecosystem.

	Platform to support data-driven decision-making processes	The action concerns the installation of an infrastructure to collect and manage the data of the city's smart ecosystem. The action includes the central platform for collecting and processing city data and infrastructure, the interconnection of existing City data sources, the website for displaying municipal information and actions, the system for managing and presenting the progress of technical projects. The goals of the action are to create a single set of geospatially defined time-varying and permanent data, to create a reliable and flexible storage of data and information to support smart actions and the operation of the municipality, to provide appropriate tools to facilitate management processes and policy formulation with measurable results for citizens, to simplify conditions for the provision of new smart services to citizens, to establish a support environment for the development of smart services for citizens, to establish a supportive environment for the implementation of smart services, and to provide a platform for the development of new services for citizens.
	Integrated service, information and citizen awareness infrastructures for a smart city ecosystem	The action concerns the development of an integrated citizen service system based on smart city infrastructure. The action will include the service user profile infrastructure, the system for registration of citizen requests/reports (crowdsourcing) and lifecycle management of tasks, processes and events of municipal services, the infrastructure for citizen response management, the unified application of smart devices. It aims to improve the conditions of service to the citizen by simplifying the way of interaction and providing possibilities to evaluate and monitor his/her requests, to coordinate more efficiently the operation of municipal services, to improve the citizen's awareness through gamification, to simplify the processes of interaction between the municipality and the citizen and to create an infrastructure for the future exploitation of innovative feedback practices and new municipal applications.

	Protection plan against physical / logical system / information breach and drafting of an open data policy for the Municipality	The action aims to create a legacy of documentation on the operating policies that should characterise the city's ecosystem. The preparation of the integrated policy for good use and crisis response includes the drafting of a policy for the protection of open and personal data, the drafting of a cyber-attack response plan, and the study and certification of security and information protection. The action aims to describe the capabilities and how to exploit the Municipality's data, protect citizens' personal data, prevent timely consequences to the Municipality from malicious actions against the City's smart city ecosystem, protect the integrity of City data and information following cyber-attacks, and minimize threats against the City's smart city ecosystem information.
	Commissioning of services to support the operation, maintenance, development, deployment, training and promotion of the smart city ecosystem	This action aims to cover the needs for the operation and creation of conditions for the acceptance by citizens of the smart city ecosystem. It includes preparation of a transition plan to smart city operation, provision of specialised services of citizen experience support, system operation, support to municipal officials, municipal staff and provision of communication and promotion services of smart ecosystem benefits to citizens. The action aims to protect the overall investment of the smart city ecosystem, to enhance the sustainability prospects of the project in providing high quality services to citizens, to highlight the importance of the project in the minds of citizens and municipal officials, to create a climate of credibility and professionalism aimed at attracting innovation investment in the development and implementation of smart technologies and to create communities of action and innovation that support and sustain the city through the smart ecosystem.

	Mobility actions	
	Installation of intelligent traffic signalling and control infrastructure	The development of an intelligent traffic management system in the city includes the installation of smart controllers on all traffic lights in the city, the deployment of intelligent motion control sensors and atmospheric pollution measurement for traffic management and monitoring environmental conditions. It involves creating smart crossings for pedestrians and micro-mobility, as well as the procurement and installation of Variable Message Signs (VMS). The objectives are the collection of necessary traffic, environmental, and other data to support the real-time optimization of the signaling system, traffic control through traffic lights, and the improvement of the operation of connected nodes in a coordinated artery mode. The goals also encompass the establishment of intelligent traffic management strategies in the city center, the use of VMS, enhancing traffic quality in the city center with simultaneous information on interventions to reduce environmental impacts. Additionally, it includes strengthening road safety for vehicles, pedestrians, and people with disabilities, along with the optimal maintenance process and reduction of downtime for repairs to the signaling system.
	Creation of a control and information system for smart parking	The initiative aims to create improvements in urban mobility conditions through directed parking tools and the prevention of illegal parking in the city. This involves the installation of parking control sensors (e.g., magnetic, optical, etc.) and the development of an information system for parking that utilizes sensor data. The objectives include real-time collection of parking information, facilitating citizens in parking decisions in combination with available transportation options, restricting illegal parking to controlled visitor parking spaces or areas affecting traffic conditions, and enhancing traffic conditions in the city by minimizing the time required to find parking spaces.

	Health & Social Care Actions	
	Infrastructure to support and enhance digital advancement for the "Help at Home" program	The action aims to improve the quality of provided care services using smart solutions through integrated patient management systems. This includes increasing the number of assistance recipients through remote monitoring, providing 24/7 support through first aid notification systems, developing a sense of safety and independence for beneficiaries, enhancing caregivers' working conditions, enabling continuous care delivery in conditions of social exclusion through telemedicine and telecare, and reducing the environmental footprint of caregivers' frequent home visits by using electric vehicles. Simultaneously, it involves increasing transportation means for care provision.
	Development of "Social GIS" support infrastructure	The action aims to establish geographic-based organization of various social data, allowing access to information for the planning and implementation of policies through map reading. The initiative involves developing a unified management system for municipal social structures and creating social geoinformation layers by collecting data from the management system. The objectives include designing local-level social policies, supporting the implementation of social initiatives, reducing instances of social exclusion, and monitoring the geographic distribution of social monitoring indicators.
	Development of smart citizen wellness support infrastructure	The initiative aims to create a unified set of technical infrastructure for cultivating sports habits with the goal of improving the citizens' fitness and health. This includes installing shared facilities for measuring sports activities in municipal sports areas and establishing information and communication infrastructure for sports and the physical condition of the city. The action aims to integrate the sports culture into the collective consciousness of citizens, enhance the physical well-being of the population, provide advanced sports services to residents for free, and promote an advanced sports ethos in conjunction with other parallel informational activities.
	Energy Actions	

	Installation of infrastructure for remote management, remote control and telemetry of distribution boards (pillars) of municipal infrastructure of public space (street lighting)	The initiative aims to manage the street lighting network, which represents the largest in terms of the number of points and one of the most energy-intensive infrastructures in the city. It includes the installation of remote management and telemetry systems, which will involve the supply and installation of telecontrol, telemetry, and access control devices on the pillars of the Trikala Municipality. It also encompasses the installation and operation of a remote management and telemetry system, allowing centralized control and supervision of the entire electric lighting network. The action aims to reduce the downtime for network repairs, increase the lifespan of lighting bulbs, decrease electricity consumption, monitor 25,000 lighting bulbs in real-time, enhance safety for pedestrians and drivers, and reduce the strain on the electric power transmission network.
	Installation of energy saving infrastructure in municipal facilities	The role of Building Energy Management Systems (BEMS) is significant and involves actions related to the installation of smart meters for electricity/gas consumption, the implementation of energy management and monitoring systems in school units and other municipal buildings, data collection and monitoring through IoT, and the creation of a unified central management platform for the selected BMS buildings. It aims at the energy efficiency of municipal buildings, reducing operational expenses from usage and operation, creating thermal comfort, improving the indoor environment of the building stock, establishing historical data for municipal buildings to enhance the decision-making process by the municipal authority for further energy upgrades and improvements in their operation. Moreover, it aims to set an example for the adoption of energy upgrades in the city's building stock and create incentives for citizens.

	Development of a city energy balance recording and information application	During the action, there should be integration with information systems related to energy production, distribution, and consumption. This involves developing an algorithm to estimate the overall energy consumption and production for the entire city. The action also includes informative and educational initiatives, providing scientific and technical support to citizens and students. Additionally, smart electricity meters will be distributed for selective installation in residents' homes. The goal of the action is to inform and raise awareness among citizens about energy consumption and its more rational use. It emphasizes the importance of using renewable energy sources for both energy savings and reducing the city's energy footprint, addressing the impacts of climate change.
	Smart interactive electric lighting of emblematic points of the city	The action involves the creation of an infrastructure for the illumination of iconic landmarks in the city of Trikala. It includes the installation of RGBW LED lighting fixtures with remote control capabilities using the DALI protocol. The implementation of a remote control system that communicates with all lighting points through the city's networks is also part of the initiative.
	Civil Protection Actions & Environment	
	Configuration of a crisis management command center	Establishment of a fully organized Crisis Management Center (CMC). The action includes the reconfiguration of a space for use as a crisis management center with the appropriate adaptation of an existing municipal area to serve its function. It involves the installation of communication, surveillance, and control equipment for the smart city ecosystem, as well as the coordination of civil protection units and the upgrade of the municipality's mobile emergency response unit. The action aims to support the coordination of implementing the Municipality's Civil Protection plans, overcome city control infrastructure constraints in case of damage or crisis, alleviate congestion at the Citizen Service Center (KEP), allocate additional roles and responsibilities during crisis situations, and enable on-site coordination of crisis response teams, leveraging information from the smart city system.

	Installation of emergency detection and management infrastructure	This action aims to create mechanisms to support the detection and management of situations requiring the activation of the Municipality's Civil Protection mechanisms. The action includes the installation of IoT smart meters capable of providing data for immediate notification of emergency situations, automatic crowd counters using smart device detection techniques, the implementation of citizen protection policy support for informing and involving citizens in dealing with emergencies, and the implementation of evacuation support systems for facilities in case of fire or earthquake. The action focuses on timely informing citizens about imminent natural phenomena, immediate identification of cases of natural disasters, improving the intervention capabilities of citizen protection services (police, firefighting) through the city's control center, informing citizens about possible emergency situations and the corresponding response methods, creating social awareness about civil protection issues, and avoiding casualties in crowded areas due to panic.
	Establishment of infrastructure for sustainable urban green management	The action involves the installation of technical equipment for the management of urban greenery and the monitoring of the city's environmental conditions. Specifically, the action includes the installation of autonomous energy-efficient irrigation systems using IoT sensors and remotely managed electrometers, the installation of environmental monitoring stations for measuring mixed environmental indicators and mapping the differentiation of microclimates in urban green spaces, as well as remote control irrigation software for decision-making with artificial intelligence algorithms (precision agriculture technology - smart farming). The action aims to reduce the waste of water resources, minimize the waste of human resources, raise awareness among citizens about the contribution of green spaces to the urban environment, prevent accidents at points of water accumulation on road surfaces, avoid setting a bad example of public water wastage by the Municipality to citizens, and monitor the impact on the climatic conditions of the urban environment through the proper care of the city's green spaces.

	Water Resources Actions	
	Installation of smart consumption and water quality meters in the water supply network	The action involves the installation of 'smart water meters in selected municipal buildings or facilities, the distribution of smart water meters for selective installation in households, and the installation of water quality measurement stations at selected points in the water supply network and in the Municipality's reservoirs. The action aims to provide real-time information on leaks in the metering installation, automatically collect data from each smart connected water meter, provide an immediate view of actual water consumption, promptly notify of any intervention, problem, or malfunction in the network of connected water meters as they are detected, determine the water balance on a daily basis, distribute the load in the water supply network, enable detailed consumer information on daily consumption, and provide real-time information on possible deviations from water quality indicators in the water supply.
	Digitization, mapping and geospatial representation of water, sewer and stormwater networks	The action involves the conversion of existing geospatial representation of water supply and drainage networks, mapping the stormwater network, and integrating a remote network management system for real-time measurement data retrieval. The objectives are to record/map the stormwater network, convert already mapped networks (water supply), and integrate the newly mapped network (stormwater) into the new GIS infrastructure, establish communication between the smart city platform and the SCADA of the Municipal Water Supply and Sewage Company.

	Waste Management Actions	
	Creation of a waste management platform, alternative waste management systems and information-awareness actions	The action includes the creation of a campaign aimed at recycling and reuse, proper use of bins, etc., the establishment of a scoring system for specific actions related to waste management, the possibility of crowdsourcing for recording events and data, the design of the "PAYT" system, the development of the "PAYT" application, and the smart waste management platform that will enable the recording, storage, and analysis of data. The action aims to establish standards and best practices for waste management by citizens, introduce a tool to promote the Municipality's waste management policies to the citizens, digitize waste management actions, and optimize related services to citizens. It also targets achieving better environmental subsidies through waste management optimization, improving citizens' living conditions, enhancing recycling and circular economy through reuse or processing of objects to reduce the burden and cost of managing green bins through the implementation of the "Source Segregation" system. Additionally, the action aims to minimize the landfill percentage, resulting in resource savings for the Municipality and citizens, expedite the achievement of goals set in the “Local Waste Action Plan”, facilitate the waste processing in treatment units by reducing generated residues, create better quality bio-waste for further processing, and improve citizen information processes on recycling and "Source Segregation" issues.
	Installation of smart submerged bins	The action involves a system of graded waste compression in shared bins, a non-compression system in recycling bins, placement of labels on the bins, and the use of RFID technology for communication system reading. It also includes bin fill-level sensors, management software by the relevant authority, and vocal installation with usage instructions for the “Source Segregation.” The action aims to reduce the number of shared bins, decrease collection frequency (resource savings, reduction in energy footprint and emissions), improve the cleanliness and hygiene levels of the area, and create historical management data for easier decision-making.

	Economic Development & Building Actions	
	Implementation of management, allocation and utilisation of municipal buildings and public spaces	The action involves creating services to support transparency and citizen information regarding the management of municipal property and communal spaces. The action aims to enhance transparency in the administration of public spaces, reduce bureaucratic burdens for information related to public spaces and municipal property, strengthen collective actions through the provision of suitable public spaces, support volunteer actions for the enhancement of public spaces, conduct a comprehensive analysis of city data to formulate improvement policies, with appropriate utilization of communal spaces and municipal property, and optimize the management and utilization of municipal property by the Municipality.
	Creation of infrastructure for collecting and presenting data, commercial, and tourist activities	The action aims at further developing the tourist product and enhancing the commercial activity of the city through the use of digital applications. Objectives include creating infrastructure to boost the city's tourism and commercial activities, providing incentives for businesses to create competitive offers for city explorers, and creating conditions for generating promotional content for the city's tourist and commercial products.
	Participation Actions	
	Creation of a platform for information and citizen participation in Local Governance	The action involves informing citizens about local governance, including updates on Municipal Council meetings, engaging citizens' opinions in local governance as an advisory tool to the Municipal Council and city administration bodies, and fostering active citizen participation in local governance and Municipal Council meetings. The objectives include raising citizens' awareness of local governance through their participation in decision-making processes in various ways, creating a transparent environment around traditional decision-making processes, formulating policies taking citizens' opinions into account, and utilizing citizens' decisions to identify and address issues facing the city and its development.

	Connectivity Actions	
	Development of a unified infrastructure for interconnection through wireless / wired broadband and wireless narrowband networks	The action involves expanding the optical fiber network to remote areas from the city center, creating a Wifi Gen 6 MESH technology network to extend public access wireless networks and override the operation of the Municipal Area Network (MAN), establishing targeted coverage of LoRaWAN network for serving IoT devices, designing cybersecurity from the planning phase for network modification and equipment, and the ability to monitor the network status through active equipment in the network infrastructure and other relevant environments. The action aims to expand access for citizens, visitors/businesses, and electronic services of the smart ecosystem on the Internet, interconnecting IoT devices for data collection and transfer, detecting congestion through device localization in the WiFi network, connecting to the central core of the network, reaching remote or telecommunication-disadvantaged areas of interest to the Municipality, supporting a wide variety of connected devices such as wireless sensors, IoT telemetry devices, etc., reducing telecommunication costs for connecting IoT and WiFi devices within the network coverage area, achieving a high level of security for the smart city ecosystem, and monitoring the status and real-time troubleshooting of network issues.
	Acquisition of smart portable field equipment to support the operational management of the Municipality's personnel and vehicles	The action involves the procurement of smart personal devices for municipal employees to access the smart city ecosystem and the provision of geolocation and telemetry devices for vehicles. The action aims to reduce response time for executing work programs, provide real-time updates on assigned tasks, deliver immediate and dynamic technical information to field personnel, update central information systems for municipal operational support with actual field data, respond promptly to emergency situations, provide data for optimal field personnel management to meet citizen needs, and execute the rewarding services of the smart city ecosystem.

Table B-2.2 further analyses the action portfolio presented above, explaining the action outline, the connection to impact pathways, the implementation process and the impact and cost of each action. In the “comments on implementation” section the actions connected to the six key strategic priorities are highlighted:

- Citizen-centric governance model
- Trikala - Restart mAI City
- Decarbonising electricity and heating generation
- Shift to public and non-motorised transport
- Energy renovation and efficient utilisation of building stock
- Sustainable management of waste & promotion of circular economy

At the same time, a responsible body and the involved stakeholders are defined for each action. In some cases the responsible body already exists but is some other actions the responsible body will be an Office/Organisation created through Trikala’s Climate Mission. Similarly, some of the stakeholders mentioned have already signed the Commitments document, while some others are wanted by the city but haven’t signed yet. Trikala has a plan on how to attract more important stakeholders to support its effort.

Firstly, Trikala will initiate an inclusive stakeholder engagement process. This involves reaching out to various groups including local businesses, community organizations, residents, academic institutions, and governmental bodies. Hosting town hall meetings, workshops, and online forums will provide platforms for stakeholders to voice their concerns, ideas, and aspirations for the city's climate action plan. Additionally, forming advisory committees comprising representatives from diverse sectors will ensure that all voices are heard and incorporated into the planning process. The city will communicate with potential stakeholders to invite them to take part in its participatory processes.

Transparency is key to building trust and garnering support from stakeholders. Trikala will commit to transparent communication channels, providing regular updates on progress, challenges, and decision-making processes. Establishing a dedicated online portal or newsletter will keep stakeholders informed about ongoing initiatives, opportunities for involvement, and the impact of their contributions. Moreover, transparent reporting mechanisms will demonstrate accountability and help build credibility for Trikala's climate neutrality efforts.

Incentives play a crucial role in motivating stakeholders to actively participate and invest in Trikala's climate neutrality journey. The city can offer financial incentives such as grants, subsidies, or tax breaks to businesses and residents adopting sustainable practices or investing in renewable energy projects. Furthermore, non-financial incentives such as recognition programs, awards, and access to networking opportunities can incentivize stakeholders to showcase their commitment to climate action. Collaborating with financial institutions to develop innovative financing mechanisms for green projects will also attract investors and unlock funding for sustainable initiatives in Trikala.

By prioritizing stakeholder engagement, transparency, and incentives, Trikala can effectively mobilize support from diverse stakeholders and accelerate its transition towards climate neutrality. This collaborative approach will strengthen community resilience and sustainability.

B-2.2: Individual action outlines		
Energy Systems		
Action outline	Action name	Photovoltaic on buildings
	Action type	Technical Intervention
	Action description	Photovoltaic (PV) systems are designed to convert sunlight into electricity using solar panels. These panels contain solar cells that absorb photons from the sunlight and generate an electric current through the photovoltaic effect. This process allows PV systems to produce clean and renewable energy without emitting GHG or other harmful pollutants. As a result, PV systems play a crucial role in promoting sustainable energy solutions and reducing our dependence on fossil fuels.
Reference to impact pathway	Field of action	Energy systems
	Systemic lever	Technology & Infrastructure
	Outcome (according to module B-1.1)	Renewable energy integration
Implementation	Responsible bodies/person for implementation	One-stop shop for energy renovation on buildings, Municipal ESCO, Trikala Climate Team
	Action scale & addressed entities	Buildings - 3,16 Mwp
	Involved stakeholders	Municipality of Trikala, Ministry of Environment and Energy, HEDNO S.A., TEE Trikalon, University of Western Macedonia, University of Western Attica, DUTH, CRES, Hellenic Energy Competence Center, Cooperative Bank of Thessaly, Ministry of Economy and Finance, National Bank of Greece, Piraeus Bank, Alpha Bank, Eurobank, Citizens

	Comments on implementation	The Municipality should encourage citizens to install photovoltaic (PV) panels on their rooftops. Buildings mainly rely on the grid for electricity, which is typically generated from fossil fuels. The installation of PV systems in buildings can generate their own electricity, reducing the reliance on fossil fuels. This leads to a decrease in GHG emissions associated with electricity generation. Sunshine in Greece is estimated at 1.542 hours per year. The power of the PV installation is 3,16 MWp. Therefore, the total energy produced by the installation per year amounts to 4.872,72 MWh. During this action the potential for local production and storage of energy with batteries while disconnecting from the grid will be researched and promoted, in an effort to decongest the grid. This is a priority action linked to decarbonising electricity and heating generation.
Impact & cost	Generated renewable energy (if applicable)	4.873 MWh
	Removed/substituted energy, volume or fuel type	4.873 MWh
	GHG emissions reduction estimate (total) per emission source sector	1,31 kt CO_2e
	Total costs and costs by CO2e unit	3,16 mil € -2.412,21 €/tn CO_2e
Action outline	Action name	Municipal photovoltaic parks
	Action type	Technical Interventions

	Action description	Photovoltaic (PV) systems are designed to convert sunlight into electricity using solar panels. These panels contain solar cells that absorb photons from the sunlight and generate an electric current through the photovoltaic effect. This process allows PV systems to produce clean and renewable energy without emitting GHG or other harmful pollutants. As a result, PV systems play a crucial role in promoting sustainable energy solutions and reducing our dependence on fossil fuels.
Reference to impact pathway	Field of action	Energy systems
	Systemic lever	Technology & Infrastructure
	Outcome (according to module B-1.1)	Renewable energy integration
Implementation	Responsible bodies/person for implementation	One-stop shop for energy renovation on buildings, Municipal ESCO, Trikala Climate Team
	Action scale & addressed entities	50 MWp
	Involved stakeholders	Municipality of Trikala, Ministry of Environment and Energy, HEDNO S.A., TEE Trikalon, University of Western Macedonia, University of Western Attica, DUTH, CRES, Hellenic Energy Competence Center, Cooperative Bank of Thessaly, Ministry of Economy and Finance, National Bank of Greece, Piraeus Bank, Alpha Bank, Eurobank, Urban Development Company of Trikala S.A.
	Comments on implementation	Municipality should proceed with the construction of photovoltaic power plants at specific locations outside city boundary. PV power plants located outside the city can contribute to the overall supply of renewable energy to the region or even the national grid. This increase in clean energy capacity helps to displace electricity generated from fossil fuels, reducing GHG emissions and supporting climate neutrality goals.

		Sunshine in Greece is estimated at 1542 hours per year. The power of the PV installation is 50 MWp. Therefore, the total energy produced by the installation per year amounts to 77.100 MWh. This is a priority action linked to decarbonising electricity and heating generation.
Impact & cost	Generated renewable energy (if applicable)	77.100 MWh
	Removed/substituted energy, volume or fuel type	77.100 MWh
	GHG emissions reduction estimate (total) per emission source sector	20,76 kt CO_2e
	Total costs and costs by CO2e unit	50 mil € - 2.408,48 €/tn CO_2e
Action outline	Action name	RES energy through grid
	Action type	Technical Intervention
	Action description	Photovoltaic (PV) systems are designed to convert sunlight into electricity using solar panels. These panels contain solar cells that absorb photons from the sunlight and generate an electric current through the photovoltaic effect. This process allows PV systems to produce clean and renewable energy without emitting greenhouse gases or other harmful pollutants. As a result, PV systems play a crucial role in promoting sustainable energy solutions and reducing our dependence on fossil fuels.
	Field of action	Energy systems

Reference to impact pathway	Systemic lever	Technology & Infrastructure
	Outcome (according to module B-1.1)	Renewable energy integration
Implementation	Responsible bodies/person for implementation	Ministry of Environment and Energy, HEDNO S.A., Municipal ESCO
	Action scale & addressed entities	390 MWp
	Involved stakeholders	Municipality of Trikala, Ministry of Environment and Energy, HEDNO S.A., TEE Trikalon, University of Western Macedonia, University of Western Attica, DUTH, CRES, Hellenic Energy Competence Center, Cooperative Bank of Thessaly, Ministry of Economy and Finance, National Bank of Greece, Piraeus Bank, Alpha Bank, Eurobank
	Comments on implementation	Electricity generated by photovoltaic facilities can be fed into the grid, offsetting the need for additional electricity generated from fossil fuels. This interaction with the grid allows for a more efficient use of renewable energy resources and further reduces GHG emissions. This action is not coming from the city, but from the national grid. Greece has committed to reach 80% RES integration to the national energy mix until 2030. Thus, Trikala can continue consuming electricity from the grid but with a significantly lower carbon footprint. This fact is also favorable for the city, because is reduced the investment costs for Trikala. Sunshine in Greece is estimated at 1.542 hours per year. The power of the PV installation is 390 MWp. Therefore, the total energy produced by the installation per year amounts to 601.380 MWh. This is a priority action linked to decarbonising electricity and heating generation but is not controlled by the city.

Impact & cost	Generated renewable energy (if applicable)	601.380 MWh
	Removed/substituted energy, volume or fuel type	601.380 MWh
	GHG emissions reduction estimate (total) per emission source sector	207,26 kt CO_2e
	Total costs and costs by CO2e unit	The investment is coming from the government and HEDNO for the upgrade of the national grid and the integration of RES.
Action outline	Action name	Development of a joined and smart RES management system
	Action type	Technical Intervention

	Action description	Creation of an integrated platform that efficiently manages and optimizes the generation, distribution, and consumption of renewable energy from various renewable sources. The system will be able to collect data from various sources such as wind farms, photovoltaic installations, hydroelectric plants, etc. The analysis of the collective data can include predictions of energy production, efficiency and maintenance need and it is imperative that the analysis should provide indications about the overall performance of the RES systems. Scheduled maintenance and adaptation to conditions can optimize the performance of RES installations. Such a system is critical for enhancing the reliability and sustainability of energy grids, reducing carbon emissions, and ensuring a smooth transition to a renewable energy future. The main parts of smart RES management system are: • Data collection and sensors installment • Data integration from various sources to a centralized platform • Predictive analysis in order to optimize energy distribution and storage • Control and automation • Energy Storage Integration • Demand response programs that allow consumers to adjust their energy usage • Load management techniques to balance energy supply and demand • Grid Integration • Implement robust cybersecurity measures to protect RES management system • User interfaces to monitor energy production, consumption and grid status • Scalability and Interoperability • Continuous monitoring and optimization

		• Economic benefit
Reference to impact pathway	Field of action	Energy systems
	Systemic lever	Technology & Infrastructure Social innovation Finance & Funding
	Outcome (according to module B-1.1)	• Resilience enhancement • Smart grids and energy management systems • Energy storage innovation • Renewable energy expansion • Green entrepreneurship • Renewable energy deployment • Developing codes and standards for energy efficiency
Implementation	Responsible bodies/person for implementation	Municipal ESCO, Trikala Climate Team, e-Trikala SA

	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, Ministry of Environment and Energy, HEDNO S.A., TEE Trikalon, University of Western Macedonia, University of Western Attica, DUTH, CRES, Hellenic Energy Competence Center, Cooperative Bank of Thessaly, Ministry of Economy and Finance, National Bank of Greece, Piraeus Bank, Alpha Bank, Eurobank, Urban Development Company of Trikala S.A., ICCS, Cities Net, P-net, ABB Hellas, DOTSOFT SA
	Comments on implementation	The development of a joined and smart RES management system requires collaboration among energy providers, technology developers, policymakers, and the community. It is a critical component of the transition to a cleaner and more sustainable energy ecosystem. It is necessary to raise public awareness by educating citizens about the benefits of renewable energy and the massive role of smart RES management in transforming the city to climate neutrality. This is a priority action linked to decarbonising electricity and heating generation and Trikala - Restart mAI city.
Impact & cost	GHG emissions reduction estimate (total) per emission source sector	1 kt CO_2e
	Total costs and costs by CO2e unit	0,5 mil € - 500 €/tn CO_2e
Action outline	Action name	Solar thermal power systems on buildings
	Action type	Technical Intervention

	Action description	Solar thermal power systems on buildings, harness the sun’s energy to provide heat for various applications within the building. These systems are distinct from solar photovoltaic (PV) systems, which generate electricity from sunlight. Solar thermal power systems can be applied for: • Domestic Hot Water • Space Heating • Pool Heating • Process Heat Solar thermal systems utilize sunlight, which is a clean and RES, reducing reliance on fossil fuels. They can significantly reduce energy costs by providing free hot water or space heating. Solar thermal systems have a low environmental impact compared to conventional heating methods, while they help in the reduction of GHG emissions. Lastly, solar thermal power systems have a long lifespan, providing savings over many years. Solar thermal power systems on buildings offer an eco-friendly way to meet heating and hot water needs while reducing energy costs and environmental impact. The suitability of such a system depends on factors like climate, available space, and the building's energy requirements.
Reference to impact pathway	Field of action	Energy systems
	Systemic lever	Technology & Infrastructure
	Outcome (according to module B-1.1)	Reduction of residential buildings energy consumption and improve municipality resilience.
Implementation	Responsible bodies/person for implementation	One-stop shop for energy renovation on buildings, Municipal ESCO, Trikala Climate Team

	Action scale & addressed entities	Buildings
	Involved stakeholders	Municipality of Trikala, Ministry of Environment and Energy, HEDNO S.A., TEE Trikalon, University of Western Macedonia, University of Western Attica, DUTH, CRES, Hellenic Energy Competence Center, Cooperative Bank of Thessaly, Ministry of Economy and Finance, National Bank of Greece, Piraeus Bank, Alpha Bank, Eurobank, Citizens
	Comments on implementation	The action concerns 1370 homes on average per year, with eligibility criteria for homes that have not been upgraded, to change from fossil fuels to electricity through high-efficiency heat pumps, with accompanying positive results in terms of reducing air pollution in winter. The average Greek home consumes about 300 kWh of electricity every month. The most energy-consuming appliance in a household is proven to be the water heater/boiler, consuming about 40% of the total energy. This means that a home installing a solar thermal power systems that covers 80% of its energy needs can save up to 1.150 kWh yearly. This is a priority action linked to decarbonising electricity and heating generation.
Impact & cost	Generated renewable energy (if applicable)	11.028,5 MWh
	Removed/substituted energy, volume or fuel type	11.028,5 MWh
	GHG emissions reduction estimate (total) per emission source sector	17,22 ktn CO_2
	Total costs and costs by CO2e unit	10,3 mil € - 599,3 €/tn CO_2e

Action outline	Action name	Virtual Power Plants (VPP)
	Action type	Technical Intervention
	Action description	Virtual Power Plant (VPP) is a distributed energy system that connects a network of decentralized, often small-scale, energy resources and uses advanced software and control systems to operate them as a unified, coordinated power source. Essentially, a VPP aggregates a variety of energy assets, such as solar panels, wind turbines, energy storage systems (batteries), and even demand response from consumers, to function as a single, controllable entity within the energy grid.
Reference to impact pathway	Field of action	Energy systems
	Systemic lever	Technology & Infrastructure
	Outcome (according to module B-1.1)	Promotion of energy efficiency
Implementation	Responsible bodies/person for implementation	Municipal ESCO, Trikala Climate Team, e-Trikala SA
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, Ministry of Environment and Energy, HEDNO S.A., TEE Trikalon, University of Western Macedonia, University of Western Attica, DUTH, CRES, Hellenic Energy Competence Center, Cooperative Bank of Thessaly, Ministry of Economy and Finance, National Bank of Greece, Piraeus Bank, Alpha Bank, Eurobank, Urban Development Company of Trikala S.A., ICCS, Cities Net, P-net, ABB Hellas, DOTSOFT SA

	Comments on implementation	Promoting VPPs is crucial for advancing the transition to a cleaner, more efficient, and more resilient energy system. The most significant reasons to promote VPPs are: • Clean Energy Integration: VPPs enable the integration of diverse clean energy sources, including solar, wind, and hydropower. This helps reduce dependence on fossil fuels and mitigates climate change by lowering GHG emissions. • Enhanced Grid Stability: VPPs contribute to grid stability by providing grid operators with the flexibility to balance supply and demand, especially during peak periods or when intermittent renewable sources are not producing energy. • Energy Reliability: VPPs can improve energy reliability by incorporating energy storage systems like batteries. This ensures a consistent power supply, even during grid outages or fluctuations. • Energy Cost Savings: VPPs can lower energy costs for both utilities and consumers by optimizing energy production and consumption, reducing peak demand charges, and enabling energy trading. • Empowering Consumers: VPPs empower consumers to actively participate in the energy market. Individuals and businesses can sell excess energy back to the grid, participate in demand response programs, and have more control over their energy use. • Grid Decentralization: VPPs support the decentralization of energy production, reducing the need for large centralized power plants. This distributed approach enhances energy resilience and reduces transmission losses. • Incentive for Renewable Energy Adoption: By making renewable energy sources more economically viable, VPPs encourage greater adoption of solar panels, wind turbines, and other clean technologies.

		• Job Creation: The development, operation, and maintenance of VPPs create job opportunities in the renewable energy and energy management sectors, contributing to economic growth. • Scalability: VPPs are scalable and adaptable to various scales, from residential neighborhoods to entire cities or regions. They can accommodate the growing demand for clean energy. • Technological Innovation: The promotion of VPPs drives innovation in energy management, grid optimization, and renewable energy technologies, leading to advancements that benefit multiple industries. • Grid Resilience and Disaster Recovery: VPPs can enhance grid resilience during natural disasters. Decentralized energy resources can continue to provide power when centralized power plants are offline. • Environmental Benefits: By reducing reliance on fossil fuels and optimizing energy use, VPPs contribute to air quality improvements and environmental preservation. • Policy Support: Governments and regulatory bodies are increasingly recognizing the benefits of VPPs and implementing policies and incentives to support their development and deployment. This is a priority action linked to decarbonising electricity and heating generation and Trikala - Restart mAI city.
Impact & cost	GHG emissions reduction estimate (total) per emission source sector	1 kt CO_2e
	Total costs and costs by CO2e unit	0,5 mil € - 500 €/tn CO_2e

Action outline	Action name	Power through RES the water pumping and distribution system
	Action type	Technical Intervention
	Action description	The water pumping and distribution system is one of the main contributors in the municipal emitted GHG emissions. With the installation of a sustainable RES to provide power, the final emitted GHG will be significantly reduced.
Reference to impact pathway	Field of action	Energy systems
	Systemic lever	Technology & Infrastructure
	Outcome (according to module B-1.1)	Reduction of GHG emissions, raises awareness within the community and provides positive impact in the urban landscape
Implementation	Responsible bodies/person for implementation	One-stop shop for energy renovation on buildings, Municipal ESCO, Trikala Climate Team
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, DEYAT, HEDNO S.A., TEE Trikalon, University of Western Macedonia, University of Western Attica, DUTH, CRES, Hellenic Energy Competence Center, Cooperative Bank of Thessaly, Ministry of Economy and Finance, National Bank of Greece, Piraeus Bank, Alpha Bank, Eurobank
	Comments on implementation	Installation of a 4.6 MW PV station owned by the municipal Water Supply and Sewage Company (DEYAT), in a publicly owned area granted by the Municipality to DEYAT for the electrification needs of the drinking water pumping stations & to cover local households needs. This is a priority action linked to decarbonising electricity and heating generation.

Impact & cost	Generated renewable energy (if applicable)	7.093 MWh
	Removed/substituted energy, volume or fuel type	7.093 MWh
	GHG emissions reduction estimate (total) per emission source sector	3,1 ktn CO_2e
	Total costs and costs by CO2e unit	14,7 mil € - 4.741,93 €/tn CO_2e
Mobility & Transport		
Action outline	Action name	Clean and efficient vehicles (electric)
	Action type	Governance Intervention

	Action description	Clean vehicles (such as electric) produce fewer or zero tailpipe emissions compared to conventional vehicles. Specifically, electric vehicles have zero tailpipe emissions, while hybrids and biofuel vehicles emit significantly lower levels of GHG. The replacement of fossil fuel powered vehicles with clean alternatives will contribute to the reduction of carbon dioxide and other harmful emissions. In addition, clean vehicles are designed to be more energy efficient than conventional vehicles. This increased efficiency means that they require less energy to travel the same distance, reducing overall energy consumption and associated emissions. Clean vehicles can be charged using RES such as solar or wind power. By combining clean vehicles with renewable energy generation, we can create a synergistic effect that further reduces GHG emissions. This integration helps to decarbonize the transportation. These advancements not only improve the performance and range of clean vehicles but also make them more accessible and cost-effective for consumers. They provide incentives for users with older conventional cars to transition to newer more efficient cars. Promoting clean and efficient vehicles is crucial for several compelling reasons, which are primarily related to environmental, economic, and social benefits. The market penetration of low emission vehicles can be intensified by the provision of financial incentives and an integrated system of vehicle chargers ' infrastructure. The financial incentives can be tax breaks, consumer subsidies and reduced public fees.
Reference to impact pathway	Field of action	Mobility & Transport
	Systemic lever	Technology & Infrastructure Finance & Funding
	Outcome (according to module B-1.1)	• Alternative fuels infrastructure • Mobility as a Service (MaaS) • Electrification of transportation • Green mobility initiatives • Mobility infrastructure investments • Green mobility initiatives

Implementation	Responsible bodies/person for implementation	Municipality of Trikala, Trikala Climate Team
	Action scale & addressed entities	City of Trikala, 20% of passenger cars and motorcycles till 2040
	Involved stakeholders	Motorcycle Club of Trikala, Association of Professional Motor Truck Owners, Association of Candidate Driver Instructors, Urban Bus Station of Trikala, Intercity Bus Station of Trikala, Taxi Association of Trikala, Association of petrol dealers, Ministry of Environment and Energy, Cooperative Bank of Thessaly, Ministry of Infrastructure and Transport, Ministry of Economy and Finance, National Bank of Greece, Piraeus Bank, Alpha Bank, Eurobank, EDOE - Alternative Management System for End of Life Cycle Vehicles
	Comments on implementation	This action will focus in a shift from conventional combustion engines to a more efficient/clean engines. Particularly, it aims at a conversion rate of 20% to more efficient vehicles, a rate of 40% for conversion to hybrid vehicles and 20% to electric vehicles. Conversion in this action refers to private and commercial transport. Therefore, since we are not referring at all to public transport, the implementation and success of the action is quite difficult, as it is quite challenging to adopt this change universally. The launch of the action could be made first in commercial transport and this can be implemented with the help of possible investment programs and credits that can be used to support and decarbonise the interested stakeholders. This action will be fully implemented in cooperation with other actions of the project. In particular, the city has already implemented the Electric Vehicle Charging Plan (2021) in which 94 charging stations for EVs are mentioned and thus the market for vehicles can be sufficiently profitable.
Impact & cost	GHG emissions reduction estimate (total) per emission source sector	1,6 ktn CO_2e

	Total costs and costs by CO2e unit	137,68 mil € - 86.050,0 €/tn CO_2e
Action outline	Action name	Clean public transport
	Action type	Organizational Intervention
	Action description	Transportation is responsible for a significant percentage of total GHG emissions. Recognizing this as a key source of environmental pressures, the European Union has set ambitious targets specifically for the reduction of carbon dioxide emissions from vehicles. In order to achieve this reduction, it is deemed necessary to increase the share of EVs in the total number of vehicles for the target years. For their adaptation to the new conditions and requirements and their effective transition to electrification, the automotive industries exist and must make structural changes. In particular, the following measures are proposed: • Replacing 60% of the existing old diesel municipal fleet with new technology vehicles by 2030 • Training on the benefits of ecological driving to the administrative staff of the competent departments and to the residents of the municipality. • Improving the management and efficiency of the municipal fleet using new technologies and streamlining existing routes
	Field of action	Mobility & Transport

Reference to impact pathway	Systemic lever	Technology & Infrastructure Government and policy Social Innovation Finance and Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Integration of new mobility services • Green mobility initiatives • Electrification of transportation • Public transport and fleet upgrade • Mobility infrastructure investments • Demand Responsive Transport (DRT) • Promotion of public transport • Zero - Emission Zones
Implementation	Responsible bodies/person for implementation	Public Transport Organisation of Trikala, Intercity Bus Organisation of Trikala, Trikala Climate Team
	Action scale & addressed entities	60% of fleet
	Involved stakeholders	Municipality of Trikala, Ministry of Environment and Energy, Cooperative Bank of Thessaly, Ministry of Infrastructure and Transport, Ministry of Economy and Finance, National Bank of Greece, Piraeus Bank, Alpha Bank, Eurobank, EDOE - Alternative Management System for End of Life Cycle Vehicles, Urban Development Company of Trikala, ICCS

	Comments on implementation	Trikala estimates that 60% of the bus fleet can be replaced with electric buses until 2030, with an aim of 100% to 2040. More specifically in 2024 5% of the fleet will be upgraded, in 2025 another 5%, in 2026 10% and the same for 2027 - 2028, in 2029 15% will be replaced and the last 5% in 2030. Electric vehicles technology is continuously upgraded reaching better efficiency and financial savings. Public transport can receive funding for upgrades more easily. This is a priority action linked to the shift to public and non-motorised transport.
Impact & cost	GHG emissions reduction estimate (total) per emission source sector	0,38 ktn CO_2e
	Total costs and costs by CO2e unit	10,45 mil € - 27.500,0 €/tn CO_2e
Action outline	Action name	Fleet management application for heavy vehicles
	Action type	Organizational Intervention

	Action description	A fleet management application for municipal fleets and public transport can greatly improve the efficiency, safety, and sustainability of transportation services. A well-designed fleet management application tailored to municipal fleets and public transport can enhance operational efficiency, reduce costs, improve safety, and contribute to environmental sustainability while providing passengers with convenient and reliable transportation services. It's important to collaborate with relevant stakeholders, including public transportation agencies and fleet managers, to ensure that the application meets their specific needs and regulatory requirements. Using such an application, users can Monitor the real-time location and status of all vehicles in the fleet, including buses and municipal vehicles, or receiving alerts when vehicles passing from specific areas. It can be also useful for drivers to monitor the health of vehicles by collecting data on engine performance, fuel consumption, and emissions and receiving alerts for maintenance tasks. Drive safety is promoted through these applications with monitoring driver behavior, offering training modules to improve driver safety and eco-driving skills and immediate reporting accidents and incidents. Moreover, passengers can use these applications to plan their journeys using public transport and to purchase tickets.
Reference to impact pathway	Field of action	Mobility & Transport
	Systemic lever	Technology & Infrastructure Finance & Funding
	Outcome (according to module B-1.1)	• Mobility infrastructure investments • Public transport and fleet upgrade • E-mobility infrastructure • Intelligent transportation Systems
Implementation	Responsible bodies/person for implementation	Trikala Climate Team, e-Trikala

	Action scale & addressed entities	Public and private heavy vehicles (trucks and buses)
	Involved stakeholders	Municipality of Trikala, Association of Professional Motor Truck Owners, Association of Candidate Driver Instructors, Public Transport Organisation of Trikala, Intercity Transport Organisation of Trikala, Ministry of Environment and Energy, Ministry of Infrastructure and Transport, Ministry of Economy and Finance, Ministry of Digital Governance, Urban Development Company of Trikala, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, P-net, ABB Hellas, DOTSOFT SA
	Comments on implementation	Many local governments have successfully adopted fleet management applications to improve the efficiency, safety, and sustainability of their transportation services. Careful planning, stakeholder engagement, and a commitment to addressing these obstacles can pave the way for successful implementation. Yet there are some obstacles that must be faced in order to have greater results by this action. At first there are some costs on developing, implementing, and maintaining a fleet management application. In addition, the existing public fleet that will remain may lack the necessary technology infrastructure (e.g., GPS, telematics) for seamless integration with the application. Upgrading or retrofitting older vehicles can be costly. On the other hand, municipal fleet must be transitioned to electric or hybrid vehicles in terms of cost-efficiency. Moreover, employees, especially those in long-established roles, may resist adopting new technology and processes. Also, drivers may lack of knowledge of these applications. Training and change management efforts may be required to address those obstacles.
Impact & cost	GHG emissions reduction estimate (total) per emission source sector	0,90 ktn CO_2e
	Total costs and costs by CO2e unit	0,61 mil € - 673,23 €/tn CO_2e

Action outline	Action name	Development of a DRT (Demand-Responsive Transport) app
	Action type	Organizational Intervention
	Action description	Demand-Responsive Transport (DRT), also known as Demand-Responsive Transit, is a type of transportation service that adapts to passengers' specific requests and needs, often using flexible routing and scheduling. It contrasts with traditional fixed-route public transportation systems like buses and subways, which follow predetermined routes and schedules. Passengers can request DRT services on-demand, often using a mobile app or a phone call. This can be extremely useful for people with disabilities, seniors or those living in areas with limited access to traditional transit. In addition, DRT services are more flexible than the traditional transit. They typically operate in areas or during times when fixed-route services may be less practical or cost-effective. Also, DRT vehicles are smaller than traditional buses, so it can serve areas with lower passenger demand more efficiently and navigate narrower streets. Overall, Demand-Responsive Transport applications provide a valuable solution for communities seeking more flexible and inclusive transportation options. They adapt to the changing needs of passengers and can complement existing public transit networks to create a more comprehensive and accessible transportation system.
Reference to impact pathway	Field of action	Mobility & Transport
	Systemic lever	Finance & funding Learning capabilities Social innovation

	Outcome (according to module B-1.1)	• Integration of new mobility services • Behavioral change and cultural shift • Green mobility initiatives • Collaborative ride-sharing • Community-led transportation initiatives • Demand-Responsive Transport (DRT) • Sustainable and inclusive mobility solutions for vulnerable social groups • Shared mobility platforms
Implementation	Responsible bodies/person for implementation	Trikala Climate Team, e-Trikala
	Action scale & addressed entities	Public transportation
	Involved stakeholders	Municipality of Trikala, Association of Professional Motor Truck Owners, Association of Candidate Driver Instructors, Public Transport Organisation of Trikala, Intercity Transport Organisation of Trikala, Ministry of Environment and Energy, Ministry of Infrastructure and Transport, Ministry of Economy and Finance, Ministry of Digital Governance, Urban Development Company of Trikala, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, P-net, ABB Hellas, DOTSOFT SA
	Comments on implementation	Although its benefits, there are several barriers and challenges that need to be overcome when implementing Demand-Responsive Transport (DRT) systems. First of all, DRT services can be environmental harmful if the service uses individual vehicles. Implementing green and sustainable transportation options can mitigate these concerns. In addition, coordinating DRT services with existing fixed-route transit systems can be

Impact & cost		complex. Ensuring smooth transfers and fare integration between DRT and traditional transit is essential for a seamless passenger experience. Moreover, DRT services often require subsidies, especially in areas with low passenger density. Identifying sustainable funding sources and cost-recovery models is essential for the long-term viability of the service. In any case, the more completed collaboration among various stakeholders, including local governments, transit agencies, private sector partners, and the community, the more successful DRT system will be. This is a priority action linked to the shift to public and non-motorised transport and also Trikala - Restart mAI city.
	GHG emissions reduction estimate (total) per emission source sector	0,26 ktn CO_2e
	Total costs and costs by CO2e unit	0,075 mil € - 289,58 €/tn CO_2e
Action outline	Action name	Zero Emission Zones
	Action type	Spatial Intervention
	Action description	Establish legislative zone in the city center where only zero-emission vehicles are allowed to operate, meaning vehicles that produce no tailpipe emissions, primarily carbon dioxide (CO2), and other harmful pollutants. ZEZs are a strategic policy tool used to combat air pollution, reduce GHG emissions, and promote the use of cleaner transportation options. The main purpose of ZEZs is to significantly reduce air pollution by restricting or prohibiting the entry of vehicles that emit pollutants, including nitrogen oxides (NOx) and particulate matter (PM), which can harm public health. This would help mitigate climate change by reducing GHG emissions. By reducing vehicular emissions, ZEZs contribute to improved air quality, which can have positive effects on public health,

		including reduced respiratory and cardiovascular illnesses. Also, ZEZs encourage the adoption of electric vehicles (EVs) and other zero-emission technologies, such as hydrogen fuel cell vehicles. These zones provide an incentive for individuals and businesses to transition to cleaner transportation options. Furthermore, ZEZ will promote the use of public transport, cycling and walking as sustainable alternatives to private vehicles. Finally, ZEZ can be introduced in phases, so either emission standards will be stricter or the area will be larger over time. This approach allows for a gradual transition and minimizes the impact on affected businesses and individuals.
Reference to impact pathway	Field of action	Mobility & Transport
	Systemic lever	Governance & Policy Finance & Funding Technology & Infrastructure
	Outcome (according to module B-1.1)	• Zoning and urban planning • Zero emissions zones • Inclusive accessibility • Mobility infrastructure investment • Vehicle emissions standards
Implementation	Responsible bodies/person for implementation	Municipality of Trikala, Trikala Climate Team
	Action scale & addressed entities	City of Trikala, central locations
	Involved stakeholders	Association of Professional Motor Truck Owners, Association of Candidate Driver Instructors, Public Transport Organisation of Trikala, Urban Development Company of Trikala, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Cities Net, Commercial Association of Trikala, Youth City Council

	Comments on implementation	To ensure the success of implementing Zero Emission Zones (ZEZ), robust community engagement is paramount. This engagement should extend beyond the planning phase and actively involve residents in the execution of ZEZ initiatives. Educational campaigns are vital in this regard, serving to promote the adoption of low-emission and non-motorised vehicles and to disseminate information about the benefits of establishing ZEZs in the city center. Furthermore, there's inherent synergy with complementary actions such as transitioning the municipal vehicle fleet to low-emission vehicles and encouraging increased usage of such vehicles by citizens. By fostering collaboration and awareness among residents, businesses, and local authorities, the city can effectively pave the way for a smoother transition towards cleaner and more sustainable urban environments. This is a priority action linked to the shift to public and non-motorised transport.
Impact & cost	GHG emissions reduction estimate (total) per emission source sector	3,32 ktn CO_2e
	Total costs and costs by CO2e unit	1 mil € - 300,84 €/tn CO_2e
Action outline	Action name	Behavioral shift to public transport, walking and cycling (inc. infrastructure)
	Action type	Social Intervention & Technical Intervention
	Action description	Bicycle is a low-cost means of transportation, which is particularly environmentally friendly. Commuting by bicycle is done with the consumption of human energy, giving the users of the specific medium better health and quality of life over time. At the same time, bicycles take up little space when moving and standing in comparison to cars, "saving" public space for other uses. Shifting citizen behavior toward using bicycles instead of

		other vehicles involves a multifaceted approach that addresses various factors, including infrastructure, incentives, education, and safety. It is necessary to public awareness campaigns for all citizens to learn the benefits of cycling for health, the environment, and reducing traffic congestion. The Municipality of Trikala has carried out several actions that promote bicycle usage, while the city has a satisfactory network of cycle paths. However, cycle network should be upgraded and widened in order to serve more city's areas that do not have the appropriate infrastructure. Also, new parking spaces for bicycles should be placed across the cycle network. In the same context, it is important to make zones around schools where vehicle speeds will be reduced through traffic calming measures like speed bumps and narrower roadways to enhance cyclist safety. Additionally, new policies must be implemented that will allow people to more extensively use of bicycle. For instance, the Municipality could have flexible work hours for its employees so they can go to work by bicycle. Also, the Municipality of Trikala could provide financial incentives for the purchase of bicycles, e-bikes or related accessories.
Reference to impact pathway	Field of action	Mobility & Transport
	Systemic lever	Social Innovation Technology & Infrastructure Learning and Capabilities
	Outcome (according to module B-1.1)	• Behavioral change and cultural shift • Regulatory and policy understanding • Collaborative ride - sharing • Cycling and walking initiatives • Sustainable and inclusive mobility solutions for vulnerable social groups • Youth - Led
Implementation	Responsible bodies/person for implementation	Municipality of Trikala, Trikala Climate Team

Impact & cost	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Association of Professional Motor Truck Owners, Association of Candidate Driver Instructors, Public Transport Organisation of Trikala, Urban Development Company of Trikala, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Cities Net, Commercial Association of Trikala, Youth City Council, Citizens
	Comments on implementation	There are some barriers to overcome in order to promote cycling. The most important is to shift cultural norms and habits around car ownership and use. This may require time and targeted actions such as the educational campaigns. There must be highlighted that bicycle not only is a recreational activity but a practical means of transportation too. In addition, as it is mentioned in the Energy Transition Plan of Trikala there are some areas that do not have cycling infrastructure. Municipality of Trikala has made several steps to promote the use of bicycle. As an illustration, the municipality has already proceeded to develop an application under the SMARTA Project that gives the opportunity to users to book bicycles offered at the city center. This is a priority action linked to the shift to public and non-motorised transport.
	GHG emissions reduction estimate (total) per emission source sector	1,81 ktn CO_2e
	Total costs and costs by CO2e unit	5 mil € - 2.757,86 €/tn CO_2e
Action outline	Action name	Improvement of logistics and urban freight transport
	Action type	Organizational Intervention

	Action description	Logistics and urban freight transport can become more eco-friendly by implementing a combination of strategies and technologies that reduce environmental impacts, including emissions, congestion, and noise pollution. Companies have to adopt electric vehicles (EVs) and low-emission delivery trucks to reduce tailpipe emissions. Electric vans, cargo bikes, and e-cargo trikes are suitable for last-mile deliveries in congested urban areas. To achieve this, economic incentives must be provided by the local government. Furthermore, there are great practices of reducing delivery trips and number of vehicles on the road, such as establishing of consolidation centers on the outskirts of urban areas where goods from various suppliers are consolidated into fewer, larger shipments before entering the city. Also, partnerships among retailers or suppliers should be promoted, where they could share the same delivery infrastructure. In the same context, adoption of intracity freight is important to boost eco-friendly last mile delivery options. Intracity freight often involves the last-mile delivery segment, which is the final leg of the supply chain where goods are transported from a distribution center or warehouse to the end consumer or business. This is a critical and often challenging part of urban freight due to the need for timely and efficient deliveries to individual addresses. In this part, there are some great eco solutions such as the investment in autonomous delivery vehicles and drones for last-mile deliveries and the establishment of urban freight hubs within the city to minimize the distance goods need to travel from distribution points to the final destination.
Reference to impact pathway	Field of action	Mobility & Transport
	Systemic lever	Technology & Infrastructure
	Outcome (according to module B-1.1)	Reduction of GHG emissions and boost eco-friendly mobility
Implementation	Responsible bodies/person for implementation	Municipality of Trikala, Trikala Climate Team, Private Sector

	Action scale & addressed entities	Commercial transports & courier vehicles
	Involved stakeholders	Association of Professional Motor Truck Owners, Association of Candidate Driver Instructors, Public Transport Organisation of Trikala, Urban Development Company of Trikala, Commercial Association of Trikala, ICCS
	Comments on implementation	The ever-changing habits of people regarding online shopping are associated with an increase in parcel volumes, creating significant challenges in the management of Urban Freight Transport. Further, there are some barriers that need to overcome and planning measures must be adopted. For example, parking and loading zones for delivery vehicles must be placed around city center. Additionally, city regulations and zoning laws can impact delivery operations. Restrictions on delivery hours, vehicle types, and emissions standards may require adaptation. In order to achieve the objectives of the social and environmental policy implemented by the delivery companies to achieve sustainable Urban Freight Transport, the use of low or zero emission vehicles is promoted - among other things as a good practice. The whole set of actions will focus in a 5% vehicle reduction.
Impact & cost	GHG emissions reduction estimate (total) per emission source sector	3,62 ktn CO_2e
	Total costs and costs by CO2e unit	0,5 mil € - 138,27 €/tn CO_2e
Action outline	Action name	Support of remote working and online services
	Action type	Organizational Intervention

	Action description	Supporting remote working and online services has become increasingly important, especially in response to global events like the COVID-19 pandemic. This support encompasses various aspects of technology, infrastructure, policies, and culture to enable individuals and organizations to work, collaborate, and access services from remote locations. Supporting remote working and online services not only enhances flexibility for employees but also enables organizations to adapt to changing circumstances, improve efficiency, and expand their reach. It's essential to maintain a proactive approach to technology and policy enhancements to meet evolving needs effectively.
Reference to impact pathway	Field of action	Mobility & Transport
	Systemic lever	Governance & Policy
	Outcome (according to module B-1.1)	Minimize the total number of daily trips, reduction of GHG emissions and promotes new business models
Implementation	Responsible bodies/person for implementation	Trikala Climate Team, Private Sector
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, Ministry of Digital Governance, e-Trikala, Local businesses, ICCS, P-net, DOTSOFT SA, Google Hellas, Ministry of Labour and Social Security, Citizens
	Comments on implementation	Supporting remote working in the private sector of Trikala, can offer several benefits, including increased flexibility for employees, reduced commuting, and potential cost savings for businesses. However, there are several barriers that organizations may need to overcome to successfully adopt and implement remote working practices. One of the most practical issues is not only the technology infrastructure of each company but of

		each employee too. Organizations must ensure that employees have reliable and high – speed internet connections at home that can be difficult especially for rural areas. Also, companies have to provide employees the necessary hardware and software for remote work. It is self-evident that the more employees an organization has the more costly providing with hardware and software will be. Therefore, economic incentives must be provided either from Municipality of Trikala and from the National Government. Further, transitioning to a remote work culture can be challenging, especially in organizations where traditional office-based work is the norm. Some employees and managers may resist the shift to remote work due to concerns about productivity, team collaboration, or traditional work habits. It may require changes in management style and mindset. That can be achieved through campaigns that will highlight the benefits of remote work. This action will focus in a 5% reduction of total transport GHG.
Impact & cost	GHG emissions reduction estimate (total) per emission source sector	2,22 ktn CO_2e
	Total costs and costs by CO2e unit	0,5 mil € - 225,63 €/tn CO_2e
Action outline	Action name	Mobility as a Service (MaaS)
	Action type	Organizational Intervention
	Action description	Mobility as a Service (MaaS) is a concept and emerging model in transportation that aims to revolutionize the way people plan, pay for, and use transportation services. It is often seen as a response to the challenges of urbanization, congestion, environmental concerns, and the proliferation of various transportation options. MaaS integrates various modes of transportation into a single, user-centric platform or application. This includes public transit, ridesharing, car rentals, bike-sharing, taxis, and more. The goal of MaaS is

		to provide users with a seamless and convenient travel experience. Instead of dealing with multiple providers and separate payment systems, users can plan, book, and pay for their entire journey through a single interface. With MaaS, users are encouraged to use a mix of transportation modes for their journeys. For instance, a MaaS platform might recommend taking a bus to a train station, followed by a shared bicycle for the last mile. One of the great aspects about MaaS is that some platforms often use data analytics and algorithms to offer personalized travel recommendations based on user's preferences, schedules and budgets. Furthermore, MaaS platforms provide real-time information about the status and location of different transportation services. There are several practical examples of Mobility as a Service (MaaS) initiatives and platforms in various cities around the world. Whim is one of the first MaaS platforms. It was first launched in Helsinki, Finland. Through Whim users can plan and pay for different modes of transport, including public transport, taxis, car rentals, and bike-sharing. Further, users can pay for individual trips or subscribe to monthly plans that cover their transportation needs.
Reference to impact pathway	Field of action	Mobility & Transport
	Systemic lever	Social Innovation
	Outcome (according to module B-1.1)	Minimize the total number of daily trips, reduction of vehicle usage and city congestion, reduction of GHG emissions and promotes new business models, encourage public transport use
Implementation	Responsible bodies/person for implementation	Trikala Climate Team, e-Trikala
	Action scale & addressed entities	Public transportation

	Involved stakeholders	Municipality of Trikala, Association of Professional Motor Truck Owners, Association of Candidate Driver Instructors, Public Transport Organisation of Trikala, Intercity Transport Organisation of Trikala, Ministry of Environment and Energy, Ministry of Infrastructure and Transport, Ministry of Economy and Finance, Ministry of Digital Governance, Urban Development Company of Trikala, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, P-net, ABB Hellas, DOTSOFT SA
	Comments on implementation	Despite the benefits of Mobility as a Service (MaaS), several obstacles necessitate collaborative efforts among government agencies, private sector stakeholders, technology providers, and communities. Chief among these challenges is the primary objective of MaaS: to integrate diverse transport options into a single platform. Achieving this goal demands collaboration between MaaS platforms and various stakeholders, including public transit agencies, private transportation firms, and local governments, to deliver a seamless user experience. Additionally, altering user behaviors and habits concerning transportation is crucial. In Trikala, where individual car usage predominantly dictates mobility, resistance to adopting new transportation models may arise. Furthermore, MaaS services have the potential to increase transportation costs for certain users who heavily rely on multiple modes of transportation, posing affordability and accessibility challenges across income levels. Overcoming these obstacles necessitates targeted educational campaigns designed to inform all Trikala citizens about the socio-ecological benefits of utilizing MaaS platforms. Such campaigns can play a vital role in fostering acceptance and adoption of new transportation paradigms, ultimately contributing to the city's transition towards sustainable mobility solutions. This is a priority action linked to the shift to public and non-motorised transport.
Impact & cost	GHG emissions reduction estimate (total) per emission source sector	0,26 ktn CO_2e
	Total costs and costs by CO2e unit	0,1 mil € - 386,1 €/tn CO_2e

Action outline	Action name	Development of apps and initiatives for vehicle sharing - Car pooling
	Action type	Organizational Intervention
	Action description	New technologies or business models for urban transport can also help shift demand towards options with lower carbon footprints. The development of apps and initiatives for vehicle sharing plays a crucial role in promoting sustainable transportation, reducing congestion, and lowering the environmental impact of personal vehicle ownership. For example, apps that support shared bikes, electric cars, or electric mopeds can provide solutions to many mobility needs.
Reference to impact pathway	Field of action	Mobility & Transport
	Systemic lever	Technology & Infrastructure
	Outcome (according to module B-1.1)	Reduction of car ownership, reduction of GHG emissions and promotes new business models
Implementation	Responsible bodies/person for implementation	Trikala Climate Team, e-Trikala
	Action scale & addressed entities	City of Trikala, private transportation
	Involved stakeholders	Municipality of Trikala, Association of Professional Motor Truck Owners, Association of Candidate Driver Instructors, Public Transport Organisation of Trikala, Intercity Transport Organisation of Trikala, Ministry of Environment and Energy, Ministry of Infrastructure and Transport, Ministry of Economy and Finance, Ministry of Digital Governance, Urban Development Company of Trikala, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, P-net, ABB Hellas, DOTSOFT SA

Impact & cost	Comments on implementation	Municipality of Trikala is participating in SMARTA2 Project which focuses on how to interconnect sustainable shared mobility with public transport in European rural areas. In this context, Municipality of Trikala is developing an online application that allows users to have real-time public transport information and to examine whether to use public transport or any available carpooling options. This action will focus in a 5% reduction of total transport GHG.
	GHG emissions reduction estimate (total) per emission source sector	0,51 ktn CO_2e
	Total costs and costs by CO2e unit	0,6 mil € - 1.176,47 €/tn CO_2e
Action outline	Action name	Enhancement of E-powered Micromobility
	Action type	Organizational Intervention
	Action description	Electric-powered micromobility options have gained popularity as cities seek sustainable and efficient transportation solutions. It is important to shift citizens' thought for short-distance transportation within urban areas. The key benefits of electric-powered micromobility are either ecological (e-powered micromobility produce no direct emissions), economical (cost-effective compared to car ownership) and social (promoting healthier lifestyle and physical activity). In addition, there are some traffic issues that micromobility mitigates such as traffic congestion and demand for parking spaces. Municipality of Trikala will collaborate with micromobility businesses to provide personal mobility vehicles.
	Field of action	Mobility & Transport

Reference to impact pathway	Systemic lever	Social innovation
	Outcome (according to module B-1.1)	Reduction of car ownership, reduction of GHG emissions, promotes alternate means of transportation and promotes new business models
Implementation	Responsible bodies/person for implementation	Trikala Climate Team, e-Trikala
	Action scale & addressed entities	City of Trikala, public transportation
	Involved stakeholders	Municipality of Trikala, Association of Candidate Driver Instructors, Public Transport Organisation of Trikala, Urban Development Company of Trikala, ICCS, Cities Net, P-net, ABB Hellas, DOTSOFT SA, Citizens
	Comments on implementation	Municipality of Trikala have strengthened the use of electric-powered micromobility from 2018 when participating in the ELVITEN Project. This project is an H2020 European Project that aims to boost the usage of light electric vehicles. Municipality of Trikala procured electric bicycles and other electric micromobility vehicles to examine the potential of using such vehicles in the city. In addition, in April 2023 the Municipality launched an open tender for the supply, installation, configuration and operation of an integrated electric bicycle rental system for Trikala. This is a priority action linked to the shift to public and non-motorised transport.
Impact & cost	GHG emissions reduction estimate (total) per emission source sector	0,26 ktn CO_2e
	Total costs and costs by CO2e unit	0,3 mil € - 1.158,3 €/tn CO_2e

Action outline	Action name	Eco-driving workshops and application (especially for professional drivers)
	Action type	Social Intervention
	Action description	Eco-driving workshops and applications are effective tools for promoting environmentally friendly driving practices, reducing fuel consumption, lowering emissions, and improving road safety. These initiatives are particularly valuable for professional drivers, such as truck drivers, delivery personnel, and fleet operators, as they spend a significant amount of time on the road. Implementing eco-driving workshops and applications for professional drivers not only benefits businesses and the environment but also enhances the skills and job satisfaction of the drivers themselves. It's a win-win strategy that aligns with sustainability goals and operational efficiency.
Reference to impact pathway	Field of action	Mobility & Transport
	Systemic lever	Learning & Capabilities
	Outcome (according to module B-1.1)	Reduction of GHG emissions, reduction of car accidents
Implementation	Responsible bodies/person for implementation	Trikala Climate Team
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, Association of Professional Motor Truck Owners, Association of Candidate Driver Instructors, Public Transport Organisation of Trikala, Intercity Bus Transport Company of Trikala Urban Development Company of Trikala, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, Citizens

	Comments on implementation	Workshops must be organized by specialists who will collaborate with various stakeholders (local government, car manufacturers and environmental organizations. The workshops will be open to everyone interested, but they will mostly target professional drivers.
Impact & cost	GHG emissions reduction estimate (total) per emission source sector	0,45 ktn CO_2e
	Total costs and costs by CO2e unit	0,5 mil € - 1.106,19 €/tn CO_2e
Waste & Circular economy		
Action outline	Action name	Separate collection and sustainable management of organic municipal waste
	Action type	Organisational intervention
	Action description	Organic waste is defined as biodegradable garden and park waste, food and kitchen waste from homes, offices, restaurants, wholesalers, canteens, and retail outlets, and associated waste from food processing establishments. Separate collection of organic waste has several benefits. It has been estimated that 35-40% of organic waste can be composted. Composting is the natural process that converts organic materials into a high-quality soil amendment, called compost. Specifically, composting refers to the aerobic decomposition of organic waste with the aim of reducing its volume and producing compost. Nutrient-rich compost improves the fertility and structure of soil while sequestering carbon from atmosphere, helping to reduce GHG emission. In this manner, composting is not only a great way to recycle organic waste but also contributes to mitigating climate change. In addition, the decomposition of organic waste in landfills produces methane emissions.

		Methane is a potent GHG that contributes to climate change.To mitigate methane emissions from organic waste in landfills, it is important to reduce the amount of them going to landfills through recycling and composting. And last but not least, separating biowaste from other waste streams prevent contamination. Organic waste can easily contaminate other recyclable materials, making them unsuitable for recycling. Separate collection and sustainable management of organic municipal waste requires active participation of citizens and proper information and collaboration by Municipality. Public awareness campaigns and educational programs can help promote the importance of organic waste separation and encourage participation from individuals and communities.
Reference to impact pathway	Field of action	Waste & Circular economy
	Systemic lever	Technology & Infrastructure Government & Policy Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Waste management digitalization • Waste services upgrade (separate collection, smart bins, frequent collection) • Sustainable and more efficient waste management plants • Waste to energy conversion • Tax incentives for recycling and Circular Economy practices • Strict waste management city regulation • Local Circular Economy plans

		• Community-led waste management initiatives • Waste education in schools • Sharing and swapping • Waste reduction incentives • Circular infrastructure development • Public - private partnerships • Waste upcycling projects • Behavioural change and cultural shift
Implementation	Responsible bodies/person for implementation	Municipality of Trikala & PADYTH SA
	Action scale & addressed entities	City-wide scale
	Involved stakeholders	Commercial Association of Trikala, Ministry of Environment and Energy, Thessaly Region, Urban Development Company of Trikala, DUTH, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Solid Waste Management Association, Mellon Labs, Wastecloud, EPTA, Organisation Earth, Youth City Council, ANAKEM, AFIS, Appliances Recycling SA, Hellenic Recovery Recycling Corporation, ENDIALE, ECO Elastika, EDOE, Re-Battery, NECCA, Ecological Recycling Society, Citizens
	Comments on implementation	According to NWMP (2020-2030), the goal is to establish separate collection of municipal organic waste (40% by weight) and develop related infrastructure throughout the country. The main actions to achieve this goal include strengthening existing separate collection initiatives and integrating new ones, such as, the implementation of separate collection of organic waste (biowaste bin) and the implementation and operation of GPs.

		The proper preparation and implementation of separate organic waste collection require a set of resources, including equipment (containers, waste collection vehicles, weighing machines, etc.), personnel for program organization and waste collection processes, digital media, and expenses for awareness and outreach activities. The members of the project team involved in the design and operation of this waste management plan will be responsible for determining this equipment, conducting market research, finding the necessary sources of funding, etc. Awareness and information of citizens is particularly important for achieving this goal. All actions that promote alternative waste management, beyond the existence of infrastructure and organization by the Municipality, require active participation of the majority of citizens. For this reason, an integrated communication framework should be designed to inform the residents about the system. The MSW Treatment Plant of Western Thessaly is currently under construction. The plant includes a composting unit for the processing of the source separated organics. This is a priority action linked to sustainable management of waste & promotion of circular economy.
Action outline	Action name	Separate collection and sustainable management of paper municipal waste
	Action type	Organisational intervention
	Action description	Recycling and reusing paper creates a closed - loop system where materials are continuously cycled and waste is minimized. Paper waste segregation at source enables composting and recycling, while diverting large quantities from disposal in landfills.This reduces the amount of waste that decomposes in landfills and releases methane. Recycling paper also saves energy compared to producing new paper from virgin

		materials, further reducing GHG emissions. This shift towards a Circular Economy reduces the extraction of raw materials, energy consumption, and waste generation, all of which have positive climate impacts. Recycling paper requires less energy compared to producing paper from virgin materials. Specifically, it takes 70% less energy and water to recycle paper than to create new paper products from trees. This also helps preserving forests. Forests act like natural carbon sinks, as trees absorb carbon dioxide from atmosphere, so their preservation contributes to climate neutrality.
Reference to impact pathway	Field of action	Waste & Circular economy
	Systemic lever	Technology & Infrastructure Government & Policy Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Waste management digitalization • Waste services upgrade (separate collection, smart bins, frequent collection) • Sustainable and more efficient waste management plants • Waste to energy conversion • Tax incentives for recycling and Circular Economy practices • Strict waste management city regulation • Local Circular Economy plans • Community-led waste management initiatives • Waste education in schools

		• Sharing and swapping • Waste reduction incentives • Circular infrastructure development • Public - private partnerships • Waste upcycling projects • Behavioural change and cultural shift
Implementation	Responsible bodies/person for implementation	Municipality of Trikala & PADYTH SA
	Action scale & addressed entities	City-wide scale
	Involved stakeholders	Commercial Association of Trikala, Ministry of Environment and Energy, Thessaly Region, Urban Development Company of Trikala, DUTH, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Solid Waste Management Association, Mellon Labs, Wastecloud, EPTA, Organisation Earth, Youth City Council, ANAKEM, AFIS, Appliances Recycling SA, Hellenic Recovery Recycling Corporation, ENDIALE, ECO Elastika, EDOE, Re-Battery, NECCA, Ecological Recycling Society, Citizens
	Comments on implementation	According to NWMP (2020-2030), the goal is to establish separate collection of municipal paper waste (18%+55%) and develop related infrastructure throughout the country. The main actions to achieve this goal include strengthening existing separate collection initiatives and integrating new ones, such as the implementation and operation of GPs and the installation of RCs. The proper preparation and implementation of separate paper waste collection require a set of resources, including equipment (containers, waste collection vehicles, weighing machines, etc.), personnel for program organization and waste collection processes,

		digital media, and expenses for awareness and outreach activities. The members of the project team involved in the design and operation of this waste management plan will be responsible for determining this equipment, conducting market research, finding the necessary sources of funding, etc. Awareness and information of citizens is particularly important for achieving this goal. All actions that promote alternative waste management, beyond the existence of infrastructure and organization by the Municipality, require active participation of the majority of citizens. For this reason, an integrated communication framework should be designed to inform the residents about the system. This is a priority action linked to sustainable management of waste & promotion of circular economy.
Action outline	Action name	Separate collection and sustainable management of glass municipal waste
	Action type	Organisational intervention
	Action description	Separate collection and sustainable management of glass municipal waste contributes to climate neutrality by reducing energy consumption, conserving natural resources and minimizing methane emissions from landfills. Glass materials can be recycled and reused easily. Recycling glass requires less energy than producing new glass from raw materials, resulting in significant energy savings and reduced GHG emissions. Additionally, proper management and recycling of glass waste contribute to the preservation of natural resources. Glass is made from limited resources such as sand, soda and limestone. Recycling glass reduces the extraction of these resources, thus protecting biodiversity and ecosystems associated with extraction.
Reference to	Field of action	Waste & Circular economy

impact pathway	Systemic lever	Technology & Infrastructure Government & Policy Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Waste management digitalization • Waste services upgrade (separate collection, smart bins, frequent collection) • Sustainable and more efficient waste management plants • Waste to energy conversion • Tax incentives for recycling and Circular Economy practices • Strict waste management city regulation • Local Circular Economy plans • Community-led waste management initiatives • Waste education in schools • Sharing and swapping • Waste reduction incentives • Circular infrastructure development • Public - private partnerships • Waste upcycling projects • Behavioural change and cultural shift
Implementation	Responsible bodies/person for implementation	Municipality of Trikala & PADYTH SA

	Action scale & addressed entities	City-wide scale
	Involved stakeholders	Commercial Association of Trikala, Ministry of Environment and Energy, Thessaly Region, Urban Development Company of Trikala, DUTH, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Solid Waste Management Association, Mellon Labs, Wastecloud, EPTA, Organisation Earth, Youth City Council, ANAKEM, AFIS, Appliances Recycling SA, Hellenic Recovery Recycling Corporation, ENDIALE, ECO Elastika, EDOE, Re-Battery, NECCA, Ecological Recycling Society, Citizens
	Comments on implementation	According to NWMP (2020-2030), the goal is to establish separate collection of municipal glass waste (71%) and develop related infrastructure throughout the country. The main actions to achieve this goal include strengthening existing separate collection initiatives and integrating new ones, such as the the implementation and operation of GPs and the installation of RCs. The proper preparation and implementation of separate glass waste collection require a set of resources, including equipment (containers, waste collection vehicles, weighing machines, etc.), personnel for program organization and waste collection processes, digital media, and expenses for awareness and outreach activities. The members of the project team involved in the design and operation of this waste management plan will be responsible for determining this equipment, conducting market research, finding the necessary sources of funding, etc. Awareness and information of citizens is particularly important for achieving this goal. All actions that promote alternative waste management, beyond the existence of infrastructure and organization by the Municipality, require active participation of the majority of citizens. For this reason, an integrated communication framework should be designed to inform the residents about the system. This is a priority action linked to sustainable management of waste & promotion of circular economy.

Action outline	Action name	Separate collection and sustainable management of metals municipal waste
	Action type	Organisational intervention
	Action description	Metals are typically obtained through energy-intensive processes that release large amounts of GHG. The efficient separation of metals from other waste streams and their recycling can reduce the need for primary metal extraction, thereby reducing the GHG emissions associated with mining and refining operations. Metal recycling demands far less energy than metal extraction and reduces the carbon footprint associated with metal production.
Reference to impact pathway	Field of action	Waste & Circular economy
	Systemic lever	Technology & Infrastructure Government & Policy Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Waste management digitalization • Waste services upgrade (separate collection, smart bins, frequent collection) • Sustainable and more efficient waste management plants • Waste to energy conversion • Tax incentives for recycling and Circular Economy practices

		• Strict waste management city regulation • Local Circular Economy plans • Community-led waste management initiatives • Waste education in schools • Sharing and swapping • Waste reduction incentives • Circular infrastructure development • Public - private partnerships • Waste upcycling projects • Behavioural change and cultural shift
Implementation	Responsible bodies/person for implementation	Municipality of Trikala & PADYTH SA
	Action scale & addressed entities	City-wide scale
	Involved stakeholders	Commercial Association of Trikala, Ministry of Environment and Energy, Thessaly Region, Urban Development Company of Trikala, DUTH, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Solid Waste Management Association, Mellon Labs, Wastecloud, EPTA, Organisation Earth, Youth City Council, ANAKEM, AFIS, Appliances Recycling SA, Hellenic Recovery Recycling Corporation, ENDIALE, ECO Elastika, EDOE, Re-Battery, NECCA, Ecological Recycling Society, Citizens

	Comments on implementation	According to NWMP (2020-2030), the goal is to establish separate collection of municipal metal waste (70% Fe + 50% Al) and develop related infrastructure throughout the country. The main actions to achieve this goal include strengthening existing separate collection initiatives and integrating new ones, such as the implementation and operation of GPs, the installation of RCs. The proper preparation and implementation of separate metal waste collection require a set of resources, including equipment (containers, waste collection vehicles, weighing machines, etc.), personnel for program organization and waste collection processes, digital media, and expenses for awareness and outreach activities. The members of the Project Team involved in the design and operation of this waste management plan will be responsible for determining this equipment, conducting market research, finding the necessary sources of funding, etc. Awareness and information of citizens is particularly important for achieving this goal. All actions that promote alternative waste management, beyond the existence of infrastructure and organization by the Municipality, require active participation of the majority of citizens. For this reason, an integrated communication framework should be designed to inform the residents about the system. This is a priority action linked to sustainable management of waste & promotion of circular economy.
Action outline	Action name	Separate collection and sustainable management of plastic municipal waste
	Action type	Organisational intervention

	Action description	Recycling plastic waste contributes to climate neutrality by conserving energy and natural sources, reducing greenhouse gas emissions, minimizing waste and promote Circular Economy. A large proportion of municipal waste consists of plastics. This constantly increasing quantity and their contribution to climate change make it necessary to collect this waste stream separately. Plastic stands out as one of the most harmful materials for the environment. The manufacturing of plastics releases GHG into the atmosphere, such as carbon dioxide and methane and requires significant mineral resources and energy consumption. So recycling not only reduces emissions but also leads to significant energy savings. Additionally, decomposition of plastics in landfills releases methane that significantly contributes to global warming. By separating plastics and diverting them from landfills, methane emissions are reduced and climate change is combated. The concern, awareness, and action of citizens play a crucial role in achieving this goal.
Reference to impact pathway	Field of action	Waste & Circular Economy
	Systemic lever	Technology & Infrastructure Government & Policy Democracy & Participation Finance & Funding Learning & Capabilities

Implementation	Outcome (according to module B-1.1)	• Waste management digitalization • Waste services upgrade (separate collection, smart bins, frequent collection) • Sustainable and more efficient waste management plants • Waste to energy conversion • Tax incentives for recycling and Circular Economy practices • Strict waste management city regulation • Local Circular Economy plans • Community-led waste management initiatives • Waste education in schools • Sharing and swapping • Waste reduction incentives • Circular infrastructure development • Public - private partnerships • Waste upcycling projects • Behavioural change and cultural shift
	Responsible bodies/person for implementation	Municipality of Trikala & PADYTH SA
	Action scale & addressed entities	City-wide scale

Involved stakeholders	Commercial Association of Trikala, Ministry of Environment and Energy, Thessaly Region, Urban Development Company of Trikala, DUTH, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Solid Waste Management Association, Mellon Labs, Wastecloud, EPTA, Organisation Earth, Youth City Council, ANAKEM, AFIS, Appliances Recycling SA, Hellenic Recovery Recycling Corporation, ENDIALE, ECO Elastika, EDOE, Re-Battery, NECCA, Ecological Recycling Society, Citizens
Comments on implementation	According to NWMP (2020-2030), the goal is to establish separate collection of plastic municipal waste (48%) and develop related infrastructure throughout the country. The main actions to achieve this goal include strengthening existing separate collection initiatives and integrating new ones, such as the implementation and operation of GPs and the installation of RCs. The proper preparation and implementation of separate plastic waste collection require a set of resources, including equipment (containers, waste collection vehicles, weighing machines, etc.), personnel for program organization and waste collection processes, digital media, and expenses for awareness and outreach activities. The members of the Project Team involved in the design and operation of this waste management plan will be responsible for determining this equipment, conducting market research, finding the necessary sources of funding, etc. Awareness and information of citizens is particularly important for achieving this goal. All actions that promote alternative waste management, beyond the existence of infrastructure and organization by the Municipality, require active participation of the majority of citizens. For this reason, an integrated communication framework should be designed to inform the residents about the system. This is a priority action linked to sustainable management of waste & promotion of circular economy.

Action outline	Action name	Separate collection and sustainable management of bulky municipal waste
	Action type	Organisational intervention
	Action description	Bulk waste refers to materials which have no immediate value and are unwanted by their owner, which are produced from household activities (e.g. old or unwanted furniture, unwanted household appliances, mattresses, large toys, suitcases, bicycles, carpets, trolleys, etc.). Minimizing the amount of bulk waste sent to landfills has a positive impact to the reduction of GHG emissions. With separate collection of bulk waste, effective recycling becomes more feasible items are more likely to go through appropriate recycling channels, reducing needs for primary materials and energy - intensive production processes. Additionally, it reduces landfill burden, leading to reduced emissions. Another benefit is the minimized transportation. Collecting bulky waste separately can lead to more efficient transportation, to recycling or processing facilities. This can lead to a decrease in fuel usage and emissions linked to transporting oversized items across significant distances. Recycling, recovering materials, and reusing these items saves resources and diminish the demand for new materials as well as the production of new goods. To carry out this, it requires a collaboration among multiple stakeholders, like government entities, citizens, and educational institutions.
Reference to impact pathway	Field of action	Waste & Circular economy
	Systemic lever	Technology & Infrastructure Government & Policy Democracy & Participation Finance & Funding Learning & Capabilities

	Outcome (according to module B-1.1)	• Waste management digitalization • Waste services upgrade (separate collection, smart bins, frequent collection) • Sustainable and more efficient waste management plants • Waste to energy conversion • Tax incentives for recycling and Circular Economy practices • Strict waste management city regulation • Local Circular Economy plans • Community-led waste management initiatives • Waste education in schools • Sharing and swapping • Waste reduction incentives • Circular infrastructure development • Public - private partnerships • Waste upcycling projects • Behavioural change and cultural shift
Implementation	Responsible bodies/person for implementation	Municipality of Trikala & PADYTH SA
	Action scale & addressed entities	City-wide scale

	Involved stakeholders	Commercial Association of Trikala, Ministry of Environment and Energy, Thessaly Region, Urban Development Company of Trikala, DUTH, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Solid Waste Management Association, Mellon Labs, Wastecloud, EPTA, Organisation Earth, Youth City Council, ANAKEM, AFIS, Appliances Recycling SA, Hellenic Recovery Recycling Corporation, ENDIALE, ECO Elastika, EDOE, Re-Battery, NECCA, Ecological Recycling Society, Citizens
	Comments on implementation	According to NWMP (2020-2030), the goal is to establish separate collection of bulky municipal waste (65%) and develop related infrastructure throughout the country. The main actions to achieve this goal include strengthening existing separate collection initiatives and integrating new ones, such as the establishment of a Creative Materials Reuse Center, the implementation and operation of GPs and the installation of RCs. Bulky municipal waste (old furniture, mattresses, household appliances, etc.) constitute a special category and are the responsibility of the person who produces them. These waste items are not abandoned anywhere, but are collected by the Municipality service after a phone call. The proper preparation and implementation of separate bulky waste collection require a set of resources, including equipment (containers, waste collection vehicles, weighing machines, etc.), personnel for program organization and waste collection processes, digital media, and expenses for awareness and outreach activities. The members of the Project Team involved in the design and operation of this waste management plan will be responsible for determining this equipment, conducting market research, finding the necessary sources of funding, etc. Awareness and information of citizens is particularly important for achieving this goal. All actions that promote alternative waste management, beyond the existence of infrastructure and organization by the Municipality, require active participation of the majority of citizens. For this reason, an integrated communication framework should be designed to inform the residents about the system.

		This is a priority action linked to sustainable management of waste & promotion of circular economy.
Action outline	Action name	Separate collection and sustainable management of green waste
	Action type	Organisational intervention
	Action description	Green waste is the waste that arises from landscaping or gardening work and generally consists of leaves, twigs, small branches, bushes and grass. Separate collection of green waste reduces the amount of waste going to landfills. Green waste recycling is part of the natural cycle of growth and decomposition in the environment. Sustainable management of green waste contributes substantially to climate neutrality by reducing methane emissions and promoting carbon sequestration. By composting, green waste allows organic materials to decompose naturally, releasing carbon dioxide in the process.
Reference to impact pathway	Field of action	Waste & Circular economy
	Systemic lever	Technology & Infrastructure Government & Policy Democracy & Participation

		Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Waste management digitalization • Waste services upgrade (separate collection, smart bins, frequent collection) • Sustainable and more efficient waste management plants • Waste to energy conversion • Tax incentives for recycling and Circular Economy practices • Strict waste management city regulation • Local Circular Economy plans • Community-led waste management initiatives • Waste education in schools • Sharing and swapping • Waste reduction incentives • Circular infrastructure development • Public - private partnerships • Waste upcycling projects • Behavioural change and cultural shift
Implementation	Responsible bodies/person for implementation	Municipality of Trikala & PADYTH SA
	Action scale & addressed entities	City-wide scale

	Involved stakeholders	Commercial Association of Trikala, Ministry of Environment and Energy, Thessaly Region, Urban Development Company of Trikala, DUTH, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Solid Waste Management Association, Mellon Labs, Wastecloud, EPTA, Organisation Earth, Youth City Council, ANAKEM, AFIS, Appliances Recycling SA, Hellenic Recovery Recycling Corporation, ENDIALE, ECO Elastika, EDOE, Re-Battery, NECCA, Ecological Recycling Society, Citizens
	Comments on implementation	According to NWMP (2020-2030), the goal is to establish separate collection of municipal green waste (60%) and develop related infrastructure throughout the country. The main actions to achieve this goal include strengthening existing separate collection initiatives and integrating new ones, such as the implementation and operation of GPs, the installation of RCs. The proper preparation and implementation of separate green waste collection require a set of resources, including equipment (containers, waste collection vehicles, weighing machines, etc.), personnel for program organization and waste collection processes, digital media, and expenses for awareness and outreach activities. The members of the Project Team involved in the design and operation of this waste management plan will be responsible for determining this equipment, conducting market research, finding the necessary sources of funding, etc. Awareness and information of citizens is particularly important for achieving this goal. All actions that promote alternative waste management, beyond the existence of infrastructure and organization by the Municipality, require active participation of the majority of citizens. For this reason, an integrated communication framework should be designed to inform the residents about the system. This is a priority action linked to sustainable management of waste & promotion of circular economy.

Action outline	Action name	Municipal waste prevention 10%
	Action type	Organisational intervention
	Action description	Waste prevention is the first option to minimise waste management costs and maximise environmental and quality of life benefits. By reducing the total amount of waste generated, waste prevention leads to lower environmental impacts in terms of waste management, landfill use, emissions from transport and resource depletion. It also helps to conserve valuable natural resources by producing and consuming fewer goods, such as recyclable materials, water and energy. This promotes sustainability and efficient use of resources. Often, waste prevention means using products for longer through conservation, repair and reuse, increasing the life of goods and reducing the need to purchase new items. Less waste means less energy consumed. Savings are also significant, as waste disposal fees, purchase costs and maintenance costs of waste management infrastructure are reduced.
Reference to impact pathway	Field of action	Waste & Circular economy
	Systemic lever	Technology & Infrastructure Government & Policy Democracy & Participation Finance & Funding Learning & Capabilities

	Outcome (according to module B-1.1)	• Waste management digitalization • Waste services upgrade (separate collection, smart bins, frequent collection) • Sustainable and more efficient waste management plants • Waste to energy conversion • Tax incentives for recycling and Circular Economy practices • Strict waste management city regulation • Local Circular Economy plans • Community-led waste management initiatives • Waste education in schools • Sharing and swapping • Waste reduction incentives • Circular infrastructure development • Public - private partnerships • Waste upcycling projects • Behavioural change and cultural shift
Implementation	Responsible bodies/person for implementation	Municipality of Trikala & PADYTH SA
	Action scale & addressed entities	City-wide scale

	Involved stakeholders	Commercial Association of Trikala, Ministry of Environment and Energy, Thessaly Region, Urban Development Company of Trikala, DUTH, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Solid Waste Management Association, Mellon Labs, Wastecloud, EPTA, Organisation Earth, Youth City Council, ANAKEM, AFIS, Appliances Recycling SA, Hellenic Recovery Recycling Corporation, ENDIALE, ECO Elastika, EDOE, Re-Battery, NECCA, Ecological Recycling Society, Citizens
	Comments on implementation	According to NWMP (2020-2030), the goal is to mitigate the volume of waste that is sent to sanitary landfills. The hierarchy of actions regarding the management of municipal solid waste indicates that the most preferable solution is waste prevention, followed by reuse. Next in line is material recycling, and then other types of recovery, with energy recovery being the most common. The worst option in waste management is the disposal in sanitary landfills. The main actions to achieve this goal include strengthening existing separate collection initiatives and integrating new ones, such as the establishment of a Creative Materials Reuse Center, the implementation and operation of GPs and the installation of RCs. The proper preparation and implementation of separate green waste collection require a set of resources, including equipment (containers, waste collection vehicles, weighing machines, etc.), personnel for program organization and waste collection processes, digital media, and expenses for awareness and outreach activities. The members of the Project Team involved in the design and operation of this waste management plan will be responsible for determining this equipment, conducting market research, finding the necessary sources of funding, etc. Awareness and information of citizens is particularly important for achieving this goal. All actions that promote alternative waste management, beyond the existence of infrastructure and organization by the Municipality, require active participation of the majority of citizens. For this reason, an integrated communication framework should be designed to inform the residents about the system.

		This is a priority action linked to sustainable management of waste & promotion of circular economy.
Action outline	Action name	Separate collection and sustainable management of SQHW municipal waste
	Action type	Organisational intervention
	Action description	SQHW is the Small Quantities of Hazardous Waste contained in Municipal Solid Waste . This category usually includes hazardous construction materials (e.g. paints, varnishes), chemical waste (e.g. disinfectants, pesticides), waste such as printer ink, toners, etc. Separate collection of SQHW is important as they contain components that may be harmful to the environment and prevents the mixing of hazardous substances with everyday waste, thus reducing the risk of environmental pollution. Furthermore, helps maintain the natural environmental balance and protect biodiversity from potential harmful effects of hazardous materials and contribute to compliance with laws and regulations on hazardous waste disposal.
Reference to impact pathway	Field of action	Waste & Circular economy
	Systemic lever	Technology & Infrastructure Government & Policy Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Waste management digitalization • Waste services upgrade (separate collection, smart bins, frequent collection)

		• Sustainable and more efficient waste management plants • Waste to energy conversion • Tax incentives for recycling and Circular Economy practices • Strict waste management city regulation • Local Circular Economy plans • Community-led waste management initiatives • Waste education in schools • Sharing and swapping • Waste reduction incentives • Circular infrastructure development • Public - private partnerships • Waste upcycling projects • Behavioural change and cultural shift
Implementation	Responsible bodies/person for implementation	Municipality of Trikala & PADYTH SA
	Action scale & addressed entities	City-wide scale
	Involved stakeholders	Commercial Association of Trikala, Ministry of Environment and Energy, Thessaly Region, Urban Development Company of Trikala, DUTH, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Solid Waste Management Association, Mellon Labs, Wastecloud, EPTA, Organisation Earth, Youth City Council, ANAKEM, AFIS, Appliances Recycling SA, Hellenic Recovery Recycling Corporation, ENDIALE, ECO Elastika, EDOE, Re-Battery, NECCA, Ecological Recycling Society, Citizens

	Comments on implementation	According to NWMP (2020-2030), the goal is to establish separate collection of SQHW (85 %) and develop related infrastructure throughout the country. As SQHW are characterized small quantities of hazardous waste that can be mixed with municipal solid waste and include insect repellents, agricultural pesticides, cleaners, fluorescent lamps, inks, paints, medications, etc. The main actions to achieve this goal include strengthening existing separate collection initiatives and integrating new ones, such as the establishment of a Creative Materials Reuse Center and the implementation and operation of GPs. Until the installation of these facilities takes place, it is recommended to place special bins, on a pilot scale, for the collection of Small Quantities of Hazardous Waste that do not fall under an alternative management system (empty containers with hazardous residues, packaging of hazardous construction materials such as paints, varnishes, adhesives, solvents, etc., packaging of chemicals such as detergents, insecticides, shampoos, etc., pressurized containers such as aerosols, non-refillable fire extinguishers). The installation of such bins can be done at points of interest or central locations in order to facilitate the citizens' access. Additionally, as for the collection of expired medicines and other household medical waste, these can be collected in special bins that will be placed in pharmacies and clinics. Awareness and information of citizens is particularly important for achieving this goal. All actions that promote alternative waste management, beyond the existence of infrastructure and organization by the Municipality, require active participation of the majority of citizens. For this reason, an integrated communication framework should be designed to inform the residents about the system. This is a priority action linked to sustainable management of waste & promotion of circular economy.
Action outline	Action name	Separate collection and sustainable management of WEE municipal waste
	Action type	Organisational intervention

	Action description	Waste of Electrical and Electronic Equipment (WEEE) refers to household-originated WEEE that comes from households, as well as commercial, industrial, institutional, and other sources, whose nature and quantity are similar to those of WEEE originating from households and the WEEE that may be used by both private households and users other than private households, which are considered household-originated WEEE. Today WEEE constitute 4% of municipal waste in the EU .In our country their annual production is estimated at 80,000-115,000 tonnes per year. WEEE has been identified by the Greek legislation as a priority waste stream, due to their hazardous nature, their rapidly increasing volume and the significant impact that the production of electrical and electronic equipment has on the environment. Separate collection of WEEE allows for the safe disposal of the hazardous materials they contain, such as toxic substances and heavy metals, with care for human health and the environment, and contributes to the development of the Circular Economy, where materials are recycled and reused instead of being discarded. Also, reduce CO2 emissions and the amount of waste that sent to landfills. The achievement of this goal will be the result of collaboration among the government, the Municipality, and the citizens.
Reference to impact pathway	Field of action	Waste & Circular economy
	Systemic lever	Technology & Infrastructure Government & Policy Democracy & Participation Finance & Funding Learning & Capabilities

	Outcome (according to module B-1.1)	• Waste management digitalization • Waste services upgrade (separate collection, smart bins, frequent collection) • Sustainable and more efficient waste management plants • Waste to energy conversion • Tax incentives for recycling and Circular Economy practices • Strict waste management city regulation • Local Circular Economy plans • Community-led waste management initiatives • Waste education in schools • Sharing and swapping • Waste reduction incentives • Circular infrastructure development • Public - private partnerships • Waste upcycling projects • Behavioural change and cultural shift
Implementation	Responsible bodies/person for implementation	Municipality of Trikala & PADYTH SA
	Action scale & addressed entities	City-wide scale

	Involved stakeholders	Commercial Association of Trikala, Ministry of Environment and Energy, Thessaly Region, Urban Development Company of Trikala, DUTH, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Solid Waste Management Association, Mellon Labs, Wastecloud, EPTA, Organisation Earth, Youth City Council, ANAKEM, AFIS, Appliances Recycling SA, Hellenic Recovery Recycling Corporation, ENDIALE, ECO Elastika, EDOE, Re-Battery, NECCA, Ecological Recycling Society, Citizens
	Comments on implementation	According to NWMP (2020-2030), the goal is to establish separate collection of WEEE (85 %) and develop related infrastructure throughout the country. The main actions to achieve this goal include strengthening existing separate collection initiatives and integrating new ones, such as the establishment of a Creative Materials Reuse Center and the implementation and operation of GPs. The proper preparation and implementation of separate WEEE collection require the collaboration of municipality with an alternative management system in order to separately collect electrical and electronic waste and install collection points for WEEE, while at the same time operating a dedicated collection stream at the GP. Additionally, it is proposed to install special bins for WEEE in large scale waste producers, such as public services. Awareness and information of citizens is particularly important for achieving this goal. All actions that promote alternative waste management, beyond the existence of infrastructure and organization by the Municipality, require active participation of the majority of citizens. For this reason, an integrated communication framework should be designed to inform the residents about the system. This is a priority action linked to sustainable management of waste & promotion of circular economy.
Action outline	Action name	Separate collection and sustainable management of edible fats and oils municipal waste

	Action type	Organisational intervention
	Action description	Edible fats and oils, during their decomposition, release methane, a gas that is one of the strongest GHG. Large quantities of edible fats and oils are produced in restaurants. Proper separation and recycling of edible fats and oils prevents their disposal in landfills or sewage systems. By diverting them from other waste streams, it is possible to reduce methane emissions and their impact on climate change. Keeping edible fats and oils out of water bodies contributes to their protection and to the protection of aquatic ecosystems. Furthermore, it is very important to mention that with the recycling of these materials, it is possible to produce biodiesel and other biofuels, which can be used as RES compared to fossil fuels.The recycling of edible fats and oils contributes to sustainable waste management and enhances recycling and resource recovery. Finally, the separate collection process can raise public awareness of environmental consciousness and the need to maintain sustainable practices in everyday life.
Reference to impact pathway	Field of action	Waste & Circular economy
	Systemic lever	Technology & Infrastructure Government & Policy Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Waste management digitalization • Waste services upgrade (separate collection, smart bins, frequent collection) • Sustainable and more efficient waste management plants

		• Waste to energy conversion • Tax incentives for recycling and Circular Economy practices • Strict waste management city regulation • Local Circular Economy plans • Community-led waste management initiatives • Waste education in schools • Sharing and swapping • Waste reduction incentives • Circular infrastructure development • Public - private partnerships • Waste upcycling projects • Behavioural change and cultural shift
Implementation	Responsible bodies/person for implementation	Municipality of Trikala & PADYTH SA
	Action scale & addressed entities	City-wide scale
	Involved stakeholders	Commercial Association of Trikala, Ministry of Environment and Energy, Thessaly Region, Urban Development Company of Trikala, DUTH, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Solid Waste Management Association, Mellon Labs, Wastecloud, EPTA, Organisation Earth, Youth City Council, ANAKEM, AFIS, Appliances Recycling SA, Hellenic Recovery Recycling Corporation, ENDIALE, ECO Elastika, EDOE, Re-Battery, NECCA, Ecological Recycling Society, Citizens

	Comments on implementation	According to NWMP (2020-2030), the goal is to establish separate collection of municipal edible fats and oils waste (85 %) and develop related infrastructure throughout the country. The main actions to achieve this goal include strengthening existing separate collection initiatives and integrating new ones, such as the implementation and operation of GPs. The proper preparation and implementation of separate edible fats and oils waste collection require the development of collaborations with specialized waste management companies for the separate collection and management of edible oils is recommended. At a primary level, bins should be placed near large-scale producers (mass catering facilities), as well as specialized bins at selected points, so that edible oil waste generated in households within the Municipality can also be diverted. A dedicated stream for edible oils will operate within the GP. Awareness and information of citizens is particularly important for achieving this goal. All actions that promote alternative waste management, beyond the existence of infrastructure and organization by the Municipality, require active participation of the majority of citizens. For this reason, an integrated communication framework should be designed to inform the residents about the system. This is a priority action linked to sustainable management of waste & promotion of circular economy.
Action outline	Action name	Reduction in landfill under 10%
	Action type	Organisational intervention
	Action description	Alternative waste management refers to innovative approaches to waste management, avoiding traditional methods such as landfilling. Landfilling is the least preferable option and should be limited to the necessary minimum. By recycling and composting organic

		materials, properly sorting and recycling materials such as paper, plastic, glass, and metal and minimizing consumption and reusing items, the amount of waste ending up in landfills is reduced. This reduction can lead to cost savings and mitigate environmental impacts.
Reference to impact pathway	Field of action	Waste & Circular economy
	Systemic lever	Technology & Infrastructure Government & Policy Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Waste management digitalization • Waste services upgrade (separate collection, smart bins, frequent collection) • Sustainable and more efficient waste management plants • Waste to energy conversion • Tax incentives for recycling and Circular Economy practices • Strict waste management city regulation • Local Circular Economy plans • Community-led waste management initiatives • Waste education in schools • Sharing and swapping • Waste reduction incentives • Circular infrastructure development

		• Public - private partnerships • Waste upcycling projects • Behavioural change and cultural shift
Implementation	Responsible bodies/person for implementation	Municipality of Trikala & PADYTH SA
	Action scale & addressed entities	City-wide scale
	Involved stakeholders	Commercial Association of Trikala, Ministry of Environment and Energy, Thessaly Region, Urban Development Company of Trikala, DUTH, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Solid Waste Management Association, Mellon Labs, Wastecloud, EPTA, Organisation Earth, Youth City Council, ANAKEM, AFIS, Appliances Recycling SA, Hellenic Recovery Recycling Corporation, ENDIALE, ECO Elastika, EDOE, Re-Battery, NECCA, Ecological Recycling Society, Citizens

	Comments on implementation	According to NWMP (2020-2030), the goal is to mitigate the volume of waste that is sent to sanitary landfills. Landfilling is the worst option in waste management. Alternative waste management refers to innovative approaches for handling waste, avoiding landfilling. The main actions to achieve this goal include strengthening existing separate collection initiatives and integrating new ones, such as the establishment of a Creative Materials Reuse Center, the implementation and operation of GPs and the installation of RCs. The proper preparation and implementation of separate collection of various waste streams require a set of resources, including equipment (containers, waste collection vehicles, weighing machines, etc.), personnel for program organization and waste collection processes, digital media, and expenses for awareness and outreach activities. The members of the Project Team involved in the design and operation of this waste management plan will be responsible for determining this equipment, conducting market research, finding the necessary sources of funding, etc. Awareness and information of citizens is particularly important for achieving this goal. All actions that promote alternative waste management, beyond the existence of infrastructure and organization by the Municipality, require active participation of the majority of citizens. For this reason, an integrated communication framework should be designed to inform the residents about the system. The MSW Treatment Plant of Western Thessaly is currently under construction. The plant includes mechanical pretreatment and composting in order to achieve high landfill diversion rates. Residual streams will be converted to RDF/SRF in order to get incinerated. The operation of this plant is key to achieving the target. This is a priority action linked to sustainable management of waste & promotion of circular economy.
Impact & cost	GHG emissions reduction estimate (total) per emission source sector	21,38 ktn CO_2e

	Total costs and costs by CO2e unit	11,04 mil € - 516,51 €/tn CO_2e
Green infrastructure & Nature-based solutions		
Action outline	Action name	Green walls and green roofs
	Action type	Green infrastructure & Nature-based solution
	Action description	Planted walls and roofs are sustainable architectural elements that incorporate living plants to cover vertical surfaces or roofs. Green walls are panels of plants that grow vertically without the need for soil. All the

		necessary nutrients are provided to the plants by the hydroponic method through water. Green walls benefits' : • Improved Air Quality: Assisting in the removal of contaminants from the air and emitting oxygen, they contribute to enhanced indoor air quality. • Temperature Regulation: They offer thermal insulation and mitigate the urban heat island effect in cities, which aids in stabilizing building temperatures. • Aesthetic Appeal: They enhance the aesthetics of buildings and create a natural, calming environment. • Noise Reduction: The plants have the ability to absorb and dampen sound, thereby decreasing noise pollution. • Biodiversity: Birds and insects can live there. Green roofs involve planting vegetation on the roof of a building. Same us green walls, green roofs can absorb rainwater, reducing runoff and the risk of flooding, help combat the urban heat island effect by cooling the surrounding area and protect biodiversity. Both green walls and green roofs reduce heating and cooling energy needs, reduce environmental impact and contribute to sustainable building practices. Bodies that should cooperate for the implementation of the action are municipality, construction industry, governmental bodies, educators and environmental awareness organizations and social participation.
Reference to impact pathway	Field of action	Green infrastructure & Nature-based solution
	Systemic lever	Technology & Infrastructure Government & Policy Social innovation Democracy & Participation Finance & Funding

		Learning & Capabilities
	Outcome (according to module B-1.1)	• GIS use and spatial analysis • Innovative green infrastructure integration • Simulation and modelling • Tax incentives for the integration of green infrastructure on buildings • Urban greening targets • Zoning and land use policies • Mandatory integration of green infrastructure in new constructions • Green infrastructure investments • Public-private partnerships • Green infrastructure & Nature-based solutions initiatives • Skill development for professionals and citizens • Targeted and meaningful citizen participation • Citizen engagement and education • Collaboration between different business sectors • Resilience and adaptation • Behavioural change and cultural shift

Implementation	Responsible bodies/person for implementation	Trikala Climate Team, Urban Development Company of Trikala
	Action scale & addressed entities	10% of total building area (503.024,2 m^2), Buildings
	Involved stakeholders	Municipality of Trikala, National and Kapodistrian University of Athens, DUTH, Cooperative Bank of Thessaly, TEE Trikalon, Organisation Earth, Citizens
	Comments on implementation	Green roofs and walls are common practices in sustainable buildings. An important advantage of them is that their construction does not require additional space, which is difficult to find within a city, but is carried out on existing buildings. It is estimated that the action scale of green roofs and walls will reach 10% of the total surface area of the city's buildings. The installation of green roofs and walls will start on municipal buildings, serving as a good example for citizens to follow. Target areas for green roofs and walls are areas with high building density, where they can have a bigger impact. The construction of any green roofs or walls must include eco-friendly and durable materials, reducing the project's carbon footprint during its whole life cycle. Following construction, maintenance plans need to be developed and staff trained to ensure the longevity and effectiveness of the green roofs/walls. In addition, the city will install systems to monitor the performance of said projects in areas like reduction of stormwater runoff or heat island effect, carbon sequestration, energy demand reduction and air quality improvement. It is important that in every building where a green roof or wall is to be implemented, the necessary design and construction studies are conducted (structural stability, insulation, moisture control, selection of native plants - plants that thrive in the city's climate etc).
Impact & cost	GHG emissions compensated (natural sink)	2,16 ktn CO_2e

	Total costs and costs by CO2e unit	32,69 mil € - 15.137,03 €/tn CO_2e
Action outline	Action name	Green pavements
	Action type	Physical/spatial intervention

	Action description	Green pavements, or eco-pavements or sustainable pavements, refer to innovative and environmentally friendly approaches to designing and constructing road surfaces and walkways. • Permeable Pavements: help manage stormwater runoff, reduce flooding, and recharge groundwater. • Porous Asphalt and Concrete: their structure allows water to flow through them, which means that they can help in preventing surface water accumulation and runoff, reducing the risk of erosion. • Cool Pavements: they reflect more sunlight and absorb less heat than the traditional asphalt or concrete surfaces. They help mitigate the urban heat island effect, reduce surface temperatures, and lower energy consumption for cooling buildings. • Solar Pavements: Incorporating solar panels or materials with embedded solar capabilities into road surfaces to produce renewable energy directly from the pavement. • Vegetated Pavements: include grass pavers or paver systems filled with vegetation. They allow for some greenery within urban areas. They can help in stormwater management. • Bicycle and Pedestrian-Friendly Pavements: ex. wider sidewalks, bike lanes, and shared spaces. They promote alternative transportation methods and pedestrian safety. • Recycled Materials: they can incorporate recycled materials, such as recycled asphalt or recycled concrete aggregates. In this way, the demand for virgin resources is reduced and the environmental footprint of pavement construction is getting lower.

		The choice of the type of Green Pavements to achieve the best results will be chosen according to the requirements of the Municipality, as well as the choice of the locations where the Green Pavements will be created will be based on the climatic and morphological characteristics of the area. Green Pavements can significantly enhance the urban design of the city, offering both environmental and aesthetic benefits. Benefits: • Stormwater Management: they reduce stormwater runoff and improve water quality by filtering pollutants. • Environmental Sustainability: sustainable construction techniques and the use of recycled materials minimize the environmental impact of pavement projects. • Reduced Heat Island Effect: they reflect more sunlight and reduce localized heating. • Improved Air Quality: incorporation of some materials can help capture and reduce air pollutants. • Enhanced Aesthetics: artistic designs can enhance the visual appeal of urban areas. Green pavements play an important role in increasing the amount of green space in urban areas, as they include plants, trees and flowers. Their use improves air quality, provides shade, reduces temperature and contributes to biodiversity. They are also good for social cohesion, as they can be places for meeting, relaxation, exercise, walking, etc. and thus improve the physical and mental health of citizens and reduce stress. Green pavements help absorb carbon dioxide from the air and can act as filters for water and reduce flooding. The creation of more resilient and eco-friendly communities is a vital issue. To accomplish this goal requires the cooperation of Municipality, citizens, government and construction industry.
	Field of action	Green infrastructure & Nature-based solutions

Reference to impact pathway	Systemic lever	Technology & Infrastructure Government & Policy Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Remote sensing and data analysis • GIS use and spatial analysis • Simulation and modelling • Innovative green infrastructure integration • Smart irrigation and water management • Urban greening targets • Zoning and land use policies • Creation of groups for outdoors/nature activities • Green spaces access increase • Green infrastructure investments • Green infrastructure & Nature-based solutions initiatives • Behavioural change and cultural shift
Implementation	Responsible bodies/person for implementation	Trikala Climate Team, Urban Development Company of Trikala
	Action scale & addressed entities	1.000.000 m^2 of pavements, Streets and pavements

	Involved stakeholders	Municipality of Trikala, National and Kapodistrian University of Athens, DUTH, Cooperative Bank of Thessaly, TEE Trikalon, Organisation Earth, Citizens
	Comments on implementation	Green pavements can be an important addition to the urban design of the city, with environmental and aesthetic advantages. Their implementation will require careful planning, both in the selection of installation areas and in construction studies. The special climatic and morphological characteristics of the city and the application area should be taken into account for the selection of the type of Green Pavement that will have the best results. The materials used for green pavement construction are going to have a small carbon footprint, high durability and high solar reflectance. Furthermore, the plants selected will have low maintenance and water requirements, while they will thrive in the city's climatic conditions. It is particularly important to design a maintenance plan for the pavements in question, so that their effectiveness does not decrease. The municipality staff should be trained in the maintenance of green pavements. Proper maintenance also ensures a beautiful aesthetic result, in addition to efficiency, that can have a positive effect on the awareness of citizens. As mentioned for green roofs, the city will establish a system to monitor the performance of green sidewalks regarding stormwater runoff, heat island effects, or improvement of air quality etc. These accurate data will be used for GHG inventories, strategic climate planning and adjustments to increase efficiency.
Impact & cost	GHG emissions compensated (natural sink)	2,5 ktn CO_2e
	Total costs and costs by CO2e unit	50 mil € - 20.000 €/tn CO_2e

Action outline	Action name	Planting 23.000 trees inside the city and on its outskirts
	Action type	Nature-based solutions
	Action description	The planting of trees can create new or expand existing green spaces within the urban area. It is important that tree planting will be integrated in urban planning, aiming to improve the city's micro-climate. Trees in urban areas have a variety of benefits for the environmental as well as the citizens well-being. Benefits: • Improved Air Quality: trees absorb carbon dioxide and release oxygen, like lungs for the city. • Biodiversity: trees can support a variety of animal species. • Enhanced Physical and Mental Health: green spaces with trees are offered for physical activity, which can reduce stress, and foster mental well-being. • Heat Mitigation: they offer shade and aid in mitigating the urban heat island effect, which results in cooling the nearby environment. • Stormwater Management: same as the other nature-based solutions, green spaces and trees in urban areas can absorb rainwater and reduce flooding and stormwater runoff. • Aesthetic Appeal: enhancing the visual aesthetics, the result is a city more attractive and appealing. This action can be easily implemented without big financial expenses. To achieve these advantages, collaboration among municipal authorities and citizen groups is necessary.
	Field of action	Green infrastructure & Nature-based solutions

Reference to impact pathway	Systemic lever	Technology & Infrastructure Government & Policy Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Greenery and habitat restoration • Remote sensing and data analysis • GIS use and spatial analysis • Urban greening targets • Zoning and land use policies • Collective gardens • Green infrastructure investments • Green infrastructure & Nature-based solutions initiatives • Citizen engagement and education • Targeted and meaningful citizen participation
Implementation	Responsible bodies/person for implementation	Trikala Climate Team, Urban Development Company of Trikala
	Action scale & addressed entities	City-wide, Area
	Involved stakeholders	Municipality of Trikala, National and Kapodistrian University of Athens, DUTH, Cooperative Bank of Thessaly, TEE Trikalon, Organisation Earth, Citizens

	Comments on implementation	The planting of trees in the city will include areas both inside the city and on its outskirts. 5.000 trees are expected to be planted inside the city. It is important to plant trees along busy roads, densely built areas and pedestrian areas, contributing to improving air quality, reducing the heat island effect and enhancing the aesthetics of the areas. At the same time, 18.000 trees will be planted in the city forest and its outskirts where vacant land is available. Trees can absorb significant amounts of carbon dioxide annually. The planting of the trees is necessary to be carried out in collaboration with schools and groups of voluntary citizens, as it is an action that can significantly contribute to public awareness about climate neutrality.
Impact & cost	GHG emissions compensated (natural sink)	0,48 ktn CO_2e
	Total costs and costs by CO2e unit	2,3 mil € - 4.761,9 €/tn CO_2e
Built environment		
Action outline	Action name	Energy renovation/retrofit of existing buildings
	Action type	Technical intervention
	Action description	Energy retrofitting is the process of making significant improvements to an existing building's energy efficiency and sustainability. Goal of energy retrofitting is to reduce building's energy consumption and environmental impact. Energy retrofitting include: • Insulation: in walls, roofs or floors • Door Upgrades: replacing old windows and doors

		• HVAC System Upgrades: replacing or retrofitting heating and cooling systems • Lighting Improvements: LED lighting or installation lighting controls. • Renewable Energy Integration: solar panels or wind turbines • Smart Building Technologies: sensors, controls, and automation systems Benefits: • Reduces GHG emissions • Reduces a building's carbon footprint, • Supports environmental sustainability and climate change mitigation There are also some economic benefits that energy retrofitting offers. Long-term savings on energy bills often outweigh the costs of the initial investment. Building owners benefit from reduced operating expenses and increased property value. This goal to be achieved, requires the cooperation of many factors, such as government, municipalities, companies and banks. The energy savings expected to be achieved are 60%.
Reference to impact pathway	Field of action	Built environment
	Systemic lever	Technology & Infrastructure Government & Policy Democracy & Participation Finance & Funding Learning & Capabilities

	Outcome (according to module B-1.1)	• Energy efficiency and sustainability • Smart building increase • RES building integration • Circular buildings and materials policies • Incentives for sustainable renovation in buildings • Accelerating the energy retrofitting of buildings • Creation of smart and connected city districts • Development of resilient buildings with adaptable functions and systems • Affordable sustainable housing policies • Mandatory sustainable housing policies • Community schemes investment • Collaboration between different business sectors
Implementation	Responsible bodies/person for implementation	One-stop shop for energy renovation on buildings, Trikala Climate Team
	Action scale & addressed entities	Buildings, 2,5% renovation rate per year
	Involved stakeholders	Municipality of Trikala, Ministry of Environment and Energy, HEDNO SA, TEE Trikalon, Cooperative Bank of Thessaly, Ministry of Economy and Finance, National Bank of Greece, Piraeus Bank, Alpha Bank, Eurobank, Urban Development Company of Trikala, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Energy Competence Center, Commercial Association of Trikala, ANAKEM - Alternative Management System for Demolition Waste, Citizens

	Comments on implementation	Commercial buildings and facilities present the second largest energy consumption after residential buildings. Given that in commercial buildings the energy consumption ranges from 358,4 to 1480,9 kWh/m^2, compared to residential energy consumption estimated at 406,0 kWh/m^2, the need for extensive energy retrofitting of commercial buildings is evident. The Municipality, in collaboration with the Technical Chamber of Greece (Trikala department) and Trikala Climate Team that will be created, will proceed to record all the commercial buildings of the city, with detailed information about the owner, the surface area, the existing energy efficiency, etc. It is recommended that the energy upgrade starts from the oldest buildings or the buildings that show the lowest energy efficiency. In addition, large buildings such as supermarkets and hotels should be prioritised, compared to small shops and offices. Finally, the Municipality will contact large franchise companies that operate stores in the city for their energy upgrade, as these companies have the financial ability to support the action. However, the Municipality must offer technical and financial support to smaller businesses that want to proceed with an energy upgrade of their space, in order to ensure equality. One of the main goals of the One-Stop-Shop that is presented at Part C of the Action Plan, is the support of these small businesses. The materials used for commercial building energy retrofitting are going to have a small carbon footprint and be sustainable during their whole life cycle. Any construction waste produced during renovations will be sustainably managed and recycled. The secondary products from recycling will be used in the same buildings or in other projects within the city, where and when it is possible. The importance of training local engineers, builders and craftsmen in the principles of sustainable and green building is highlighted, so that they can implement such projects within their city. The energy renovation study will be carried out separately for each building, in order to take into account their distinct characteristics and design the appropriate projects to achieve the goal of reducing energy consumption.

Impact & cost		This is a priority action related to energy renovation and efficient utilisation of building stock.
	GHG emissions reduction estimate (total) per emission source sector	5,86 ktn CO_2e
	Total costs and costs by CO2e unit	315,26 mil € - 53.798,63 €/tn CO_2e
Action outline	Action name	Nearly Zero Energy Buildings (NZEBs) (renovation of existing residential buildings)
	Action type	Technical intervention
	Action description	Nearly Zero Energy Buildings (NZEBs) are highly energy efficient structures that require minimal energy for heating, cooling and general operations, while the rest of the energy needs are largely covered by renewable sources. Choosing to build new NZEBs is preferable and easier than converting existing buildings into NZEBs as they can choose to use environmentally friendly materials from the start and integrate energy saving systems. However, the renovation in existing buildings to NZEBs plays a crucial role in transitioning toward a sustainable and energy-efficient built environment. NZEBs try to achieve a balance between energy consumption and renewable energy generation, so they produce as much energy as they consume over the course of a year. Benefits: • reducing energy costs

		• reducing CO2 emissions • improving energy efficiency • improving health Achieving this goal requires the cooperation of many factors, such as government, citizens, Municipality, companies and bank. The energy savings expected to be achieved are 80%.
Reference to impact pathway	Field of action	Built environment
	Systemic lever	Technology & Infrastructure Government & Policy Social innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Energy efficiency and sustainability • Creation of smart and connected city districts • Smart buildings increase • Development of resilient buildings with adaptable functions and systems • RES building integration • Circular Economy and materials adaptation • Innovative technologies integration • Affordable sustainable housing policies • Mandatory sustainable standards for new constructions

		• Circular buildings and materials policies • Incentives for sustainable renovation in buildings • Community owned RES plants for buildings electrification • Development of digital platform for citizen engagement for spatial and building decision-making • Accelerating the energy retrofitting of buildings • Public-private partnerships • Skilled workforce • Collaboration between different business sectors
Implementation	Responsible bodies/person for implementation	One-stop shop for energy renovation on buildings, Trikala Climate Team
	Action scale & addressed entities	Buildings, 2,5% renovation rate per year
	Involved stakeholders	Municipality of Trikala, Ministry of Environment and Energy, HEDNO SA, TEE Trikalon, Cooperative Bank of Thessaly, Ministry of Economy and Finance, National Bank of Greece, Piraeus Bank, Alpha Bank, Eurobank, Urban Development Company of Trikala, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Energy Competence Center, Commercial Association of Trikala, ANAKEM - Alternative Management System for Demolition Waste, Citizens
	Comments on implementation	The average energy consumption for residential buildings in Trikala is estimated at 406,0 kWh/m^2. As it is mentioned in the action above, the Municipality cooperating with Technical Chamber of Greece and Trikala Climate Team will create an analytical data list for all residential buildings in Trikala.

		NZEB is a special sustainable and energy efficiency category for buildings and they are characterised by strict standards. It is estimated that existing buildings that will be renovated in order to satisfy the NZEB definition will present energy savings up to 80%, meaning their final energy consumption is going to be 81,2 kWh/m^2. Reaching these levels of energy savings is not easy, especially for existing buildings. In order for the action to succeed, buildings built in the last 20 years should be selected, so that their original characteristics allow the achievement of the target in terms of energy consumption. Moreover, the cost to energy upgrade a new building is comparatively less than an older building. In any case, the Municipality should select buildings whose energy upgrading will contribute to the achievement of the energy saving and emission reduction targets estimated below. Residential buildings are usually owned by construction companies or citizens. Especially the latter may face financial difficulties that do not allow them to energy retrofit their homes. It is important for the government and the municipality to create funding schemes. The One-Stop-Shop will support residence owners that wish to renovate their properties. The materials used during the energy retrofitting of residential buildings should be sustainable and have small carbon footprints. Construction waste from the projects will be managed according to Circular Economy principles. Recycled construction waste will be used in projects within the city or even the same buildings where they came from, if it is applicable. It is important to include local engineers, builders and artisans in these projects in order to educate them on sustainable and environmentally friendly construction practices. The energy renovation study will be carried out separately for each building, in order to take into account their distinct characteristics and design the appropriate projects to achieve the goal of reducing energy consumption. This is a priority action related to energy renovation and efficient utilisation of building stock.

Impact & cost	GHG emissions reduction estimate (total) per emission source sector	0,51 ktn CO_2e
	Total costs and costs by CO2e unit	16,59 mil € - 32.529,41 €/tn CO_2e
Action outline	Action name	Integrated Energy Systems
	Action type	Technical intervention
	Action description	Integrated energy systems in buildings encompass comprehensive strategies that enhance efficiency, reliability, and sustainability in the built environment. This can be done by optimizing the coordination and utilization of diverse energy sources, technologies, and components. Benefits - Positive effects : • saving of energy and money • reduction of GHG emissions • improvement of the quality of life • conservation of natural resources • promotion of sustainable development These systems aim to create a more holistic and interconnected approach to managing energy resources within a given context, whether it's in buildings, industrial processes, or broader energy infrastructure. Collaboration is essential for achieving success in this objective.

		For the success of this goal, cooperation is required between government, municipality, banks and construction companies.
Reference to impact pathway	Field of action	Built environment
	Systemic lever	Technology & Infrastructure Government & Policy Social innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Energy efficiency and sustainability • Smart buildings increase • Development of resilient buildings with adaptable functions and systems • RES building integration • Circular Economy and materials adaptation • Innovative technologies integration • Circular buildings and materials policies • Research and innovation funding • Skilled workforce • Targeted and meaningful citizen participation • Citizen engagement and education • Collaboration between different business sectors • Sustainable practices adaptation

Implementation	Responsible bodies/person for implementation	One-stop shop for energy renovation on buildings, Trikala Climate Team, e-Trikala
	Action scale & addressed entities	Buildings, City-wide
	Involved stakeholders	Municipality of Trikala, Ministry of Environment and Energy, HEDNO SA, TEE Trikalon, Cooperative Bank of Thessaly, Ministry of Economy and Finance, National Bank of Greece, Piraeus Bank, Alpha Bank, Eurobank, Urban Development Company of Trikala, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Energy Competence Center, Commercial Association of Trikala, ANAKEM - Alternative Management System for Demolition Waste, Citizens, P-net, DOTSOFT SA, ABB Hellas
	Comments on implementation	Energy retrofitting in buildings will be accompanied by the installation of smart energy systems to further optimize energy consumption. Energy systems can also be installed in buildings before the energy upgrade, but in combination with efficient appliances and lighting to reduce energy consumption with small-scale interventions. This is a priority action related to energy renovation and efficient utilisation of building stock and Trikala - Restart mAI city.
Action outline	Action name	Efficient lighting and appliances
	Action type	Technical intervention
	Action description	The switch to energy-efficient lighting and appliances is a key step towards saving energy and reducing GHG emissions. Energy-efficient lighting, such as advanced LED lamps, and energy-efficient appliances contribute significantly to reducing electricity

		consumption. This leads not only to economic benefits for consumers but also to a surprising reduction in the ecological footprint, actively contributing to the drive for sustainable energy and environmental protection. This action also includes the upgrading of the city's street lighting in order to reduce energy consumption.
Reference to impact pathway	Field of action	Built environment
	Systemic lever	Technology & Infrastructure Government & Policy Social innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Energy efficiency and sustainability • Smart buildings increase • Development of resilient buildings with adaptable functions and systems • RES building integration • Circular Economy and materials adaptation • Innovative technologies integration • Circular buildings and materials policies • Research and innovation funding • Skilled workforce • Targeted and meaningful citizen participation • Citizen engagement and education

		• Collaboration between different business sectors • Sustainable practices adaptation
Implementation	Responsible bodies/person for implementation	One-stop shop for energy renovation on buildings, Trikala Climate Team
	Action scale & addressed entities	Buildings, City-wide
	Involved stakeholders	Municipality of Trikala, Ministry of Environment and Energy, HEDNO SA, TEE Trikalon, Ministry of Economy and Finance, Urban Development Company of Trikala, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Energy Competence Center, Commercial Association of Trikala, Appliances Recycling S.A., Citizens
	Comments on implementation	The replacement of electrical devices and lighting with new and more energy-efficient devices can significantly contribute to reducing the energy consumption of buildings, while at the same time it is a small-scale and cost-effective intervention. More specifically, municipal lighting is an important part of municipal consumption and therefore its upgrade should be considered. As long as it can be ensured with the appropriate phototechnical study that the necessary levels of visual comfort and safety can be met, it is recommended to replace the existing lamps with new, more efficient technology (e.g. LED). This is a priority action related to energy renovation and efficient utilisation of building stock.
Impact & cost	GHG emissions reduction estimate (total) per emission source sector	58,32 ktn CO_2e

	Total costs and costs by CO2e unit	8,94 mil € - 153,21 €/tn CO_2e
Action outline	Action name	New energy-efficient buildings
	Action type	Technical intervention
	Action description	Structured environmental development has a crucial role in reducing greenhouse gas emissions in cities. The introduction of energy efficiency standards in new buildings is therefore a key step towards promoting climate neutrality. Energy efficient buildings use innovative technologies and sustainable materials, significantly reducing energy consumption and environmental impacts. By incorporating new insulation materials, efficient heating and air conditioning systems, and smart design strategies, these buildings achieve significant reductions in demand for non-renewable resources and GHG emissions. In addition to reducing operational energy costs, energy efficient buildings also promote healthier indoor environments. In addition to their practical utility, they highlight the potential for sustainable low-carbon infrastructure, serving as living examples for construction and urban development.
Reference to impact pathway	Field of action	Built environment
	Systemic lever	Technology & Infrastructure Government & Policy Social innovation Democracy & Participation Finance & Funding Learning & Capabilities

	Outcome (according to module B-1.1)	• Energy efficiency and sustainability • Smart buildings increase • Development of resilient buildings with adaptable functions and systems • RES building integration • Circular Economy and materials adaptation • Innovative technologies integration • Circular buildings and materials policies • Research and innovation funding • Skilled workforce • Targeted and meaningful citizen participation • Citizen engagement and education • Collaboration between different business sectors • Sustainable practices adaptation
Implementation	Responsible bodies/person for implementation	Municipality of Trikala, Trikala Climate Team
	Action scale & addressed entities	Buildings, City-wide, 70% minimum building standard, 30% top performing building standard
	Involved stakeholders	One-stop shop for energy renovation on buildings, Ministry of Environment and Energy, TEE Trikalon, Ministry of Economy and Finance, Urban Development Company of Trikala, National Bank of Greece, Piraeus Bank, Alpha Bank, Eurobank

Impact & cost	Comments on implementation	The adoption of strict energy codes and certifications incentivises developers to prioritise sustainability, fostering positive change in the construction industry. It is a fact that it is easier to build a new building to meet the energy efficient building code than it is to completely renovate an older building. In the context of changing the profile of the city and the transition to a climate neutral future, it is imperative that all new buildings meet high energy standards. This is a priority action related to energy renovation and efficient utilisation of building stock. All new buildings constructed must conform with energy efficiency standards.
	GHG emissions reduction estimate (total) per emission source sector	0,16 ktn CO_2e
	Total costs and costs by CO2e unit	6,31 mil € - 39.409,5 €/tn CO_2e
Action outline	Action name	Commercial and residential buildings electrification
	Action type	Technical intervention

	Action description	Building electrification is the transition of energy sources in buildings from fossil fuels to electricity. This approach aims to reduce GHG emissions, enhance energy efficiency, and promote the use of RES. Building electrification is a critical strategy which can reduce carbon emissions from the building sector. Buildings which are electificated can significantly reduce GHG emissions. This can be done as the electricity generation is increasingly necessary to transition to cleaner sources (wind, solar, hydropower). Energy-efficient building design and technologies can be combined with building electrification to maximize energy efficiency and lower electricity usage. The successful electrification requires cooperation between government, Municipality, banks, research centers and universities, consumers, construction companies, etc.
Reference to impact pathway	Field of action	Built environment
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities

	Outcome (according to module B-1.1)	• Energy efficiency and sustainability • Smart building increase • RES building integration • Incentives for sustainable renovation in buildings • Accelerating the energy retrofitting of building • Community owned RES plants for buildings electrification • Creation of smart and connected city districts • Development of resilient buildings with adaptable functions and systems • Affordable sustainable housing policies • Mandatory sustainable housing policies • Community schemes investment • Collaboration between different business sectors
Implementation	Responsible bodies/person for implementation	One-stop shop for energy renovation on buildings, Municipal ESCO, Trikala Climate Team
	Action scale & addressed entities	Buildings, 60% share of electric in heating
	Involved stakeholders	Municipality of Trikala, Ministry of Environment and Energy, HEDNO SA, TEE Trikalon, Ministry of Economy and Finance, Urban Development Company of Trikala, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Energy Competence Center, Commercial Association of Trikala, Appliances Recycling S.A., Citizens, National Bank of Greece, Piraeus Bank, Alpha Bank, Eurobank

	Comments on implementation	Building electrification is a key action for weaning the energy needs of buildings from fossil fuels. Building electrification will occur by replacing existing burners/boilers in residential and commercial buildings with electric heat pumps. The heat pumps will be supplied with electricity from RES installed in the same building or from the grid. The energy from the grid will be ensured to be 100% renewable, so that GHG emissions remain zero. Building electrification concerns all the residential and commercial buildings in the city, i.e. both the buildings referred in energy retrofitting and NZEB actions, as well as the rest of them. This is a priority action related to decarbonising electricity & heating generation, as well as energy renovation and efficient utilisation of building stock.
Impact & cost	GHG emissions reduction estimate (total) per emission source sector	14,93 ktn CO_2e
	Total costs and costs by CO2e unit	128,48 mil € - 8.608,41 €/tn CO_2e
Action outline	Action name	Citizen and renewable energy communities
	Action type	Social Intervention

	Action description	The production of energy at a local level us crucial for strengthening renewable energy production, promoting energy democracy, and reducing energy poverty. Saving energy and creating a network for generating electricity from renewable sources are within the hands of citizens. This can be achieved by upgrading the energy efficiency of their buildings and installing RES on available surfaces. In this way, citizens can transition from being energy consumers to energy producers, contributing excess energy they generate back to the grid, efficiently using it as a battery. If this is done on a large scale, it can create an energy community capable of producing sufficient electricity to meet many of its own needs. As buildings become more energy-efficient, they will require less energy to create comfortable conditions for occupants. Energy communities continue to face various obstacles to their development, including: • Restrictive national legal framework • Limited access to national electricity grids • A general lack of policy support The future of energy production should be in the hands of the citizens. The Municipality of Trikala will contribute to ensuring that local energy communities can fully participate in decentralizing and democratizing energy systems, fostering sustainable local economic and social development. Local energy production, distribution and consumption are crucial for combating energy poverty.
Reference to impact pathway	Field of action	Energy systems
	Systemic lever	Democracy & Participation
	Outcome (according to module B-1.1)	Enhance RES utilization, raises awareness within the community, and encourages renewable energy projects

Implementation	Responsible bodies/person for implementation	One-stop shop for energy renovation on buildings, Municipal ESCO, Trikala Climate Team
	Action scale & addressed entities	Pilot area within city of Trikala
	Involved stakeholders	Municipality of Trikala, Ministry of Environment and Energy, HEDNO SA, TEE Trikalon, Ministry of Economy and Finance, Urban Development Company of Trikala, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala, Hellenic Energy Competence Center, Commercial Association of Trikala, Appliances Recycling S.A., Citizens, National Bank of Greece, Piraeus Bank, Alpha Bank, Eurobank, e-Trikala, P-net, DOTSOFT, ABB Hellas
	Comments on implementation	Firstly, a survey will be conducted in order to select the best city district for the pilot project. It is important that the district in question includes buildings with different types of usage. For example, the district should include at least one public building (possibly a school), commercial buildings like shops or offices and residential buildings. The difference between the usage type of the buildings is translated as a difference in their energy needs within a day. For example, a school shows increased energy needs during the morning when it operates. On the contrary, residences show greater energy needs in the evening. Such differences can contribute to the distribution of energy consumption so that the energy balance remains positive. Responsible bodies will facilitate banks and other investment schemes in providing special financial support programs for local energy communities, particularly in the planning and establishment stages. This is a priority action related to decarbonising electricity & heating generation, as well as energy renovation and efficient utilisation of building stock.
Impact & cost	GHG emissions reduction estimate (total) per emission source sector	0,3 ktn CO_2e

	Total costs and costs by CO2e unit	1,5 mil € - 4.924,49 €/tn CO_2e
Action outline	Action name	Establishment of Smart City Executive Management Centre
	Action type	Technical intervention
	Action description	Establishment of a thoroughly structured Executive Management Center within the smart ecosystem of the city. The center's function will revolve around continuous 24/7 monitoring of the city in real-time using smart infrastructure, with the aim of minimizing the time taken to detect issues and optimizing the coordination for their resolution. The initiative will encompass the redesign of a designated area to serve as the smart city control center, adapting an existing municipal space accordingly. Additionally, it involves the installation of communication, monitoring, and control equipment dedicated to the city's smart ecosystem.
Reference to impact pathway	Field of action	Smart city - Horizontal actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities

	Outcome (according to module B-1.1)	• Enhanced city-wide connectivity • Increased energy efficiency & lower carbon emissions • Improved data collection and integration • Reduced traffic congestion & enhanced transportation infrastructure • Support for emerging technologies • Enhanced governance efficiency & data-driven decision making • Improved public services • Optimised resource allocation • Increased economic productivity & reduced financial losses
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, Trikala Climate Team, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Digital Governance, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas

	Comments on implementation	Space redesign for use as a smart city control center with appropriate adaptation of an existing municipal space to serve its function. Specifically, this action includes interventions in the space related to structural configuration, installation of structured cabling/electromechanical/access control systems, and office space equipment with provisions for remote personnel operation and 24/7 access. Installation of communication, surveillance, and control equipment for the smart city ecosystem. This includes display and control equipment, as well as network access to smart city infrastructure and the telephone network. The use of the above equipment aims to present primary or processed city data in a way that facilitates drawing conclusions and making action decisions, especially in cases that require validation and critical capacity. These situations are accompanied by significant responsibility and cannot be solely addressed through the use of artificial intelligence (AI). The determination of the maximum number and roles of the personnel at the center will be specified during the drafting of the technical sheets for smart actions. The finalization will result from the collaboration between municipal staff and the contractors responsible for developing the smart applications of the plan. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	62.000 €
Action outline	Action name	Platform to support data-driven decision-making processes
	Action type	Technical Intervention

	Action description	The initiative involves establishing an infrastructure for gathering and overseeing data within the city's intelligent ecosystem. This encompasses setting up a central platform for collecting and processing urban data and infrastructure, linking existing data sources within the city, developing a website for displaying municipal information and initiatives, and implementing a system for overseeing and presenting the progress of technical projects. The objectives of this initiative include generating a unified collection of geospatially defined, dynamic, and permanent data; creating a dependable and adaptable data storage system to support smart initiatives and municipal operations; offering suitable tools to streamline management processes and formulate policies with quantifiable outcomes for citizens; simplifying conditions for introducing new intelligent services to citizens; establishing a supportive environment for the development and implementation of smart services; and providing a platform for the creation of novel services for citizens. The interpretation of these data as geospatially and temporally variable is precisely what can transform them into useful information for real-time event management in the city, support the processes of formulating municipal strategies and policies, and enhance the prospects of successful collective actions. Techniques that can be employed in these directions include, among others, appropriate visualizations, integration of artificial intelligence methods, statistical analyses, monitoring of Key Performance Indicators (KPIs) in suitable environments depending on the expected outcome. Beyond the utilization of data/information by the Municipality for the benefit of the city and its citizens, the formulation of policies and intent for third-party use can shape prospects for economic exploitation and/or attracting investments.
Reference to impact pathway	Field of action	Smart city - Horizontal actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding

		Learning & Capabilities
	Outcome (according to module B-1.1)	• Improved communication networks • Support for emerging technologies • Enhanced governance efficiency • Data-driven decision making • Improved public services • Strengthened community-government relations • Increased citizen engagement • Inclusive decision making • Strengthened community ties • Improved trust in local government • Informed and engaged citizens • Enhanced digital inclusion • Participatory decision-making processes • Responsive and accountable local governance • Increased economic productivity • Enhanced business environment
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala

	Involved stakeholders	Municipality of Trikala, Trikala Climate Team, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Digital Governance, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Citizens
	Comments on implementation	The action involves the installation of an infrastructure to meet the needs of collecting, processing, and disseminating geospatially and temporally variable data and information, according to the application requirements arising from city planning. More specifically, the action will include: • A central platform for data collection and processing, as well as city infrastructure, equipped with management capabilities and decision support using both human and artificial intelligence. • Interconnection of existing Municipality data sources with the systems of the city's data collection and processing platform. This action ensures the consumption of data generated by the Municipality's existing infrastructures.A website for displaying municipal information and actions to support the publicity needs of the Municipality's data and the smart city. • A system for managing and presenting the progress of technical projects for the immediate update of citizens regarding their developments. Essentially, this is a platform for managing the Municipality's Technical Projects, through which all active projects will be monitored by the engineers of the service as well as by citizens in real-time. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	563.000 €
Action outline	Action name	Integrated service, information and citizen awareness infrastructures for a smart city ecosystem

	Action type	Technical & Social Intervention
	Action description	The initiative involves creating an interconnected system for citizen services, utilizing smart city infrastructure. This undertaking encompasses the establishment of a user profile infrastructure for services, the implementation of a system for registering citizen requests/reports (crowdsourcing), and the comprehensive management of tasks, processes, and events related to municipal services. Additionally, it includes the development of infrastructure for managing citizen responses and the unified application of smart devices. The primary goals are to enhance citizen service conditions by streamlining interaction processes, offering evaluation and monitoring options for citizen requests, facilitating more efficient coordination of municipal services, raising citizen awareness through gamification, simplifying interaction processes between the municipality and citizens, and establishing a foundation for future utilization of innovative feedback practices and new municipal applications.
Reference to impact pathway	Field of action	Smart city - Horizontal actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities

	Outcome (according to module B-1.1)	• Improved communication networks • Support for emerging technologies • Enhanced governance efficiency • Data-driven decision making • Improved public services • Increased citizen engagement • Inclusive decision making • Participatory decision-making processes • Responsive and accountable local governance • Enhanced business environment
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, Trikala Climate Team, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Digital Governance, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Citizens
	Comments on implementation	The action involves the creation of a unit of interconnected systems positioned between citizens and municipal services, specifically including: • User profile infrastructure for services, which will be used for the unified identification of the individual user across all systems of the smart ecosystem and administrative support of the Municipality. • System for citizen requests/reports registration (crowdsourcing) and lifecycle management of tasks, processes, and events of municipal services through written and

		verbal communication to digitize and optimize citizen service processes and make optimal use of smart infrastructure in processing and management. • Infrastructure for managing and rewarding citizens through the use of a convertible municipal reward unit called Tricoin. This infrastructure can be utilized to promote the policies that the Municipality wishes to advance, providing a clear incentive for citizens. Initially, these credit units can be exchanged for the purchase of services offered by the Municipality (e.g., controlled parking, event tickets, etc.), while there is potential for more complex reward systems to be designed in the future. • A unified application of smart devices for all applications related to citizens/visitors and municipal employees. The development of this application aims to consolidate the different interfaces of the Municipality's smart applications into a single user environment and experience. This environment will be adapted accordingly to the user's role and preferences. This is a priority action related to Trikala - Restart mAI city and citizen-centric governance model.
Impact & cost	Total costs	198.000 €
Action outline	Action name	Protection plan against physical / logical system / information breach and drafting of an open data policy for the Municipality
	Action type	Technical intervention

	Action description	The initiative seeks to establish a lasting record of guidelines governing the operational policies essential for the city's ecosystem. The development of an encompassing policy for responsible use and crisis management involves creating guidelines for safeguarding both open and personal data, formulating a response plan for cyber-attacks, and conducting assessments and certifications for security and information protection. The primary objectives of this initiative include defining the capabilities and optimal utilization of the Municipality's data, safeguarding the personal data of citizens, proactively addressing potential repercussions to the Municipality resulting from malicious actions against the City's smart ecosystem, preserving the integrity of City data and information in the aftermath of cyber-attacks, and mitigating threats to the information within the City's smart ecosystem.
Reference to impact pathway	Field of action	Smart city - Horizontal actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities

	Outcome (according to module B-1.1)	• Support for emerging technologies • Enhanced governance efficiency • Data-driven decision making • Improved public services • Conservation policies • Strengthened community-government relations • Proactive social interventions • Strengthened social networks • Community resilience • Strengthened community ties • Improved trust in local government • Informed and engaged citizens • Enhanced digital inclusion • Participatory decision-making processes • Responsive and accountable local governance • Reduced financial losses from disasters • Increased funding for resilience projects
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, Trikala Climate Team, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Digital Governance, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas

	Comments on implementation	This involves drafting a comprehensive policy for the proper use and crisis management of the smart city ecosystem, which specifically includes: • Drafting a policy for the protection of open and personal data with the aim of ensuring citizen privacy and transparency regarding the utilization of municipal data. • Drafting a response plan to cyber-attacks for the recovery of operational capability and addressing the consequences of malicious actions. This plan is of paramount importance, as the successful operation of the smart city ecosystem will inherently depend on the smooth functioning of its relevant subsystems and data. • Conducting a study and certification of the security and information protection of the city's smart ecosystem. This action encompasses both proactive design considerations and subsequent alignment of the technical implementation of the city's smart ecosystem with the ISO 27001 standard. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	124.000 €
Action outline	Action name	Commissioning of services to support the operation, maintenance, development, deployment, training and promotion of the smart city ecosystem
	Action type	Organisational intervention

	Action description	This initiative seeks to address the requirements for establishing and facilitating citizen acceptance of the smart city ecosystem. It involves developing a plan for transitioning to smart city operations, offering specialized services to support citizen experience, system operation, and assistance for municipal officials and staff. Additionally, it includes providing communication and promotional services to highlight the benefits of the smart ecosystem to citizens. The primary goals of this initiative are to safeguard the overall investment in the smart city ecosystem, enhance the project's sustainability by delivering high-quality services to citizens, emphasize the project's significance to citizens and municipal officials, cultivate a climate of credibility and professionalism to attract innovative investments in the development and implementation of smart technologies, and establish communities of action and innovation that contribute to the support and sustainability of the city through the smart ecosystem.
Reference to impact pathway	Field of action	Smart city - Horizontal actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Improved communication networks • Support for emerging technologies • Enhanced governance efficiency • Data-driven decision making

		• Improved public services • Conservation policies • Proactive social interventions • Empowered communities in sustainable energy practices • Reduced energy poverty • Environmental conscious behaviour • Community-driven circular economy initiatives • Strengthened community ties • Responsive and accountable local governance • Increased economic productivity • Enhanced business environment • Optimised resource allocation • Improved creditworthiness • Reduced financial losses from disasters • Increased funding for resilience projects • Increased revenue from circular economy initiatives
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, Trikala Climate Team, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Digital Governance, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas
	Comments on implementation	The action involves procuring a variety of services aimed at creating conditions for the success, acceptance, and sustainability of the smart city ecosystem, specifically including:

		• Drafting a transition plan for the operation of the smart city, describing the smooth transfer of the smart ecosystem into productive operation. • Provision of specialized services to support citizen experience in the operation of the city's smart ecosystem. • Provision of specialized support services for the operation of the system within the city's smart ecosystem. • Provision of specialized support services for municipal officials to facilitate the operation of the city's smart ecosystem. • Provision of training services for municipal staff on the use of the technological infrastructure of the smart ecosystem. • Provision of communication and promotion services to highlight the benefits of the smart city ecosystem to citizens. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	535.000 €
Action outline	Action name	Installation of intelligent traffic signalling and control infrastructure
	Action type	Technical intervention
	Action description	The implementation of an advanced traffic management system in the city involves incorporating intelligent features across the entire traffic light network. This includes the installation of smart controllers on all traffic signals, the deployment of sophisticated motion control sensors, and the integration of atmospheric pollution measurement tools for both traffic management and environmental monitoring. The initiative also encompasses the creation of intelligent pedestrian crossings and micro-mobility solutions, alongside the acquisition and setup of Variable Message Signs (VMS). The

		primary objectives revolve around gathering essential traffic, environmental, and related data to facilitate the real-time enhancement of the signaling system, traffic regulation via traffic lights, and the optimization of interconnected nodes in a coordinated artery mode. Furthermore, the overarching goals extend to the development of intelligent traffic management strategies within the city center. This involves utilizing VMS for disseminating real-time information to improve traffic quality while simultaneously providing guidance on interventions aimed at minimizing environmental impacts. Additionally, the initiative focuses on reinforcing road safety for vehicles, pedestrians, and individuals with disabilities. It also strives to streamline the maintenance process, ensuring optimal functioning and reducing downtime for repairs within the signaling system.
Reference to impact pathway	Field of action	Smart city - Mobility actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Reduced traffic congestion • Lower carbon emissions • Improved communication networks • Support for emerging technologies • Optimised urban mobility and transportation safety • Sustainable energy policies • Sustainable urban development policies • Enhanced digital inclusion

		• Optimised resource allocation • Increased innovation
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	Public transportation
	Involved stakeholders	Municipality of Trikala, Trikala Climate Team, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Digital Governance, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Public Transport Organization of Trikala, Taxi union of Trikala, Intercity Bus Transport Company of Trikala, Ministry of Infrastructure and Transport
	Comments on implementation	As mentioned in the above description, the action includes: • Installation of smart controllers on all traffic lights in the city. • Installation of intelligent motion control sensors and measurement sensors for atmospheric pollution to manage traffic and monitor environmental conditions. • Creation of smart crossings for pedestrians and micro-mobility, with simultaneous consideration for the safer movement of people with disabilities and individuals with visual impairments. • Procurement and installation of Variable Message Signs (VMS). The action aims to: • Collect the necessary traffic, environmental, and other data to support real-time optimization of the signaling system. • Control traffic through traffic lights and improve the operation of connected nodes in a coordinated artery mode.

		• Create intelligent traffic management strategies in the city center. • Use Variable Message Signs (VMS) for immediate and comprehensive information and guidance for drivers. • Improve traffic quality in the city center while simultaneously informing about interventions to reduce environmental impacts. • Enhance road safety for vehicles, pedestrians, and people with disabilities. • Optimize the maintenance process and reduce downtime for repairs to the signaling system. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	471.000 €
Action outline	Action name	Creation of a control and information system for smart parking
	Action type	Technical intervention
	Action description	The initiative strives to enhance urban mobility conditions by implementing targeted parking solutions and deterring unauthorized parking in the city. This entails deploying parking control sensors (such as magnetic or optical sensors) and establishing an information system for parking that leverages data from these sensors. The goals include the real-time gathering of parking data, assisting citizens in making parking decisions while considering available transportation alternatives, confining unauthorized parking to designated visitor spaces or areas that impact traffic flow, and improving overall traffic conditions by reducing the time spent searching for parking spots.
	Field of action	Smart city - Mobility actions

Reference to impact pathway	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Reduced traffic congestion • Lower carbon emissions • Improved communication networks • Support for emerging technologies • Optimised urban mobility and transportation safety • Sustainable energy policies • Sustainable urban development policies • Enhanced digital inclusion • Optimised resource allocation • Increased innovation
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	Public transportation
	Involved stakeholders	Municipality of Trikala, Trikala Climate Team, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Digital Governance, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Public Transport Organization of Trikala, Taxi union of Trikala, Intercity Bus Transport Company of Trikala, Ministry of Infrastructure and Transport

	Comments on implementation	The intervention of the action will be spatially focused on the urban center of the city of Trikala and will include the monitoring of occupancy in controlled parking spaces, as well as the prevention of illegal parking. It will also involve the installation of infrastructure for controlling incoming and outgoing vehicles in municipal parking areas, aiming to assess availability. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	248.000 €
Action outline	Action name	Infrastructure to support and enhance digital advancement for the "Help at Home" program
	Action type	Technical & Social intervention
	Action description	The initiative seeks to enhance the quality of care services delivered by incorporating intelligent solutions into integrated patient management systems. This encompasses expanding the reach of assistance recipients through remote monitoring, delivering round-the-clock support via first aid notification systems, fostering a feeling of safety and independence for beneficiaries, improving the working environment for caregivers, facilitating uninterrupted care delivery in socially excluded situations through telemedicine and telecare, and lessening the environmental impact of caregivers' frequent home visits by transitioning to electric vehicles. Additionally, the action involves augmenting transportation resources for the provision of care services.
	Field of action	Smart city - Health & Social Care Actions

Reference to impact pathway	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Enhanced city-wide connectivity • Environmental sustainability • Improved communication networks • Support for emerging technologies • Improved public services • Informed public health policies • Increased energy efficiency and reduced GHG emissions • Better healthcare accessibility • Reduced social disparities in mobility • Improved trust in local government • Responsive and accountable local governance • Optimised social and healthcare service spending • Increased innovation • Community resilience • Organisational agility
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala

	Involved stakeholders	Municipality of Trikala, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Digital Governance, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Medical Association of Trikala, Citizens
	Comments on implementation	This action aims to strengthen the operational capacity of the Municipality's assistance services. On one hand, it involves establishing a central support structure, and on the other hand, leveraging modern technical solutions in the field of caregiving. Specifically, the action will include: • Operation of a Telecare Center for telemetry-monitoring and 24-hour telephone support for households benefiting from the "Help at Home" and "Day Care Center for the Elderly" programs. • Acquisition of telecare and independence support services in the form of software for smart portable devices. • Procurement of smart portable devices supporting the provision and receipt of telecare and independence services for the beneficiaries of the Municipality. • Procurement of fully equipped electric vehicles to cover the transportation needs and assistance provision of the Municipality's social care department personnel. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	248.000 €
Action outline	Action name	Development of "Social GIS" support infrastructure
	Action type	Technical & Social Intervention

	Action description	The objective of this initiative is to implement a spatially organized structure for diverse social data, enabling information accessibility for policy planning and execution through map analysis. The initiative encompasses the creation of an integrated management system for municipal social entities and the formulation of social geoinformation layers by aggregating data from the management system. The goals include the formulation of social policies at the local level, facilitation of social initiatives, mitigation of instances of social exclusion, and monitoring the spatial distribution of indicators for social monitoring.
Reference to impact pathway	Field of action	Smart city - Health & Social Care Actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Enhanced city-wide connectivity • Support for emerging technologies • Proactive social interventions • Strengthened social networks • Increased citizen engagement • Inclusive decision making • Community resilience • Strengthened community ties • Enhanced digital inclusion • Increased funding for resilience projects

Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Digital Governance, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Medical Association of Trikala, Citizens
	Comments on implementation	This is an initiative in which infrastructure will be established for the collection, processing, and visualization of data from the structures managed by the Social Welfare Department of the Municipality of Trikala. Specifically, it includes: • Development of a unified management system for municipal social structures. This system is intended for use by the personnel of these structures and will not only handle the basic management of the structures but also capture information about the beneficiaries of social structures and social solidarity benefits. • Development of social geoinformation layers by collecting data from the management system as well as from other administrative systems of the Municipality of Trikala. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	62.000 €
Action outline	Action name	Development of smart citizen wellness support infrastructure
	Action type	Technical & Social Intervention

	Action description	The goal of this endeavor is to establish a cohesive technical foundation that fosters sports habits, ultimately contributing to the enhancement of citizens' fitness and health. This involves implementing common facilities to track sports activities within municipal sports areas and developing information and communication infrastructure dedicated to sports and the overall physical well-being of the city. The primary objective is to integrate a sports culture into the collective awareness of citizens, elevate the physical health of the population, offer advanced sports services to residents at no cost, and advance a sports ethos through coordinated informational initiatives.
Reference to impact pathway	Field of action	Smart city - Health & Social Care Actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Support for emerging technologies • Informed public health policies • Sustainable urban development policies • Empowered communities in sustainable energy practices • Informed and engaged citizens • Data-informed environmental policies
Implementation	Responsible bodies/person for implementation	e-Trikala

	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Digital Governance, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Medical Association of Trikala, Citizens
	Comments on implementation	The initiative involves the installation of interconnected recording and measurement systems for exercise using active chips, as well as the display of training progress on an electrical panel, the use of electric power-generating bicycles for warm-up/cool-down, smart scales for individuals, and more. The information and communication system will be structured around a central infrastructure hosting the profiles of participating athletes, maintaining both a fundamental set of individual characteristics and preferences and a record of sports and physical condition based on the above measurements and other compatible facilities. Through this application, beyond personal measurements, the participating citizen can receive personalized advice on sports and well-being, as well as suggestions for using shared fitness equipment. In addition to individual information, this infrastructure will be capable of generating public statistics at the municipal level regarding physical condition and the achievement of collective goals. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	74.000 €
Action outline	Action name	Installation of infrastructure for remote management, remote control and telemetry of distribution boards (pillars) of municipal infrastructure of public space (street lighting)
	Action type	Technical intervention

	Action description	The initiative seeks to oversee the extensive street lighting network, the city's largest infrastructure in terms of the number of points and one of the most energy-consuming. This involves implementing systems for remote management and telemetry, entailing the procurement and installation of telecontrol, telemetry, and access control devices on the lamp posts throughout the Trikala Municipality. Additionally, it includes setting up and operating a remote management and telemetry system to enable centralized control and monitoring of the entire electric lighting network. The goal of this action is to minimize downtime for network repairs, extend the lifespan of lighting bulbs, reduce electricity consumption, provide real-time monitoring of 25,000 lighting bulbs, improve safety for pedestrians and drivers, and alleviate the strain on the electric power transmission network.
Reference to impact pathway	Field of action	Smart city - Energy Actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Enhanced city-wide connectivity • Improved communication networks • Support for emerging technologies • Community-driven circular economy initiatives • Informed and engaged citizens • Optimised resource allocation • Reduced financial losses from disasters • Increased funding for resilience projects

Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, HEDNO SA, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Environment and Energy, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Hellenic Energy Competence Center, TEE Trikalon
	Comments on implementation	The action involves the installation of a central management and control system for the electrical distribution panels (pillars) managed by the Municipality, primarily used for street lighting. Specifically, the action will include the following: Installation of remote control systems, including the procurement and installation of control, telemetry, and access control devices on the distribution panels (pillars). The installation of this equipment is expected to enable the direct execution of complex commands on the panels for lighting management and simplify the network maintenance process by expanding fault detection capabilities. Through the installation and operation of the remote management and telemetry system, optimization of the lighting network's performance, easier network supervision with notification and visualization tools, and an increase in the lifespan of lighting bulbs are anticipated. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	620.000 €
Action outline	Action name	Installation of energy saving infrastructure in municipal facilities

	Action type	Technical intervention
	Action description	Energy savings in building facilities constitute one of the key pillars of the energy transition in the city of Trikala, and the modern trend in energy management of the building stock is based on the development of intelligent models for energy and environmental building management. These models aim to maintain comfortable indoor climates while reducing energy consumption. The installation of tools for energy control and consumption monitoring is one of the primary methods for energy monitoring, rational energy management, and taking measures to improve the existing situation. The primary objective is to enhance the energy efficiency of municipal buildings, reduce operational costs associated with usage and maintenance, ensure thermal comfort, improve the indoor environment across the building portfolio, create a historical data repository for municipal structures to support decision-making by the municipal authority for future energy enhancements and operational improvements. Additionally, it aims to serve as a model for promoting energy upgrades in the city's building inventory and encouraging citizens to follow suit.
Reference to impact pathway	Field of action	Smart city - Energy Actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities

	Outcome (according to module B-1.1)	• Support for emerging technologies • Increased citizen engagement • Inclusive decision making • Empowered communities in sustainable energy practices • Reduced energy poverty • Environmental conscious behaviour • Community resilience • Community-driven circular economy initiatives • Strengthened community ties • Improved trust in local government • Informed and engaged citizens • Enhanced digital inclusion • Participatory decision-making processes • Lower energy costs and revenue from sustainable energy initiatives • Reduced financial losses from disasters • Increased funding for resilience projects • Increased revenue from circular economy initiatives
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala, Municipal buildings
	Involved stakeholders	Municipality of Trikala, HEDNO SA, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Environment and Energy, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Hellenic Energy Competence Center, TEE Trikalon, Directorate of Primary Education of Trikala, Directorate of Secondary Education of Trikala

	Comments on implementation	The significance of Building Energy Management Systems (BEMS) lies in various activities, including: • Installation of intelligent meters to track electricity and gas consumption. • Implementation of energy management and monitoring systems in educational institutions and other municipal structures. • Utilization of Internet of Things (IoT) for data collection and monitoring. • Establishment of a centralized management platform for the designated Building Management System (BMS) structures. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	669.000 €
Action outline	Action name	Development of a city energy balance recording and information application
	Action type	Technical intervention
	Action description	The initiative aims to develop an application for recording and informing citizens about the city's energy balance, which will be based on the use of the city's smart ecosystem, specifically the smart city platform, the intelligent application, and the information and publicity system. The primary objective of the initiative is to educate and heighten awareness among citizens regarding energy consumption and its more efficient utilization. It underscores the significance of incorporating renewable energy sources for both energy conservation and the reduction of the city's energy footprint, addressing the challenges posed by climate change.

Reference to impact pathway	Field of action	Smart city - Energy Actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Increased energy efficiency • Environmental sustainability • Cleaner urban environment • Improved communication networks • Support for emerging technologies • Community-driven circular economy initiatives • Informed and engaged citizens • Enhanced digital inclusion • Lower energy costs and revenue from sustainable energy initiatives • Skilled workforce proficient in technology and digital services • Increased innovation • Community resilience
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala

	Involved stakeholders	Municipality of Trikala, HEDNO SA, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Environment and Energy, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Hellenic Energy Competence Center, TEE Trikalon
	Comments on implementation	Throughout the initiative, there is a need for collaboration with information systems related to energy generation, distribution, and usage. This entails the creation of an algorithm designed to estimate the overall energy consumption and production across the entire city. Educational and informative programs will be implemented, providing scientific and technical assistance to residents and students. Furthermore, intelligent electricity meters will be selectively deployed in households. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	161.000 €
Action outline	Action name	Smart interactive electric lighting of emblematic points of the city
	Action type	Technical intervention
	Action description	The present action aims to establish an infrastructure for the decorative lighting of iconic landmarks in the city of Trikala. Specifically, it involves the interactive illumination of the city clock, the central bridge, and the riverside zone, in correlation with environmental conditions and the need to create a surrounding emotional atmosphere (e.g. promoting awareness campaigns, supporting participatory actions in combination with other tools). This entails the study and installation of a centrally controlled array of lighting fixtures at these locations in a manner suitable for highlighting the architectural and technical details of the aforementioned structures.

Reference to impact pathway	Field of action	Smart city - Energy Actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Enhanced city-wide connectivity • Improved communication networks • Support for emerging technologies • Implementation of smart energy policies • Adoption of policies supporting digital infrastructure • Policies to enhance broadband access and support for IoT infrastructure • Optimised resource allocation • Environmental conscious behaviour • Skilled workforce proficient in technology and digital services • Increased innovation
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, HEDNO SA, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Urban Development Company of Trikala SA, University of Western

		Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Hellenic Energy Competence Center, TEE Trikalon, Citizens
	Comments on implementation	More specifically, the action will include: • Installation of RGBW LED lighting fixtures with remote control capabilities for operation, intensity, and color, appropriately positioned to support different lighting scenarios. • Installation of a remote control system that will communicate with the entire lighting points using the city's communication networks. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	235.000 €
Action outline	Action name	Configuration of a crisis management command center
	Action type	Organisational intervention
	Action description	The present action concerns the establishment of a fully organized Crisis Management Center. The role of this center will be complementary to that of the Executive Management Center and will involve coordinating municipal units and volunteers following the activation of the Municipality's Civil Protection mechanism. Additionally, this space will be geographically diversified and can either substitute or complement the operation of the Executive Management Center in cases of emergency.
	Field of action	Smart city - Civil Protection Actions & Environment

Reference to impact pathway	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Enhanced city-wide connectivity • Improved disaster response • Improved communication networks • Support for emerging technologies • Integration of smart technologies in disaster response planning • Adoption of policies supporting digital infrastructure • Improved creditworthiness • Reduced financial losses from disasters • Increased funding for resilience projects • Organisational agility • Skilled workforce proficient in technology and digital services • Community resilience
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Environment and Energy, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Ministry of Climate Crisis and Civil Protection

	Comments on implementation	This involves the structural reconfiguration and equipping of a space with basic workspace infrastructure and suitable technical equipment for carrying out the aforementioned tasks. More specifically, the action will include the following: • Redesign of a space for use as a crisis management center with appropriate adaptation of an existing municipal space to serve its function. • Installation of communication, surveillance, and control equipment for the smart city ecosystem, as well as coordination of civil protection units. • Upgrade of the mobile unit for handling municipal emergency situations, focusing on the technical integration with the smart city ecosystem. The determination of the maximum number and roles of the Crisis Management Center's staff will be specified during the drafting of the technical documents for smart actions. The finalization will result from the collaboration between municipal staff and the developers responsible for the smart applications. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	62.000 €
Action outline	Action name	Installation of emergency detection and management infrastructure
	Action type	Technical intervention

	Action description	The present action aims to create mechanisms to support the detection and handling of situations that require the activation of the Municipality's Civil Protection mechanisms, based on the utilization of the smart city infrastructure. Typically, situations of this kind may include natural disasters (floods, earthquakes, fires), large-scale accidents, and the spread of infectious diseases. The action involves infrastructure based on the smart city ecosystem, focusing on the installation of immediate response systems in the city and the development of tools for two-way communication with citizens regarding emergency situations.
Reference to impact pathway	Field of action	Smart city - Civil Protection Actions & Environment
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities

	Outcome (according to module B-1.1)	• Enhanced city-wide connectivity • Improved disaster response • Improved communication networks • Support for emerging technologies • Integration of smart technologies in disaster response planning • Adoption of policies supporting digital infrastructure • Improved creditworthiness • Reduced financial losses from disasters • Increased funding for resilience projects • Organisational agility • Skilled workforce proficient in technology and digital services • Community resilience
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Environment and Energy, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Ministry of Climate Crisis and Civil Protection
	Comments on implementation	The action is expected to include:

		• Installation of smart IoT meters capable of providing immediate notification data for emergency situations. The types of sensors to be installed will involve fire and smoke detection in municipal forests, surface water quality, and water level in the rivers of Litheos, Agiamoniotis, Pinios, and seismic activity detection at various points in the municipality. • Automatic crowd meters using smart device detection techniques. • Implementation of citizen civil protection support for information and participation in addressing emergencies. • Evacuation support systems for facilities in case of fire or earthquake. The installation of integrated systems aimed at organizing the evacuation of public gathering spaces following the detection of an event will be examined. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	186.000 €
Action outline	Action name	Establishment of infrastructure for sustainable urban green management
	Action type	Technical intervention
	Action description	The action aims at creating infrastructure for the proper management of green irrigation within the urban fabric. For this action, urban green spaces considered are islands, nodes, parks, sports facilities, and squares that have been systematically irrigated until now either by the relevant municipal service or through private contracts. Up to now, the irrigation methods have involved the use of programmed systems or the physical presence of employees with corresponding costs in human resources commitment. The value of this action is based on the assessment of the systematic care of urban greenery as a significant factor in enhancing the overall quality of life in the city. The action specifically involves the installation of technical equipment for the management of urban greenery and monitoring the environmental conditions of the city.

Reference to impact pathway	Field of action	Smart city - Civil Protection Actions & Environment
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Environmental sustainability • Efficient water management - reduced wastage • Water conservation measures • Sustainable energy policies • Data-informed environmental policies • Conservation policies • Sustainable water management • Sustainable urban development policies • Awareness of water issues and collective efforts for sustainable water management • Community-driven circular economy initiatives • Strengthened community ties • Improved trust in local government • Informed and engaged citizens • Optimised resource allocation • Lower energy costs and revenue from sustainable energy initiatives • Reduced financial losses from disasters • Increased funding for resilience projects • Culture of continuous learning • Increased innovation

Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala, Urban green area
	Involved stakeholders	Municipality of Trikala, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Environment and Energy, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Ministry of Climate Crisis and Civil Protection, DUTH
	Comments on implementation	The implementation of the action includes: • Installation of autonomous energy systems for irrigation using IoT sensors and remotely controlled electrovalves. • Installation of environmental stations for measuring mixed environmental indicators and capturing the differentiation of microclimates in urban green spaces. Strategically placed small measuring stations will record the rate, degree, and manner of influencing urban green spaces, contributing directly to improving the microclimate within the urban fabric, ultimately enhancing the quality of life for citizens. Measurement parameters will include air temperature, relative air humidity, CO2 levels, suspended particles PM 1/ PM 2.5/ PM 10, UV radiation, chill factor and heat index. • Remote control irrigation software for decision-making with artificial intelligence algorithms (precision agriculture technology - smart farming). For this purpose, information from the equipment of the two aforementioned categories will be utilized. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	124.000 €

Action outline	Action name	Installation of smart consumption and water quality meters in the water supply network
	Action type	Technical intervention
	Action description	The present action concerns the control of consumption in municipal infrastructure and the quality of water in the water supply network. Since the rational management of water resources falls within the responsibilities of municipalities with the aim of meeting water supply needs, it is deemed necessary to acquire the capability to monitor consumption in municipal buildings. Furthermore, the dominant role of water as a crucial factor in the quality of life for residents raises concerns regarding the qualitative control at selected points in the network. The use of data in conjunction with the existing network control systems of the Municipal Water Supply and Sewerage Enterprise of Trikala is expected to highlight the smart ecosystem of the city as a powerful tool for monitoring the status of drinking water in the municipality.
Reference to impact pathway	Field of action	Smart city - Water Resources Actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities

	Outcome (according to module B-1.1)	• Environmental sustainability • Efficient water management - reduced wastage • Water conservation measures • Sustainable energy policies • Data-informed environmental policies • Conservation policies • Sustainable water management • Sustainable urban development policies • Awareness of water issues and collective efforts for sustainable water management • Community-driven circular economy initiatives • Strengthened community ties • Improved trust in local government • Informed and engaged citizens • Optimised resource allocation • Lower energy costs and revenue from sustainable energy initiatives • Reduced financial losses from disasters • Increased funding for resilience projects • Culture of continuous learning • Increased innovation
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala, Municipal buildings, Some residential buildings
	Involved stakeholders	Municipality of Trikala, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Environment and Energy, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Ministry of Climate Crisis and Civil Protection, DEYAT, Global Water Partnership - Mediterranean

	Comments on implementation	This involves the installation of measurement devices for consumption in municipal infrastructure and water quality measurement stations at points in the water supply network. Specifically: • Installation of smart water meters in selected municipal buildings or infrastructure. The equipment will be connected to the smart city platform to record consumption and identify leakage cases. • Distribution of smart water meters for selective installation in residents' homes. This action aims at providing personalized information services and raising awareness among residents regarding water consumption habits. • Installation of water quality measurement stations at selected points in the water supply network and the municipality's reservoirs. The data linkage with the smart platform can generate alerts for water quality. The collection and processing of data related to water consumption habits will significantly contribute to determining policies and designing communication actions regarding the proper use of the city's water resources. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	241.000 €
Action outline	Action name	Digitization, mapping and geospatial representation of water, sewer and stormwater networks
	Action type	Technical intervention

	Action description	The action involves integrating information related to the Municipal Water Supply and Sewerage Enterprise of Trikala into the smart ecosystem of the city. Evaluating water supply and sewage management is crucial for the quality of the living environment and critical for addressing issues of civil protection (e.g., flood events), it is considered significant to make this information available in the service of the smart city system in Trikala. The combined utilization of data and the use of smart infrastructure can lead to positive outcomes for the city as well as the functioning of the Municipal Enterprise (e.g., timely detection and notification of issues in the water supply/sewerage network).
Reference to impact pathway	Field of action	Smart city - Water Resources Actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Enhanced city-wide connectivity • Environmental sustainability • Efficient water management - reduced wastage • Water conservation measures • Improved communication networks

		• Support for emerging technologies • Implementation of smart energy policies • Smart water management policies • Regulations for efficient water use • Implementation of smart waste management policies • Adoption of policies supporting digital infrastructure • Optimised resource allocation • Lower energy costs and revenue from sustainable energy initiatives • Reduced financial losses from disasters • Environmental conscious behaviour • Community resilience • Awareness of water issues and collective efforts for sustainable water management • Community-driven circular economy initiatives • Skilled workforce proficient in technology and digital services • Increased innovation
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Environment and Energy, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Ministry of Climate Crisis and Civil Protection, DEYAT, Global Water Partnership - Mediterranean

	Comments on implementation	These actions involve enriching and integrating data from the Municipal Water Supply and Sewerage Enterprise of Trikala (MWSSET) into the smart ecosystem of the city, including: • Transfer of existing geospatial representation of water supply and sewerage networks. MWSSET maintains an outdated geoinformation system with networks and water meters, which will be migrated to the new upgraded geoinformation system of the smart city platform. • Mapping of stormwater networks. The existing network has been partially recorded in terms of above-ground points until now. The plan includes a comprehensive recording of the entire network, its depth, slopes, materials, etc. • Integration of a remote network management system to provide real-time measurement data. The SCADA system of MWSSET, which controls the individual elements and units of the municipal water supply installation, will be connected to the smart city platform to provide data. These actions aim to enhance the capabilities of the smart city platform by incorporating detailed information from the water supply and sewerage infrastructure for more effective management and monitoring. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	285.000 €
Action outline	Action name	Creation of a waste management platform, alternative waste management systems and information-awareness actions
	Action type	Technical intervention

	Action description	The action aims to design and implement an integrated waste management system through a smart management platform, with the implementation of Source Separation and Pay-As-You-Throw systems as fundamental measures to expedite and facilitate the implementation of waste management processes for all streams of urban solid waste, as defined in the Local Waste Management Plan. Additionally, it involves creating awareness campaigns to inform and sensitize citizens, supporting intelligent and sustainable waste management practices. For this purpose, a set of applied tools within the smart city ecosystem will be designed. This, in combination with organized and reliable information, is expected to serve as a model of best practices in utilizing the smart ecosystem to improve the living conditions of citizens, among other objectives.
Reference to impact pathway	Field of action	Smart city - Waste Management Actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities

	Outcome (according to module B-1.1)	• Enhanced city-wide connectivity • Improved communication networks • Support for emerging technologies • Environmental sustainability • Increased recycling and reduced landfilling • Cleaner urban environment • Implementation of smart waste management policies • Adoption of policies supporting digital infrastructure • Policies promoting citizen engagement • Optimised resource allocation • Improved creditworthiness • Lower energy costs and revenue from sustainable energy initiatives • Increased funding for resilience projects • Increased revenue from circular economy initiatives • Proactive social interventions • Strengthened social networks • Increased citizen engagement • Empowered communities in sustainable energy practices • Reduced energy poverty • Environmental conscious behaviour • Community resilience • Community-driven circular economy initiatives • Organisational agility • Culture of continuous learning • Increased innovation • Community resilience
Implementation	Responsible bodies/person for implementation	e-Trikala, PADYTH SA

	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Environment and Energy, Cities Net, NOVA Hellas, Mellon Labs, Wastecloud, EPTA, Hellenic Solid Waste Management Association, Hellenic Recycling Agency, ANAKEM - Alternative Management System for Demolition Waste, AFIS - Alternative Management System for Batteries, Appliances Recycling S.A., Hellenic Recovery Recycling Corporation, ENDIALE - Alternative Management System for Lubricant Oils, Eco Elastika - Alternative Management System for Used Vehicle Tires, EDOE - Alternative Management System for End of Life Cycle Vehicles, Re-Battery - Alternative Management System for Waste Batteries and Accumulators, Ecological Recycling Society, DUTH
	Comments on implementation	The systems planned to be integrated include the Smart City platform, waste management platform, individual applications (PAYT and Source Separation), municipal information and action display infrastructure (website, application), request management and crowdsourcing infrastructure, as well as the reward system. All these components are part of the citizen application, which will also be connected to the citizen reward system for implementing sustainable waste management practices. Specifically, the action will include: • Creating a targeted campaign for recycling and reusing specific materials and sustainable waste management practices. • Establishing a point-based system for actions contributing to better waste management and improved waste services planning. Integration of gamification mechanisms to enhance citizen participation.

		• Enabling crowdsourcing for recording events and information of public interest related to the waste and recycling system. • Designing the Source Separation and PAYT systems and pilot applications tailored to the municipality's needs. • Developing a PAYT application with citizen participation for further utilization of the Source Separation system and for separately collected waste streams. • Implementing a smart waste management platform providing data recording, storage, and analysis capabilities. This platform allows real-time monitoring of waste flows, creating useful reports, ensuring compliance with environmental legislation, and managing the entire range of waste-related functions. This platform will be interconnected with the Smart City platform. This is a priority action related to Trikala - Restart mAI city as well as sustainable management of waste & promotion of circular economy.
Impact & cost	Total costs	99.000 €
Action outline	Action name	Installation of smart submerged bins
	Action type	Technical intervention
	Action description	The current action aims to install an intelligent underground waste bin system to optimize the municipal waste collection process, representing an intervention with increased environmental and aesthetic impact. This involves an integrated management and information system that requires the configuration of the space for the underground placement of the bins, as well as the installation and operation of interconnected subsystems.

Reference to impact pathway	Field of action	Smart city - Waste Management Actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Enhanced city-wide connectivity • Environmental sustainability • Increased recycling and reduced landfilling • Cleaner urban environment • Improved communication networks • Support for emerging technologies • Adoption of policies supporting digital infrastructure • Implementation of smart waste management policies
Implementation	Responsible bodies/person for implementation	e-Trikala, PADYTH SA
	Action scale & addressed entities	City of Trikala

	Involved stakeholders	Municipality of Trikala, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Environment and Energy, Cities Net, NOVA Hellas, Mellon Labs, Wastecloud, EPTA, Hellenic Solid Waste Management Association, Hellenic Recycling Agency, ANAKEM - Alternative Management System for Demolition Waste, AFIS - Alternative Management System for Batteries, Appliances Recycling S.A., Hellenic Recovery Recycling Corporation, ENDIALE - Alternative Management System for Lubricant Oils, Eco Elastika - Alternative Management System for Used Vehicle Tires, EDOE - Alternative Management System for End of Life Cycle Vehicles, Re-Battery - Alternative Management System for Waste Batteries and Accumulators, Ecological Recycling Society, DUTH
	Comments on implementation	The action includes the following components: • Installation of a waste compression system in communal bins. • Installation of a non-compression system in recycling bins. • Placement of tags on the bins and use of RFID technology for communication. Automatic connection between the bin and the waste collection vehicle for lifting commands. • Fullness sensor for the bins, communicating with the system and sending notifications for collection when the bin is full. • Management software by the responsible department, connected to the GPS tracker, receiving RFID stamps, route information, fullness sensor data, and other details from the waste collection vehicle. • Voice installation with usage instructions for citizens to guide them in proper source separation. Data from smart bins will be stored on the smart city platform, gradually allowing for better decision-making regarding waste management and improving the quality of life in the city. This is a priority action related to Trikala - Restart mAI city as well as sustainable management of waste & promotion of circular economy.

Impact & cost	Total costs	124.000 €
Action outline	Action name	Implementation of management, allocation and utilisation of municipal buildings and public spaces
	Action type	Organisational intervention
	Action description	The action focuses on creating services to support transparency and citizen information regarding the management of municipal property and shared spaces. In order to make this capability possible, the development of an efficient mechanism for integrated management of different categories of properties related to the municipality's services is necessary. These categories involve municipal real estate, green areas/forests, shared spaces, etc., as well as different municipal services responsible for their various management aspects (technical, economic, administrative, and legal). Additionally, the integration of this management information into the smart city ecosystem is expected to enhance citizens' collectiveness and contribute to the formulation of policies (e.g., allocation of shared spaces for events, organization of voluntary actions). The initiative encompasses the establishment of services designed to foster transparency and provide citizens with information concerning the oversight of municipal assets and shared areas. The goal is to augment transparency in the governance of public spaces, alleviate bureaucratic hurdles related to information about public spaces and municipal assets, fortify collaborative endeavors by offering well-suited public areas, encourage volunteer initiatives to improve public spaces, perform a thorough examination of urban data to shape enhancement policies, ensuring the judicious use of communal spaces and municipal assets, and streamline the administration and utilization of municipal property by the local government.
	Field of action	Smart city - Economic Development & Building Actions

Reference to impact pathway	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Improved communication networks • Support for emerging technologies • Streamlined data sharing among government departments • Improved inter-agency collaboration • Increased economic productivity • Increased citizen engagement • Organisational agility • Increased innovation • Community resilience • Informed and engaged city administration • Public capability in participation and decision making processes
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala, Municipal buildings
	Involved stakeholders	Municipality of Trikala, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Environment and Energy, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas

	Comments on implementation	This involves thematic management and geospatial representation of properties pertaining to the Municipality within the smart city geoinformation system. Specifically, it will include: • Administration of municipal properties and shared spaces for the rational management of the Municipality's real estate. This will involve collecting thematic information concerning the technical, economic, administrative, and legal status of each property, identified by a unique identifier. • Geospatial representation of information on the smart city GIS (Geographic Information System). • Implementation of municipal property and shared spaces for citizen oversight of the utilization status of municipal and public spaces. This is a priority action related to Trikala - Restart mAI city as well as energy renovation and efficient utilisation of building stock.
	Total costs	62.000 €
Action outline	Action name	Creation of infrastructure for collecting and presenting data, commercial, and tourist activities
	Action type	Technical intervention
	Action description	The action aims at further developing the tourist product and enhancing the commercial activity of the city through the use of digital applications. Objectives include creating infrastructure to boost the city's tourism and commercial activity, providing incentives for entrepreneurs to create competitive offerings for city explorers, and establishing conditions for producing promotional content for the city's tourism and commercial products.

Reference to impact pathway	Field of action	Smart city - Economic Development & Building Actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Support for emerging technologies • Adoption of policies supporting digital infrastructure • Increased economic productivity • Enhanced business environment • Revenue streams from mobility services • Organisational agility • Increased innovation
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Environment and Energy, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Thessaly Region

	Comments on implementation	This involves creating a city navigation application that utilizes both public and specially tailored city guide data to provide a personalized exploration experience and infrastructure for generating audiovisual content to support the city's outward activities. More specifically, the action will include: • Developing a city navigation application based on user characteristics and city guide data. • Establishing infrastructure for producing audiovisual content for live streaming over the internet or storage of the relevant material. This is a priority action related to Trikala - Restart mAI city.
	Total costs	62.000 €
Action outline	Action name	Creation of a platform for information and citizen participation in Local Governance
	Action type	Technical & Social Intervention
	Action description	The action includes citizen information on local governance which will include information on C.C meetings, the participation of citizens' opinion in Local Governance as an advisory tool to the C.C and city governing bodies and the live participation of citizens in local governance and C.C meetings.
	Field of action	Smart city - Participation Actions

Reference to impact pathway	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Learning & Capabilities
	Outcome (according to module B-1.1)	• Improved communication networks • Support for emerging technologies • Policies promoting citizen engagement • Policies to enhance broadband access and support for IoT infrastructure • Proactive social interventions • Strengthened social networks • Increased citizen engagement • Inclusive decision making • Organisational agility • Increased innovation • Community resilience • Public capability in participation and decision making processes
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Environment and Energy, Ministry of Digital Governance, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, DUTH, Citizens

	Comments on implementation	This involves the creation of infrastructure to support Cityl Councils in terms of process transparency and information, incorporating additional procedures for public opinion gathering and enhancing participation. More specifically, the action will include: • Citizen information about local governance, including updates on City Council sessions. Citizens will have the ability to stay informed about the schedule, discussion topics for each session, and options for online monitoring. • Involvement of citizens' opinions in local governance as an advisory tool for the City Council and city administration bodies. • Active citizen participation in local governance, specifically during Municipal Council sessions, either with physical presence or through online platforms. This is a priority action related to Trikala - Restart mAI city as well as citizen-centric governance model.
Impact & cost	Total costs	86.000 €
Action outline	Action name	Development of a unified infrastructure for interconnection through wireless / wired broadband and wireless narrowband networks
	Action type	Technical intervention
	Action description	The action involves strengthening the data network interconnection infrastructure at the municipal level. The city's existing infrastructure includes a Metropolitan Area Network (MAN) of optical fibers and numerous wireless access points for citizen use. In the development of the city's smart ecosystem, this network infrastructure will be called upon to support the connectivity and access needs of various actor devices, encompassing IoT (WiFi, LoRaWAN), as well as various access devices for citizens and municipal

		services. Specifically for IoT devices, alternative access methods via mobile networks (GSM, 4G, 5G, NB-IoT) will be considered where deemed technoeconomically viable. More precisely, the action focuses on strengthening the data network interconnection infrastructure in terms of geographic coverage, supported communication protocols, the implementation of redundancy, and the level of cybersecurity.
Reference to impact pathway	Field of action	Smart city - Connectivity Actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Enhanced city-wide connectivity • Improved communication networks • Support for emerging technologies • Streamlined data sharing among government departments • Improved inter-agency collaboration • Policies to enhance broadband access and support for IoT infrastructure • Increased economic productivity • Optimised resource allocation • Strengthened social networks • Community resilience • Organisational agility • Increased innovation • Community resilience

Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	Outlying area of the city of Trikala
	Involved stakeholders	Municipality of Trikala, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Environment and Energy, Ministry of Digital Governance, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas
	Comments on implementation	The action will include: • Expansion of the optical fiber network to remote areas not currently served by the existing network infrastructure. Specifically, municipal buildings, commercially significant areas, and strategic surveillance points will be served through this expansion. • Creation of a WiFi Gen 6 mesh technology network to extend the wireless public access network and enhance the operation of the Metropolitan Area Network (MAN). • Establishment of a targeted LoRaWAN network coverage to facilitate access for IoT devices. • Integration of cybersecurity measures into the design of the network topology and equipment. • Implementation of network status monitoring capabilities through the active equipment of the network infrastructure, using relevant environments or other monitoring tools. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	830.000 €

Action outline	Action name	Acquisition of smart portable field equipment to support the operational management of the Municipality's personnel and vehicles
	Action type	Technical intervention
	Action description	The action involves the provision of smart personal devices for the access of municipal officials to the smart city ecosystem and the supply of geolocation and telemetry devices for vehicles. The goal of the action is to reduce response time for executing work programs, provide immediate updates on the progress of assigned tasks, offer direct and dynamic technical information to field personnel, update the central informational systems of the Municipality's operational support with real field data, respond promptly to emergency situations, provide data for optimal management of field personnel to serve citizen needs, and execute the rewarding services of the smart city ecosystem.
Reference to impact pathway	Field of action	Smart city - Connectivity Actions
	Systemic lever	Technology & Infrastructure Government & Policy Social Innovation Democracy & Participation Finance & Funding Learning & Capabilities
	Outcome (according to module B-1.1)	• Improved communication networks • Support for emerging technologies • Streamlined data sharing among government departments • Improved inter-agency collaboration • Implementation of smart transportation policies • Increased funding for resilience projects

		• Skilled workforce proficient in technology and digital services
Implementation	Responsible bodies/person for implementation	e-Trikala
	Action scale & addressed entities	City of Trikala
	Involved stakeholders	Municipality of Trikala, P-net emerging network & applications, DOTSOFT S.A., ABB Hellas, Ministry of Environment and Energy, Ministry of Digital Governance, Urban Development Company of Trikala SA, University of Western Macedonia, University of Western Attica, ICCS, Cities Net, NOVA Hellas, Trikala Climate Team
	Comments on implementation	It involves a multitude of smart devices with interconnection and georeferencing capabilities designed for monitoring and controlling vehicles and personnel from the central management structures of the Municipality. Specifically, the action will include: • Procurement of smart personal devices to provide municipal officials with access to the city's smart ecosystem. These devices will consist of mobile phones and tablets, enabling direct transmission of work orders to the end users and reverse updates on the status of assigned tasks and actual field conditions. • Procurement of geolocation and telemetry devices for the control of the municipality's vehicle fleet. This is a priority action related to Trikala - Restart mAI city.
Impact & cost	Total costs	124.000 €

Summary strategy for residual emissions

Residuals emissions refers to the GHG emissions that remain even after implementing all feasible reduction measures. These emissions are arise from various sources and may be impossible to fully eliminate. To offset residual emissions, individuals or organizations often engage in activities or mechanisms that either remove an equivalent amount of GHG from the atmosphere or prevent their release. Offset mechanisms encompass strategies or initiatives designed to counterbalance these lingering emissions, usually achieved by investing in projects that mitigate or eliminate an equivalent volume of GHG from the air. A common method to to offset residual emissions is investing in carbon offset projects. These projects can include renewable energy initiatives (such as wind or solar power), reforestation projects, methane capture from landfills, endeavors promoting sustainable agriculture practices. These projects result in measurable emissions reductions.

Another method for offsetting residual emissions is the purchase of carbon credits from verified and reputable carbon offset programs. These credits represent a reduction or removal of greenhouse gas emissions, and their purchase helps funding projects that contribute to emission reduction. Carbon credits are tradable on the carbon market, with businesses often purchasing them to offset their emissions and compensate for their carbon footprint. The purchaser can use these carbon credits to offset a portion of their own emissions. This means that emissions that cannot entirely be eliminate can be offset by supporting projects that reduce or remove an equivalent amount of GHG. Thus, the concept behind carbon credits is to create a financial incentive for businesses and individuals to invest in emission reduction projects.

Apart from the compliance market, there exist a voluntary carbon market. In this voluntary carbon market, individuals, companies, and organizations engage in the buying and selling carbon credits to offset or compensate for their greenhouse gas emissions. In contrast to compliance markets, where entities are legally obligated to meet emission reduction targets, the voluntary market operates on a voluntary basis, enable participants to voluntarily offset carbon dioxide emissions. Participants in the voluntary market trade carbon credits, representing a reduction or removal of greenhouse gas emissions and measured in terms of carbon dioxide equivalent (CO2e). These credits are generated through various projects that either reduce emissions (e.g., renewable energy projects) or remove carbon from the atmosphere (e.g., afforestation projects).

Afforestation Sustainable management of private forests assumes a critical role in carbon sequestration, biodiversity conservation, and overall environmental well-being. Carbon sequestration in private forests involves the process by which trees and forest ecosystems capture and store carbon dioxide (CO2) from the atmosphere, contributing to climate change mitigation. Private forest owners or managers can participate in carbon offset projects, implementing practices like reforestation, afforestation, avoided deforestation, and sustainable forest management to enhance carbon sequestration and reduce emissions.

According to the GHG inventory (baseline year 2019), residual emissions for the Municipality of Trikala amount to 86,07 kt of CO2e. In order to offset these emissions, the Municipality will invest in green infrastructure through which 3,42 kt of CO2e will be absorbed. The remaining residual emissions (82,65 kt CO2e) will be offset through voluntary carbon market.

The carbon price in the voluntary market is 0.95 $ which is equivalent to 0.87 €. Based on this price, the amount 71.905,5€ is required to offset the remaining residual emissions. Therefore, and taking into account the daily price fluctuations on the market, an investment of 80.000€ is required to compensate for the residual emissions.

The utilization of Carbon Credits from external sources to offset residual emissions within our city's boundaries will be governed by specific regulations and limitations, ensuring a credible demonstration of the city's climate neutrality. This involves the use of officially recognized credits/certificates, rigorously verified and validated by certified third-party auditors, adhering to stringent standards.

These restrictions are implemented to eradicate the potential for 'double-counting' and to establish a framework that guarantees transparency and accountability. It is emphasized that the selection of Carbon Credits should prioritize nearby projects whenever feasible, ideally within our country or at least within the European Union. Additionally, these credits should offer tangible additionality and co-benefits to enhance their environmental impact.

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

Smart city initiatives will play a crucial role in this monitoring process. By leveraging advanced technologies and data analytics, the city will harness real-time information from various sectors such as energy consumption, transportation, waste management, and other key areas covered by the CCC.

Specifically, through the implementation of the Restart mAI city actions, the establishment of a robust monitoring and evaluation system will enable tracking progress in climate actions across all sectors, ensuring accountability and transparency. The monitoring indicators presented in the action plan and investment plan will be assessed every two years, with progress reports made available to the public. With regular updates, the data will be adaptive, responding to new situations, evolving challenges, and opportunities.

In the renewed contracts, extensive consultations with stakeholders, citizens, and experts will be included. This approach aims to cultivate a sense of shared responsibility and commitment within the community.

The monitoring and enhancement of the CCC will be managed by a specialized team (Trikala Climate Team) as the central organization for monitoring and coordination of all aspects related to the CCC. The Trikala Climate Team will issue a yearly review about the city's progress based on the collected data. The city will establish a specific MEL plan and the frequent reporting of the CCC's progress will support the documents' revisions every 2 years. The citizen and stakeholder forum will be provided with data connected to the indicators, in order to be able to review the city's process. The co-creation and/or adjustment of existing policies will be made based on this reviews.

B-3.1: Impact Pathways						
Sector addressed	**Indicator No.**	**Indicator name**	**Unit of measurement**	**Target values**		
				2025	**2027**	**2030**
Stationary Energy	I.01	GHG emissions from stationary energy	ktn CO_2e	356,92	198,29	64,84
	I.02	Energy use by fuel/energy type within city boundary	MWh/year	*To be applied after the city establishes an Trikala Climate Team*		

Transportation	I.03	GHG emission from transport	ktn CO_2e	35,39	15,73	16,25
	I.04	Fuel consumption for in-boundary transportation per fuel type	MJ/kg/KWh	*To be applied after the city establishes an Climate Team*		
Waste	I.05	GHG emission from waste	ktn CO_2e	18,57	8,67	3,38
	I.06	Mass of waste processed per end-of-life treatment type within city boundary	ktn CO_2e	Not applicable		
	I.07	Mass of waste processed per end-of-life treatment type outside city boundary	ktn CO_2e	18,57	8,67	3,38
AFOLU	I.11	GHG emission from AFOLU	ktn CO_2e	-9,08	-11,2	-12,4
	I.12	Net annual rate of change in carbon stocks per hectare of land	tn CO_2e/ha	-	-	-
IPPU	I.08	GHG emissions from IPPU	ktn CO_2e	2,42	2,42	2,42
	I.09	Emission generation potential per unit of input/output for industrial processes within he city boundary	CO_2e/kg production	Not applicable		

	I.10	Emissions from energy product use non-energy product use	tn CO_2e	Not applicable		
Energy	I.13	Energy (in)dependence	%	2%	8,5%	13%
	I.14	Local renewable energy production	% in KWh	2%	8,5%	13%
Grid supplied energy (electricity, heat, steam or cooling)	I.15	GHG emission from grid supplied energy	ktn CO_2e	229,57	98,39	17,99
	I.16	Grid specific emission factor	tn CO_2e/MWh	Not applicable, Depends on the national grid		
	I.17	Transmissions and distribution loss factor for grid supplied energy	%	Not applicable		
Carbon capture and residual emissions	I.18	Amount of permanent sequestration of GHG within city boundary	tn CO_2e	9,08	11,2	12,4
	I.19	Negative emissions through natural sinks	tn CO_2e	-9,08	-11,2	-12,4
	I.20	Residual emissions	%	89,2%	48,6%	18,7%

B-3.2: Indicator Metadata	
Indicator Name	GHG emission from stationary energy
Indicator Number	I.01
Indicator Unit	t CO2 equivalent
Definition	GHG emissions (mainly CO2 emissions) from the operations of buildings.
Calculation	Base emission information can be derived through "Amount of fuel consumption per fuel type x GHG emission per fuel type". Calculation methodology has been described in detail in GHG Protocol for Cities (GPC) pages 60 – 73.
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	Stationary energy
Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	YES
Data requirements	

Expected data source	ELSTAT, Municipal ESCO, Trikala Property Owners Association (SIAT), Association of Contractors of Electrical Installers of the Prefecture of Trikala, Trikala Climate Team
Is the data source local or regional/national?	Local, national
Expected availability	High
Suggested collection interval	Monthly, Annually
References	
Deliverables describing the indicator	IPCC, GHG Protocol for Cities
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Energy use by fuel/energy type within city boundary
Indicator Number	I.02
Indicator Unit	MWh/year
Definition	Real consumption data for each fuel or energy type disaggregated by sub-sector. Where data is only available for a few of the total number of fuel suppliers, determine the population (or other indicators such as industrial output, floor space, etc.) served by real data to scale-up the partial data for total city-wide consumption.

Calculation	Calculation formulae for stationary energy from GHG Protocol for Cities (GPC) pages 60 – 73.
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	Stationary energy, Transport
Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	NO
Data requirements	
Expected data source	ELSTAT, Association of petrol dealers, Trikala Climate Team
Is the data source local or regional/national?	Local, national
Expected availability	Medium
Suggested collection interval	Monthly, Annually
References	
Deliverables describing the indicator	GHG Protocol for Cities
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	GHG emission from transport
Indicator Number	I.03
Indicator Unit	t CO2 equivalent
Definition	GHG emissions from the operations of vehicles.
Calculation	Calculation methodology and spreadsheet for GHG emissions from transport can be found under Indicator 7, SUMI. This overall methodology is recommended but the extent of application of such calculations can be defined by the data granularity available to the cities.
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	Transport and mobility
Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO

Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	NO
Data requirements	
Expected data source	ELSTAT, Association of petrol dealers, Urban Bus Station of Trikala, Intercity Bus Station of Trikala, Taxi Association of Trikala, Trikala Climate Team
Is the data source local or regional/national?	Local, national
Expected availability	High
Suggested collection interval	Monthly, Annually
References	
Deliverables describing the indicator	Sustainable Urban Mobility Indicators (SUMI) by DG MOVE
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Fuel consumption for in-boundary transportation per fuel type
Indicator Number	I.04
Indicator Unit	MJ/kg/kWh
Definition	Emissions per fuel type emerging from the operations of vehicles.

Calculation	Calculation formulae for Transport indicators from GHG Protocol for Cities (GPC) pages 75 to 87.
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	Transport & Mobility
Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	NO
Data requirements	
Expected data source	ELSTAT, Association of petrol dealers, Trikala Climate Team
Is the data source local or regional/national?	Local, national
Expected availability	Low
Suggested collection interval	Monthly, Annually
References	
Deliverables describing the indicator	

Other indicator systems using this indicator	GHG Protocol for Cities

B-3.2: Indicator Metadata	
Indicator Name	GHG emission from waste
Indicator Number	I.05
Indicator Unit	t CO2 equivalent
Definition	GHG emissions from waste treatment, waste incineration and landfills
Calculation	Quantity of waste per End-of-life (EoL) treatment type x emission factors per EoL treatment. Detailed methods for different waste types are defined under GPC, pages 89 - 107
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	Circular economy & Waste
Does the indicator measure indirect impacts (i.e. co- benefits)?	NO

Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	YES
Data requirements	
Expected data source	PADYTH SA
Is the data source local or regional/national?	Local
Expected availability	High
Suggested collection interval	Monthly, Annually
References	
Deliverables describing the indicator	IPCC, GPC, GCom CRF, JRC Info kit for Cities
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Mass of waste processed per end-of- life treatment type within city boundary
Indicator Number	I.06
Indicator Unit	t CO2 equivalent

Definition	Depending on end-of-life treatment options available in the city boundary, the city can report mass of waste sent towards each treatment type.
Calculation	Detailed calculation and scoping methodology described in GPC, pages 89 - 107
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	Circular Economy & Waste
Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	NO
Data requirements	
Expected data source	PADYTH SA
Is the data source local or regional/national?	Local
Expected availability	High
Suggested collection interval	Monthly, Annually
References	

Deliverables describing the indicator	GHG Protocol for Cities
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Mass of waste processed per end-of-life treatment type outside city boundary
Indicator Number	I.07
Indicator Unit	t CO2 equivalent
Definition	If waste types or end-of-life treatments are unknown for exported waste, a singular "mixed waste exported" weight can be reported. If waste types and treatment types are known, then all data can be reported.
Calculation	Detailed calculation and scoping methodology described in GPC, pages 89 - 107
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	Circular Economy & Waste

Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	NO
Data requirements	
Expected data source	PADYTH SA
Is the data source local or regional/national?	Local
Expected availability	High
Suggested collection interval	Monthly, Annually
References	
Deliverables describing the indicator	GHG Protocol for Cities
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	GHG emission from IPPU
Indicator Number	I.08

Indicator Unit	t CO2 equivalent
Definition	GHG emissions from industrial processes and product use within city boundary
Calculation	GHG emission calculation methodology for the IPPU sector is described in detail in the 2014 IPCC Mitigation of Climate Change, chapter 10, page 746. City-level calculation and scoping methodology described in GPC, pages 109 onward.
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	IPPU
Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	NO
Data requirements	
Expected data source	ELSTAT, National Inventory, Research
Is the data source local or regional/national?	National
Expected availability	Low
Suggested collection interval	Annually

References	
Deliverables describing the indicator	IPCC, GPC, JRC Infokit for Cities
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Emission generation potential per unit of input/output for industrial processes within the city boundary
Indicator Number	I.09
Indicator Unit	t CO2 equivalent per kg of production
Definition	The carbon intensity of products produced in the city. These are defined using the GHG emissions from industrial processes, which may include the production and use of mineral products (e.g. cement, lime, glass), chemicals (inorganic and organic) and metals.
Calculation	Detailed calculation and scoping methodology described in GPC, page 109 onward. Emission factors per material can be found in 2006 IPCC Guidelines for National Greenhouse Gas Inventories, volume 3.
Indicator Context	

Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	IPPU
Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	NO
Data requirements	
Expected data source	ELSTAT, National Inventory, Reasearch
Is the data source local or regional/national?	National
Expected availability	Low
Suggested collection interval	Annually
References	
Deliverables describing the indicator	IPCC, GHG Protocol for Cities (GPC)
Other indicator systems using this indicator	

B-3.2: Indicator Metadata

Indicator Name	Emissions from energy product use non-energy product use
Indicator Number	I.10
Indicator Unit	t CO2 equivalent
Definition	GHG emissions from industrial product use, which may include: the use of lubricants and paraffin waxes in non-energy products, FC gases used in electronic production and Fluorinate gases used as substitutes for Ozone depleting substances.
Calculation	Detailed calculation methodology described in GPC, Equation 9.5. Adapted from 2006 IPCC Guidelines for National Greenhouse Gas Inventories, chapter 3. 'Emission factors can be found in the IPCC Emissions Factor Database (EFDB)
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	IPPU
Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	NO

Data requirements	
Expected data source	ELSTAT, National Inventory, Reasearch
Is the data source local or regional/national?	National
Expected availability	Low
Suggested collection interval	Annually
References	
Deliverables describing the indicator	IPCC, GHG Protocol for Cities (GPC)
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	GHG emission from AFOLU
Indicator Number	I.11
Indicator Unit	t CO2 equivalent
Definition	IPCC guidelines divides AFOLU emission activities into three categories: Livestock, Land, Aggregate sources and non-CO2 emissions sources on land. The cumulative of these emissions forms the sectoral emissions. It is ideal for cities to identify which categories of the AFOLU sector are relevant for their reporting purposes.
Calculation	Detailed calculation and scoping methodology described in GPC pages 121- 137

Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	AFOLU
Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	NO
Data requirements	
Expected data source	ELSTAT, Agricultural Association of Trikala
Is the data source local or regional/national?	Local, national
Expected availability	High
Suggested collection interval	Annually
References	
Deliverables describing the indicator	IPCC, GPC, JRC Info Kit for Cities
Other indicator systems using this indicator	

B-3.2: Indicator Metadata

Indicator Name	Net annual rate of change in carbon stocks per hectare of land
Indicator Number	I.12
Indicator Unit	t CO2 / ha
Definition	IPCC divides land-use into six categories: forest land; cropland; grassland; wetlands; settlements; and other. Further refinements for each land use category may be based on national or local definitions. Using national definitions for land use categories will promote consistency with the national GHG inventory, while local definitions may be more relevant to specific policies and measures being taken at the local level.
Calculation	Detailed calculation and scoping methodology described in GPC pages 121-137; Estimating carbon stock changes can also be derived from 2006 IPCC guidance, vol 4 chapter 2, and the 2019 IPCC revision, section 4.
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	AFOLU
Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO

Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	NO
Data requirements	
Expected data source	ELSTAT, Agricultural Association of Trikala, Urban Planning Office
Is the data source local or regional/national?	Local, national
Expected availability	Medium
Suggested collection interval	Annually
References	
Deliverables describing the indicator	IPCC, GPC
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Energy (in)depence
Indicator Number	I.13
Indicator Unit	%
Definition	The indicator shows the extent to which an economy relies upon imports in order to meet its energy needs. It is calculated as net imports divided by the gross available energy.

Calculation	Energy dependence = (Net imports / Gross available energy) * 100.
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	Stationary Energy
Does the indicator measure indirect impacts (i.e. co- benefits)?	YES
If yes, which co-benefit does it measure?	Energy security, Independence from energy markets
Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	YES
Data requirements	
Expected data source	Municipal ESCO, HEDNO, Trikala Climate Team
Is the data source local or regional/national?	Local, national
Expected availability	High
Suggested collection interval	Annually

B-3.2: Indicator Metadata

Indicator Name	Local renewable energy production
Indicator Number	I.14
Indicator Unit	% in kWh
Definition	Percentage increase in the share of local renewable energy due to the renewable project.
Calculation	The percentage of the increase in local renewable energy production as a result of the renewable energy project is calculated as the difference between the annual renewable energy generation related to the project before and after project completion (or as the difference between the annual renewable energy generation related to the project compared to BAU). The result will be divided by the annual total energy consumption related to the project, and then it is multiplied by 100 to express the result as a percentage. Relevant unit conversions are 1 J = 1 Ws; 1 kWh= 3,600,000 J; and 1 TOE = 41.868 GJ, 11,630 kWh, or 11.63 MWh (ITU-T L.1430: 2013)
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	Energy
Does the indicator measure indirect impacts (i.e. co- benefits)?	YES
If yes, which co-benefit does it measure?	Energy security, Independence from energy markets

Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	NO
Data requirements	
Expected data source	Municipal ESCO, HEDNO, Trikala Climate Team
Is the data source local or regional/national?	Local, national
Expected availability	High
Suggested collection interval	Annually

B-3.2: Indicator Metadata	
Indicator Name	GHG emission from grid supplied energy
Indicator Number	I.15
Indicator Unit	t CO2 equivalent
Definition	GHG emissions occurring as a consequenc e of the use of grid- supplied electricity, heat, steam and/or cooling within the city boundary
Calculation	Detailed calculation and scoping methodology described in GPC pages 56 – 75.

Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	Stationary Energy, Transport
Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	YES
Data requirements	
Expected data source	Municipal ESCO, HEDNO, Trikala Climate Team
Is the data source local or regional/national?	Local, national
Expected availability	High
Suggested collection interval	Monthly, Annually

B-3.2: Indicator Metadata	
Indicator Name	Grid specific emission factor
Indicator Number	I.16

Indicator Unit	tCO2 eq/ MWh
Definition	Mass GHG emissions per unit of grid- supplied energy
Calculation	Detailed calculation and scoping methodology described in GPC pages 56 – 75.
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	Stationary Energy, Transportation
Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	NO
Data requirements	
Expected data source	Municipal ESCO, HEDNO, Trikala Climate Team
Is the data source local or regional/national?	National
Expected availability	High
Suggested collection interval	Monthly, Annually

B-3.2: Indicator Metadata	
Indicator Name	Transmission and distribution loss factor for grid supplied energy
Indicator Number	I.17
Indicator Unit	%
Definition	Average loss rate of the grid and amount of energy transmitted. These include losses from generation (upstream activities and combustion) of electricity, steam, heating, and cooling that is consumed (i.e., lost) in a Transmission and Distribution (T&D) system reported by end user. Localised Grid Loss Factors are usually provided by local utility or government publications.
Calculation	Transmission & Distribution Losses (%) = (Energy Input at Power Plants (kWh) – Billed Energy to Consumer (kWh)) / Energy Input (kWh) x 100 Detailed scoping methodology described in GPC standard 56-75 for various sectors and more specific calculations in the GPC scope 3 guidance, incl. pages 44-45. Transmission and distribution losses vary by location, see The World Bank's World Development Indicators (WDI) for an indication of national transmission and distribution losses as a percent of output, see: http://data.worldbank.org/indicator/EG.ELC.LOSS. ZS
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES

If yes, which emission source sectors does it impact?	Stationary Energy, Trasport
Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	NO
Data requirements	
Expected data source	HEDNO, RAE
Is the data source local or regional/national?	National
Expected availability	High
Suggested collection interval	Annually

B-3.2: Indicator Metadata	
Indicator Name	Amount of permanent sequestration of GHG within city boundary
Indicator Number	I.18
Indicator Unit	t CO2 equivalent

Definition	This indicator supports the reporting of carbon sequestration through “Technological sinks”, such as industrial CSS, Biomass for Energy with Carbon Capture and Storage (BECCS) and Direct Air Carbon Dioxide Capture and Storage (DACCS) technologies as well as the use of bio- based materials. This indicator can only be reported for Carbon Capture Project (CCP) applications which result in permanent sequestration of the CO2 (i.e., injected into geological structures, or stored in bio-based construction materials used in buildings)
Calculation	Direct reporting from CCPs
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	AFOLU
Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	NO
Data requirements	
Expected data source	Trikala Climate Team, Urban planning office
Is the data source local or regional/national?	Local
Expected availability	Medium

Suggested collection interval	Annually

B-3.2: Indicator Metadata	
Indicator Name	Negative emissions through natural sinks
Indicator Number	I.19
Indicator Unit	t CO2 equivalent
Definition	“Natural sinks” refer to the planting of trees or other conversion of land use. Cities are allowed to account for negative emissions through the enlargement or enhancement of natural sinks within the territory to address residual emissions (accounting for all changes in the carbon stock). Carbon sinks should be accounted for as part of the ‘AFOLU’ sector of the GHG inventory and can be independently monitored as a progress indicator to show negative emissions.
Calculation	Refer to AFOLU indicators section
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	AFOLU

Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	NO
Data requirements	
Expected data source	Trikala Climate Team, Urban planning office
Is the data source local or regional/national?	Local
Expected availability	Low
Suggested collection interval	Annually

B-3.2: Indicator Metadata	
Indicator Name	Residual emissions
Indicator Number	I.20
Indicator Unit	%

Definition	The difference between the city's GHG emissions inventory and their 2030 climate neutrality target. The Mission recommends as a guideline to aim for a level of 'residual emissions' within the city boundary in 2030 that does not exceed 20% of the baseline GHG inventory, with the possibility that the remainder could be accounted for using carbon sinks or credits.
Calculation	Refer to 2030 Climate Neutrality Action Plan guidance document
Indicator Context	
Does the indicator measure direct impacts (i.e. reduction in GHG emissions?)	YES
If yes, which emission source sectors does it impact?	All sectors
Does the indicator measure indirect impacts (i.e. co- benefits)?	NO
Can the indicator be used for monitoring impact pathways?	NO
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	NO
Data requirements	
Expected data source	Municipal ESCO, Trikala Climate Team
Is the data source local or regional/national?	Local
Expected availability	High
Suggested collection interval	Annually

4. Part C – Enabling Climate Neutrality by 2030

4.1. Module C-1 Technical, Organisational and Governance Innovation Interventions

C.1.1: Enabling organisational and governance interventions					
Intervention name	**Description**	**Systemic barriers/opportunities addressed**	**Leadership and stakeholders involved**	**Enabling impact**	**Co-benefits**
Trikala Climate Neutrality Hub	The Climate Neutrality Hub is pivotal in Trikala's journey towards sustainability, coordinating cutting-edge technologies and community involvement for transformative solutions. As 84,1% of emissions in the city comes from stationary energy, the hub will primarily focus on optimizing energy usage, energy efficiency of city building stock and infrastructure, implementation of Positive Energy Districts and community engagement. Key services include One stop shop for energy renovation on buildings, Climate Neutrality Observatory, Greenhouse Gas Measurement Platform, and Citizen Training and Stakeholder Engagement.	Centralize efforts and facilitate coordination among various stakeholders, overcoming fragmentation. Data collection and analysis to inform decision making. Raising awareness about climate action. Attracting investments and funding opportunities. Policy support through technical expertise and evidence-based recommendations to policymakers.	Municipality, Technical Chamber of Greece – Committee of Regional Department of Central & Western Thessaly, Hellenic Electricity Distribution Network Operator, University of Western Macedonia, ABB SA Greece, Environmental Development Agency of Western Thessaly (PADYTH) S.A, e-	Evidence-based decision-making and targeted interventions to achieve climate neutrality goals. Fostering innovation by supporting research, development, and adoption of climate-friendly technologies and solutions. Building capacity of local stakeholders to understand, prioritize, and implement climate actions effectively.	Stimulation of economic growth and creation of employment opportunities in green jobs. Improved Public Health through interventions, lower healthcare costs, increased productivity, and enhanced quality of life for residents. Enhancement of energy security, reduction of city dependency on fossil fuels. Social Equity and Inclusion.

	Additionally, it advocates for energy efficiency policies and collaborates with stakeholders to amplify its impact.		Trikala SA, Urban Development Company of Trikala S.A.	Fostering awareness, and participation ensuring that climate actions are inclusive, responsive to local needs, and supported by the broader community	international reputation as a forward-thinking and sustainable city that attracts investments, tourism and partnerships.
One-stop shop for energy renovation on buildings	A "one-stop service for building energy renovation" refers to a specialized service designed to provide extensive assistance and resources to property owners or managers aiming to enhance the energy efficiency and sustainability of their buildings. The aim is to streamline the planning and execution of energy-efficient improvements by providing a central hub for information, support, and coordination throughout the renovation process. Some of the services it can offer are:	Understaffing of municipality, Interest & awareness of citizens, Technological limitations, Climate Policy advancements, Renewable Energy transition, Green Finance and investment, Acceleration of energy renovation rates in privately owned buildings	Municipality, Technical Chamber of Greece – Committee of Regional Department of Central & Western Thessaly, PADYTH SA, building owners, building managers	This service simplifies the process of designing and implementing energy efficient building upgrades and coordinates all the necessary work and needs to achieve this. In addition, potential funding offered, experts available, as well as the provision of educational	The process of energy upgrading is becoming easier and more affordable. It brings together all the stakeholders needed to complete a project. This service offers financial savings by providing information on available financial incentives, grants and subsidies.

	Energy Audits, Technical Expertise, Financial Assistance, Project Coordination, Energy-Efficient Solutions, Environmental Impact Assessment. With an emphasis on sustainability and the preservation of energy, the objective is to ensure that building owners can easily and readily engage in energy-efficient renovations. The service will be offered in cooperation with the Technical Chamber of Greece – Committee of Regional Department of Central & Western Thessaly that will offer voluntarily its members, i.e. local engineers.			resources and training programs for building owners, managers and contractors, reinforce actions to achieve climate neutrality. Since energy upgraded buildings have low energy consumption, they are more sustainable and environmentally friendly.	In addition, it offers capacity building through the provision of information on the environmental benefits of energy renovation and through the educational resources and training programs for building owners.
Creation of a municipal ESCO	Creating a municipal Energy Service Company (ESCO) means establishing a business entity that provides energy related services to a municipality. In more detail, an ESCO provides energy efficiency and sustainability solutions to public facilities and municipal	Bureaucracy, Political Instability, Technological limitations, Fossil Fuel lobbying, Interconnection of the HEDNO network with RES installations, Climate	Municipality, Utility companies, Technical Chamber of Greece, Banks	ESCO offers solutions related to energy efficiency and sustainability for public establishments and municipal infrastructure. An ESCO provides	With the implementation of energy saving initiatives of the service, financial savings are also achieved through the funding that the municipal

	infrastructure. The main goals of this entity are: • Reduction of energy consumption, • Improvement of energy efficiency • Energy generation from RES The municipal ESCO will offer services such as energy audits, project development, financing, implementation and ongoing monitoring of energy saving initiatives. The primary goal is to help the municipality reduce energy consumption, lower operational costs and contribute to environmental sustainability. Partnerships can enhance the success of a municipal ESCO. Engage stakeholders such as local government officials, community organizations, and utility companies. Furthermore, establish partnerships with suppliers, contractors, technology providers, and other stakeholders in the energy sector.	Policy Advancements, Renewable Energy Transition, Green Finance & Investment		energy efficiency and sustainability solutions for public facilities and municipal infrastructure. By reducing dependence on fossil fuels and using RES, climate neutrality is made easier to achieve. In addition, the energy efficiency monitoring and optimisation services after the renovation ensure that energy savings continue to be realised.	service can offer. Furthermore, with the monitoring of these initiatives, there is a development of skills and the creation of practical jobs, as new energy works will be developed, of course with low energy consumption.

Establishment of Trikala Climate Team	The creation of a municipal Climate Team (Trikala Climate Team) demonstrates a commitment to addressing climate change. A Climate Team will be the main task force that will coordinate all municipal departments working toward the transition towards climate neutrality. It will offer technical assistance, progress monitoring, coordination of actions and reporting, awareness raising. By establishing a dedicated team within local government structure that is responsible for overseeing energy-related matters, promoting energy efficiency, supporting sustainable energy initiatives, and coordinating efforts will benefit the municipal effort to reduce the energy consumption, environmental impact and energy poverty.	Bureaucracy, Understaffing of municipalities, Political Instability, Interest and awareness of citizens, Interconnection of the HEDNO network with RES installations, Climate Policy Advancements, Renewable Energy Transition	Municipality, Universities, Research institutions, Technical Chamber of Greece	The specialised department within the local government structure will oversee energy issues and promote energy efficiency. It will also support sustainable energy initiatives so that the Municipality can reduce energy consumption and environmental impacts and achieve climate neutrality.	Trikala Climate Team, by offering technical assistance and training programs, manages to enhance the participation and motivation of residents and businesses, the creation of green jobs and the development of their capacities. In addition, sustainable development projects are adopted that contribute to the promotion of prosperity and energy security.

	The engagement of the Trikala Climate Team with stakeholders is also very important. Partnerships with regional energy agencies, universities and research institutions are important to leverage their expertise. In addition, working with local governments officials, community groups, businesses, and residents is essential to gathering data and support of the Trikala Climate Team.				
Establishment of Climanet	Climanet is strategically designed to consolidate the efforts of Greek Mission cities and Limassol by creating a unified front to advocate for additional support from the government and leveraging financial tools in collectively attaining the shared objective of climate neutrality. This collaborative approach is instrumental in laying the groundwork for a sustainable future and promoting a shift in	Changing the prevailing mindset, streamlining bureaucratic procedures, removing regulatory gaps and barriers, and addressing legislative deficiencies	Municipality, other Greek Municipalities, Ministry of Environment and Energy, other Ministries, Region of Thessaly, other regions	Enhanced Collaboration among municipalities to advocate for crucial issues, Increased Influence in policy making, Creation of streamlined processes, Shared Learning, Heightened Accountability for	Improved quality of life through acceleration of climate action, increased transparency and public trust in local government efforts, enhanced community preparedness and adaptation to climate-related

	societal attitudes toward environmental responsibility.			climate commitment	risks and disasters, stimulation of green investment, job creation, and economic development
Implementation of innovative energy storage technologies for RES	The implementation of innovative energy storage technologies for RES is critical to improve the reliability, efficiency, and sustainability of the grid. Energy storage systems can help manage the intermittent nature of RES like solar and wind by storing excess energy during periods of high production and	Financial scarcity, Technological Limitations, Fossil Fuel Lobbying, Interconnection of the HEDNO network with RES installations, Climate Policy	Ministry of Environment and Energy, HEDNO, Universities, Research institutions, Private companies	As the efficient use of RES is allowed, the dependence on traditional fossil fuels is reduced, leading to a more sustainable and resilient energy system and thus to climate neutrality.	The implementation of innovative renewable energy technologies is a crucial step towards achieving climate neutrality as it reduces dependence on

	releasing it when demand is high or renewable energy production is low. The implementation of innovative energy storage technologies for RES is a critical step towards achieving climate neutrality. It enables the effective utilization of RES, reduces reliance on traditional fossil fuels, and contributes to a more sustainable and resilient energy system. The implementation of RES storage technologies requires a multidisciplinary approach that combines expertise in engineering, energy management.	Advancements, Renewable Energy Transition, Green Finance & Investment		By combining research and expertise in engineering, energy management and projects, the achievement of energy storage manages to balance energy according to its demand and in this way we move towards a sustainable energy system.	traditional fossil fuels and contributes to a more sustainable and resilient energy system, energy market independence and well-being. Energy storage systems can help manage the intermittent nature of renewables and release energy when it is needed, thus achieving savings and proper management of precious energy.
Promotion of using recycled and recyclable, renewable and sustainable materials	Using recycled and recyclable, renewable and sustainable materials can make a significant contribution to achieving climate neutrality. These materials reduce the demand for raw materials, minimize waste generation, and decrease GHG	Financial scarcity, Interest & awareness of citizens, Technological Limitations, Social & Cultural Factors, Citizens with different background, Climate Policy	Ministry of Environment and Energy, Municipality, Environmental Development Agency of Western Thessaly (PADYTH) S.A.,	The use of recycled and recyclable, renewable and sustainable materials reduces the demand for raw materials, minimises waste	The choice of recycled and recyclable, renewable and sustainable materials brings economic savings as it avoids the creation of new

	emissions throughout their life cycle. By promoting the use of recycled materials, we can reduce the need for the extraction and processing of new resources, that often require large amounts of energy and contribute to carbon emissions. By giving new life to materials that would otherwise be thrown into landfills or incinerators, we conserve natural resources and reduce the environmental impact of manufacturing processes. Recyclable materials further enhance sustainability by ensuring that products can be collected, sorted, and recycled at the end of their useful life. This closed-loop approach minimizes waste and reduces the need for additional resource extraction. It also helps create a Circular Economy where materials are continuously reused, reducing the overall environmental footprint.	Advancements, Green Finance & Investment, Youth Movements, Corporate Social Responsibility	Commercial Association of Trikala, Urban Development Company of Trikala S.A., Hellenic Solid Waste Management Association	generation and reduces GHG emissions throughout their life cycle. By giving new life to materials that would otherwise go to landfill, environmental impacts are reduced and fossil resources are saved. Waste is minimised and fewer GHG emissions are released as the energy required to create recyclable and sustainable materials is much lower.	products that require the demand for energy and new resources and we have independence from the energy market. In general, by using this type of products we are leading to a more sustainable and prosperous environment.

	Incorporating renewable materials into our production processes is another important aspect of achieving climate neutrality. Renewable materials, such as plant-based fibers or bio-based plastics, come from renewable sources and have a lower carbon footprint than materials derived from fossil fuels. Their production often requires less energy and releases fewer greenhouse gas emissions, helping to mitigate climate change.	

Green Public Procurement	Green Public Procurement (GPP) are defined by the European Commission as the process by which fiscal authorities seek to contract goods, services and with less environmental studies throughout their life cycle, compared to goods, services and works that perform the same primary function that would be the subject of the contract under other circumstances. GPP's are an important action to be implemented because there are many benefits which they	Bureaucracy, Financial scarcity, Political Instability, Interest and awareness of citizens, Technological limitations, Climate Policy Advancements, Green Finance & Investment, Youth Movements	Ministry of Environment and Energy, Municipality, PADYTH SA	GPPs can help to save resources for the public sector and minimise or even avoid negative environmental impacts. They also reduce the energy and ecological footprint, helping to tackle climate change and reduce GHG emissions. The processes by	GPPs bring justice and prosperity to the public sector and their development reduces environmental impacts.

	offer. Some of the benefits are: GPP's can contribute to savings for the public sector, particularly when the life-cycle cost of the good, service or project is taken into account and not just the purchase price. They are directly linked to the principles of the Circular Economy. According to the European Commission, what is referred to as Circular Public Procurement can be defined as "the procedures by which public authorities procure goods or contract works and services that seek to contribute to closed cycles of energy and materials within supply chains, while minimising and/or avoiding negative environmental impacts and waste generation throughout their life cycle. The gradual application of environmental criteria in public	which public authorities procure goods or contract works and services seek to contribute to closed energy and material cycles. They are linked to the principles of the Circular Economy and help to achieve climate neutrality.

procurement should contribute to:

- Reducing the energy and ecological footprint, contributing to tackling climate change and reducing greenhouse gas emissions.
- Reducing negative impacts on the environment.
- Contributing to the sustainable and more efficient use of natural resources and energy.
- Saving public resources, taking into account life-cycle costs.

Creation of a Center for the Creative Reuse of Materials	The establishment of a Center for the Creative Reuse of Materials contributes to climate neutrality by promoting waste reduction, resource conservation and creative inspiration. The extension of lifespan material reduces the need for new production, which in turn decreases the demand for raw materials and energy-intensive manufacturing processes. Furthermore, such a center plays a vital role in reducing the environmental impact of waste disposal by diverting materials	Bureaucracy, Financial scarcity, Interest and awareness of citizens, Technological limitations, Climate Policy Advancements, Green Finance & Investment, Youth Movements	Municipality, PADYTH SA	Waste reduction, resource conservation and creative inspiration, which are all possibilities offered by the creation of eco-innovations, lead to the achievement of climate neutrality. In particular, the diversion of waste from landfills reduces environmental	A Center for the Creative Reuse of Materials contributes to the participation of citizens and the development of their skills, as well as the creation of green jobs. Very important is the fact that the environmental impact of diverting materials from landfill is greatly

	away from landfill. Landfills are responsible for producing methane. Through the reuse of materials, the center actively works towards decreasing these emissions and conserving resources. Additionally, the center can serve as a hub for innovative ideas and collaborations. It can facilitate the exchange of knowledge and resources, allowing for the development of new techniques and technologies focused on sustainability. These advancements can have a positive impact on various industries, promoting a more Circular Economy and reducing GHG emissions.		impacts and methane production. In addition, by extending the life of materials, the need for new production of products and thus the need for raw materials and energy-intensive production processes is minimised. Additionally, with the development of new technologies and knowledge based on sustainability, new ideas and innovations can be generated which in turn can contribute to achieving climate neutrality.	reduced and, in addition to aesthetic improvements, it also enhances well-being and restores public health is very important. Aditionally, economic savings are achieved, since the materials are reused and therefore there is no need to produce new materials, thus saving money.

Pay As You Throw (PAYT) implementation using technology and IoT	PAYT is a waste management system where residents are charged based on the amount of waste they produce. For the operation of this system, it is necessary municipality has implemented alternative management systems such as recycling of packaging, separate collection of biowaste and other streams, so that citizens have the opportunity to carry out Source Selection and thus gradually reduce the load of green bins with mixed waste. The system will be designed for each municipality individually, taking into account its characteristics, such as population, dense or sparse structure etc. The purpose of the implementation of the PAYT system and the replacement of the existing charging system is the compliance with the legislation, to charge citizens fairlier, to reduce overall waste	Bureaucracy, Understaffing of municipalities, Financial scarcity, Interest and awareness of citizens, Social and Cultural factors, Citizens with different background, Climate Policy Advancements, Green Finance & Investment, Youth Movements, Corporate Social Responsibility	Municipality, PADYTH SA, Citizens, Businesses,Commercial Association of Trikala, Association of Cafes of Trikala, Union of Food Service Professionals and Fast Food, Wastecloud, Mellon Labs, EPTA environmental engineering, Universities	In this system, the charging of municipal taxes is based on the amount of waste produced by each household and not on the square meters of the building. With the parallel recycling of packaging, the implementation of separate collection of different waste streams such as biowaste, paper and cardboard, etc. but also with the contribution of GPs, RCs and other supporting tools, we are leading to a reduction in the amount of waste going to landfill, thus reducing the	The implementation of the PAYT system will bring prosperity, equality and justice, as citizens will be charged based on the actual amount of waste they produce and not on the square metres of their house. This will also achieve cost rationalisation and long-term financial savings. By participating in the program, citizens will raise awareness and interest in environmental issues. This system will bring greater transparency and

	production and to promote the Circular Economy.			environmental impact and methane production, and therefore a step closer to climate neutrality. For the successful implementation of the PAYT system, proper information and education of citizens is essential. this can be done through information campaigns, seminars, brochures, a relevant column on the municipal website, application for mobile phones, etc.	fairness to the municipal services.
Recycling Corners (RC)	A Recycling Corner (RC) is defined as a public or private very small area, without fencing or any structures, where citizens can deposit separately collected recyclable municipal waste or	Financial scarcity, Interest and awareness of citizens, Social and Cultural factors, Citizens with	Municipality, PADYTH SA, Citizens, Local Businesses, Universities, WasteCloud,	RCs allow citizens to deposit separately collected recyclable municipal waste or	Public awareness and participation on recycling and environmental responsibility are enhanced by the

	used items, in suitable containers, which are collected by the local authority for reuse, preparation for reuse or recycling. Citizens can leave there: paper, plastics, metals, glassware, tetrapack, wooden packaging, edible oils and fats, WEEE (small size). They are recommended for densely populated areas, as they will provide quick access to a GP. The most important which offers the existence of RCs is that they can reduce municipal charges. This happens as many waste streams end up there, thus reducing the volume of waste that eventually ends up in landfills. One of the purposes of RCs is to serve citizens in separate deposition of recyclable materials and to enhance active citizen participation in recycling. RCs increase public awareness of recycling and environmental responsibility by enhancing the visibility and accessibility of recycling.	different background, Climate Policy Advancements, Green Finance & Investment, Youth Movements, Corporate Social Responsibility	EPTA environmental engineering	used items, in suitable containers, which are collected by the local authority for reuse, preparation for reuse or recycling. The volume of waste going to landfill is reduced as many waste streams end up in landfills. Separate collection and recycling are facilitated by PCs and by their combination with GPs.	RCs as citizens engage in source separation, deposit recyclable materials in the RCs and slowly active recycling and environmental awareness are integrated into their habits. Prosperity is restored, upgraded and green jobs are created as the management of the land requires staff from the Municipality.

Green Points (GP)	Green Point is a defined and landscaped area with appropriate building infrastructure (where required) and equipment, organized by the municipality, so that citizens can deposit separately collected recyclable materials, such as paper, glass, metal, plastics, textiles, edible oils or used items and equipment (such as clothing, furniture, electrical and electronic equipment) in order to be subsequently forwarded for recycling or reuse. There are “Small” or “Big” GPs and they can be created within or outside urban and settlement plans. The development of GPs contributes substantially to the adoption of the national policy on solid waste management, as it is expected to contribute significantly to the following: • promoting the prevention of waste generation • the promotion of reuse and recycling activities • the diversion of waste from landfills • recycling of household waste	Understaffing of municipalities, Financial scarcity, Interest and awareness of citizens, Social and Cultural factors, Citizens with different background, Climate Policy Advancements, Green Finance & Investment, Youth Movements, Corporate Social Responsibility	Municipality, PADYTH SA, Citizens, Businesses, Commercial Association of Trikala, Association of Cafes of Trikala, Union of Food Service Professionals and Fast Food, Wastecloud, Mellon Labs, EPTA environmental engineering, Universities	The creation of the GPs contributes significantly promoting the prevention of waste generation, promoting reuse and recycling and diverting waste from landfills. With the development of GPs, new patterns of social and environmental behaviour are being developed and citizens adopt the right policies for solid waste management. In the GPs, citizens deposit various separately collected recyclable materials such as clothes, furniture, electrical and electronic appliances, thereby facilitating and	Public participation in recycling and reuse reinforces their social responsibility and environmental awareness. Prosperity is restored, upgraded and green jobs are created, as their management requires staff from the Municipality.

- separate collection of paper, metal, plastic and glass
- developing a new approach to what is and what is not waste, reducing the reducing the ease of disposing of useful objects and materials, and developing new patterns of social behaviour.

decongesting the municipalities' management process.

Nearly Zero Energy Buildings (NZEBs) (new buildings)	Nearly Zero Energy Buildings (NZEBs) are highly energy efficient structures that require minimal energy for heating, cooling and general operations, while the rest of the energy needs are largely covered by renewable sources. Choosing to build new NZEBs is preferable and easier than converting existing buildings into NZEBs as they can choose to use environmentally friendly materials from the start and integrate energy saving systems. NZEBs are designed and constructed in such a way that their energy consumption is close to zero. This is achieved through effective insulation, the use of RES and energy saving technologies. Benefits: • reducing energy costs • reducing CO2 emissions • improving energy efficiency • improving health Achieving this goal requires the cooperation of many factors, such as government, citizens,	Financial scarcity, Interest and awareness of citizens, Technological limitations, Social and cultural factors, Citizens with different backgrounds, Interconnection of the HEDNO network with RES installations, Climate Policy Advancements, Renewable Energy Transition, Green Finance & Investment	Ministry of Environment and Energy, Municipality, Citizens, Companies, Banks	The use of energy reduces energy demand and energy consumption and the simultaneous use of environmentally friendly materials helps to achieve the goal of climate neutrality. The buildings reduce carbon dioxide emissions and improve energy efficiency. Energy saving systems and efficient insulation technologies help to achieve this.	They improve public health as environmentally friendly materials are used and energy is saved as they also use energy efficient systems and the purpose of these buildings is to consume almost zero energy.

	Municipality, companies and banks.

Stakeholder engagement

Citizen Forum	The creation of a citizen's forum dedicated to climate neutrality is an innovative effort that has the potential to actively engage citizens in the fight against climate change. These platforms serve as spaces where citizens can discuss, exchange ideas and voice their concerns about the city's climate strategy. To ensure a holistic approach, it's imperative to organize sector-specific groups focusing on key areas such as energy, transportation, waste management, and more. Each group will be tasked with delving deeply into the unique challenges and opportunities within their respective sectors. This approach fosters understanding of the complexities and facilitates collaborative efforts to achieve climate neutrality effectively.	Bureaucracy - Public sector System Financial scarcity-Economic System Interest & awareness of citizens - Social System, Social & Cultural Factors - Social System, Citizens with different background, Climate Policy Advancements, Youth Movements - Social System, Corporate Social Responsibility - Economic/Social System	Citizens, Municipality, other stakeholders per sector, NGOS, universities	The enabling impact of establishing a citizen forum dedicated to climate neutrality lies in its ability to empower individuals and communities to actively engage in discussions and decision-making processes related to climate action. The establishment of a forum where citizens are able to voice their opinions, concerns, and ideas fosters a sense of ownership and involvement in addressing climate issues.Through this process,	Through active participation and inclusivity, these forums promote equity and justice, community empowerment, and fostering a sense of shared responsibility and collective action toward environmental sustainability.

	These meetings will provide a valuable opportunity for the exchange of information, discussion of challenges, and formulation of action proposals.			economically sustainable and socially acceptable solutions for protecting the environment and reducing the impact of climate change can be developed.	
Stakeholder Forum	The stakeholder forum provides a space for robust discussions, knowledge sharing, and the exchange of best practices. It serves as a forum where stakeholders can share insights, identify barriers, and co-create innovative strategies to advance our climate goals. By convening representatives from government, business, academia, non-profit	Bureaucracy - Public sector System Financial scarcity- Economic System Interest & awareness of citizens - Social System, Social & Cultural Factors - Social System,	Businesses, local authorities, and non-governmental organizations businesses, banks, Universities, Technical Chamber of Greece – Committee of Regional	The establishment of a stakeholder forum dedicated to climate neutrality can have a transformative impact by fostering collaboration, mobilizing resources, sharing knowledge, influencing policies,	Through active participation and inclusivity, these forums promote equity and justice, accountability, and transparency. Additionally, they enhance investor confidence by demonstrating a commitment to

	organizations, and the broader community, they pool together a wealth of expertise, resources, and perspectives crucial for crafting holistic and impactful strategies. Within the stakeholder forum, robust discussions, knowledge sharing, and the exchange of innovative ideas thrive. It serves as a hub where stakeholders can not only share insights but also collectively identify barriers and co-create solutions to propel their journey towards climate neutrality.	Citizens with different background, Climate Policy Advancements, Green Finance & Investment - Economic System, Corporate Social Responsibility - Economic/Social System	Department of Central & Western Thessaly	driving market transformation, and empowering communities to take collective action towards a sustainable and climate-resilient future. Through collaborative decision-making, the forum facilitates stakeholders from various sectors to develop comprehensive strategies for climate neutrality. Additionally, by pooling resources and expertise, the forum catalyzes investments in climate mitigation and adaptation, enhancing the effectiveness of climate action.	addressing environmental challenges and promoting sustainable practices.

Participatory platform	Establishing a participatory platform is a commendable step toward ensuring that the implemented measures align with local needs and priorities. This platform can serve as a crucial channel for citizens, stakeholders and City Council to collaborate, share ideas, and contribute to the development and refinement of climate policies. This platform will serve as a dynamic space where the participants can actively engage, collaborating and communicating to draft and refine climate policies. By fostering collaboration and communication through this platform, the aim is to cultivate a profound sense of commitment among participants. This commitment is essential for building a shared responsibility and ownership of the climate policies that emerge from this collaborative effort. Through	Bureaucracy - Public sector System Financial scarcity- Economic System Interest & awareness of citizens - Social System, Social & Cultural Factors - Social System Citizens with different background, Climate Policy Advancements, Youth Movements - Social System, Corporate Social Responsibility - Economic/Social System	Citizens, Stakeholders and City Council	The establishment of a participatory platform connects citizens, stakeholders and City Council. Collaborative Problem-Solving enables collective efforts, allowing participants to identify challenges and devise innovative solutions, thus fostering creativity and tailored approaches to address specific community needs. Enhanced Participation fosters inclusive engagement among citizens, stakeholders, and municipal councils,	Offers a dynamic environment where participation and inclusivity thrive, empowering diverse stakeholders, citizens and city council to engage meaningfully in decision-making processes. By fostering open dialogue and embracing a range of perspectives, these platforms ensure that all voices are heard and valued, leading to community empowerment, capacity building, and enhanced accountability and transparency.

	active involvement and connection with the authorities, citizens and stakeholders alike become integral contributors to the decision-making process, ensuring that the implemented measures are reflective of the diverse perspectives within Trikala.			harnessing diverse perspectives for more robust solutions.	
Educational campaigns	These campaigns are envisioned to encompass a range of initiatives, such as workshops, seminars, and awareness programs. The primary goal is to educate the public about key concepts such as climate neutrality, sustainability, and the imperative role that collaborative efforts among diverse stakeholders play in addressing environmental challenges. By employing varied educational formats, including interactive workshops and informative seminars, these campaigns seek to foster a deeper understanding of the interconnected issues surrounding climate change.	Bureaucracy - Public sector System Financial scarcity-Economic System Understaffing of municipalities-Public sector System, Financial scarcity-Economic System, Interest & awareness of citizens - Social System, Social & Cultural Factors - Social System, Citizens with different background, Climate policy advancements, Youth Movements - Social System,	Municipality, PADYTH, Department of Environmental Engineering, University of Patras, Technical Chamber of Greece	Educational campaigns play a vital role in addressing climate change by increasing awareness, promoting behavioral change, empowering individuals, and fostering community engagement. By informing the public about climate change and its impacts, these campaigns highlight the urgency for action.	Educational campaigns facilitate capacity building by providing access to valuable knowledge and resources. This capacity building empowers individuals and organizations to take proactive steps towards positive change, both in their personal lives and within their communities. Additionally, campaigns

		Corporate Social Responsibility - Economic/Social System		They encourage individuals to adopt sustainable practices and support climate-friendly policies, empowering them to actively engage in climate action efforts. Additionally, educational campaigns foster collaboration and resilience within communities, strengthening bonds and creating a collective response to climate change challenges.	promote community empowerment by fostering a sense of shared responsibility and collective action.
Feedback through digital platforms	Beyond forums and co-creation platform, Trikala recognizes the importance of continuous and direct communication with the community. Social media platforms provide this opportunity by allowing structured discussions, question and answer sessions, and thematic	Bureaucracy - Public sector System Financial scarcity-Economic System Interest & awareness of citizens - Social System,Technologic	Citizens, Stakeholders, Municipality	Digital platforms provide real-time feedback allowing individuals and organizations to monitor their environmental impact	These platforms serve as powerful tools for amplifying community voices, enabling individuals to share their feedback,

	topics related to climate policies and initiatives. Trikala aims to engage with the community where it is most active, ensuring that information about climate actions is accurate and easily accessible. This approach facilitates a broader and more inclusive dialogue, accommodating the community's different preferences and habits. It also allows the city to gather diverse perspectives and feedback, nurturing a sense of shared responsibility and ownership of environmental initiatives among residents.	al Limitations - Economic System, Corporate Social Responsibility - Economic/Social System, Citizens with different background, Youth movements- Social System,		continuously. By analyzing feedback from digital platforms, users gain valuable insights into their energy usage patterns and environmental footprint. This information can inform behavioral changes, leading to more sustainable practices and reduced carbon emissions. Additionally, social media platforms facilitate engagement and collaboration among users, fostering a sense of community around climate action. Users can share experiences, tips, and best practices, creating a supportive	concerns, and ideas with accountability and transparency. By providing accessible channels for engagement, digital platforms ensure community empowerment and participation and inclusivity. This inclusivity provides that the range of perspectives are considered, leading to more equitable outcomes.

				environment for sustainable living.	
Incentive programs	The introduction of incentive programs aims to attract both citizens and stakeholders to actively participate in climate-driven initiatives. One aspect of incentive programs involves recognising and rewarding sustainable practices within the community. This recognition not only serves to highlight the efforts of citizens and stakeholders committed to environmentally friendly practices, but also serves as an inspiration for others to follow suit. In addition to recognition, incentive schemes can offer rewards (e.g municipal taxes reduction) for achievements in areas such as energy efficiency and waste reduction. In addition, incentive programs could expand financial support to promote innovative climate projects. This financial mechanism aims to	Bureaucracy - Public sector System Financial scarcity- Economic System Interest & awareness of citizens - Social System, Social & Cultural Factors - Social System, Citizens with different background, Climate policy advancements, Youth Movements - Social System, Corporate Social Responsibility - Economic/Social System	Citizens, Stakeholders	Incentive programs motivate individuals and organizations to adopt sustainable practices and reduce carbon emissions by offering rewards, rebates, or financial incentives. These programs encourage the adoption of energy-efficient technologies, renewable energy systems, and environmentally friendly behaviors. By providing financial incentives for sustainable investments and	The implementation of incentive programs not only fosters participation and inclusivity but also spurs economic development. By offering rewards and benefits for engagement, incentive programs attract a diverse range of participants, ensuring that voices from all backgrounds are heard and valued.

	empower individuals and businesses to implement innovative solutions that contribute to climate resilience and sustainability goals of Trikala.	practices, incentive programs stimulate market demand for green technologies and products. This leads to the development of a more robust green economy, with increased availability and affordability of climate-friendly alternatives.

With the implementation of proposed organizational and governance interventions, the city of Trikala aims to transform the current governance structure into a more collective one. This implies that citizens will be able to participate in decision-making, and a common (collective) decision will be reached by all stakeholders. Essentially, the goal is to achieve a participatory governance model, where all citizens, on an equal footing, can decide and take responsibility for climate mitigation practices and the achievement of climate neutrality.

The main governance innovation is the Creation of a platform for information and citizen participation in Local Governance. This platform will necessarily bring about changes in the way the local authority works to date and will bridge the gap between citizens and government. City processes become more democratic, with respect for citizens' views, while at the same time public trust increases.

Additionally, to achieve climate neutrality, it is essential to plan for organisational and administrative innovations and to promote inclusiveness, trust and legitimacy of the necessary actions. The actions - solutions proposed are the creation of a One-stop shop for energy renovation on buildings, which is a specialised service designed to provide extensive assistance and resources to property owners or managers aiming to improve the energy efficiency and sustainability of their buildings. Also, creation of a municipal ESCO with the establishment of a business entity that provides energy-related services to the municipality, energy efficiency and sustainability solutions to public facilities and municipal infrastructure and has as main objectives the reduction of energy consumption, improvement of energy efficiency and renewable energy

generation. Another intervention is the creation of a municipal climate team (Trikala Climate Team), which provides technical assistance and coordination services to the municipality, thus contributing to the transition towards climate neutrality.

The implementation of innovative energy storage technologies for RES, is crucial to improve the reliability, efficiency and sustainability of the grid. In addition, the promotion of using recycled and recyclable, renewable and sustainable materials can reduce the need to extract and process new resources, which often require large amounts of energy and contribute to carbon emissions.

In addition, GPP's is an important action to be implemented because there are many benefits which they offer. They are defined by the European Commission as the process by which fiscal authorities seek to contract goods, services and with less environmental studies throughout their life cycle, compared to goods, services and works that perform the same primary function that would be the subject of the contract under other circumstances.
Some of the benefits which they offer are their contribution to saving resources for the public sector, in particular when the life-cycle costs of the good, service or work are taken into account rather than just the purchase price, and are directly linked to the principles of the Circular Economy.

The promotion of waste reduction, resource conservation and creative inspiration is achieved through the creation of a Centre for Creative Reuse of Materials which contributes to climate neutrality.

Furthermore, the implementation of the PAYT waste management system, where residents are charged based on the amount of waste they generate, puts in place source separation, separate collection of biowaste and recyclable materials and thus reduces the amount of green waste and consequently the final quantities sent to landfills.

Equally important is the creation of Recycling Corners (RCs) and Green Points (GPs), where a GP is defined as a public or private very small space where citizens can deposit separately collected recyclable municipal waste or used items in appropriate containers, which are collected by the local authority for reuse, preparation for reuse or recycling, and a RC is a designated and configured area with appropriate building infrastructure and equipment, organised by the Municipality, where citizens deposit separately collected recyclable materials (e.g. paper, glass, metal, plastic, textiles, edible oils or used items and equipment (such as clothes, furniture, electrical and electronic equipment) in order to be forwarded for recycling or reuse.

RCs raise public awareness of recycling and environmental responsibility by increasing the visibility and accessibility of recycling, and the development of RCs contributes substantially to the adoption of national policy on solid waste management, the promotion of waste prevention, the promotion of reuse and recycling activities, the diversion of waste from landfills, the recycling of household waste the separate collection of paper, metal, plastic and glass, etc.

Finally, the action on Near Zero Energy Buildings (NZEB) is very important. NZEB are highly energy-efficient buildings that require minimal energy for heating, cooling and general operations, while the remaining energy needs are largely met by renewable sources and achieve energy cost reductions, CO2 emission reductions, energy efficiency improvements and health improvements.

During the implementation of these actions, citizens actively participate in greenhouse gas emission mitigation policies. They engage in separate waste collection, participate in the Center for Creative Reuse of Materials, and find personalized solutions for building renovation through the One-stop shop for energy renovations, aiming to reduce emission rates from their buildings. Additionally, through Climate Neutrality Hub, citizens can stay informed, receive education through educational programs, seminars, campaigns, etc., and adopt sustainable practices.

Stakeholder Engagement

Achieving climate neutrality requires a multifaceted approach that includes enhancing citizen participation, raising awareness, educating the public, and mobilizing economic resources. Forums and participatory platforms play a crucial role in fostering open dialogue and idea exchange among citizens, stakeholders, and local government bodies. These platforms provide valuable spaces for community feedback, ensuring that the voices of citizens are heard and considered in the formulation of climate policies and initiatives. By bringing together experts, policymakers, and community members, these forums facilitate the collaborative design of solutions that promote climate neutrality and address local environmental challenges. Through this process of open communication and collaboration, stakeholders can review the current situation, collectively address challenges, identify innovative solutions, and propose ways to integrate best practices into updating Climate City Contract.

Educational campaigns play a vital role in citizen participation in climate action. Specifically, through these actions, climate challenges are deeply understood, the necessity of action is recognized, and information and resources regarding sustainable practices are provided. This promotes behavioral and mindset change regarding climate issues and enhances the environmental awareness of citizens and stakeholders. This empowerment leads to tangible contributions to climate neutrality, as individuals adopt more sustainable behaviors and practices.

Feedback through digital platforms facilitates real time communication and interaction with citizens regarding climate-related matters. By actively seeking input and suggestions from the public, these platforms help policymakers and organizations gain deeper insights into community priorities and preferences. This enhanced understanding enables more targeted and effective climate interventions to be implemented.

Incentive programs offer financial rewards or other benefits to encourage the adoption of climate-friendly practices and investments. These programs incentivize actions such as transitioning to renewable energy sources, enhancing energy efficiency, and mitigating carbon emissions. By providing tangible rewards for such initiatives, incentive programs motivate both individuals and businesses to actively contribute to achieving climate neutrality objectives.

Overall, citizen engagement interventions play a pivotal role in advancing climate neutrality by fostering collaboration, raising awareness, empowering individuals, and incentivizing sustainable actions at both the community and individual levels. Through these collective efforts, society can move closer to achieving a more sustainable and climate-neutral future.

As part of stakeholder engagement, the Municipality of Trikala has implemented a targeted strategy to enhance participatory planning, emphasize the importance of transitioning to climate neutrality, and raise citizens' environmental awareness. Annex 1 delineates the engagement strategy and offers illustrative examples of initiatives. These examples include detailed descriptions accompanied by photographic evidence, providing a comprehensive view of the community's dedication to sustainability and citizen involvement

4.2. Module C-2 Social and Other Innovation Interventions

The following are social and technological interventions that Trikala aim to implement to expedite the fair transition to climate neutrality. Trikala recognizes that systemic changes in the way the city operates today are essential to achieving this goal. For this reason, it will continue to develop social innovation interventions throughout its journey, identifying needs and responding to them.

C.2.1: Enabling social innovation interventions

Intervention name	Description	Systemic barriers/opportunities addressed	Leadership and stakeholders involved	Enabling impact	Co-benefits
Creation of repairing workshops for citizens	Establishing repair workshops provides numerous advantages to both individuals and the environment, fostering sustainable consumption practices and contributing to the principles of the Circular Economy. In recent years more second hand shops have been introduced	Interest and awareness of citizens, Social and cultural factors, Citizens with different background, Youth Movements, Corporate Social Responsibility	Municipality, Companies, Citizens, Federation of Commercial Associations of Thessaly, Commercial Association of Trikala, Technical Chamber of Greece, Universities	By repairing items and buying clothes from these stores, their life cycle is extended and the re-creation of products is prevented. Consequently, the amount of products going to landfill is reduced, thus reducing emissions and ultimately, with fewer emissions, we	Repairing items is often more advantageous than buying new ones. People can save money by learning how to repair their belongings, which can be particularly useful for those on a tight budget. Repair workshops promote the practice of repairing items instead of discarding

	to the market, representing a more environmentally friendly philosophy and practice. In fact, buying clothes from these stores extends their life cycle and prevents the re-creation of products. This means that resources, energy and money are saved for the buyer, as these products are always much cheaper than new ones. Also, repairing products saves money by repairing old products instead of buying new ones. Furthermore, the repair of objects promotes sustainable consumption as it allows reuse and increases the lifetime of products and reduces the amount of waste going to landfills, thus		are one step closer to climate neutrality.	them when they malfunction or get damaged. This contributes to a decrease in the volume of waste sent to landfills or incineration facilities, thus aiding in waste reduction and enhancing waste management practices, so well-being is achieved.

	contributing to sustainability.				
Seminars for engineers, builders, craftsmen for sustainable buildings	Training engineers, craftsmen, builders etc. about sustainable buildings is crucial, as it helps reduce GHG emissions and improve the quality of life. These can be achieved by making wiser choices of practices, more environmentally friendly, with lower GHG emissions and impacts, and materials, sustainable and more environmentally friendly. There are various seminars and training programs aimed at engineers, builders and craftsmen who wish to specialise in the	Interest and awareness of citizens, Social and cultural factors, Citizens with different background, Youth Movements, Corporate Social Responsibility	Municipality, Department of Environmental Engineering of Patra, University of Western Macedonia, Technical Chamber of Greece of Trikala	Participants could be involved in activities such as designing sustainable building elements or upgrading existing structures. Presenting successful sustainable building projects and their results can inspire participants and provide practical insights into challenges and solutions. With guest experts in the field of sustainable construction, the experience and knowledge they can offer can inspire participants.	By introducing the basic principles of sustainability in construction, such as energy efficiency, the use of renewable energy sources and the minimisation of GHG emissions, and information on the latest innovative technologies and practices in the field of sustainable buildings, and by learning techniques to improve the energy efficiency of existing buildings through renovation and upgrading, participants adopt new practices and the buildings they build are more sustainable

	environmental sustainability of buildings.				and therefore less GHG emitting. As a result, prosperity is achieved, green jobs are created and energy and economic savings are made.
Workshop for good practices regarding climate neutrality	The creation of a good practice workshop for citizens in the context of climate neutrality is an excellent initiative to inform and encourage the population to contribute to the reduction of GHG emissions and to adopt sustainable practices. The workshop provides information and educates the public on issues related to climate change, energy efficiency, sustainable transport, sustainable living and other aspects related to climate neutrality.	Interest and awareness of citizens, Social and cultural factors, Citizens with different background, Youth Movements, Corporate Social Responsibility	Municipality, Department of Environmental Engineering of Patra, University of Western Macedonia, ICCS, NGOs, Technical Chamber of Greece, PADYTH SA	Participants in these workshops can learn how to reduce their ecological footprint, take steps to save energy, adopt sustainable habits and contribute to the effort to reduce the negative effects of climate change.	Also, creation of these workshops provides an opportunity for citizens to learn new skills related to repair and maintenance. This can empower individuals with valuable knowledge and abilities, potentially leading to new green job opportunities or hobbies.

Research and Investment incentives for micro-generation practices	Micro-generation, or on-site renewable energy generation in the buildings sector should be promoted alongside renewable generation. In a climate neutral cite, networked micro-generation might even be sufficient to cover all local electricity and heat demand, given that the final energy product is reduced through end-use efficiency.	Financial scarcity, Technological limitations, Fossil fuel lobbying, Interconnection of the HEDNO network with RES installations, Climate Policy Advancements, Renewable Energy Transition, Green Finance & Investment	Municipality - ESCO and Trikala Climate Team, Technical Chamber of Greece of Trikala, Universities, Companies, Research institutions	More efficient, reliable and cost-effective solutions for producing energy on a smaller scale are being created. Investment incentives can help reduce the upfront costs associated with setting up microgeneration systems, making the technologies more accessible to a wider range of individuals and businesses. Also, more individuals and businesses invest and adopt microgeneration technologies and new jobs are created in the renewable energy sector. The adoption of cleaner and more sustainable energy	Investments in microgeneration practices based on renewable energy contribute to the reduction of GHG emissions and enhance the sustainability of the energy system. Innovation in microgeneration technologies is fostered and new green jobs are created and the social economy is improved through the adoption of microgeneration practices. Increasing the use of RES helps to reduce pollution and the environmental impact of conventional

				sources is being promoted, helping to preserve the environment and reduce GHG emissions. Finally, incentives for microgeneration can improve access to energy in remote or underserved areas.	energy production methods.
Seminars for fiber optic cables installers	Training engineers with certified seminars on fiber optic cables installations will help towards the transition to the digital era and improve the quality of life.	Technological limitations, Interest and awareness of citizens, Citizens with different background, Youth Movements, Corporate Social Responsibility	Municipality, Universities, Utility companies	The participants can then be certified and evolve their careers by including fiber optic cables installations in their skills	The participants can then facilitate the penetration of fiber optic cables installations and green jobs are created and energy and economic savings are made.
Seminars for electric vehicles automotive engineers and EV charging points installers	Training automotive engineers and electrical engineers, with electric vehicles maintenance and charging points certified seminars, as they help reduce GHG emissions and improve life quality	Technological limitations, Interest and awareness of citizens, Citizens with different background, Corporate Social Responsibility	Municipality - ESCO and Trikala Climate Team, University of Western Macedonia, Utilities companies, ICCS	The participants can then be certified and evolve their careers by including EV and charging points maintenance and construction	The participants can then facilitate the penetration of EVs in the city fleet and green jobs are created and energy and economic savings are made.

Seminar Series: Empowering Municipal Officers for Climate Neutrality	Provide municipal officers with essential knowledge and skills to effectively contribute to the city's journey towards climate neutrality in the domains of interventions as stated in Climate Neutrality Portfolio and also in green procurement and awareness raising	Interest and awareness of municipal officers, Social and cultural factors, lack of interest for climate action, lack of staff available, bureaucratic procedures/ Capacity building of municipal staff, empower for climate action	Municipality, Climate Transition Team, Ministry of Environment, e-Trikala, Universities	Deeper understanding of climate-related issues, policies, and best practices relevant to their roles. Practical skills and tools to integrate climate considerations into their daily decision-making processes. Strengthened Capacity for Climate Action and better coordination. Accelerated Progress Towards Climate Goals	Identification of new economic opportunities for the municipality, public health improvement, address social equity concerns by integrating inclusive policies and programs for vulnerable groups.
Awareness raising for energy poverty through Trikala's controlled parking system	"Park & Volt-aro", is the first controlled parking system in Greece with direct return of revenues to vulnerable households. Through the dedicated parking application, users can conveniently pay for parking services while simultaneously contributing to the community, as 50% of the parking fee is earmarked to support vulnerable households living below the energy poverty threshold.	Socio-cultural norms or stigmas surrounding energy poverty may deter individuals from seeking assistance. Lack of awareness about available resources, energy-saving practices, or financial assistance programs / Community involvement and participation in tackling energy poverty, Advocacy for policy changes and regulatory measures that support vulnerable households	Municipality, Climate Transition Team, Trikala Urban Development Company, e-Trikala, Social Welfare Municipal Dpt., Municipal Youth Council	Educating local community about the causes and consequences of energy poverty, as well as potential solutions. By raising awareness and providing information about energy-saving practices, households can make informed decisions to reduce their energy consumption and expenses. Leverage technology and innovation to develop new tools, platforms, or solutions that address	Strengthening of social bonds and cohesion, leading to a more inclusive and supportive community environment. Empower individuals and households to take proactive steps to reduce energy costs and improve energy efficiency. Raising awareness about energy poverty can lead to improved health outcomes by highlighting the link between inadequate energy access and

		energy poverty more effectively.	health risks, such as cold-related illnesses, indoor air pollution, and mental health issues.

Up-skilling and re-skilling seminars for sensitive groups	The city aims to undertake a commendable initiative to empower and equip sensitive groups through targeted up-skilling and re-skilling seminars. Recognizing the critical role of education and expertise in the transition to a sustainable future, these seminars are tailored to meet the unique needs of vulnerable populations, including individuals from marginalized communities, the economically disadvantaged, and other sensitive groups.	Interest and awareness of citizens, Citizens with different background, Corporate Social Responsibility, Youth movements	Municipality, Universities, ICCS, Technical Chamber of Trikala, Business Associations, Companies, Youth Municipal Council, Municipal Equality Committee	These specialized training sessions will not only focus on enhancing the participants' skill sets in alignment with green technologies and eco-friendly practices but also serve as a catalyst for social and economic empowerment. By imparting knowledge related to sustainable practices, renewable energy, and climate-conscious industries, these seminars will contribute to fostering a more inclusive and resilient community. Through up-skilling and re-skilling initiatives, the city will foster a sense of environmental stewardship while	By prioritizing the education and empowerment of vulnerable populations, these initiatives generate a ripple effect of positive outcomes. Firstly, they contribute to the creation of a skilled and adaptable workforce, enhancing employability within emerging green sectors. Simultaneously, these seminars foster community resilience by equipping individuals with the knowledge to adapt to the changing climate and promote sustainable living practices. Moreover, the social inclusivity embedded in these

				simultaneously addressing social equity concerns, ultimately paving the way for a more sustainable and equitable future for all residents.	programs not only narrows economic disparities but also strengthens social cohesion, fostering a sense of collective responsibility towards climate action. Overall, the co-benefits extend into economic empowerment, community resilience, and enhanced social cohesion, illustrating the profound impact that targeted up-skilling and re-skilling efforts can have on both individual lives and the broader community.
Carbon-less	Trikala aims to create an interesting workshop series named “Carbon-less” for citizens and households to delve into the vision of sustainable living. Through the	Interest and awareness of citizens, Social and Cultural Factors, Citizens with different background, Youth Movements	Trikala Climate Team, Municipality, Citizens, Schools, Youth Municipal Council, Universities	Through these workshops, Trikala city will witness a transformative shift towards sustainability and reduced carbon emissions. By engaging households and stakeholders in	Actions to reduce individual carbon footprints are connected to well-being and health, promoting an active lifestyle. This project can also lead to better air quality and

	workshops, stakeholders can understand and implement changes in their lifestyles, significantly reducing their carbon footprint. Throughout the workshop series, we'll calculate individual carbon footprints at the start of the project and monitor progress over time.		the exploration of Carbon-less, participants will gain invaluable insights into the specific changes needed to lower their carbon footprint. As individuals adopt these sustainable practices, they will collectively contribute to a significant reduction in the city's overall carbon emissions. Moreover, by monitoring progress over time, these workshops will enable ongoing accountability and inspire continuous improvement in sustainable living practices. Ultimately, this collective effort will not only mitigate climate impact but also foster a culture of environmental stewardship.	reduced traffic, due to the behavioural shift of citizens. All social innovations promote participation and inclusivity in the city's effort.

City farmers	The creation of green roofs and walls are an important action of CCC. In this context the city will support the creation of citizen teams for urban farming, and more specifically in rooftops. These projects leverage underutilized rooftop spaces to cultivate a variety of crops, promoting local food production and reducing reliance on imports. By harnessing the power of vertical farming techniques, Trikala aims to maximize the efficiency of land use while minimizing environmental impact.	Interest and awareness of citizens, Social and Cultural Factors, Citizens with different background, Youth Movements	Trikala Climate Team, Municipality, Citizens, Schools, Universities	Beyond just providing fresh produce, rooftop farming fosters community engagement and education about sustainable food systems. Through workshops, residents learn about urban farming practices, composting, and the importance of biodiversity. These initiatives not only enhance food security and resilience but also contribute to the city's green infrastructure, mitigating urban heat island effects and improving air quality.	This project promotes well-being, health and active lifestyles. Green urban spaces can lead to financial savings and air quality, as they reduce heat island effect. More green spaces in cities provide biodiversity support. Important co-benefits are also participation and inclusivity, capacity building and resilience

Play for Climate	Trikala along with its stakeholders will develop a ~~a~~ series of serious games to educate and raise awareness about climate change and carbon footprints. These games will vary from quizzes to collaborative board games and there will be editions for different age groups. Each game will address a specific emissions sector in connection with urban carbon footprints. When it is possible, the games will be combined with participatory processes.	Interest and awareness of citizens, Social and Cultural Factors, Citizens with different background, Youth Movements	Trikala Climate Team, Municipality, Citizens, Schools, Universities, Technology Stakeholders	By developing a series of serious games tailored to educate and raise awareness about climate change and carbon footprints, Trikala and its stakeholders are initiating a transformative approach to environmental education and action. These games, ranging from quizzes to collaborative board games and designed for various age groups, will serve as powerful tools for engaging the community in understanding the complexities of urban carbon footprints and emissions sectors. By incorporating participatory	This innovation promotes equity, justice, participation and inclusivity as it is open for everyone interested and is connected to participatory processes. It promotes capacity building and community empowerment.

				processes whenever feasible, these games will foster a sense of ownership and collective responsibility among participants, driving them to implement tangible solutions in their daily lives. Through increased awareness and education facilitated by these innovative gaming experiences, Trikala will empower its residents to make informed choices, adopt sustainable practices, and collectively contribute to significant reductions in carbon emissions, thus fostering a more resilient and climate-conscious city.	
Social Green Kitchen	This project aims to raise awareness about food waste and sustainable food systems, while at the same time support	Interest and awareness of citizens, Social and Cultural Factors, Citizens with	Trikala Climate Team, Municipality, Citizens, Schools, Local Businesses -	By focusing on raising awareness about food waste and promoting sustainable food systems, this project	This project results in capacity building, participation and inclusivity, community empowerment and resilience.

sensitive social groups. The project includes cooking workshops, discussion sessions and co-designing. The participants will learn how to upcycle their food waste with new recipes or other ways in order to minimise their production. The project will collaborate with social structures in order to donate the food that is cooked during the workshops. Participants will also be encouraged to donate any food that was going to waste.	different background, Youth Movements	Restaurants, Social structures	addresses a critical aspect of climate impact. Through cooking workshops and discussion sessions, participants will learn to upcycle food waste, minimizing its production and reducing methane emissions from landfills. Collaborating with social structures to donate excess food from workshops not only supports sensitive social groups but also reduces food waste and associated carbon emissions. Encouraging participants to donate surplus food further mitigates environmental impact by diverting it from landfills.

The establishment of repairing workshops for citizens signifies a transformative shift towards a more sustainable and circular economy. By equipping individuals with the skills to repair and repurpose, this initiative not only promotes resource conservation but also cultivates a sense of self-sufficiency among community members. These workshops not only contribute to waste reduction but also foster a culture of responsible consumption, encouraging citizens to actively engage in prolonging the lifespan of products.

Seminars tailored for engineers, builders, and craftsmen focusing on sustainable buildings play a pivotal role in advancing green construction practices. By imparting knowledge on eco-friendly materials, energy-efficient designs, and sustainable construction methodologies, these sessions empower professionals to integrate climate-conscious principles into their projects. The resulting shift towards sustainable buildings not only reduces environmental impact but also enhances the overall resilience of urban infrastructure in the face of climate change.

Workshops dedicated to climate neutrality practices provide a collaborative platform for diverse stakeholders, fostering knowledge exchange and collective action. This shared space allows for the development of innovative solutions, strategies, and best practices to accelerate the city's journey towards climate neutrality. By encouraging collaboration and cross-sectoral engagement, these workshops become hubs for driving systemic change and fostering a community-driven approach to addressing climate challenges.

Introducing social innovation projects, like “Park & Volt-aro”, to create awareness about energy poverty and other social phenomena related to climate change is crucial for fostering inclusive and sustainable communities. These projects serve as vehicles for raising awareness among individuals and the community about the interconnectedness of environmental, social, and economic factors shaping their well-being. Furthermore, social innovation projects encourage community participation and engagement, promoting collective action and solidarity in addressing pressing societal challenges. By amplifying marginalized voices, advocating for equitable solutions, and fostering collaboration between diverse stakeholders, these projects pave the way for transformative change that prioritizes social justice and environmental sustainability.

Research and investment incentives for micro-generation practices propel the adoption of decentralized and renewable energy solutions. This not only diversifies the energy mix but also empowers citizens to become active contributors to the city's energy landscape. Incentivizing micro-generation practices ensures that individuals are not only consumers but also producers of clean energy, creating a more resilient and distributed energy infrastructure.

Seminars for fiber optic cable installers and EV vehicles and charging points respond to the burgeoning demand for advanced technologies that support sustainable urban development. These sessions not only enhance the technical expertise of professionals in these domains but also contribute to the seamless integration of smart city solutions. By promoting the deployment of fiber optics for efficient communication and electric vehicles for sustainable mobility, these initiatives align with the broader goal of building a technologically advanced and environmentally conscious urban environment.

Lastly, up-skilling and re-skilling sessions for sensitive groups go beyond addressing environmental concerns; they serve as instruments of social empowerment. By providing tailored education and training, these sessions ensure that vulnerable populations gain access to opportunities in emerging green sectors. This not only bridges socio-economic gaps but also fosters inclusivity and resilience within the community.

Beyond merely breaking down traditional entry barriers, these innovations play a transformative role in fostering social equity. Repairing workshops and sustainable building seminars, by providing accessible education and skill development, empower citizens from marginalized groups to actively participate in the burgeoning green economy. Not only do these initiatives open doors to meaningful employment opportunities, but they also contribute to a more inclusive workforce, where diverse perspectives and talents are valued. The emphasis on up-skilling and re-skilling for sensitive groups ensures that individuals facing socio-economic challenges gain the necessary expertise to contribute actively to the workforce, thereby enhancing their economic independence and overall well-being.

The incentives for micro-generation practices and EV infrastructure go beyond mere accessibility, actively democratizing the adoption of sustainable technologies. By offering tangible benefits for engaging in eco-friendly practices, such as generating clean energy or using electric vehicles, these innovations make environmentally conscious choices financially feasible for a broader audience. This deliberate effort to make green technologies economically accessible lowers financial barriers for marginalized groups, allowing them to participate in the city's sustainable transformation actively.

To secure long-term impact and scalability, the city will establish a robust framework for monitoring and evaluating the effectiveness of these initiatives. Regular assessments, informed by feedback from participants, will facilitate continuous improvement and optimization of program outcomes. Collaborative partnerships with local organizations and institutions will extend the reach of these programs, ensuring that they are tailored to the specific needs of the community. A sustained commitment to funding and resources is paramount for the longevity of these initiatives, as it guarantees their continued operation and evolution over time. Additionally, community engagement and awareness campaigns will play a pivotal role in embedding a culture of sustainability within the city's fabric, ensuring that the knowledge and practices disseminated through these innovations become enduring components of the community's ethos, thereby fostering lasting impact and scalability.

5. Outlook and next steps

Following the submission of the Climate City Contract, the primary goal of the Municipality is to create a dedicated task force, Trikala Climate Team, within the Municipal Authority to oversee the development of the Action Plan, create capacity building opportunities, oversee stakeholders' participation and closely monitor the city's progress, conduct reporting and evaluation refine strategies and improve implementation.

As a next step, Trikala endeavors to establish a Climate Neutrality Hub outlined in part C, which will serve as the overseeing mechanism for all climate neutrality actions. The city is actively seeking funding to establish the hub and therefore will apply for funding through the Call for Pilot Cities Cohort 3 (2024).

Focal point for the implementation of the Action Plan is the establishment of the One-stop Shop for energy renovations. With the guidance from the Trikala Climate Team the implementation process will go one step further as there will be dedicated task force to actively seek for funding and innovative procurement schemes to accelerate energy renovations of private buildings as this sector is among the most significant source of GHG in the city.

Moreover, over the next three years, the city plans to execute all smart city initiatives defined at the Restart Mai City program, aiming to build a comprehensive and dependable database for monitoring progress toward climate neutrality, as well. The implementation of Restart mAI city initiatives will enable the establishment of a robust monitoring and evaluation system to track the advancement of climate actions, ensuring accountability and transparency. Utilizing smart technologies for CCC's progress monitoring becomes a valuable tool supporting the plan's revision.

The Action Plan is designed to be a recurring document, allowing for updates and revisions as needed until 2030. Monitoring and progress reports play a crucial role in supporting the implementation of the Action Plan, guided by data-driven insights, allowing Trikala to enhance strategies and reallocate resources for maximum impact. Trikala is committed to a dynamic and iterative CCC process every two years, ensuring that climate action plans remain adaptable and responsive to evolving challenges, new situations, and opportunities. Iterations of the Climate City Contract involve extensive consultations with stakeholders, citizens, and experts to incorporate updated data, technological advancements, and lessons learned from previous implementation phases. The monitoring indicators outlined in the Action and Investment Plan will undergo regular assessments, and progress reports will be made accessible to the public. This approach promotes a sense of shared responsibility and community engagement.

Concurrently, Trikala will emphasize in community awareness, seeking to empower and actively involve citizens and stakeholders in the strategic planning process. This objective will be facilitated by the introduction of citizen and stakeholder fora and participatory platforms and incentive programs.

Moreover, Trikala will focus on fortifying its economic strategies and attracting investors to materialize the vision of climate neutrality. Launching smaller-scale initiatives and pilot programs will allow the city to monitor their effectiveness and gradually expand their implementation citywide. Pilot programs serve as cost-effective tools for action, acting as educational instruments for citizens and attracting potential investors.

Lastly, through Climanet, in collaboration with the other Greek Mission cities and Limassol, Trikala will closely collaborate with the central government to establish institutional and investment frameworks conducive to achieving their shared goals.

6. Annexes

6.1. Annex 1 - Stakeholder engagement

6.1.1. Preliminary participatory design

Since the launch of the Mission in Trikala in September 2021, the Municipality of Trikala has actively engaged in public consultations, involving stakeholders across various domains to define the initial intervention areas and develop the action portfolio to support the city's candidacy for the Mission. Initially, targeted outreach efforts focused on engaging high school students, who collectively contributed proposals that were subsequently organized and included in the dossier. Furthermore, dedicated workshops were conducted with stakeholders from the Stationary Energy, Mobility, and Circular Economy sectors, allowing them to provide expertise and select sector-specific interventions. Additionally, a dedicated consultation website was established, enabling citizens to submit proposals for inclusion in the candidacy dossier.

6.1.1.1. Participatory Labs with experts

Participatory workshops were conducted successfully with experts from the main sectors responsible for GHG emissions in the city. The goal was to collaboratively agree on potential measures and interventions. This inclusive and informed approach involving experts from key areas demonstrates a comprehensive effort to address and mitigate GHG emissions in the city.

Workshop to launch the Mission for 100 Climate Neutral and Smart Cities by 2030

During the European Mobility Week 2021, the Municipality of Trikala showcased its candidacy to join the Mission for 100 Climate Neutral and Smart Cities, with Maria Vassilakou, Mission Board member, underlining the criticality of local-level action. A workshop convened with stakeholders representing energy, mobility, waste management, and urban development sectors, who provided valuable insights and recommendations for interventions in their respective domains. This collaborative session also highlighted the challenges, barriers, and opportunities in Trikala's journey towards climate neutrality.

Workshop for Energy Transition

The Municipality of Trikala conducted a comprehensive training, information, and seminar series as part of its climate neutrality initiatives, focusing on the city's energy transition. In collaboration with the Technical University of Athens and the Hellenic Institute of Passive Buildings, a series of seminars were organized during a five-day event on Near Zero Energy Buildings (nZEB). These seminars, held within the framework of the nZEB Roadshow and VilaWatt project in which the Municipality participated, targeted engineers and professionals specializing in various aspects including passive building construction, thermal insulation, window framing, airtightness, thermal bridges, mechanical ventilation, and heat pumps. Additionally, a dedicated session was conducted to present Trikala's Energy Transition strategy, engaging stakeholders in a co-design process to gather valuable insights and feedback.

6.1.1.2. Participatory Labs at schools

The campaign and the overall effort of the Municipality started in the summer of 2021, with a series of initiatives (targeting, planning, publicity, study, consultation). One of the important initiatives, is the participation of the community in the co-creation of proposals to be included in the portfolio. In particular the students, who will in fact experience the consequences of climate change for many years to come. Thus, the Municipality of Trikala addressed students of the 2nd and 3rd grade of Trikala high schools.

Trikala is the first city that conducted workshops for climate neutrality at schools to engage students in co-designing climate mitigation measures at citizens of the future. Lessons learnt will be taken into consideration also in the preparation of future initiatives to climate change mitigation. Total number of participants was more than 1200 students.

The workshop included, in addition to the information on the objectives of the Municipality's initiative, the specification of the objectives and actions for the Municipality, information on existing and previous initiatives and actions and - most importantly - cooperation and the formulation of proposals, based on the objectives for a Climate Neutral City.

After the grouping of these proposals, they were then processed, so that the most important ones could be included in the application file that was finally submitted to the EU by the Municipality of Trikala.

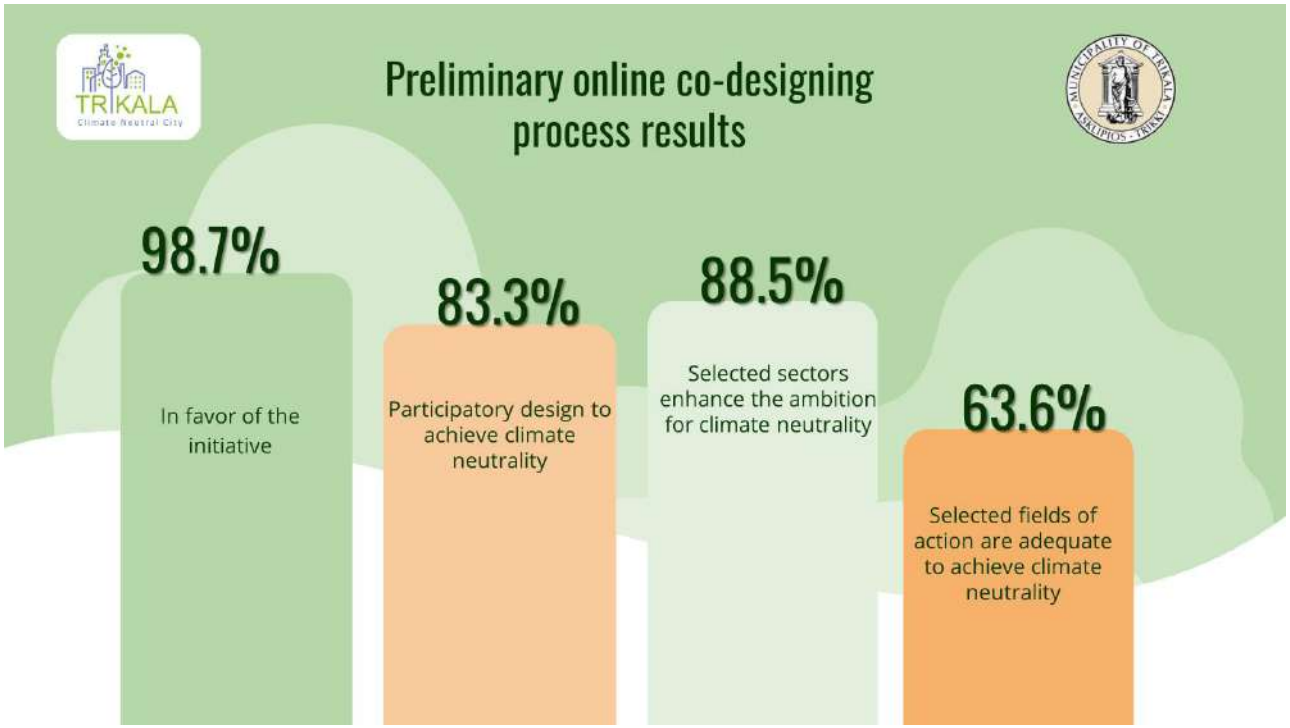
TRIKALA
Climate Neutral City

24
Workshops at schools

1200
Students reached

6.1.1.3. Preliminary online co-designing process

The inaugural public consultation, initially conducted online due to prevailing COVID-19 restrictions, took place via the Municipality of Trikala's website (www.trikalacity.gr). During this virtual co-designing phase, citizens exhibited remarkable enthusiasm, with an overwhelming 98.7% expressing support for the municipality's decision. This resounding endorsement underscores the community's strong backing for the initiative. Additionally, a substantial majority (64%) affirmed that the selected sectors and measures align with the desired trajectory, further emphasizing the widespread approval and collective endorsement of the chosen strategies and actions by the residents.



6.1.2. Climate City Contract Design Phase

6.1.2.1 Questionnaire for citizens

In the sphere of civic participation, a formal questionnaire was systematically administered, extending invitations to participants to respond to inquiries pertaining to Trikala's decision to engage in the distinguished European Mission for "100 Climate-Neutral and Smart Cities by 2030." Participants were earnestly requested to articulate their intricate association with the overarching objective of climate neutrality and provide insights into the tailored actions envisioned for the city of Trikala.

Furthermore, participants were tasked with a discerning evaluation of the nuanced significance ascribed to actions categorized by sector. This discernment aimed to distill a granular understanding of the perceived impact and relevance of each sector-specific initiative. Simultaneously, participants were prompted to appraise the environmental footprint affiliated with each sector, thereby gauging the level of pollution imputed to these vital domains. This meticulous approach toward soliciting opinions yielded a substantive dataset, encompassing the perspectives of a commendable cohort of 120 engaged citizens.

The majority of respondents to the survey were primarily individuals aged between 40 and 60 and 25 to 40. There was also a percentage represented by individuals over 60, while much fewer responses came from age groups under 25, and only one person belonged to the age group 0 to 18. Specifically, 43,3% of the participants were between 40 and 60, 38,6% between 25 and 40, followed by those over 60 with 10% and 18 to 25 with 7,5%. Finally, only one response was from a person aged up to 18 years (0,8%).

Of the responses, 52,5% came from men, while 47,5% came from women. 47,5% have completed tertiary education, while 37,5% of participants hold a postgraduate degree. 10% have completed secondary education, and 4,2% hold a doctoral degree. Less than 1% of participants have been educated in a Public Vocational Training Institute.

In terms of participants' employment status, it appears that a majority of them are engaged in various professional sectors. Specifically, 28,3% are employed in the public sector, 27,5% are private employees, and 20,8% are self-employed. Additionally, 9,2% reported being unemployed, and 6,7% identified themselves as retired participants.

Notably, 95% of respondents affirm their understanding of GHG emissions. Among these, 50,8% acquired their knowledge from educational institutions such as schools or universities, 33,3% from the internet, and 6,7% from television. Other sources accounted for a minimal percentage, with only 2,5% referencing the Municipality of Trikala's campaign as their information source.

Encouragingly, 100% of participants assert their awareness of climate change, with the internet being the primary source for 41,2%, schools for 39,5%, and television for 11,8%. The majority of respondents (34,2%) consider themselves "moderately informed" about climate change, followed

by 33,3% who classify themselves as "well-informed." Additionally, 23,3% claim to be "very well informed" about climate change and greenhouse gas emissions, while 8,3% characterize themselves as "slightly informed."

79,7% of participants are familiar with the term "climate transition," and 77,5% are also acquainted with the concept of a "climate-neutral city."

A significant number of respondents consider that the most climate transition-related interventions concern the industrial processes and product use sector, followed by the waste sector and then the transport sector.

Concerning awareness of Trikala's decision to participate in the European Mission "100 Climate-Neutral and Smart Cities by 2030," 77,5% of participants acknowledged their awareness. Of this group, 37,5% gathered information from the internet, 32,5% referred to the Municipality's Campaign, while 9,2% relied on the media for information.

Furthermore, a majority of participants perceive the Industrial Processes and Product Use sector as more polluting, while the Agriculture, Forestry, and Other Land Use sector is seen as less polluting.

Surprisingly, 81,7% of participants indicated that they are not aware of any existing actions undertaken by the city of Trikala contributing to the reduction of greenhouse gas emissions.

Subsequently, participants who responded affirmatively to the preceding question are requested to specify the particular initiatives they are acquainted with.

The actions most widely recognized by participants include the construction of cycle paths and the promotion of bicycle usage, as well as the implementation of countdown timers at traffic lights within the city and the replacement of conventional street lighting with energy-efficient LED lamps. Furthermore, respondents also indicated awareness of initiatives such as the energy upgrading of municipal buildings, controlled parking measures, integration of photovoltaic systems, adoption of electric vehicles, and enhancements to pedestrian sidewalks.

Most participants considered that the most important actions proposed in the field of Static Energy are solar thermal power systems on buildings, developing smart buildings with energy-saving systems and implementation of innovative energy storage technologies for RES. Less important actions were considered the establishment of a municipal energy services company (ESCO), creation of a municipal climate team (Trikala Climate Team) and Virtual power plants (VPP).

A majority of participants deem the most crucial proposed actions in the realm of Mobility & Transport to be Green Public Transport, Behavioral shift to public transport, walking, and cycling (including infrastructure), along with the Improvement of logistics and urban freight transport. Subsequently, the prioritized actions include Electrification of trucks, Zero Emission Zones, Fleet management application for the municipal fleet and public transport, and Clean and efficient vehicles (electric). Conversely, actions such as Mobility as a Service (MaaS) and Enhancement of E-powered micromobility are perceived as less significant.

A majority of participants opine that the paramount actions proposed in the field of Waste & Circular Economy include the Promotion of using recycled and recyclable, renewable, and sustainable materials, the Separate collection and sustainable management of organic municipal waste, and the Construction of a Green Point and Construction of Recycling Corners. Conversely, actions such as Municipal waste prevention (10%), Green Public Procurement, and the implementation of Pay As You Throw (PAYT) utilizing technology and IoT are considered less significant.

A predominant view among participants is that the planting of 23,000 trees within the city and its outskirts stands out as one of the most crucial actions proposed in the realm of Green Infrastructure and Nature-based Solutions. Additionally, the other two suggested actions, namely Green walls & green roofs and Green pavements, are deemed equally significant in this domain.

A prevailing perspective among participants is that the paramount actions outlined in the Built Environment sector encompass the renovation of existing residential buildings into Nearly Zero Energy Buildings (NZEBs) and the energy renovation/retrofit of existing buildings. Concurrently, initiatives involving Citizen and Renewable Energy Communities, as well as the implementation of Integrated Energy Systems, are regarded as equally pivotal within this sector.

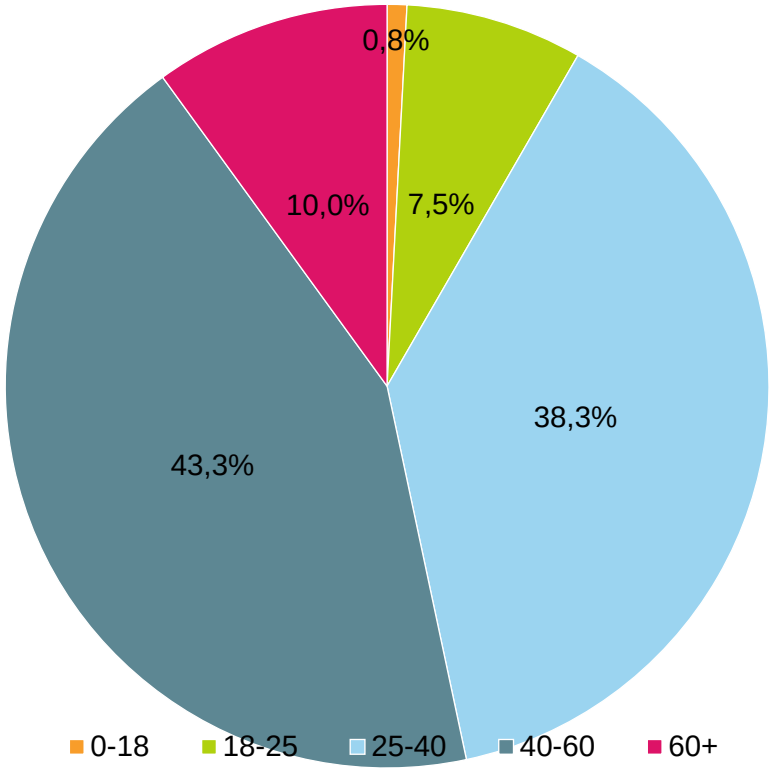
In response to the question "How would you assess the Climate Neutrality Action Plan 2030 overall? (1:Bad, 2:Very good)," participant feedback reveals that 33% selected 4, 32% opted for 3, and 30% chose 5. Consequently, a mere 5% of participants expressed dissatisfaction with the overall Action Plan.

Moreover, it is noteworthy that 30% of respondents conveyed their explicit interest in actively participating in the forthcoming activities, and an additional 26,7% demonstrated a substantial degree of enthusiasm. It is important to highlight that, in the aggregate, a mere 9,2% of the respondents exhibited a lack of interest in participation, emphasizing the overall positive inclination towards engagement.

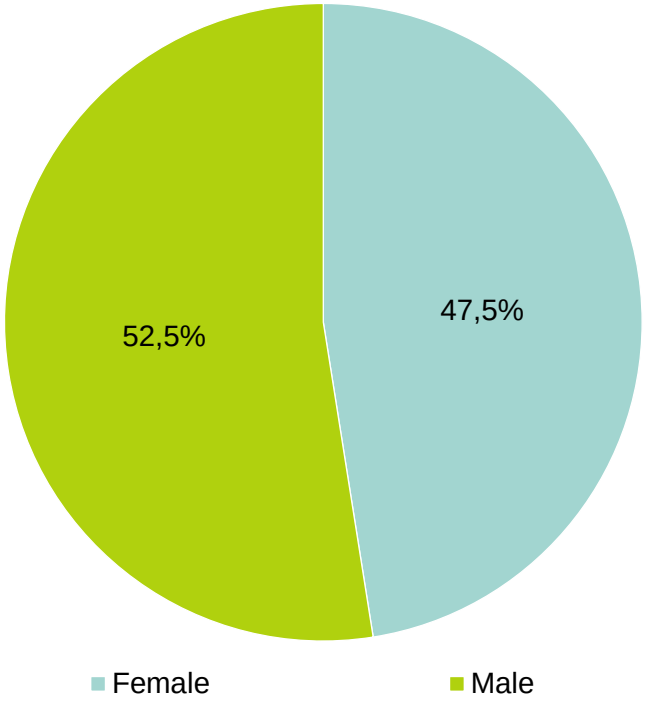
In conclusion, the predominant sentiments gleaned from participants in the questionnaire underscored notable concerns. Chief among these were reservations regarding the municipality's perceived capacity to effectively implement the proposed actions. Financial constraints emerged as a recurring theme, casting a shadow over the ambitious endeavors outlined in the Climate Neutrality Action Plan. Moreover, a prevalent dearth of knowledge and educational resources among the majority of citizens stood out as a prominent issue, reflecting the need for targeted awareness campaigns and educational initiatives to foster a more informed and engaged community, which has also been taken into account in the Action Plan.

The following schematic presentation encapsulates the comprehensive array of responses furnished by the participants.

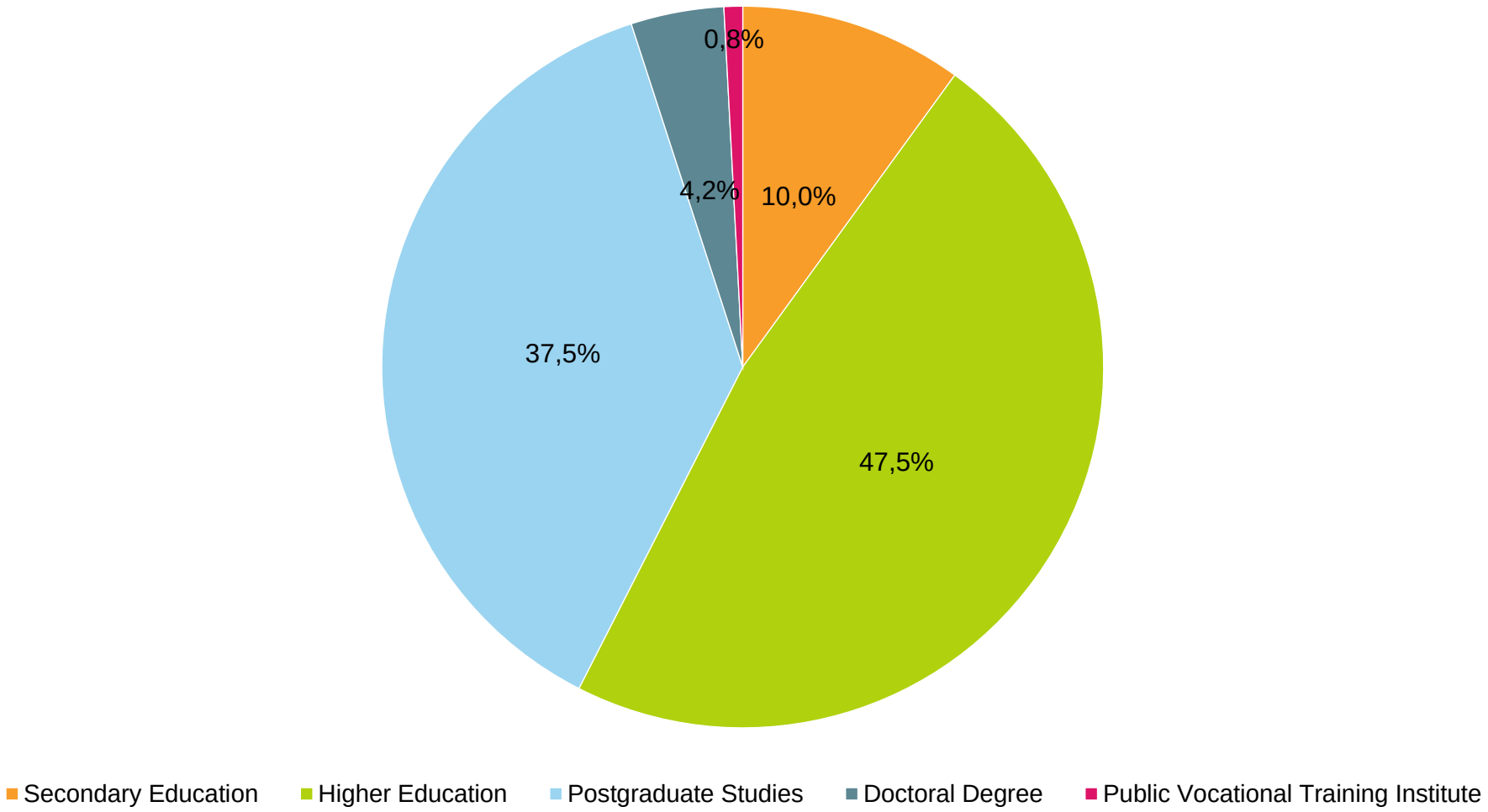
1. What is your age?



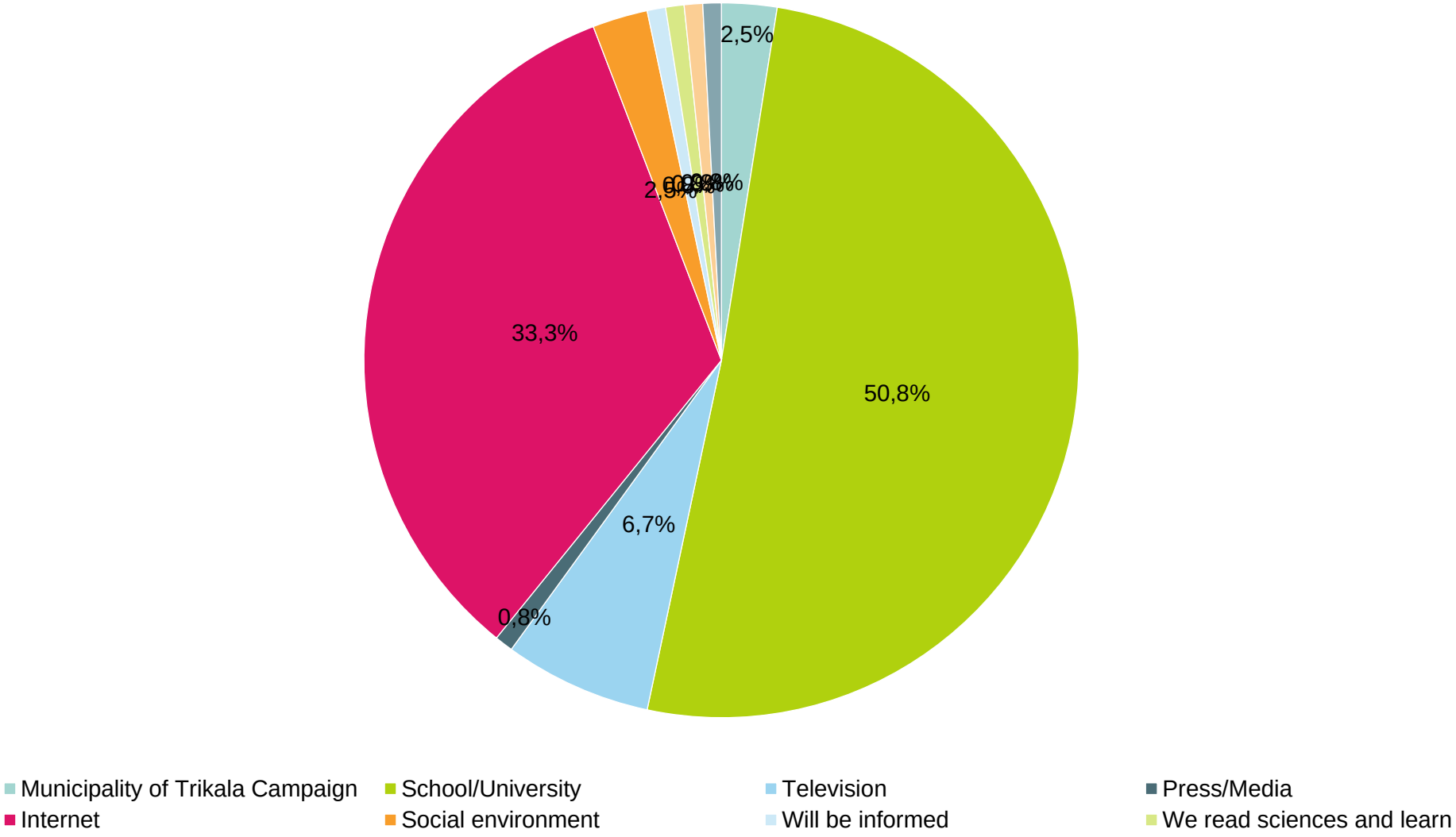
2. What is your gender?



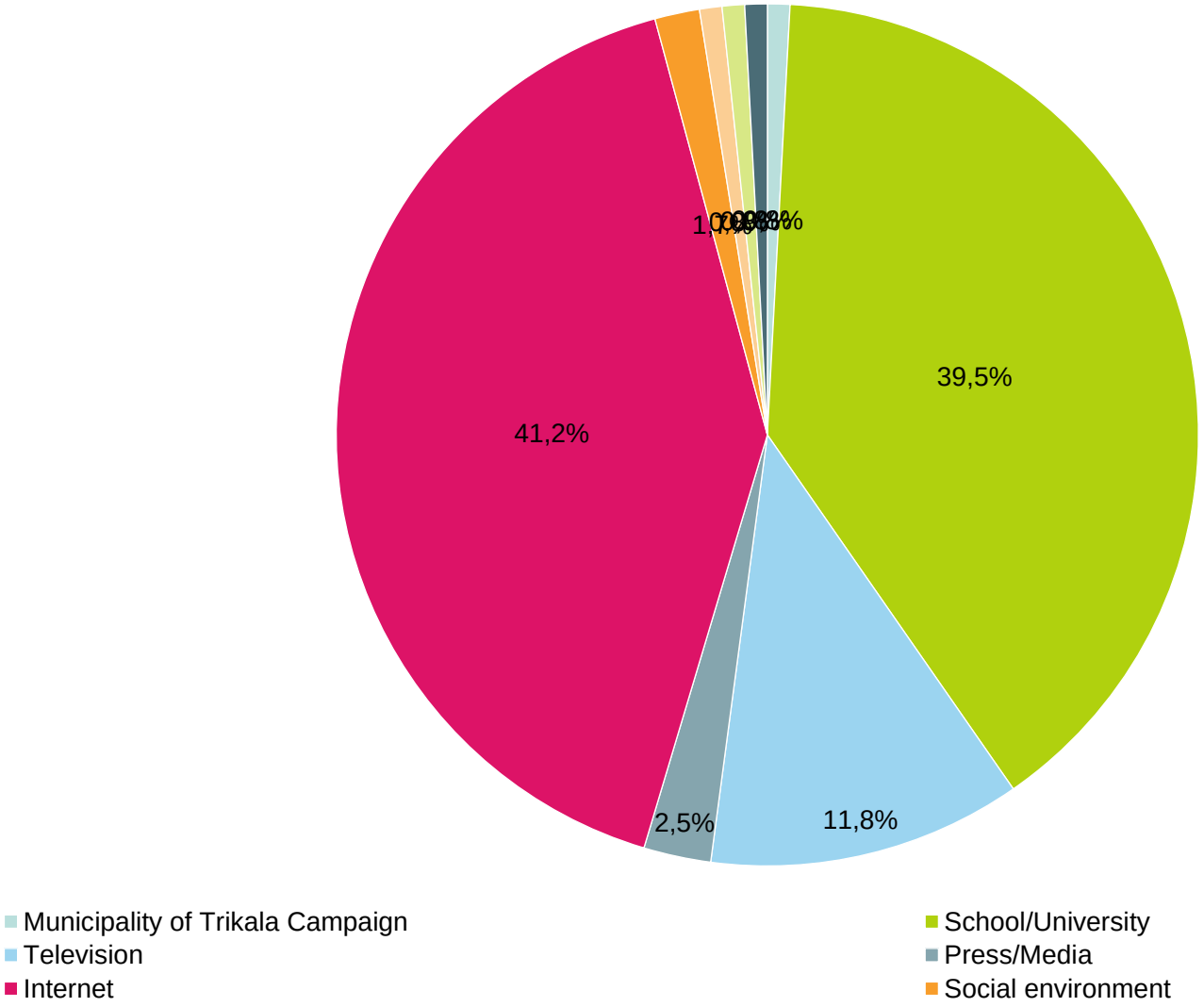
3. What is your educational level?



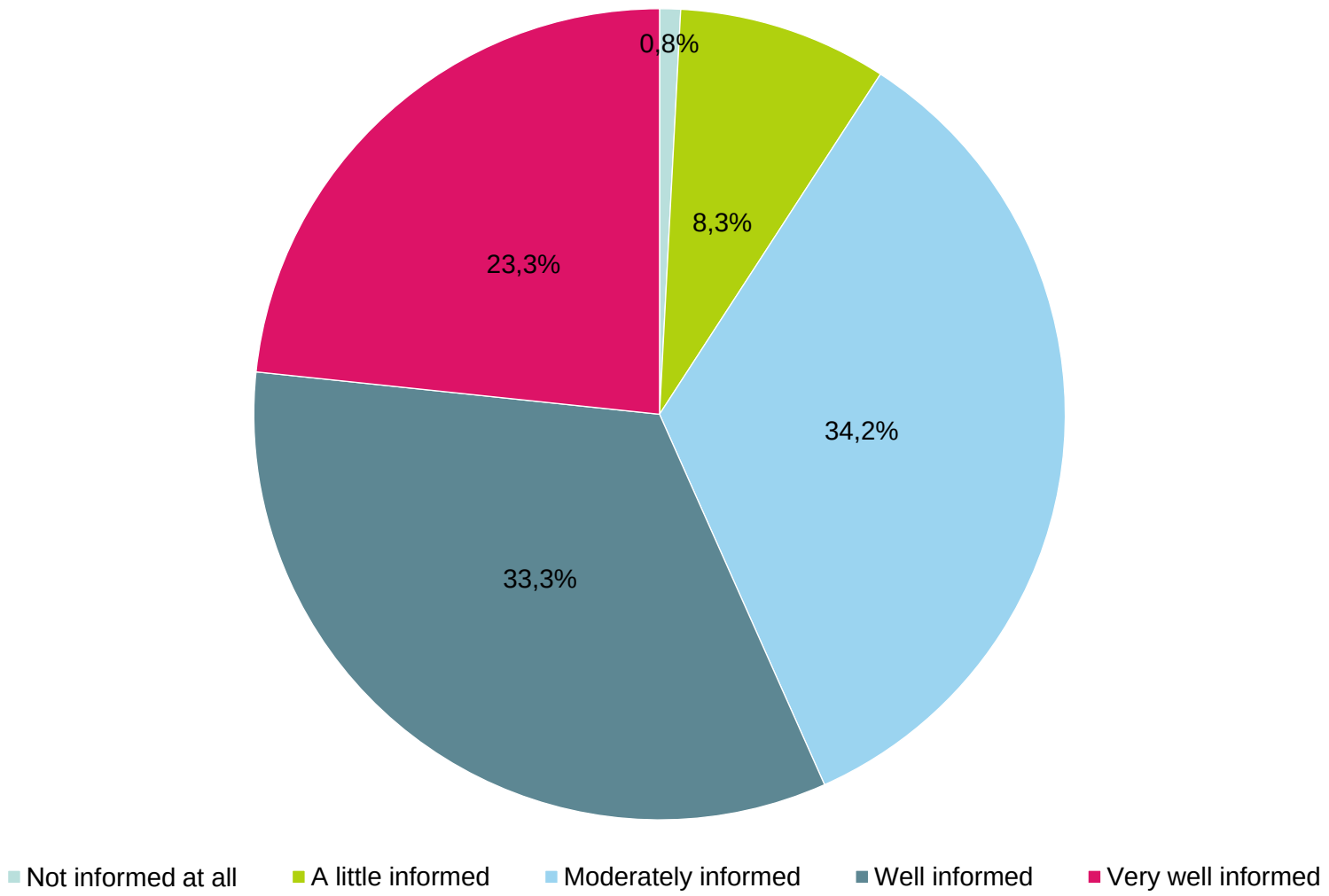
6. If yes, where did your information come from?



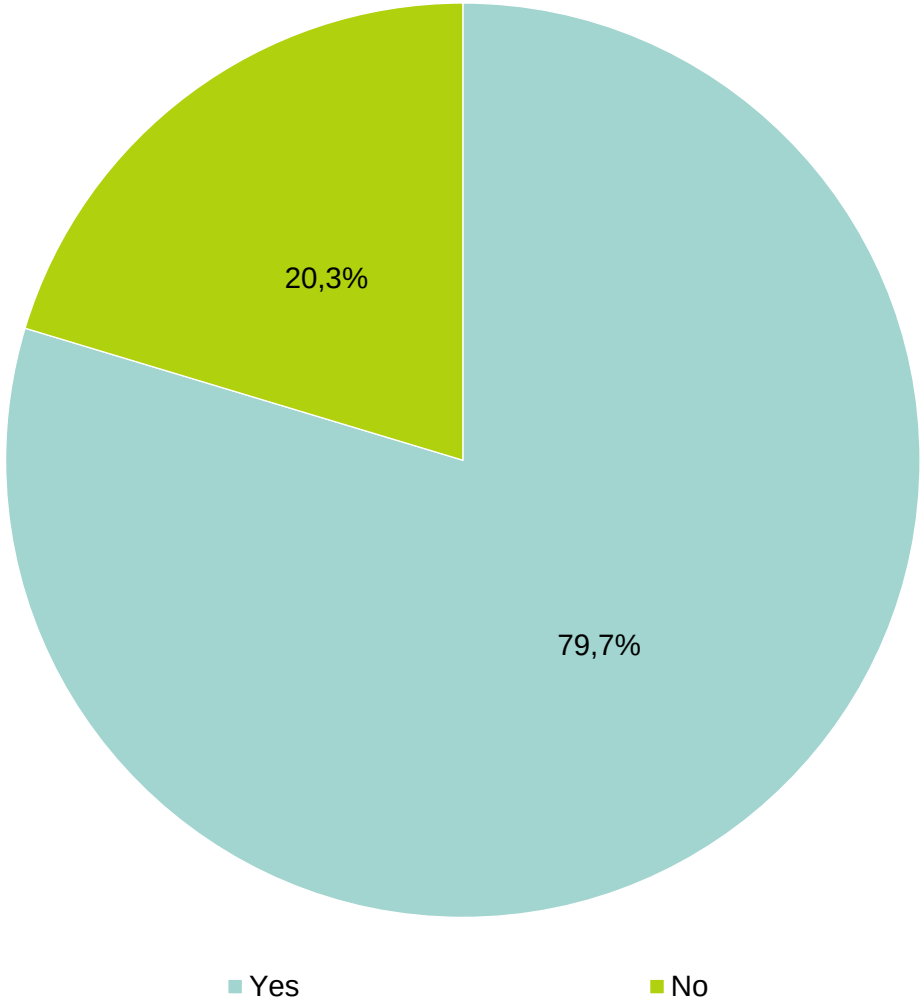
8. If yes, where did your information come from?



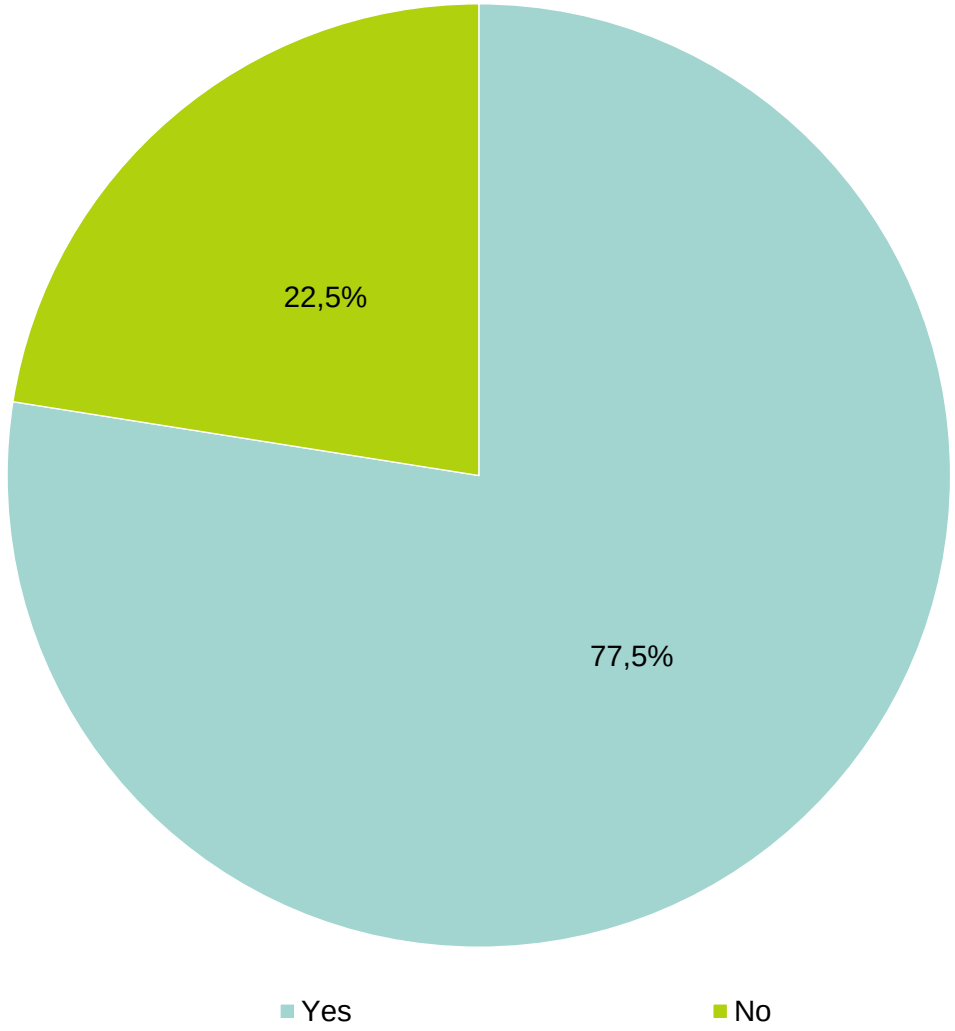
9. How well do you consider yourself informed about greenhouse gas emissions and climate change?



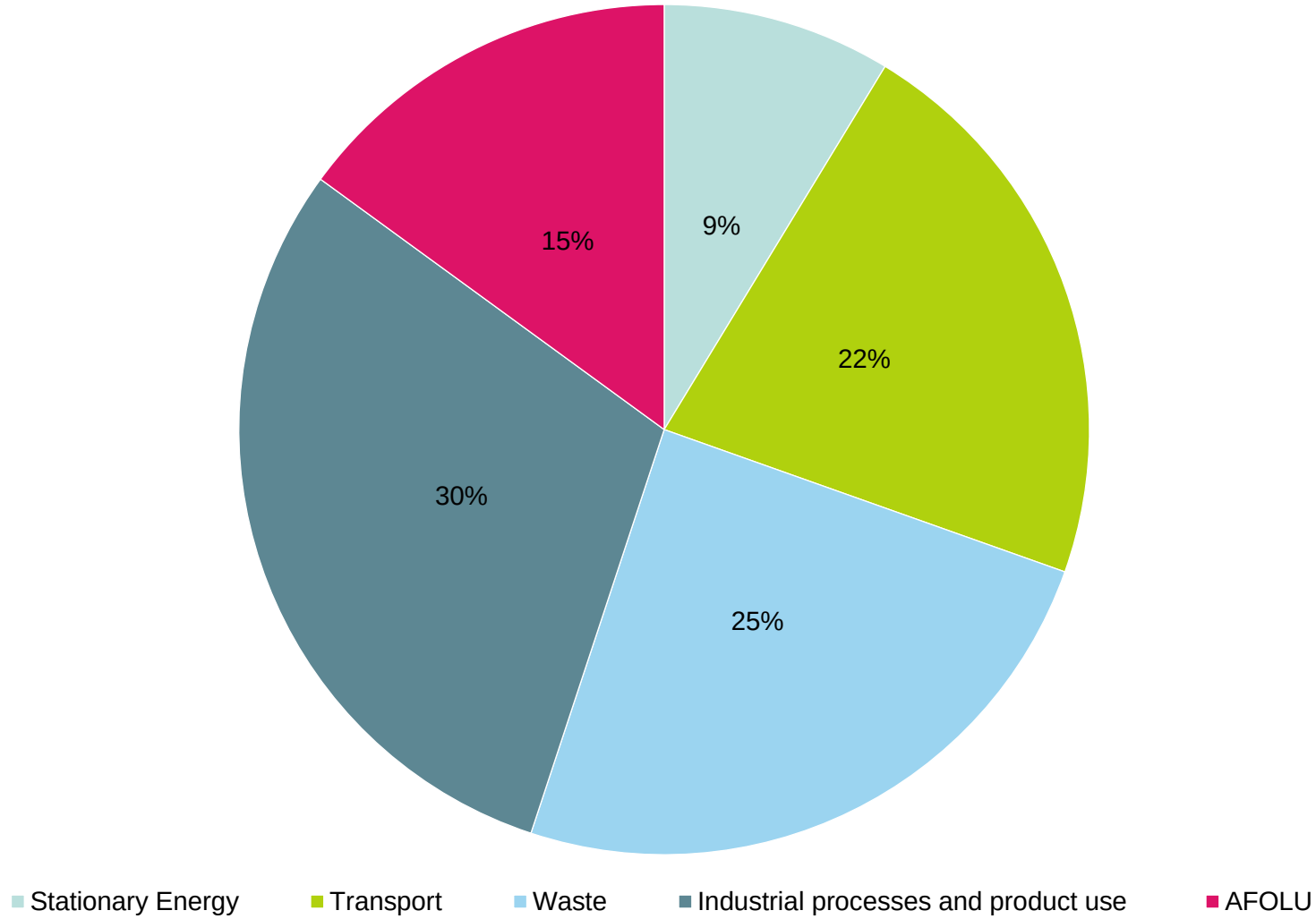
10. Do you know what the phrase "climate transition" means?



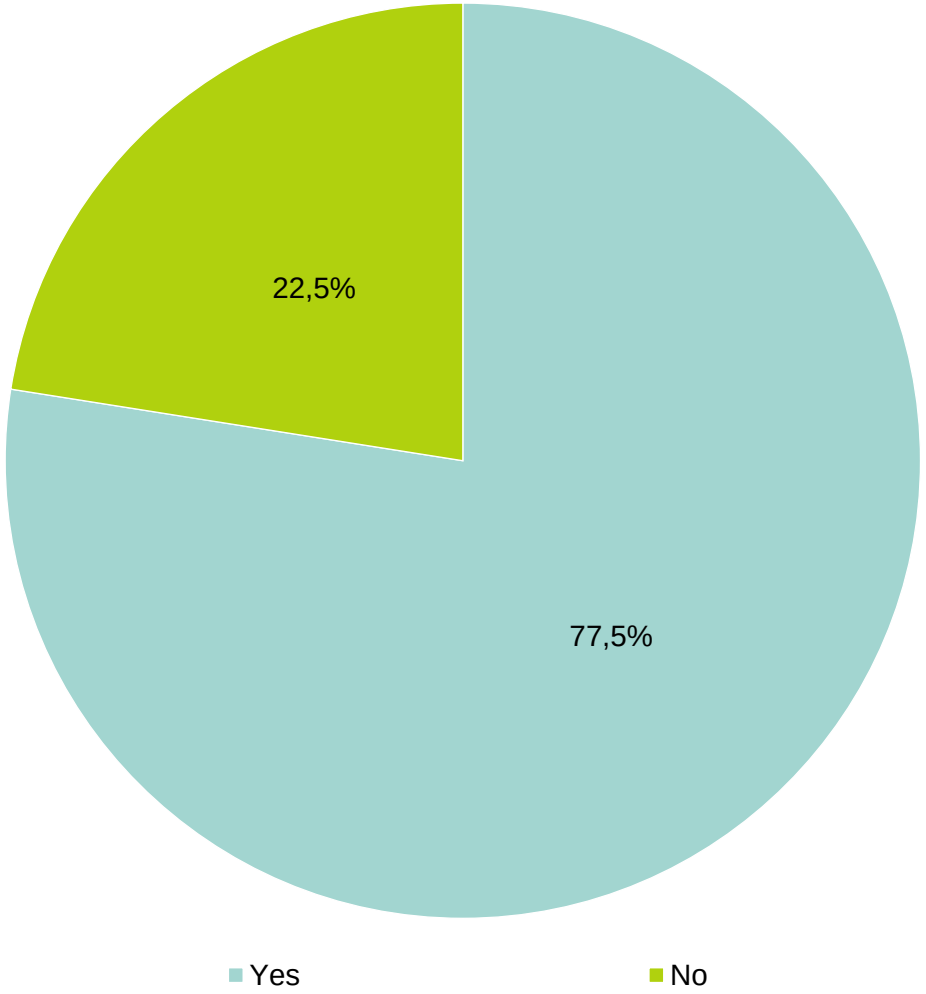
11. Do you know what the phrase "climate-neutral city" means?



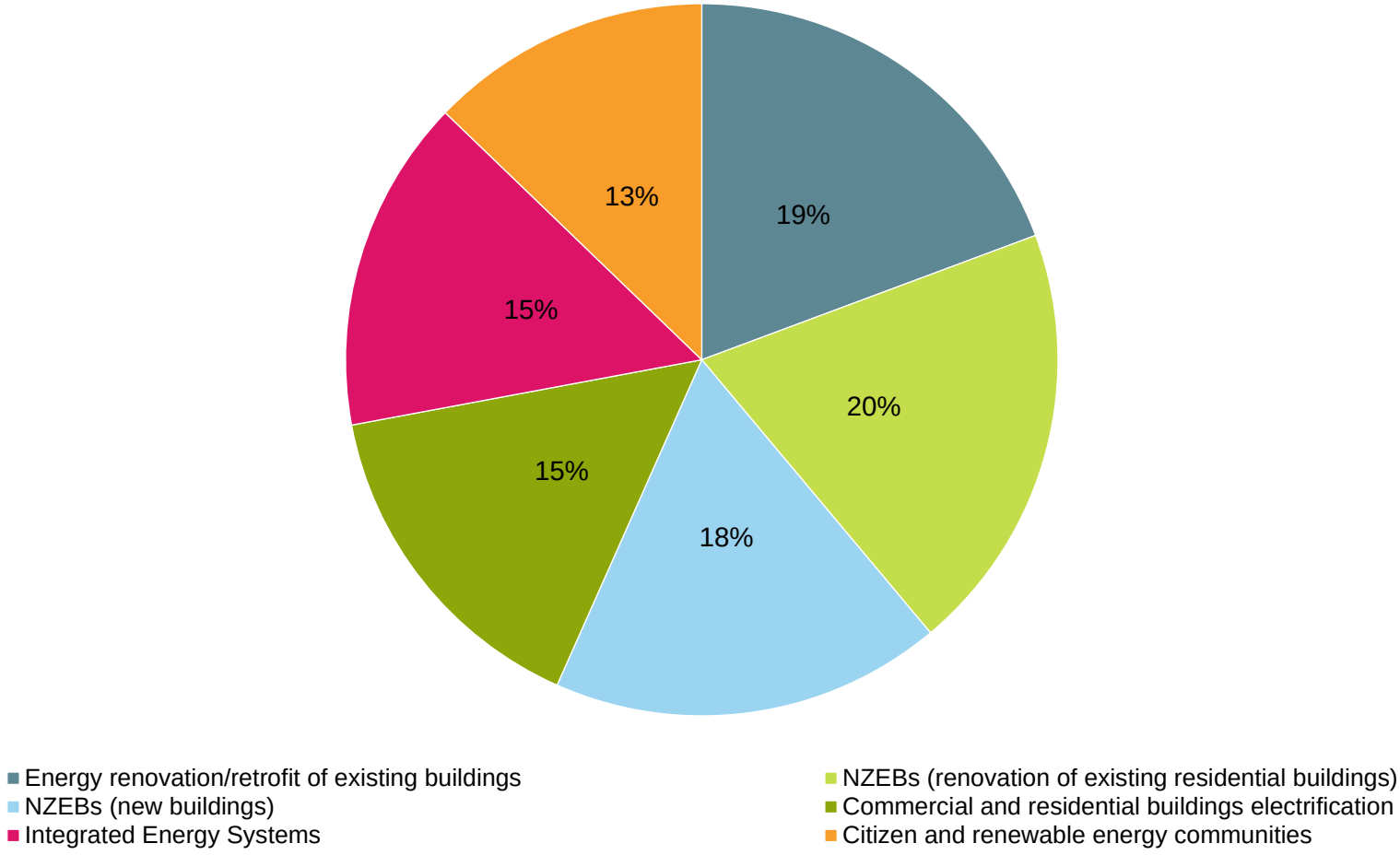
12. Which greenhouse gas emissions sector do you think requires more interventions related to climate transition?



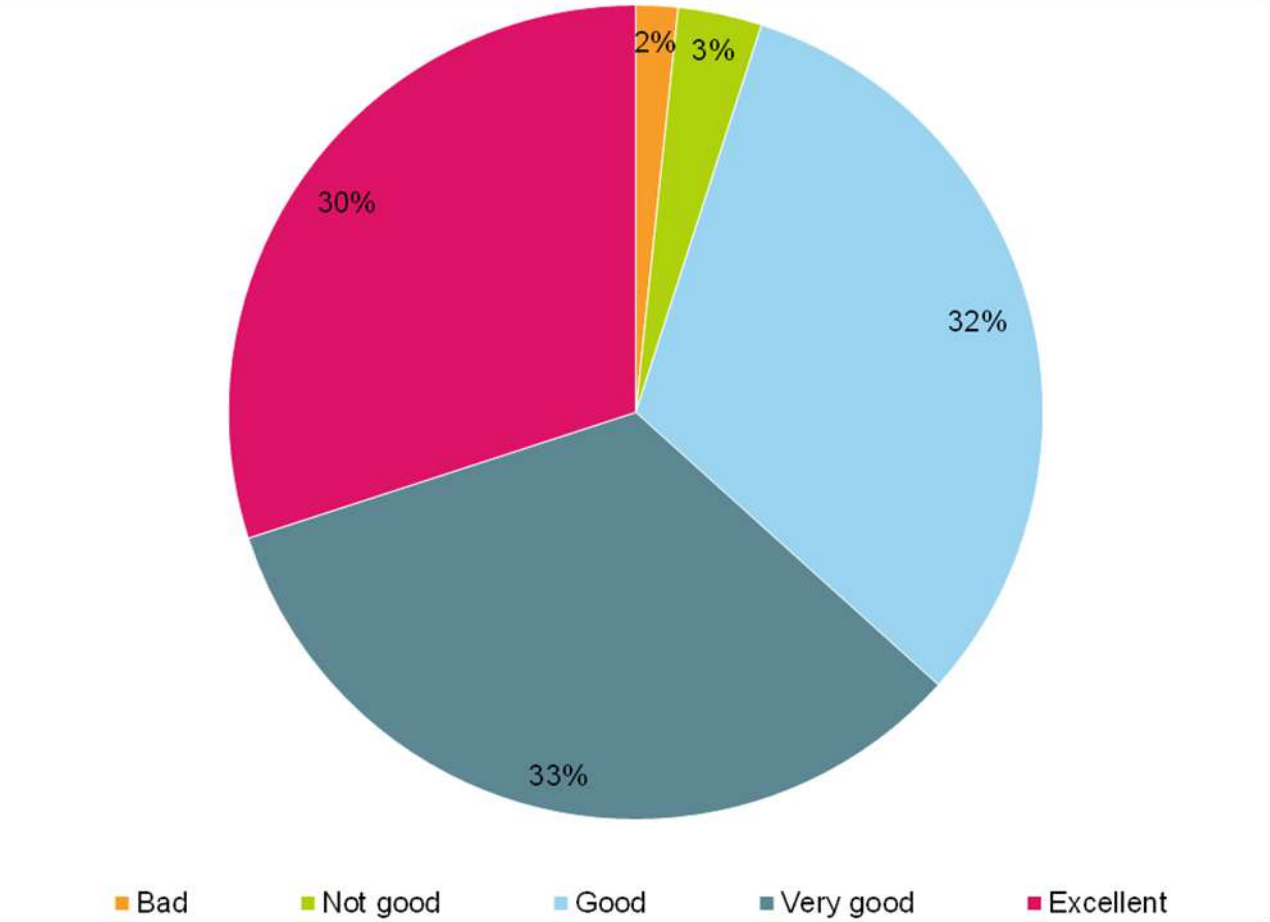
13. Are you aware of Trikala's choice to participate in the European Mission for "100 Climate Neutral and Smart Cities by 2030"?



21. Which of the proposed actions of the Climate Neutrality Action Plan 2030 in the Built environment sector is more favorable?



22. How would you assess the Climate Neutrality Action Plan 2030 overall?



6.1.2.2. Workshops for climate neutrality with students

Trikala stands as a trailblazer, pioneering workshops for climate neutrality within schools—an innovative initiative aimed at actively involving students in the collaborative design of climate mitigation measures, fostering their role as future citizens committed to environmental sustainability. Expanding on this initiative, the Municipality issued an open call to schools for bilateral visits, facilitating exchanges where schools visited the Municipality and vice versa. During these visits, experts from the Municipality presented ongoing climate neutrality efforts and collaborated with students to design targeted interventions. The insights gained from these workshops did not only contributed to the ongoing efforts but will also play a pivotal role in shaping forthcoming initiatives dedicated to climate action. The program engaged students of all school levels.

At the conclusion of these workshops, the recorded opinions, suggestions, and ideas were meticulously collected. They now constitute an integral part of the CCC. This inclusive approach underscores the municipality's commitment to involving the younger generation in shaping the sustainable and climate-resilient future of Trikala.

6.1.2.3. Trikala 2030 Conference

On the 20th and 21st of April 2023, Trikala hosted a prestigious conference within the historic warehouses of the Hellenic Railways Organization (OSE). This newly repurposed complex of buildings stands as an excellent example of circularity, symbolizing the city's commitment to sustainable practices. The conference, themed "Trikala2030: Designing the Sustainable City of Tomorrow," was held under the esteemed auspices of the Region of Thessaly, drawing attention to the city's forward-looking vision and dedication to shaping a more sustainable, climate-neutral future.

The primary focus of the conference was to engage in comprehensive discussions on the methodologies and strategies involved in crafting a sustainable and contemporary urban environment and present Trikala’s journey to climate neutrality. Deliberations encompassed a spectrum of vital subjects, including optimizing existing infrastructure, fostering urban and thematic tourism, implementing sustainable resource management practices, devising strategies to curtail the city's carbon footprint and address climate change, elevating civic services through the integration of cutting-edge technological solutions for the welfare of its inhabitants, instigating active involvement of the younger generation in urban planning and decision-making processes, fostering innovation and entrepreneurial spirit, and capitalizing on the developmental potential of the region by showcasing its distinct comparative advantages.

The roster of distinguished speakers featured notable figures, including the incumbent Mayor of Trikala, the former Mayor, various ministers, and deputy ministers specializing in Environment and Energy, Tourism, Infrastructure and Transport, among others. Additionally, mayors from other municipalities, municipal councilors, and accomplished engineers, spanning various disciplines such as civil and mechanical engineering, contributed their expertise. Representatives from esteemed consulting companies, were also integral participants.

The conference featured dedicated workshops and roundtable discussions involving stakeholders to deliberate on strategic interventions earmarked by Trikala for achieving climate neutrality. Representatives from various sectors, including industry, local stakeholders, municipal officials, NGOs, and citizens, actively participated, offering invaluable insights that informed the development of Trikala's climate city contract. Their collective expertise and input played a pivotal role in shaping the comprehensive portfolio of actions aimed at advancing the city's climate goals.

The conference will convene biennially, serving as the flagship event for Trikala, attracting stakeholders from across sectors linked to climate neutrality. It will provide a platform for discussing the progress of Trikala and other cities, sharing insights on technological advancements, urban innovations, and policy strategies aimed at achieving a zero-emission future.

6.1.2.4. Participatory workshops through innovation pilots and citizens engagement projects

The Municipality of Trikala coordinates and participates in a multitude of projects and pilots related to the issue of climate neutrality. These projects have significantly aided the Municipality in embracing innovation, whether technological, social, etc., and applying these practices in its daily life. Through these projects, there is also a great opportunity to create a steadily increasing number of stakeholders, whom we have used to co-shape parts of the climate city contract.

6.1.2.5. Establishment of Climanet

On Thursday, June 15, 2023, the establishment of the Climanet Network was officially announced. This collaborative initiative involves six Greek municipalities and Limassol, all active participants in the European Mission aspiring to achieve 100 climate-neutral cities in Europe by the year

2030.

A celebratory event took place in Ioannina, attended by representatives from local stakeholders. Additionally, two Secretaries General from the Ministry of Environment expressed their support and enthusiasm for the initiative through a videoconference.

The commitment made by the six Greek municipalities and Limassol is pivotal, signifying their dedication to spearhead the ambitious European mission aiming for climate neutrality by 2030. Beyond their individual efforts, these cities aim to serve as role models, inspiring other urban centers to adopt similar climate-neutral practices. This collaborative network marks a significant step towards a sustainable and environmentally conscious future. The Climanet Network is strategically designed to consolidate the efforts of all participating municipalities, creating a unified front to advocate for additional support from the government. Undoubtedly, altering the prevailing mindset is a formidable challenge, and the Network serves as a crucial starting point. Over time, leveraging financial tools will play a pivotal role in collectively attaining the shared objective of climate neutrality. This collaborative approach is instrumental in laying the groundwork for a sustainable future and promoting a shift in societal attitudes toward environmental responsibility.

6.1.2.5. Presentation of Finalized Action Plan & Investment Plan)

On Tuesday, December 5, 2023, at an open discussion at the Tsitsanis Museum, the Climate City Contract was presented to city authorities and the local community. The Municipality of Trikala, as a member of the European Mission for 100 Smart and Climate Neutral Cities by 2030, continues the relevant activities to achieve the targets. The presentation was on the CCC as it was formulated after the initial consultation. Maria Vassilakou, Member of the Mission Board for Climate Neutral and Smart Cities, former Deputy Mayor of Vienna, spoke in her address about the "excellent opportunity that is opening up before us" through the European Mission initiative. Essentially, the current situation regarding greenhouse gas pollutants in the city was presented, which was the basis for the Climate Action Plan, which is essentially the roadmap to climate neutrality.

The presentation was made by the advisor to the Mayor and coordinator of Trikala2030 initiative, Konstantina Zachari, specifying the main axes for climate neutrality. The Investment Plan was presented by the Municipality's special advisors, outlining the financial instruments and the allocated investments for implementing the projects identified in the Action Plan. Following the presentation, participants actively engaged in a workshop, expressing their thoughts and suggestions on various aspects of the Action Plan.

Afterwards, the participants expressed their own thoughts and suggestions, in the form of a workshop, on the issues related to the Climate Action Plan.

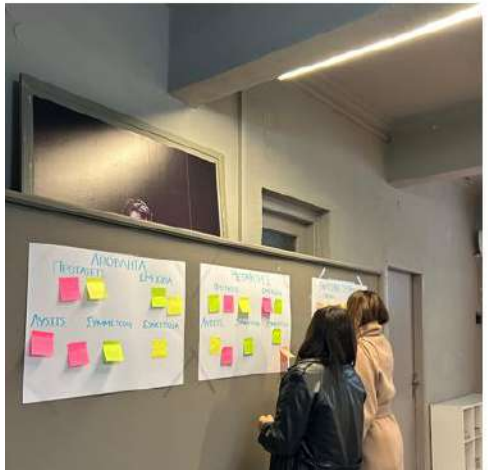
The workshop focused on five sectors corresponding to each part of the action plan and then each sector was divided into 5 sub-sectors.

- Proposals: Participants provided ideas and suggestions for strengthening the climate action plan.
- Barriers: Identification and discussion of barriers and challenges related to the plan.
- Solutions: Collaborative exploration of possible solutions to overcome identified barriers.
- Participation: Recommendations on how to involve each stakeholder.
- Collaboration: Discussion on how to promote partnerships and collaborations to effectively implement the plan.

The results of the workshop, as illustrated in the accompanying figures, highlight the collective input and collaborative efforts of participants to shape and improve the climate action plan. This inclusive approach ensures an integrated and holistic perspective, contributing to the success of the initiatives outlined in the plan.

The Mayor of Trikala, Nikolaos Sakkas, and the deputy mayors, the president of Urban Development SA, the delegated advisor of Public Relations, the president of the Medical Association of Trikala, the president of the Commercial Association of Trikala, the president of the TEE, the president of the Cooperative Bank of Thessaly, the vice-president, representatives of catering associations, the vice-president and members of the Municipal Youth Council of the Municipality of Trikala and other citizens groups participated in the workshop.


ΑΠΟΣΤΟΛΕΣ
ΚΛΙΜΑΤΙΚΑ ΟΥΔΕΤΕΡΕΣ ΚΑΙ ΕΞΥΠΝΕΣ ΠΟΛΕΙΣ
Τρίκαλα



NET ZERO CITIES

EU MISSION PLATFORM | CLIMATE NEUTRAL AND SMART CITIES

Climate City Contract

2030 Climate Neutrality Commitments

Climate Neutrality Commitments of Trikala

NetZeroCities has received funding from the H2020 Research and Innovation Programme under the grant agreement n°101036519.

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Table of contents

Designing tomorrow's sustainable city

1. Introduction

Climate change presents one of the most significant challenges for cities today, necessitating increased action from municipalities to ensure future sustainability. Acknowledging the adverse impacts of climate change and the crucial role of local initiatives in mitigating them, the Municipality of Trikala has taken significant steps to align with European and national climate policies.

In furtherance of these efforts, the Municipality officially joined the European Commission's mission for "100 Climate Neutral and Smart Cities by 2030" on April 28, 2022. This initiative aims to expedite the transition to green practices and achieve climate neutrality in 100 European cities by 2030, two decades ahead of the timeline outlined in the European Green Deal (2050). Participating cities will serve as hubs of innovation for the wider European community.

Trikala's decision to participate in this mission is integral to its broader strategy to combat climate change, foster sustainable development, and secure a green, socially equitable future for its residents. By joining the mission, the city aims to take a central role in climate action, driving innovation and fostering collaboration among stakeholders. City stakeholders, including experts and supporters, will play a crucial role in translating climate goals into tangible outcomes.

This document serves as a compendium of the Municipality of Trikala's actions, strategies, and policies toward achieving climate neutrality, aimed at informing stakeholders and aligning priorities for collective action. To kickstart these efforts, the Municipality introduced the Climate City Contract comprising Commitments, an Action Plan, and an Investment Plan for Climate Neutrality 2030. This contract aims to assess the current state of greenhouse gas emissions in the city, expedite climate action, and foster stronger commitments from authorities, businesses and citizens.

The Climate City Contract (CCC) is a dynamic strategic instrument that necessitates partnerships with stakeholders across various levels of governance to achieve its objectives. Leveraging its longstanding partnerships and strong political will, the Municipality is poised to engage with national, regional, and local agencies, businesses, organizations, and citizens in a collaborative journey toward climate neutrality.

Trikala has made significant progress in aligning with European and national climate policies, on a multidimensional level, including strategies to reduce greenhouse gas emissions, increase the resilience of infrastructure to the effects of climate change, promote sustainable urban development and participatory dialogue with stakeholders. Trikala’s efforts are exemplified by its commitment to the Covenant of Mayors for Climate and Energy in 2008, pledging a 20% reduction in carbon dioxide emissions by 2020. Since then, the city has implemented a comprehensive climate strategy through various initiatives focused on emission reduction, sustainable development, and natural resource management, underscoring its dedication to a greener, more resilient future. Subsequently, the Municipality has developed several cross-sectoral strategies and action plans to support climate policies and guide climate actions:

1. Covenant of Mayors/ Sustainable Energy Action Plan of Trikala Municipality (2008 - 2020)
2. Operational Programme 2014 - 2019, “Trikala 2050 - Smart, Self-sufficient and Resilient Municipality”

3. Local Waste Action Plan (2015 - 2020 & 2021 - 2025)
4. Sustainable Urban Development Strategy -– Municipality of Trikala (2018 - 2023)
5. Sustainable Urban Mobility Plan of Municipality of Trikala (2019 – 2024)
6. Sustainable Energy and Climate Action Plan (2021 - 2030)
7. Electric Vehicles Charging Plan (2021)
8. Smart City Strategic Plan - Restart mAI city (2021)
9. Energy Transition Strategy (2022 - 2030)

Successful key climate change mitigation/ GHG reduction measures and initiatives include:

1. Stationary energy reduction
   - Energy retrofitting in municipal buildings (total area 25.000 m²)
   - Improvement of energy efficiency in 14 Municipal buildings through subsidies of €11M from the Ministry of the Environment and Energy, “ELECTRA” programme
   - Modernization of part of the street lighting network and smart management
2. Energy production from RES: Promotion of RES and installation.
   - Development of a solar power plant of 4.6MW to cover electricity demand of the Municipal Water Supply and Sewerage Company
   - Establishment of the first Municipal Energy Community in 2022
3. Circular Economy and Municipal Waste Management
   - Construction of a new waste treatment plant with a capacity of 60,000 tons – and investment of €31 million, with energy production from biogas utilization
   - Establishment of a Green Point and Recycling Corners in 2024
   - Design of a “Pay as you Throw” pilot activity for 5.000 households and businesses
4. Urban Regeneration and mobility projects
   - Environmental - and aesthetic interventions to enhance functionality and accessibility of the urban fabric:
   - Regeneration of 2 central squares, the riverside of city river, the municipal skate park, pavements expansion, new roundabouts to facilitate urban mobility (57,400 m²)
   - The world's first passive museum from the renovation of a listed building
   - Creation of extensive network of bicycle lanes (17,500 m²)
   - Repurpose of 2 municipal buildings & a former military camp to serve the cultural community (17,900 m²)
   - Procurement of micromobility means and promotion of electromobility
5. Digitalization and smart city infrastructure
   - Trikala has received €6,9M funding from the Recovery and Resilience Facility (RRF) to deploy smart city solutions in a city-wide level. Approximately €2M is dedicated at energy efficiency interventions
   - Wireless network establishment to enable IoT based applications in monitoring environmental conditions, assets and infrastructure and optimize their operation

Moreover the Municipality of Trikala is a pioneer in implementing R&I projects relevant to smart city and climate change mitigation/GHG emissions reduction. To name a few, such initiatives include:

1. Digiplace (Structural Funds), an action planning network to set up an acceleration mechanism to enable cities catch up the digitalisation opportunities in hard & soft infrastructure
2. CityMobil2 (Framework Programme 7), the first large scale pilot of driverless automated vehicles in a city context
3. Circ4Food - A circular Economy Inspired Food Production System that combines composting and rainwater harvesting, while reducing the environmental footprint
4. Harmony, (Horizon 2020) that demonstrated the use of drones in the transportation of goods in emergency conditions
5. SHared automation Operating models for worldwide adoption (SHOW) (Horizon 2020) to support the deployment of shared, connected, electrified automation in urban transport

Some further actions taken by Trikala in response to climate change mitigation and reducing greenhouse gas emissions are as follows:

- Trikala has been labelled in 2004 as Greece's "1st digital city" and henceforth made significant effort in smart interventions by becoming a testbed for state-of-the-art solutions. That nurtured a culture within the city and its 'stakeholders around the necessity of digital transformation and further on provided insights for smart, socially responsible, and sustainable growth through advanced technologies, which we believe will help the city proceed toward its' 2030 climate neutrality targets.
- Trikala is actively engaged in the 100 Intelligent Cities Challenge (ICC) with the objective of crafting a Local Green Deal in collaboration with city stakeholders to develop Demand-Responsive Transport (DRT) programs tailored to serve suburban mobility needs in low demand routes.
- As partner of the VILAWATT – Urban Innovation Action, Trikala gained experience into pilots and methodologies aimed to boost the energy transition process by setting up public-private-citizen partnerships.
- Representation of the Municipality of Trikala in the CIVITAS Policy Advisory Committee to promote sustainable mobility.

The above plans and actions show the practical commitment of the city of Trikala to climate actions, with the goal of climate neutrality. TheClimate City Contract developed under the Mission builds on the existing plans, actions and initiatives and integrates them into a single roadmap for climate neutrality, as it is shown in Figure 1.

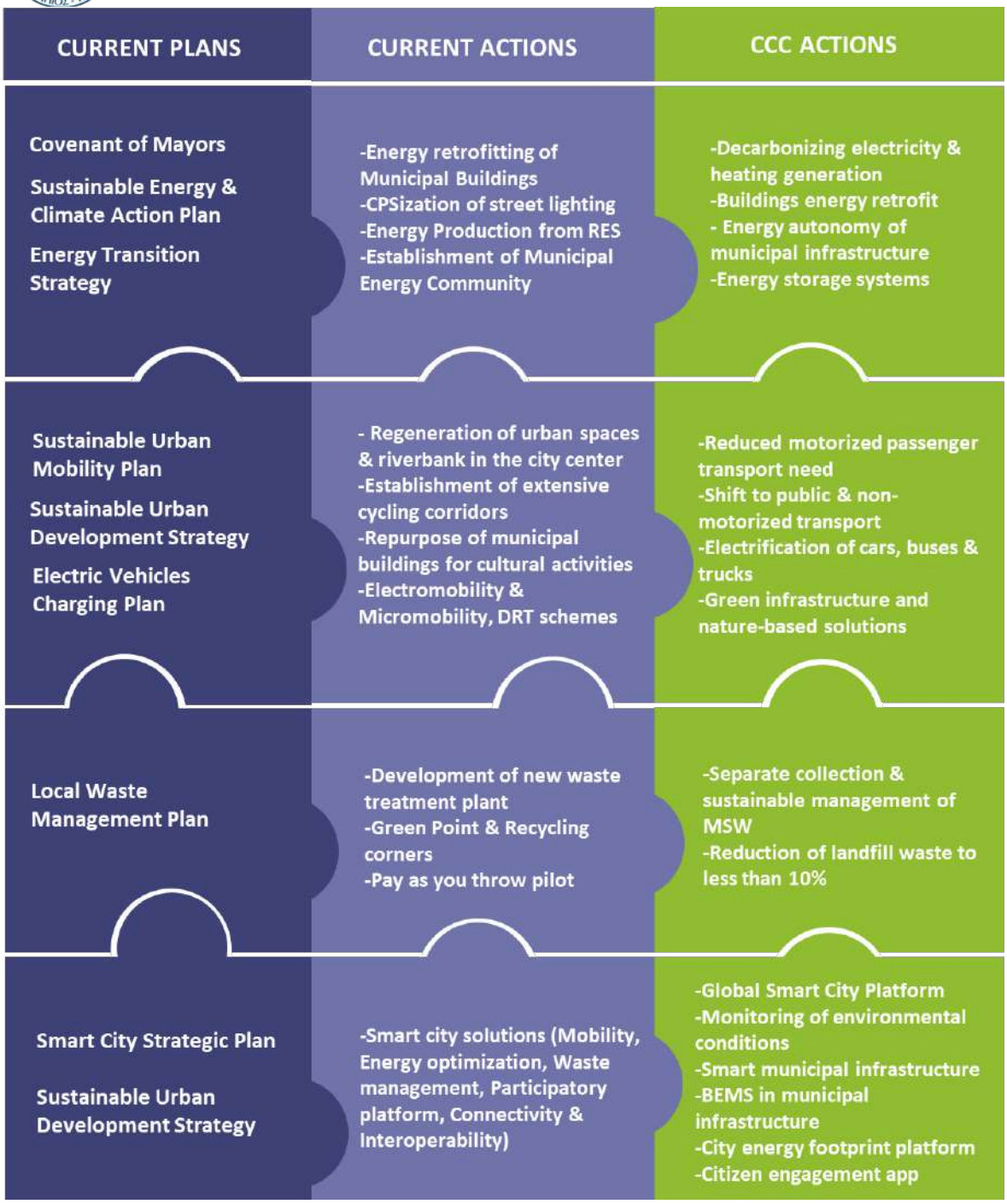


Figure 1 Alignment of Existing Actions with the City Climate Contract

The Sustainable Energy and Climate Action Plan and Energy Transition Strategy are plans mostly targeted to Stationary Energy and Energy Systems. Based on these plan, Trikala city has already began its effort towards implemented climate change mitigation actions. The current actions referring to existing plans are Energy retrofitting of 14 municipal buildings, CPSization of street lights, Energy production from RES and Establishment of a Municipal Energy Community. These actions have been integrated in the CCC, under Decarbonisation of electricity generation, Building renovation and Decarbonisation of heating generation.

At the Mobility and Transport as well as the Urban Sustainability sectors, Trikala has developed the Sustainable Urban Mobility Plan, Electric Vehicles Charging Plan and Sustainable Urban Development Strategy. Current actions connected to these plans are Regeneration of 2 central squares, Creation of an extensive bicycle network, Repurpose of 2 municipal buildings and a former military camp and Procurement of micromobility means and promotion of electromobility. These activities have been incorporated into the CCC, as Reduced motorised passenger transportation need, Shift to public and non-motorised transport, Electrification of cars, buses and trucks and Green infrastructure and nature-based solutions.

The Local Waste Action Plan is mandatory for every Greek municipality. Based on the national waste strategy, Environmental Development Agency of Western Thessaly (PADYTH) S.A. currently constructing a new waste management plant. At the same time, Trikala in collaboration with PADYTH SA will establish a Green Point and Recycling Corners, while also implement a Pay as you Throw pilot program. All the above actions are included in the CCC, under the Waste & Circular economy sector where all the actions aim at the separate collection and sustainable management of Municipal Solid Waste (MSW) and the reduction of landfilled waste under 10%.

Last but not least, Trikala City has developed a Smart City Strategic Plan which is integrated within the CCC under Smart City solutions. Smart action include Horizontal actions, Mobility actions, Health and social actions, Energy Actions, Action of civil protection and environment, Actions related to water sources, Actions related to waste management, Actions of economic development and construction, Participation Actions and Connectivity actions.

These actions have passed the stage of approval and financing and the majority of them are already being implemented. However, because they have not been completed, they are included again as actions in the CCC, so that there is an overall road map towards climate neutrality. It is pointed out that special importance has been given to avoiding double counting of emissions reduction.

2. Goal: Climate neutrality by 2030

The City of Trikala is steadfast in its commitment to achieving climate neutrality by 2030. To fulfill this objective, Trikala is actively implementing climate action measures, ensuring the city meets its target within the designated timeframe. Importantly, these actions are undertaken with a dedication to equity and inclusivity, ensuring that no individual or community is overlooked or left behind during the process.

The first step in developing a climate action strategy requires the creation of a greenhouse gases (GHG) inventory. The purpose of the inventory is to quantify the sources and sinks of greenhouse gases, which are responsible for climate change. A comprehensive GHG inventory allows cities to take focused action against climate change.

It's worth noting that the geographic boundary aligned with Trikala's 2030 climate neutrality target is smaller than the city's administrative boundary, focusing primarily on the Trikala municipal unit. This unit, representing the core city, accommodates 80% of the municipality's total inhabitants, making it the sole urban center within the administrative boundaries. The density of the Trikala unit is 886.6 persons/km², emphasizing its urban nature and relevance for targeted interventions.

Taking 2019 as a baseline year, Trikala has analysed the current state and classified emissions from city activities into five main sectors. The greenhouse gas inventory was

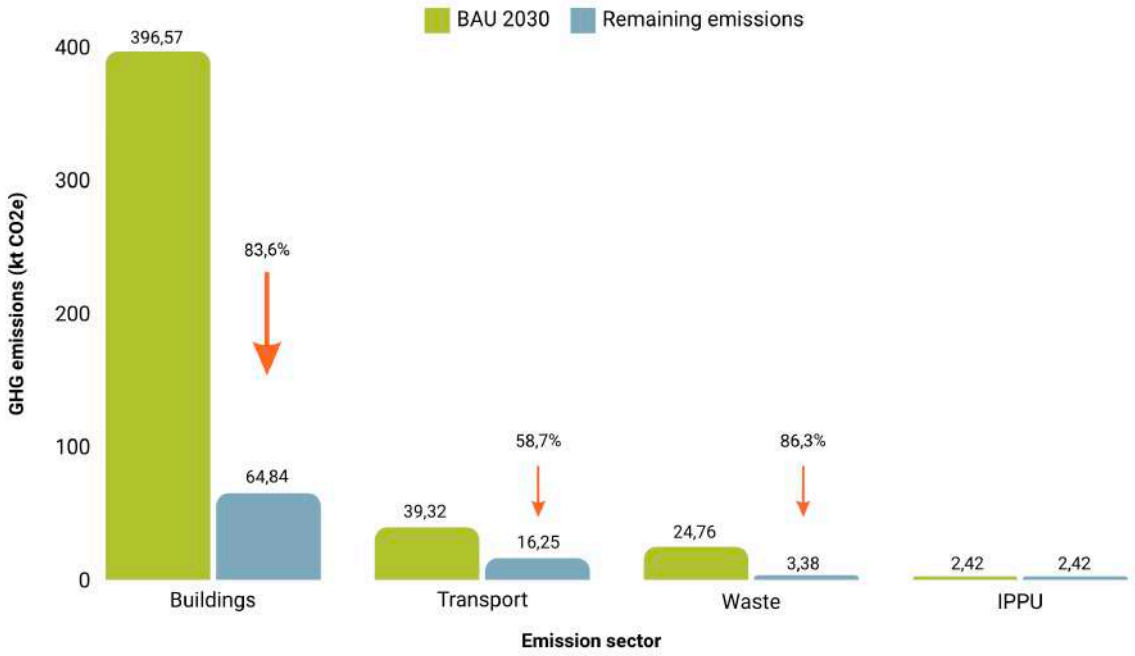


Figure 2 Trikala's emission gap.

conducted according to the Global Protocol for Community-Scale Greenhouse Gas Inventories (GPC). Using the BASIC+ inventory level, the total greenhouse gas emissions amount to 467.714,66 metric tons of CO_2e. This corresponds to 7,59 metric tons of CO_2e per citizen per year. Emissions per source sector for Trikala city, are:

- **Stationary Energy:** 393.504,16 tn CO_2e
- **Transportation:** 45.198,83 tn CO_2e
- **Waste:** 26.599,46 tn CO_2e
- **IPPU:** 2.419,46 tn CO_2e
- **AFOLU:** -7,26 tn CO_2e

The Stationary Energy sector constitutes 84,1% of the city's total greenhouse gas (GHG) emissions. Following, the Transportation sector emerges as the second-largest source of GHG emissions, contributing 9,7% to the overall total. The Waste sector contributes 5,7% to the city's total GHG emissions, while the Industrial Processes and Product Use (IPPU) sector makes up 0,5% of the total GHG emissions.

Implementing the action portfolio to reach climate neutrality, Trikala's remaining emissions to be offset are 86,07 kt CO_2e. The current situation in the city using the Business As Usual (BAU) 2030 approach and the remaining emissions after the Action Plan are shown in Figure 2.

The target of climate neutrality for Trikala involves achieving net-zero greenhouse gas (GHG) emissions, primarily through emission reduction, investment in green technologies, and preservation/enhancement of the natural environment. Net zero cities, including Trikala, prioritize measures across various sectors like transportation, energy, waste management, and buildings. These measures focus on energy efficiency, renewable energy sources, and sector-specific actions to achieve climate neutrality.

Specific key measures that Trikala will concentrate on to achieve climate neutrality by 2030 include energy-saving measures in all buildings, sustainable transport and mobility systems,

renewable energy generation suitable for local climate and geological conditions, efficient water resources management, sustainable waste management, circularity of goods, reduction of consumption-based emissions, and sustainable land use and urban regeneration interventions.

Actions regarding Energy systems include the construction of municipal photovoltaic parks and placement of PV systems on building roofs. In addition, Trikala aims to boost solar thermal power systems on buildings. All these systems are going to be controlled by a smart RES management system.

In the Transport and mobility sector, the main actions identified are reduced motorised passenger transportation need, shift to public and non-motorised transport, increased car pooling, electrification of cars, motorcycles, buses and trucks and optimised logistics.

In the Waste and circular economy sector, the majority of the actions refers to the need for separate collection and sustainable management of different Municipal Solid Waste (MSW) streams. The ultimate goal in the waste sector is to reduce landfilled MSW under 10% of total produced amounts.

In the Built environment sector, building envelope renovations and efficient lighting and appliances coupled with the decarbonisation of heating generation can help substantially reduce the sector’s carbon footprint.

Smart city solutions in mobility, health, energy, civil protection and environment, water resources, waste management, participation and connectivity lead to the city’s digitization, which contributes significantly in Trikala’s journey to climate neutrality.

Nature-based solutions create natural sinks within the city through the establishment of green walls, roofs and pavements and the planting of 23.000 trees.

Trikala aims to achieve 11-20% GHG residual emissions, specifically targeting 18,76% according to the city's planning. "To tackle residual emissions that prove challenging to mitigate by 2030, the city will implement carbon offsetting measures.

Below is a schematic presentation of the actions outlined in the City Climate Contract of Trikala, categorized by intervention per sector.

Figure 3 Trikala's action portfolio towards climate neutrality

Co-benefits

Working towards climate neutrality the city of Trikala not only mitigates environmental challenges but also yields a diverse array of co-benefits that positively impact society. Among these are:

- Improved well-being and public health outcomes: Cleaner air and reduced pollution levels lead to healthier living conditions for residents.
- Equity and justice promotion: Ensuring that vulnerable communities are included in the transition to climate neutrality and benefit from the changes.
- Creation of green jobs and economic opportunities: Boosting local economies and fostering community development.
- Financial savings through energy efficiency measures.
- Resilience and adaptation strategies to withstand and recover from the impacts of climate change.
- Enhanced air quality, supporting active lifestyles and improving overall quality of life.
- Improved urban mobility and livability through reduced traffic congestion.
- Energy security, ensuring stable access to essential resources.
- Independence from energy markets, enhancing local control and stability.
- Environmental stewardship, fostering a sense of responsibility towards preserving natural resources for future generations.

In addition to the tangible benefits mentioned, such as improved air quality and financial savings, working towards climate neutrality can also foster social cohesion and community empowerment. As cities transition to greener practices, opportunities arise for citizen engagement and participation in decision-making processes related to urban development and sustainability initiatives. This engagement not only strengthens the relationship between local governments and residents but also builds trust and accountability within the community. Moreover, by prioritizing sustainability and resilience, Trikala can attract investment and enhance their reputation as forward-thinking and environmentally conscious places to live and work. This, in turn, can lead to increased investor confidence and economic growth, further reinforcing the city's position as a leader in climate action.

Ultimately, the pursuit of climate neutrality for Trikala is not just about reducing greenhouse gas emissions; it's about creating an inclusive, thriving, and resilient community that prioritize the well-being of both people and the environment.

3. Strategic priorities

Trikala's strategic priorities are more than a list of objectives. They embody a comprehensive approach towards fostering a resilient and sustainable future for the city and its inhabitants. The city faces these priorities as citywide challenges to create an empowered ecosystem of stakeholders and citizens facilitated by distributed leadership.

At the heart of Trikala's strategic priorities lies a citizen-centric governance model, emphasizing the vital role of community engagement and participation in shaping the city's response to climate change. Furthermore, the city's focus on smart city actions underscores its commitment to leveraging technology and innovation to address key areas of concern. Trikala recognises the importance of adopting sustainable practices across all sectors of urban life to minimize its ecological footprint and create a more resilient and resource-efficient urban ecosystem.

Analysing its inventory and the existing ecosystem of the city, Trikala identified six key priorities that need to be urgently addressed in order to achieve 2030 climate neutrality goal:

1. Citizen-centric governance model

The transformation towards a citizen-centric governance model stands as a systemic strategic priority in Trikala, reflecting a fundamental shift in the city's approach to civic engagement and public administration. This model places the needs, preferences, and aspirations of the residents at the forefront of decision-making processes, emphasizing a more inclusive and participatory form of governance. Trikala envisions a city where citizens actively contribute to shaping policies, programs, and urban development initiatives, fostering a sense of shared responsibility and community ownership. By embracing a citizen-centric model, Trikala seeks to establish a transparent and accountable governance structure that not only responds to the diverse needs of its population but also cultivates a culture of trust and collaboration between local authorities and residents.

The adoption of a citizen-centric governance model in Trikala involves not only a structural reconfiguration of administrative processes but also a cultural transformation that values the

input of citizens in the co-creation of public policies. This approach entails leveraging technology to enhance communication channels, facilitating real-time feedback mechanisms, and promoting citizen participation in decision-making forums. Trikala recognizes that a citizen-centric model is instrumental in building resilient and sustainable communities, as it ensures that the city's development aligns closely with the collective aspirations of its inhabitants. This strategic shift reaffirms the city's commitment to democratic principles, social inclusion, and the creation of a vibrant urban environment that reflects the shared vision and values of its diverse population.

Stakeholders: All

2. Trikala - Restart mAI city

Cities represent dynamic spaces that undergo continuous changes, interacting with both endogenous and exogenous factors. Within the context of these transformations, the internal processes of cities are directly impacted, resulting in the emergence of challenges across the city's functions that require addressing. Trikala faces numerous challenges such as energy efficiency, climate change, employment, economic development, migration, social cohesion, and environmental pollution, while also grappling with the competition from other cities in attracting investors, new residents, and visitors. In the midst of the Fourth Industrial Revolution and the rapid growth of digital technology, Trikala is called upon to play a distinctive role. It is tasked with becoming a leader in devising and implementing solutions that creatively and effectively address the contemporary problems of urban governance.

The digitisation of city processes at the governance, mobility, healthcare, social care, natural resources, civil protection, and other levels stands as a fundamental strategic priority for the city. This commitment is evidenced by the initiatives undertaken as part of the Restart mAI City (smart city actions) program, which is funded by the Recovery and Resilience Facility (RRF) with €6.9 million. In this new era and amid the exponential growth of digital technology, Trikala is positioning itself as a pioneer in leveraging these advancements to enhance the efficiency, responsiveness, and overall quality of urban governance.

Digitisation supports climate neutrality actions by providing real-time data and analytics, enabling cities like Trikala to make informed decisions on energy consumption, emissions reduction, and resource management. Additionally, smart technologies facilitate the implementation of targeted interventions, optimising urban systems and processes for more sustainable and efficient practices.

Stakeholders: Municipality of Trikala, Hellenic Ministry of Digital Governance, e-Trikala S.A, PADYTH SA, DEYAT, Urban Development Company of Trikala, University of Western Macedonia, University of Western Attica, Institute of Communication & Computer Systems (ICCS), Cities Net, P-net, Cooperative bank of Thessaly, Technical Chamber of Greece – Committee of Regional Department of Central & Western Thessaly, ABB Hellas, NOVA Hellas, DOTSOFT SA, Wastecloud.

3. Decarbonising electricity & heating generation

The decarbonisation of electricity and heating generation plays a pivotal role in the pursuit of climate neutrality, as it addresses a significant contributor to greenhouse gas emissions. This is evident from the city's inventory, where the Stationary Energy sector, particularly Scope 2 emissions stemming from grid-supplied energy, emerges as the primary contributor to

greenhouse gas emissions. This is attributed to the extensive use of electricity for heating/cooling, coupled with energy-inefficient buildings and appliances.

The fundamental objective of decarbonising electricity and heating generation is to shift away from sources responsible for greenhouse gas emissions. Greenhouse gases, notably carbon dioxide (CO2), are major contributors to global warming and climate change. Decarbonising electricity and heating generation contributes to mitigating these impacts by reducing the release of greenhouse gases into the atmosphere. The commitment to decarbonise electricity and heating generation serves as a catalyst for research and development in clean energy technologies.

Decarbonisation initiatives entail an increased reliance on renewable energy sources. This transition to renewables fosters the development of a sustainable energy system that aligns with the goals of climate neutrality.

Stakeholders: Municipality of Trikala, DEYAT, Hellenic Energy Competence Center, HEDNO SA, Cooperative Bank of Thessaly, Technical Chamber of Greece – Committee of Regional Department of Central & Western Thessaly, University of Western Macedonia, Ministry of Environment and Energy, e-Trikala, Urban Development Company of Trikala S.A., Mellon Labs, EPTA Environmental Engineering, ATHENA RC

4. Shift to public and non-motorised transport

Public and non-motorized transportation alternatives, encompassing buses, bicycles, and pedestrian modes, typically exhibit lower carbon footprints in comparison to individual conventional vehicles. Buses, for instance, possess the capacity to transport a considerable number of individuals with a relatively lower energy consumption per passenger when contrasted with private cars. This heightened efficiency contributes significantly to the establishment of a more sustainable and environmentally conscious transportation system.

Moreover, the advocacy for non-motorized transportation options, specifically walking and cycling, not only fosters eco-friendly commuting practices but also advocates for healthier and more active lifestyles. This paradigm shift aligns seamlessly with broader sustainability objectives, promoting human well-being and concurrently diminishing the environmental impact linked to sedentary and motorized living patterns. Encouraging the adoption of these alternatives represents a strategic approach in achieving a more sustainable and climate-resilient urban mobility landscape.

Stakeholders: Municipality of Trikala, Ministry of Environment and Energy, Hellenic Electricity Distribution Network Operator (HEDNO S.A.), Urban Development Company of Trikala S.A., e-Trikala, ICCS, Public Transport Organization of Trikala

5. Energy renovation and efficient utilisation of building stock

Energy renovation and the efficient utilization of the building stock constitute critical components in the journey toward climate neutrality. In Trikala, akin to many urban centers, the building sector stands out as the primary contributor to greenhouse gas emissions. In Greece, a prevailing challenge lies in the accurate documentation of the building stock. As part of its commitment to climate neutrality, Trikala places a strategic emphasis on comprehensively inventorying the entire building stock, incorporating essential data such as the year of construction, usage patterns, ownership status, and overall condition.

This meticulous inventorying process serves a dual purpose. Firstly, it facilitates the precise identification and subsequent reduction of greenhouse gas emissions, enabling targeted and

effective interventions. Secondly, it lays the groundwork for the formulation of a strategic plan dedicated to the enhancement and retrofitting of existing buildings. The concurrent pursuit of energy upgrades for buildings, coupled with the overarching objective of decarbonizing electricity and heat production, is poised to yield the most significant impact on Trikala's carbon footprint. This comprehensive approach is expected to result in an exponential reduction in emissions, marking a substantial leap toward the city's climate neutrality objectives.

Stakeholders: Municipality of Trikala, Hellenic Energy Competence Center, HEDNO SA, Cooperative Bank of Thessaly, Technical Chamber of Greece – Committee of Regional Department of Central & Western Thessaly, University of Western Macedonia, Ministry of Environment and Energy, e-Trikala, Urban Development Company of Trikala S.A.

6. Sustainable management of waste & promotion of circular economy

The sustainable management of waste emerges as a pivotal factor in the pursuit of climate neutrality, primarily through the attenuation of methane emissions emanating from landfills, and the advocacy for recycling and the circular economy paradigm. Landfills, renowned as substantial sources of methane, a potent greenhouse gas, are targeted for mitigation through the adoption of sustainable waste management practices, prominently including recycling and composting. These practices not only divert significant quantities of waste away from landfills but concurrently curtail the release of methane emissions, thus aligning with climate neutrality objectives.

The incorporation of a circular economy framework, exemplified by recycling initiatives, plays a dual role in fostering climate neutrality. Primarily, the recycling process diminishes the demand for raw material extraction and manufacturing, activities inherently linked to greenhouse gas emissions. Secondly, by extending the life cycle of materials through recycling, a pivotal contribution is made to resource conservation, concurrently mitigating the carbon footprint associated with the production of new commodities. This approach underscores the symbiotic relationship between sustainable waste management practices, the circular economy, and the overarching objective of climate neutrality.

Stakeholders: Municipality of Trikala, PADYTH SA, DEYAT, Ministry of Environment and Energy, Democretus University of Thrace, Hellenic Solid Waste Management Association, Commercial Association of Trikala, Mellon Labs, Wastecloud, EPTA Environmental Engineering

The citizen-centric governance model and the Restart mAI city constitute the primary and immediate priorities set by Trikala. On one hand, active citizen participation in local governance leads to co-designing the city's strategy, while on the other, digitising city processes makes participation more accessible and allows for goal monitoring. Through these two key priorities emerge the four pillars of climate actions by and for the citizens.

The priorities of decarbonising electricity & heating generation and energy renovation & efficient utilization of building stock are directly interconnected and linked to the Built environment sector. As indicated by the GHG inventory, buildings represent the largest source of greenhouse gas emissions in Trikala, underscoring the importance of reducing their carbon footprint. Upgrading a building typically involves simultaneous energy renovation and decarbonising electricity and heating generation through the installation of residential renewable energy sources and heat pumps.

Simultaneously, households and businesses in the city are directly linked to waste production and management. The energy renovation and efficient utilization of building stock will promote awareness among users regarding waste management issues, fostering a more circular character for buildings.

Finally, through the citizen-centric governance model and smart city solutions, there is significant promotion of the shift to public and non-motorized transport for a more sustainable city. The comprehensive integration of these strategic priorities reflects a holistic approach to achieving climate neutrality in Trikala, emphasizing the active involvement of citizens and the incorporation of innovative technologies for a greener and more sustainable urban future.

Figure 4 presents the six strategic priorities of Trikala's journey towards climate neutrality and showcases the number of actions linked with each one of them. The citizen-centric governance model and the Restart mAI city are seen as a foundational systemic approach within the city's climate planning, enabling the realisation of other goals and the creation of an inclusive, fair and sustainable ecosystem in Trikala.

The city of Trikala is embarking on an ambitious initiative, necessitating the redesign of its urban operational model, the development of a collaborative network, and the exploration of funding sources. Within the next three years, the city aims to implement all smart city actions, creating a comprehensive and reliable database to monitor its progress toward climate neutrality. Simultaneously, Trikala will focus on informing and educating its citizens, aiming to empower and actively involve them in the strategic planning process. This objective will be supported by the creation of citizen engagement and participation platforms.

Furthermore, Trikala will concentrate on strengthening its economic plans and attracting investors to realize the vision of climate neutrality. Initiating smaller-scale actions and pilot programs will enable the city to monitor their operations and gradually scale them citywide. Pilot programs offer a cost-effective means to implement actions, acting as educational tools for citizens and attracting potential investors. Finally, Trikala, in collaboration with the other Greek Mission cities and the city of Limassol, have established CLIMANET a network to engage with the central government to establish institutional and investment frameworks towards climate neutrality.

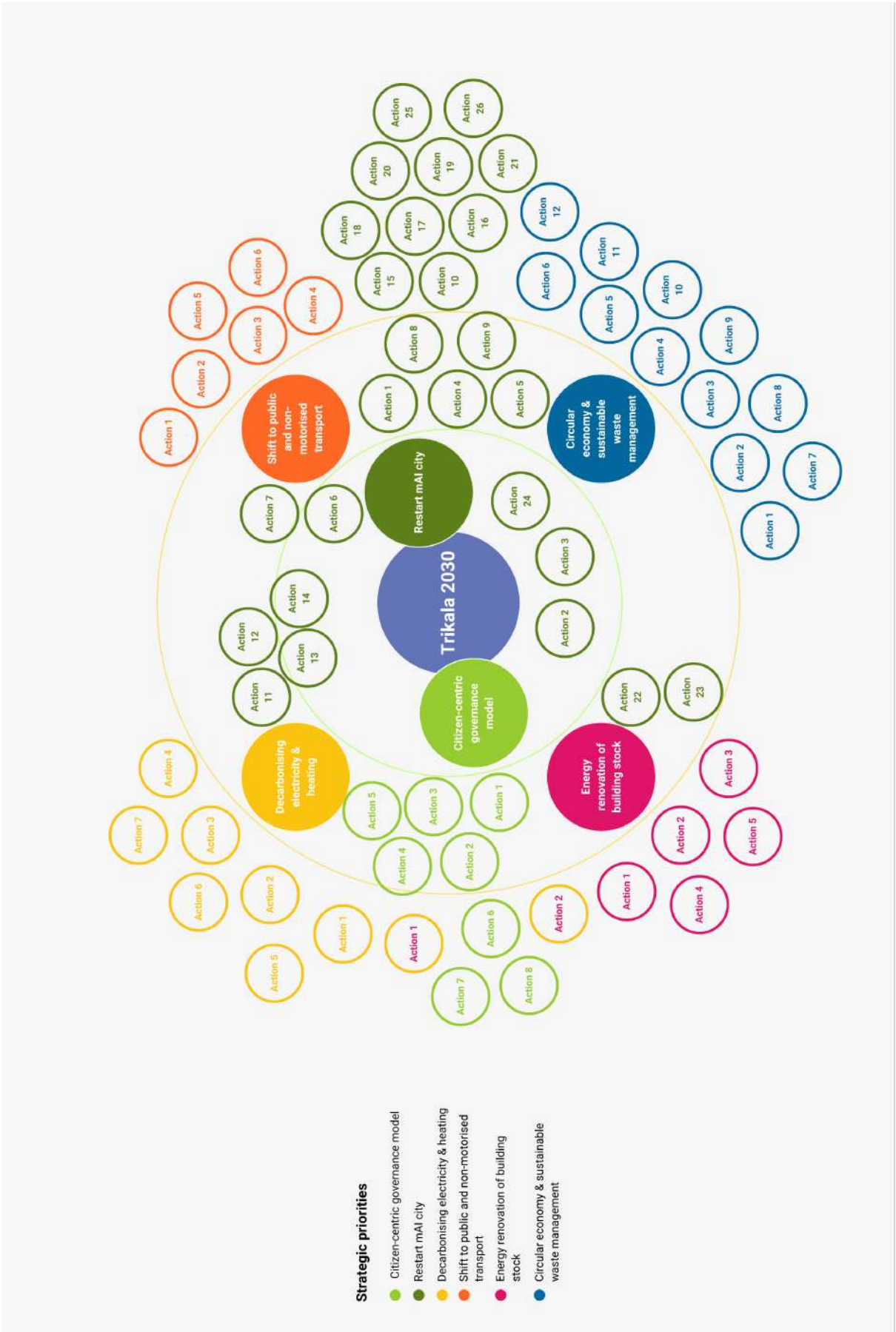


Figure 4 Trikala's key priorities towards climate neutrality.

The imperative to achieve climate neutrality by 2030 underscores the critical importance of collaboration among various levels of government, citizens, and diverse stakeholders. Right from the initial phase of the City's expression of interest in the Mission, Trikala's principal stakeholders have unequivocally expressed their commitment to expanding collaboration with the Municipality and providing steadfast support. A pivotal agreement has already been reached, outlining the collaborative creation and execution of the "Climate City Contract" by both the City and its Stakeholders. This collaborative endeavor aims to concentrate collective efforts and allocate resources effectively to expedite the city's transition toward climate neutrality by the specified target year.

The key stakeholders actively engaged in the implementation of climate change mitigation measures encompass national and regional governmental bodies, research and innovation institutions, universities, the private sector, financial institutions, transport operators and utility companies. Their involvement signifies a comprehensive and interdisciplinary approach, bringing together the expertise and resources of multiple sectors to address the multifaceted challenges associated with climate neutrality. This collaborative model underscores the shared commitment to achieving the city's climate goals and reflects a united front in tackling the complex issues posed by climate change.

4. Principles and process

Trikala is committed to implementing specific principles and processes to ensure the successful attainment of its climate neutrality target by 2030. This includes the establishment of clear governance structures to oversee the implementation of climate initiatives, fostering robust citizen engagement mechanisms to gather diverse perspectives and encourage community participation, actively seeking funding opportunities and attracting investors to support climate projects and initiatives, conducting regular iterations of the Climate City Contract (CCC) every two years to adapt strategies based on evolving circumstances and knowledge, and implementing rigorous progress monitoring mechanisms to track the effectiveness of interventions and ensure accountability. Through these tailored approaches and dedicated efforts, Trikala aims to pave the way for a sustainable and resilient future for its residents and stakeholders alike.

Governance model

1. Citizen engagement

The city of Trikala aims to establish a citizen-centric model, prioritising transparency, inclusivity and active involvement of citizens in decision-making processes. This citizen engagement model will include regular town hall meetings, where citizens can participate with physical or virtual presence, community forums and digital platforms to collect citizen input, making sure their concerns and aspirations are integrated into climate action plans. in addition, the city will create and implement educational programs and workshops to raise awareness about climate issues, encouraging citizens to adopt sustainable practices and actively contribute to the climate neutrality initiative.

2. Stakeholder network expansion

Collaborations between the city and potential stakeholders is one of the key parameters of CCC and achieving climate neutrality. Trikala already has an extended stakeholder network

with local and national actors from different fields, as it is shown in the Signatories section. However, it is of great importance to keep working on the continuous expansion of this network, creating new partnerships with stakeholders that can support the city's mission with knowledge, expertise, funding or any other way.

Citizen and Stakeholder engagement

Stakeholder engagement will serve as a cornerstone in guiding Trikala's transition to climate neutrality. The city aims to ensure that its whole ecosystem is fully informed about climates actions and on top of that actively participates in shaping and implementing them.

The strategy for actively engaging citizens and stakeholders in Trikala is depicted in the following diagram and elaborated upon below.

- City forums: Comprising citizens, businesses, and organizations pertinent to specific intervention domains, these committees will provide local insights, expertise, and ideas crucial for implementing key actions outlined in the CCC. Regularly organized by the Municipality, they serve as platforms for collaboration, information sharing, co-design and transparency.
- Participatory Platforms: The Municipality operates a public consultation platform to ensure that proposed actions align with local needs. On this platform, individuals and organizations can collaborate and communicate to draft and refine climate policies, among other initiatives. This approach fosters a sense of commitment among participants and enhances transparency. However, the platform has not been widely utilized, prompting the creation of new participatory tools to attract a broader audience.

- Educational campaigns: Creating a culture of environmental responsibility premises the continuation of educational campaigns targeting citizens and stakeholders. The campaigns include workshops, seminars and awareness programs to educate the public about climate neutrality, sustainability and the importance of collaborations between different actors.
- City Media: In addition to the Municipality's social media accounts and website, dedicated platforms have been established to promote Trikala's journey towards climate neutrality. These specialized websites and social media accounts serve as central hubs for disseminating information about climate action initiatives, goals, and progress, ensuring easy access for the community. These include:
    - Trikala Municipality Website
    - Trikala Municipality Facebook Page
    - Trikala Municipality X (former Twitter) Account
    - Trikala Municipality YouTube Channel
    - Trikala Municipality Instagram Profile
    - Trikala Municipality TikTok Profile
    - Trikala2030 Website
    - Trikala2030 LinkedIn Page

All media outlets and webpages adhere to a standardized set of references, logos, and hashtags (#Trikala2030, #netzerocities, #climateneutrality, #missioncities) when discussing the Mission for "100 Climate Neutral and Smart Cities by 2030" and Trikala's pursuit of climate neutrality. This ensures a cohesive visual identity across platforms and reinforces our commitment to this important initiative.

- Incentive programs: Through “Restart MAi City” program, the Municipality will create incentive programs and citizen engagement applications to attract citizens and businesses to actively participate in climate policies. This involves recognition for sustainable practices and rewards through a digital local currency, called Tricoin.

3. CCC progress monitoring

The realisation of Restart mAI city actions will allow for the implementation of a robust monitoring and evaluation system to track the progress of climate actions, ensuring accountability and transparency. The monitoring indicators presented in Action and Investment Plan will be regularly assessed and progress reports will be available to the public. This way a sense of shared responsibility and community engagement is fostered. Monitoring and progress reports can greatly support regular CCC iterations based on data-driven insights, allowing Trikala to refine strategies and reallocate resources for maximum impact.

4. CCC iterations

Trikala commits to a dynamic and iterative process of CCC every two years, ensuring that climate action plans remain adaptive and responsive to new situations, evolving challenges and opportunities. Climate City Contract iterations will involve extensive consultations with stakeholders, citizens and experts to incorporate updated data, technological advancements and lessons learned from previous implementation phases. CCC’s progress monitoring with utilisation of smart technologies will be a great tool supporting the plan’s revision.

5. Attracting funding and investors

One of the biggest challenges is funding the climate actions. Trikala will actively seek funding from various sources, including national and EU grants, private investors, banks and sustainable finance mechanisms. It is important for the city to create an attractive investment environment by highlighting the economic benefits of climate projects, emphasizing long-term results and offering incentives for green initiatives. The city will establish collaborative platforms to connect local businesses, investors and financial institutions interested in supporting Trikala's climate plan.

6. Trikala Climate team

In Trikala, a specialized Climate team, consisting of a dedicated team and representatives from pertinent municipal departments, will oversee and coordinate the monitoring and updating of the Climate City Contract (CCC). Serving as the focal point for all CCC-related activities, Trikala Climate Team will possess the requisite expertise to evaluate and monitor progress comprehensively. Through diligent oversight, it will play a pivotal role in ensuring that the city remains aligned with its climate neutrality objectives by 2030.

Smart city actions will play a pivotal role in this monitoring process. Implementing advanced technologies and data analytics, the city will leverage real-time information from various sectors such as energy consumption, transportation, waste management, and other key areas covered by the CCC. These smart city initiatives will provide valuable insights and enable prompt adjustments to the CCC based on the evolving needs and challenges faced by the city.

Monitoring indicators are suggested in Action and Investment Plan, to quantify and assess the city's progress toward climate neutrality. These indicators cover a range of factors, including greenhouse gas emissions reduction, energy efficiency improvements, renewable energy integration, and other relevant metrics, as well as economic and financial fields. Regular assessments and evaluations, conducted in collaboration with stakeholders and utilizing data from smart city initiatives, will inform updates to the CCC. The iterative nature of this process, combined with periodic CCC iterations every two years, ensures that the city remains adaptable and responsive to emerging opportunities and challenges in its pursuit of climate neutrality.

Key Principles

Climate action design necessitates not only technical and environmental considerations, but also social principles to guarantee that solutions are equitable, inclusive, and responsive to community needs and ambitions. The key principles that will guide Trikala city while it implements its Climate City Contract are:

- Equity and justice

By incorporating equity and justice into the design of climate action, we can develop more comprehensive and effective responses to climate change while working towards a more just and inclusive society. This approach recognizes that climate change is not merely an environmental issue, but that it intersects with social and economic factors, requiring a holistic, people-centred approach.

- Community engagement

Community engagement is an important aspect of effectively addressing climate change. By engaging communities in the planning, decision-making and implementation of climate change initiatives, we can develop more inclusive, resilient and impactful solutions to climate change challenges at the local level.

- Inclusivity

Inclusivity is an essential element of effective climate action. By taking into account a wide range of perspectives, involving all stakeholders, and addressing the specific needs of vulnerable communities, we can create more robust and equitable solutions to combat climate change. Climate change is a global challenge that requires a collective effort, and inclusivity is fundamental in ensuring that no one is left behind in the journey towards a sustainable and resilient future.

- Capacity building

Capacity building refers to the process of strengthening the knowledge, skills and resources of individuals, organizations, and communities to effectively address the challenges and opportunities presented climate change. This includes providing training, education and support to increase the capacity of stakeholders to understand, plan, implement and monitor climate related initiatives.

- Resilience and adaptation

By adopting resilience and adaptation strategies, societies can better manage the impacts of climate change, reduce vulnerability and create a more sustainable and climate-resilient future for future generations.Resilience means anticipating climate risk and preparing to adapt to changing conditions and recover from climate-related disruption. Adaptation involves the adaptation of human systems, practices and behaviors to address the current and projected impacts of climate change.

- Cultural Preservation

Incorporating cultural preservation into climate action ensures that efforts to address climate change are not only environmentally focused but also socially and culturally sensitive. Climate change poses significant threats to cultural heritage and traditions, making cultural preservation an essential aspect of climate action. Cultural preservation in the context of climate change refers to safeguarding the tangible and intangible aspects of a community's culture, history, and identity from the impacts of climate change.

- Affordability and accessibility

To ensure affordability and accessibility in climate action, policymakers and stakeholders must consider the needs and circumstances of diverse communities. This involves providing financial support, incentives, and subsidies where necessary, as well as designing policies that prioritize equitable outcomes.

- Transparency and accountability

These principles create a foundation of trust and collaboration, enabling a more coordinated and impactful response to the urgent challenge of climate change. By incorporating transparency and accountability in climate change action, stakeholders can ensure that efforts are effective, fair, and aligned with climate goals.

- Collaboration and partnerships

Collaboration and partnerships are crucial components of effective climate change action. They involve various stakeholders, including governments, businesses, non-governmental organizations (NGOs), communities, and international bodies, working together to develop and implement comprehensive climate solutions.

6. Signatories

Effective stakeholder engagement is crucial throughout the Climate City Contract process. Cities engage with a diverse range of stakeholders, including local communities, businesses, civil society organizations, academia, and technical experts. Collaborative workshops, public consultations, and partnerships are established to ensure that multiple perspectives are considered and integrated into the planning and implementation process. Stakeholders play a vital role in providing insights, expertise, and support to make the climate goals a reality.

Name of the signatory (organisation)	Sector/ Domain/Level of operation	Legal form	Name of the responsible person	Position of the responsible person
Municipality of Trikala	Public sector/Local Authority	Local Authority (O.T.A.) 1st degree	Nikolaos Sakkas	Mayor
Hellenic Ministry of Digital Governance	Public sector/National Authority	Legal Entity of Public Law	Dimitrios Papastergiou	Minister
Ministry of Environment and Energy – General Secretariat of Spatial Planning & Urban Environment	Public sector/National Authority	Legal Entity of Public Law	Efthymios Bakogiannis	General Secretary
Region of Thessaly*	Public sector/Regional Authority	Legal Entity of Public Law	Dimitrios Kouretas	Governor of Thessaly Region
Regional Union of Municipalities of Thessaly*	Regional Union	Private legal entity	Nikolaos Sakkas	President
Hellenic Electricity Distribution Network Operator (HEDNO)*	Utilities – Electricity/National level	Limited company		
Regulatory Authority for Energy, Waste and Water	Independent Regulatory Authority	Legal Entity of Public Law	Athanasios Dagoumas	President
Municipal Water Supply and Sewerage Company (DEYAT)	Utilities - Water resources/Local level	Private legal entity	Christos Blougouras	President of the Board

Environmental Development Agency of Western Thessaly (PADYTH) S.A.	Waste Management/Regional & Local level	Public Limited Company	Tsiakos Vasileios	Vice President of the Board and Mayor of Karditsa
e-Trikala SA	Information Technology/Smart city & urban development/Local level	Public Limited Company	Odyssefs Raptis	Chief Executive Officer
Urban Development Company of Trikala S.A.	Urban development/ Municipal property utilization/Local level	Public Limited Company	Georgios Ziogas	President of the Board
University of Western Macedonia	Higher education/ Electrical Engineering & Energy /National level	Legal Entity of Public Law	Theodoros Theodoulidis	Rector
National and Kapodistrian University of Athens – Department of Geology and Geoenvironment	Higher education/ Climatology and Atmospheric Environment/ National level	Legal Entity of Public Law	Panagiotis Nastos	Director of Laboratory of Climatology and Atmospheric Environment
University of Western Attica	Higher education/ Electrical and Electronic Engineering /National level	Legal Entity of Public Law	Dimitrios Piromalis	Associate Professor, Smart Technologies, RES and Quality Research Lab
Democritus University of Thrace (DUTH)	Higher education/Sustainable development/ National level	Legal Entity of Public Law	Aristotelis Papageorgiou	Chair of the Committee for Sustainable Development
Institute of Communication and Computer Systems (ICCS) - National Technical University of Athens	Research institution/Communications, Mobility, Smart City/National level	Private legal entity	Ioannis Psarras	Director
Athena Research Center	Research institution/Information Technologies /National level	Non-Governmental Organisation	Ioannis Emiris	General Director & President of the Board

Centre for Renewable Energy Sources and Savings	Research and Technology Center/National Energy Center /National level	Private legal entity	Dimitrios Kardomateas	Chairman of the Board/General Director
Directorate of Primary Education of Trikala	Primary education/local level	Legal Entity of Public Law	Christos Trikalis	Director
Directorate of Secondary Education of Trikala	Secondary education/local level	Legal Entity of Public Law	Alexandros Kapaniaris	Director
Hellenic Solid Waste Management Association	Scientific Organization/Waste Management-Circular Economy/National level	Non-profit	Georgios Iliopoulos	President
Hellenic Energy Competence Center*	Energy research institution	Private company		
Cities Net – Digital Cities of Central Greece S.A.	Intermunicipal Telecommunications Company	Public Limited Company		
P - net Competence Center	Energy research institution	Private company	Didoe Prevedourou	Managing Director
Cooperative Bank of Thessaly	Financial Institution/Regional level	Limited liability company	Anastasios Lappas	President - Executive Member of the Board
Commercial Association of Trikala	Business association	Private legal entity	Christos Blougouras	President
Technical Chamber of Greece – Committee of Regional Department of Central & Western Thessaly	Professional organization	Legal Entity of Public Law	Apostolos Batavanis	President
Public Transport Organization of Trikala	Mobility/local level	Private Limited Company	Dimitrios Ioannou	President of the Board

Intercity Transport Organization of Trikala*	Mobility/national level	Private Limited Company		
ABB SA Greece*	Engineering and Digital Technologies /International level	Private Limited Company		
NOVA Hellas*	Telecommunications/International level	Private Limited Company		
DOTSOFT S.A.	Smart solutions	Private Limited Company	Anastasios Manos	CEO
Google Hellas*				
Mellon Labs	Environmental consulting/waste management-circular economy/local level	Private company	Kyriakos Tsitouridis	CEO
WasteCloud	Environmental consulting/waste management-circular economy/local level	Private company	Kyriakos Tsitouridis	CEO
EPTA Environmental Engineering	Environmental engineering/local level	Private company	Damianos Bourkas	President
Global Water partnership - Mediterranean	Sustainable development/ Natural Resources/international level	Non-profit civil society organisation	Vaggelis Konstantianos	Executive Secretary
Organisation Earth	Sustainable development/national level	Non-Governmental Organisation	Alexis Galinos	General Director
Common Space	Urban planning-Participatory design/local level	Social Cooperative Enterprise	Konstantinos Vourekas	President

Municipal Youth Council	Municipal governance/Youth engagement/local level	Municipal Body	Ioannis Lappas	President
Municipal Committee for Equality	Municipal governance /Equality/local level	Municipal Body	Dimitra Natsina	President/ Elected Vice Mayor of Social Welfare
Municipal Counseling Center for Women	Municipal governance /Equality/local level	Municipal Body	Styliani Peligkou	Head of the center
Municipal Social Welfare Department	Municipal governance /Social Services/local level	Municipal Department	Styliani Peligkou	Director of Social Welfare

*Organizations marked with an asterisk intended to cosign the CCC but were unable to meet the deadline due to prolonged internal procedures. Their signatures are planned to be submitted in the dedicated slot reserved by NZC solely for this purpose.

TRIKALA

2019 Greenhouse Gases (GHG) Inventory

TABLE OF CONTENTS

1.Introduction

1.Introduction

Climate change is the greatest global environmental challenge

Climate change refers to the long-term alteration of Earth's climate patterns, predominantly caused by human activities that release excessive greenhouse gases into the atmosphere. The burning of fossil fuels, deforestation, industrial processes, and agriculture are major contributors to the heightened concentrations of carbon dioxide, methane, and other greenhouse gases, trapping heat and leading to a warming planet. The consequences of climate change are far-reaching and alarming, including rising global temperatures, melting ice caps, sea-level rise, extreme weather events, and disruptions to ecosystems and wildlife.

Moreover, climate change exacerbates food insecurity as changing weather patterns disrupt agricultural systems and decrease crop yields. The availability of clean water is also at risk due to the alteration of precipitation patterns and increased evaporation rates. Additionally, climate change contributes to the spread of diseases as shifting temperatures create favourable conditions for disease vectors like mosquitoes.

It is imperative that we take immediate action to mitigate the impacts of climate change by transitioning to renewable energy sources, implementing sustainable land-use practices, and adopting eco-friendly policies. Furthermore, education and awareness campaigns are crucial in promoting behavioural changes that reduce carbon emissions and promote environmental stewardship.

According to the European Commission, cities occupy only 4% of the EU's land area, but gather 75% of its citizens. Moreover, cities consume over 65% of the world's energy and they are source for more than 70% of global CO_2 emissions. It is clear that cities can play an important role in the effort to tackle climate change.

Horizon Europe research and innovation programme 2021-2027 innovates by creating the Cities Mission to deliver 100 climate-neutral and smart cities by 2030. Trikala city is one of the participants, aiming to act as a center for innovations and a role model for all European cities.

The first step in developing a climate action strategy requires the creation of a greenhouse gases (GHG) inventory. Cities can use an inventory to comprehend how different community activities contribute to emissions. A comprehensive GHG inventory allows cities to take focused action against climate change.

2. Trikala City

2.Trikala City

2.1. General information

Municipality of Trikala consists of 8 municipal geographical units. Trikala unit which is basically the city of Trikala, gathers 80% of the total municipality citizens making it the only urban center within the municipality's administrative boundary.

Trikala city has a population of 61.653 citizens (2011) and occupy a land area of 69,93 km². Trikala has a population density of more than 880 inhabitants/km², whereas the 7 remaining municipal units altogether account for approximately 100 inhabitants/km².

2.2. Morphology and climate data

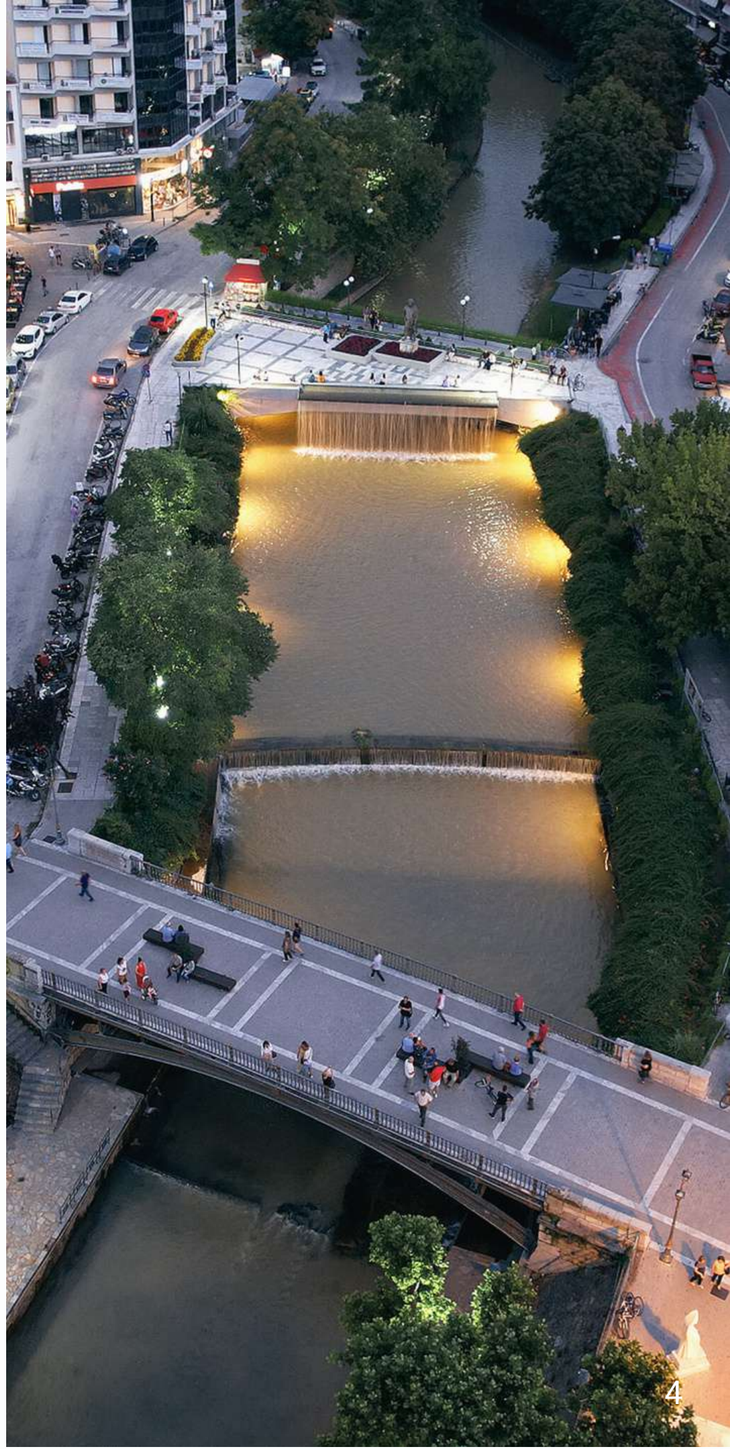
Trikala regional unit is the most mountainous of Thessaly. Two large rivers of Greece, Acheloos and Pineos, flow through it. One of the tributaries of Pinios is the Litheos, on whose banks Trikala city is built.

The climate in Trikala, as in the whole of Thessaly, is continental with large temperature differences between winter and summer. The average annual temperature is 16-17 ºC in the lowlands and lower in the mountains. Due to the river Litheos, the relative humidity in Trikala is quite high.

2.3. Local economy

Trikala's regional unit economy is mainly agricultural. In the lowlands, cereals and vegetables are grown using modern agricultural means. Animal breeding is also developed, especially cattle, which has created corresponding milk industries. At the same time, the forest wealth is another important economic source for the prefecture.

In recent years, a significant share of revenue has been tourism and the provision of services, as the prefecture receives a large number of visitors throughout the year, being one of the most popular tourist destinations in mainland Greece. It is estimated that about one million tourists visit the regional unit of Trikala both in the summer, but mainly in the winter months. The main tourist destinations are considered to be Meteora, the city of Trikala, the city of Pyli with its unique bridges and monasteries, the traditional settlements of the mountain mass of Pyli, as well as the Ski Center in Pertouli.



3.Greenhouse Gases (GHG) Inventory

3.GHG Inventory

3.1. Overview

A GHG inventory estimates the quantity of greenhouse gases emitted as a result of the activity occurring within a city's boundary. GHG emissions are accounted for every source/activity and for a specific time span, called baseline year. GHG inventories are necessary for a city to design and realise climate actions. Data reporting is important for several reasons:

- Informs about current situation and allows emissions prediction based on different scenarios
- Highlights sectors/activities contributing the most to GHG emissions
- Helps in goal setting
- Allows progress monitoring from implemented climate actions
- Improves a city's green profile and encourages climate investments

3.2. GPC

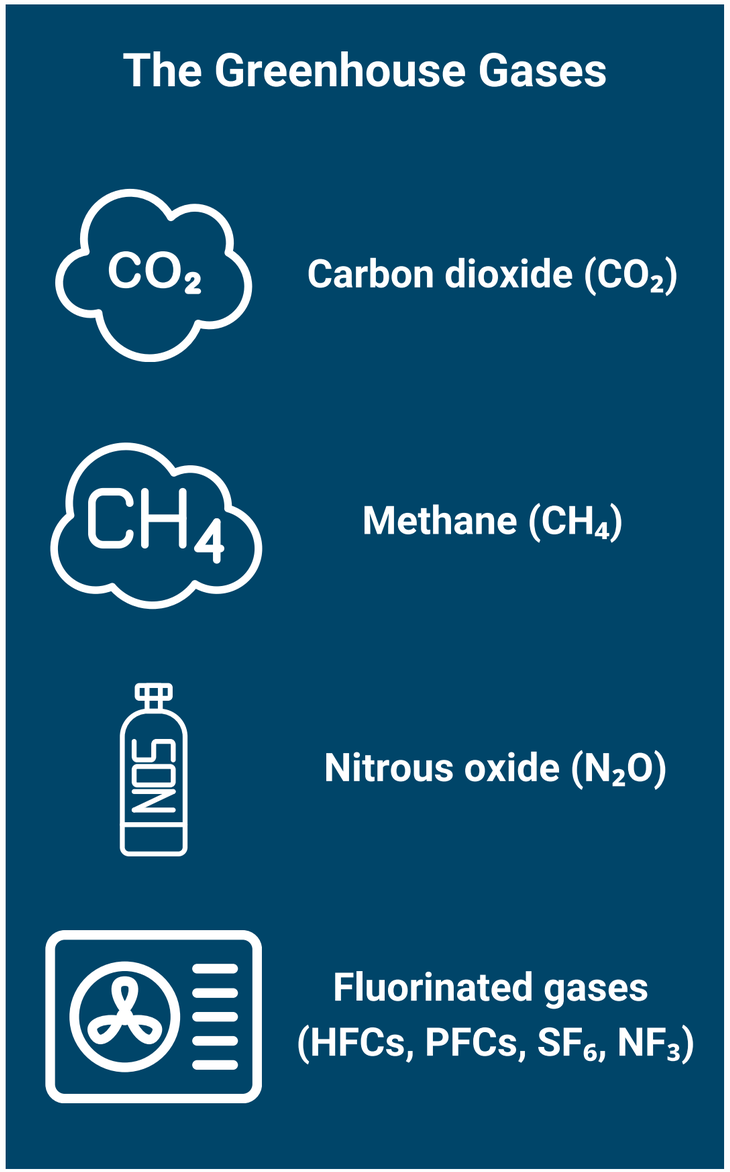
The Global Protocol for Community-Scale (GPC) Greenhouse Gas Inventories is a global standard for the calculation and reporting of city-wide GHG emissions, consistent with the 2006 IPCC (Intergovernmental Panel on Climate Change) Guidelines for National Greenhouse Gas Inventories.
In order to use the GPC, cities must define the inventory boundary. The boundary includes the geographic area, time span, gases and emission sources covered by a GHG inventory. The GPC covers the 7 gases covered by the Kyoto Protocol:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulfur hexafluoride (SF_6)
- Nitrogen trifluoride (NF_3)

GHG emissions from city activities are classified into six main sectors:

- Stationary energy
- Transportation
- Waste
- Industrial processes and product use (IPPU)
- Agriculture, forestry and other land use (AFOLU)
- Any other emissions occurring outside the geographic boundary as a result of city activities

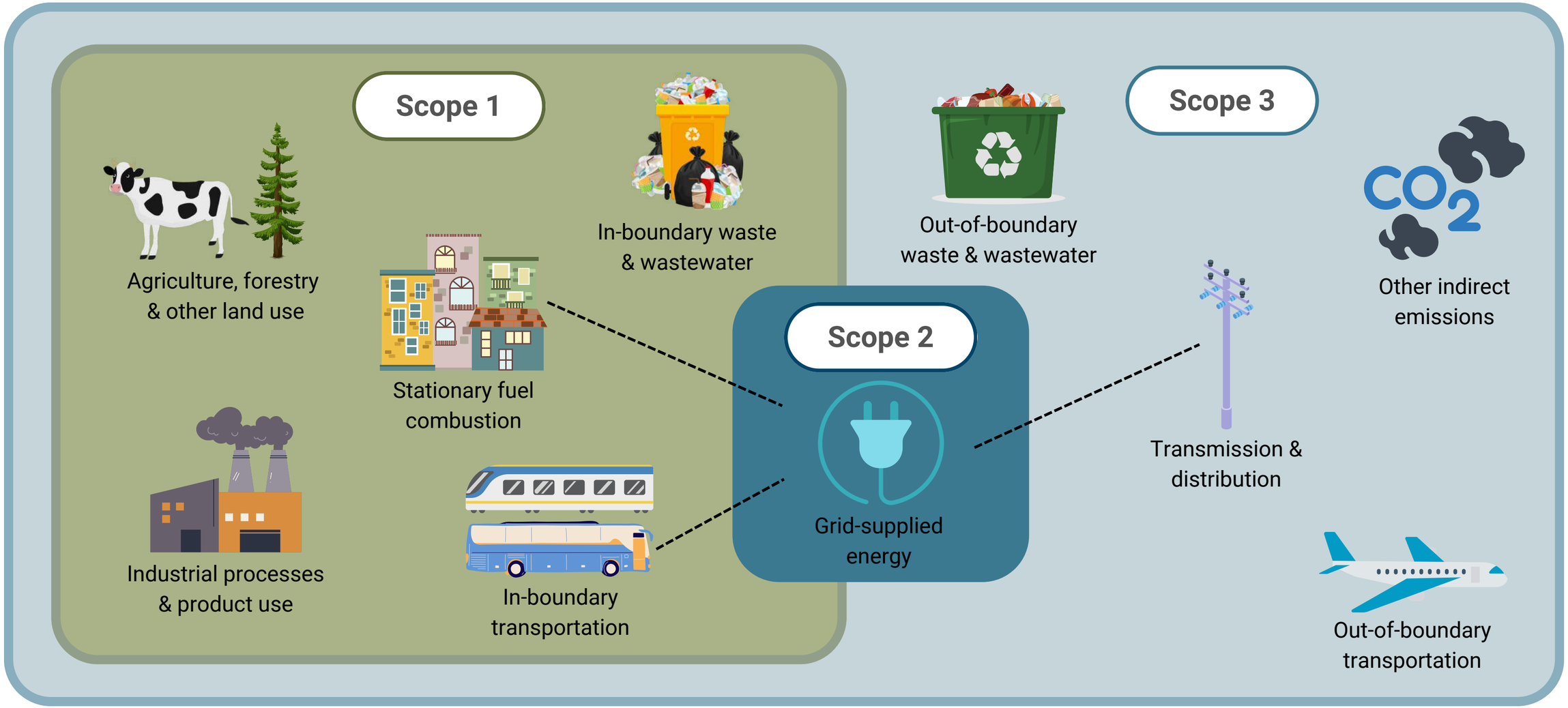
Activities taking place within a city can generate GHG emissions that occur whether inside of outside the city boundary. To distinguish among them, the GPC groups emissions into three categories based on where they occur: scope 1, scope 2 and scope 3 emissions.



Scope 1: GHG emissions from sources located within the city boundary

Scope 2: GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary

Scope 3: all other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary



Inventory boundary (including scopes 1,2 & 3)

Geographic city boundary (including scope 1)

Grid-supplied energy from a regional grid (scope 2)

3.3. Reporting requirements

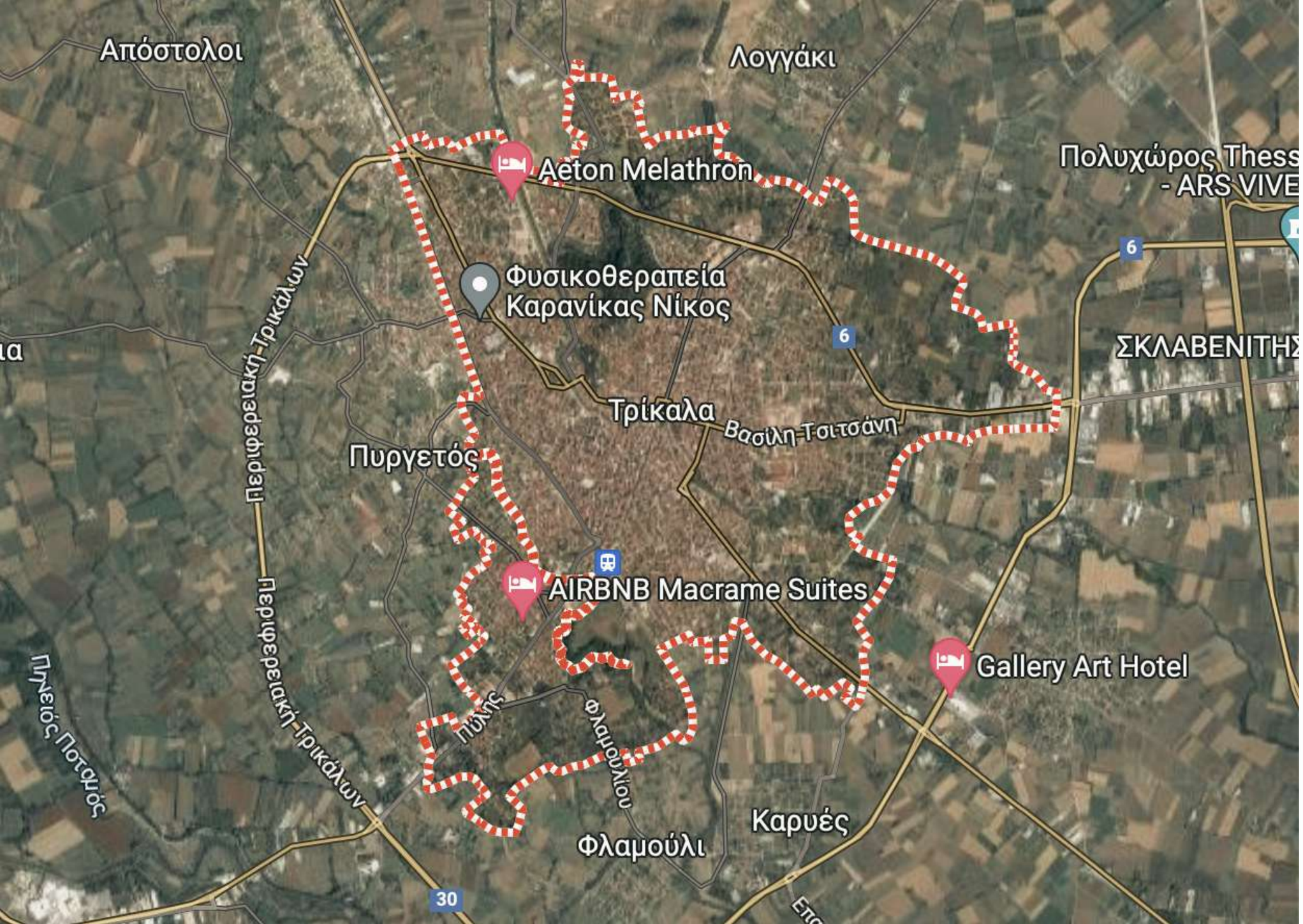
Cities can choose between two reporting levels: BASIC or BASIC+. The BASIC level covers scope 1and scope 2 emissions from stationary energy and transportation, and also scope 1 and scope 3 emissions from waste.
BASIC+ includes in addition emissions from IPPU, emissions and removals from AFOLU and emissions from transboundary transportation.

3.4. Inventory boundary

Extreme environmental pressures are frequently concentrated within cities. At the same time, cities serve as the locations where remedies are being implemented first. As mentioned before, Trikala city gathers 80% of citizens and is the only urban area within the Municipality of Trikala.
Therefore, the geographic boundary of the inventory coincides with the city's boundary.
The inventory's baseline is 2019, because it is the year with the most complete and accurate data available.
The sources' sectors of GHG emissions which should be included in a city's GHG inventory for the purposes of the Cities Mission are Buildings/Stationary Energy, Transport, Waste, IPPU and AFOLU. In light of this, the inventory's reporting level chosen is BASIC+.

Table 3.1. Inventory city information.

Required information	
Name of city	Trikala
Country	Greece
Inventory year	2019
Geographic boundary	Smaller than the administrative boundary
Land area (km²)	69,93
Resident population	61.653
GDP	1.498€ million



Picture 1. Trikala city GHG emissions inventory geographic boundary.

Activities included in the inventory

1. Stationary Energy

Fossil fuel combustion & transmission and distribution losses from grid-supplied energy in:

- Residential buildings
- Commercial buildings and facilities
- Institutional buildings and facilities

Fugitive emissions from oil and natural gas systems

2. Transport

- On-road transportation
- Railways

3. Waste

- Solid waste disposal
- Wastewater treatment and discharge

4. IPPU

- Lubricant use in vehicles
- Paraffin wax use
- Urea use as a catalyst
- Product uses as substitutes for ODS

5. AFOLU

- Emissions/removal from forest land

3.5. Emissions factors

The calculation of greenhouse gases emissions requires the use of standard emission factors based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. These standard factors are based on the carbon content of each fuel, as is the case in national statistical inventories of GHG emissions under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. Where necessary, emission factors specific to the city of Trikala were used based on the methodology proposed in the GPC standard.

Table 3.2. Emission factors for different energy sources and activities.

Energy source	Units	CO_2	CH_4	N_2O	CO_2 (b)	Source
Electricity from the grid	tn/MWh	0,606				National emission factor
Natural gas	kg/TJ	56.100	1	0,1		2006 IPCC Guidelines
Liquid gas	kg/TJ	63.100	8,02	1,36		2006 IPCC Guidelines
Diesel oil	kg/TJ	74.100	0,7	0,4		2006 IPCC Guidelines
Biomass	tn/MWh				0,3	National emission factor
Motor gasoline	kg/TJ	69.300	22,43	1,72		2006 IPCC Guidelines

3.6. Emissions units

The unit of measurement for greenhouse gas emissions is defined as a metric ton of each gas (t or tn) and the ton (tn) of carbon dioxide equivalent (tCO2e), according to the international system of units (SI).

Carbon dioxide equivalent (tCO2e) enables the comparison between various greenhouse gases, as each of them has a different impact on global warming. The carbon dioxide equivalent is calculated by multiplying the emissions of each of the greenhouse gases by the Global Warming Potential (GWP) over a period of 100 years.

The GWP used for the purpose of this inventory are according to the IPCC Fifth Assessment Report, which is the most recent one (2013).

Table 3.3. GWP (100 years) of major GHGs.

Name	Formula	GWP value in IPCC Fifth Assessment Report (CO_2e)
Carbon dioxide	CO_2	1
Methane	CH_4	28
Nitrous oxide	N_2O	265

3.7. Notation keys

Collecting data is a crucial aspect of developing and regularly updating a GHG inventory. The data will likely originate from diverse sources and will vary in terms of quality, format, and completeness. Often, it will require adjustments to suit the inventory's specific requirements.

Since data availability and emission sources can differ significantly between cities, the GPC mandates the use of notation keys, following the recommendation of the IPCC Guidelines. Notation keys are employed to handle limitations in data availability and to accommodate variations in emission sources. Cities using notation keys must provide an accompanying explanation, justifying any exclusions or partial accounting of GHG emission source categories in their inventory.

Table 3.4. Notation keys (Source: GPC).

Notation key	Definition	Explanation
IE	Included Elsewhere	GHG emissions for this activity are estimated and presented in another category of the inventory. That category shall be noted in the explanation.
NE	Not Estimated	Emissions occur but have not been estimated or reported; justification for exclusion shall be noted in the explanation.
NO	Not Occurring	An activity or process does not occur or exist within the city.
C	Confidential	GHG emissions which could lead to the disclosure of confidential information and can therefore not be reported.

3.8. Data quality and uncertainty

To ensure complete transparency in estimating GHG emissions, all data sources and assumptions used, whether obtained through scaling, extrapolation, interpolation, or models, must be properly referenced.

Furthermore, cities must not only identify the method employed for calculating emissions but also evaluate the quality of the activity data and emission factors used. These evaluations should categorize each data aspect as high, medium, or low quality based on various factors. These factors include how well the data represent the geographical location, time or age, and technologies used in the activity, as well as the assessment boundary and emission source. The reliability and verifiability of the data sources are also taken into account during the evaluation process.

Table 3.5. Data quality assessment (Source: GPC).

Data quality	Activity data	Emission factor
High (H)	Detailed activity data	Specific emission factors
Medium (M)	Modeled activity data using robust assumptions	More general emission factors
Low (L)	Highly-modeled or uncertain activity data	Default emission factors

4.Stationary Energy

4.Stationary Energy

4.1. Stationary Energy sub-sectors

The Stationary Energy sector includes emissions from:

- Residential buildings
- Commercial and institutional buildings and facilities
- Manufacturing industries and construction
- Energy industries
- Agriculture, forestry and fishing activities
- Non-specified sources
- Fugitive emissions

Some of the above emissions do not occur within the city of Trikala boundary. The existing emissions sectors are analysed below.

4.2. Residential buildings

Residential buildings are one of the most important sources of GHG emissions in a city. According to the Energy Efficiency Certificates (EECs) of the Municipality of Trikala for the years 2018-2019 (a total of 6,109 EECs), the need for primary energy for heating in the Municipality's residences is on average 285,6 kWh/m². Considering the total area of residential buildings, the theoretical primary consumptions of the domestic sector are calculated, which amount to 974.830,8 MWh of thermal energy and 502.328,9 MWh of electrical energy.
Using the appropriate conversion factors and, in the case of thermal energy, the percentage distribution of fuels as well as the 20% reduction due to energy poverty, we have the final consumptions of the household sector.

Table 4.1. Energy consumption in residential buildings.

Fuel	Consumption (MWh)
Electricity	231.488,0
Natural gas	110.838,9
Diesel oil	52.495,6
Biomass	542.750,6
Total	937.573,1

4.3. Commercial buildings and facilities

The energy consumption in commercial buildings and facilities was calculated with the same method as in residential buildings. The natural gas consumption is an exemption, because there are recorded data from the gas distribution company regarding commercial customers. The theoretical primary consumptions of the commercial sector are 168.028,0 MWh of thermal energy and 567.737,3 MWh of electrical energy.

4.4. Institutional buildings and facilities

This category includes energy consumption in buildings of the public sector, such as schools, municipal office buildings, hospitals, street lighting etc. It also includes the city's water supply and drainage system energy consumption.
The fact that institutional buildings are public gives an advantage in terms of data accuracy, because there are bills and invoices for the fuels and electricity consumed.

Table 4.2. Energy consumption in commercial buildings and facilities.

Fuel	Consumption (MWh)
Electricity	261.630,1
Natural gas	16.226,5
Liquid gas	12.802,1
Diesel oil	84.014,0
Biomass	10.081,7
Total	384.754,4

4.5. Fugitive emissions from oil and natural gas systems

To calculate the fugitive emissions, which are essentially due to the distribution of natural gas within the city of Trikala, the Greenhouse Gas Emssions Inventory Report for the Municipality ofAthens was used, as well as data on the length of the natural gas network within the Prefecture of Trikala and in particular the city of Trikala. Specifically, the pipeline length of natural gas systems in Athens is 762,9 km, whereas in Trikala it is 87,7 km.

Table 4.3. Energy consumption in institutional buildings and facilities.

Fuel	Consumption (MWh)
Electricity	37.893,9
Natural gas	1.224,8
Diesel oil	9.598,3
Total	48.717,0

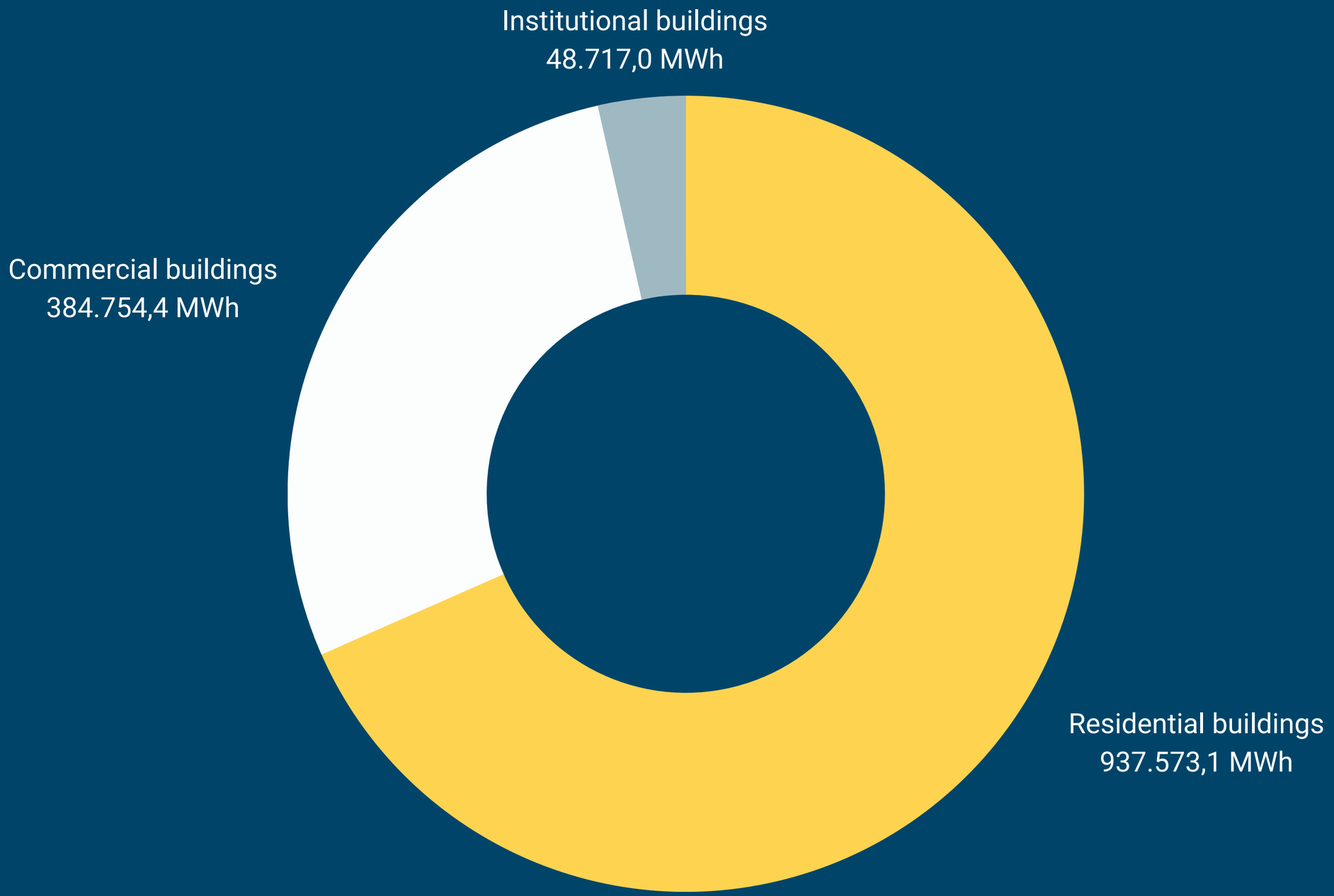


Figure 4.1. Energy consumption in Stationary Energy subsectors.

Table 4.4. Stationary Energy Overview (Source: GPC).

GHG Emission Source	Scope 1	Scope 2	Scope 3
STATIONARY ENERGY	Emissions from fuel combustion and fugitive emissions within the city boundary	Emissions from consumption of grid-supplied energy consumed within the city boundary	Transmissions and distribution losses from the use of grid-supplied energy
Residential buildings			
Commercial and institutional buildings and facilities			
Manufacturing industries and construction			
Energy industries			
Agriculture, forestry and fishing activities			
Non-specified sources			
Fugitive emissions			

Sources required for BASIC reporting

\+ Sources required for BASIC+ reporting

Sources included in Other Scope 3

Not-applicable emissions

Table 4.5. GHG emissions from Stationary Energy sources.

Scope	GHG Emissions Source	Notation keys	Gases (in tones)					Data Quality		Comments
			CO_2	CH_4	N_2O	Total CO_2e	CO_2 (b)	AD	EF	
Residential buildings										
1	Natural gas combustion		22.384,85	0,40	0,04	22.406,59	0	M	L	
1	Diesel oil combustion		14.003,61	0,13	0,08	14.027,35	0	M	L	
1	Biomass combustion		0	0	0	0	162.825,18	M	L	
2	Grid-supplied electricity		140.281,73	0	0	140.281,73	0	M	H	
3	Transmissions and distribution losses from grid-supplied electricity	IE								Included in the emission factor during grid-supplied electricity consumption
Commercial buildings and facilities										
1	Natural gas combustion		3.277,08	0,06	0,01	3.280,26	0	H	L	
1	Liquid gas combustion		2.908,1	0,37	0,06	2.935,06	0	M	L	

Scope	GHG Emissions Source	Notation keys	Gases (in tones)					Data Quality		Comments
			CO_2	CH_4	N_2O	Total CO_2e	CO_2 (b)	AD	EF	
1	Diesel oil combustion		22.411,40	0,21	0,12	22.449,38	0	M	L	
1	Biomass combustion		0	0	0	0	3.025,0	M	L	
2	Grid-supplied electricity		158.547,84	0	0	158.547,84	0	M	L	
3	Transmissions and distribution losses from grid-supplied electricity	IE								Included in the emission factor during grid-supplied electricity consumption
Institutional buildings and facilities										
1	Natural gas combustion		247,36	0,004	0,0004	247,60	0	H	L	
1	Diesel oil combustion		2.560,42	0,02	0,01	2.564,76	0	H	L	
2	Grid-supplied electricity		26.716,60	0	0	26.716,60	0	H	L	
3	Transmissions and distribution losses from grid-supplied electricity	IE								Included in the emission factor during grid-supplied electricity consumption

Scope	GHG Emissions Source	Notation keys	Gases (in tones)					Data Quality		Comments
			CO_2	CH_4	N_2O	Total CO_2e	CO_2 (b)	AD	EF	
Manufacturing industries and construction		NO								These activities do not exist within the city boundary for the baseline year.
Energy industries		NO								These activities do not exist within the city boundary for the baseline year.
Agriculture, forestry and fishing activities		NO								These activities do not exist within the city boundary for the baseline year.
Non-specified sources		NO								These activities do not exist within the city boundary for the baseline year.
Fugitive emissions from mining, processing, storage and transportation of coal		NO								These activities do not exist within the city boundary for the baseline year.

Scope	GHG Emissions Source	Notation keys	Gases (in tones)					Data Quality		Comments
			CO_2	CH_4	N_2O	Total CO_2e	CO_2 (b)	AD	EF	
Fugitive emissions from oil and natural gas systems										
1	Natural gas transport and storage		0	0,68	0	19,06	0	L	L	
1	Natural gas distribution		1,15	0,96	0	27,93	0	L	L	

4.6. GHG Emissions from Stationary Energy sources

As it is shown on Table 4.5 the total greenhouse gases emissions from Stationary Energy sources reaches a total of 393.504,16 tn CO_2e. More specifically, the residential buildings subsector accounts for 176.715,67 tn CO_2e, the commercial buildings and facilities subsector for 187.212,55 tn CO_2e, the institutional buildings and facilities subsector for 29.528,96 tn CO_2e and the fugitive emissions from oil and natural gas systems for 46,99 tn CO_2e. It is obvious that commercial buildings and facilities energy consumption is responsible for almost half (47,5%) of the Stationary Energy sector's GHG emissions, while residential buildings come close second with 44,9% of the emissions.

In addition to total GHG emissions by city-induced reporting (BASIC+) level, there are 165.850,18 tn CO_2e of biogenic CO_2. Biogenic emissions encompass the release of carbon dioxide that arises from burning biomass materials that store and trap CO_2, which includes the materials utilized in the production of biofuels. These emissions are reported separately, under the column CO_2(b) and they are not counted in emissions totals according to the GPC protocol.

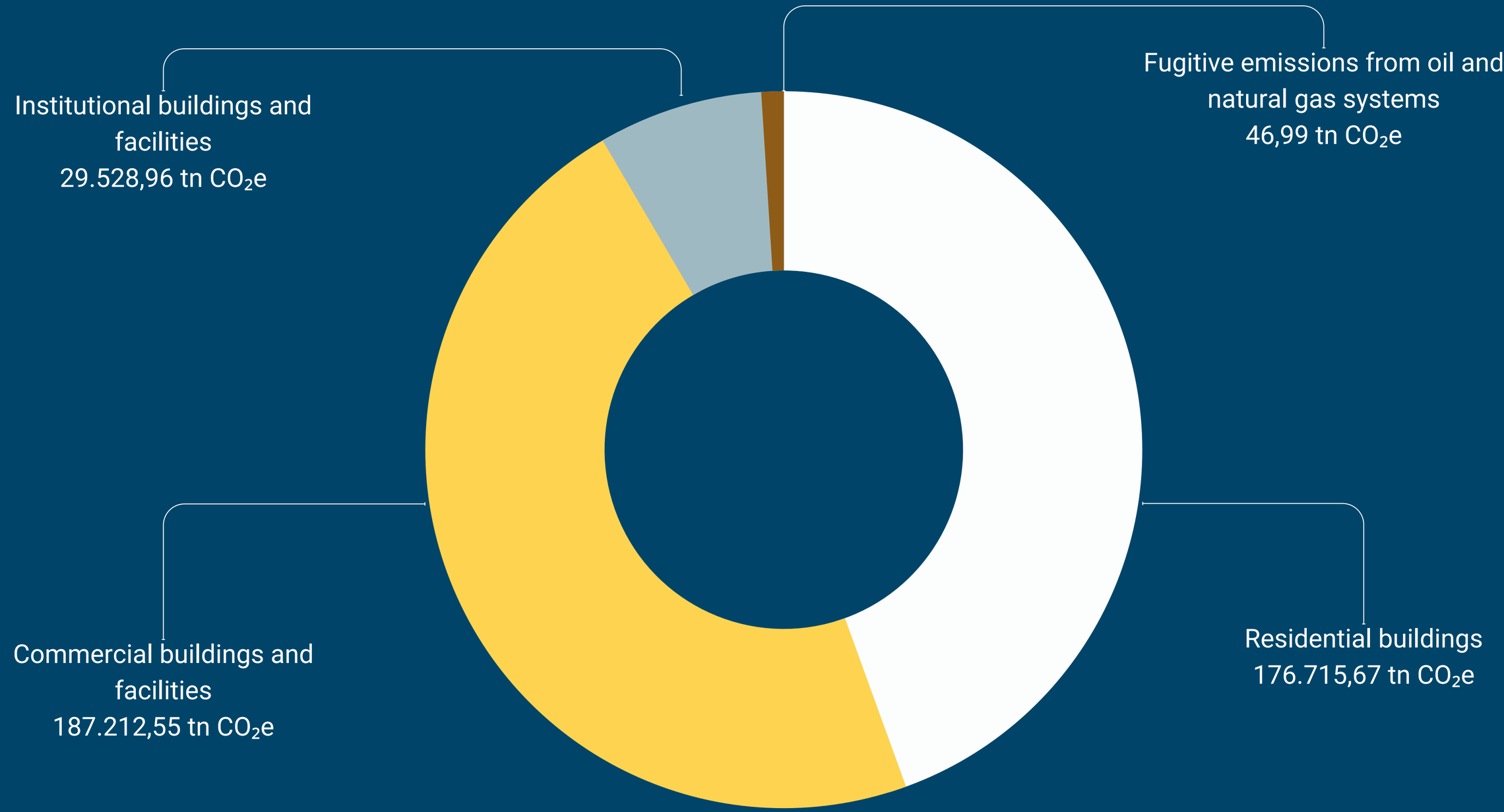


Figure 4.2. GHG emissions per Stationary Energy subsector.

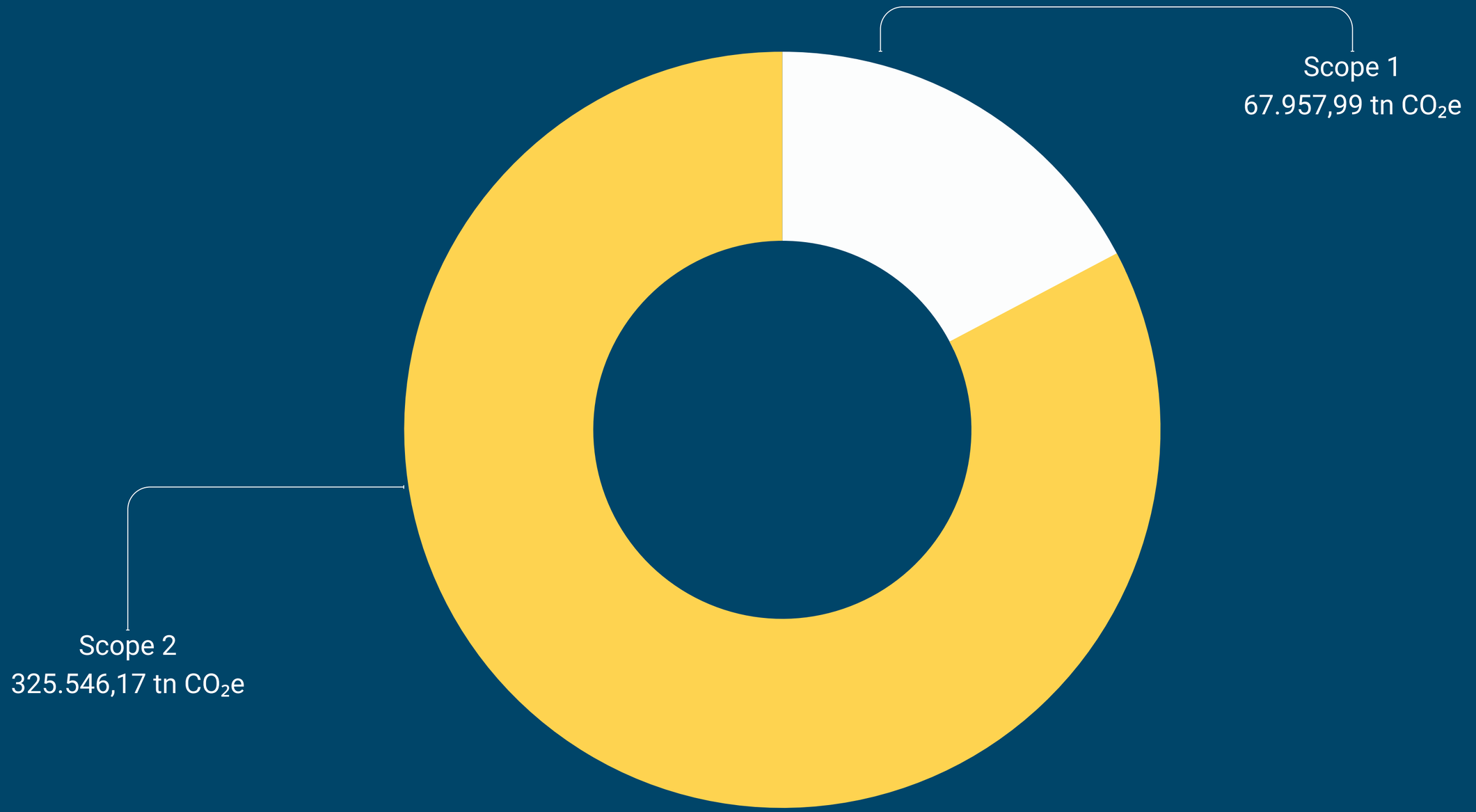


Figure 4.3. GHG emissions per scope in Stationary Energy sector.

5.Transportation

5.Transportation

5.1. Transportation sub-sectors

Transport in urban areas contribute significantly in a city's GHG emissions. The Transportation sector includes emissions from:

- On-road transportation
- Railways
- Water-borne transportation
- Aviation
- Off-road transportation

Some of the above emissions do not occur within the city of Trikala boundary. The existing emissions sectors are analysed below.

5.2. On-road transportation

On-road transportation includes vehicles such as buses, trucks, motorcycles, on-road waste collection and transportation vehicles. All the vehicles in Trikala city burn liquid or gaseous fuel in internal combustion engines and currently there are not any electric or hybrid vehicles in the city. The on-road transportation in Trikala includes the municipal fleet and public, private and commercial transport.

The municipal fleet of Trikala consists of vehicles of different types and characteristics which are utilized for the needs of municipal services.

The total annual fuel consumption has been recorded by the Municipality (in liters) and these data were used for the estimation of energy correspondence. All municipal fleet vehicles consume diesel oil. The municipal fleet's energy consumption equals to 2.748 MWh.

In addition, the Municipality of Trikala had recorded data for public transport. All public transport vehicles are also fuelled with diesel oil. The public transport's energy consumption for the baseline year was 23.110,4 MWh.

Regarding private and commercial transport, the monitoring of vehicle movement cannot be based on real data and it is usually based on models suggested by the GPC or other standars. The difficulty in the models lies practically in the accurate calculation of the moving vehicles, the kilometers traveled within a city, the use of different motor fuels by the multiple types of vehicles in circulation, etc.

The total fuel consumption of on-road private and commercial transportation for Trikala city was estimated with the following method:

- The Hellenic Statistical Authority records fuel consumption for the Prefecture of Trikala. Using population as a scaling factor, the consumption for Trikala city was estimated.
- The municipal fleet and public transport consumptions which are known are then abstracted from the total estimated consumption.
- The remaining fuel quantities are considered to roughly correspond to the consumption by the private and commercial transport of the city.

Transboundary journeys are assumed to account for 10% of private and commercial transport journeys.

Table 5.1. Energy consumption in on-road transportation.

Fuel	Consumption (MWh)
Liquid gas	90.132,2
Diesel oil	257.568,5
Motor gasoline	155.831,2
Total	503.531,9

5.3. Railways

Railways are a widespread means of transport for both people and cargo. Trains are powered by a locomotive, typically using energy through combustion of diesel fuels or electricity.

All railways in Greece are managed by Hellenic Train. Hellenic Train currently owns 13 different types of locomotives, with most of them being diesel powered and only a small portion electric powered.

The railway network of the Trikala region includes the axis of the Trikala-Kalambaka line which, as part of the Paleofarsala-Kalambaka line, has a line of normal gauge (1,44m) and a speed of 120km/h. The railway line passes through the city of Trikala, where the Railway Station of the same name is located. The railway lenght inside the city boundary is 4,82 km. Daily itineraries run to and from Athens, Thessaloniki, Karditsa and Kalambaka.

The trains that serve this line are diesel powered. Electrification projects in the Palaiofarsalos-Kalambaka section are expected to be tendered and implemented in the next years, contributing significantly to the reduction of emissions.

Scope 1 emissions from railways are estimated based on the total distance travelled within the city boundary for the baseline year and emission factors from a study conducted in Technical University of Thessaly (2018). These emission factors refer to diesel powered locomotives moving within an urban area and they are:

- 3,35 g CO_2/km
- 0,16 g CH_4/km
- 1,12 g N_2O/km

Scope 3 emissions from transboundary railway journeys are estimated based on Greece's 2019 National Inventory Report (NIR), using population as a scaling factor.

Table 5.2. Transportation Overview (Source: GPC).

GHG Emission Source	Scope 1	Scope 2	Scope 3
TRANSPORTATION	Emissions from fuel combustion for transportation occurring in the city	Emissions from consumption of grid-supplied energy for in-boundary transportation	Emissions from portion of transboundary journeys occurring outside the city, and transmission and distribution losses from grid-supplied energy
On-road transportation			
Railways			
Water transport			
Aviation			
Off-road transportation			

Sources required for BASIC reporting

\+ Sources required for BASIC+ reporting

Sources included in Other Scope 3

Table 5.3. GHG emissions from Transportation sources.

Scope	GHG Emissions Source	Notation keys	Gases (in tones)					Data Quality		Comments
			CO_2	CH_4	N_2O	Total CO_2e	CO_2 (b)	AD	EF	
On-road transportation										
1	Fuel combustion		45.195,62	0	0	45,195,62	0	H	L	
2	Grid-supplied energy	NO								According to the city's data, there are no electric vehicles for the baseline year.
Railways										
1	Diesel oil combustion		0,035	0,002	0,012	3,22	0	L	H	
Water-borne navigation		NO						These activities do not exist within the city boundary for the baseline year.		
Aviation		NO						These activities do not exist within the city boundary for the baseline year.		
Off-road transportation		IE						All emissions from fuel combustion are included in on-road transportation. Off-road transportation is assumed to be insignificant.		

5.4. GHG Emissions from Transportation sources

As it is shown on Table 5.3 the total greenhouse gases emissions from Transportation sources reaches a total of 45.195,62 tn CO_2e. GHG emissions from on-road transportation account for almost 100% of these emissions. It is important to highlight that all GHG emissions from the Transportation sector are included in scope 1.

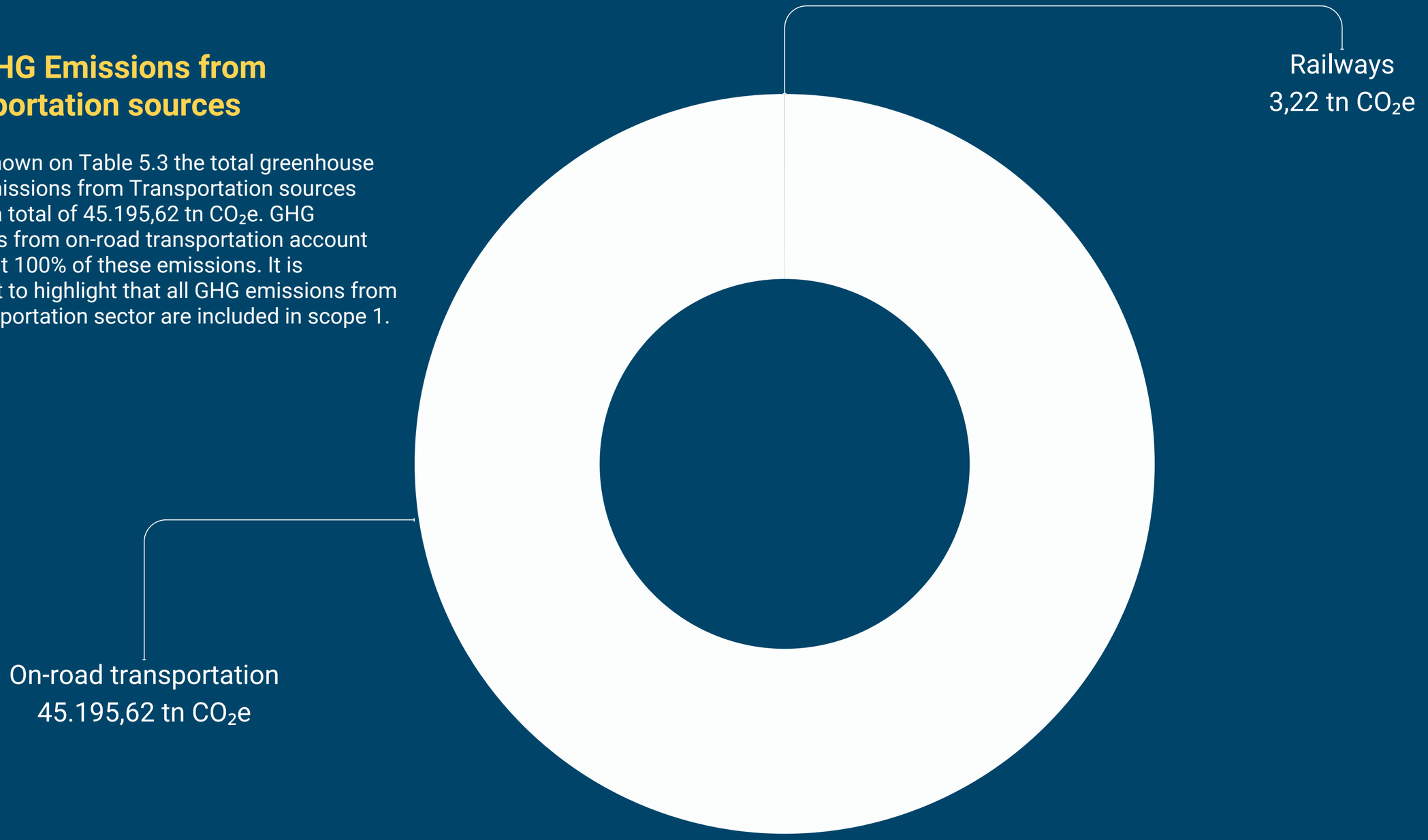


Figure 5.1. GHG emissions per Transportation subsector.

Figure 5.2. GHG emissions per scope in Transportation sector.

6.Waste

6.Waste

6.1. Waste sub-sectors

The consumption of goods leads to the production of large waste amounts. Waste treatment and disposal activities emit greenhouse gases, especially if the disposal sites are illegal. The Waste sector includes emissions from:

- Solid waste disposal in landfills or dump sites, including disposal in an unmanaged site, disposal in a managed dump or disposal in a sanitary landfill
- Biological treatment of solid waste
- Incineration and open burning of waste
- Wastewater treatment and discharge

Some of the above emissions do not occur within the city of Trikala boundary. The existing emissions sectors are analysed below.

6.2. Solid waste disposal

The total amount of Municipal Solid Waste that was landfilled in Trikala sanitary landfill and were produced from Trikala Municipality for the baseline year equals to 25.275,73 tn. Trikala's sanitary landfill is located outside the city boundary. The landfill uses the software LandGEM - Landfill Gas Emissions Model, Version 3.03 that is created from the U.S. Environmental Protection Agency (EPA).

This software provides a relatively simple approach to estimating landfill gas emissions. According to LandGEM, total emissions from the Municipality of Trikala MSW landfilling is 35.082,56 tn CO_2e.

However, this inventory's boundary is Trikala city and not the whole Municipality. For this reason, the Municipality's and the city's populations are used as scaling factors, in order to estimate the emissions attributed to the city's activities. The GHG emissions from waste produced in Trikala city and landfilled are 26.586,50 tn CO_2e. The emissions are scope 3.

6.3. Wastewater treatment

Trikala's Wastewater Treatment Plant (WWTP) is designed for 75.000 population equivalents (PE) and serves 51.800 citizens. For the baseline year, 3.781.400 m³ of wastewater were treated. The organic content of the wastewater was 945.350 kg BOD_5/yr, while 1.440,56 tn are produced annually.

The GPC protocol introduces special equations for the calculation of methane emissions from wastewater treatment and handling.

Equation 6.1. CH_4 generation from wastewater treatment

$$CH_4 \text{ emissions} = \sum_i [(TOW_i - S_i)\, EF_i - R_i] \times 10^{-3}$$

TOW_i = organic content in the wastewater (kg BOD_5/yr)
EF_i = Emission factor (kg CH_4/kg BOD_5, eq. 6.2)
S_i = Organic component removed as sludge in inventory year (kg BOD_5/yr)
R_i = Amount of CH_4 recovered in inventory year (kg CH_4/yr)

Equation 6.2. Emission factor in domestic wastewater

$$EF_j = B_o \times MCF_j \times U_i \times T_{i,j}$$

B_o = Maximum CH_4 producing capacity
MCF_j = Methane correction factor
U_i = Fraction of population in income group i in inventory year
$T_{i,j}$ = Degree of utilisation (ratio) of treatment/discharge pathway or system, j. for each income group fraction i in inventory year

Table 6.1. Waste Overview (Source: GPC).

GHG Emission Source	Scope 1	Scope 2	Scope 3
WASTE	Emissions from in-boundary waste treatment		Emissions from waste generated in the city but treated out-of-boundary
Solid waste generated in the city disposed in landfills or open dumps			
Solid waste generated in the city that is treated biologically			
Solid waste generated in the city incinerated or burned in the open			
Wastewater generated in the city			

Sources required for BASIC reporting

Sources required for BASIC+ reporting

Not-applicable emissions

Table 6.2. GHG emissions from Waste sources.

Scope	GHG Emissions Source	Notation keys	Gases (in tones)					Data Quality		Comments
			CO_2	CH_4	N_2O	Total CO_2e	CO_2 (b)	AD	EF	
Solid waste disposal										
3	Solid waste generated in the city but disposed outside the city		2.372,91	864,77	0	26.586,50	0	H	H	
Biological treatment of waste		NO						These activities do not exist within the city boundary for the baseline year.		
Incineration and open burning		NO						These activities do not exist within the city boundary for the baseline year.		
Wastewater treatment and discharge										
3	Wastewater generated in the city but treated outside the city		0	0,46	0	12,96	0	H	M	

6.4. GHG Emissions from Waste sources

As it is shown on Table 6.2 the total greenhouse gases emissions from Waste sources reaches a total of 26.599,46 tn CO_2e. It is rather obvious that the majority of GHG emissions in this sector can be attributed to solid waste disposal in sanitary landfills. In addition, the total of Waste sector GHG emissions are included in scope 3, because both Trikala's landfill and WWTP are located outside the city boundary.

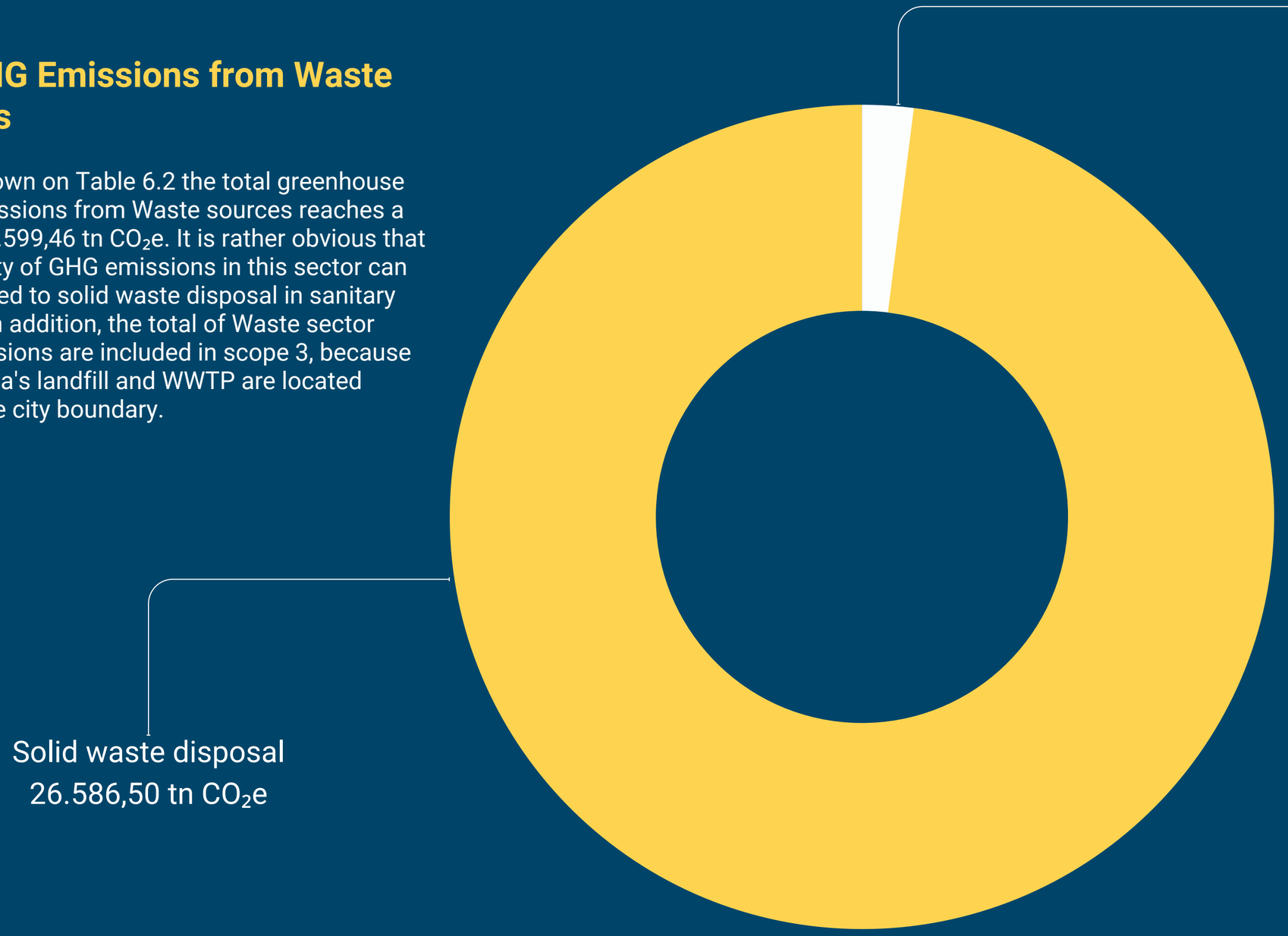


Figure 6.1. GHG emissions per Waste subsector.

Figure 6.2. GHG emissions per scope in Waste sector.

7. Industrial Processes and Product Use (IPPU)

7. IPPU

7.1. IPPU sub-sectors

The IPPU sector is separated between industrial processes and product use. There is a wide variety of industrial activities that produce GHG emissions. To avoid confusion, the emissions accounted to industrial processes are released from chemical or physical material transformation and they are not relevant to fuel combustion. At the same time, there are some product categories such as refrigerants or aerosol cans the use of which can release potent GHG emissions. Some examples for industrial processes and product use that are included in IPPU are:

1. Industrial processes
- Production and use of mineral products
- Production and use of chemicals
- Production of metals

2. Product use
- Lubricants and paraffin waxes used in non-energy products
- FC gases used in electronics production
- Fluorinated gases used as substitutes for Ozone depleting substances

Industrial processes do not occur within the city of Trikala boundary. The existing emissions from product use are analysed below.

7.2. Lubricant use

Lubricants are commonly used in transportation applications. Lubricants are manufactured in two main ways: either by separating them from crude oil at refineries or producing them at petrochemical facilities. They can be categorized into two groups: (a) motor oils and industrial oils, and (b) greases. These categories vary in their physical attributes such as viscosity, as well as their commercial applications and how they interact with the environment. When lubricants are used in engines, their primary purpose is to provide lubrication. Any emissions resulting from this use are regarded as non-combustion emissions and are included in the IPPU sector.

There are no specific activity data for lubricant use in Trikala city. The estimation of lubricant use emissions is based on the 2019 National Inventory Report, using vehicle number in national and city level as a scaling factor.

7.3. Paraffin wax use

The paraffin waxes falling into this category are obtained by separating them from crude oil during the production of light lubricating oils. These paraffin waxes find various applications, including candles, corrugated boxes, paper coating, board sizing, food production, wax polishes, surfactants used in detergents, and more. Emissions from the usage of these waxes primarily occur when they are combusted directly (for instance, in candles) or when they are incinerated, either with or without heat recovery, or during wastewater treatment (in the case of surfactants).

There are no specific activity data for paraffin wax use in Trikala city. The estimation of paraffin wax use emissions is based on the 2019 National Inventory Report, using national and city population as a scaling factor.

7.4. Urea use as catalyst

This sub-sector includes greenhouse gases emissions from the use of urea-based additives in catalytic converters (non-combustive emissions). The lack of accurate activity data in Trikala is surpassed using the corresponding emissions in 2019 National Inventory Report, using vehicle number in national and city level as a scaling factor.

7.5. Solvent use

The majority of solvents are components within end products, such as paint, and eventually, they will evaporate into the atmosphere. This evaporation of solvents, along with other products containing volatile organic compounds (VOCs), is a significant contributor to non-methane volatile organic compound (NMVOC) emissions. Once these emissions are released into the atmosphere, they react with reactive molecules, primarily HO-radicals, or high-energy light, eventually forming CO_2. As per the IPCC Guidelines, the source category for these emissions includes the following applications:

- Paint application
- Degreasing
- Dry cleaning

The estimation of solvent use emissions is based on the 2019 National Inventory Report, using buildings number in national and city level as a scaling factor.

7.6. Substitutes for ODS

As per the 2006 IPCC Guidelines, there are six distinct categories responsible for emissions resulting from the use of ODS (ozone-depleting substances) substitutes. These categories encompass emissions of f-gases and occur during the manufacturing, operation/maintenance, and final disposal of various materials and equipment, which are as follows:

- Refrigerating and air conditioning equipment
- Foam Blowing Agents
- Fire Protection
- Aerosols
- Solvent uses
- Other applications

The estimation of substitutes for ODS use emissions is based on the 2019 National Inventory Report, using buildings number in national and city level as a scaling factor. Most of the emissions are attributed to refrigerating and air condition equipment and this is the reason that buildings are selected for the scaling.

Table 7.1. IPPU Overview (Source: GPC).

GHG Emission Source	Scope 1	Scope 2	Scope 3
INDUSTRIAL PROCESSES AND PRODUCT USE	Emissions from industrial processes and product use occurring within the city boundary		
Industrial processes			
Product use			

- Sources required for BASIC+ reporting
- Not-applicable emissions
- Sources included in Other Scope 3

Table 7.2. GHG emissions from IPPU sources.

Scope	GHG Emissions Source	Notation keys	Gases (in tones)					Data Quality		Comments
			CO_2	CH_4	N_2O	Total CO_2e	CO_2 (b)	AD	EF	
Industrial processes occurring within the city boundary		NO						These activities do not exist within the city boundary for the baseline year.		
Product use										
1	Lubricant use in vehicles		130,22	0	0	130,22	0	L	L	
1	Paraffin wax use		82,14	0	0	82,14	0	L	L	
1	Use of urea as a catalyst		74,96	0	0	74,96	0	L	L	
1	Product uses as substitutes for ODS		2.132,14	0	0	2.132,14	0	L	L	

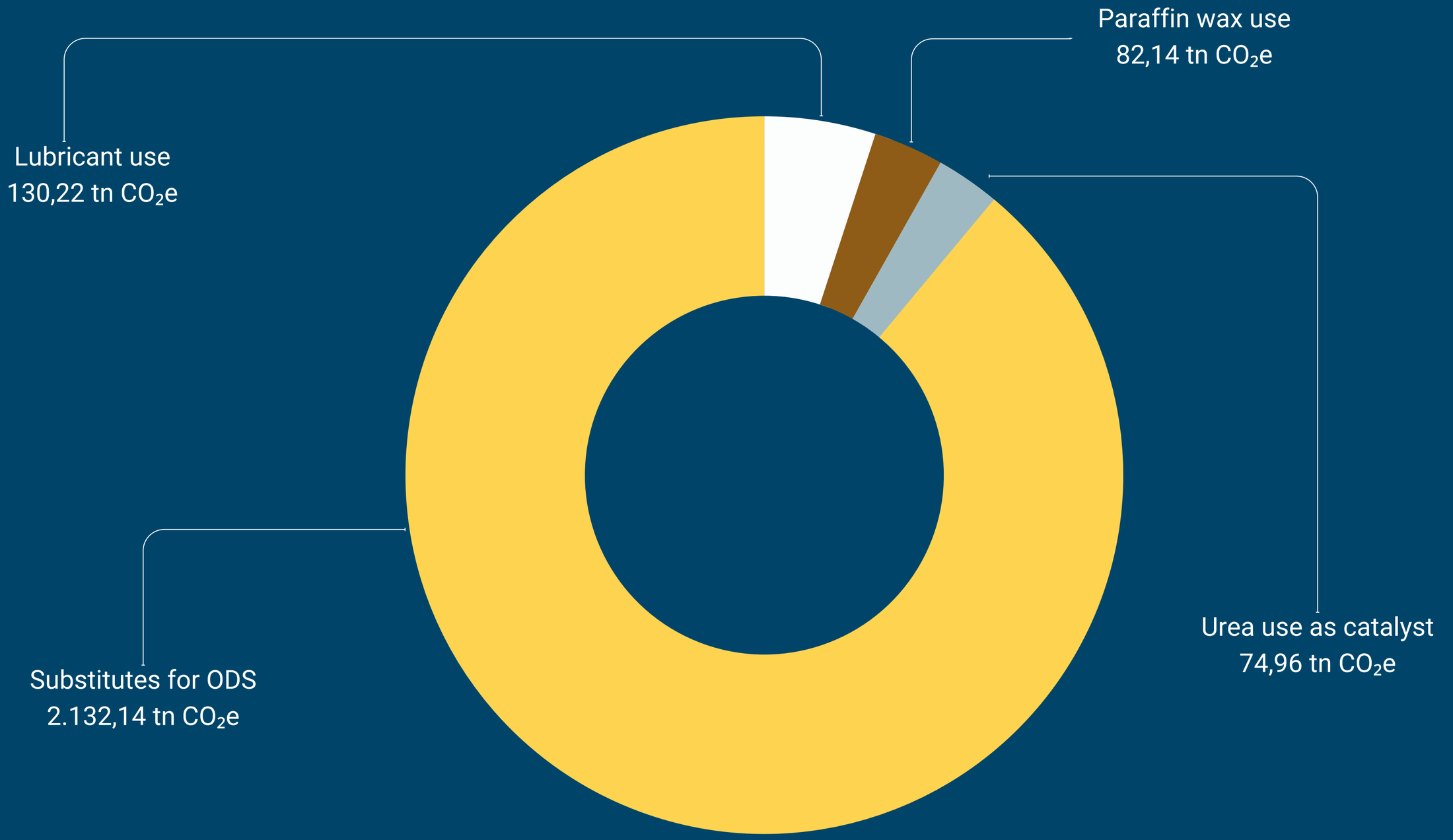


Figure 7.1. GHG emissions per IPPU subsector.

7.7. GHG Emissions from IPPU sources

The total greenhouse gases emissions from IPPU sector is 2.419,46 tn CO_2e. From the total emissions, 88,1% is attributed to substitutes use for ODS. Greece is a country with very hot summers, meaning air conditioning is widely used and frequently maintained, leading to GHG emissions.

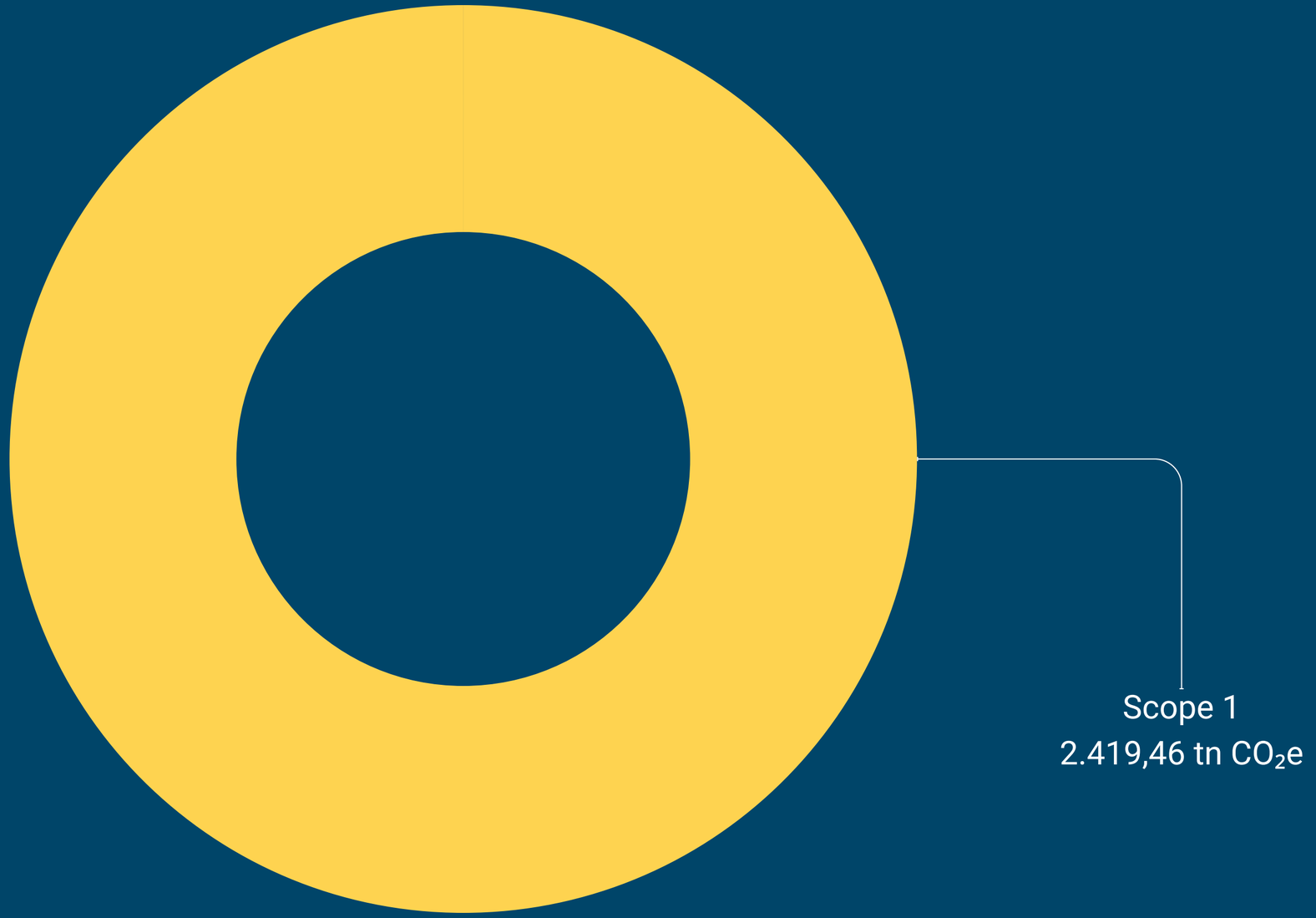


Figure 7.2. GHG emissions per scope in IPPU sector.

8. Agriculture, Forestry and Other Land Use (AFOLU)

8. AFOLU

8.1. AFOLU sub-sectors

Certain cities may lack measurable agricultural activities or have limited woody vegetation within their boundaries, resulting in negligible AFOLU emissions. On the other hand, some cities might have substantial agricultural activities with significant cropland, forests, grasslands, wetlands, or urban tree canopy that contribute to greenhouse gas (GHG) emissions or removals. To indicate the absence of sources or data gaps, notation keys are employed. The IPCC Guidelines classify AFOLU activities into three distinct categories:

- Livestock
- Land
- Aggregate sources and non-CO_2 emissions sources on land

Livestock emissions are produced due to enteric fermentation and manure management. Land emissions may be attributed to the type of land use, the change of land use or forestry. Last but not least, aggregate sources and non-CO_2 emissions sources on land include GHG emissions from biomass burning, liming, urea application, direct and indirect N_2O from managed soils, indirect N_2O from manure management, rice cultivation and harvested wood products.

8.2. Forest land

Taking into consideration that the inventory boundaries are Trikala city's boundaries, there are no significant sources of AFOLU emissions. The only activity included in an AFOLU sub-sector that is occurring within the city boundary is forest land remaining forest land.

The definition of forest land under the Kyoto Protocol is:

- minimum area of 0,3 hectares
- tree crown cover larger than 25%
- minimum height of 2 m, or the potential to achieve it

Forest land can act as a carbon sink and lead to GHG removals.

The forest of Lofon Kastrou and Ailia (Castle hills and Saint Ilias) is located within the city boundary. The artificial pine and cypress forest has a total area of 35,29 hectares.

The GHG removals from the forest land remaining forest land are estimated based on 2019 National Inventory Report, using the national and city forest area as a scaling factor.

Table 8.1. AFOLU Overview (Source: GPC).

GHG Emission Source	Scope 1	Scope 2	Scope 3
AGRICULTURE, FORESTRY AND OTHER LAND USE	Emissions from agricultural, other land-use and land-use-change		
Livestock			
Land			
Aggregate sources and non-CO_2 emission sources on land			

- Sources required for BASIC+ reporting
- Not-applicable emissions
- Sources included in Other Scope 3

Table 8.2. GHG emissions from AFOLU sources.

Scope	GHG Emissions Source	Notation keys	Gases (in tones)					Data Quality		Comments
			CO_2	CH_4	N_2O	Total CO_2e	CO_2 (b)	AD	EF	
Livestock		NO						These activities do not exist within the city boundary for the baseline year.		
Land										
1	Removals from forest land remaining forest land		-7,63	0,01	0,0001	-7,26	0	L	L	
Aggregate sources and non-CO_2 emission sources on land		NO						These activities do not exist within the city boundary for the baseline year.		

9. Summary

9. Summary

9.1. GHG Inventory results

A greenhouse gas inventory is a comprehensive assessment of greenhouse gas emissions and removals within a specified region, such as a country, city, or industrial facility. The purpose of the inventory is to quantify the sources and sinks of greenhouse gases, which are responsible for climate change.

This inventory was performed according to the GPC protocol. Using the city-induced reporting BASIC+ level, the total greenhouse gases emissions are 467.714,66 tn CO_2e. This translates as 7,59 tn CO_2e/citizen/yr. The emissions per source sector are:

- Stationary Energy: 393.504,16 tn CO_2e
- Transportation: 45.198,83 tn CO_2e
- Waste: 26.599,46 tn CO_2e
- IPPU: 2.419,46 tn CO_2e
- AFOLU: -7,26 tn CO_2e

The emissions per scope are:

- Scope 1: 115.569,02 tn CO_2e
- Scope 2: 325.546,17 tn CO_2e
- Scope 3: 26.599,46 tn CO_2e

Apart from the overall greenhouse gas (GHG) emissions reported at the city-induced reporting (BASIC+) level, there is an additional 165,850.18 tn of biogenic CO_2 emissions. Biogenic emissions refer to the release of carbon dioxide resulting from the combustion of biomass materials that store and sequester CO_2, including those used in producing biofuels. These specific emissions are recorded separately under the column CO_2(b) and are not included in the emissions totals following the GPC protocol.

The Stationary Energy sector accounts for 84% of the total city's GHG emissions. At the same time, the majority (83%) of Stationary Energy GHG emissions are included in Scope 2, meaning they occur as a result of grid-supplied electricity consumption.

The Transportation sector is the second largest GHG emissions source, accounting for 9,7% of total GHG emissions. It is prominent that there is a big gap between the Stationary Energy and the Transportation emissions. The 100% of Transportation emissions are included in Scope 1, due to fossil fuel combustion within the city boundary.

The Waste sector accounts for 5,7% of total GHG emissions. All emissions from the Waste sector are included in Scope 3, because Trikala's landfill and WWTP are located outside the city boudary.

The IPPU sector accounts for 0,5% of total GHG emissions.

The GHG inventory is a supporting tool for the city of Trikala on its path to identify GHG emission sources and take action to tackle climate change. An effective and sustainable climate action plan can only be designed based on an accurate and completed inventory.

The GHG inventory must be updated on regural bases and according to the city's needs. Regular updates and reviews of the GHG inventory are crucial to track progress towards emission reduction goals and to assess the effectiveness of climate policies and measures.

Table 9.1. GHG emissions summary.

Sector	Total by scope (tn CO_2e)				Total by city-induced reporting level (tn CO_2e)	
	Scope 1 (territorial)	Scope 2	Scope 3	Other scope 3	BASIC	BASIC+
Stationary Energy	67.957,99	325.546,17	IE		393.504,16	393.504,16
Transportation	45.198,83	0	0		45.198,83	45.198,83
Waste	0		26.599,46		26.599,46	26.599,46
IPPU	2.419,46				0	2.419,46
AFOLU	-7,26				0	-7,26
Total	115.569,02	325.546,17	26.599,46		465.302,46	467.714,66

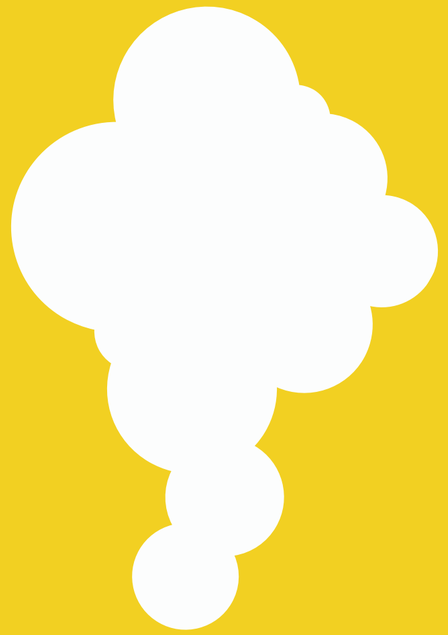
Sources required for BASIC reporting

\+ Sources required for BASIC+ reporting

Sources included in Other Scope 3

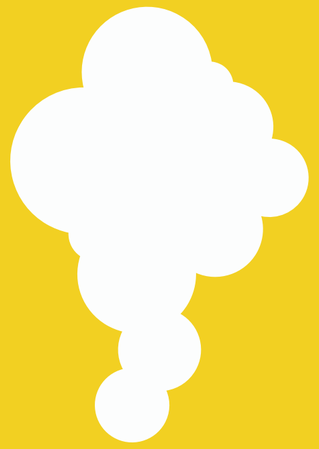
Not-applicable emissions

393.504,16 tn CO_2e



Stationary Energy

45.198,83 tn CO_2e



Transportation

26.599,46 tn CO_2e

Waste

2.419,46 tn CO_2e

IPPU

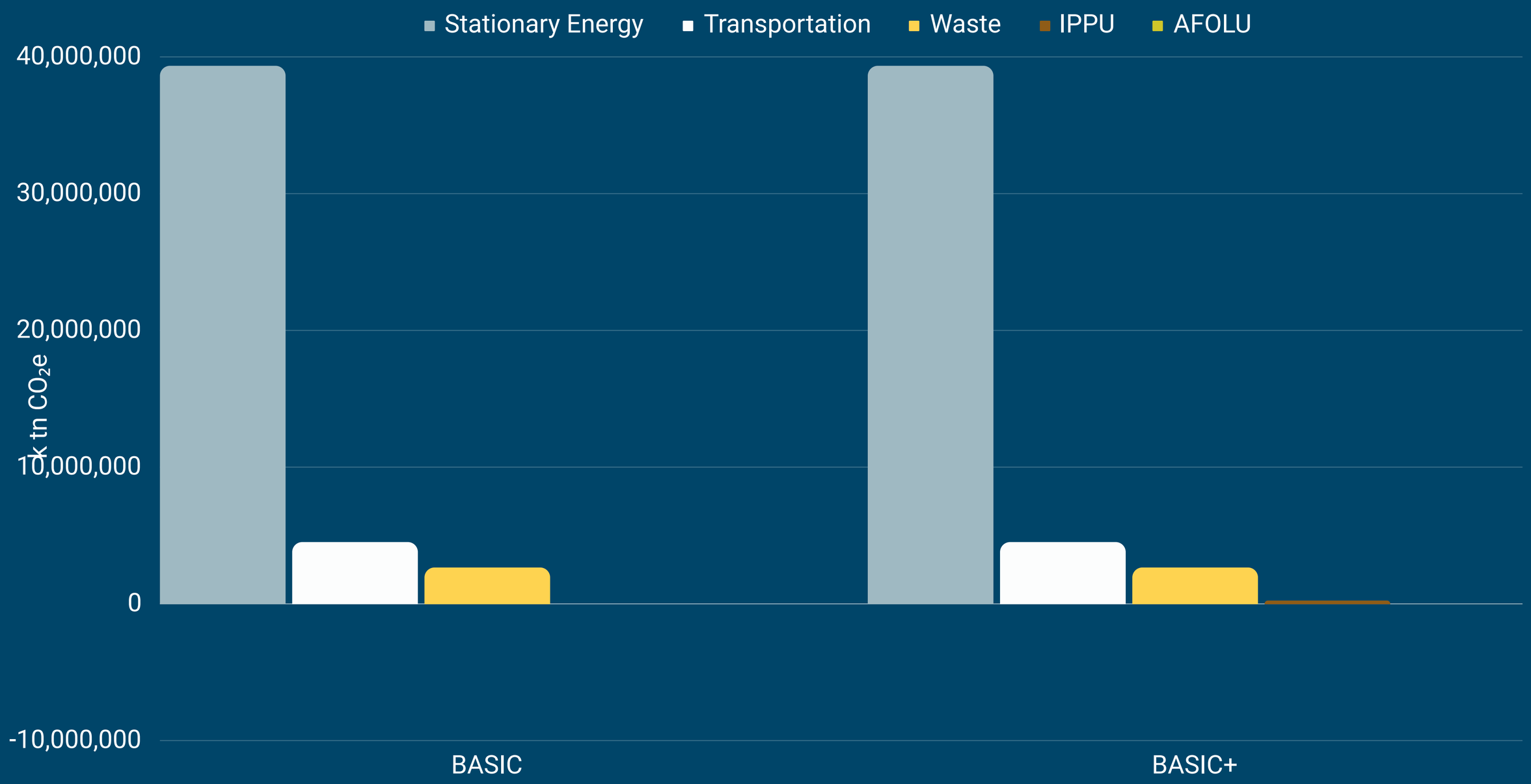


Figure 9.1. GHG emissions per emissions sector in BASIC/BASIC+ reporting level.

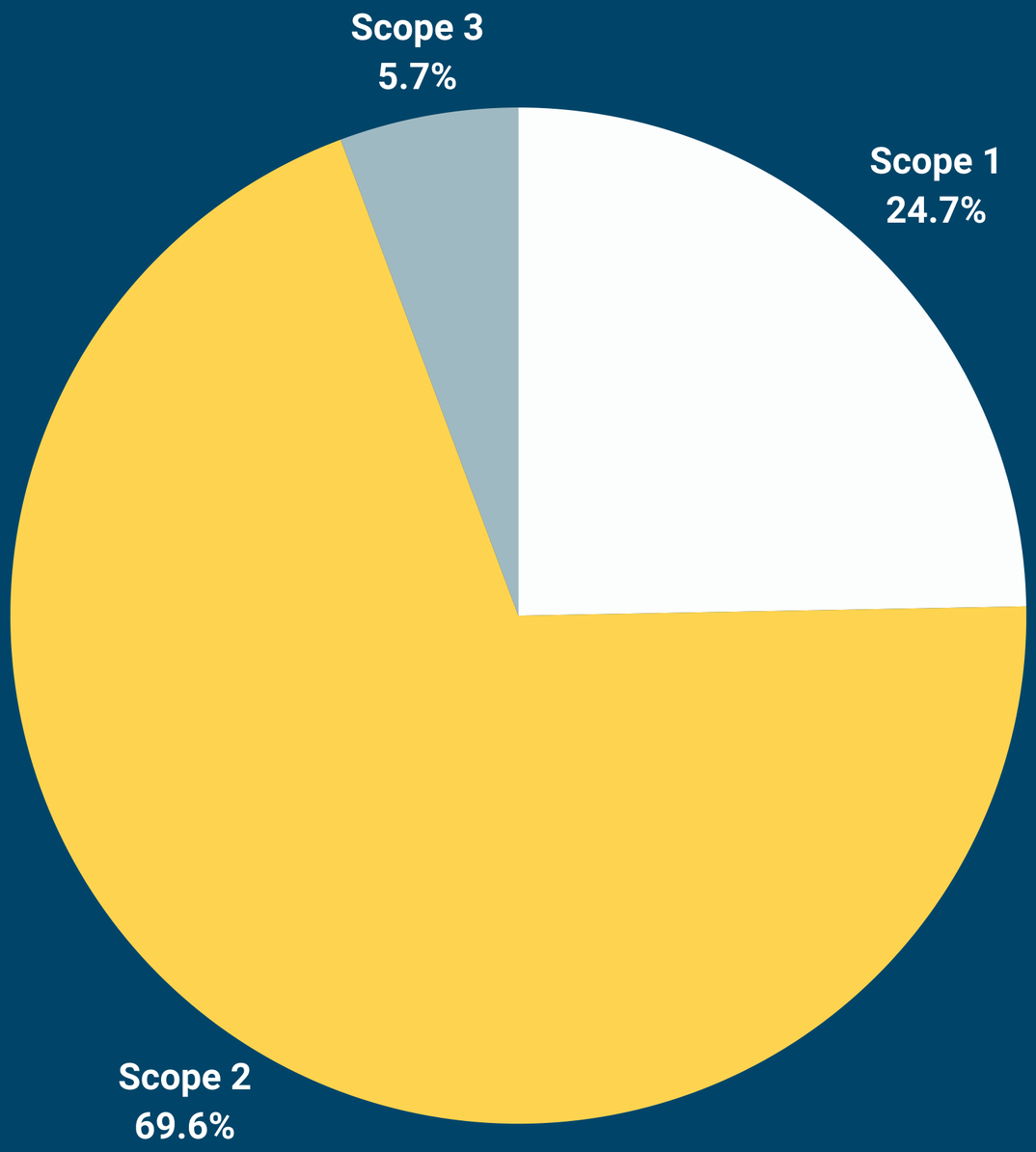


Figure 9.2. GHG emissions per scope.


ΔΗΜΟΣ ΤΡΙΚΚΑΙΩΝ
ΑΣΚΛΗΠΙΟΣ - ΤΡΙΚΚΗ