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Deliverable 8.6

Alexandroupolis replication plan

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Executive Summary

The deliverable 8.6, Alexandroupolis' Replication Plan, is the first coherent smart city plan of the city of Alexandroupolis. It defines the basis for the development of smart city projects selected as replication measures based on the integrated solutions demonstrated by the LHC within IRIS project. The main objective of this deliverable is to offer insight on the replication activities of the Follower city of Alexandroupolis within IRIS that will support its efforts towards the development of urban energy and mobility local systems resilient to economic and climate change.

Municipality of Alexandroupolis administratively belongs to the Region of Eastern Macedonia and Thrace, Greece and it is the capital of Regional Unit of Evros. The population of the municipality is 72,959 inhabitants (ELSTAT, 2011), while the city of Alexandroupolis has 58,125 inhabitants. Municipality of Alexandroupolis is of extremely strategic importance for Greece due to its geographical position since it constitutes an interconnection gate between the Mediterranean and the Asian countries. In addition, it is considered as an emerging energy hub of Europe.

This replication report aims to support the city of Alexandroupolis to implement innovative, IRIS inspired, measures by providing technical assistance and visibility. The document provides with a detailed list of prioritized selected solutions to be implemented in Alexandroupolis city, answering the recognized local challenges and needs. It provides with specifications of the replication activities and assessment of the techno-economic feasibility, as well as financing opportunities and knowledge gap identification. The replication plan presented in this deliverable supports the efforts of the city to realize its vision to become a sustainable, green municipality with increased usage of Renewable Energy Sources and environmentally aware citizens, as clearly stated in Alexandroupolis' Sustainable Energy Action Plan. Alexandroupolis' Replication Plan has been leaded by municipal employees of different departments supported by experts of CERTH and Energy HIVE Cluster, External – outside IRIS – support was specifically provided by local experts such as Democritus University of Thrace.

Alexandroupolis foreseen replication activities are targeting specific exploitation areas. Following a well-structured methodological approach, the replication team developed a list of replication activities in all five Transition Tracks of IRIS project. The methodology included analysis of local challenges and needs, deep study on the demonstrated IRIS solutions and investigation of other smart city projects at national level, analysis of local context as well as knowledge exchange activities. Based on both mature and innovative technologies the integrated solutions are defined on the basis of a common-shared know-how interchange among the lighthouse and follower cities, while planning of replication started from the early beginning of the project. All solutions already know emerging innovative business models, albeit in different phases of maturity. The below table provides and overview of the selected replication measures of each TT of IRIS project.

Transition track	Measures
#1 Smart renewables and closed-loop energy positive districts	• Measure 1: Retrofitting towards positive energy buildings
	• Measure 2: Positive energy city hall
	• Measure 3: NZEB refurbishment
	• Measure 4: Retrofitting towards NZE district

#2 Smart Energy Management and Storage for Energy Grid Flexibility	• Measure 1: Low enthalpy geothermal district heating
#3 Smart e-Mobility Sector	• Measure 1: E-buses
	• Measure 2: E-bikes sharing system
#4 City Innovation Platform (CIP)	• Measure 1: Smart Street Lighting with multi-sensoring
	• Measure 2: Energy cloud
	• Measure 3: Fighting Energy Poverty
#5 Citizen engagement and Co-creation	• Measure 1: Community building by Change agents
	• Measure 2: Campaign District School Involvement
	• Measure 3: Minecraft as a dialogue tool for citizen engagement

This deliverable presents the replication plan of Alexandroupolis at its current stage. The document will be updated according to the results of the demonstration solutions of LHCs, as well as the experiences and proposed measures of the other FCs of IRIS project. The selected integrated solutions for TT#1 and TT#2 are considered as more advanced both in terms of maturity and implementation status. Renewables and buildings energy efficiency have been clear targeted sectors for the municipal authority; therefore, TT#1 includes four proposed replication measures. All measures include buildings' energy refurbishment adopting innovative measures for achieving either near zero energy or positive energy targets. TT#1 measures focus on the refurbishment of municipal buildings and aims to develop innovative scalable and replicable projects. TT#2 comprises a single replication measure, which however is considered very important since it refers to the exploitation of the local low-enthalpy geothermal field of Antheia-Aristino. It refers to a two-phase project that will support energy transition and the increase of RES utilization for Alexandroupolis. The exploitation of low-enthalpy geothermal field of Antheia-Aristino has been a long-term target of the municipality of Alexandroupolis. Phase A of the replication project is currently under implementation having an immediate impact of the targets set by Alexandroupolis in IRIS project.

The smart e-mobility plan is an opportunity for Alexandroupolis, to explore new business models and deliver innovative solutions involving stakeholders from various sectors and thus creating a propitious environment for sustainable and intelligent growth. The replication measures proposed in TT#3 aim to increase the level of sustainability and efficiency in urban mobility setting a concrete base for future proof in different political and socio-economic contexts, intelligent, user-driven and demand-oriented urban mobility system. The city baseline analysis for TT#4 highlighted the fact that the digital transformation of Alexandroupolis is in its infancy and therefore there is limited availability for extensive replication of IRIS integrated solutions. The selected measures include the development of two pilot smart pedestrian crossing and the replacement of 20 lampposts with smart lamppost with integrated multi-sensors, as well as the development of meaningful services to mitigate energy poverty aiming to support the development of innovative business models. The replication of "Energy Cloud" solution is expected to initiate urban monitoring activities. TT#5 activities included in Alexandroupolis' replication plan aim to support the implementation of the replication measures of other TTs and in general boost the development of focused mechanism and inclusive services for citizens in order to incentivize and engage them in efforts being made towards a green and sustainable urban environment.

The current replication plan includes specific timeline for each of the proposed measures which ranges from the beginning of 2020 until 2025. The implementation of some replication projects has already started, whereas others are still at design phases. Prior to implementation, the Municipality of Alexandroupolis, considers the re-evaluation of the selected solutions which will be based on the available information generated by the demonstration and monitoring of the LHCs' measures and the re-assessment of the local context to include potential alterations in challenges and needs.

The replication plan of Alexandroupolis is mainly developed as a guiding document for local decision-makers, city managers and municipal employees providing technical assistance and visibility. It can also provide a comprehensive framework and guidance on how individual solutions examined can be adapted to the climatic conditions and the citizens' customs and way of life in the SE Europe. The municipality aims to utilize this document as a communication tool for engaging and informing citizens about smart city plans and sustainable public investments.

This deliverable is part of WP8 "Replication by Lighthouse regions, Follower cities, European market uptake" and is closely related to other tasks and deliverables of this WP. All three deliverables (D8.1, D8.2, D8.3) together form a reference on which the actual design of the replication activities of the integrated solutions in the Transition Tracks #1-#5 is based. The demonstration actions presented in WP5.x, WP6.x and WP7.x strongly impacted this deliverable. Moreover, WP3 and WP4 provided input for the activities included in D8.6, which is expected to feed WP3 with input for monitoring and evaluation schemes.

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List of Abbreviations and Acronyms

Abbreviation	Definition
AHU	Air Handling Unit
BMS	Building Management System
BSS	Battery Storage System
CIP	City Innovation Platform
DHN	District Heating Network
DHW	Domestic Hot Water
EIP-SCC	The European Innovation Partnership on Smart Cities and Communities
EU	European Union
FC	Follower City
FCU	Fan Coil Unit
HVAC	Heating, Ventilation Air Condition
IS	Integrated Solution
KPI	Key Performance Indicator
LH	Lighthouse
LHC	Lighthouse City
NZEB	Near Zero Energy Building
SC	Smart City
SCIS	The Smart Cities Information System
SEAP	Sustainable Energy Action Plan
SECAP	Sustainable Energy and Climate Action Plan
TT	Transition Track
WP	Work Package

1. Introduction

1.1. Scope, objectives and expected impact

The main objective of this deliverable is to offer insight on the replication activities of the Follower city of Alexandroupolis within IRIS that will support its efforts towards the development of urban energy and mobility local systems resilient to economic and climate change. Knowledge and experiences gained from the design and implementation of innovative integrated solutions in the Lighthouse cities within the five Transition Tracks (TT#1 - TT#5), along with the support of the replication roadmap developed together with IRIS partners, guides the selection of solutions for the city of Alexandroupolis linked with its main city needs and challenges. This replication report includes a number of innovative, IRIS inspired, measures in all TT of IRIS project and supports their implementation by providing technical assistance and visibility.

The secondary objectives of this deliverable are:

- To provide a detailed list of prioritized selected solutions to be replicated in Alexandroupolis that answer the local challenges and needs
- To provide with specifications of the replication activities and assess their techno-economic feasibility
- To analyse barriers and drivers for the replication activities and identify knowledge gaps, as well as provide with financing opportunities

The expected impact of this deliverable is that all replication activities performed by the city of Alexandroupolis shall be better prepared and carried out; the replicated projects can be faster implemented, with lower risks and leading to higher impact on the city level.

1.2. Contributions of partners

- **Municipality of Alexandroupolis**: overall coordination, producing draft text and match with inputs from other WPs and Deliverables (i.e., WP8 and D8.1, D8.2, D8.3, and D8.7; WP3 and D3.1, D3.2; and WP9 D9.2, D9.5 and D9.6), and providing input for transition tracks #4 and #5, review input from other partners;
- **Energy HIVE**: coordinate the input for transition tracks #2, #4 and #5 and providing input for #1;
- **CERTH**: coordinate the input for transition tracks #1 and #3 and providing input for #2 and #4;

The lighthouse cities contribute with information regarding the demonstrations in the project. Horizontal partners contribute with information from other projects, initiatives and communities, bankable business models, KPIs and evaluations. Every result in the IRIS project with a relevance to the replication process of the follower cities is considered a tool that will help the design of the replication activities

1.3. Relation to other activities

This deliverable (D8.6) is part of the WP 8: Replication by Lighthouse regions, Follower cities, European market uptake and is closely related to the other tasks and deliverables in WP8, in particular T8.1 “Replication activities planning and roadmap creation” and its Deliverables D8.1 and D8.2; and T8.2 “Replication tools development for capacity building, training and knowledge transfer” and its Deliverables D8.3 and T8.7 “European scale-up activities” and its Deliverable D8.7. Task 8.3 and Deliverable D8.6 describes the way the replication in the City of Alexandroupolis will be executed. Deliverables D8.1 provides a comprehensive framework on designing the replication activities based on the demonstration activities taking place for the LH cities. T8.2 and its D8.3 provides a toolbox as identified and depicted before and during the demonstration activities of the LH cities offering a set of tools on how to engage the relevant stakeholders and facilitate the design of the replication activities that are suitable for the context of City of Alexandroupolis. All three deliverables (D8.1, D8.2, D8.3) together form a reference on which the actual design of the replication activities of the integrated solutions in the Transition Tracks #1-#5 will be based. This deliverable is also informed by the activities in WP3, and namely the Deliverables D3.1 “Learnings from innovative business model adaptation tool” and D3.2 “Sustainable Business Model Dash-board tool”, which provide input for IS business models during replication activities in the FCs. Finally, this deliverable feeds WP9 and specifically Deliverables D9.2, D9.5 and D9.6 providing input for monitoring and evaluation schemes for the integrated solutions to be replicated.

1.4. Structure of the deliverable

Chapter 2 start with the methodology implemented for designing the replication activities for the City of Alexandroupolis and is followed by an overview of the main characteristics, city needs and challenges of replication area in chapter 3. Chapters 4, 5, 6, 7 and 8 provide a comprehensive overview of the baseline, ambition, barriers & drivers and replication activities planned for the City of Alexandroupolis in each of the individual transition tracks describing the integrated solutions selected to be replicated. Chapter 9 provides and overview of the output to other work-packages and finally chapter 10 holds the conclusions.

2. Methodology

2.1. Introduction

This deliverable is related to T8.4 Alexandroupolis Follower City replication activities. Alexandroupolis foreseen replication activities are targeting specific exploitation areas. Although each of the Solutions demonstrated in IRIS, could be considered to be replicable in terms of infrastructure and renewable energy locality, the City of Alexandroupolis followed a well-structured methodological approach, in accordance with the IRIS Replication Roadmap (D8.1) for prioritizing solutions to be replicated in view of addressing the needs of its approximately 60,000 citizens. The replication plan developed for the City of Alexandroupolis can also provide a comprehensive framework and guidance on how individual solutions examined can be adapted to the climatic conditions and the citizens' customs and way of life in the SE Europe.

2.2. Replication methodology

Alexandroupolis' efforts in replicating IRIS solutions follow a well-structured methodology following the IRIS Roadmap for replication activities (D8.1) and applying the IRIS Replication toolbox (D8.3). The replication plan for the City of Alexandroupolis (D8.6) is based on a city and user needs and challenges analysis taking into consideration the local context conditions. This analysis helped in prioritizing the replication projects in each Transition Track according to the city's transition development goals, commitments, envisaged improvements areas and available funding opportunities. Based on the identified priority areas for replication projects, relevant stakeholders and experts are mapped at city level, while at project level a contact point for each integrated solution provides relevant and specific information on each integrated solution selected for replication.

For each Transition Track a city team represented by a City Transition Track Leader is formed to manage the working tasks and milestones for each team and contribute to the replication plan of the city. Any similarities and potential links with other smart city projects performed at national level were investigated to assist in the identification of regulatory, governmental and juridical details. Then a plan on the knowledge exchange actions was formed including *project deliverables, events, webinars, tools, guidelines and handbooks* and using the tool(s) for knowledge exchange and capacity building as described in D8.3. Then the tool for designing the replication of the selected integrated solutions for the City of Alexandroupolis (D8.6) was used to depict it replication plan. Additionally, the business models applied in the LHC were considered and adaptation details that fit the case of the city of Alexandroupolis are outlined according to the national regulatory framework, the available financing instruments and the blended funding mechanisms identified in WP3 (D3.7). Citizen engagement activities is of outmost importance in designing the replication activities for the City of Alexandroupolis, not only for capturing the citizen needs but also to understand how the solutions could be easier adopted by the end users, since this is considered as the cornerstone for the success of the replication activities. Finally, the governance structure that could facilitate the replication processes is defined along with potential barriers, risks and mitigation plans.

2.3. Solutions chosen for replication

The overall IRIS concept and its Transition Strategy comprising of five (5) Transition Tracks (TT) that together provide a universal yet versatile framework to address both common and district specific challenges consists also a comprehensive framework for the replication activities. Based on both mature and innovative technologies the integrated solutions are defined on the basis of a common-shared know-how interchange among the lighthouse and follower cities, while planning of replication started from the early beginning of the project. All solutions already know emerging innovative business models, albeit in different phases of maturity. Table 1 provides an overview of the integrated solutions selected to be replicated, and which are further detailed towards specific measures, which will be replicated in the City of Alexandroupolis. These are presented in detail per transition track in the chapters 4, 5, 6, 7 and 8.

Table 1. Integrated solutions (measures) that will be replicated at the City of Alexandroupolis

Transition track	Integrated solution	Measures	Inspired by LHC demonstrators
#1 Smart renewables and closed-loop energy positive districts	1.1: Positive energy buildings 1.2: Near zero energy retrofit district	• Measure 1: Retrofitting towards positive energy buildings	• NZEB refurbishment, Utrecht • Geo energy, BIPV, Gothenburg
		• Measure 2: Positive energy city hall	• Collective self-consumption, Nice
		• Measure 3: NZEB refurbishment	• NZEB refurbishment, Utrecht • Commissioning process, Dashboard, Nice
		• Measure 4: Retrofitting towards NZE district	• NZEB refurbishment, Utrecht • VIVA, Gothenburg
#2 Smart Energy Management and Storage for Energy Grid Flexibility	IS-2.1: Smart multi-sourced low temperature district heating with innovative storage solutions	• Measure 1: Low enthalpy geothermal district heating	• Smart DCHN, Nice • Smart energy management system, Utrecht • Low temperature DH, Gothenburg
#3 Smart e-Mobility Sector	IS-3.1: Smart Solar V2G EVs charging IS-3.2: Innovative Mobility Services for the Citizens	• Measure 1: E-buses	• Gothenburg bus line 55 • V2G e-buses, Utrecht
		• Measure 2: E-bikes sharing system	• Innovative mobility services, Nice • EC2B, Gothenburg
#4 City Innovation Platform (CIP)	IS-4.1: Services for Urban Monitoring IS-4.2: Services for City Management and Planning	• Measure 1: Smart Street Lighting with multi-sensoring	• Smart Street lighting with multi-sensoring, Utrecht
		• Measure 2: Energy cloud	• Energy Cloud, Gothenburg
		• Measure 3: Fighting Energy Poverty	• Fighting Energy Poverty, Utrectht

	IS-4.4: Services for Grid Flexibility		
#5 Citizen engagement and Co-creation	IS-5.1: Co-creating the energy transition in your everyday environment IS-5.4: Apps and interfaces for energy efficient behaviour	• Measure 1: Community building by Change agents	• Community building by change agents, Utrecht
		• Measure 2: Campaign District School Involvement	• Campaign District School Involvement, Utrecht
		• Measure 3: Minecraft as a dialogue tool for citizen engagement	• Minecraft, Gothenburg

3. City needs, challenges and prioritization

2.4. City context and relevant action plans

Municipality of Alexandroupolis administratively belongs to the Region of Eastern Macedonia and Thrace, Greece and it is the capital of Regional Unit of Evros. The population of the municipality is 72,959 inhabitants (ELSTAT, 2011), while the city of Alexandroupolis has 58,125 inhabitants. Municipality of Alexandroupolis is of extremely strategic importance for Greece due to its geographical position since it constitutes an interconnection gate between the Mediterranean and the Asian countries. In addition, it is considered as an emerging energy hub of Europe, since it is the first European municipality to be crossed by Transadriatic pipeline and within its region a new Floating Storage Regasification Unit (FSRU) is expected to be constructed in the near future.

Alexandroupolis enjoys significant potential of several renewable energy sources, as it is recognized in both its strategic operational plan (Alexandroupolis, 2016) and its sustainable energy action plan (Alexandroupolis, 2012). Solar energy and wind energy are accompanied with a significant - in terms of potential - low enthalpy geothermal field that is located within the administrative boarders of the municipality. The strategic operational plan of Alexandroupolis is divided in four (4) axis and includes nineteen (19) measures that will support the sustainable growth of Alexandroupolis. The plan recognizes the importance of RES utilization and particularly the exploitation of the available geothermal energy.

Alexandroupolis is a member of the Covenant of Mayors initiative since 2011 and has developed a Sustainable Energy Action Plan. The vision of Alexandroupolis is to become a sustainable, green municipality with increased usage of Renewable Energy Sources and environmentally aware citizens. The SEAP targets to significantly reduce the local energy poverty and establish the basis for the transition to a circular economy. The target of 20% reduction of greenhouse gas emission by 2020 is currently under revision, since the municipal council has decided to sign the updated Covenant of Mayors and achieve 40% reduction of CO_2 by 2030. According to the baseline emission inventory of the updated version of Alexandroupolis' SEAP (Alexandroupolis, 2014), the building sector accounts of more than 50% of the total energy consumption and of more than 60% of the total CO_2 emissions (Figure 1). As concluded, the private transport sector follows with about 40% of total energy consumption and 25% of total CO_2 emissions (Figure 2). The total carbon footprint of Alexandroupolis of the baseline year (2011) is estimated at 6.0 t of CO_2 per capita. Thus, the target is to reduce the carbon footprint to 3.6 tCO_2 per capita by 2030.

To achieve the target of CO_2 reduction, the Alexandroupolis' SEAP includes measures and actions such as energy renovation of municipal buildings, energy upgrade of public lighting, promotion of RES technologies including the utilization of the low-enthalpy geothermal field, as well as awareness raising activities in respect to building energy efficiency measures and renewable energy sources utilization.

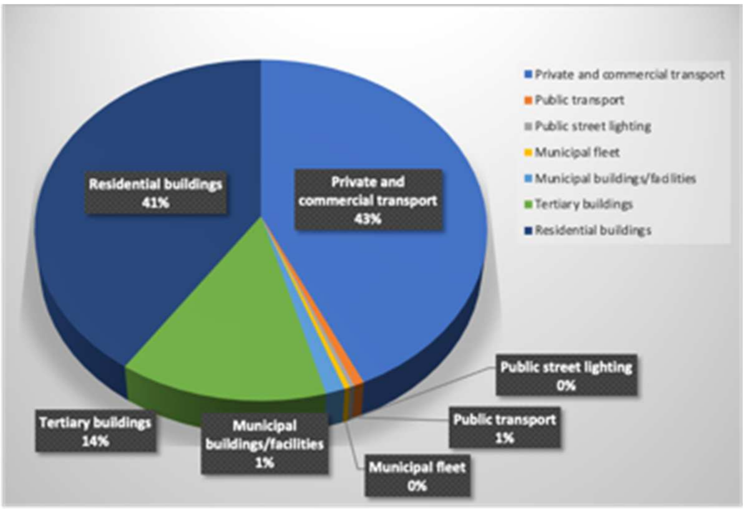


Figure 1. Final energy consumption breakdown for Municipality of Alexandroupolis (source: SEAP)

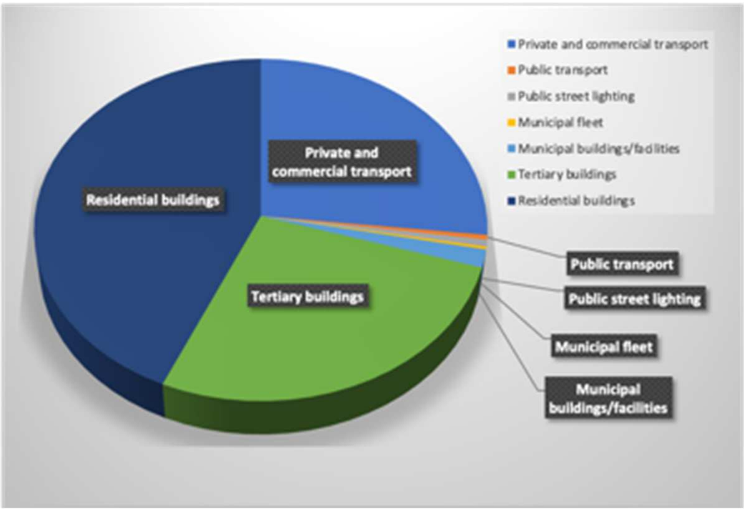


Figure 2. CO_2 emissions breakdown for Municipality of Alexandroupolis (source: SEAP)

In addition, Alexandroupolis has developed Sustainable Urban Development Strategy, called “Attractive City”, which aims to increase the number of visitors and tourists of the city and support the social and economic growth of the region. The intervention area is shown in Figure 3 and the activities included in this strategic plan include among others the regeneration of the coastal area, the restoration and reuse of historic warehouse buildings and the development of new bicycle route. The plan is currently under implementation, funded by the Regional Operational Programme, 2014-2020, of Region of Eastern Macedonia and Thrace.

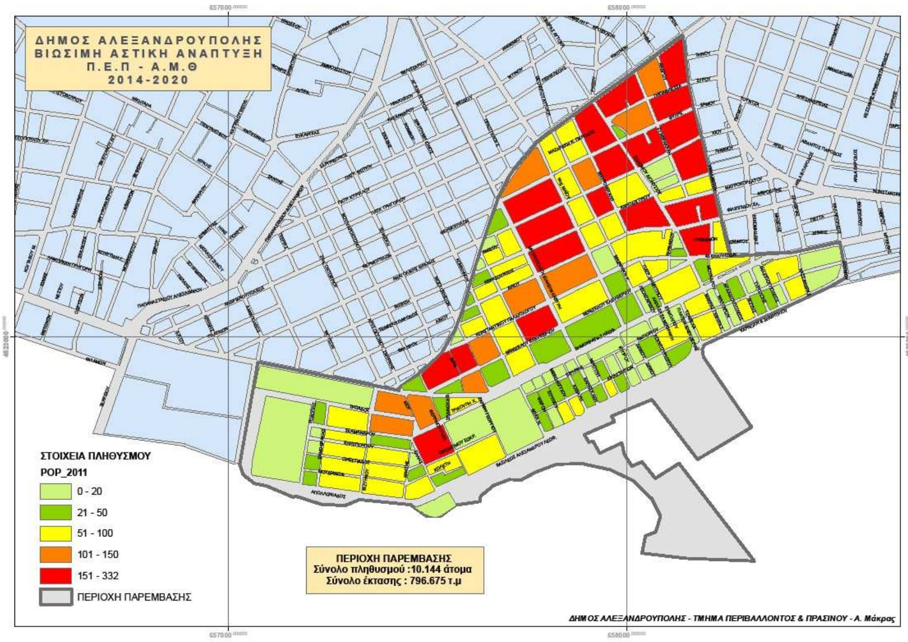


Figure 3. Intervention area of “Attractive city” project

The vision of the Municipality of Alexandroupolis and its pursuance is depicted in the above-described action plans. The replication plan will be part of the new Sustainable Energy and Climate Action Plan (SECAP) that will be developed and be approved by the municipal council of Alexandroupolis. The city Alexandroupolis envisions the transformation towards one of the most energy efficient cities of Europe.

2.5. Challenges and needs analysis

In relation the vision of a sustainable, green municipality with increased usage of RES and environmentally aware citizens, Alexandroupolis has recognized the main challenges and has analyzed the needs to foster the transition towards a low-carbon and smart economy. The under development Sustainable Energy and Climate Action Plan will update the commitment of Alexandroupolis to meet the objectives of the Paris Agreement, as these have been included in the new National Strategic Energy and Climate Action Plan. To achieve increased CO_2 reduction and improve energy efficiency the following specific challenges has been recognized for the context of Alexandroupolis. Energy transition emerges as embedded in a series of life interactions and experiences, with reference to the ecological transformations that depend on situated politics and embedded in particular cultures which have coevolved with the built environment. It is therefore a challenge that encompasses technological, societal, cultural, economic and environmental aspects.

- Density, typology and ownership of buildings.
  Alexandroupolis has gone through a rapid urbanisation process, as highlighted in building stock development (30% increase from 2002 to 2011), and in population increase (14% from 2001 to 2011). Although the economic crisis decelerated the building sector’s development, urbanisation process is expected to continue. Drawing data from the municipality’s approved SEAP, it is highlighted that more than 95% of its carbon footprint originates by the private sector’s activities

(43% houses, 27% tertiary buildings, 27% private & commercial transport), which combined with the specific and common Greek urban architecture that is dominated by the residential multi-family building typology, the so called “Polykatoikies”, provides with a view of the city’s urban energy landscape. The density and typology of buildings leaves little space for RES integration. Moreover, the over 90% of the residential buildings in Alexandroupolis is privately owned meaning that the role of citizens is crucial, and their wide engagement is considered as an important challenge.

- Fragmented markets, lack of new business models and socio-economic inequalities
  Smart city activities are usually based on highly innovative solutions that require solid markets and new business models for market upscaling and replication. In addition, the increased role of citizens in the energy transition brings forward the need to overcome socio-economic inequalities that have been increased in the recent years.
- Inactive citizens, absence in the decision-making process, lack of confidence
  The top-down approach of the decision makers that was significantly used in the previous years has limited and discouraged the involvement of citizens, resulting in inactivity and lack of confidence. The participatory approach has been followed in the recent year, but it is usually characterized by the low participation rates.
- Lack of infrastructure of data collection and management
  It goes without saying that energy transition cannot happen without the support of digital technologies. The lack of infrastructure is considered as an important barrier. The need for development of City Information Platform is highly recognized.
- Increased use of private cars for commuting and leisure
  This is a common challenge among medium-sized Greek cities that arises mainly from the lack of a cohesive urban mobility plan. Public transport is usually considered as inadequate and the city center, as opposed to other European cities, is accessible by private cars. In addition, it has been concluded that citizens show an increased resistance to change in this matter, which affects the political decisions.

4. Transition track #1: Smart renewables and closed-loop energy positive districts

4.1. TT#1 Replication in a nutshell

The co-operation between LHCs and FCs throughout the project has been extensive and very productive. The IRIS solutions demonstrated by the LHCs inspired the FC teams to proceed with innovative replication projects. Events, thematic webinars, specific workshops and other activities targeting the replication strategy have been performed during the project and contributed to the completion of the replication framework, identifying the innovative and sustainable solutions that will be included in the replication plan of Alexandroupolis fellow city. Following the 13 steps mentioned in the proposed replication roadmap (D8.1), the FC of Alexandroupolis developed a replication plan for transition track #1 selecting integrated solutions to be replicated according city baseline analysis and in alignment with the existing action plans regarding energy transition and CO_2 reduction targets.

Identifying the most applicable actions that respond to the local reality and local challenges, FC of Alexandroupolis aims to develop four projects that will replicate measures of the integrated IRIS solutions of Transition Track #1. These specific replication projects aim to support the energy transition of Alexandroupolis and increase the energy performance of the local building stock. The targeted replication projects of TT#1 are:

- Measure 1: Retrofitting towards positive energy buildings
- Measure 2: Positive energy city hall
- Measure 3: NZEB refurbishment
- Measure 4: Retrofitting towards NZE district

Deviations for Grant Agreement: FC Alexandroupolis could not commit to replicate all of the TT#1 solutions demonstrated by the LHCs. Assessing the local replication potential, Alexandroupolis expressed interest to replicate projects in all three IRIS solutions, as included in D1.2 – User, Business and Technical requirements of TT#1 Solutions. After re-evaluating the IRIS integrated solutions, the FC team decided not to move forward with IS1.3 (symbiotic waste heat networks).

4.2. Selection process

The selection process followed by Alexandroupolis is based on the replication methodology adopted, as presented on D8.1 - IRIS Roadmap for replication activities. The list of available IRIS integrated solutions that will be demonstrated by the LHCs are used as a pool of innovative technologies and services that are being utilized by Alexandroupolis to capture the replication projects. The selection process is depicted in Figure 4 and includes all steps performed from the initial stage until the selection of specific replication projects. With the wider strategy of the city to be clear at this stage and in respect to the specific topic of the transition track, the first step of the selection process includes the alignment of the local policies and existing action plans with the IRIS solutions. This work is followed by an initial selection of specific objectives that are targeted to be addressed through replication projects, as well as a selection of potential projects already recognized by the city in the area of this transition track. The next step is to update the city vision and set priorities in relation to the potential project implementation. This step requires the collection of local context data and the engagement of local stakeholders. With the support of the local ecosystem the next step is the selection of IRIS integrated solutions that are targeted to be replicated by Alexandroupolis. The information that is acquired through capacity building and knowledge transfer activities formulates the list of IRIS I.S. to be replicated in Alexandroupolis. The final selection of the replication projects utilizes the results of the previous step along with the assessment of the local framework conditions and potentials for replication within the city of Alexandroupolis.

Figure 4. Selection process followed by FC of Alexandroupolis

4.3. Mapping of stakeholders

Following the statement of D1.7-Tranistion strategy, Commissioning plan for the demonstration & replication, regarding the main stakeholders and in respect to the selected replication projects of TT#1 the main stakeholders recognized are:

- Municipality of Alexandroupolis (enabler/end-user)
- Energy HIVE Cluster (utilizer)
- CERTH/CPERI (provider)
- Democritus University of Thrace (DUTH) (provider)
- Citizens of selected districts (depending on the specific measure) (end-user)

The prioritization of the above stakeholders was also performed utilizing the classification presented in D1.7.

4.4. Identified knowledge gaps

The complexity, as well as the integrated nature of the replication projects that are based on IRIS solutions demonstrated by LHCs requires a thorough analysis of existing knowledge and capacities within the FC local ecosystem in order to identify potential knowledge gaps that will prevent smooth project design and implementation. The identified knowledge gaps are then covered through the knowledge exchange activities between the IRIS partners.

In terms of TT#1, the above process resulted in specific knowledge gap regarding the citizen engagement approach that is required to support the implementation of measure #4. In more detail, as recognized in challenges and needs analysis, the ownership of the residential buildings, namely the high percentage (more than 90%) of privately-owned house, requires different approach for engaging citizens/owners and ensure success project implementation.

4.5. Capacity building and knowledge transfer

The importance of capacity building and knowledge transfer has been extensively stated within IRIS project, as well as in other smart city projects. During the development of the replication plan, Alexandroupolis took advantage of the knowledge tools provided by IRIS project in order to support its activities towards successful replication project identification and implementation. Workshops and webinars provided valuable information that is utilized to formulate the replication projects of TT#1. IRIS deliverables are the main source of information for the replication team of Alexandroupolis that are supplemented with knowledge gained through webinars, workshops, peer-2-peer sessions and communication material.

The development of TT#1 replication plan of Alexandroupolis required also several internal roundtables and workshops targeting capacity building of the municipality employees. Energy HIVE Cluster and CERTH provided with the required expertise and scientific knowledge in order to assess the replication potential and find innovative solutions to the local challenges. Energy HIVE Cluster represented the private sector and provided with valuable insights regarding the business case of the selected replication projects. Alexandroupolis took advantage and secured important support from Democritus University of Thrace, and particularly the Mechanical Design Laboratory of Production and Management Engineering department.

4.6. IS-1.1: Positive Energy Buildings

4.6.1. Baseline

The integrated solution of positive energy buildings includes three measures that replicate specific technologies and services demonstrated in IRIS LHCs. The selected replication projects include the renovation of existing buildings towards positive energy ones.

Measure #1: Retrofitting towards positive energy buildings

The main objective of this project is the energy refurbishment of six municipal buildings of Alexandroupolis in order to become “energy positive”. The desirable outcome is minimizing the energy and HVAC needs of the buildings while producing enough energy through RES combined. The selected buildings are the following, also presented in Figure 5.

- 1st Kindergarten of Alexandroupolis.
- 2nd Kindergarten of Alexandroupolis.
- 7th Kindergarten of Alexandroupolis.
- 1st Senior Citizen Community Centre.
- 2nd Senior Citizen Community Centre.
- Office Building (Polidinamo Centre).

Figure 5: Aerial view of the city Alexandroupolis and location of the six municipal buildings

1st Kindergarten Alexandroupolis

2nd Kindergarten Alexandroupolis

7th Kindergarten Alexandroupolis

1st Senior Citizen Community Centre

2nd Senior Citizen Community Centre

Office Building (Polidinamo Centre)

Figure 6: Photos of the six municipal buildings targeted to become energy positive

The selected buildings have been equipped with RES technologies through the implementation of REIS[2] project funded by EEA Grants 2009-2014. Their energy condition is upgraded, and their typical energy label is C-D. Therefore, these buildings constitute a suitable business to economically achieve the positive energy target. The buildings are considered as typical public-municipal buildings offering a great replication potential in other medium-sized Greek cities.

Table 2 presents the energy consumed by each building that is used as the base case for the calculation of the positive energy target that will result after the installation of specific energy retrofit interventions. The values of table 2 have been calculated using the available information from the energy inspection reports of each building.

Table 2. Energy consumption/generation of the municipal buildings – base case

Municipal building	Electricity consumption (kWh)	Electricity generation/ displacement (kWh)	Biomass (kWh)	Heating oil (kWh)
1st Kindergarten Alexandroupolis	43081	-	-	-
2nd Kindergarten Alexandroupolis	70357	7799	-	-
7th Kindergarten Alexandroupolis	65167	20576	-	-
1st Senior Citizen Community Centre	87257	-	143605	-
2nd Senior Citizen Community Centre	73459	1258	-	112117
Office Building (Polidinamo Centre)	84020	7666	95650	-

Measure #2: Positive energy city hall

The city hall of Alexandroupolis is located in the very city center and constitutes a highly visited building, since it gathers the majority of the services of the Municipality of Alexandroupolis. It is an office building which according to the energy performance certificate has an energy label of D. The building was constructed in 1979 and has been renovated in 2001. The total area is 2,336.23 m^2 and the heating area is 2,116.20 m^2. It has uninsulated envelope and extensive double-glazed aluminum windows without thermal break. The heating system consists of low efficiency heating oil boiler of 850 kW and conventional radiators that distribute the thermal energy to the different areas of the building. For cooling, the building is equipped with 45 split units located in each office room.

The renovation of this building has been recognized in the very first Sustainable Energy Action Plan of Alexandroupolis that was conducted and approved by the Covenant of Mayors Secretariat in 2012. The average real energy consumption of the building includes about 145,000 kWh of electricity per annum and about 30,000 lt of heating oil per annum.

Figure 7. City hall of Alexandroupolis (left) – thermal image of city hall (right)

4.6.2. Ambitions

Alexandroupolis' ambition is to implement projects that will lead to a green and sustainable urban environment and creation of green jobs. In particular, the ambition for IS-1.1 is to contribute to positive energy buildings by replicating integrated solutions demonstrated in LHCs of IRIS project.

The applied measures concern integrating (1) energy savings thanks to refurbishing towards positive energy buildings and (2) energy refurbishment and RES installation for positive energy buildings.

Measure 1 replicates technologies and services demonstrated in Utrecht, such as the energy saving interventions included in measure #4 of D5.3 – Launch of TT#1 activities on Smart renewables and near zero energy district, as well as solutions demonstrated by Gothenburg, as presented in D7.3 - Launch of TT#1 activities on Smart renewables and near zero energy district. Measure 1 refers to the energy refurbishment of six existing municipal buildings located in the core urban area of Alexandroupolis. Measure 2 replicates the integrated solution presented by Nice in measure #1 as included in D6.3 - Launch of TT#1 activities on Smart renewables and near zero energy district. The building of Alexandroupolis city hall is expected to be renovated towards positive energy by adapting the demonstrated technologies and solutions along with specific interventions required due to local conditions.

4.6.3. Planning of replication activities

The selected measures of TT#1 are related to the retrofit of municipal buildings and to the development of new-built positive energy neighborhood. Thus, the overall planning of TT#1 depends on the both the planning of the retrofit activities and the planning of a new-built area. Having selected the specific replication projects, the replication team will develop the Work Breakdown Structure (WBS) and define – if relevant – sub-projects and tasks. The Gantt chart presented in the same section depicts the planning of the replication activities.

4.6.4. Organisation of work

Municipality of Alexandroupolis is the owner of the buildings that are targeted to be renovated to positive energy buildings. Thus, responsible for the organization of work is the municipality. The technical department of the municipality is responsible for development studies and licensing procedure of the project, whereas the procurement department will issue the public tenders required to realize the renovation project.

4.6.5. Data collection and management

Monitoring the energy performance of the refurbished buildings and of the new-built neighborhood included in TT#1 replication measures of utmost importance. Each measure includes the procurement and installation of smart meters/sensors that will be connected to a platform (e.g., the CIP), operated by the municipality in order to collect data and monitor the new installations. For the installations that are owned by the municipality, it is foreseen to install building management system (BMS) to each specific building or system, in order to provide with easier and remote control. Data that will be collected within the replication area include:

- Energy consumption on building level (thermal energy & electricity).
- Energy generation of RES technologies at building level (thermal energy & electricity).
- Energy consumption and generation at neighborhood level (thermal energy & electricity).
- Humidity, temperature and CO_2 levels per building to measure the indoor thermal comfort.

Regarding the new houses that will participate in the new-built positive energy neighborhood the data collection will comply with GDPR regulations. The data collection makes the calculation of KPI fairly easy. Thus, the project can be closely monitored and evaluated.

4.6.6. Barriers and drivers

Political

- **Barriers:** No political barriers were identified.
- **Drivers:** The Municipality of Alexandroupolis is committed to reduce its carbon footprint by at least 40% as compared to the baseline year of 2011, as stated in the latest municipal decision to sign the updated Covenant of Mayors. The IRIS initiative contributes to the commitments and will be incorporated in the new Sustainable Energy and Climate Action Plan of Alexandroupolis.

Economical

- **Barriers:** Increased capital cost considering the fact that currently there is no incentive to develop positive energy buildings (e.g., for the surplus energy).
- **Drivers:** Potential drive for the renovation is the opportunity to develop buildings with low operational cost. The same applies with the development of new houses that will participate in the new positive energy neighbourhood.

Sociological

- **Barriers:** Citizens' acceptance rate of projects such as the new-built positive energy neighborhood is crucial to their implementation, due to the fact that in most cases they will be the owners of the houses. Therefore, the need to strike out the important benefits stemming from the measures proposed and the impact they have on the future of the city is crucial. The resistance to change has to be well recognized although it can be considered that positive energy building operation is less connected to the end-user behavior, as compared to the building design.
- **Drivers:** Citizens' environmental awareness is continuously growing and may act as a driver for the realisation of such replication measures.

Technological

- **Barriers:** Deep renovation of existing building stock towards positive energy buildings may be considered as a technical barrier and as a driver for the development of solutions required for the specific climate conditions of Greece (south Europe).
- **Drivers:** The limited number of positive energy buildings and the absence of positive energy neighborhoods highlight the need to closely monitor the performance of the proposed innovative solutions after their implementation and at the same time acts as a technological driver.

Legal / Regulatory framework

- **Barriers:** No barriers were identified
- **Drivers:** The regulatory framework on energy performance of buildings is based on National Greek Law 4122/2013 and the Ministerial decision DEPEA/oik. 178581 (KENAK) that introduces to the Greek legislation the European Directive 2010/31/EC. The current regulatory framework supports positive energy buildings as far as new constructions are concerned and in particular, in case of positive energy building, the building factor is increased. It can be considered as a low impact incentive and therefore, current framework is considered as neutral in terms of positive energy buildings. In addition, there is uncertainty in respect to excess energy that is produced from positive energy buildings. Buildings that produce electricity with PV panels and other RES technologies are given the opportunity to balance their consumption and own production (the so-called "net-metering" regulation). This means that the energy supplier deducts the produced electricity from the consumption of the customer. For public bodies, the Greek legislation provides with the opportunity to install the RES technologies in different geographic area from the consumption and in that way develop a "virtual-metering" scheme. Thus, the issue of low availability of area on building roofs is encountered.

Environmental

- **Barriers:** There is uncertainty regarding the evaluation of life cycle environmental benefits/costs that may arise as a barrier for successful implementation and operation.
- **Drivers:** There is opportunity to achieve a substantial reduction in CO_2 emissions, and to improve the indoor climate of the buildings.

4.6.7. Specifications

The measures included in TT#1 are well matured in terms of technical specifications that have been concluded by the feasibility studies conducted by the FC local ecosystem team. The below technologies, as well as the various integration configurations were assessed against selected technical and financial criteria, to ensure that proposed measures are both technically feasible and financially viable investments. First, the technical analysis is conducted using appropriate software to determine the energy flows at the building and district level. Suitable KPIs are then identified to evaluate the results obtained.

Measure #1

As far as measure #1 is concerned the pool of interventions involved includes:

- Internal insulation to reduce the thermal transmittance of walls and ceiling. The U-value of the walls was reduced from to 0.45 W/m^{2}K and of the ceiling to 0.4 W/m^{2}K.
- External insulation on the building walls and ceiling. The U-value of the external walls was lowered to 0.4 W/m^{2}K while the U-value of the ceiling was reduced to 0.4 W/m^{2}K.
- Replacement of old inefficient windows with new energy efficient double-glazed windows. This will result in a new U-value for the windows of 1.5 W/m^{2}K.
- Replacement of the existing energy consuming lightbulbs with new efficient LED lighting.
- Improving biomass boiler efficiency through pipe insulation and storage tank insulation.
- Replacement of old A/C units with new more efficient A/C units. The SEER of the new A/C units will be 6.
- Replacing the heating oil boiler with Ground-Source Heat Pump that will work in combination with the solar thermal panels.
- Increase of the storage capacity of the solar thermal system to increase system efficiency.
- Installation of small scale solar thermal Organic Rankine Cycle (ORC) unit with an efficiency of 65%.
- Replacement of old A/C units with biomass absorption chiller.
- PV net metering for offsetting the electricity needs of the building for providing heating, cooling and electricity.
- PV virtual metering for offsetting the electricity needs of the building for providing heating, cooling and electricity.
- Smart meters/sensors and building management system (BMS) integration.

Detailed presentation of the specific interventions applied in each building of measure #1 and the technical and financial performance of the retrofit investments is presented in Annex 1.

Measure #2

Although measure #2 includes retrofitting activities to achieve positive energy performance, as it is the case with measure #1, it is selected to be examined and presented separately due to the importance of the building, i.e., the city hall of Alexandroupolis. Thus, the objective is to replicate the collective self-consumption concept that is being tested in Nice Meridia (D6.3). The main difference which however has significant impact on the design process, is that the exemplar office building “Palazzo Meridia” of NEXITY is a newly constructed building, whereas the city hall of Alexandroupolis is an existing building constructed in 1979. To that extent, the specific replication project includes deep energy renovation actions that will allow the building to significantly reduce its energy demand.

A feasibility study was conducted, and all measures were assessed in terms of their economic and technical performance using suitable Key Performance Indicators: Degree of Energetic Self-Supply (thermal and electrical, DE_T and DE_E), Emissions Reduction (Kg), Payback Period (years), Net Present Value (€) and Internal Rate of Return (%). These indicators and the results of the economic and technical analysis are presented in the following sections.

4.6.8. Citizen engagement

The measures foreseen for the energy refurbishment of the municipal buildings means that the municipality is the only entity responsible for implementation and operation. The engagement of citizens is required to the extent of end-users of the selected building. It is important to mention that the proposed buildings are occupied by either children of the age of 2 to 4 years old (Kindergartens) or elderly people (senior citizen community centers). The city hall and the “Podidinamo center” are considered as office buildings.

Different citizen engagement activities have been designed per building category of TT#1 replication plan, as presented in chapter 8 of this deliverable.

4.6.9. Business model

Since the municipality is the owner and operator of the selected buildings (measure #1 and measure#2), the business model to be followed is straightforward. The municipality of Alexandroupolis will proceed with the investments either by own funds or by utilizing any of the available financial instruments also presented in table 1 of D3.7 – Financing solutions for cities and city suppliers. The Regional Operational Programme of Region of East Macedonia and Thrace includes in its scope the funding of projects as the retrofitting projects included in replication plan of Alexandroupolis for TT#1. Thus, the municipality has a clear aim to complete the required studies and acquire the required licenses in order to proceed with the application for funding under the Regional Operational Programme.

In correlation to IRIS program goals, the aim is to make the business plan profitable for the replication by privately funded individuals and/or companies in the area. All the evidence needed in terms of economic viability of the project have been calculated. Internal Rate of Return, Net Present Value and payback period are making the investment profitable in the near future. These indicators are described in Annex 3.

The commonly used thresholds for assessing financial viability are used, i.e., an investment is considered viable when it results in a positive Net Present Value and Internal Rate of Return greater than 5%. Furthermore, a payback period of 15 years was also considered as a reasonable threshold for considering an investment attractive.

For measure #1 the financial evaluation for each building has been developed based on the following assumptions:

- Annual inflation rate: 1%
- Annual fuel increase rate 3%
- Own equity: 100%
- No loan/subsidy considered
- Project lifetime: 30 years
- PV net metering cost per kWh: €0.10/kWh
- Electricity purchase price: € 0.10/kWh
- Cost of biomass: € 350/tonne

The feasibility study conducted regarding the retrofitting of the buildings included an economic analysis as well as a technical one. Parameters set for the economic analysis were: DE_T, DE_E, Emissions Reduction (Kg), Payback Period (years), NPV (€) and IRR (%). The payback period was set to being less that 15 years, NPV must be definition be positive and IRR over 5%. The results of the economic analysis meeting those criteria are as follows.

Table 3 presents the financial indicators calculated for each of the six municipal building that participate in measure #1. Table 3 clearly indicates that from an economic point of view retrofitting the “Polidinamo” building is regarding the economic view a bad investment. Furthermore, retrofitting the 2nd Kindergarten and 7th Kindergarten buildings were not considered attractive investments (despite meeting the NPV and IRR criteria) due to their significantly long payback periods. Despite this analysis the assessment made is that with sufficient funding and a wider ROI (Return on Investment) horizon these retrofits can and should be implemented.

Table 3. Financial indicators for energy renovation of six municipal buildings

Municipal building	Simple payback period	Net Present Value (NPV) (€)	Internal Rate of Reture (IRR) (%)
1st Kindergarten Alexandroupolis	14.1	23,793.00	10.50
2nd Kindergarten Alexandroupolis	22.8	2,853.00	5.20
7th Kindergarten Alexandroupolis	23.1	8,388.00	5.60
1st Senior Citizen Community Centre	13.4	110,051.00	11.10
2nd Senior Citizen Community Centre	6.9	294,594.00	17.70
Office Building (Polidinamo Centre)	70.9	-168,093.00	-1.70

4.6.10. Governance

Municipality of Alexandroupolis is the main stakeholder of all measures included in TT#1.

4.6.11. Impact assessment

The impact of the measures included in TT#1 contribute to the reduction of CO_2 emissions, which is the overall goal of IRIS and of the Municipality of Alexandroupolis. The successful implementation of the proposed replication projects will contribute to the specific objective to increase energy building performance locally and reduce the carbon footprint of the building sector.

The following KPIs have been selected in order to assess the success and suitability of these measures in this context (see Annex 3 for their description):

- Degree of Energetic Self-Supply
- CO_2 Emissions Reduction

KPI	Parameters	Baseline
1. Degree of energetic self-supply	Ratio of locally produced energy from RES and the energy consumption over a period of time	The buildings before the implementation of energy savings interventions and RES integration
2. CO_2 emissions reductions	Ton of CO_2	The buildings before the implementation of energy savings interventions and RES integration

The technical assessment of each of the six buildings of measure #1 with the use of the aforementioned indicators is presented in the following table. It can be seen that in all cases the proposed measures resulted in degree of energetic self-supply equal to or even greater than 100% as well as significant emissions reduction ranging from 36,935 to 91,565kg CO_2.

Table 4. Results on KPIs of the feasibility study

	DE_T	DE_E	Emissions reduction (kg)
1st Kindergarten Alexandroupolis	100%	101%	36,935
2nd Kindergarten Alexandroupolis	100%	100%	53,868
7th Kindergarten Alexandroupolis	100%	100.1%	38,974
1st Senior Citizen Community Centre	100%	100%	75,132
2nd Senior Citizen Community Centre	100%	100.3%	91,565
Office Building (Polidinamo Centre)	100%	100%	65,778

4.6.12. Implementation plan

The measures included in TT#1 will be replicated in Alexandroupolis following an implementation plan which has been developed by the FC replication team. At this stage, Alexandroupolis has conducted clear implementation plans that will support efficient and successful replication of the integrated IRS solutions. The implementation of the selected measures will follow the steps described.

1. Re-evaluation of identified integrated solutions. The selection process of the measures to be replicated included a deep assessment of the integrated solutions that are being demonstrated in LHCs. Nevertheless, the potential changes in the local context before the implementation period and the availability of valuable information mainly from the monitoring period of the demonstrations require to include this first step in the implementation plan.
2. Feasibility study. The feasibility study of the selected measures has been developed and the results are presented in this chapter. However, the feasibility study will be updated accordingly in

case new data are available prior the implementation of each measure, including updates on the national legal framework in respect to the replication measures.

3. Risk analysis. This step includes risk identification and description of their mitigation activities.
4. Financial analysis. This step includes the investigation of financing schemes and opportunities that are available prior to implementation of the specific measures and the preparation of an analysis in order to select the most suitable. The financial analysis also includes the development of a budget plan regarding the costs estimated at the feasibility study. At this stage, the municipality is expected to take the firm decision to implement each proposed measure and select the targeted business model of implementation.
5. Detailed design studies. The municipality will develop the documents required for the public tender of the detailed design studies. As included in Law 4412/2016, the detailed design study will be approved by the Municipality Council.
6. Procurement and contracting for installations. This step includes the public tender procedure for the selection of the construction companies. It is suggested to follow the Green Public Procurement guidelines and criteria set by EC. The tender documents are being developed strictly following the detailed design study of the previous step.
7. Project implementation. This includes the construction phase of each replication measure, including construction works and equipment installation.
8. Commissioning. Before operation, the commissioning step is recognized as of increased importance due to the fact that the designed measures are innovative and complex. Since the selected measures include new installations that will be operated by the municipality personnel, personnel qualification is mandatory.
9. Operation monitoring. The performance of each measure will be monitored according to a specific monitoring plan. The selected KPIs will be calculated to evaluate the impact of each measure.

The success of the implementation plan depends - in different degree for each measure - on the engagement of stakeholders and citizens.

4.6.13. WBS – Work Breakdown Structure & Gantt chart

Figure 8 presents the work breakdown structure for the implementation of the measures included in this IS, which common among other IS. The Gantt charts of measures #1 and #2 are presented in Annex 4.

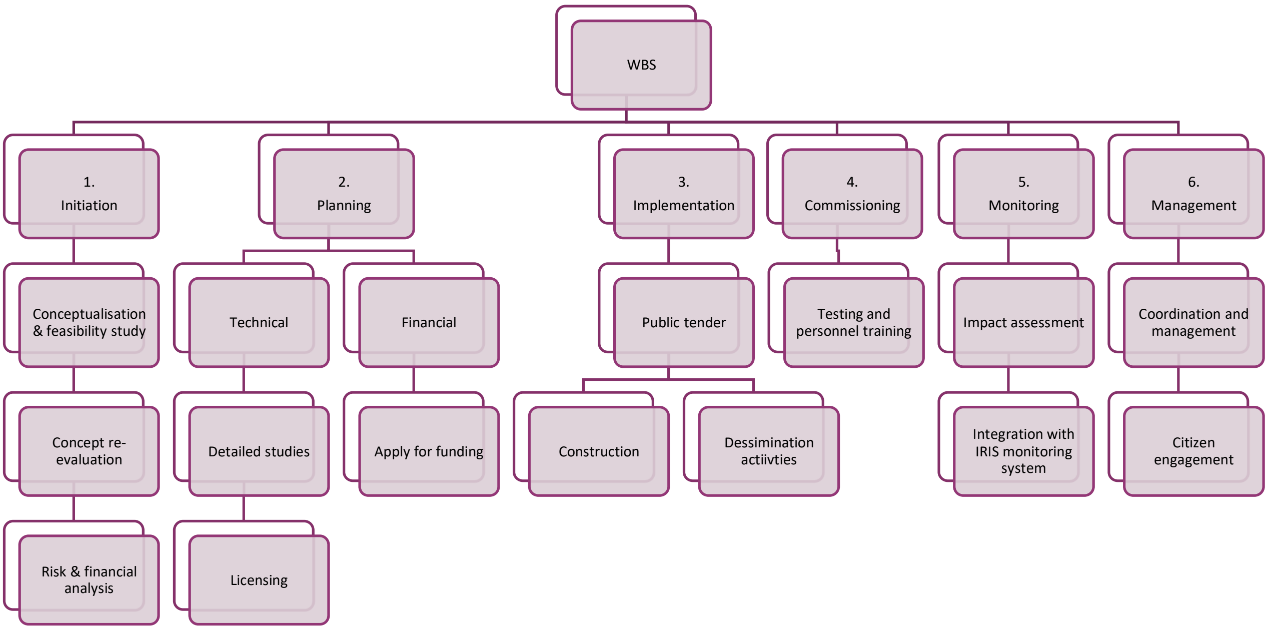


Figure 8: Work breakdown structure for the implementation of IS-1.1. replication measures

4.6.14. Financing schemes and opportunities

Measure #1 and measure #2 are clearly municipal projects and therefore public funding is targeted. The project size does not justify the use of European Investment Banks financing schemes; however, the innovation of the proposed project does support their potential financing from EU funding (e.g., EFSI 4.8) as presented in table 1 of D3.7. The bankability of these measures, as assessed by the feasibility study, clearly highlights the need for grants, which drives to the conclusion that financing solutions such as Energy Service Companies (ESCOs) are not suitable in this case. The Regional Operational Programme 2014-2020 of East Macedonia and Thrace and particularly the thematic objective 04 (support of transition to a low carbon economy to all sectors), investment priority 4c (support of energy efficiency, smart energy management and use of RES at public infrastructure, including public buildings) provides with a strong funding opportunity for the specific projects.

4.7. IS-1.2: Near zero energy retrofit district

4.7.1. Baseline

The integrated solution of near zero energy retrofit includes two measures that replicate specific technologies and services demonstrated in IRIS LHCs. The selected replication projects include both the development of a near zero energy refurbished building and the development of near zero energy district through residentials building refurbishment.

Measure #3: NZEB refurbishment

The main objective of this measure is to renovate the indoor gym of Alexandroupolis "Michalis Paraskevopoulos" and achieve the target of near zero energy building (Figure 9). This measure has been selected from the pool of projects included in the existing energy transition action plan of the municipality of Alexandroupolis. The projects will be partially inspired by IRIS solutions.

The selected building, located close to the city center, was constructed in 1977 and according to the energy performance certificate it is a D labelled building. It has uninsulated walls and poorly insulated metal roof. The building's windows are aluminum without thermal breaker and single-glazed or with polycarbonate plastic glazing. The total heating area of the building is 1,774.58 m^2. The openings of the building area extensive and have a total area of 293.23 m^2. The building is currently being heated by a heating oil boiler of 232.56 kW and through wall mounted fan coil units. In addition, two air-condition units of total power of 27.2 kW_{th} and 24 kW_c are used for heating and cooling purposes of the basketball/volleyball court.

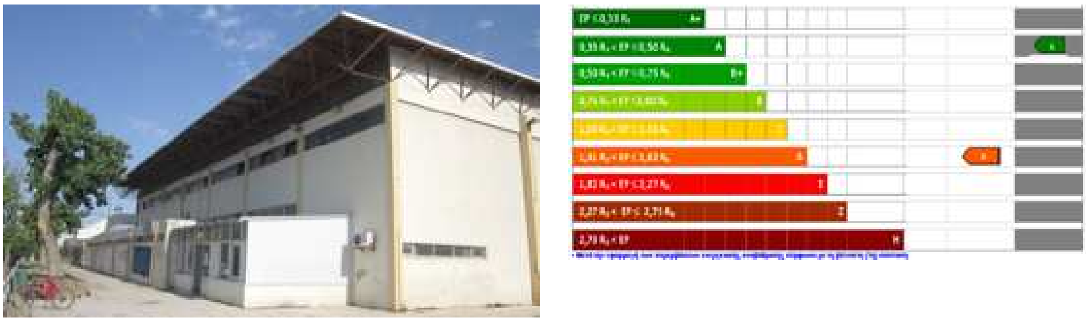


Figure 9: Photo of Indoor Gym "Michalis Paraskevopoulos" of Alexandroupolis and energy label

It has to be mentioned that it is the only indoor gym of the city of Alexandroupolis, where national level volleyball games are being held. According the available statistics of the municipality, the average end-users of this building are estimated at 60,000 per annum. The low energy performance of the building and the increased usage of the building justify the need for deep energy renovation. In addition, the selected measure is highly replicable in the national context, since an important number of indoor gyms with similar construction can be found in the other Greek municipalities.

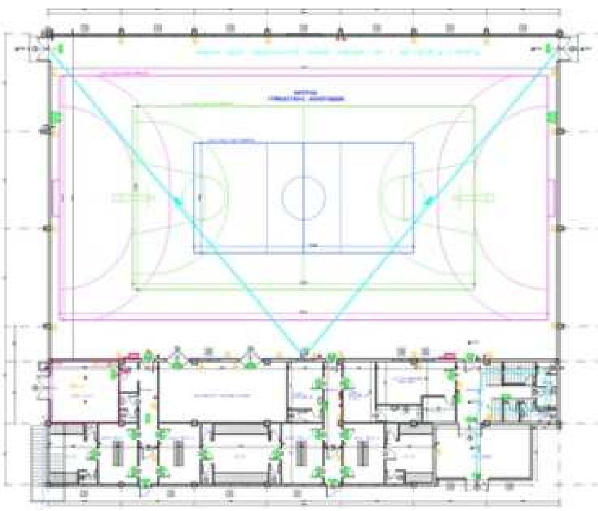


Figure 10: Floor plan of Indoor Gym "Michalis Paraskevopoulos" of Alexandroupolis.

Measure #4: Retrofitting towards NZE district

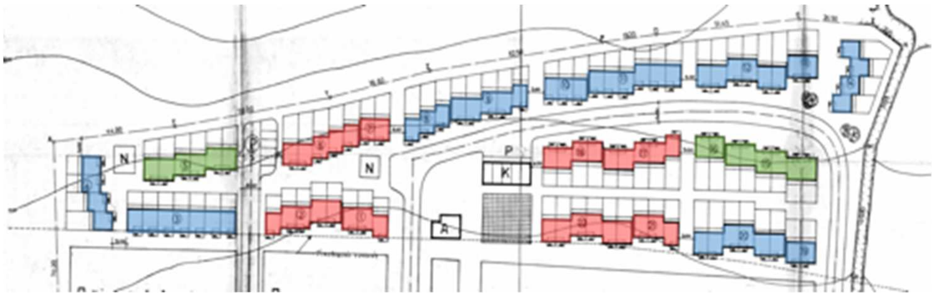
The proposed near-zero energy district is located in the western side of the city of Alexandroupolis. The district comprises of 95 terrace and mid-terrace houses grouped together in several blocks within a total area of approximately 22,500 m^2. The general plan and an aerial view of the district is presented in Figure 11, where the layout and the orientation of the dwellings can be seen. The houses are 1-storey buildings (each with a ground floor and a first floor) with a total heated floor area of about 73 m^2 and were built in the 1970s as social housing. However, these are now privately owned by the residents.

Figure 11. General plan (left) and aerial view of the proposed near zero-energy district (source: google earth).

No provision for insulation was taken at the design stage, as the first Regulation for Insulation in Greece came into effect in 1979. The construction of these dwellings is the typical construction for that period, namely solid uninsulated walls with uninsulated concrete frame, uninsulated concrete slab floor, concrete slab roof and single glazed windows with metal frame. However, it is considered that a number of houses have since been refurbished to a smaller or larger extent, while others have remained in their original condition. Therefore, it is considered that the houses of the district fall within one of the following categories according to their level of insulation a) uninsulated dwellings, b) dwellings with minor interventions and c) dwelling with major interventions. Minor interventions include the replacement of the single glazed windows with double glazed windows with metal frame (without thermal break) while major interventions include insulating the external walls and the roof to the current building regulations standard and replacing the single glazed windows with new efficient double-glazed ones. Table 5 provides a summary of the U-values for the building elements based on the three levels of insulation considered, while the layout of the buildings and the different insulation categories are presented in Figure 12.

Table 5. U-value of building elements for the district buildings

Municipal building	Uninsulated U-value (W/m^2K)	Minor interventions U-value (W/m^2K)	Major interventions U-value (W/m^2K)
External walls	2.38	2.38	0.40
Windows	4.6	3.3	1.40
Doors	3.5	3.5	1.40
Roof	4.7	4.7	0.35
Floor (in contact to the air)	2.75	2.75	0.35
Floor (in contact to the ground)	3.1	3.1	3.1



Uninsulated (48 units)
Minor interventions (33 units)
Major interventions (14 units)

Figure 12. Arrangement of houses based on the insulation level

4.7.2. Ambitions

Alexandroupolis' ambition is to implement projects that will lead to a green and sustainable urban environment and creation of green jobs. In particular, the ambition for IS-1.2 is to contribute to the realization of retrofitting project that result in near zero-energy buildings and districts neighborhoods by replicating integrated solutions demonstrated in LHCs of IRIS project.

The applied measures concern integrating (1) energy savings thanks to refurbishing towards near zero-energy buildings, (2) a high share of locally produced and consumed renewable energy at district scale and (3) energy refurbishment and RES installation for near zero-energy buildings.

Measure #3 replicates the technologies and services demonstrated in LHCs of Utrecht, such as the energy saving interventions included in measure #4 of D5.3 – Launch of TT#1 activities on Smart renewables and near zero energy district, as well as solutions demonstrated by Nice Cot' Azur, as presented in D6.3, such as the innovative commission process to measure the real energy savings and the dashboard solution to raise environmental awareness. Measure #4 also replicates integrated solutions demonstrated by Utrecht, as well as technologies and services demonstrated in LHCs of Gothenburg and particularly within the Viva project.

4.7.3. Planning of replication activities

The selected measures of TT#1 are related to the retrofit of the indoor gym and to the development of a near zero-energy district of existing residential buildings. Thus, the overall planning of TT#1 depends on the planning of the retrofit activities.

Having selected the specific replication projects, the replication team will develop the Work Breakdown Structure (WBS) and define – if relevant – sub-projects and tasks. The WBS TT#1 has been developed and it is presented in following section. The Gantt chart presented in the same section depicts the planning of the replication activities.

4.7.4. Organisation of work

Municipality of Alexandroupolis, as the owner and responsible for the operation of the indoor gym will undertake of the actions and activities required to design, develop and implement measure #3. The support of local partner Energy HIVE Cluster enhances the project realization and ensures successful implementation. Energy HIVE Cluster will act as an external expert advisor particularly for the design and the implementation process of this measure.

Measure #4 requires the engagement of citizens/stakeholders in the design and implementation phase. Municipality of Alexandroupolis is required to act as facilitator and undertake the activities to engage citizens and stakeholders. CERTH and Energy HIVE Cluster are responsible for feasibility study of this measure.

4.7.5. Data collection and management

Monitoring the energy performance of the refurbished district and of the energy upgraded indoor gym included in TT#1 replication measures of utmost importance. Each measure includes the procurement and installation of smart meters/sensors that will be connected to a platform (e.g., the CIP), operated by the municipality in order to collect data and monitor the new installations. For the installations that are owned by the municipality, it is foreseen to install building management system (BMS) to each specific building or system, in order to provide with easier and remote control. Data that will be collected within the replication area include:

- Energy consumption on building level (thermal energy & electricity).
- Energy generation of RES technologies at building level (thermal energy & electricity).
- Energy consumption and generation at district level (thermal energy & electricity).
- Humidity, temperature and CO_2 levels per building to measure the indoor thermal comfort.

Regarding the refurbished houses that will participate in the near zero-energy district the data collection will comply with GDPR regulations.

The data collection makes the calculation of KPI fairly easy. Thus, the project can be closely monitored and evaluated.

4.7.6. Barriers and drivers

Political

The same applies as included in section 4.6.6.

Economical

- **Barriers:** The main hurdle of this endeavor is financing such a project off of private funds. The housing complex as mentioned is privately owned and the considerable costs regarding a retrofit of this magnitude may prove to be unbearable for the owners.
- **Drivers:** The implementation of such measures involves very low operational costs, which is undoubtedly an important driver for such projects.

Sociological

- **Barriers:** Closely tied to the economic barriers are the sociological ones, considering the fact that for the project to be successful wide public acceptance is required. The citizens of the area need to agree the solutions at hand as a whole and this might prove difficult.
- **Drivers:** same as section 4.6.6.

Technological

The same applies as included in section 4.6.6.

Legal / Regulatory framework

The same applies as included in section 4.6.6.

Environmental

The same applies as included in section 4.6.6.

4.7.7. Specifications

According to European Directive 2010/31/EU 'nearly zero-energy building' means a building that has a very high energy performance, as determined in accordance with Annex I of the Directive. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby.

Both measures included in IS-1.2 well matured in terms of technical specifications. For measure #4 the detailed studies are currently under development. The specifications of measure #5 have been concluded by the feasibility study conducted by the FC local ecosystem team.

In order to achieve the zero-energy target the following interventions have been selected by an external expert that have awarded through public tender for the development of the detailed studies of the energy refurbishment of indoor gym "Michalis Paraskevopoulos".

- External insulation on the building walls and ceiling. The U-value of the external walls was lowered to 0.35 W/m^2K while the U-value of the ceiling was reduced to 0.4 W/m^2K. The selected material for the external walls is graphite expanded polystyrene of 80 mm thickness and conductivity factor of 0.031 W/mK. For ceiling the selected material is extruded polystyrene of 100 mm thickness and conductivity factor of 0.034 W/mK.
- Replacement of old inefficient windows with new energy efficient double-glazed windows. This will result in a new U-value for the windows of lower than 1.5 W/m^2K.
- Installation of new heating and ventilation air condition (HVAC) system that includes three new Air Handling Units, new air duct system and new air to water heat pumps. More specifically, the building requires one heat pump of 196 kW and one heat pump of 109 kW for the AHU and one heat pump of 32 kW for the fan coil heating/cooling distribution network and the domestic hot water. All heat pumps will have seasonal COP higher than 3.2 and a seasonal EER higher than 3.5. The AHUs will be of 10,000 m^3/h equipped with heat exchanger with efficiency of at least 75%.

- New LED lighting. According to the lighting study that was performed following EN 12464 and EN 15193 the new lighting system will decrease to 7.06 W/m^2, that is to say more than 70% of the existing.
- New BMS system. A new building management system is designed to integrated in the building for enhancing the automation of the installed systems and reduce energy consumption. The BMS will also record the values from the smart meter/sensors that can be visualized through a SCADA system and transferred to any third-party platform (e.g., CIP).
- PV net metering system. A new photovoltaic system is designed to be installed at the roof of the building consisting of 65 kWp of monocrystalline PV panels and three inverters of 20 kW each. The PV system will be connected to the national grid (low voltage) through a net-metering scheme in order to offset the electricity consumed by the buildings.
- Solar thermal system for DHW. A new solar thermal system consisting of 24 solar collectors of 2 m^2 area each has been designed to operate in collaboration with the heat pump. The system includes two new DHW tanks of 1,500 lt.
- A new dashboard. It refers to a direct replication of the demonstration included in LHCs of Nice Cot’ Azur.

According the detailed study, the above interventions upgrade the indoor gym building to a A-labelled building with energy consumption of 241.9 kWh/m^2 as opposed to the current of 632.8 kWh/m^2.

The analysis of measure #5 considered the replication of a number of technologies demonstrated by the Lighthouse Cities of Gothenburg, Utrecht and Nice Côte d’Azur as discussed in Deliverable 5.3, 6.3 and 7.3:

- Increased insulation levels, additional to those imposed by the Regulation on the Energy Efficiency of Buildings (KENAK) for dwellings in the area of Alexandroupolis (Climatic Zone C).
- The use of Low Temperature district heating and district cooling (DHC) network
- Geothermal Heat Pumps with borehole storage for providing heating and cooling in the DHC network
- PV panels for on-site electricity generation.
- Electrical storage for increasing the levels of electricity self-supply of the district by RES

Various combinations of these technologies were considered in order to achieve Near Zero Energy district. A model for a representative building of the district was developed using the energy rating software provided by the Technical Chamber of Greece for conducting Energy Performance Certificate assessments, and a study was conducted to identify the levels of insulation and the size of the PV system that would lead to an A+ rating which is considered suitable for NZEB performance. Insulation levels slightly higher than what is currently required by the Building Regulations and a PV system of at least 2.2kW installed on the roof was required for achieving a score of A+. The thermal transmittance of the main building elements required for NZEB performance is shown in Table 6. These values of thermal transmittance and size of PV system were considered the minimum requirements when examining the various configuration for NZEB performance of the district buildings.

Table 6: Thermal transmittance of main building elements to achieve NZEB performance

	U-value (W/m2K)
Walls	0.35
Roof	0.30
Floor	0.65
Windows	1.20

Having determined the level of insulation required and the minimum size of the PV system, the performance of the district as a whole was then investigated. Several configurations were examined when assessing the performance of the whole neighborhood where the size of the PV system and the storage capacity of the battery were varied in order to identify those solutions that were technically and financially feasible. In order to determine the optimum combinations, a parametric analysis was conducted where the capacities of the key technologies were amended as follows:

- PV system. Three different capacities were examined: 350kW, 300kW and 250kW.
- Batteries. Electrical storage is required in order to increase the degree of electricity self-supply and meet the relative criterion. The total daily average electricity load of the neighborhood (including the power required for running the geothermal heat pumps) was approximately 1,100kWh. For this reason, four different electricity storage capacities were evaluated: 550 kWh ensuring approximately half-day autonomy for the neighborhood, 1,100 kWh – corresponding to a day's autonomy, 1,650kWh for a day and a half autonomy and 2,200 kWh for 2 days of autonomy. The case of no electricity storage was also examined.
- District Heating and Cooling Network. This was considered in all cases.
- Geothermal Heat Pumps with borehole storage. This technology was considered in all cases. The required capacity in each case was determined by the heating and cooling loads resulting from the respective insulation levels.

The various scenarios that were examined are presented in Table 7 below. A Business-as-Usual (BaU) retrofit scenario is also considered, against which all configurations were compared in order to determine potential benefits arising from the implementation of additional measures towards achieving near-zero performance. The BAU scenario involved the use of conventional heating oil boiler and A/C units for delivering heating and cooling whilst no PV and battery system was considered.

Table 7: Summary of scenarios examined and the Business-as-Usual scenario for the Near Zero Energy district

	PV (kW)	Batteries (kWh)	Heating/ Cooling
BaU configuration	0	0	Boiler + A/C
Configuration 1	350	0	DHC + GSHP
Configuration 2	350	550	DHC + GSHP
Configuration 3	350	1,100	DHC + GSHP
Configuration 4	350	1,650	DHC + GSHP
Configuration 5	350	2,200	DHC + GSHP
Configuration 6	300	0	DHC + GSHP
Configuration 7	300	550	DHC + GSHP
Configuration 8	300	1,100	DHC + GSHP

	PV (kW)	Batteries (kWh)	Heating/ Cooling
Configuration 9	300	1,650	DHC + GSHP
Configuration 10	300	2,200	DHC + GSHP
Configuration 11	250	0	DHC + GSHP
Configuration 12	250	550	DHC + GSHP
Configuration 13	250	1,100	DHC + GSHP
Configuration 14	250	1,650	DHC + GSHP
Configuration 15	250	2,200	DHC + GSHP

A feasibility study was conducted and both measures were assessed in terms of their economic and technical performance using suitable Key Performance Indicators: Degree of Energetic Self-Supply (thermal and electrical, DE_T and DE_E), Emissions Reduction (Kg), Payback Period (years), Net Present Value (€) and Internal Rate of Return (%).

4.7.8. Citizen engagement

The measures foreseen for the energy refurbishment of the indoor gym means that the municipality is the only entity responsible for implementation and operation. Citizens, as end-users of the indoor gym, have crucial role, considering the fact that approximately 60,000 citizens and visitors of Alexandroupolis visit the indoor gym per year. This is the reason behind the decision to replicate the dashboard demonstrated in LHC of Nice Cot' Azur.

In addition, the specific citizen engagement measures are highly required to realize a successful implementation of measure #4 for TT#1. It is recognized that this measure will require well planned citizen engagement activities and increased effort from the municipality, as part of measure #1 of TT#5, since the realization of the project depends on the active participation of citizens as building owners of the selected district.

4.7.9. Business model

Measure #3 has been well matured, and its' implementation has already started. The business model followed to realize this project is the same as the one proposed for the energy retrofit of municipal buildings of IS-1.1. This replication project has secured funding from the Operational Programme "Transport Infrastructure, Environment and Sustainable Development" after the successful application of the Municipality of Alexandroupolis.

Municipality is the owner and operator of the indoor gym buildings, the business model to be followed is straightforward. The municipality of Alexandroupolis will proceed with the investments either by own funds or by utilizing any of the available financial instruments also presented in table 1 of D3.7 – Financing solutions for cities and city suppliers. The Regional Operational Programme of Region of East Macedonia and Thrace includes in its scope the funding of projects as the retrofitting projects included in replication plan of Alexandroupolis for TT#1. Thus, the municipality has a clear aim to complete the required studies and acquire the required licenses in order to proceed with the application for funding under the Regional Operational Programme.

The financial evaluation of the proposed solutions of measure #4 was conducted on the basis of several assumptions regarding the cost of the different technologies. The following assumptions were made:

- Cost of Geothermal Heat Pumps: €1,500/kW
- Cost of District Heating and Cooling Network: € 650,000
- Cost of the PV system (PV panels, inverters etc): € 1,000/kW
- Cost of the battery storage: € 400/kWh
- Cost of heating oil boilers: € 1,500/house
- Cost of A/C units: € 1,500/house
- Selling Price of electricity: € 0.065/kWh
- Cost of electricity purchase: € 0.10 /kWh
- Heating oil costs: € 1.10/litre
- Insulation costs: € 45/m^2
- Cost of double-glazed windows: € 250/m^2

The financial analysis is based on the same criteria presented in section 4.6.9. Results of the financial analysis for all configurations are presented in Table 12 below. All possible configurations were assessed against the BAU configuration. The analysis for the dynamic payback period considered a 5% discount rate and a 2% energy price increase rate. In addition, a 0.5% reduction of the PV panels' performance was also taken into account in the NPV and IRR calculation. The commonly used thresholds for assessing financial viability are used in this case as well, i.e., an investment is considered viable when it results in a positive Net Present Value and Internal Rate of Return greater than 5%. The period of the investment was considered 25 years. Results when the financial criteria were met are marked in bold.

Table 8: Financial evaluation of the configurations examined

	Simple payback	Payback (Type C)	NPV (25 YEARS)	IRR (25 years)
Configuration 1	**11.9**	**8.4**	**398,187 €**	**8.2%**
Configuration 2	**13.3**	**9.7**	**287,913 €**	**7.0%**
Configuration 3	**15.2**	**11.8**	**104,553 €**	**5.6%**
Configuration 4	17.4	14.2	-103,940 €	4.4%
Configuration 5	19.5	17.1	-312,977 €	3.4%
Configuration 6	**12.0**	**8.5**	**363,900 €**	**8.1%**
Configuration 7	**13.5**	**10.0**	**249,292 €**	**6.8%**
Configuration 8	**15.6**	**12.2**	**62,681 €**	**5.4%**
Configuration 9	17.9	14.9	-146,119 €	4.1%
Configuration 10	20.2	18.0	-355,045 €	3.1%
Configuration 11	**12.2**	**8.6**	**329,066 €**	**8.0%**
Configuration 12	**13.8**	**10.3**	**209,163 €**	**6.6%**
Configuration 13	**16.1**	**12.7**	**18,235 €**	**5.1%**
Configuration 14	18.5	15.7	-190,620 €	3.8%
Configuration 15	21.0	19.2	-399,542 €	2.8%

4.7.10. Governance

Municipality of Alexandroupolis is the main stakeholder of all measures included in TT#1. The selected district building owners of measure #4 are also considered as main stakeholders in respect to this replication project.

4.7.11. Impact assessment

The impact of the measures included in TT#1 contribute to the reduction of CO_2 emissions, which is the overall goal of IRIS and of the Municipality of Alexandroupolis. The successful implementation of the proposed replication projects will contribute to the specific objective to increase energy building performance locally and reduce the carbon footprint of the building sector.

The following KIPs have been selected in order to assess the success and suitability of these measures in this context and are analytically discussed in section 4.6.11.

- Degree of Energetic Self-Supply (electrical and thermal)
- CO_2 Emissions Reduction

KPI	Parameters	Baseline
1. Degree of energetic self-supply (electrical and thermal)	Ratio of locally produced energy from RES and the energy consumption over a period of time	The buildings before the implementation of energy savings interventions and RES integration
2. CO_2 emissions reductions	Ton of CO_2	The buildings before the implementation of energy savings interventions and RES integration

Results of the technical evaluation in terms of the Degree of Self-Supply and the Emissions Reduction for all configurations are presented in Table 9 below.

Table 9: Technical evaluation of the configurations examined

	PV (kW)	Storage (kWh)	Electricity Own-Use (kWh)	Electricity Imports (kWh)	Electricity Exports (kWh)	Self-supply (thermal)	Self-supply (electrical)	CO_2 displaced (kg)
Con.1	350	0	123,767	307,113	428,624	100%	54.5%	-515,934
Con.2	**350**	**550**	**306,314**	**124,544**	**246,031**	**100%**	**82.7%**	**-814,578**
Con.3	**350**	**1100**	**354,475**	**76,412**	**197,890**	**100%**	**95.9%**	**-893,310**
Con.4	**350**	**1650**	**356,373**	**74,511**	**195,986**	**100%**	**96.5%**	**-896,417**
Con.5	**350**	**2200**	**357,271**	**73,611**	**195,084**	**100%**	**96.8%**	**-897,887**
Con.6	300	0	119,651	311,226	353,845	100%	46.3%	-441,280
Con.7	300	550	294,326	136,553	179,107	100%	68.6%	-726,971
Con.8	**300**	**1100**	**336,447**	**94,431**	**136,994**	**100%**	**77.6%**	**-795,887**
Con.9	**300**	**1650**	**337,763**	**93,115**	**135,686**	**100%**	**77.9%**	**-798,046**
Con.10	**300**	**2200**	**338,864**	**92,016**	**134,587**	**100%**	**78.2%**	**-799,844**
Con.11	250	0	114,559	316,294	279,993	100%	38.2%	-365,039
Con.12	250	550	279,417	151,417	115,083	100%	54.9%	-634,733

Con.13	250	1100	313,617	117,235	80,910	100%	60.4%	-690,659
Con.14	250	1650	314,840	116,010	79,687	100%	60.6%	-692,665
Con.15	250	2200	315,944	114,907	78,586	100%	60.8%	-694,471

According to Greek legislation, a refurbished building is considered as "NZEB", when its energy performance is B+ or higher (after renovation). A minimum level of self-supply (for considering 'near-zero' performance of the district) of 75% is set as a reasonable threshold and was used in order to evaluate the various configurations examined. Configurations that satisfy at least 75% of electrical and thermal self-supply are considered technically feasible for implementing the Nearly Zero Energy district. These are marked in bold.

It can be seen that whilst there is a number of configurations that meet the technical requirements, only three configurations meet both the technical and financial criteria and are therefore considered technically and financially viable investments. These are configurations 2, 3 and 8 (Table 10) and result in total emissions reduction from 795,887 to 893,310 kgCO_2 It can be seen that the size of the PV system is required to be 300kW$_p$ at a minimum whilst the optimum battery size provides 0.5 to 1 day's autonomy.

Furthermore, it is also apparent that none of the configurations in-between 11–15 that have a 250 kWp total PV capacity (corresponding to approximately 2.6 kWp available per house) are able to meet the 75% self-supply target. This suggests that the A+ rating that considers 2.2 kW$_p$ PV capacity is not sufficient for achieving the near-zero energy neighborhood target, as defined here. This highlights the need to update the definition and provide specific guidelines for near zero-energy buildings, as well as to establish a definition for near zero energy districts, if a truly near-zero energy performance is to be achieved.

Table 10: Configurations that meet both the technical and financial criteria set

	PV (KW)	Storage (KW)	Self-Supply (thermal)	Self-Supply (electrical)	NPV	IRR
Configuration 2	350	550	100%	82.7%	€ 287,913	7.0%
Configuration 3	350	1100	100%	95.9%	€ 104,553	5.6%
Configuration 8	300	1100	100%	77.6%	€ 62,681	5.4%

4.7.12. Implementation plan

The implementation of the selected measures follows the steps described in section 4.6.12. The success of the implementation plan depends - in different degree for each measure - on the engagement of stakeholders and citizens. It has to be mentioned that the measure #5 requires increased effort to involve citizens and stakeholders, since the project is based on the renovation of privately-owned buildings that will follow strict construction specifications in order to successfully develop a near zero-energy district. In addition, the low-income families that own these buildings dramatically limit the possibility of the owners to finance such measures and highlight the need for national and/or EU subsidies. Therefore, the implementation plan described here is highly depend on the success of the stakeholder and citizen engagement activities.

4.7.13. WBS – Work Breakdown Structure & Gantt chart

For WBS see section 4.6.13. The Gantt chart of measure #3 is presented in Annex 4. The Gantt chart of measure #4 is under development.

4.7.14. Financing schemes and opportunities

Measure #3 has already secured funding as already mentioned in this deliverable. Measure #4 is a highly innovative projects that has not been developed to that extent in Greece before. The role of the municipality in this project is less interventional since the project success is based on the engagement of citizens/stakeholders. In addition, the feasibility study concluded that the near zero-energy district project has low economic efficiency. Thus, the financial analysis is crucial and has to be developed by external experts. It goes without saying that public private partnership is required to successfully implement this innovative measure.

4.8. Conclusions on ambitions and planning of activities for TT#1 1 Smart renewables and closed-loop energy positive districts

Municipality of Alexandroupolis, in accordance with its long-term commitment, has set an ambitious replication plan for TT#1, including four (4) specific measures. Measures #1, #2 and #3 will be accomplished by the municipal authority and their successful implementation is not related to citizen engagement, whereas measure #4 requires the engagement of citizens and stakeholders. Measure #3 is the most advanced replication project which is expected to be completed within IRIS project duration.

The replication plan of Alexandroupolis for TT#1 aims to make urban energy systems resilient to economic and climate change through innovative business model exploitation and research breakthroughs in low carbon technologies, taking advantage of the demonstrated integrated solutions in LHCs of IRIS project.

5. Transition track #2: Smart energy management and storage for grid flexibility

5.1. TT#2 Replication in a nutshell

Following the 13 steps mentioned in the proposed replication roadmap (D8.1), the FC of Alexandroupolis developed a replication plan for transition track #2 selecting integrated solutions to be replicated according city baseline analysis and in alignment with the existing action plans regarding energy transition and CO_2 reduction targets. FC Alexandroupolis could not commit to replicate all of the TT#2 solutions demonstrated by the LHCs. Assessing the local replication potential, Alexandroupolis expressed interest to replicate projects in IS-2.2, as included in D1.2 – User, Business and Technical requirements of TT#1 Solutions.

Identifying the most applicable actions that respond to the local reality and local challenges, FC of Alexandroupolis aims to replicate integrated solutions of TT#2 to further exploit the low-enthalpy geothermal field of Antheia-Aristino, that is leased by the Municipality of Alexandroupolis. The selected measure comprises two phases. Phase A includes the development of geothermal district heating network (DHN) for municipal buildings, social housing and greenhouses while phase B includes the expansion DHN to households of the local area. Phase A has is currently under implementation with the contractor to have already started the construction works.

5.2. Selection process

The exploitation of the low-enthalpy geothermal field of Antheia-Aristino has been a long-term target for the municipality of Alexandroupolis. The development of the exploitation project required significant effort, the support of external experts and the engagement of stakeholders. The project development started back in 2010 and concluded with the construction tender issued in 2018. This project is considered as the most important energy project of Alexandroupolis and therefore, it selected to as the base for further development through replication activities within IRIS project.

The procedure shown in Figure 4 and described in section 4.2 is also applied to the selection of the replication activities for TT#2. As early as the initiation of IRIS project, the replication team of FC of Alexandroupolis concluded that the local and national context has low replication potential for the demonstrated solutions of LHCs. Thus, the only measure included in TT#2 for Alexandroupolis is related to the geothermal district heating network of Antheia-Aristino, which however is considered as highly important for achieve the targets and goals set for the energy transition of the city.

5.3. Mapping of stakeholders

Following the statement of D1.7-Tranistion strategy, Commissioning plan for the demonstration & replication, regarding the main stakeholders and in respect to the selected replication projects of TT#2 the main stakeholders recognized are:

- Municipality of Alexandroupolis (enabler/end-user)
- Energy HIVE Cluster (utilizer)
- CERTH/CPERI (provider)
- Citizens of selected districts (end-user)

5.4. Identified knowledge gaps

The complexity, as well as the integrated nature of the replication projects that are based on IRIS solutions demonstrated by LHCs requires a thorough analysis of existing knowledge and capacities within the FC local ecosystem in order to identify potential knowledge gaps that will prevent smooth project design and implementation. The identified knowledge gaps are then covered through the knowledge exchange activities between the IRIS partners.

For this TT#2, the FC replication team identified knowledge gaps regarding the innovative solutions presented by Nice Cot' Azur. More specifically, the different temperature operation range of the geothermal DHN of Alexandroupolis may require different design of the innovative PCM storage solutions demonstrated in LHC of Nice.

5.5. Capacity building and knowledge transfer

The importance of capacity building and knowledge transfer has been extensively stated within IRIS project, as well as in other smart city projects. During the development of the replication plan, Alexandroupolis took advantage of the knowledge tools provided by IRIS project in order to support its activities towards successful replication project identification and implementation. Workshops and webinars provided valuable information that is utilized to formulate the replication projects of TT#2. IRIS deliverables are the main source of information for the replication team of Alexandroupolis that are supplemented with knowledge gained through webinars, workshops, peer-2-peer sessions and communication material.

The development of TT#2 replication plan of Alexandroupolis required also several internal roundtables and workshops targeting capacity building of the municipality employees. Energy HIVE Cluster and CERTH provided with the required expertise and scientific knowledge in order to assess the replication potential and find innovative solutions to the local challenges.

5.6. IS-2.2: Smart multi-sourced low temperature district heating (DH) with innovative storage solutions

5.6.1. Baseline

The low-enthalpy geothermal filed of Antheia-Aristino is considered as one the most important geothermal fields located in North Greece, mainly due to the availability of geothermal fluid of more than 90^{o}C temperature and its potential for exploitation. The exploitation of this low-enthalpy geothermal field is considered as the most important objective of Alexandroupolis' strategic plan towards a resilient low-carbon local economy.

Following a long and bureaucratic procedure, the Municipality of Alexandroupolis leased the exploitation of the geothermal field and secured funding for a geothermal project of 6 million €. The project includes the development of a geothermal district heating network that will provide heat for municipal buildings, social housing and greenhouses with a total thermal power estimated at 10 MW. The utilized geothermal fluid supply is expected to be 150 m^3/h. The geothermal project includes the development of approximately 18 km of network that will be developed with polypropylene pipes of 4th generation (PPRCT) being the first installation of district heating with such plastic pipe network in Greece. The project includes the development of a thermal station that houses the required electromechanical equipment for the DHN system. According to the completed studies, the DHN will include eight (8) plate heat exchangers from which three (3) are installed for back up purposes. The DHN consists of two (2) different sub-systems that serve the municipal buildings and the greenhouse facilities (Figure 14). Each building/greenhouse connected to the DHN will be equipped with a thermal station consisting of a heat exchanger, thus forming an indirect district heating network.


Figure 13. Photos during pumping tests of the geothermal wells

The geothermal DHN is currently under implementation with no experienced delays until today and it is expected to be completed within 18 months period (starting from September 2020). As stated in the development studies of the project, the geothermal potential of the low-enthalpy field of Antheia-Aristino is more than 20 MW. Therefore, the objective of the activities for TT#2 is to further exploit the renewable geothermal energy through replication of technologies and services demonstrated in the LHCs of IRIS project.

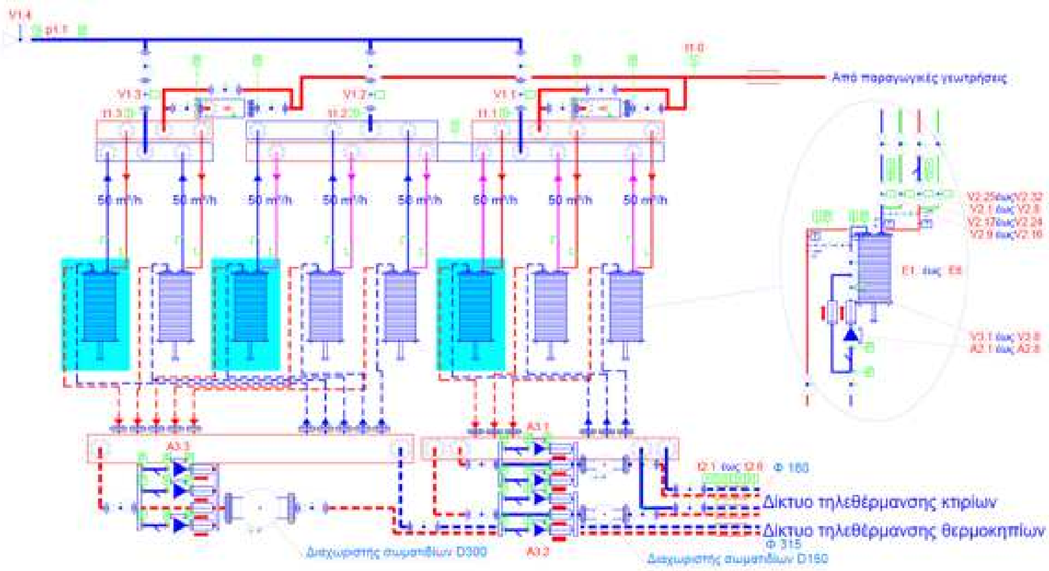


Figure 14. Diagram of geothermal central thermal station

5.6.2. Ambitions

Alexandroupolis' ambition is to implement projects that will lead to a green and sustainable urban environment and creation of green jobs. In particular, the ambition for IS-2.2 is to contribute to further exploitation of the low-enthalpy geothermal field of Antheia-Aristino, located within the administrative boarders of Alexandroupolis, by replicating integrated solutions demonstrated in LHCs of IRIS project.

The selected measure for TT#2 includes a first phase which entails the geothermal DHN network development and will be partially inspired by Nice Cot' Azur demonstration activities and a second phase that aims to expand the DHN to local households by replicating integrated solutions presented in D5.4/6.4 and 7.4 of IRIS project. The objective of the second phase is to develop a DHN for 622 houses and approximately 1,600 citizens of the area utilizing smart and innovative solutions demonstrated in LHCs and adapt to the local context.

The replication activities in this TT#2 aim to leverage private capital and attract private investments in the area by providing low-cost renewable thermal energy. The overall objective from the exploitation of the low-enthalpy geothermal field is local economic growth and local energy transition.

5.6.3. Planning of replication activities

Thus, the overall planning of TT#2 depends on the planning of the development of the geothermal DHN. Having concluded to the specific replication project, the replication team will develop the Work Breakdown Structure (WBS) of the project and define – if relevant – sub-projects and tasks. The WBS TT#2 has been developed and it is presented in following section. The Gantt chart presented in the same section depicts the planning of the replication activities.

5.6.4. Organisation of work

Municipality of Alexandroupolis will be the owner and the operator of the under development geothermal DHN and there will undertake the actions and activities required to design, develop and implement the selected replication project. The support of local partner Energy HIVE Cluster enhances the project realization and ensures successful implementation. Energy HIVE Cluster will act as an external expert advisor particularly for the design and the implementation process of this measure.

The second phase of the selected measure requires the engagement of citizens as potential end-users of the expanded geothermal DHN. Municipality of Alexandroupolis will undertake the activities to engage citizens and stakeholders. CERTH and Energy HIVE Cluster are responsible for development of the feasibility study of this measure.

5.6.5. Data collection and management

Monitoring and control of the new geothermal DHN is included in the under implementation public contract. It includes the procurement and installation of controllers, smart meters and sensors that will allow remote and on-site monitor and control of installed equipment. In addition, each consumer (end-user of geothermal energy) will have a smart thermal meter installed in the thermal sub-station for monitoring energy consumption and billing purposes. The foreseen data collection system will have the capability to connect with third party platforms (e.g., city CIP) for data transfer.

Data that will be collected within the replication area include:

- Temperature of geothermal fluid (in-out)
- Thermal energy production (primary loop-geothermal fluid)
- Thermal energy production (secondary loop-DHN)
- Electricity consumption of geothermal DHN facilities
- Thermal energy consumption on consumer level (thermal sub-station)
- Thermal energy consumption on consumer level (back-up heating system)

Regarding the private entities that will participate in the DHN, the data collection will comply with GDPR regulations.

The data collection makes the calculation of KPI fairly easy. Thus, the project can be closely monitored and evaluated.

5.6.6. Barriers and drivers

Political

The same applies as included in section 4.6.6.

Economical

- **Barriers:** The increased capital cost of such projects acts as a barrier for the implementation without public support.

- **Drivers:** The provision of low-cost (and environmentally friendly) thermal energy may be considered as economic drive to attract investors and citizens in the area and therefore support local economic growth.

Sociological

- **Barriers:** The second phase of this measure strongly relies to citizens of the area as potential end-users of the expanded geothermal DHN. District heating networks are not common in Greece and in Alexandroupolis in particular. The information of citizens for the benefits of such projects is crucial for the viable operation of DHNs.
- **Drivers:** See section 4.6.6.

Technological

- **Barriers:** The reintroduction of the geothermal fluid to the reservoir is a technological barrier.
- **Drivers:** The efficient operation of a LT DHN is a barrier as well as driver for low-cost operation and expansion of the distribution network to more consumers.

Legal / Regulatory framework

- **Barriers:** Geothermal energy exploitation is cover by Law 3175/2013. The promotion of renewable energy sources follows Law 3468/2006, as altered by Law 3851/2010. The development of district heating networks falls under the Law 4001/2011 and licensing procedure must be according to Ministerial Decision D5-HL/B/F.1/oik.17951. No specific regulatory framework for low temperature networks is currently in place in Greece. Licensing procedure for DHNs is bureaucratic and acts as a significant barrier for project implementation, as also highlighted by the long and painful process that the municipality had to follow in order to develop the base geothermal project.
- **Drivers:** No drivers were identified.

Environmental

- **Barriers:** No barriers were identified
- **Drivers:** The planned replication measures for TT#2 provide the opportunity to achieve a substantial reduction in CO_2 emissions and increase of the use of RES technologies.

5.6.7. Specifications

The replication project consists of two different phases, as already stated in this deliverable. Phase A includes the project under-development for the construction of a geothermal district heating network. The geothermal based DHN is a first of its kind development for the city of Alexandroupolis and will give important feedback for further, similar type of replications in the Region of East Macedonia and Thrace. Phase A will replicate the proposed solution by Nice Cot' Azur regarding the integration of an AI driven supervision platform that will provide valuable experimentation for the industry on possible energy savings and further flexibility driven hybrid systems integration.

It is considered as a direct replication activity that will allow Alexandroupolis to smarten the designed geothermal DHN and eventually increase the overall operation efficiency. The supervision platform to be implemented, will use in a first step, AI algorithms to optimize the production station's thermal and the network's hydraulic balance through forecast and optimization. This will be achieved by training the platform on historic data series and identify new optimization levers.

The project includes the installation of an optic fibre network that will be used to implement the MES supervision platform and related enhancements, as demonstrated by Nice Cot' Azur. Through this network all data will be centralised in a central platform and will be used to develop new reliable forecast and optimization strategies for geothermal well utilisation, as well as for the distribution network pumping operation.

Phase B of the replication measure for TT#3 include the expansion of the DHN to local households. The local FC replication team developed a technical approach for this replication project. According to the estimations made based on the statistics available, the thermal demand of the targeted households is approximately 3,500 kW. To cover this demand, the required geothermal fluid supply is calculated at approximately 130 m^3/h.

The proposed design of the new DHW involves the development of 4 individual closed distribution networks for each of the settlements of the project, as shown in Figure 16. The networks are designed as a radial dendroid type as follows for each settlement.

The distribution networks will be developed following the same piping solution of the base project, that is to say 4th generation polypropylene pre-insulated pipes (PPRCT). The required diameters depend on the consumers that are connected on each branch of the network. According to the initial calculations the required length for each pipe diameter is presented in Table 11.

Table 11. Estimated length for the expansion of geothermal DHN per pipe diameter required

Pipe Diameter (external) (mm)	Estimated length (m)
Φ200	1,400
Φ160	2,000
Φ125	4,600
Φ75	5,720
Φ63	3,000
Φ50	4,200
Φ32	960
Φ20	4,648

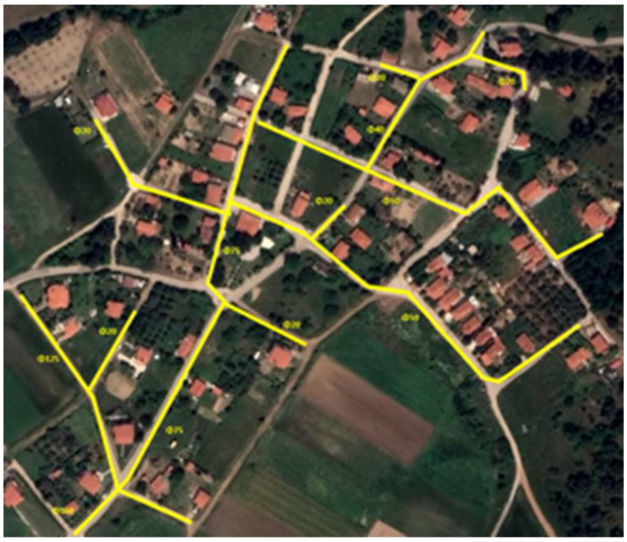
For the technical analysis two different scenarios are examined.

<u>1st Scenario</u>

The 1st scenario consists of drilling a new geothermal production well near Antheia and approximately 1 Km away from the under construction central thermal station. The primary network transfers geothermal fluid from the new geothermal well to the under construction central thermal station. The central thermal station will be expanded with new plate heat exchangers in order to deliver the available thermal energy to the new secondary closed-loop distribution networks of Antheia, Aristino, Doriko and Aetochori. The geothermal fluid is reinjected into the geothermal system through a newly drilled well in a suitable location near the central thermal station.

Distribution network of Antheia

Distribution network of Aristino



Distribution network of Aetochori

Distribution network of Doriko

Figure 15. Indicative distribution network for each settlement

Regarding the secondary network all the closed internal networks are designed to service the needs of the settlements and have the same starting point of the existing thermal station near Antheia. The design scenario calls for 3 distinct closed-loop networks as follows:

1. Heating Distribution Network of Antheia settlement.
2. Heating Distribution Network of Aristino settlement.
3. Heating Distribution Network of Doriko-Aetochori.

<u>2nd Scenario</u>

The second scenario taken into consideration consists of creating two independent primary networks for servicing:

1. The settlements of Antheia and Aristino
2. The settlements of Doriko and Aetochori.

Each network will consist of one new geothermal production well and one new geothermal reinjection well. Specifically, the new network that will service the settlements of Antheia- Aristeino is designed to feature a new productive well of 100m^3/h capacity and new primary network for transferring geothermal fluid to the central thermal station of Antheia and to the position of the new reinjection well. The same secondary network as in the first scenario is considered to distribute the thermal energy to the households of Antheia and Aristino.

For the other two settlement, that is to say Aetochori and Doriko, a new geothermal productive well will be constructed with a targeted capacity of 30m^3/h, accompanied with a new reinjection geothermal well. As oppose to the first scenario, this solution requires the development of a new thermal station, that – for techno-economic reasons – must be constructed near the new geothermal well. Municipality of Alexandroupolis is the owner of land property that is place within the geothermal field in close proximity to Aetochori (250m) comprising the best positioning of the new geothermal wells and the new thermal station.

The selected position of the new productive well is set to be made in a plot of land owned by the municipality located roughly 250m from the settlement of Aetochori. The thermal station is set to be situated near the borehole in the same plot of land in a distance of 50m. The reintroduction borehole of the geothermal fluid is planned to be situated approximately in a distance of 1 km from the thermal station.

According to the feasibility study developed, both scenarios are technically feasible, and the selection should be based on the economic performance of each scenario.

The expanded geothermal DHN will include the MES supervision platform proposed by Nice Cot' Azur, which will have been already tested in phase A of this replication project. The geothermal fluid temperature (above 90^{o}C) means that there is no need for integration of other sources for heating. In addition, district cooling of residential houses of the specific location is not considered as a viable project. Nevertheless, the solution demonstrated that integrate storage solutions in the geothermal DHN are of great interest, since there is potential to reduce operating costs and simultaneously enhance the response rate of the DHN.

Therefore, phase of this replication project introduces a distribute heat storage, inspired by the "Smart Thermal Energy Storage-SETI" demonstrated in Nice Cot' Azur. This storage system will be used as a "buffer" between the primary and secondary DHN. The use of phase change materials is proposed. As opposed to the demonstrations, the high geothermal fluid temperature required different approach in terms of the selection of the most suitable and efficient PCM.

5.6.8. Citizen engagement

The proposed measure (phase B of the project) is of high capital cost and due to the low density of the buildings of the location of interest the connection of increased percentage of household to the new geothermal DHN is of utmost importance. In addition, the Greek legislation does not oblige citizens to be connected to DHNs, as it is the case in other cities (e.g. Nice Cot' Azur). Therefore, the engagement of citizens is crucial for the successful project implementation and requires well planned citizen engagement activities and increased effort from the municipality and the local ecosystem. The Municipality aims to have a clear citizen engagement plan for this measure, before the completion of the development studies of phase B of the is measure. It has to be mentioned that phase A (currently under construction) has low sensitivity in terms of its successful implementation to citizens' engagement.

5.6.9. Business model

Phase A of the replication project is developed utilizing the common business model of public projects, that is to say application for public funding. This phase of the project is funded by the Regional Operational Programme 2014-2020 of Region of East Macedonia and Thrace (6.2 million €). According to the financial study developed by the municipality, the thermal energy will be priced at 35 €/MWh, as also stated in the specific license for thermal energy distribution.

The business model is targeted to be followed for phase B of the replication project. In correlation to IRIS program goals, the aim is to make the business plan profitable for the replication by privately funded individuals and/or companies in the area. All the evidence needed in terms of economic viability of the project have been calculated. IRR, NPV and payback period are making the investment profitable in the near future. For this measure the financial evaluation has been developed for both scenarios mentioned in section 5.6.7. The second scenario is considered as the best option due to less operational expenses.

- Operational expenses
  - Personnel cost 14,400 €/year (12 person months)
  - Maintenance expenses 20,300 €/year (4% of electromechanical equipment)
  - Electricity consumption 122,000 €/year (740,000 kWh/year)
- Profit
  - 430,000 €/year (12,300 MWh with 35 €/MWh)
- Annual inflation rate: 1%
- Annual electricity price increase rate 2%
- Own equity: 100%
- Project lifetime: 30 years

According to the financial evaluation based on the criteria presented in 4.6.9, the second scenario of phase B of the project can be considered as techno-economically feasible, with low however economic performance.

- NPV: 160,000 €
- IRR: 5,9 %
- Simple payback: 15 years

5.6.10. Governance

Municipality of Alexandroupolis is the owner of the geothermal DHN under construction and will be the operator after completion of the construction works. Therefore, the municipality is responsible for the project study and implementation and will coordinate all activities required.

5.6.11. Impact assessment

The impact of the measures included in TT#2 contribute to the reduction of CO_2 emissions, which is the overall goal of IRIS and of the Municipality of Alexandroupolis. The successful implementation of the proposed replication project will contribute to the specific objective to increase the utilization of geothermal energy, as well as reduce the energy consumption and carbon footprint of the residential building sector. The following KIPs have been selected in order to assess the success and suitability of these measures in this context are:

KPI	Parameters	Baseline
1. Energy Savings	Energy consumption reduction to reach the same services after interventions, taking into consideration the energy consumption of the reference period (in %)	Energy consumption of residential buildings before connection to DHN
2. CO_2 emissions reductions	Ton of CO_2	CO_2 emissions of residential buildings before connection to DHN
3. Degree of energetic self-supply	Ratio of locally produced energy from RES and the energy consumption over a period of time	Residential buildings before connection to DHN

5.6.12. Implementation plan

Phase A of the selected measure for TT#2 is currently under implementation. The current stage includes the construction phase which is expected to be finished in late 2021. Phase B of the selected measure for TT#2 will be replicated in Alexandroupolis following a clear implementation plan that will support efficient and successful replication. The implementation will follow the steps described in section 4.6.12. The success of the implementation plan of phase B, highly depends on the engagement of stakeholders and citizens.

5.6.13. WBS – Work Breakdown Structure & Gantt chart

For WBS see section 4.6.13. The Gantt chart the measure included in IS-2.2 is presented in Annex 4.

5.6.14. Financing schemes and opportunities

The implementation of Phase A of this replication project is funded by Regional Operational Programme 2014-2020 of East Macedonia and Thrace. Following the same process, the municipality aims to apply for funding at the Regional Operational Programme 2014-2020. To do so, the detailed studies and licenses of the project must be completed. The municipality of Alexandroupolis will finance the required detailed studies in order to mature the replication project and apply for funding at the ROP of East Macedonia and Thrace.

5.7. Conclusions on ambitions and planning of activities for TT#2 Smart Energy Management and Storage for Energy Grid Flexibility

As stated in TT#1, Municipality of Alexandroupolis is strongly committed to foster the energy transition locally and achieve the local and national targets set for climate change mitigation. In TT#2, Alexandroupolis is expected to implement an important energy project, which required significant and long-term effort for its realization. The exploitation of low-enthalpy geothermal field of Antheia-Aristino has been a long-term target of the municipality of Alexandroupolis. Phase A of the replication project includes the development of a geothermal district heating network and it is currently under implementation having an immediate impact of the targets set by Alexandroupolis in IRIS project. Phase B of the project includes the expansion and smartening of this geothermal DHN and it is expected to have a strong impact on the local energy transition efforts.

Although only one replication project is selected in TT#2, Alexandroupolis' replication plan for TT#2 is expected to have a strong impact on the ultimate objective to make urban energy systems resilient to economic and climate change through innovative business model exploitation and research breakthroughs in low carbon technologies.

6. Transition track #3: Smart e-mobility sector

6.1. TT#3 Replication in a nutshell

Productive cooperation between lighthouse and follower cities was achieved from the beginning of the IRIS project. Multiple events, activities and co-authored documents took place, including a replication strategy, workshops, training manuals, various thematic webinars, city baseline reports, peer-learning visits and work-shadowing visits.

These replication frameworks firstly look into what cities have learned and then focus on what each follower city has already planned to replicate. Each city has also indicated what could be the barriers for the replication of the smart city solutions and what they would need to ensure as a successful replication for each case. Fellow cities will use these roadmaps as their guiding document, fostering a shared vision amongst their colleagues in different areas and departments. This will create internal buy-in and guarantee that the services and experts within their cities take ownership in replication. Parameters such as city's administration, national legislation for the implementation of the proposed and the economic feasibility of the proposed schemes.

The smart e-mobility plan is an opportunity for Alexandroupolis, to explore new business models and deliver innovative solutions involving stakeholders from various sectors and thus creating a propitious environment for sustainable and intelligent growth. The smart e-mobility for the follower city of Alexandroupolis, aims to increase the level of sustainability and efficiency in urban mobility. The way to reach the target, include solutions such as shared system of electric bicycles, electric bus and an electric shuttle bus.

6.2. Selection process

The selection process presented in Figure 4 and described in section 4.2 is also applied for the selection of the smart e-mobility measures to be replicated in Alexandroupolis. The replication team of FC of Alexandroupolis investigated the local and national context and concluded that there is low replication potential for the demonstrated solutions adopted by IRIS LHCs. An important factor that has been recognized is the size of the city of Alexandroupolis, which compared to the lighthouse cities is significantly smaller resulting in "no business case" for several of the demonstrated projects.

Thus, the selection of the replication projects followed the steps presented in figure 4 and concluded in two measures presented in this chapter. The selection process for TT#3 was strongly supported by the local stakeholders and citizens (third step of figure 4). The final selection of the IRIS integrated solutions was also strongly supported by the knowledge and expertise of the local ecosystem, which provided with valuable insights of the potential replicability of the demonstrated IRIS solutions and suggested the necessary adaptation to the local context of the city of Alexandroupolis.

6.3. Mapping of stakeholders

Following the statement of D1.7-Tranistion strategy, Commissioning plan for the demonstration & replication, regarding the main stakeholders and in respect to the selected replication projects of TT#2 the main stakeholders recognized are:

- Municipality of Alexandroupolis (enabler)
- CERTH/CPERI (provider)
- ASTIKO KTEL ALEXANDROUPOLIS S.A. (utilizer)

The prioritization of the above stakeholders was also performed utilizing the classification presented in D1.7.

6.4. Identified knowledge gaps

The complexity, as well as the integrated nature of the replication projects that are based on IRIS solutions demonstrated by LHCs requires a thorough analysis of existing knowledge and capacities within the FC local ecosystem in order to identify potential knowledge gaps that will prevent smooth project design and implementation. The identified knowledge gaps are then covered through the knowledge exchange activities between the IRIS partners.

6.5. Capacity building and knowledge transfer

The importance of capacity building and knowledge transfer has been extensively stated within IRIS project, as well as in other smart city projects. During the development of the replication plan, Alexandroupolis took advantage of the knowledge tools provided by IRIS project in order to support its activities towards successful replication project identification and implementation. Workshops and webinars provided valuable information that is utilized to formulate the replication projects of TT#3. IRIS deliverables are the main source of information for the replication team of Alexandroupolis that are supplemented with knowledge gained through webinars, workshops, peer-2-peer sessions and communication material.

Figure 16. Photo from peer – 2 – peer meeting between Alexandroupolis and "ASTIKO KTEL".

The development of TT#3 replication plan of Alexandroupolis required also several internal roundtables and workshops targeting knowledge transfer to public transport operator company "ASTIKO KTEL ALEXANDROUPOLIS S.A.". CERTH provided with the required expertise and scientific knowledge in order to assess the replication potential and find innovative solutions to the local challenges.

6.6. IS-3.1: Smart Solar V2G EVs charging

6.6.1. Baseline

Decarbonizing transport and mobility systems is a pressing challenge for global and European climate change mitigation. Understanding and differentiating the performance and potential of emerging new and innovative transport and mobility systems will be fundamental in implementing successful and sustainable transformation paths.

The principal prospects for decarburization are strong better utilization of underused assets in transport fleets and infrastructures can accommodate increasing demand and reduce the share of unsustainable travel modes. Smart mobility systems and services have the promise to contribute to the needed decarburization of the transport sector and will help address persistent problems of congestion and accessibility.

Based on current scenario projections, a radical transformation of transport systems is required and will become a key policy challenge. Transport transformation and innovation scenarios currently focus mainly on fuel efficiency, fuel substitution, and end-of-pipe carbon capture as levers for decarburization. Future efforts need to focus on the combined and synergetic effects of integrating urban energy, infrastructure and mobility systems including via modal-shift measures and expansion of public transport options.

6.6.2. Ambitions

Electrification typically requires a rethink of the whole transport operation. This includes procurement, charging, maintenance and driver training. Cities should treat this transition as a major and multi-year project. It should incorporate in-depth feasibility studies of technology and financing options, staggered introduction of buses and infrastructure upgrades while working on a continued performance analysis to ensure a smooth and affordable transition. Cities will need to engage new stakeholders and negotiate new models of working with bus suppliers.

6.6.3. Planning of replication activities

Alexandroupolis participates in IRIS smart cities project as Follower city. The replication activities that city is responsible to foster in order to minimize emissions in the city, are associated with the implementation of transition of two conventional buses to electric ones.

The first activity of the IRIS project, is the implementation of the connection of city's Centre (Eleutherias square) with the facilities of Democritus University of Thrace, operating with an electric bus. Nowadays, this service is facilitated with fuel power buses. Through IRIS project, the parameters will be calculated in order to alter from the conventional bus operating today to an electric one, taking into consideration the necessary frequency of the service so that demand is met.

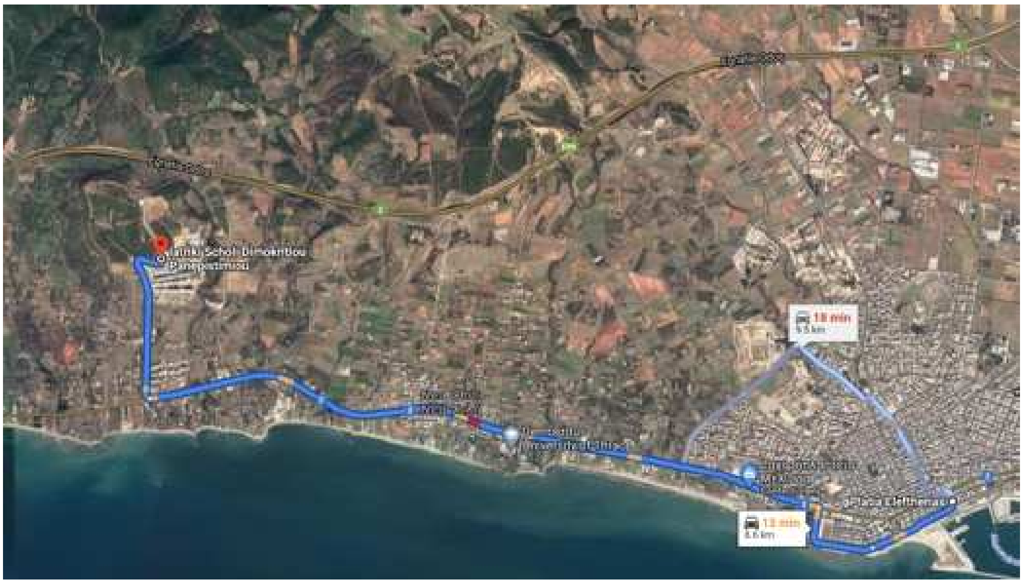


Figure 17. Bus route

Under IRIS project another service is proposed to operate in order to promote park and ride in Alexandroupolis. Today, a conventional shuttle bus is operating connecting the parking lot located at the west side of the city (Apoloniados street) with centre of the city. The route nowadays is being held free of charge with conventional bus and as part of the replication action of IRIS project, the bus will be replaced by an electric one.

Both replication activities for Alexandroupolis, are based on the experience that Gothenburg and Utrecht provided in the framework of IRIS project.

6.6.4. Organisation of work

ASTIKO KTEL ALEXANDROUPOLIS, as the owner and responsible for the operation of the public transport of Alexandroupolis will undertake of the actions and activities required to design, develop and implement this measure of IS-3.1. The support of the Municipality of Alexandroupolis is crucial to support the funding procedure and the promotion of the replication project. CERTH will act as a technical advisor of this measure having significant experience and expertise in the mobility sector.

6.6.5. Data collection and management

Data collection and analysis can intelligently schedule and reschedule journeys to avoid bottlenecks, sensibly distributing commuters increase the efficiency of the entire transport network, promote contactless payments (considering the pandemic crisis of COVID-19 too) and establish more sustainable and ecofriendly mobility services. Data collection and management of the received data allow stakeholders to increase road safety. Smart traffic management systems will be on the major pillars in the innovative solutions gained from IRIS project in the city of Alexandroupolis.

Digitalisation and service innovation are generating transformation across all transport domains. Within the overall Smart City paradigm, smart mobility and transport systems are embedded into wider urban systems integration relating to smart energy, utilities and infrastructure. Assessment of smart mobility services needs to account for the contribution to wider smart city performance, in particular with regard to renewable energy and electrification strategies, as well infrastructure management and urban design.

Once an electric fleet will be established, access to real-time data is a key factor to a program's continued success. Key business analytics provided include battery state-of-charge, outside air temperature trends, GPS location and average speeds, HVAC energy consumption per km, regenerative braking, range achieved and remaining and energy consumption (kWh/km). Benefits of collecting and managing data received from electric buses, provide operators with additional range of capabilities such as ideal driver performance, decision-making information to optimize charging strategies and intelligence on how to preserve battery energy throughout the day. The efficient manipulation and analysis of buses' data is to reduce operating cost and maximum fleet utilization

6.6.6. Barriers and drivers

The barriers outlined are cautionary tales that can guide high-level planners safely along the road to electric bus adoption. Within the transportation sector, public transport fleets are of special interest because of their significant emissions impact. Although public transport fleets are relatively small in number compared to private vehicle fleets, they account for a disproportionately large number of externalities.

Political:

- Political will and commitment, having an open-minded approach to new ideas and innovations
- Continuity in political strategy, avoiding projects' changes when new government officials or elected politicians take over
- Capacity of decision makers including skilled employees in the administration, adequate number of people associated with the project from the public authorities and reliance on technical assistance
- Coordinate actions among different government's departments
- Coordination among external partners
- Lack of space and land to install infrastructure

Economical

- Allocating public funds to support the innovative solutions proposed or develop synergies with private sector companies, to financially support developments
- Financial commitments avoiding rhetoric verses practice
- Difficult to determine grid infrastructure responsibilities

Sociological

- Promoting interventions with campaigns and informative seminars by targeting the right audience, through local and mass media
- Regular presentation of evidence to decision makers and public
- Availability, accessibility and coverage of the system to all citizens and visitors, without any limitations
- Fostering community awareness, engagement and demand for innovation
- Addresses community needs

In the city engagement section, more information can be found in regard to the sociological barriers.

Technological

- Accessibility of appropriate commodities in the country where the implementation will take place
- Offering incentives to attract new innovative technologies from abroad and widen the horizon of effectiveness of those in the new technological era
- Range and power limitations of e-buses
- Grid and charging infrastructure are also new and evolving technologies that face limitations and stability challenges

Legal / Regulatory framework

- Institutional rules and laws securing innovation and technology
- National and European regulatory context for electric mobility services

Environmental

- Promote sustainability and efficient mobility
- Zero emission target for urban mobility

6.6.7. Specifications

Ahead of procurement, conduct a detailed analysis of your service. Identify technology and vehicle specifications that match your requirements. This knowledge is critical for successful procurement; it enables you to narrow down the list of potential manufacturers and evaluate the suitability of tenders.

- Autonomous range. The maximum range for charging electric bicycles and buses is limited. For operations with greater mileage, on-route (opportunity) charging is an option. Effective range can vary greatly depending on local conditions.
- Total cost of ownership. Find solutions that will deliver efficient interventions
- Total cost of maintenance. For the different scenarios and replications, the cost of maintenance varies. From charging stations for the electric bus to the operational cost of the software and the docking stations for the bicycles
- Procurement model. There are a number of options to procure the examined means of transport (electric bicycles and buses), especially at the pilot stage. This includes outright purchase, lease, loans and joint purchasing.
- Product availability. Not all levels of the needed infrastructure will be available, not only locally but in same country too. Early engagement with manufacturers is highly recommended.

Literature research for methodological approach

Charging options found in literature for electric buses, differ. Depending on the method, the operational cost is different. Although, for the economic feasibility of the service, it is crucial to identify the optimal solution for each case scenario of urban electric bus.

Opportunity charging (OC), also referred as fast charging:

Batteries are charged several times during operation, usually during dwell times at terminal stations, by automated charging systems (pantograph or induction system). The daily range is therefore theoretically unlimited and is only limited by cleaning and maintenance procedures in the depot. Since only short dwell times are available, high charging power is required

In motion charging

The roadway of the buses is partially equipped with an overhead cable, which is connected with the vehicle by means of a current collector. The batteries are charged while driving under the overhead cable, so that the energy for route segments without overhead wires can be supplied by the battery storage. The daily range is also theoretically unlimited.

Depot charging (DC)

At this case, battery is only charged during the operating pause in the depot, usually with a manual plug. The maximum range of such buses is currently about 200-300 km. Depot charging is also known as overnight or slow charging.

Vehicle body and passenger capacity

Electric buses are based on the same vehicle bodies as diesel buses. Table 12 lists typical body types used in metropolitan bus services. The market surveys have shown that currently, the market for battery buses is dominated by standard 12 m buses and 18 m articulated buses. 25 m bi-articulated buses are currently only encountered in the form of trolley buses.

Table 12: Overview of common urban bus body types. Typical empty weight refers to conventional diesel buses. Sources: MAN Nutzfahrzeuge Gruppe (2008), Berliner Verkehrsbetriebe AöR (2013, 2016), European Union (2015) and Omnibus Revue (2017)

Body type	Length (m)	EU GVW (t)	Typical empty weight (t)	Max payload (t)	Max. no passengers
12 m single deck	12	19.5	11,6	7,9	115
18 m articulated	18-18.75	28	17,3	10,7	156
25 m bi-articulated	24.8	36	22,3	13,7	200
2-axle double -deck	10.5-12	19.5	12,5	7	101
3-axle double -deck	12-13.7	26	17,3	8,7	126

Table also specifies the respective gross vehicle weight (GVW) permitted by EU regulations, typical empty masses and the resulting payload and passenger capacity.

Although the empty weight is taken from datasheets for diesel buses, it can still serve as a valid basis for electric bus system design because the empty mass of diesel buses and electric buses excluding traction batteries and charging equipment can be assumed to be roughly equal.

Powertrain

A typical electric bus powertrain configuration consists of an energy source (e.g., battery), a single traction motor with controller and a final drive differential gearbox. Alternative configurations are two traction motors with reduction gears near the wheels or two to four in wheel motors[1]. These configurations with multiple traction motors can use a simple torque splitting or a specific driving and regenerative braking regulation design can be used to optimize the vehicle efficiency, as shown in the study of Zhang and Goehlich[2]. According to the ZeEUS Project[3] the majority of bus suppliers, have single traction central motors using asynchronous motor (ASM) or permanent magnet synchronous motor (PSM). The power peak ranges from 100 kW to 480 kW for 8 m - 24 m buses

Battery system

While nearly all modern electric vehicles feature some form of lithium-based battery[4], various cell chemistries exist whose technical parameters differ significantly. The most important characteristics of a specific cell type with regard to electric bus operations are energy density, charge rate and cycle life. Currently, lithium iron phosphate (LFP), lithium titanium oxide (LTO) and lithium nickel manganese cobalt oxide (NMC) are the most common cell types encountered in electric buses, as our surveys of electric bus projects indicate.

Grid connection

Connection of charging infrastructure to the electricity grid is highly dependent on local circumstances. For example, depending on charging power and local grid capacity, individual opportunity-charging stations may be connected directly to the low-voltage grid (400 V), or they may have a dedicated transformer substation connected to the medium-voltage grid (10-20 kV). An energy storage unit (batteries or capacitors) can be implemented within the charging station to reduce peak load[5]. Electric bus depots usually require a dedicated substation connected to the medium-voltage grid; large depots (>200 vehicles) may even need a high-voltage grid connection (60-132 kV) with a distribution station.

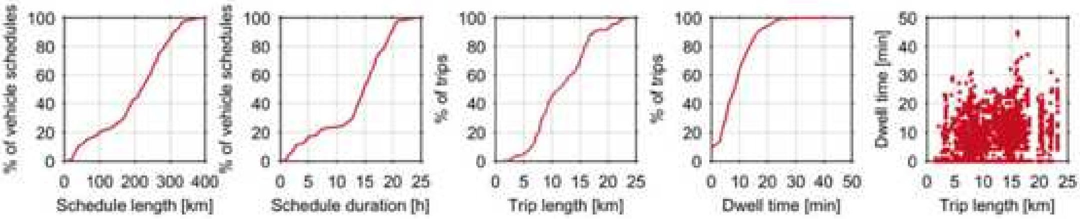
General requirements

A holistic electric bus system design first needs to analyse the requirements of an urban bus system. This includes the daily operation range, distance of trips, driving pattern and idle time at end stops. Depending on the charging technology used, deployment of electric buses may be limited by schedule length (i.e., the distance covered by a vehicle before it returns to the depot) or by a combination of individual trip

[1] Lajunen, A. 2014 improving the energy e-ciency and operating performance of heavy vehicles by powertrain electrification. Dissertation. Aalto University, Espoo, Finnland. School of Engineering
[2] Zhang, X. & Goehlich, D. 2016 A novel driving and regenerative braking regulation design based on distributed drive electric vehicles. In 2016 IEEE Vehicle Power and Propulsion Conference (VPPC), Hangzhou, China, 17.10.2016-20.10.2016, pp. 1-6. IEEE
[3] ZeEUS Project (Ed.) 2016 ZeEUS eBus Report. An Overview of Electric Buses in Europe.
[4] Thielmann, A., Neef, C., Hettesheimer, T., Döscher, H.,Wietschel, M. & Tübke, J. 2017 Energiespeicher-Roadmap_Update 2017.
[5] Prenaj, B. 2014 TOSA flash elektrobus system: Erfahrungen und Perspektiven nach neun Monaten im öffentlichen Betrieb.

length and subsequent dwell time. An investigation carried out for a sub-network of a public transit operator reveals the typical range and distribution of these parameters encountered in metropolitan areas, as seen in the figure below. In particular,

- 95% of all vehicle schedules cover a distance shorter than or equal to 330 km, while the maximum distance observed was 407 km; also, 95% of vehicle schedules operate for 20.4 h or less, the maximum schedule duration observed being 24.7 h.
- 95% of all passenger trips are shorter than or equal to 20.6 km, the longest being 23.3 km.



Charging interface

In stationary opportunity-charging systems, there is currently a coexistence of several non-interoperable, automated charging interfaces. Conductive systems feature a pantograph that is either mounted on the roof of the vehicle or on a wayside pole (the latter also being referred to as an inverted pantograph). Inductive systems feature a coil beneath the road surface and a matching coil on the underside of the vehicle to enable wireless energy transfer; here, also, several incompatible solutions exist, e.g., systems with a fixed or shifting vehicle-side coil[6,7]. To increase interoperability, the EU has instructed its standardisation agencies to develop a European standard for conductive charging interfaces by the end of 2019 and for inductive charging interfaces by the end of 2018[8].

Depot-charging vehicles in Europe are usually equipped with an IEC 62196 based, manual plug interface (CCS, combined charging system). Opportunity charging buses generally also feature this interface not only to recharge the battery, but also to ensure thermal conditioning of the battery while parked in the depot.

6.6.8. Citizen engagement

Gaining the interest and engagement of citizens is key to success for smart city projects. To do so, several social and behavioral obstacles need to be tackled. First of all, it is challenging to get citizens engaged in issues they have limited knowledge about it. Due to lack of information, people tend to question new interventions and confidence in new technologies, as they trust traditional services. Moreover, citizens' age and background and therefore their (technical) knowledge varies immensely. As a result, it is challenging to find a common vocabulary when trying to make the topics understandable for a broad

[6] Bombardier Transportation (Ed.) 2015 Primove Charging 200. Datenblatt.
[7] IPT Technology GmbH (IPT) (Ed.) 2016 Competitive, Clean and E-cient Public Transport with IPT Charge Bus.
[8] European Commission 2015 Commission Implementing Decision of 12.3.2015 on a Standardisation Request to Draft European Standards for Alternative Fuels Infrastructure (M/533).

audience. Another important point of attention is the difference between communities. For example, depending on a community's vulnerability, priorities are different and the approach to engage them should be tailored.. This difference between communities also makes it hard to always utilize local knowledge to the same extent. The citizen engagement activities in TT#2 and TT#3 are interconnected and are presented in combination here.

A way to facilitate the engagement process is to use tools such as social media, applications, engagement workshops, contests and gamification. Citizen engagement is a long-term process. Therefore, in order to make sure the necessary budgets are available at all time, it is important to be aware of the process' long duration and to understand the cost of the engagement process before getting started. Once the process starts, the first thing to do is to proof citizens the relevance of the solution you want to implement and inform them about the outcomes the product will deliver.

Along the process, planning regular meetings and give presentations to provide feedback to citizens in a good practice. Both project managers, engineers and technicians could be answering questions and solving problems. Central information sharing spots (physical or virtual) and visibility in the streets help to maintain support for the project. Local engagement enterprises and trusted partners can facilitate the engagement process.

6.6.9. Business model

In transportation systems, the benefits of a project are not always easy to quantify. Although, perquisites from the conversion of a conventional bus to an electric one, have noticeable long-term environmental and health benefits for residents.

- **Negotiate a loan of buses from the suppliers to test during the pilot.** For example, Buenos Aires negotiated a free loan of eight buses for their pilot in 2018. City's budget to the project was targeted on the upgrade of the existing infrastructure.
- **Battery leasing.** This was first offered by Proterra in the United States as a way to reduce the high upfront costs and lower risks for operators. It is also the approach used in Shenzhen in China. Maintenance and repair costs for the battery are covered by the leasing company. This also provides a way to avoid being locked into aging battery technology.
- **Joint purchasing.** Joint purchasing by two or more bus operators increases their purchasing power and reduces upfront costs. For instance, several transit authorities in the Los Angeles region collaborated with the State of California to develop a state-wide joint procurement schedule and maximise economies of scale. A similar approach was taken by Washington State and the Indian Government.

Each aspect of the purchasing of different elements of an electric bus, options can vary. The number of the electric buses needed to meet the existing demand, swill not exceed the number of buses operating today. Budgeting estimation will be a subject of the operational aspects of the electric buses fleet. Furthermore the identification of the most applicable version of charging station will affect the financial plan of the intervention iiin order to meet European and national regulations in electric buses operational.

6.6.10. Governance

The revised Clean Vehicles Directive promotes clean mobility solutions in public procurement tenders, providing a solid boost to the demand and further deployment of low- and zero-emission vehicles. The new Directive defines "clean vehicles" and sets national targets for their public procurement. It applies to different means of public procurement, including purchase, lease, rent and relevant services contracts. Adopted by the European Parliament & Council in June 2019, the Directive needs to be transposed into national law by 2 August 2021. The Directive applies to cars, vans, trucks and buses (excluding coaches), when they are procured through:

- Purchase, lease, rent or hire-purchase contracts under obligations by EU public procurement rules (Dir. 2014/24/EU and 2014/25/EU)
- Public service contracts for the provision of passenger road transport services (Reg. 1370/2007)
- Services contracts for public road transport services, special-purpose road passenger-transport services, non-scheduled passenger transport, refuse collection services, mail and parcel transport and delivery. (Annex I of the Directive). The Directive will only apply to contracts whose awarding procedure starts after 2 August 2021 (the end date for transposition)

The national targets are defined as a minimum percentage of clean vehicles in the aggregate public procurement across a Member State. This means, Member States have full flexibility in how they distribute the effort across different contracting authorities and contracting entities. A Member State has to meet at least half of the procurement target for clean buses in each period through the procurement of zero-emission buses.

6.6.11. Impact assessment

The implementation of electric buses in the following city of Alexandroupolis, will be analyzed by the following KPI's.

KPI	Parameters	Baseline
1. Nox emission	Electric bus monitoring system	Same amount of km per year driven by conventional buses
2. Carbon monoxide emission reduction	Electric bus monitoring system	Same amount of km per year driven by conventional buses
3. Carbon dioxide emission reduction	Electric bus monitoring system	Same amount of km per year driven by conventional buses

6.6.12. Implementation plan

Electric bus connecting Alexandroupolis' city center with University's facilities

The implementation plan for the IRIS project in Alexandroupolis, refers to those activities that are required to set the roadmap of activities from all partners and stakeholders. In the plan, strategy of the following actions is determined and the economic appraisal of those is assessed, in the extend to ensure that proposals are viable. Steps followed to design the plan for the design of Alexandroupolis implementation for electric buses will be described in the sections below.

Bus scheme

In order to identify the existing characteristics of the provided service of bus, interviews were conducted with the stakeholders. The aim of the interviews is to quantify the demand of users using the service today and operational information of the service. Based on the demand quantified then the applicable electric bus will be selected, along with the business model of the service.

Another parameter for identifying the right type of the electric bus applicable for the examined scenario is the battery system and the autonomy the bus can provide. Information such as average speed of the existing bus and the consumption of the bus in terms of electric independence of the unit will be used to understand the existing needs.

Furthermore, the regulation context of the national and European environment will be taken into account, based on the research took place in the “governance” section. It is important that the charging station is aligned with the European regulatory framework and the national one, in terms of selecting the location and the type of the charging station. The connection grid of the bus will be the major key element of the implementation of the electric bus service in Alexandroupolis.

Legal Framework

Greek government has announced extensive subsidies to foster electric mobility in the country. The goal is for one in three new vehicles in Greece to be electric in 2030 as the country introduces buying premiums as well as charging infrastructure advances. In the first phase, Greece holds a 100-million-euro budget for purchase premiums over a period of 18 months. Specifically, electric cars and light commercial vehicles will be subsidized with 15% of the purchase price. Greek Prime Minister announced the roadmap of the electric mobility in Greece pointing the importance of building the infrastructure to charge electric vehicles in every new building.

Till day, greek law (4439/2016/ Government Gazette 222/A/30-11-2016) sets the minimum terms, conditions and technical requirements for the installation of public accessible EV charging stations at:

- fuel stations (already operating or pending to be licensed)
- parking or rest areas inside ports (already operating or pending to be licensed)
- covered or open-air car parks
- public or private vehicle testing centres
- publicly accessible areas, whether public or private along motorways or highways
- car parks in public or private buildings
- terminals and other transport hubs

The relevant ministerial decision also specifies in detail the legal and technical requirements for e-mobility infrastructure. Joint Ministerial Decision No 42863/438 (Government Gazette 2040/B/04-06-2019) indicates that

- Installation and operation of an EV charging station requires a prior approval process or simply a notification to the competent authorities depends on where the charging station is intended to be installed and the nature of the general regulatory requirements applicable to the particular infrastructure.
- Special requirements apply to the installation of charging stations at fuel stations and any site with supplies
- EV charging stations must comply with certain technical requirements, including The EU certification marking ("CE"),[9] and conform to spatial, construction and security rules. The connection to the grid of the Distribution Network Operator is governed by existing provisions.

Another parameter that should be taken into consideration is whether a charging station is built on private or state-owned land and whether it will be installed at already operating and licensed infrastructure. In each case, different legal requirements shall be met such as, where the charging station is built (on state-owned land and operated by a private entity), land usage rights with relation to the State-owned property, usually by means of an installation permit and the issuance of an installation protocol by the competent authority.

6.6.13. WBS – Work Breakdown Structure & Gantt chart

Figure 18 presents the work breakdown structure for the implementation of the measure included in this IS. The Gantt chart of measures #1 is presented in Annex 4.

6.6.1. Financing schemes and opportunities

The electrification of mobility has recently started to be highly promoted by the Greek government. To that extend, it is expected to provide funding tools for citizens and companies in the near term. The municipality will support the local public transport company to secure funding (e.g., ERDF). The bankability of the project will be assessed with the support of CERTH in order to justify a potential bank financing.

[9] https://ec.europa.eu/growth/single-market/ce-marking_en

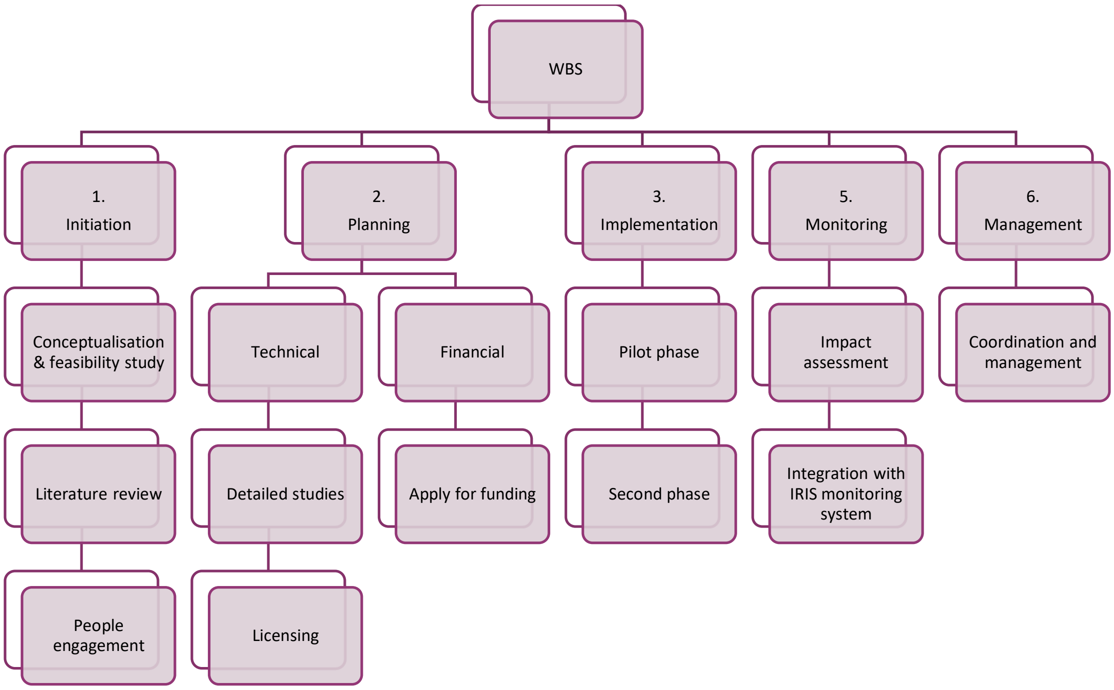


Figure 18: Work breakdown structure for the implementation of IS-3.1. replication measure

6.7. IS-3.2: Innovative Mobility Services for the Citizens

6.7.1. Baseline

Shaping this new innovative mobility services, will be a strategic opportunity and challenge for following cities, their regions and governments. One of the main goals of the IRIS project is to assess evolving technology and use innovations in the field of urban mobility services, following the good practices implemented from the lighthouse cities. Aiming to the gradual decarburization and sustainability of urban mobility in Alexandroupolis, IRIS project will focus on the implementation of a sharing bike system in the city. Identifying city's needs and priorities for urban mobility, while assessing the economic sustainability of the project, will set the guiding recommendation for the proposed interventions.

6.7.2. Ambitions

Smart cities must deliver effective smart mobility solutions while encouraging innovation, facilitating a collaborative ecosystem, and meeting sustainability goals. These challenges are part of the rapidly changing landscape of urban mobility. Strategies to meet city mobility challenges and solve urban mobility problems are unique to each city and involve different approaches for each case study.

The ambition of the IRIS project in Alexandroupolis, is through the replication of lighthouses cities, to design effective, equitable, safe and secure public transport systems, integrated with mobility-as-a-service (MaaS) and other platforms. Through the proposed bicycle sharing system, a sustainable and emission free urban roadmap will be created.

6.7.3. Planning of replication activities

Following lighthouses paradigm, there will be an investigation of the implementation of electric bike-sharing system in the following city of Alexandroupolis. The study will examine the appropriate location of the charging station for electric bikes (public space or private facilities), the business model (free-floating or station-based), number of bikes needed and the management of the fleet. The ultimate goal of the replication will be to create an integrated bike system, to facilitate citizens and visitors of Alexandroupolis. The proposed bike-sharing system will be a replication of the MaaS concept of the city of Gothenburg (EC2B) in order to design and implement, an integrated the electric BSS.

6.7.4. Organization of work

Municipality of Alexandroupolis will implement the sharing bike system and therefore will be the owner and operator. Through the implementation of this replication project, Alexandroupolis is aiming to develop and promote a potential business case and scale and the project through the participation of private actors.

6.7.5. Data collection and management

The economic stability of a project is a key element for every partner of the procedure. Public administrators need to see the outcome of government's funds while private sector companies' aim to profit from their investment. A vast amount of information can be collected from various sources. Data received from users of the system, will provide administrations, with the operational insights of the service. Open flow of data across infrastructure and user domains is an important enabler for smart mobility services and systems innovation. The decision makers of the BSS will identify users' needs and work on improving the provided service. Back-end software and computer hardware provide on-the-ground operators with tools for real-time management of the docking system in order to facilitate maintenance, repair, and redistribution. The system allows monitoring of the following conditions:

1. Number of empty docking points and bicycles available at any site
2. Functional status of bicycles
3. Traffic and usage patterns of docking stations and bicycles
4. Real-time locating of any bicycle at any docking station in the system
5. Other usage data that the Back-end Software and Computer Hardware generates includes:
6. Bicycle miles travelled (from GPS or estimates of average trip length)
7. Number of trips and their duration
8. Number of subscribers with each type of subscription
9. Number of uses
10. Number of uses per subscriber per day, week or month
11. Average number of miles biked per subscriber (based on average trip length estimates)

6.7.6. Barriers and drivers

The availability and affordability of the bike sharing systems are considered as a growing enthusiasm for urban bicycling, leading to a rapid growth in this new form of public transport. Through years, bike-sharing system tend to expand, from small pilot programs to those in Wuhan and Hangzhou, China with 90,000 and 70,000 bicycles respectively. Bike sharing systems have been identified as a system providing flexible mobility, reduces emissions in the urban environment, increases physical activity, leads to congestion mitigation and fuel conservation. Simultaneously the financial viability of the system is of great importance for stakeholders and investors. Thus, barriers and drivers should be identified before the implementation takes place, in order to understand risks and opportunities.

Key barriers to bikeshare membership include car convenience, docking station inconvenience, inconsistencies and problems in existing bike network infrastructure and complexity of the system especially for elder people.

- Car convenience: people habit to use on daily basis their private vehicle for their urban trips, is one of the greatest constrain of the BSS. Lack of changing their routine, lead people to be sceptical to foster different ways of mobility
- Docking station inconveniences: the greatest challenge before the implementation of a bike sharing system, is the efficient allocation of the stations. Accessibility of the stations, is vital component for system's economic viability and the long-term operation of the system
- Infrastructure: Existing and potential improvement of bike network infrastructure is also a key barrier which will promote or discourage the usage of a bike sharing system.
- Complexity of the system: BS systems and the application of those, is important to follow a simple way of using them so that the system can be accessible to everyone.

6.7.7. Specifications

The components of a fourth-generation bike share system include a network of stations, a fleet of bicycles, a software back-end and maintenance/redistribution teams that operate the system. These elements are described in further detail below.

Bicycles

Bicycle share fleets typically consist of upright bicycles, with step through frames and adjustable seats to allow use by persons of any height. Most models feature a chain guard and 3-speed internal hub gearing, which protects the most vulnerable mechanical parts of the bicycle from exterior wear. Bicycles can be equipped with additional gears if steep topography is a consideration. Most bicycles also feature built in safety features such as pedal-powered lights, thick tires, a bell, and reflectors. Some models also include a rack for holding small items, while GPS units can be included to track bicycle locations for system monitoring (operations) as well as planning. The numerous accessories and rugged construction for durability makes the bicycles heavier than most consumer models. The weight and upright riding position of the bicycles encourages users to travel at moderate speeds. Bicycles are appropriate for intended use of the bicycle transportation network on existing roadways, bike lanes, and multi-use paths.

Apart from the conventional bike sharing system, dockless systems is a pioneer system for urban mobility. In dockless systems, bikes can be located and unlocked using a smartphone app and can be parked within a defined district at a bike rack or along the sidewalk in a city. This system is an affordable way of implementing bike sharing system, because cities can avoid infrastructure costs of installing and maintaining docking stations, kiosks and docks. The operational costs are minimized due to the fact that every action from the users is happening through their smartphone application, which automatically collects data to a remote server.

Stations

Bicycle share stations have two main elements: the kiosk provides the interface where users initiate a transaction to rent a bicycle, and a number of docks that securely hold bicycles waiting to be checked out and accept returns. A typical bicycle share station consists of a single kiosk and anywhere from 5-10 to several dozen docks, depending on local demand and available space. Minimum station size by number of docks varies among equipment vendors.

Kiosks

The kiosk provides the interface where users complete a transaction to rent a bicycle, which can include purchasing a temporary (for visitors) or annual system membership (for residents or employees). A redit card or system membership card is usually required to complete the transaction. Fourth-generation bicycle share kiosks are solar-powered, which differs from third-generation systems that are hard-wired to local utilities.

Docks

Once a transaction at the station kiosk is complete, the kiosk will direct the user to a dock where the user can unlock a bike, typically through use of a temporary PIN code or membership card swipe. When the user has completed their trip, they can return the bicycle to any empty dock at a station to complete their rental. The dock that accepts the turn will then lock the bike in place until it is needed for another rental. Fourth generation bicycle share docks are modular, coming in plates of several docks each, allowing station size to be expanded or reduced adjusted if required by demand.

Operations

Operating costs include those required for operating and maintaining the system and include hiring employees for operational tasks such as maintaining the stations, bikes, and other infrastructure, rebalancing the system, providing customer service, etc. Generally, the operating parameters of the system are agreed upon during contract negotiations and documented in a 'Service Level Agreement'. These represent the contractual obligation of the operator and balance user experience and cost to provide the service.

6.7.8. Citizen engagement

The core promise of bike share is increased mobility and freedom, helping people to get more easily to the places they want to go. To meet this promise, and to make sure that bike share's benefits are equitably offered to people of all incomes, races, and demographics, public engagement must be at the fore of bike share advocacy, planning, implementation, and operations. Cities, advocates, community groups, and operators must work together to engage with their communities, ensure that bike share provides a reliable, accessible mobility option that is as vibrant as the communities it serves. As operators and advocates around the world have found, sometimes you have to get creative to get people to try bikes. Developing incentives, competitions, and games can help encourage ridership, especially in colder months or for less common trips. When integrated into marketing campaigns, ride incentives can help get more people riding.

For the purposes of the IRIS BSS replication a questionnaire was released on social media and local media of Alexandroupolis. The aim of this action was to quantify demand for the BSS and the level of acceptance of the intervention from residents of the city. It is important to mention at this point that due to COVID-19 and for the larger distribution of the questionnaire, it was produced on Google Forms. The link of the online questionnaire is https://forms.gle/z68KqCQ7HR13KV2J9

6.7.9. Business model

One of the peculiarities of shared bicycle systems is the existence of various business models. This peculiarity is a consequence of the great success of the third generation of systems, with the operation of many young people systems around the world. Initially, it is important to define the term of a business model for bike sharing system.
Based on this definition, a shared bicycle system creates value developing specific services, which it "sells" to various customers, such as residents of an area, tourists and companies from the private sector that want to advertise either on bicycles or bicycle stations[10].Business models found in the literature, based on its provider service are as follows [11] [12]

- ***Advertising companies***: these companies provide shared bicycle services, in exchange for the return of the right to use urban equipment for advertising purposes. This activity is also the main source of income for advertising company, while revenue is also received from system use fees.
- ***Public transport organizations***: the service of shared bicycles is provided under guiding a public authority, with the main goal of strengthening the system public transport. Revenue comes mainly from government subsidies and secondly from usage fees and ads.
- ***Local authorities***: the local authority either designs and operates the public utility system itself bicycle or buy the specific services from another provider, with the main purpose of improving the standard of living in the city. The system is funded by the local authority, while in this case profit is generated from usage fees and advertisements on bicycles and stations.
- ***For-profit organizations***: the bike shared systems are managed by services from the private sector. Public involvement is limited to a possible agreement in terms of the rights of the parties involved. In this case, the main goal is the financial gain, which comes from usage fees and advertisements.
- ***Non-profit organizations***: services are provided with support of the public sector and the goal is to expand the service, ensuring coverage operating costs. The revenue of the system comes from grants, sponsorships and loans.

Choosing the most efficient business model is a complex issue for many cases, with much expertise on the subject of bike sharing system, to support different approaches. Some believe that a system can be successful, if the main goal of the system is not the economic profit. They suggest that systems should be subsidized by local authorities or other financial institutions due to the fact that the long-term goal is to

[10] Zhang, L., Zhang, J., Duan, Z., Bryde, D. (2015). Sustainable bike-sharing systems: characteristics and commonalities across cases in urban China. Journal of Cleaner Production, 97, 124-133.
[11] Shaheen, S., Guzman, S., Zhang, H. (2010). Bikesharing in Europe, the Americas, and Asia: Past, Present, and Future. Transportation Research Record: Journal of the Transportation Research Board, 2143, 159-167.
[12] Shaheen, S., Cohen, A., Martin, E. (2013). Public Bikesharing in North America Early Operator Understanding and Emerging Trends. Transportation Research Record: Journal of the Transportation Research Board, 2387, 83-92

reduce emissions, traffic congestion etc. On the contrary, others argue that having the right market to make a profit from business is a prerequisite for a sustainable shared bicycle system[13].

In Europe, the most commonly used business model is the one where companies from private sector wok along with local authorities. Advertising companies have developed their own model system, with which they supply cities, taking public space for advertising in return. In contrast, this particular business model is not widely used in North America, where the non-profit model of organizations prevails, ensuring that expenditures are met through large sponsorships. The role of advertising companies (e.g., Clear Channel, JCDecaux) and sponsors (e.g. Barclays, Citibank, MasterCard) was crucial in the development of shared bicycle systems, as they provided initial investments[14].

Market research

The operational cost of a bike sharing system, is a crucial parameter. In order the system to be a successful endeavor, the economic feasibility of the project should be one of the major examined parameters. In literature many authors are under the opinion that the economic feasibility should not be the first priority due to the fact that the expected benefits from them are greater, such as limitation of environmental footprint of urban mobility and enhancing sustainable urban life.

The operational cost of a bike sharing system differs for different countries. Based on the European guidance for clean transport and urban transport, the annual operation costs of a scheme, could amount to between €1,200 and €1,500 per bike per year[15.] A research in private sector companies in Greece, associated with the operational chain of the bike sharing system, give an extensive view of the cost of the elements of the system. A conventional bicycle costs 450€ while a docking place for each bike costs 1,500€. On the other hand, a docked electric bike costs 1100€ and the docking place 1,680€ for each bike. A dock less electric bike cost 1,350€.

Detailed list of the cost of each element of the bike sharing system, is described in the table below. Those values were obtained by providers of electric bikes in Greece. In those, there should be added

Detailed list of the cost of each element of the bike sharing system, is described in the table below. Those values were obtained by providers of electric bikes in Greece. In those, there should be added

- the maintenance cost which is approximately 10% of the cost of each bicycle
- the cost for the online platform (software, website and application) 1,500€ per station
- Insurance covering damages for every docking places 40€

Conventional	
Cost of bicycle (per unit)	€450
Cost of docking place (per bike)	€1,500

[13] Zhang, L., Zhang, J., Duan, Z., Bryde, D. (2015). Sustainable bike-sharing systems: characteristics and commonalities across cases in urban China. Journal of Cleaner Production, 97, 124-133.

[14] Parkes, S., Marsden, G., Shaheen, S., Cohen, A. (2013). Understanding the diffusion of public bikesharing systems: evidence from Europe and North America. Journal of Transport Geography, 31, 94-103.

[15] https://ec.europa.eu/transport/themes/urban/cycling/guidance-cycling-projects-eu/cycling-measure/bicycle-sharing_en

Electric bicycles	
Cost of docking place (per bike)	€1,680
Docked bicycle	€1,100
Dock less bicycle	€1,350

6.7.10. Governance

Municipality of Alexandroupolis is the main stakeholder of the measures included in TT#3. The local authority is responsible for implementation and operation of the proposed replication project.

6.7.11. Impact assessment

KPI	Parameters	Baseline
1. Nox emission	Electric bikes monitoring system	Same amount of km per year driven by cars/bikes
2. Carbon monoxide emission reduction	Electric bikes monitoring system	Same amount of km per year driven by cars/bikes
3. Carbon dioxide emission reduction	Electric bikes monitoring system	Same amount of km per year driven by cars/bikes

6.7.12. Implementation plan

The implementation plan for the IRIS project in Alexandroupolis, refers to those activities that are required to set the roadmap of activities from all partners and stakeholders. In the plan, strategy of the following actions is determined and the economic appraisal of those is assessed, in the extend to ensure that proposals are viable. Steps followed to design the plan for the design of Alexandroupolis' bike sharing system will be described in the sections below.

Literature research for the methodological approach

The first step for planning the implementation strategy is to provide foundation of knowledge on BSS topic of BSS. Exploring existing information in the field of the research, someone can notice main methodologies and research techniques, followed by successful implementation examples of BSS. Identify main ideas, conclusion and theories while trying to establish similarities and avoid bad practices. In any bike-sharing program, one of the keys to success is the location and the distribution of bike stations[16]. However, most authors and studies tend to give only general recommendations regarding the station implementation.[17]

[16] Lin, J.R., Yang, T.H. (2011). Strategic design of public bicycle sharing systems with service level constraints. Transportation Research Part E, 47, 284-294.
[17] García-Palomares, J.C., Gutiérrez, J., Latorre, M. (2012). Optimizing the location of stations in bike-sharing programs: A GIS approach. Applied Geography, 35, 235-246

The first of these recommendations concerns network coverage. In general, the distribution of stations is dependent on the size and configuration of the city. The methodological guide for introducing bike-sharing in Spain differentiates based on the size and density of the city and the type of loan system[18]. In high-density cities with more than 200,000 inhabitants, automatic stations distributed across the whole city are recommended, whereas in those cities where density is low, coverage with automatic stations is proposed only in city center or higher-density areas. In most large cities, however, bike-sharing programs are usually limited to the city center. Only Paris has a program that covers the whole city. Some studies recommend initially introducing the system in zones with the highest density, which are usually the city centers, and gradually extending it to reach the peripheral areas.

When selecting station locations, the distance between stations should be taken into consideration. Velib' bike-stations (Paris), for example, are located approximately every 4 blocks (300 m), which allows for easy access. The BIXI program has a station every 250–300 m throughout a 15 km^2 section of central Montreal. This density ensures that users can find a bicycle when they need one and return it easily when they are done. However, such a high density of stations requires substantial investment, and some authors have noted that over coverage may be detrimental to the success of the system because it increases maintenance costs.

García Palomares[19] approach, is considered to be very comprehensive, as it identifies the optimal positions of the stations and their dimensions by using Geographic Information Systems (GIS), while at the same time facilitating the process of redistribution of bicycles through the recognition of the characteristics of the demand of each station. The data used by this methodology are:

- The road network of the city with full connectivity
- The land uses in the examined area
- Origin and Destination trips of the city and
- The stops of the operating means of transport.

As a result of the application, the methodology in the city of Madrid show that the maximize coverage technique is more effective, while the minimize impedance technique is more effective for areas with low potential demand. Bryant[20], used a similar methodology to identify the best places for public bicycle stations in the city of Richmond, USA. In both of the methodologies, the location of the stations is based on the selection of the demand points. Recognizing demand points and delivering weights to them is important in sizing stations.

Methodology followed

Do300 scenario

[18] IDAE (Instituto para la Diversificación y Ahorro de la Energía) (2007). Guía metodológica para la implantación de sistemas de bicicletas públicas en España, Madrid

[19] García-Palomares, J.C., Gutiérrez, J., Latorre, M. (2012). Optimizing the location of stations in bike-sharing programs: A GIS approach. Applied Geography, 35, 235-246.

[20] Bryant, J. (2013). Finding the Optimal Locations for Bike Sharing Stations: A Case Study within the City of Richmond, Virginia. MSc Thesis, George Mason University, Fairfax

In the Do300 scenario, the number of stations of the bicycle sharing system is the biggest from all the available scenarios. The diameter of the circles used to define the number of stations in the area of interest is 300m. Thus, the number of the points where the station will be located are nine (9). Those points are:

1. Altinalmazi Park
2. Parking lot at the intersection of Papanastasiou, Kaviri and Dimitras streets
3. Public swimming pool
4. Eleftheriou Venizelou square
5. Alexandroupolis' lighthouse square
6. Church of Agios Eleftherios
7. Wooden park
8. French station of the Hellenic Railways Organization
9. The public parking lot in Apolloniados street

Figure 19: Do300 scenario stations' location

Do400 scenario

In the D400 scenario, the number of stations of the bicycle sharing system is the biggest from all the available scenarios. The diameter of the circles used to define the number of stations in the area of interest is 400m. Thus, the number of the points where the station will be located are seven (7). Those points are:

1. The Parking lot at the intersection of Papanastasiou, Kaviri and Dimitras streets
2. Public swimming pool
3. Alexandroupolis' lighthouse square
4. Church of Agios Eleftherios
5. Altinalmazi Park
6. French station of the Hellenic Railways Organization
7. Parking lot in Apolloniados street

Figure 20: Do400 scenario stations' location

Do500 scenario

In the Do500 scenario, the number of stations of the bicycle sharing system is the biggest from all the available scenarios. The diameter of the circles used to define the number of stations in the area of interest is 500m. Thus, the number of the points where the station will be located are five (5). Those points are:

1. The Parking lot at the intersection of Papanastasiou, Kaviri and Dimitras streets
2. Alexandroupolis' lighthouse square
3. Altinalmazi Park
4. French station of the Hellenic Railways Organization
5. Parking lot in Apolloniados street

Figure 21: Do500 scenario stations' location

Do600 scenario

In the Do600 scenario, the number of stations of the bicycle sharing system is the biggest from all the available scenarios. The diameter of the circles used to define the number of stations in the area of interest is 600m. Thus, the number of the points where the station will be located are three (3). Those points are:

1. Parking lot at the intersection of Papanastasiou, Kaviri and Dimitras streets
2. Alexandroupolis' lighthouse square
3. Parking lot in Apolloniados street

Figure 22: Do600 scenario stations' location

Beyond Present Scenario

It is beyond any shadow of doubt, that there is no established guideline in terms of installing and operating a shared bike system. In literature, someone can find cases of cities where bike sharing systems economically failed and others where the systems was a huge success.
As mentioned before, the creation of a bike sharing system in a city, depends on a plethora of parameters. From the demand and the supply of the people who will use the system, to the climate and the landscape of an area. Existing bicycle road networks or the potential of the implementation of one, is crucial in order to design the most efficient bike sharing system for the examined area.
Considering those parameters, the beyond present scenario will consist of station, proposed by taking into account a future expand of the bike sharing system. It will include the number of the station which meets the existing demand and also giving the opportunity for potential expand of the system in other areas of the city, so that future demand will be addressed.
The proposed locations of the beyond present scenario are listed below. The installation points were selected, in order to efficiently support the bike sharing system in the city of Alexandroupolis and to point out the landmarks of the city.

1) Parking lot at the intersection of Papanastasiou, Kaviri and Dimitras streets
2) Alexandroupolis' lighthouse square
3) Parking lot in Apolloniados street
4) Public swimming pool

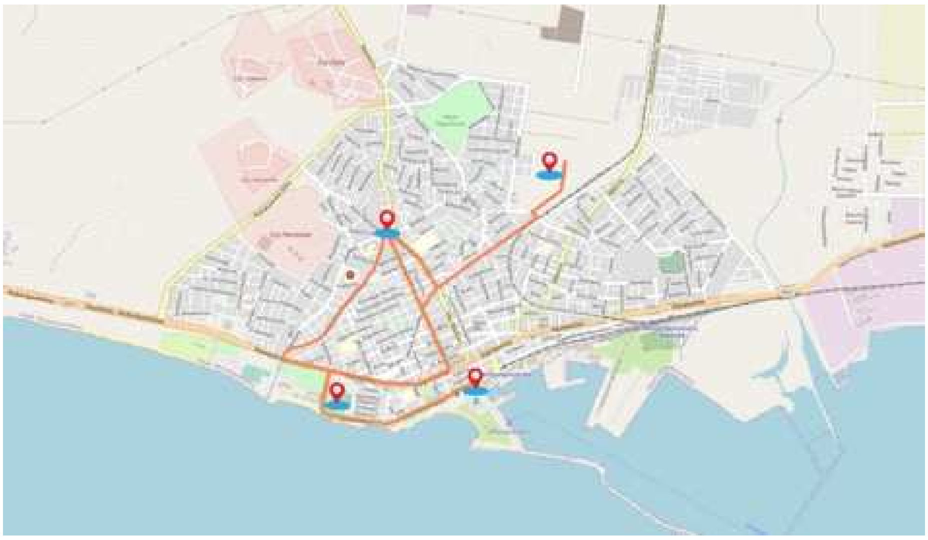


Figure 23: Beyond present scenario stations

Pilot action.

In this part of the analysis, a pilot will implement at the study area of Alexandroupolis. Dockless bicycles will be place in specific points in the city, according to methodological strategy scenarios decided in the second step of the BSS roadmap.

At the end of the pilot period, this action will be evaluated with KPIs such as

a. number of kilometers for each bike for the pilot period
b. number of people using each bike

Decision of the provided service

The last step of the implementation plan is to identify the most applicable service for the city of Alexandroupolis. The results from the pilot will be of extreme usage, as they are going to be an on-field indicator of the preferences of residents and visitors of the city.

6.7.13. WBS – Work Breakdown Structure & Gantt chart

For WBS see section 6.6.13. The Gantt chart the measure #2 included in IS-3.2 is presented in Annex 4.

6.7.14. Financing schemes and opportunities

The municipality has already funder (by own funds) the implementation of a pilot sharing bike system. The next step is to apply for funding for the expansion of this system for the whole city, after utilizing the results of the pilot phase in order to complete the design studies. There potential funding tools are a) the Regional Operational Programme 2014-2020, b) Greek green fund, c) other direct EU funding (such as LIFE, Interreg etc).

6.8. Conclusions on ambitions and planning of activities for TT #3 Smart e-Mobility Sector

Municipality of Alexandroupolis has developed a clear replication plan for TT#3 that aims to promote smart e-mobility locally through utilisation of the innovative demonstration solutions included in IRIS project. The smart e-mobility for Alexandroupolis FC, aims to increase the level of sustainability and efficiency in urban mobility setting a concrete base for future proof in different political and socio-economic contexts, intelligent, user-driven and demand-oriented urban mobility system. The replication projects will enhance the electrification process of the mobility sector demonstrating integrated smart mobility solutions in real-life environment by key stakeholders and therefore support the acceleration of their market uptake and the transition to urban sustainability.

The sharing bike system proposed has already started through the implementation of a pilot first phase. The collaboration of the Municipality of Alexandroupolis with ASTIKO KTEL Alexandroupolis has already started with clear target to secure funding within 2021 for the procurement of e-buses that will operate - at first – at the selected bus routes.

7. Transition track #4: City innovation platform

7.1. TT#4 Replication in a nutshell

Following the 13 steps mentioned in the proposed replication roadmap (D8.1), the FC of Alexandroupolis developed a replication plan for transition track #4 selecting integrated solutions to be replicated according city baseline analysis and in alignment with the existing action plans regarding energy transition and CO_2 reduction targets. Assessing the local replication potential, Alexandroupolis expressed initial interest to replicate projects in IRIS solutions IS-4.1 Urban Monitoring and IS-4.4 Energy Management. Following the detailed description of IS by the LHCs, Alexandroupolis updated its replication plan in this TT and include a new measure of IS-4.2 Services for City Management.

Identifying the most applicable actions that respond to the local reality and local challenges, FC of Alexandroupolis aims to develop three projects that will replicate measures of the integrated IRIS solutions of Transition Track #4, which are:

- Measure 1: Smart Street Lighting with multi-sensoring
- Measure 2: Energy Cloud
- Measure 3: Fighting Energy Poverty

7.2. Selection process

For the selection process see section 4.2 of this deliverable.

7.3. Mapping of stakeholders

Following the statement of D1.7-Tranistion strategy, Commissioning plan for the demonstration & replication, regarding the main stakeholders and in respect to the selected replication projects of TT#4 the main stakeholders recognized are:

- Municipality of Alexandroupolis (enabler)
- CERTH/CPERI (provider)
- Energy HIVE Cluster (provider)
- Commercial Chamber of Evros (utilizer)
- Citizens of Alexandroupolis (end-user)

7.4. Identified knowledge gaps

The complexity, as well as the integrated nature of the replication projects that are based on IRIS solutions demonstrated by LHCs requires a thorough analysis of existing knowledge and capacities within the FC local ecosystem in order to identify potential knowledge gaps that will prevent smooth project design and implementation. The identified knowledge gaps are then covered through the knowledge exchange activities between the IRIS partners.

Concerning TT#4, the knowledge gap identified was in the implementation process of measure #3. Particularly, a significant difference - as compared to the demonstration project of Utrecht - has been identified which refers to the absence of social housing corporations such as Bo-Ex in Alexandroupolis. This requires a different approach, considering the fact that houses in Alexandroupolis are in vast majority private-owned.

7.5. Capacity building and knowledge transfer

The importance of capacity building and knowledge transfer has been extensively stated within IRIS project, as well as in other smart city projects. During the development of the replication plan, Alexandroupolis took advantage of the knowledge tools provided by IRIS project in order to support its activities towards successful replication project identification and implementation. Workshops and webinars provided valuable information that is utilized to formulate the replication projects of TT#4. IRIS deliverables are the main source of information for the replication team of Alexandroupolis that are supplemented with knowledge gained through webinars, workshops, peer-2-peer sessions and communication material.

Considering the initial stage of the replication activities of TT#4, more capacity building and knowledge transfer activities are expected to be completed in the near term, which due to the pandemic of COVID-19 were delayed. Round tables and peer-2-peer sessions have been planned for the implementation of measure #3. CERTH provided with the required expertise and scientific knowledge in order to assess the replication potential and find innovative solutions to the local challenges and will support the ongoing capacity building and knowledge transfer activities.

7.6. IS-4.1: Services for Urban Monitoring

7.6.1. Baseline

Alexandroupolis city has limited assets to support its urban monitoring activities and the city baseline analysis highlights the need to gradually proceed with selected demonstration projects. Answering to the TT#4 IRIS objective to develop meaningful information services for the citizens and taking into consideration the IRIS demonstration projects, Alexandroupolis selected the replication of smart street lighting with multi-sensoring, as demonstrated by LHC of Utrecht.

It has to be mentioned that Alexandroupolis does not have any ICT urban data platform, as well as any data collection systems. Urban data collection relies only on the governmental activities, usually performed by the Hellenic Statistical Authority (ELSTAT). The digital transformation of Alexandroupolis is in its infancy and therefore there is limited availability for extensive replication of IRIS solutions.

The replication area for this measure is the city center. The city center and the whole city are equipped with LED street lighting that developed through a replacement project of 3.6 million EUR funded by

Consignment Deposits and Loans Fund in collaboration with European Investment Bank. The city's street lighting is therefore already energy efficient. Considering the next step, Alexandroupolis is aiming through this measure to smarten its street lighting by direct replication of the pilot smart lighting & crossing proposed by LHC of Utrecht.

In relation to the second stage proposed by Utrecht, that is to say the replacement of lamppost, Alexandroupolis is currently equipped with conventional lamppost that do not perform any other actions besides the traffic regulation. The number of existing lampposts of the city centre of Alexandroupolis is 20 and constitutes an opportunity to implement a pilot replacement project that is scalable and replicable to the whole municipality and beyond.

The general objective of the two-stage measure is to introduce smart street lighting and proceed with valuable data collection from smart multi-sensors that will be available to the stakeholders aiming to develop solutions which reduce/minimize citizens problems in public space.

7.6.2. Ambitions

Alexandroupolis' ambition is to implement projects that will lead to a green and sustainable urban environment. In particular, the ambition for IS-4.1 is to contribute to enable meaningful information services for households, municipality and other stakeholders.

The selected measure includes the development of two pilot smart pedestrian crossing and the replacement of 20 lampposts with smart lamppost with integrated multi-sensors. The selected replication project is considered as a "direct" replication activity, as presented in measure #2 of D5.6 – Launch of TT4 activities on CIP and information services of Utrecht.

Through the realization of this measure, the Municipality of Alexandroupolis aims to kick-start the digital transformation of the city services and initiate urban monitoring activities.

7.6.3. Planning of replication activities

Having selected the specific replication projects, the replication team developed the Work Breakdown Structure (WBS) and defined sub-projects and tasks. The WBS of TT#4 is presented in section 7.6.13. The Gantt chart presented in the same section depicts the planning of the replication activities.

7.6.4. Organisation of work

Municipality of Alexandroupolis is the owner and operator of street lighting, as well as the lamppost of the city center. Thus, responsible for the organization of work is the municipality. Upon realization of the project, the municipality will be the responsible for operation and maintenance, as it the case today. CERTH and Energy HIVE Cluster are responsible for development of the feasibility study of this measure.

7.6.5. Data collection and management

As presented by LHC of Utrecht, the selected measure will generate data such as traffic data, noise levels, air pollution, lighting levels. Sensors will detect the proximity of pedestrian and traffic to control the lamppost. The sensors can distinguish between traffic type and speed. Data collection will also include energy and power. The collection and management of the data will be performed by the selected technology provider (through public tender) and will have the capability to connect with third party platforms (e.g., the CIP) for data transfer.

7.6.6. Barriers and drivers

Political

- **Barriers:** No political barriers identified.
- **Drivers:** The commitment of the local Authority to foster the digital transformation of the city acts as a driver for the implementation of the selected replication measure.

Economical

- **Barriers:** Allocating public funds to the support the innovative solutions proposed is usually considered as a barrier, considering the prolonged economic recession of Greece.
- **Drivers:** Digital transformation is considered as an important future market and the potential business cases in that are constitute an important economical driver.

Sociological

From social point of view there were no barriers and drivers identified.

Technological

- **Barriers:** As it is the case in relevant projects, the data formats and data protocols used may cause a technical barrier for fluent data exchange.
- **Drivers:** No technological drivers identified.

Legal / Regulatory framework

- **Barriers:** GDPR compliance is considered as potential barrier for this project. Also issues on data ownership and regulating data accessibility in a just and legal manner can be complex.
- **Drivers:** No legal drivers identified.

Environmental

- **Barriers:** No environmental barriers identified.
- **Barriers:** The demand for data regarding environmental indicators (e.g air quality) is considered as a driver for the selected measure.

7.6.7. Specifications

As a direct replication measure, the project of Alexandroupolis shares the same technical specifications presented by Utrecht. The smart pedestrian crossing will be implemented in two places of Alexandroupolis. The initial proposed places include the pedestrian crossing at the end of “Ioakim Kaviri” street, next the city hall and the start of “14th of May” street, which are the most used pedestrian crossings. Nevertheless, the city foresees to proceed with citizen co-creation activities to finalize the above places, which have been delayed due to the pandemic of COVID-19.

At each of the pedestrian crossing a luminous white strip with LED lighting will be installed, as well as sensors that detect the proximity of traffic and pedestrian control the light. Multiple sensors will be attached to a Smart Pole on one side of the crossing. The smart pole is a light column in which various functions can be accommodated, such as cameras, measurement sensors for noise levels and air pollution, dynamic lighting, but also traffic detection. The sensors can distinguish between traffic type and speed.

Figure 24. Proposed pedestrian crossing of Ioakim Kaviri street.

As far as the second part of the replication measure is concerned, the city expects to develop tender documents that will entail specifications of LED-lighting, remote dynamic light management lamppost with sensor and connectivity services.

As soon as more information for the specifications are available by LHC Utrecht, the city will proceed with detailed studies for the replication area selected.

7.6.8. Citizen engagement

As mentioned above and in accordance with the activities performed by LHC of Utrecht, Alexandroupolis city is willing to proceed with citizen co-creation activities that were delayed due to COVID-19 pandemic. The co-creation activities will focus on the selection of the smart pedestrian crossing places, as well as the specific sensors to be installed.

The successful citizen engagement and co-creation process of around the development of smart street lighting solutions paves the way for Alexandroupolis to proceed.

7.6.9. Business model

Although Utrecht LHC recognizes a potential business model arising from the use the data collected, this is considered as very unlikely for case of Alexandroupolis. The collected data are expected to be used from policy makers and public authorities therefore giving social value. Since, no relevant experience is found in Greece, there is no indication that the collected data will support the development of business cases.

Nevertheless, the worldwide experience shows that there is potential for local ecosystem to develop innovative business models utilizing the collected data in the future.

7.6.10. Governance

Municipality of Alexandroupolis is responsible for design, implementation, operations and management of the smart pedestrian crossing, replicating the demonstration project of Utrecht. In the second stage the municipality will take a role as a concession provider. The technology provider of the smart pole will be responsible for processing and managing the data that are generated with the sensors connected to the smart poles. These data will be stored in third-party management system and eventually transferred to the future CIP of Alexandroupolis.

7.6.11. Impact assessment

The impact of the measure included in TT#4 contribute to the overall objective of the Municipality of Alexandroupolis to enhance the quality of life for its citizens. The following KPIs have been defined to this measure.

KPI	Parameters	Baseline
1. Social compatibility	Likert scale. The project's solution fit with people's "frame of mind"	30 surveys (at least)
2. Quality of open data	%. Percentage of data that uses DCAT standards.	N/A

7.6.12. Implementation plan

The implementation of the selected measure is based on the steps described in section 4.6.12. Due to its nature, deviations of the described steps have been identified by the replication team of Alexandroupolis. Firstly, the re-evaluation step will include citizen engagement and co-creation activities. In addition, the proposed procurement will follow a non-conventional procedure and include an open call for innovation which will result in proposed solutions by start-ups and other private companies. After selecting the specific solution, the implementation plan will continue as described in section 4.6.12.

7.6.13. WBS – Work Breakdown Structure & Gantt chart

Figure 25 presents the work breakdown structure for the implementation of the measures included in this TT (including all IS). For measure #2 (IS-4.2), the following WBS applies only to the activities that will be take place from the municipality of Alexandroupolis. The Gantt chart of measure #1 of IS-4.1 is presented in Annex 4.

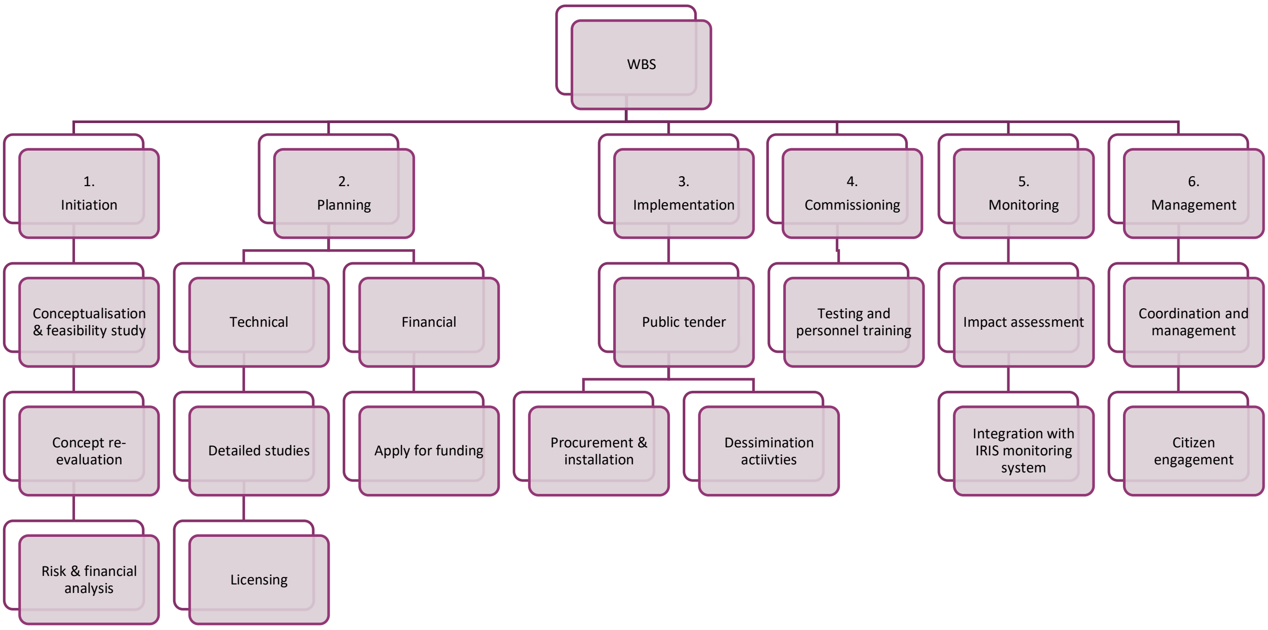


Figure 25: Work breakdown structure for the implementation of TT#4 replication measures

7.6.14. Financing schemes and opportunities

The selected measure is clearly a municipal project and therefore public funding is targeted. The project size, in terms of capital cost, is considered to be acceptable for municipality's own budget. Upon completion of the technical specifications and the conclusion of the required budget, the municipality will decide to proceed with the implementation of the project or seek for other sources of funding such as the Regional Operational Programme 2014-2020 of East Macedonia and Thrace. The measure is considered as eligible for funding by the ROP as it applies to the thematic objective 04 (support of transition to a low carbon economy to all sectors), investment priority 4c (support of energy efficiency, smart energy management and use of RES at public infrastructure, including public buildings).

7.7. IS-4.2: Services for City Management and Planning

7.7.1. Baseline

According to the Energy Poverty Observatory of Centre of Renewable Energy Sources (CRES) of Greece, the percentage of households with a percentage of heating costs below 80% of the total family income at the national level is 43.10% while at the level of the Region of East Macedonia and Thrace is 51.30%, the largest among the 13 regions of Greece. Also, the percentage of households with a percentage of total energy expenditures over 10% of total family income is 56.60% while the corresponding national percentage is 39.50%.

Energy poverty is characterized by the exclusion or insufficient access of households to energy. Serving the basic needs of daily life in a home, such as cooking, lighting, heating, cooling and hot water requires access to energy. It is recognized that citizens are insufficiently informed about the concept of energy poverty and is therefore not widely known all the causes and factors that cause it. The local authorities could take the initiative to inform and raise awareness of the citizens, as well as provide services as proposed by LHC of Utrecht.

Alexandroupolis, as the capital of Evros and the biggest city of Region of East Macedonia and Thrace faces the highest percentage of energy poverty. The lack of social housing corporation, such as Bo-Ex in Utrecht, has been recognized as a basic difference of the city context of Alexandroupolis.

7.7.2. Ambitions

Aiming to tackle energy poverty locally, Alexandroupolis is willing to replicate measure #5 proposed by LHC of Utrecht in D5.6 – Launch of TT4 activities on CIP and information services of Utrecht. The ambition for IS-4.2 is to contribute to enable meaningful information services for households, municipality and other stakeholders. Through the implementation of this measure, Alexandroupolis is expected to open up new business model and attract private companies to scale the replication measure, supporting the ambition of Alexandroupolis for increased impact on energy poverty locally.

7.7.3. Planning of replication activities

Having selected the specific replication projects, the replication team developed the Work Breakdown Structure (WBS) and defined sub-projects and tasks. The WBS of TT#4 is presented in section 7.7.13. The Gantt chart presented in the same section depicts the planning of the replication activities.

7.7.4. Organisation of work

The selected measure requires the engagement of citizens, which is targeted by Alexandroupolis in both the design and the implementation phase. Municipality of Alexandroupolis is required to act as facilitator and undertake the activities to engage citizens, as well as provide the required equipment. CERTH and Energy HIVE Cluster will support Alexandroupolis in terms of technical design of the measure.

7.7.5. Data collection and management

Data collection will be performed by the equipment that will be installed in the houses that will participate in the project (e.g., HEMS TOON or similar).

Regarding the homes that will participate in the project, the data collection will comply with GDPR regulations.

The data collection makes the calculation of KPI fairly easy. Thus, the project can be closely monitored and evaluated.

7.7.6. Barriers and drivers

Political

The same applies as included in section 4.6.6. In addition, the selected measure has a strong social character that acts as a political driver.

Economical

- **Barriers:** See section 7.6.6.
- **Drivers:** The target of the measure to minimize energy costs for low-income families is by definition a driver for implementation.

Sociological

- **Barriers:** People are usually finding it hard to speak about their energy bills and this is considered as a recognized barrier for the implementation of this replication measure.
- **Drivers:** Minimization of energy costs is directly connected with improvement of quality of life.

Technological

- **Barriers:** Usually, the old electromechanical equipment of houses in Greece (more than 75% of home has been built before 1980) may be considered as a technical barrier to implement innovative metering devices such as HEMS TOONS. In addition, as it is the case in relevant projects, the data formats and data protocols used may cause a technical barrier for fluent data exchange.
- **Drivers:** The demand for data and information services is considered as a driver for this project.

Legal / Regulatory framework

See section 7.6.6.

Environmental

- **Barriers:** No barrier in terms of the environment has been recognized.
- **Drivers:** The planned activities for TT#4 provide the opportunity to achieve a substantial reduction in CO_2 emissions due to scalability and replicability of the selected replication measures.

7.7.7. Specifications

In the absence of any social housing association operating in Alexandroupolis, the Municipality, as the closest public authority to the citizens, is willing to take action and provide with meaningful services to low-income families aiming to improve their financial position through rational use of energy and energy costs reductions. The objective is to develop a data service for low-income families in Alexandroupolis, which gives them control over and/or better understanding of their energy bills, resulting in reduced energy bills and increased disposable income.

Alexandroupolis is willing to co-create this project with citizens and therefore more specification of the energy poverty mitigation activities will be available upon completion of the citizen and stakeholder engagement activities planned.

7.7.8. Citizen engagement

As presented by Utrecht, the measure is placed at the highest level of citizen involvement in the development of the service. On the basis of various preliminary investigations into the scope of the problem and the services already available, input will be collected during planned workshop before setting out the challenge. Participants targeted are parties involved in the IRIS projects and experts from the city of Alexandroupolis working with the target group. Citizens will be invited to participate through an open call. A specific workshop will be performed for citizens and the outcomes of this workshop will be used as input for experts and stakeholders' workshop that will set up the specific challenge.

7.7.9. Business model

The development of the business model of this measure requires the identification of the specific services to be developed. In addition, the business model is related to the number of dwellings that will participate in this replication project. At this stage, the Municipality aims to engage at least 20 dwellings with different building typologies and family members and install data collection systems (e.g. TOONS). The municipality also plans to proceed with an award for the winning entry of the challenge, which will be decided in later stage. There is no profit related with the activities of the Municipality of Alexandroupolis within this measure; however, it is expected that the implementation of this measure will support the development of innovative business models for private entities.

7.7.10. Governance

City of Alexandroupolis is willing to take action towards energy poverty fighting and therefore is recognized as leader of this project.

7.7.11. Impact assessment

The impact of the measure included in TT#4 contribute to the overall objective of the Municipality of Alexandroupolis to enhance the quality of life for its citizens. As highlighted, energy poverty is a significant issue for Alexandroupolis in particular. The pilot replication project is expected to have low impact on this matter; however, the scalability of the selected measure offers potential increased impact. The following KIPs have been selected in order to assess the success and suitability of these measures in this context:

- Reduced energy costs for tenants

7.7.12. Implementation plan

See section 7.6.12.

7.7.13. WBS – Work Breakdown Structure & Gantt chart

For WBS see section 7.6.13. The Gantt chart of measure #2 is presented in annex 4 and it is considered as preliminary.

7.7.14. Financing schemes and opportunities

See section 7.6.14.

7.8. IS-4.4: Services for Grid Flexibility

7.8.1. Baseline

Alexandroupolis city has limited assets to support its urban monitoring activities and the city baseline analysis highlights the need to gradually proceed with selected demonstration projects. Answering to the TT#4 IRIS objective to develop meaningful information services for the citizens and taking into consideration the IRIS demonstration projects, Alexandroupolis selected the replication of energy cloud measure, as demonstrated by LHC of Gothenburg.

As stated in 7.6.1, Alexandroupolis does not have any ICT urban data platform, as well as any data collection systems and relies only on the governmental activities. It goes without saying that replication of IS-4.4 finds limited area for development in the local context of Alexandroupolis.

The replication area for this measure is selected municipal buildings. The municipal buildings selected, are the ones with increased energy consumption and increased daily use. As it is the case in all selected measures of TT#4, this specific project is considered as a pilot project which is highly scalable and replicable within the city of Alexandroupolis and beyond. The objective to initiate building energy data collection and provide easy access to structured energy data to promote and support primary energy savings of the building sector of Alexandroupolis and eventually Greece.

7.8.2. Ambitions

Alexandroupolis' ambition is to implement projects that will lead to a green and sustainable urban environment and creation of green jobs. In particular, the ambition for IS-4.4 is to contribute to enable meaningful information services for households, municipality and other stakeholders.

The selected measure includes the collection of energy data of three municipal buildings including micro-production, EV-charging, building control systems, smart meters and user and the data will be categorized according to a unified semantic, such as RealEstateCore[21], that enables easy sharing of data between stakeholders in the building sector and the smart city as well as fast replication of data-driven energy

[21] https://www.realestatecore.io/

efficiency services. The project replicates the proposed demonstration of LHC of Gothenburg as presented in measure #2 of D7.6 – Launch of TT4 activities on CIP and information services of Gothenburg.

Through the realization of this measure, the Municipality of Alexandroupolis aims to support the digital transformation of the city services and urban monitoring activities.

7.8.3. Planning of replication activities

Energy Cloud of Alexandroupolis will collect energy data from four (4) municipal buildings, the city hall, the former city hall building, operating now as a municipal office building, the indoor gym “Mihalis Paraskevopoulos” and the building of 4th primary school of Alexandroupolis. The selected buildings do not currently have any metering devices or building control systems.

The WBS of TT#4 is presented in section 7.6.13. The Gantt chart presented in the section 7.8.13 and depicts the planning of the replication activities.

7.8.4. Organisation of work

Municipality of Alexandroupolis is the owner and operator of the selected buildings. Thus, responsible for the organization of work is the municipality. Upon realization of the project, the municipality will be the responsible for operation and maintenance, as it the case today. CERTH and Energy HIVE Cluster are responsible for development of the feasibility study of this measure.

7.8.5. Data collection and management

The overall ambition with the Energy Cloud is to reduce energy consumption in the selected municipal buildings and after replication to all buildings operated by the municipality of Alexandroupolis. This will be achieved by targeting one of biggest bottlenecks for data driven energy savings - access to structured energy data. The Energy Cloud will collect, structure, store and share energy data from buildings in Alexandroupolis, using the RealEstateCore ontology, or similar services (to be decided after public tender procedure). The selected municipal buildings will be equipped with smart meters (heat meters, electrical meters, sensors, etc). The data collection will include at least:

- Energy consumption on building level (thermal energy & electricity).
- Energy consumption on user level (thermal energy & electricity)
- Energy generation of RES technologies at building level (thermal energy & electricity).
- Humidity, temperature and CO_2 levels per building to measure the indoor thermal comfort.

The implementation of the Energy Cloud will include appropriate measure to secure that data protection is handled in accordance with the provisions of the Data Protection Regulation (EU) 2016/679 and other applicable laws to safe guard compliance with GDPR. Any personal data collected in the Energy Cloud demonstrator will be processed lawfully, safely and properly. All data collection and research in the Energy Cloud demonstrator will be in full compliance with the ethical principles and guidelines of the Horizon2020 and European and National legislation.

7.8.6. Barriers and drivers

Political

See section 7.6.6.

Economical

See section 7.6.6.

Sociological

- **Barriers:** Energy behavior of building users may be a barrier to achieve rational use of energy in buildings.
- **Drivers:** No sociological drivers identified.

Technological

- **Barriers:** The recognized lack of standards in terms of data semantics is considered as a technological barrier.
- **Drivers:** No technological drivers identified.

Legal / Regulatory framework

See section 7.6.6.

Environmental

- **Barriers:** No environmental barriers identified.
- **Drivers:** Inherently, Energy Cloud increases awareness and transparency of the energy usage of companies, buildings and residents and thus provides the foundation for energy savings.

7.8.7. Specifications

The development of Alexandroupolis' Energy Cloud is considered as direct replication project based on the demonstrator of LHC of Gothenburg. Therefore, the proposed measure shares the specifications presented by Gothenburg, which are currently yet to be clearly defined. The objective includes demonstrating how efficient building management, development and replication of innovative energy services can be accelerated by the application of standardized data semantics across the real estate industry. Energy Cloud will collect energy data from the municipal buildings of Alexandroupolis, including micro-production, EV-charging, building control systems, smart meters and building users and the data will be categorized according to a unified, semantic RealEstateCore, that enables easy sharing of data between stakeholders in the building sector and the smart city as well as fast replication of data-driven energy efficiency services. More information about RealEstateCore can be found in D7.6.

The feasibility study of this replication measure is expected to be completed in the near term, which will include more technical details and specifications regarding the replication of Energy Cloud in Alexandroupolis context.

7.8.8. Citizen engagement

As stated by LHC of Gothenburg, Energy Cloud can be considered as a platform that could be used for rapid replication of energy service applications including services that promote energy consumption awareness among property owners, property managers as well as their tenants and the energy end user.

Alexandroupolis' pilot phase of Energy Cloud includes data collection only from municipal buildings, which however have increased usage. Therefore, citizen engagement activities have limited influence on the replication project. Nevertheless, as suggest by LHC of Gothenburg, Alexandroupolis is willing to issue an innovation call to attract start-ups and entrepreneurs to provide with innovative solutions based on access to Energy Cloud data.

7.8.9. Business model

The proposed replication project of the Municipality of Alexandroupolis refers only to a pilot implementation of Energy Cloud with limited data generated from only two municipal buildings. Therefore, no actual business model exists on this specific replication measure. Nevertheless, the scalability of such measure will allow the future creation of business models from private entities that will utilize the available data of Energy Cloud. A software as a Service (SaaS) model is expected to be applied.

7.8.10. Governance

Municipality of Alexandroupolis is the owner of the selected buildings that will be connected to the Energy Cloud. Aiming to initiate a potential business case, the Municipality of Alexandroupolis will also be the owner and operator of Energy Cloud through partnership with a external expert, awarded through a public tender procedure. The Energy Cloud data will be stored in third-party management system and eventually transferred to the future CIP of Alexandroupolis.

7.8.11. Impact assessment

The impact of the measure included in TT#4 contribute to the overall objective of the Municipality of Alexandroupolis to enhance the quality of life for its citizens. The following KPIs apply to this replication project.

KPI	Parameters	Baseline
1. Open data-based solutions	Number of applications using the RealEstateCore (or other) compliant datasets in Energy Cloud	No Energy Cloud available currently
2. Quality of open data	Number of datasets that are RealEstateCore (or other) compliant in Energy Cloud	No Energy Cloud available currently

7.8.12. Implementation plan

See section 7.6.12.

7.8.13. WBS – Work Breakdown Structure & Gantt chart

For WBS see section 7.6.13. The Gantt chart of measure #3 is presented in Annex 4.

7.8.14. Financing schemes and opportunities

See section 7.6.14.

7.9. Conclusions on ambitions and planning of activities for TT #4 City Innovation Platform (CIP)

Alexandroupolis' ambition is to implement projects that will lead to a green and sustainable urban environment and creation of green jobs. In particular, the ambition for TT#4 is to contribute to enable meaningful information services for households, municipality and other stakeholders. To realize these ambitions, the municipality is targeting to replication three measures demonstrated in the LHCs of IRIS project. The implementation of the projects will support the kick-start of digital transformation of the city services and initiate urban monitoring activities.

8. Transition track #5: Citizen engagement

8.1. TT#5 Replication in a nutshell

The City of Alexandroupolis in order to involve citizens actively into city development and decision making, it has established processes with the aim to a) receive citizen views with regard to the city's budget, b) to allow citizen to directly explain problem related to city life or local business, and c) to enable citizens to offer their views and propose projects for city development. In order to engage citizens in the decision making and city development, the City of Alexandroupolis has established: a) the Municipal Advisory Committee, b) Supporter of the citizen and the business, and c) open consultation processes through its website.

The municipal advisory committee

The city of Alexandroupolis has established a municipal advisory committee as a body with advisory powers. The advisory committee was formed, by decision of the municipal council, taken by a majority of two thirds (2/3) of its members and was issued within two (2) months from the establishment of the municipal authorities, after elections. The municipal advisory committee consists of representatives of local community bodies, such as:

a) local commercial and professional associations and organizations
b) scientific societies and bodies
c) local workers 'and employers' organizations
d) the employees in the municipality and its legal entities
e) parent associations
f) sports and cultural clubs and organizations
g) voluntary organizations and citizens' movements
h) citizens' communities
i) representatives of local youth councils; and
j) citizens.

The Municipal Advisory Committee role is to:

a) Provide an opinion to the municipal council on development and action plans of the municipality, the operational program and the technical program of the municipality.
b) Provide its opinion on issues of general local interest, which are referred to it by the municipal council or the mayor.
c) Examine the local problems and the development possibilities of the municipality and advice on problem solving and exploitation possibilities.
d) May make comments on the content of the regulatory character of decisions which are issued in accordance with article 79 of the CCP.

The issuance of an opinion by the municipal advisory committee does not exclude parallel electronic citizen consultation via the internet. The proposals of the electronic consultation are collected and systematized by the competent services of the municipality and are presented by the president of the municipal advisory committee during the corresponding meeting.

The Supporter of the citizen and the business

The City of Alexandroupolis has also established the role of the "Supporter of the citizen and the business". The supporter is administratively supported by the municipal services, and his role is to receive complaints from directly affected citizens and businesses for maladministration of municipality services, its legal entities and of their activities and mediates so as the relevant problems to be resolved, while he is obliged to respond in writing or electronically within thirty (30) days to the interested parties.

Public consultation processes

The City of Alexandroupolis has also established an open consultation procedure through its website where all prospective decisions by the municipal council are presented and are open to public consultation through direct messaging to the authorities regarding the topic that is open to open consultation.

Communication Channels

The city of Alexandroupolis communication channels between the Municipality and the citizens include:

- Municipality website
- Municipality's email
- Citizen telephone line

All the activities above allowed citizens engagement in city life and decision making and showed that citizens are willing to be involved in the decision-making processes, can point out different problems and issues but also come up with novel ideas and projects.

The City of Alexandroupolis for the IRIS Transition Track #5 aims at replicating the following integrated solutions:

- IS-5.1: Co-creating the energy transition in your everyday environment
- IS-5.4: Apps and interfaces for energy efficient behavior

Although co-creation activities have not been applied till now in the format presented in the integrated solutions of IRIS project, the Mayor and the Municipal Council are fully aware of the role and importance of such activities and are willing to elaborate steps that engage more the citizens while allow for co-creation.

8.2. Selection process

In order to select the most suitable IRIS solutions for replication with regard to citizen engagement, it has been important to get to know the demonstrations (pilot solutions) of the IRIS Lighthouse cities through careful reading of documentations, via presentations held by the demonstrators and during on-site visits in Utrecht, Gothenburg and Nice. In addition, it has been important to take into consideration what citizen engagement processes, projects and activities have been or are currently carried out in the city of Alexandroupolis as well as relevant related programs on strategic level within the city. Regarding the latter part, the city of Alexandroupolis is implementing its participation program 2017-2020, which is currently being developed for the period of the coming three years 2021-2024. In the selection process, both current activities and strategic level programs as well as those under development have been taken into account.

Based on the familiarization with the IRIS Light house cities' demonstrations and the past, current and planned future activities, projects and strategies within the city of Alexandroupolis, the following integrated solutions and underlying demonstrations as well as specific measures have been identified as the most relevant with regard to replication:

#5 Citizen engagement and Co-creation	IS-5.1: Co-creating the energy transition in your everyday environment IS-5.4: Apps and interfaces for energy efficient behaviour	• Measure 1: Community building by Change agents
		• Measure 2: Campaign District School Involvement
		• Measure 3: Minecraft as a dialogue tool for citizen engagement

8.3. Mapping of stakeholders

The City of Alexandroupolis relies upon strong cooperation between different actors, when it comes to how business is conducted, projects are planned and implemented etc. Depending on the case, involved actors can range from the City of Alexandroupolis and surrounding municipalities to companies, higher education institutions and non-profit organizations, and further to citizens and other potential actors within the region. Hence, the mapping of stakeholders is an integral part of both city and regional development. The IRIS replication in Alexandroupolis is following this existing model, and there is a continuously ongoing mapping of relevant stakeholders, besides those directly involved in the IRIS project, with regard to the chosen integrated solutions. For each solution, the following stakeholders have been identified:

For IS-5.1**:** Co-creating the energy transition in your everyday environment, the relevant stakeholders are:

- Municipality of Alexandroupolis
- City Municipal Council
- Citizens of Alexandroupolis
- Parent associations
- Sports and cultural clubs and organizations
- City Municipal Council
- The Democritus University of Thrace

For IS-5.4: Apps and interfaces for energy efficient behaviour, the relevant stakeholders are:

- Municipality of Alexandroupolis
- City Municipal Council
- Citizens of Alexandroupolis
- Software companies

8.4. Identified knowledge gaps

There is experience in engaging citizens and stakeholders in the city design and development through meetings in physical settings. However, the ongoing Covid-19 measures has accelerated the transition to identifying ways of engagement through digital settings. This kind of more extensive use of digital/virtual tools and techniques is currently a knowledge gap. Additionally, substantial differences in the local conditions of Alexandroupolis result in knowledge gaps in terms of replication of citizen engagement activities designed by the LHCs (e.g., ownership of residential houses).

8.5. Capacity building and knowledge transfer

In order to build capacity and transfer knowledge, representatives from relevant stakeholders have participated in workshops and peer-to-peer digital and face-to-face meetings organized by lighthouse city representatives. Besides active participation in workshops, also materials from these workshops together with other documentation (e.g., webpages) have been used to get more information on the chosen integrated solutions.

Considering future capacity building and knowledge transfer, we see a lot of potential in the peer-to-peer meetings held either with physical means or virtually. To maximize the potential of these meetings, it is vital to have besides the relevant people from the lighthouse cities sharing their knowledge on a specific solution also the relevant representatives from the relevant stakeholders in Alexandroupolis participating in these meetings.

8.6. IS-5.1: Co-creating the energy transition in your everyday environment

8.6.1. Baseline

Measure #1: Community building by change agents

The Municipality of Alexandroupolis has established: a) the Municipal Advisory Committee b) the Supporter of the citizen and the business, and c) public consultations as methods for municipal officials to involve residents, entrepreneurs, organization and professionals in the development of plans and projects of the municipality. With the "Municipal Advisory Committee" that is composed of city stakeholders the municipal council is advised on municipal decisions and impacts those may cause to city life and growth. With the role of the "Supporter of the citizen and the business", the municipality of Alexandroupolis receives complaints for city maladministration but also comments for improvements. With the established procedure of public open consultations, the city publishes prospective decisions and plans and receives comments, suggestions and views by citizens that are consolidated and reported to the municipal council.

Measure #2: Campaign district school involvement

The city of Alexandroupolis is planning to replicate the measure of campaigning the district school involvement, a measure developed by Utrecht city. The schools to be involved in this measure will be a) the 8th Primary School of Alexandroupolis, b) the 2nd Junior High school of Alexandroupolis, and c) the 4th General High School. The proposed schools are within the replication area for the IRIS project. The Democritus University of Thrace will be involved by providing training to youngsters, while installing and maintaining the integrated smart solutions in the replication district. The premise is that by targeting children, local students and their families, living in the district, might familiarize themselves and develop an emotional relationship with the energy solutions that is intended to be realized in their own neighborhood during the replication activities.

8.6.2. Ambitions

The city of Alexandroupolis has the ambition to design more focused mechanisms and inclusive services for citizens in order to incentivize them: to a) save energy, and b) shift their energy consumption to periods of redundant energy produced by renewables. In practical terms, the city will be working on capitalizing existing mechanisms but also creating new processes to achieve its goals and engaging more citizens in the process while accommodating their concerns and insights.

This citizen engagement processes selected aims to ensure that:

- The integrated solutions are designed with user needs and possibilities (e.g., language) in mind.
- The chance of long-term frequent interaction with the solutions, after the “newness” has faded is maximized because the integrated solutions fit the prospected users living situation better.
- Citizens are motivated during but also after the implementation of the integrated solutions through designing appropriate solutions that address real needs.
- The citizen engagement process itself increases awareness in the target area and raises public support, both benefiting initial adoption and sustained use.

The replication areas for measure #1 of TT#1 at the city of Alexandroupolis includes public buildings but also low-income households within the city. Residents in low-income households tend to be among the last groups to adopt new more efficient solutions mainly because of their capacity to invest in them including the upfront cost, and because of low awareness of the benefits i.e., energy savings in the longer term. The city plans to train three (3) Change agents on the expected benefits and impact that the solutions of the IRIS project would bring to the community. Through their participation in public and community events they will disseminate and inform the residents of the city acting as change agents.

The replication areas for measure #2 of TT#1 at the city of Alexandroupolis includes public buildings i.e., nursery schools but also low-income households, and office buildings within the city. The city plans to educate and train youngsters on the expected benefits and impact that the solutions of the IRIS project would bring to the community. Through training and awareness raising, youngsters and their families will be able to make educated decisions on how energy is consumed but also on the impact of new cost-effective technologies.

8.6.3. Planning of replication activities

Measure #1

A first step will be to identify the required characteristics of the change agents followed by the identification of the most suitable people for serving this role. As part of this exercise a mapping activity of the key formal and informal influencers in the city will be performed to identify a candidate list with suitable profiles as change agents. The three most suitable profiles will be selected with a scoring procedure regarding each of the criteria identified. As soon as the change agents will be chosen, they will be trained and then regularly consulted on how to participate to citizen engagement activities e.g., when formulating the communication messages for citizens, follow-up of progress on integrated solutions to be implemented that they provided their input for. Local news agencies will be also included as partners in the effort to raise citizens awareness.

Measure #2

A first step will be to define the timeframe for preparation and implementation of the training activities. Then the next step is to develop the training material and organize and implement the technical workshops with the proposed schools and the respective classes of students that will be engaged. As part of this exercise a mapping activity of the key educators that will be involved needs to be performed. Teacher manuals will also be designed and provided to educators so as to be able to deliver similar seminars to other classes. Webinars of the seminars will also be produced and provided for free to the schools of the community.

8.6.4. Organisation of work

The work will be directed by the Municipality of Alexandroupolis. In particular, the autonomous office of Energy and Natural Resource of the Municipality will lead this work, supported by the technical department. The main responsibility of the city for measure #1 is to a) direct the project to be in line with the City´s requirements, b) to secure budget and resources within the project and c) to identify the most suitable profiles that can serve the change agents role. The work will be managed by a Project management team that will also include the change agents. The project management team shall meet on a regular basis to handle the work ahead and tasks to be realized. The following tasks will be subcontracted:

- Training and regular consulting of the change agents.

The main responsibility of the city for measure #2 is to a) facilitate a wide dissemination campaign providing schools' educators the material to conduct workshops that promote integrated solutions that result in energy efficiency and city smartness technically customised to the IRIS project replication activities, b) secure budget and resources for the campaign project, c) to conduct seminars and workshops to a primary school and two high schools with physical means, and d) offer the seminars also as webinars for the wider dissemination to the community. The work will be managed by a Project management team that will organise the campaign. The project management team shall meet on a regular basis to handle the work ahead and tasks to be realized. The following tasks will be subcontracted:

- Preparation of the educational material and the teacher manuals
- Training seminars/workshops to schools
- Webinar production and wider dissemination

8.6.5. Data collection and management

In respect to measure #1 data will be collected by the change agents who will carry out the activities of communication and dissemination and will be reported to the City of Alexandroupolis. The frequency and way of reporting will be decided by the replication team.

For measure #2 data will be collected by the trainers who will carry out the activities of communication and dissemination and will be reported to the City of Alexandroupolis. The webinar production will not reveal young students faces unless permission is granted by the parents.

Any data collection will be handled according to GDPR rules.

8.6.6. Barriers and drivers

Political

- **Barriers:** No political barriers were identified.
- **Drivers:** There is more and more emphasis on citizens' engagement and participation in civic matters from politicians and city management in the city of Alexandroupolis.

Economical

- **Barriers:** The change agents should be perhaps incentivised requiring some non-voluntary participation, which requires the identification of appropriate funding sources. The campaign and the school seminars should be incentivised which requires the identification of appropriate funding sources.
- **Drivers:** Potential funding source is the new City Operational Program and its technical assistance.

Sociological

- **Barriers:** No sociological barriers were identified.
- **Drivers:** Citizen engagement with change agents will boost the participation in the planning process of the integrated solutions. Citizen engagement with education and training activities will further boost the participation in the co-design and co-creation process of the integrated solutions.

Technological

- **Barriers:** No technological barriers were identified
- **Drivers:** Citizen engagement and participation is becoming a more and more important aspect of city planning, while committed change agents shall manage to pass on the benefits of energy efficiency solutions and increase the adoption rates. Committed young people and their families shall increase the adoption rates.

Legal / Regulatory framework

- **Barriers:** No barriers were identified
- **Drivers:** A driver for all activities within TT5 ambition and political decision are essential. Citizen engagement is one of the main pillars to ensure adoption and uptake of solutions so the new

EPBD defining LEC and RECs are also contributing to more active and participatory engagement of the citizens.

Environmental

- **Barriers:** No environmental barriers were identified.
- **Drivers:** No environmental drivers were identified.

8.6.7. Specifications

Measure #1

The planned work will include the following activities:

- At first an open call for expression of interest for change agents will be published. Change agents' profiles will be collected and evaluated against a set of criteria. An interview with the Change Agents will be planned. At that time, there will be a presentation of the scope and purpose of the activities that the Change Agents need to conduct, and the participants will be given the opportunity to ask questions and receive feedback. Municipality aims to attract change agents that have particular interest on specific projects (e.g. citizens of targeted NZE neighbourhood).
- A training cycle of the IRIS replication activities will follow to ensure that the Change Agents can deliver the information and its technical aspects but also the benefits perspectives of the planned activities. Motivation techniques will also be demonstrated to allow the Change Agents evolve the participatory approach and motivate other citizens to participate in co-design and decision making.
- Events for participation will be identified and an action plan for each Change Agent will be formed to outline the events in which he/she will participate.
- Reporting on the activities performed and further plans for continuation of the Change Agents will follow this first iteration cycle.

The activity will be carried out in collaboration with the city of Alexandroupolis and will also be able to use the municipal website for dissemination of information and publish the results of the project.

Measure #2

The planned work will include the following activities:

Preparation of the material: the education material will be developed for the two different levels of educational activities i.e., for the primary school and the high school. The material will be adapted to match the age of the students.

Primary schools: two sustainability and technology workshops with associated lesson boxes and teacher manuals will be developed to match the technical content of the IRIS project. Guest lecturers will conduct the workshops at the 8th Primary School of Alexandroupolis. Webinars will also be produced during the delivery of the seminars. Teachers should be able to deliver further the seminars to other classes but also teachers from other schools will be encouraged to deliver the same seminars independently. At all schools it will be discussed and investigated how in the coming years the activities within the framework of the IRIS project can contribute to a structural approach to science and technology education in their curriculum.

High schools: two sustainability and technology workshops will also be prepared to be conducted to: the 2nd Junior High school of Alexandroupolis, and the 4th General High School. In groups, the students will also be requested and challenged to make plans for technical and social items:

- **technical:** the most efficient design for PV-panels on the roofs of the apartment buildings, options as requested by tenants (e.g., the enlargement of the kitchen/bathroom), solutions to minimize energy/heat losses.
- **social:** inquiries from tenants about the process and communication during and after the refurbishment, assisting citizen engagement activities, making video logs (vlogs) about the tenants, impact on the environment and the impact of the construction works to inform and involve people. The first study year (2022), 3rd years students will be elaborating plans for a period of a half-year. After this half study year, the results and assignments will be evaluated and improved for further study years.

The activity will be carried out in collaboration with the city of Alexandroupolis and the first and second grade regional agencies for education. Information on the activities will also be available to the municipal website for dissemination of information and for publishing the results of the project.

8.6.8. Citizen engagement

This is a citizen engagement activity by nature.

8.6.9. Business model

Not applicable.

8.6.10. Governance

The Municipality of Alexandroupolis is the main stakeholder for the measures included in IS-5.1. A strong collaboration with the Directorate of Primary and Secondary Education of Prefecture of Evros is required for the implementation of measure #2.

8.6.11. Impact assessment

The expected impact is to get a deeper understanding and knowledge on the perception of end-users regarding specific integrated solutions and assess the level of difficulty to use a solution depicting citizens views and expectations for city plans.

KPI	Parameter(s)	Definition	Baseline	Target
1. Ease of use for end-users of the solution	Assess the level of difficulty to use a solution	a smart city solution that is easy to use and understand will be more likely adopted	NA	4 on the scale of 1-5 (Likert Scale)

2. Advantages for end-users	The extent to which the project offers clear advantages for end users	solutions which have a higher level of advantages to end users will be more likely to be adopted than solutions which have negative or no advantages.	Anticipated advantage before implementation of the measure	4 on the scale of 1-5 (Likert Scale)
3. Local community involvement in planning/ implementation phase	public involvement during the planning/implementation stage is essential to provide developers with input to ensure that the project will perform as intended	The extent to which residents/users have been involved in the planning /implementation process	NA	4 on the scale of 1-5 (Likert Scale)
4. People reached	Gain insight in effect of effort to engage full extent of target group	Percentage of people in the target group that have been reached and/or are activated by the project	NA	80%

8.6.12. Implementation plan

The plan for the implementation of change agents is to test a different engagement process, than those ones already established for engaging the citizens by raising awareness and informing them how to participate to city decision making, also through the other already established processes. This will be implemented following a detail plan of activities. The change agents' target groups will address audiences of different ages and social and economic characteristics i.e., students in high schools, owners of low-income houses, public servants, entrepreneurs and private sector employees.

The plan for the implementation of campaigning to district schools is to engage citizens of younger ages who can become the frontrunners in testing and adopting new technologies. This will be implemented following a detailed plan of seminar and workshop activities. The campaigning to district schools will address audiences of different ages and social and economic characteristics i.e., students in primary and high schools, and their families' owners of low-income houses, public servants, entrepreneurs and private sector employees.

8.6.13. WBS – Work Breakdown Structure & Gantt chart

Figure 26 presents the work breakdown structure for the implementation of the measures included in this IS. The Gantt chart of measures #1 and #2 of IS-5.1 is presented in Annex 4.

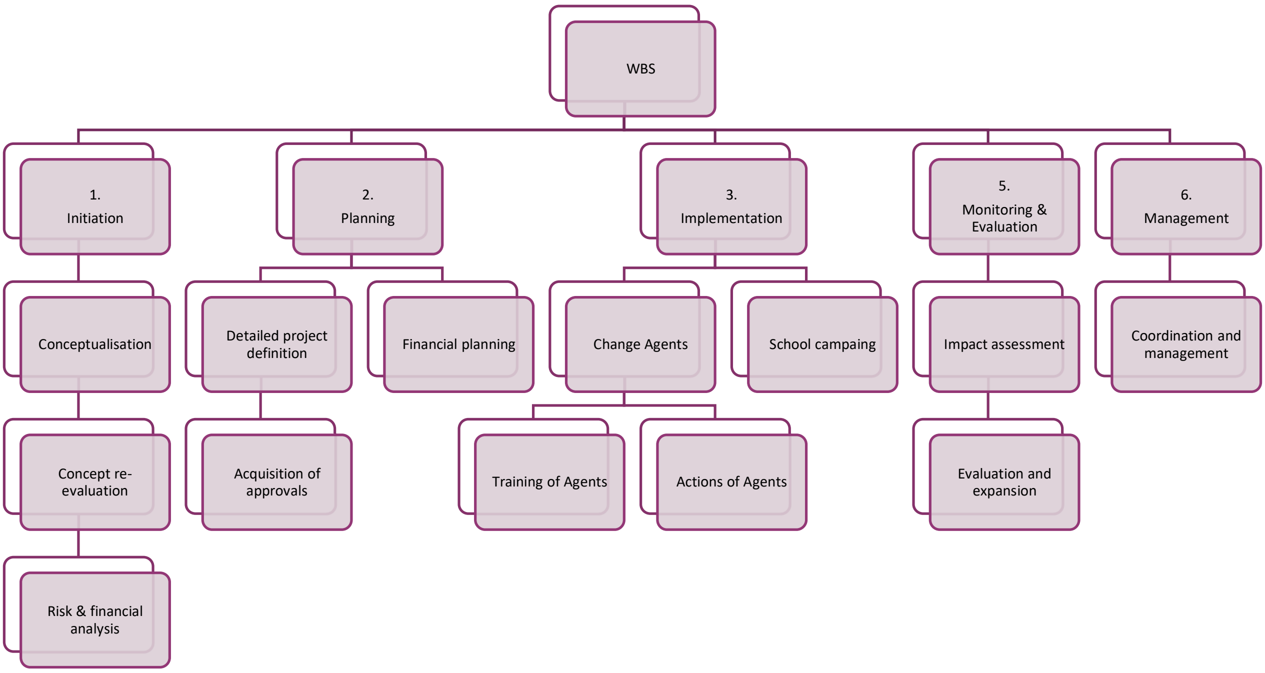


Figure 26: Work breakdown structure for the implementation of IS-5.1 replication measures

8.6.14. Financing schemes and opportunities

Costs for the activity in measure #1 are:

a) expenses for training and regular consultation of the change agents (cost 1,500 Euros)
b) expenses for compensating the change agents (cost 9,000 Euros)

Costs for the activity in measure #2 are:

- Preparation of the educational material and the teacher manuals (3,000 Euros)
- Training seminars/workshops to schools (3,000 Euros)
- Webinar production and wider dissemination (2,000 Euros)

Sources of Finance: The Regional Operational Program of East Macedonia and Thrace as well as the city planning technical assistance could finance the proposed measure.

8.7. IS-5.4: Apps and interfaces for energy efficient behavior

8.7.1. Baseline

In city planning, that has such an obvious impact on children's environment and everyday life, it is of great importance to take into consideration the children's own perspective. The city of Alexandroupolis is planning to replicate Minecraft, a tool developed by Gothenburg's city building office. Minecraft provides the city's own real geographical data, houses, roads, trees and lighting. Although the game is built on that one should construct with one square meter blocks, one can still quickly recognize himself/herself as they walk or fly through the city. Minecraft is also a new way of making geographical data available to the public. The idea is that Minecraft-Alexandroupolis will be used as a way to get ideas from children and young people, and it can also be a tool to show what the city of the future will look like. "We will use Minecraft to get children and young people more involved in urban planning. We want to make them want to be involved and influence the development of the city".

The objective of Minecraft as a dialogue tool for citizen engagement is to study the possibility to increase the ability for children to have influence of the development of their local environment through Minecraft. The hypothesis is that the digital platform and computer game Minecraft can facilitate the dialogue with children since it's both engaging and easily accessible to many children.

8.7.2. Ambitions

The City of Alexandroupolis planning process includes measures for citizens' dialogue. In proposals that directly and significantly affect the city and/or district's residents, civil dialogue is always considered, and the position taken at major changes of municipal activities should endeavour to engage in dialogue with citizens. The use of Minecraft targeting young people, will engage schoolchildren and youths using a model of Alexandroupolis in the popular game Minecraft. The objective is to reach and animate new and hard-to-reach population groups to involve them in shaping the city of the future. Towards this goal the following measure will be applied:

- the use of Minecraft city model aimed at young people, mainly students of primary and secondary schools engaging in the planning process

The ambition is to identify opportunities based on citizen views and ideas and based on success or failure factors of the demonstrators, design processes so that citizen's views and especially children views are taken into consideration in urban planning.

8.7.3. Planning of replication activities

The activities within the demonstrator Minecraft as a dialogue tool for citizen engagement has two different demonstration areas. Minecraft in the planning process is being conducted in a) primary schools and in b) secondary schools.

At first planning stage, the Regional Authority for Primary education and the Regional Authority for secondary education will be committed to organising Minecraft® Planning Competition where the intervention will be to involve and organise a spatial planning design contest for children and youths based on a Minecraft® model, targeted at the new, currently being constructed district heating system based on geothermal energy of "Antheias Aristinou" and the planned expansion of the DH. Currently the project aims to provide thermal energy to public buildings, but it is planned to be expanded to private homes in Antheia and the neighbouring village-communities i.e., Doriko and Aetochori.

8.7.4. Organisation of work

The work will be directed by the Municipality of Alexandroupolis. The main responsibility of the city is to direct the project to be in line with the City´s requirements and to secure budget and resources within the project. The work will be managed by a Project management team that will also include representatives of Antheia. The project management team shall meet on a regular basis to handle the work ahead and tasks to be realized. The following tasks will be subcontracted:

- Technical pedagog for the Minecraft workshops, interacting with personnel in the target area, carrying out workshops with students.
- Software licenses for Minecraft® Education.

8.7.5. Data collection and management

Data will be collected by the technical pedagog who will carry out the activities and will be reported to the City of Alexandroupolis. Any data collection will be handled according to GDPR rules.

8.7.6. Barriers and drivers

Political

- **Barriers:** No political barriers were identified.
- **Drivers:** There is more and more emphasis on citizens' engagement and participation in civic matters from politicians and city management in the city of Alexandroupolis.

Economical

- **Barriers:** The Minecraft should be customised and the model of the city of Alexandroupolis should be integrated in the tool.
- **Drivers:** Potential funding source is the new City Operational Program

Sociological

- **Barriers:** No sociological barriers were identified.
- **Drivers:** Gamification might boost the participation in planning process dialogue for youth.

Technological

- **Barriers:** No technological barriers were identified
- **Drivers:** Citizen engagement and participation is becoming a more and more important aspect of city planning, while a digital context of participation is more prevalent due to the Covid-19 measures requiring new digital tools

Legal / Regulatory framework

- **Barriers:** Handling of personal data is always a key issue in creating new services and managing citizens' views. Storing personal data is managed according to GDPR.

- **Drivers:** A driver for all activities within TT5 ambition and political decision are essential. Digital Agenda for Europe, and the national Programme for digital governance are important drivers.

Environmental

- **Barriers:** No environmental barriers were identified.
- **Drivers:** No environmental drivers were identified.

8.7.7. Specifications

The activity will be conducted at the a) Primary School of Antheia and b) the secondary school of Antheia. The planned work will include the following activities:

- A first open dialogue is planned in the area, where the public (= the parents of the children) can come and get information about the project currently being constructed and well as the project planned (the extension of the DH network for private houses and at the neighbouring village-communities). At this time, there will be a presentation of Minecraft and the participants will be given the opportunity to test the tool. This will also be a way to involve parents in the students' work, possibly a virtual security walk can be carried out with visitors. In the consultation in the detailed plan, it is also possible to in some way report what the students worked with in Minecraft and show how it may have affected the planning work, this also becomes a form of feedback to the participating students.
- Four different Minecraft workshop occasions, will be conducted with the children at the primary School and the secondary School with the following arrangement:
  1. Creative info on urban planning, Antheia history and a walk in the area, good, bad or potential places - analysis / discussion afterwards.
  2. Hiking in Minecraft - further discussion of these sites and discussion of the new plan proposals.
  3. Work on different creative approaches.
  4. Complete the work, analysis - presentation and summation, in a report focusing on being a good basis for collecting citizens' views and describe how the children used Minecraft.
  5. Feedback and dialogue. The Technical pedagogue will compile the material and describe thoughts on how the children used and how Minecraft worked based on their profession. Technical pedagogue compiles the children's views into a clear basis for the city of Alexandroupolis (reconciliation with plan group).

The activity will be carried out in collaboration with the city of Alexandroupolis and will also be able to use the municipal website for dissemination of information and publish the students' proposals.

8.7.8. Citizen engagement

This is a citizen engagement activity by its nature.

8.7.9. Business model

Not applicable.

8.7.10. Governance

The Municipality of Alexandroupolis.

8.7.11. Impact assessment

The expected impact is to get a deeper understanding and knowledge of how to use Minecraft as a dialogue toll for citizen engagement with children and young people and depict citizens and young children views and expectations for city plans.

KPI	Parameter(s)	Baseline	Target
Local community involvement in the planning phase	Number of participants	N/A	Number of participants in the spatial planning contest, more than 50.

8.7.12. Implementation plan

The plan for the implementation of Minecraft is to test a different digital tool in the citizen engagement of children and young people. This will be implemented following a detail plan of activities. The study will involve different age groups of children and young people (primary and secondary school students) as well as their parents.

8.7.13. WBS – Work Breakdown Structure & Gantt chart

The WBS is presented in section 8.6.13. The Gantt chart of measure #3 is presented in Annex 4.

8.7.14. Financing schemes and opportunities

Costs for the activity are:

a) possible expenses for Minecraft licenses (10,000 euros),
b) software customization for the city of Alexandroupolis with the city digital file (5,000 euros),
c) licenses for other digital tools to be used (5,000 euros),
d) compensation for the work of a technical pedagogue (cost 10,000 Euros).

Sources of Finance: The Regional Operational Program of East Macedonia and Thrace as well as the city planning technical assistance could finance the proposed measure

8.8. Conclusions on ambitions and planning of activities for TT #5 Citizen Engagement and Co-creation

Alexandroupolis' ambition is to design more focused mechanisms and inclusive services for citizens in order to incentivize and engage them in the efforts being made to develop a green and sustainable urban environment. The activities and measures included in the field of citizen engagement are considered to be significant for the successful implementation of measures in all TT, as highlighted previously.

Within TT#4, Alexandroupolis is aiming to replicate three (3) measures, demonstrated by LHCs, that according to the baseline assessment can be considered as suitable for the local context and will support the overall effort for co-creation and citizen engagement locally. The pandemic of COVID-19 strongly affects the targeted time schedule for the activities of TT#5 and it remains unknown whether the proposed activities can be performed as scheduled.

9. Output to other work packages

Output to Work Package 2

The replication plan of Alexandroupolis could be a source for WP2 “EU wide cooperation with ongoing projects, initiatives and communities” and particularly for all tasks included in this work package.

Output to Work Package 3

The replication plan of Alexandroupolis could be a source for WP3 “Development of bankable business models and exploitation activities”. The replication activities of Alexandroupolis may result in new business models that will be developed in a different local context as opposed to the LHCs.

Output to Work Package 4

WP4 aims at “offering an open, reusable and reliable platform for sharing data, speeding-up innovation, standardization and implementation of smart application.” The relevant data from the activities within this TT in Alexandroupolis is expected to contribute to the availability and connectability of data from the buildings/traffic/etc. With this data, other data solutions and tools can be developed.

Output to Work Package 8

The detailed descriptions of the replication projects, as well as their ambitions, drivers and barriers developed in this deliverable will provide excellent input for setting up updated replication plans for LHCs and FCs.

Output to Work Package 9

Although WP9 “Monitoring and evaluation” is about the demonstrators of the LHCs, the implementation of replication projects of Alexandroupolis within IRIS project duration may contribute to the activities of this work package and particularly in Task 9.5 “Overall evaluation and impact analysis for impact enhancement”.

Output to Work Package 10

The detailed descriptions of the replication projects, as well as their ambitions, drivers and barriers developed in this deliverable will provide basis and inspiration for the dissemination and communication efforts taking place within Work Package 10.

10. Conclusions

The Municipality of Alexandroupolis, as a Follower City of IRIS project takes advantage of the valuable information, knowledge and experience of partners to develop a concrete and realistic replication plan that strengthens its efforts to become a sustainable, green municipality with increased usage of Renewable Energy Sources and environmentally aware citizens.

The replication plan of Alexandroupolis will be part of the new Sustainable Energy and Climate Action Plan (SECAP) that will be developed and be approved by the municipal council of Alexandroupolis. The city Alexandroupolis envisions the transformation towards one of the most energy efficient cities of Europe.

Alexandroupolis selected replication activities that answer the local challenges and needs of the city and include replication measures in all transition tracks of IRIS project. To do so, Alexandroupolis' followed a well-structured methodology based on the IRIS replication roadmap and used the available information of IRIS replication toolbox. The selected replication projects concluded through a prioritization process for each TT according to the city's transition development goals, commitments, envisaged improvements areas and available funding opportunities.

The ambition for TT#1 is to contribute to positive energy buildings and neighborhoods, to support the realization of retrofitting project that result in near zero-energy buildings and districts neighborhoods and to further exploit the available low-enthalpy geothermal energy. The replication plan presented in this deliverable analyses the implementation of four (4) specific measures that replicate solutions and technologies demonstrated by LHCs.

The ambition for TT#2 is to design effective, equitable, safe and secure public transport systems, integrated with mobility-as-a-service (MaaS) and other platforms. Through the proposed replication measures, a sustainable and emission free urban roadmap will be created. The replication plan comprises valuable information and insights to enhance the position of the Municipality to implement the selected replication measures.

The ambition for TT#4 is to contribute to enable meaningful information services for households, municipality and other stakeholders. Through the realization of the selected replication measures, the Municipality of Alexandroupolis aims to kick-start the digital transformation of the city services and initiate urban monitoring activities.

The ambition for TT#5 is to design more focused mechanisms and inclusive services for citizens in order to incentivize and engage them in the efforts being made to develop a green and sustainable urban environment. The activities and measures included in the field of citizen engagement are considered to be significant for the successful implementation of measures in all transition tracks.

The replication plan includes specific measures that are at different stage of implementation. Prior to implementation, the Municipality of Alexandroupolis, considers the re-evaluation of the selected solutions which will be based on the available information generated by the demonstration and monitoring of the LHCs' measures and the re-assessment of the local context to include potential alterations in challenges and needs. Therefore, the replication team of Alexandroupolis expects to update the regularly update the replication plan.

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Annex 1- The use cases of measure #1 of TT#1

1st Kindergarten of Alexandroupolis building

The building was constructed in the 1950s and has a floor area of 382.57m^2. The building envelope comprises uninsulated solid block bearing structure and external walls, uninsulated ceiling slab (below roof), uninsulated concrete slab floor and double-glazed windows with timber frame (w/o low emissivity coating). A Geothermal Heat Pump was installed to provide heating and cooling

Proposed retrofit interventions

The proposed measures for reaching the positive energy targets aimed at minimizing the heating, cooling and electricity loads. The remaining energy needs were covered with the use of PV produced electricity (since the building was heated by a GSHP all energy requirements were met with electricity). The building is listed and therefore no interventions were allowed externally that would change the appearance of the façade. A summary of the technical performance and the cost of the proposed measures is shown in Table 13. The energy balance for the building before and after the energy upgrade measures is shown in Table 14.

Table 13: Summary of technical and cost parameters of the proposed measures for the 1st Kindergarten building

	Technical Performance				Costing
	Measure	**Pre-retrofit**	**Post-retrofit**	**Unit cost**	**Total cost**
1	Internal Wall Insulation	3.5 W/m^{2}K	0.45 W/m^{2}K	€ 40/m^2	€ 10.712,00
2	Roof Insulation	3.6 W/m^{2}K	0.40 W/m^{2}K	€ 45/m^2	€ 19.485,00
3	Replacing old lightbulbs with LED lighting	13.5 W/m^2	4.5 W/m^2	€ 3.75/m^2	€ 1.425,00
				Total Investment Cost	**€ 31.622,00**
4	PV virtual metering			€ 0.10/kWh	€ 2,087.00/year
				Total Annual operational costs	**€ 2,087.00/year**

Table 14: Energy Balance of the 1st Kindergarten building for the existing (base case) and the proposed case (Retrofit)

	Base Case			Retrofit		
	Energy Load (kWh)	Fuel consumption (kWh)	Fuel type	Energy Load (kWh)	Fuel consumption (kWh)	Fuel type
Consumption						
Heating	107,653	23,923	Electricity	43,466	9,659	Electricity
Cooling	54,670	12,149	Electricity	29,318	6,515	Electricity
Electrical (lights, appliances)	6,176	6,176	Electricity	3,679	3,679	Electricity
DHW	833	833	Electricity	833	833	Electricity
Total consumption		43,081	Electricity		20,686	Electricity

Production						
PV virtual metering		-	-		20,870	Electricity
Balance		**43,081**	**Electricity**		**-184**	**Electricity**
Emissions		**37,093**	**Kg CO_2**		**-158**	**Kg CO_2**

Total investment costs were €31.622,00 whilst the annual operational costs post retrofit was €2,087.00 i.e., the investment resulted in annual savings of € 2,221.10 compared to an annual operational cost prior to retrofit of €4,380.10. Considering a project lifetime of 30 years, inflation rate of 1% and a 3% annual increase of fuel costs the financial indicators were as follows:

- Simple Payback period = 14.1 years
- Net Present Value, NPV = €29,793.00
- Internal Rate of return, IRR = 10.50%

2nd Kindergarten of Alexandroupolis building

The 2nd Kindergarten building was constructed in late 1980's and has a total area of 918.23m^2. The building envelope comprises bearing structure of reinforced concrete thermally insulated (5cm of extruded polystyrene), full fill cavity external walls (5cm extruded polystyrene), uninsulated slab on grade floor and uninsulated ceiling and double-glazed windows with aluminium frame (w/o thermal break and low emissivity coating). Heating and cooling are provided by an Air-Source Heat Pump while a 5kWp PV system installed on the roof delivers part of the building's electricity consumption.

Proposed retrofit interventions

In order to achieve positive energy performance, it was sought first to minimize the heating, cooling and electricity loads. The remaining energy needs were then met with renewable energy through the use of suitable energy systems. As heating and cooling was provided by the ASHP, all energy requirements of the building were in the form of electrical energy. A summary of the technical performance and the cost of the proposed measures is shown in Table 15. The energy balance for the building before and after the energy upgrade measures is shown in Table 16.

Table 15: Summary of technical and cost parameters of the proposed measures for the 2nd Kindergarten building

		Technical Performance		Costing	
	Measure	**Pre-retrofit**	**Post-retrofit**	**Unit cost**	**Total cost**
1	External Wall Insulation	1.65 W/m^{2}K	0.35 W/m^{2}K	€ 45/m^2	€ 24.660,00
2	Roof Insulation	0.65 W/m^{2}K	0.40 W/m^{2}K	€ 45/m^2	€ 34.053,75
3	Replacing old windows with energy efficient ones	4.20 W/m^{2}K	1.50 W/m^{2}K	€ 250/m^2	€ 57,180.00
4	Replacing old lightbulbs with LED lighting	13.5 W/m^2	4.5 W/m^2	€ 3.75/m^2	€ 3.562,50
5	Roof mounted PV			€ 1,000.00/kW	€ 23.000,00
				Total Investment Cost	**€ 142.456,25**

Table 16: Energy Balance of the 2nd Kindergarten building for the existing (base case) and the proposed case (Retrofit)

	Base Case			Retrofit		
	Energy Load (kWh)	Fuel (kWh)	Fuel type	Energy Load (kWh)	Fuel (kWh)	Fuel type
Consumption						
Heating	84,536	30,191	Electricity	42,788	15,281	Electricity
Cooling	76,860	27,450	Electricity	57,278	20,456	Electricity
Electrical (lights, appliances)	11,793	11,793	Electricity	5,552	5,552	Electricity
DHW	923	923	Electricity	923	923	Electricity
Total consumption		70,357	Electricity		42,212	Electricity
Production						
PV existing (5kWp)		7,799			7,799	Electricity
PV new		-			34,420	Electricity
Total production		7,799	-		42,219	Electricity
Balance		**62,558**	**Electricity**		**-7**	**Electricity**
Emissions		**53,862**	**$KgCO_2$**		**-6**	**$KgCO_2$**

Total investment costs were €142.456,25 whilst the investment resulted in annual savings of €6,256.50 (due to post-retrofit revenues of €0.70 against annual operational costs of €6,255.80 pre-retrofit). Considering a project lifetime of 30 years, inflation rate of 1% and 3% in annual increase of fuel costs the financial indicators were as follows:

- Simple Payback period = 22.8 years
- Net Present Value, NPV = €2,853.00
- Internal Rate of return, IRR = 5.20%

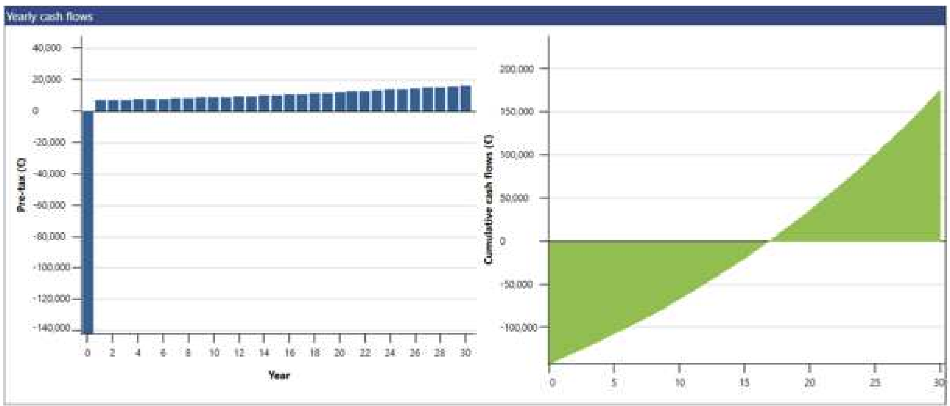

Figure 27: Annual cash flows and cumulative cash flows for the retrofit of the 2nd Kindergarten building

7th Kindergarten of Alexandroupolis building

The 7th Kindergarten building was constructed in 1980s and has a total area of 854.50 m^2. The building envelope comprises the bearing structure of reinforced concrete thermally insulated (5cm of extruded polystyrene), full fill brick cavity external walls (5cm extruded polystyrene), uninsulated slab on grade floor, uninsulated ceiling and double-glazed windows with aluminum frame (w/o thermal break and/or low emissivity coatings). Heating and cooling are provided by an Air-Source Heat Pump while a 12.5kW_p roof mounted PV system delivers part of the building's electricity consumption.

Proposed retrofit interventions

As heating and cooling is provided by the ASHP, electricity covers all the energy requirements of the building. The proposed measures therefore targeted minimizing the electricity requirements through reducing the heating and cooling loads and then supplying the remaining electrical energy from RES. A summary of the technical performance and the cost of the proposed measures is shown in Table 17. The energy balance for the building before and after the energy upgrade measures is shown in Table 18.

Table 17: Summary of technical and cost parameters of the proposed measures for the 7th Kindergarten building

		Technical Performance		Costing	
	Measure	**Pre-retrofit**	**Post-retrofit**	**Unit cost**	**Total cost**
1	External Wall Insulation	1.75 W/m²K	0.35 W/m²K	€ 45/m²	€ 22.347,00
2	Roof Insulation	0.95 W/m²K	0.40 W/m²K	€ 45/m²	€ 32.068,35
3	Replacing old windows with energy efficient ones	4.30 W/m²K	1.50 W/m²K	€ 250/m²	€ 33,992.50
4	Replacing old lightbulbs with LED lighting	13.5 W/m²	4.5 W/m²	€ 3.75/m²	€ 3.187,50
5	Roof mounted PV			€ 1,000.00/kW	€ 11.500,00
				Total Investment Cost	**€ 103.095,35**

Table 18: Energy Balance of the 7th Kindergarten building for the existing (base case) and the proposed case (Retrofit)

	Base Case			Retrofit		
	Energy Load (kWh)	Fuel consumption (kWh)	Fuel type	Energy Load (kWh)	Fuel consumption (kWh)	Fuel type
Consumption						
Heating	80,822	28,865	Electricity	39,358	14,057	Electricity
Cooling	68,798	24,571	Electricity	49,605	17,716	Electricity
Electrical (lights, appliances)	10,808	10,808	Electricity	5,223	5,223	Electricity
DHW	923	923	Electricity	923	923	Electricity
Total consumption		65,167	Electricity		37,919	Electricity
Production						
PV existing (12.5kWp)		19,902	Electricity		19,902	Electricity
PV new (4kWp)		-			17,391	Electricity

		Base Case			Retrofit	
Solar Hot Water		674	Electricity displaced		674	Electricity displaced
Total production		20,576	Electricity		37,967	Electricity
Balance		**44,591**	**Electricity**		**-48**	**Electricity**
Emmisions		**38,933**	**$KgCO_2$**		**-41**	**$KgCO_2$**

Total investment costs were €103.095,35 whilst the investment resulted in annual savings of €4,463.90 (due to post-retrofit revenues of €4.80 against annual operational costs of €4,459.10 pre-retrofit). Considering a project lifetime of 30 years, inflation rate of 1% and 3% in annual increase of fuel costs the financial indicators were as follows:

- Simple Payback period = 23.1 years
- Net Present Value, NPV = €8,388.00
- Internal Rate of return, IRR = 5.60%

1st Senior Citizen Community Centre

The 1st Senior Citizen Community Centre building has a total area of 1179.49 m^2 and was constructed in the 1980s. The building envelope comprises bearing structure of reinforced concrete thermally insulated (5cm of expanded polystyrene), full fill cavity external walls (5cm expanded polystyrene), uninsulated slab on grade floor, uninsulated ceiling (below roof) and double-glazed windows with aluminum frame (w/o thermal break and/or low emissivity coatings). Heating is provided by a biomass boiler and cooling is provided by local A/C units.

Proposed retrofit interventions

The proposed measures targeted minimizing the electricity requirements through reducing the heating and cooling loads, reducing the electrical loads with the use of energy efficient lighting and replacing old A/C units with new energy efficient ones and then supplying the remaining electrical energy from RES. The biomass boiler efficiency is also improved through pipe insulation and storage tank insulation. A summary of the technical performance and the cost of the proposed measures is shown in Table 19. The energy balance for the building before and after the energy upgrade measures is shown in Table 20.

Table 19: Summary of technical and cost parameters of the proposed measures for the 1st Senior Citizen Community Centre

		Technical Performance		Costing	
	Measure	**Pre-retrofit**	**Post-retrofit**	**Unit cost**	**Total cost**
1	External Wall Insulation	0.70 W/m^{2}K	0.35 W/m^{2}K	€ 45/m^2	€ 32,805.00
2	Roof Insulation	1.0 W/m^{2}K	0.40 W/m^{2}K	€ 45/m^2	€ 53,100.00
3	Replacing old windows with energy efficient ones	4.20 W/m^{2}K	1.50 W/m^{2}K	€ 250/m^2	€ 32,629.00
4	Replacing old lightbulbs with LED lighting	13.5 W/m^2	4.5 W/m^2	€ 3.75/m^2	€ 4,425.00

5	Improving biomass boiler efficiency	Efficiency: 80%	Efficiency: 85%	-	€ 5,000.00
6	Replacing old A/C units with new ones	SEER: 2	SEER: 6	€ 800/unit	€ 10,400.00
7	Roof mounted PV	-	-	€ 1,000.00/kW	€ 21,500.00
				Total Investment Cost	**€ 159.859,00**

Table 20: Energy Balance of the 1st Senior Citizen Community Centre for the existing (base case) and the proposed case (Retrofit)

	Base Case			**Retrofit**		
	Energy Load (kWh)	Fuel consumption (kWh)	Fuel type	Energy Load (kWh)	Fuel consumption (kWh)	Fuel type
Consumption						
Heating	114,884	143,605	Biomass	95,980	95,890	Biomass
Cooling	94,292	47,145	Electricity	70,524	11,754	Electricity
Electrical (lights, appliances)	38,854	38,854	Electricity	19,473	19,473	Electricity
DHW	1,258	1,258	Electricity	1,258	1,258	Electricity
Total biomass		143,605	Biomass		95,890	Biomass
Total electricity		87,257	Electricity		32,485	Electricity
Production						
PV new		-	-		32,489	Electricity
Balance (biomass)		**143,605**	**Biomass**		**95,890**	**Biomass**
Balance (electricity)		**87,257**	**Electricity**		**-4**	**Electricity**
Emissions		**75,129**	**$kgCO_2$**		**-3**	**$kgCO_2$**

Total investment costs were €159,859.00 whilst the investment resulted in annual savings of €11,985.03 (due to post-retrofit annual operational costs of €6,548.89 against annual operational costs of €18,533.92 pre-retrofit). Considering a project lifetime of 30 years, inflation rate of 1% and 3% in annual increase of fuel costs the financial indicators were as follows:

- Simple Payback period = 13.4 years
- Net Present Value, NPV = €110,051.00
- Internal Rate of return, IRR = 11.10%

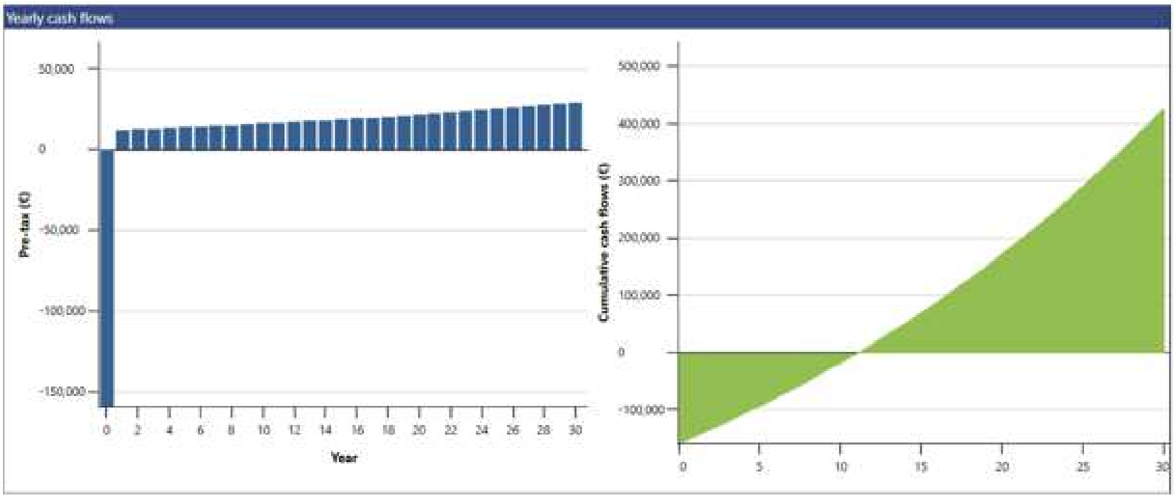

Figure 28: Annual cash flows and cumulative cash flows for the retrofit of the 1st Senior Citizen Community Centre

2nd Senior Citizen Community Centre

The construction license of the 2nd Senior Citizen Community Centre building was issued in 2009. The building has a total area of 681.55 m^2. The building envelope comprises bearing structure of reinforced concrete thermally insulated (5cm of expanded polystyrene), full fill cavity external walls (5cm expanded polystyrene), uninsulated slab on grade floor, insulated concrete ceiling (covered with roof tiles) and double-glazed windows with timber frame (w/o low emissivity coatings or inert gas between the glass panes). Heating is provided by a heating oil boiler and an auxiliary solar thermal system and cooling is provided by local A/C split units

Proposed retrofit interventions

As the building is relatively new no retrofit measures for thermally upgrading the external envelope were considered; instead retrofit interventions focused on the building systems. A summary of the technical performance and the cost of the proposed measures is shown in Table 21. The energy balance for the building before and after the energy upgrade measures is shown in Table 22.

Table 21: Summary of technical and cost parameters of the proposed measures for the 2nd Senior Citizen Community Centre

		Technical Performance		Costing	
	Measure	**Pre-retrofit**	**Post-retrofit**	**Unit cost**	**Total cost**
1	Replacement of boiler with GSHP	Efficiency: 67%	COP: 6	€ 70,000.00	€ 70,000.00
2	Replacement of A/C units with GSHP	COP: 2	SEER: 7		
3	Increase solar thermal storage capacity	-	1000 litres	-	€ 7,500.00
4	Replacing old lightbulbs with LED lighting	13.5 W/m^2	4.5 W/m^2	€ 3.75/m^2	€ 2,670.00
5	Small scale solar thermal ORC unit	-	-	€ 6,000.00/kW	€ 27,000.00

7	Roof mounted PV	-	-	€ 1,000.00/kW	€ 21.500,00
				Total Investment Cost	**€ 128.670,00**

Table 22: Energy Balance of the 2nd Senior Citizen Community Centre for the existing (base case) and the proposed case (Retrofit)

	Base Case			**Retrofit**		
	Energy Load (kWh)	Fuel consumption (kWh)	Fuel type	Energy Load (kWh)	Fuel consumption (kWh)	Fuel type
Consumption						
Heating	75,119	112,117	Heating oil	80,777	12,694	Electricity
Cooling	78,600	41,369	Electricity	72,564	10,366	Electricity
Electrical (lights, appliances)	30,832	30,832	Electricity	16,799	16,799	Electricity
DHW	1,258	1,258	Electricity	1,258	1,258	Electricity
Total heating oil		112,117	Heating oil		-	-
Total electricity		73,459	Electricity		41,117	Electricity
Production						
ORC unit		-	Electricity		7,884	Electricity
PV new (21.5kWp)		-	-		32,206	Electricity
SHW		1,258	Electricity displaced		1,258	Electricity displaced
Total production		1,258	Electricity		41,348	Electricity
Balance (heating oil)		**112,117**	**Heating oil**		**-**	**Heating oil**
Balance (electricity)		**72,201**	**Electricity**		**-231**	**Electricity**
Emissions		**91,764**	**Kg CO_2**		**-199**	**Kg CO_2**

Total investment costs were €128,670.00 whilst the investment resulted in annual savings of €18,723.98 (due to post-retrofit revenues of €13.69 against annual operational costs of €€18,710.29 pre-retrofit). Considering a project lifetime of 30 years, inflation rate of 1% and 3% in annual increase of fuel costs the financial indicators were as follows:

- Simple Payback period = 6.9 years
- Net Present Value, NPV = €294,549.00
- Internal Rate of return, IRR = 17.70%

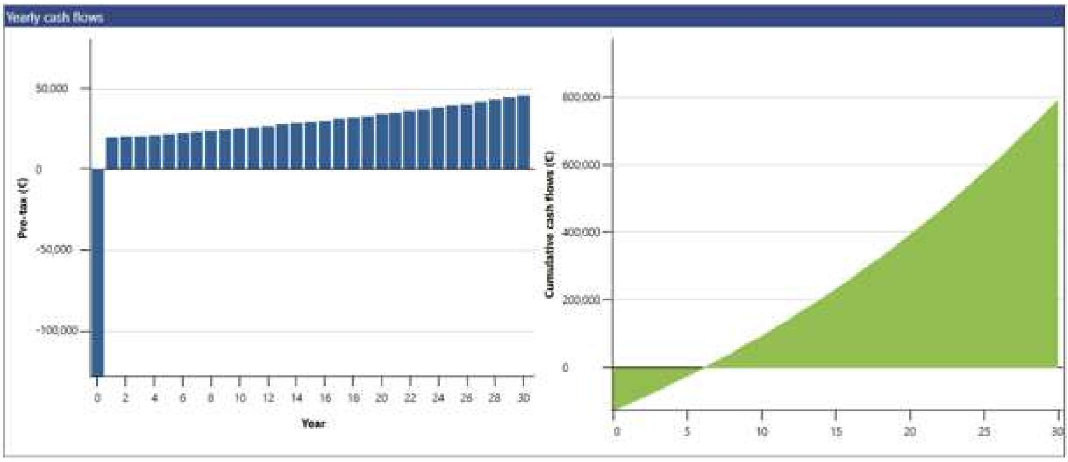

Figure 29: Annual cash flows and cumulative cash flows for the retrofit of the 2nd Senior Citizen Community Centre

Office Building (Polidinamo Centre)

The construction license of the Polidinamo Centre office building was issued in 2005. The building has a total area of 758.39 m^2. The building envelope comprises bearing structure of reinforced concrete thermally insulated (5cm of expanded polystyrene), full fill cavity external walls (5cm expanded polystyrene), uninsulated slab on grade floor, insulated concrete ceiling slab and double-glazed windows with aluminum frame with thermal break (w/o low emissivity coatings or inert gas between the glass panes). Heating is provided by a biomass boiler and cooling is provided by local A/C units.

Proposed retrofit interventions

The proposed measures targeted minimizing the electricity requirements through reducing the heating and cooling loads, reducing the electrical loads with the use of energy efficient lighting and replacing old A/C units with absorption chiller and then supplying the remaining electrical energy from RES. The biomass boiler efficiency is also improved through pipe insulation and storage tank insulation. A summary of the technical performance and the cost of the proposed measures is shown in Table 23. The energy balance for the building before and after the energy upgrade measures is shown in Table 24.

Table 23: Summary of technical and cost parameters of the proposed measures for the Polidinamo Centre building

		Technical Performance		Costing	
	Measure	**Pre-retrofit**	**Post-retrofit**	**Unit cost**	**Total cost**
1	External Wall Insulation	1.60 W/m^{2}K	0.35 W/m^{2}K	€ 45/m^2	€ 30,600.00
2	Roof Insulation	0.50 W/m^{2}K	0.40 W/m^{2}K	€ 45/m^2	€ 30,334.50
3	Replacing old windows with energy efficient ones	3.50 W/m^{2}K	1.30 W/m^{2}K	€ 250/m^2	€ 77,757.50
4	Replacing old lightbulbs with LED lighting	13.5 W/m^2	4.5 W/m^2	€ 3.75/m^2	€ 3,840.00
5	Improving biomass boiler efficiency	Efficiency	Efficiency	-	€ 5,000.00
6	Replacing A/C units with biomass absorption chiller	SEER: 2	SEER: 0.7	-	€ 100,000.00

7	Roof mounted PV	-	-	€ 1,000.00/kW	€ 5.000,00
				Total Investment Cost	**€ 252.532,00**

Table 24: Energy Balance of the Polidinamo Centre building for the existing (base case) and the proposed case (Retrofit)

	Base Case			**Retrofit**		
	Energy Load (kWh)	Fuel consumption (kWh)	Fuel type	Energy Load (kWh)	Fuel consumption (kWh)	Fuel type
Consumption						
Heating	114,884	95,650	Biomass	95,980	34,999	Biomass
Cooling	94,292	51,912	Electricity	70,524	124,575	Biomass
Electrical (lights, appliances)	38,854	30,850	Electricity	19,473	14,031	Electricity
DHW	1,258	1,258	Electricity	1,258	1,258	Electricity
Total biomass		96,448	Biomass		159,574	Biomass
Total electricity		84,020	Electricity		15,289	Electricity
Production						
PV existing (5kWp)		7,666	Electricity		7,666	Electricity
PV new (5kWp)		-	-		7,666	Electricity
Total production		7,666	Electricity		15,332	Electricity
Balance (biomass)		**95,650**	**Biomass**		**159,574**	**Biomass**
Balance (electricity)		**76,354**	**Electricity**		**-43**	**Electricity**
Emissions		**65,741**	**$KgCO_2$**		**-37**	**$KgCO_2$**

Total investment costs were €252,532.00 whilst the investment resulted in annual savings of €3,561.35 (due to annual post-retrofit cost of €10,176.52 against annual operational costs of €13,737.87 pre-retrofit). Considering a project lifetime of 30 years, inflation rate of 1% and 3% in annual increase of fuel costs the financial indicators were as follows:

- Simple Payback period = 70.9 years
- Net Present Value, NPV = - €168,093.00
- Internal Rate of return, IRR = -1.70%

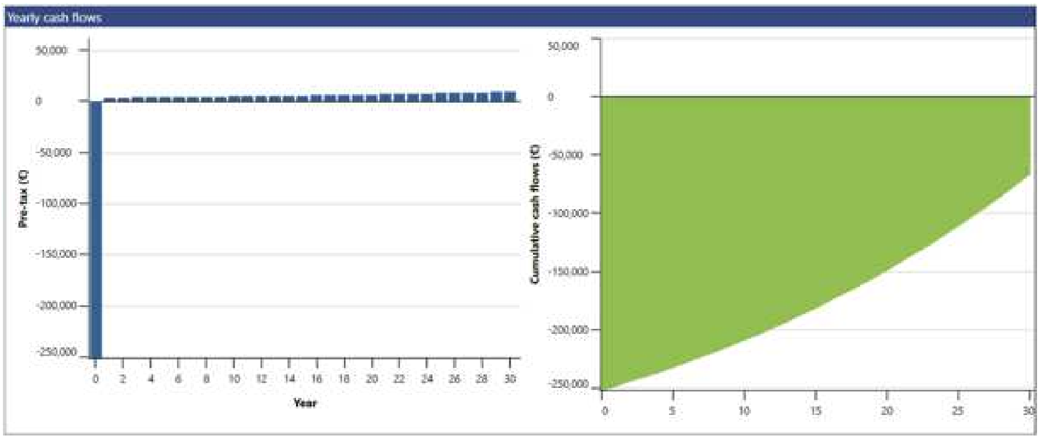

Figure 30: Annual cash flows and cumulative cash flows for the retrofit of the Polidinamo Centre building

Annex 2 – Questionnaire for bike sharing system

Introduction

This is a holistic report of the questionnaire's results for the potential installation of a bike sharing system in the city of Alexandroupolis. It is important to be mentioned that the survey launched on 10th of September and is it was available online till the 21st of September of 2020 (https://forms.gle/Nrmd31Q4FkM6f1q17), under the title "Installing a bike sharing system in the city of Alexandroupolis".

This questionnaire is part of a survey for the European IRIS Program. The partnership of the European Innovation Center for Smart Cities (EIP-SCC) aims at the cooperation of a city's actors, citizens and businesses, with the aim of improving mobility in the urban environment. The project has received funding under the European Horizon 2020 Program, from the European Union Research and Innovation Center, under the grant agreement number 774199.

Answers are anonymous, will remain completely confidential and will be used exclusively for research purposes. Respecting the regulations of the European Union GDRP, the personal data of the respondents are not stored.

Questionnaire analysis

Graphic analysis

In this section of the report, graphic representation of the results extracted from the questionnaire will be analysed.

Gender categories

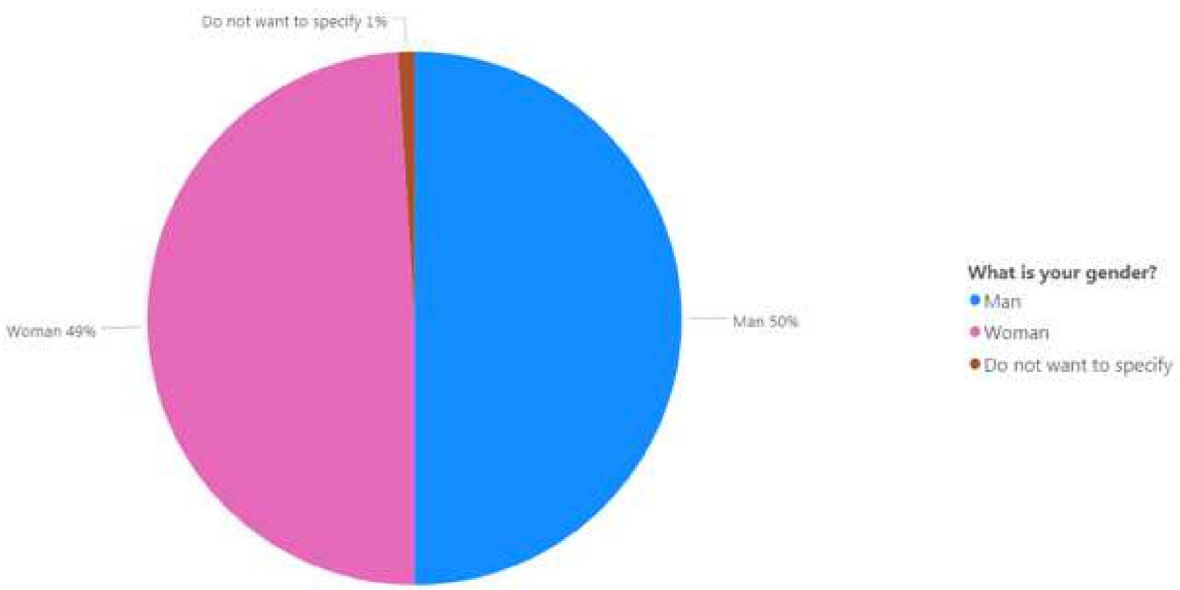

Figure 31: Gender categories

Age of the responders

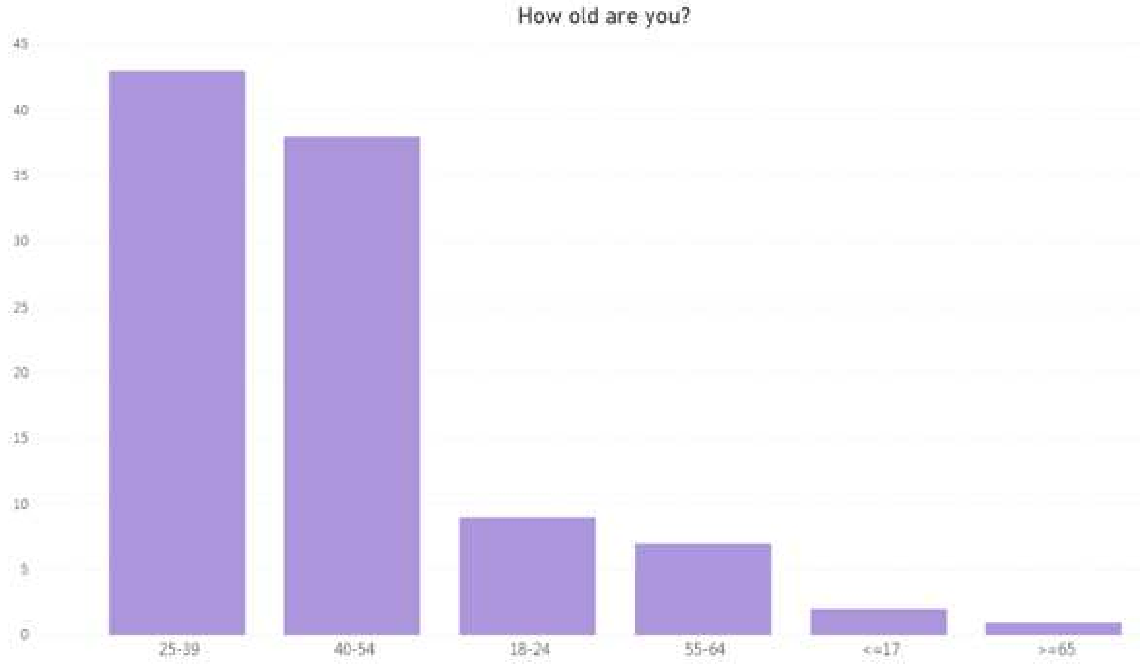

Figure 32: Age fluctuation of the responders

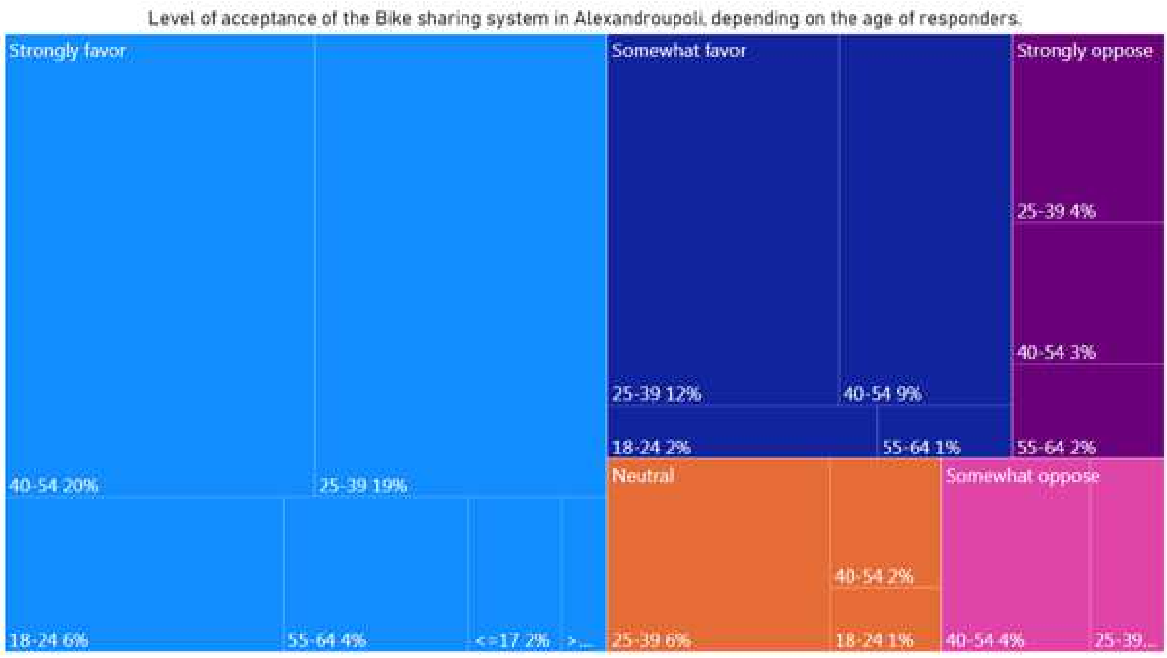

Figure 33: LoA depending on the age of the responders

The majority of the responders are less than 40 years old. People from 18 to 54 years old, mentioned that they are strongly in favour of switching their existing transport mode and start using the bike sharing system in Alexandroupoli.

Area of residence

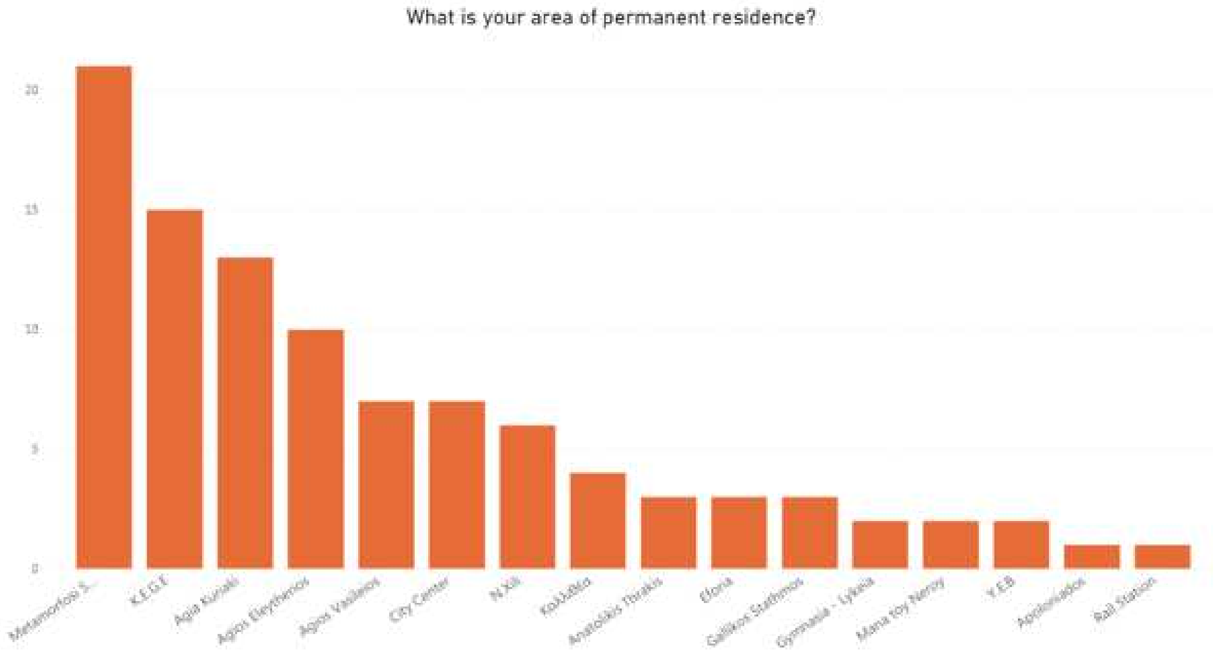

Figure 34: Permanent residence

The majority of the responders, live in the area of Metamorfoseos tou Sotiros

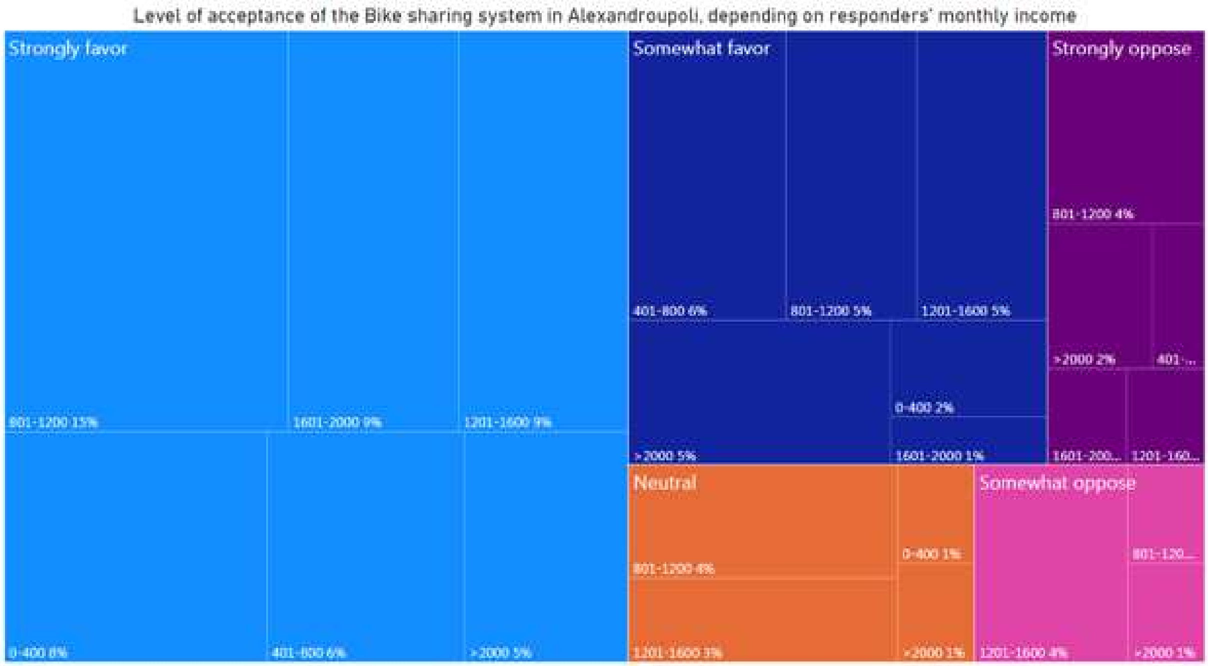

Figure 35: LoA depending on the monthly income.

People with average monthly income, in terms of country's salary, tend to accept more the BSS in contrast to people with lower monthly income, who they would not commute with the system.

Today's transport mode usage

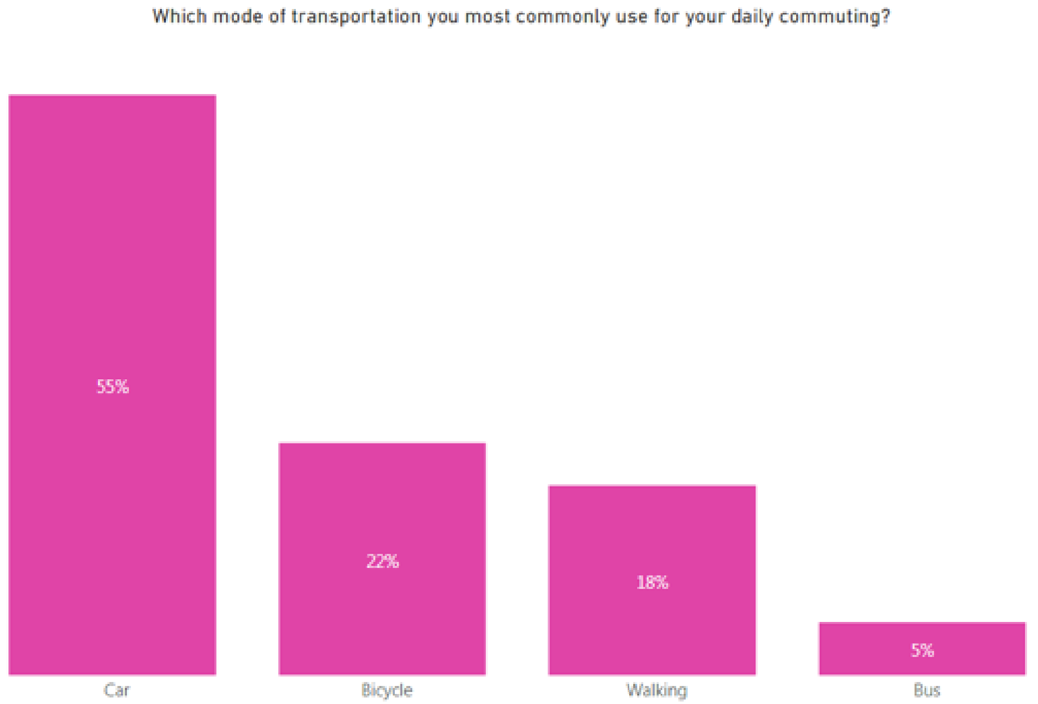

Figure 36: Transport mode fluctuation amongst responders

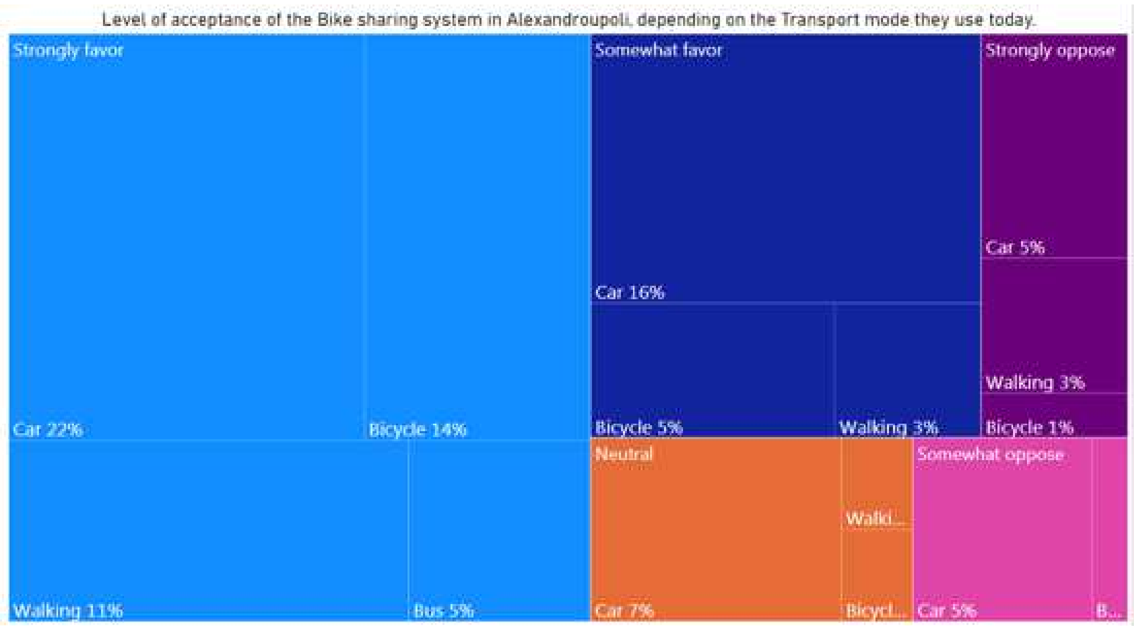

Figure 37: LoA depending on transport mode

The majority of the responders claimed that they use car for their everyday commuting. It is important to mention that 22% of those, are strongly in favour of using the bike sharing system in Alexandoupoli.

Bicycle ownership

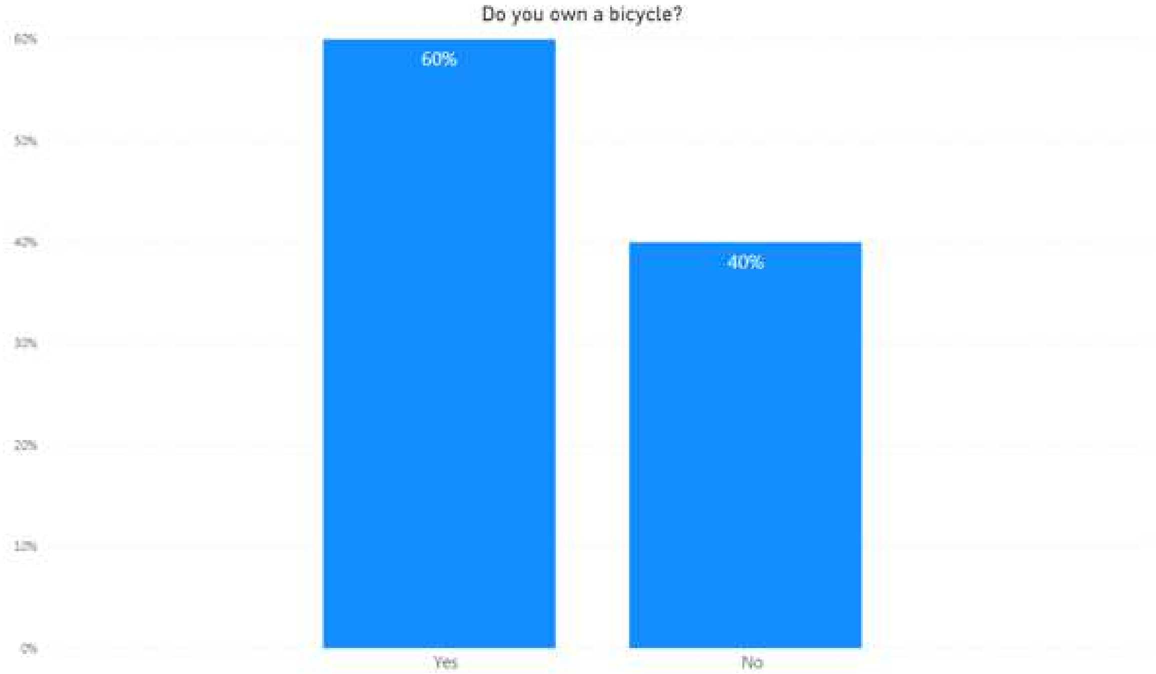

Figure 38: Bike ownership

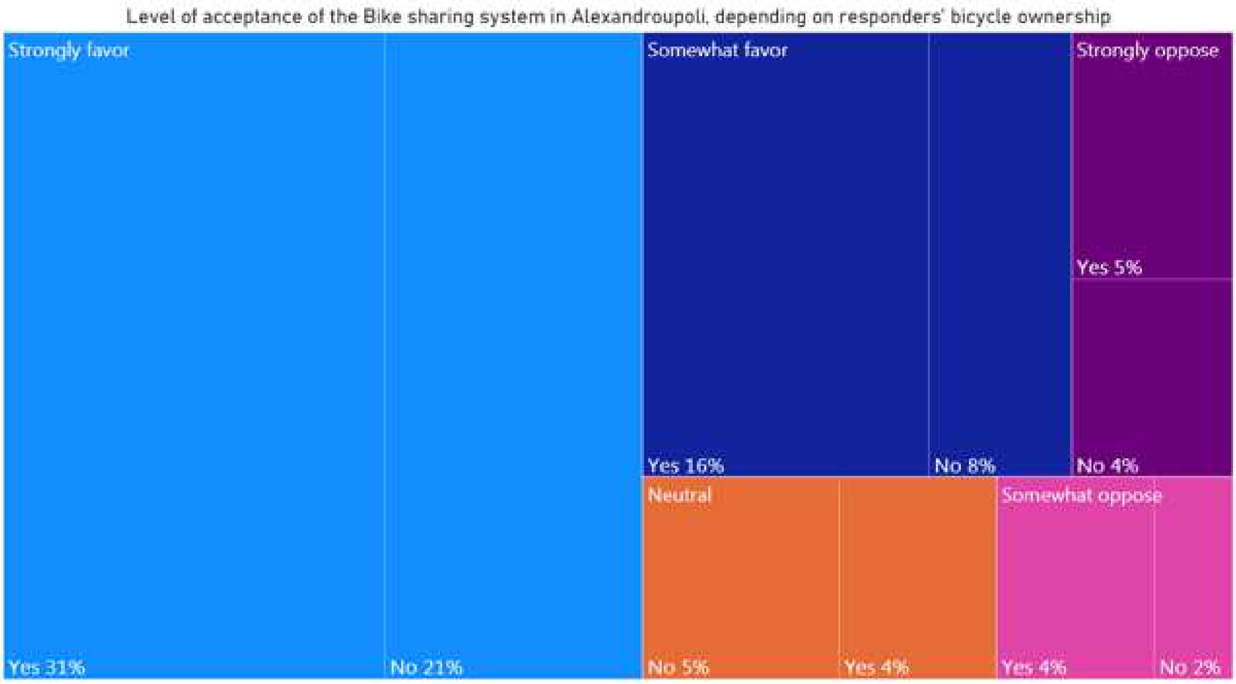

Figure 39: LoA depending on bicycle ownership

60% of the responders mentoned that they do have their own bicycle and 31% of those said that they are willing to use a bike sharing system in Alexandroupolis

Existing bicycle activity

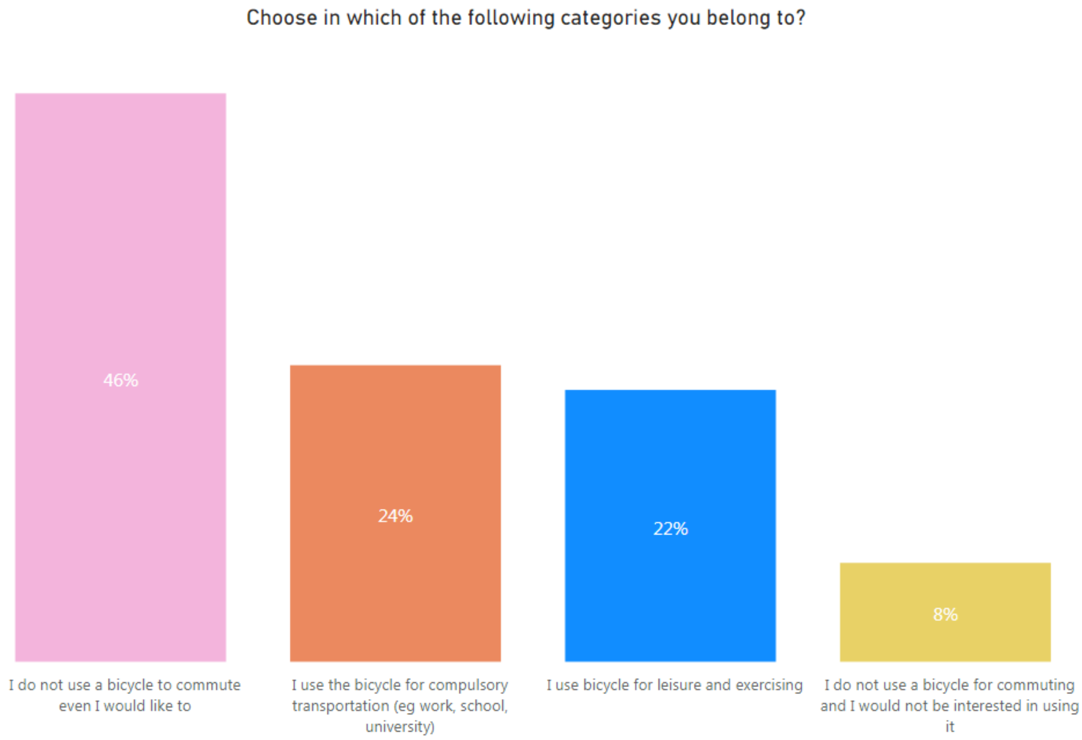

Figure 40: Categories depend on bicycle usage

46% of the people participated in the questionnaire, claimed that they are not using the bicycles today, even though they wanted to do, while 24% and 22% mentioned that they use bicycles for compulsory transportation trips and for exercising/ leisure, respectively. Only 8% responded that they do not thing of bicycles to be their main transportation mode.

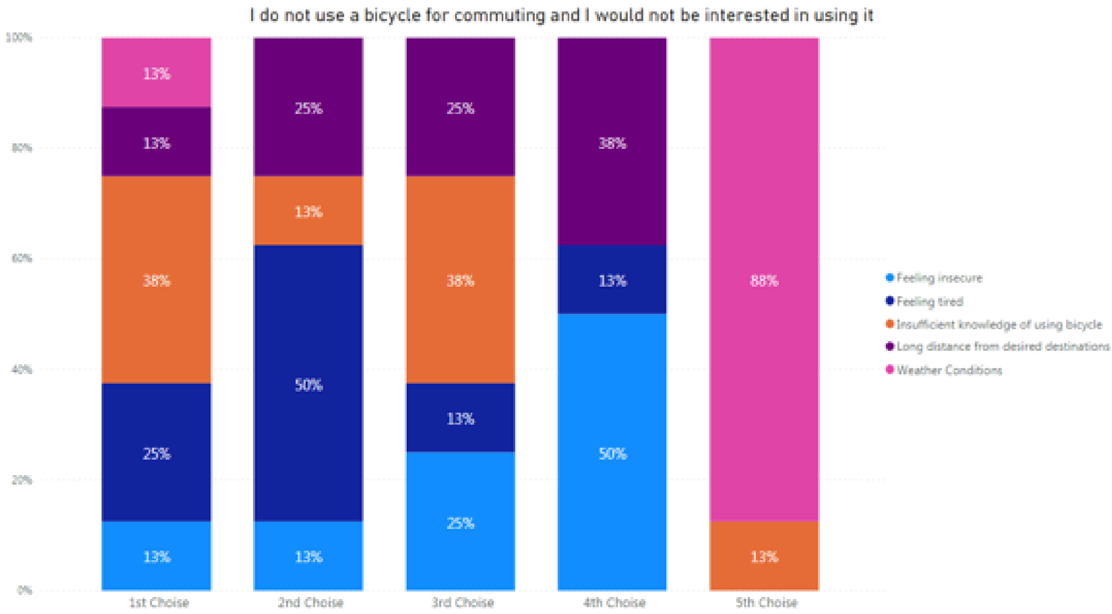

Figure 41: Graph of people not willing to use bicycles

As first choice for not using a bicycle, 38% of the responders in this category claimed that the insufficient knowledge of using a bicycle is the main reason, when 25% reported tiredness as a reason

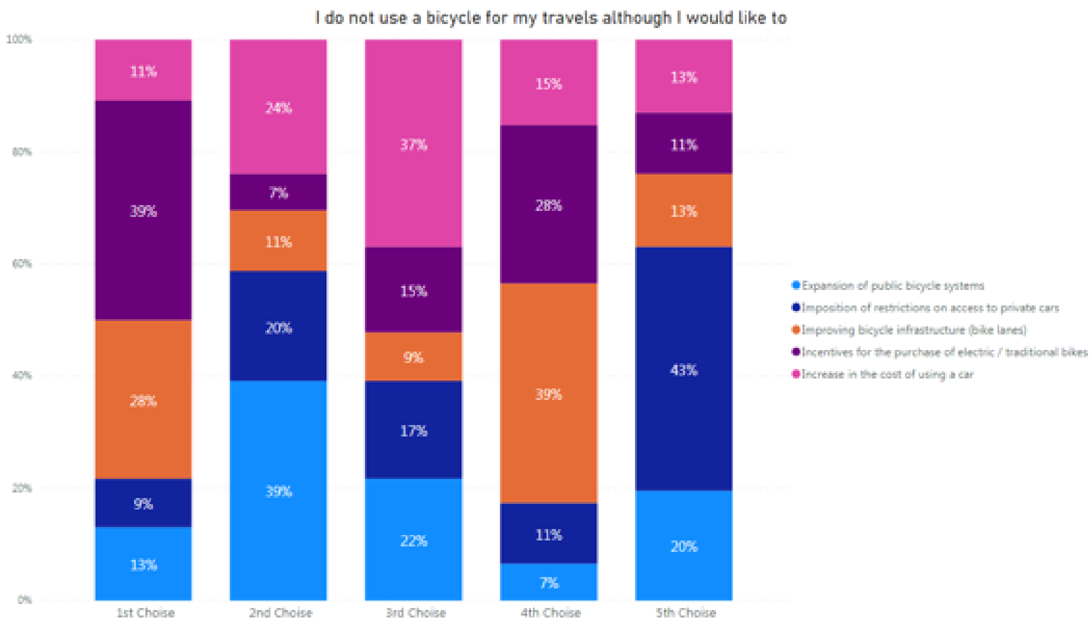

Figure 42: Graph of people willing to use bicycles

39% of the people participated in the survey, said that the lack of public electric and traditional bikes is the reason why they do not commute with bicycles, while the 28% claimed that the lack of integrated infrastructure in the city, keep them away of commuting with that mode.

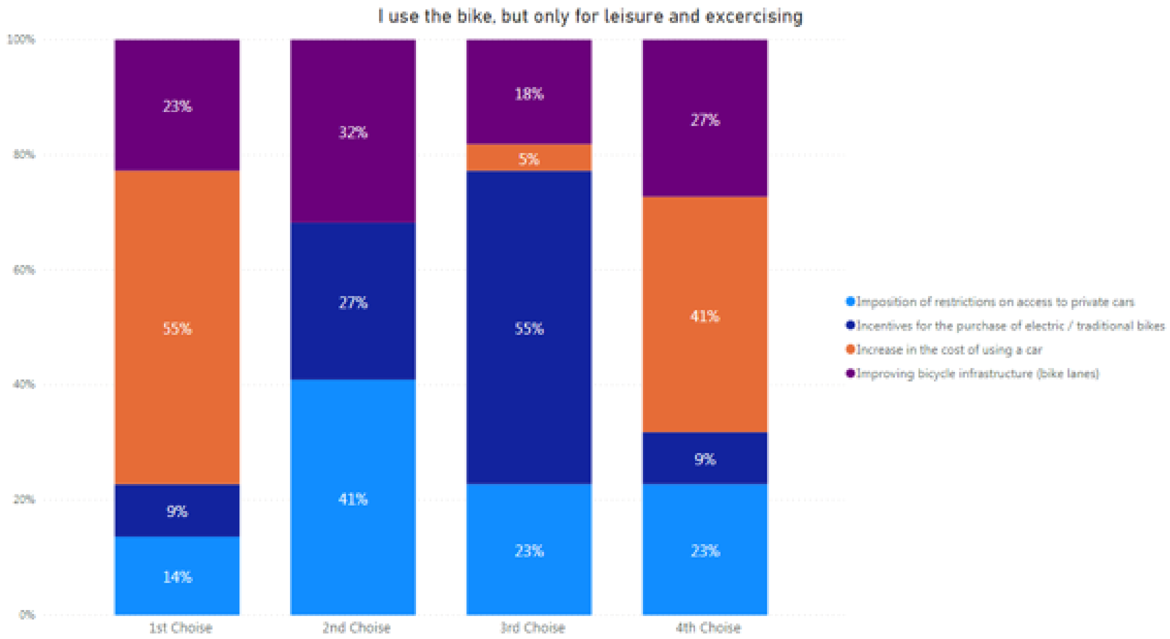

Figure 43: Graph of people using bicycles for leisure and exercise

More than the half of the responders, mentioned the increased cost of car, as the primary reason for them to start using the bicycle

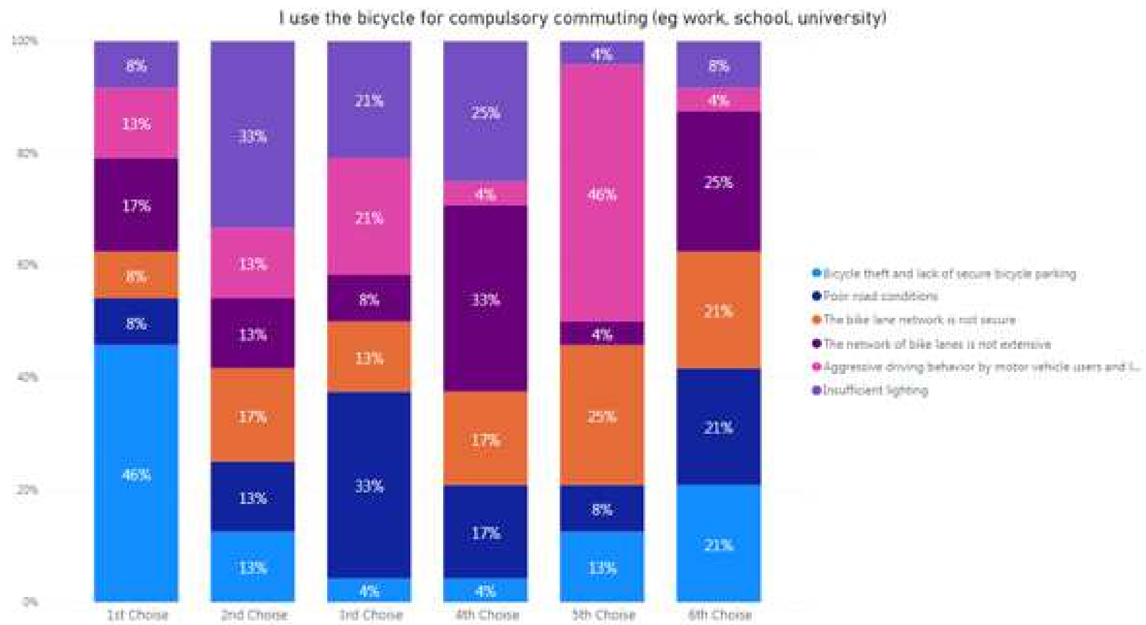

Figure 44: Graph of people using bicycles for compulsory commuting

46% of the responders, claimed that bicycle theft and lack of secure bicycle parking is the main problem of everyday users of the bicycles

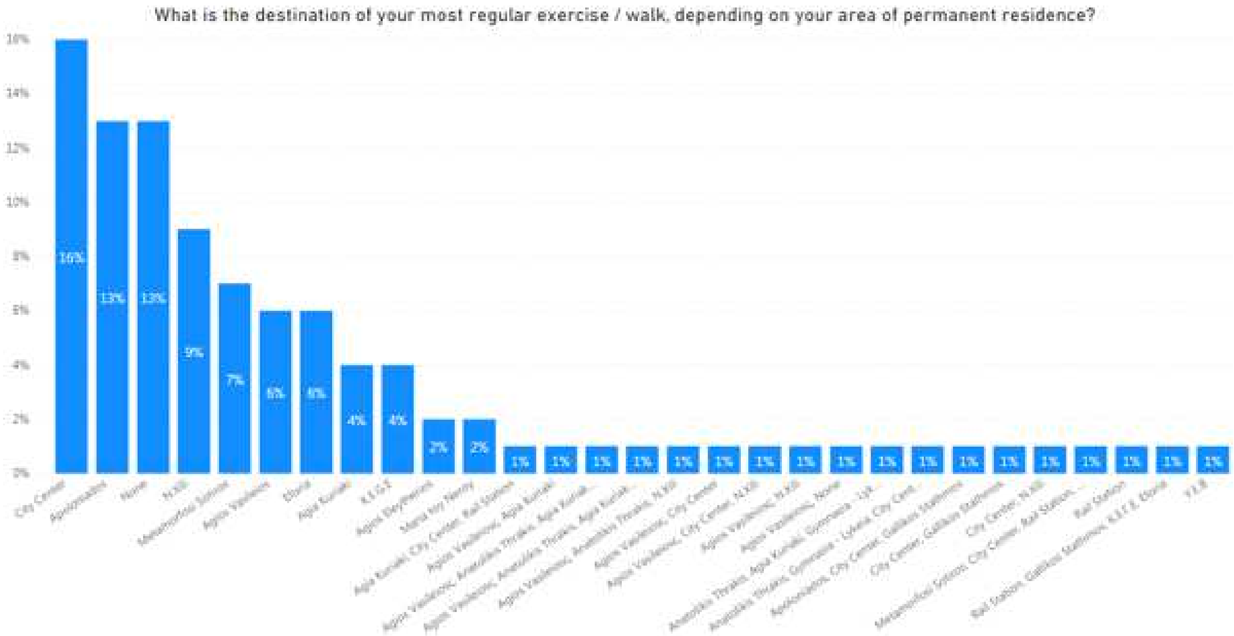

Figure 45: Most frequent destinations for exercise and walk

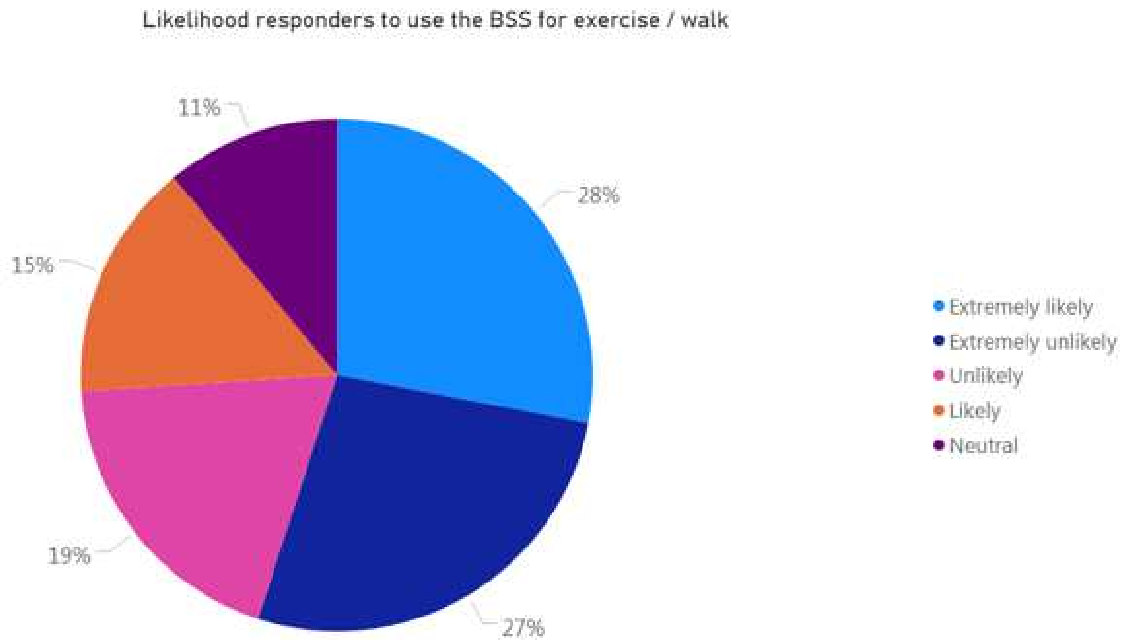

Figure 46: Likelihood to use BSS for exercise and walk

Figure 47: City Center and Apoloniados area

Most of the activities for exercise and walk are concentrated in the City Center and the area of Apoloniados. 23% of the responders answered that they will use the BSS to commute for these activities.

	Agia Kiriaki	Agios Vasilios	Metamorfosi Sotiros	Rail Station	Gymnasia Lykeia	Y.E.B	K.E.G.E	Agios Eleutherios	Cicty Center	N.Xili	Eforia	Anatolikis Thrakis	Gllikos Staymos	Mana toy nerou	Apoloniados	Kalithea	None
Agia Kiriaki	1	0	1	0	0	1	1	0	2	1	0	0	0	0	3	0	1
Agios Vasilios	0	1	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0
Metamorfosi Sotiros	0	3	2	0	0	0	0	1	4	2	3	0	0	1	1	0	2
Rail Station	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Gymnasia Lykeia	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Y.E.B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K.E.G.E	1	0	1	0	0	0	3	0	0	2	0	0	0	0	0	0	4
Agios Eleutherios	1	0	0	0	0	0	0	1	1	1	0	0	0	0	4	0	0
Cicty Center	0	1	1	0	0	0	0	0	2	0	1	0	0	0	1	0	1
N.Xili	0	0	0	1	0	0	0	0	2	1	0	0	0	0	0	0	2
Eforia	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Anatolikis Thrakis	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0
Gllikos Staymos	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Mana toy nerou	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Apoloniados	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Kalithea	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1
Total	*4*	*6*	*7*	*1*	*0*	*1*	*4*	*2*	*16*	*9*	*6*	*0*	*0*	*2*	*13*	*0*	*13*
Percentage	5%	7%	8%	1%	0%	1%	5%	2%	19%	11%	7%	0%	0%	2%	15%	0%	15%

Table 25: Distribution of responders for exercise and walking

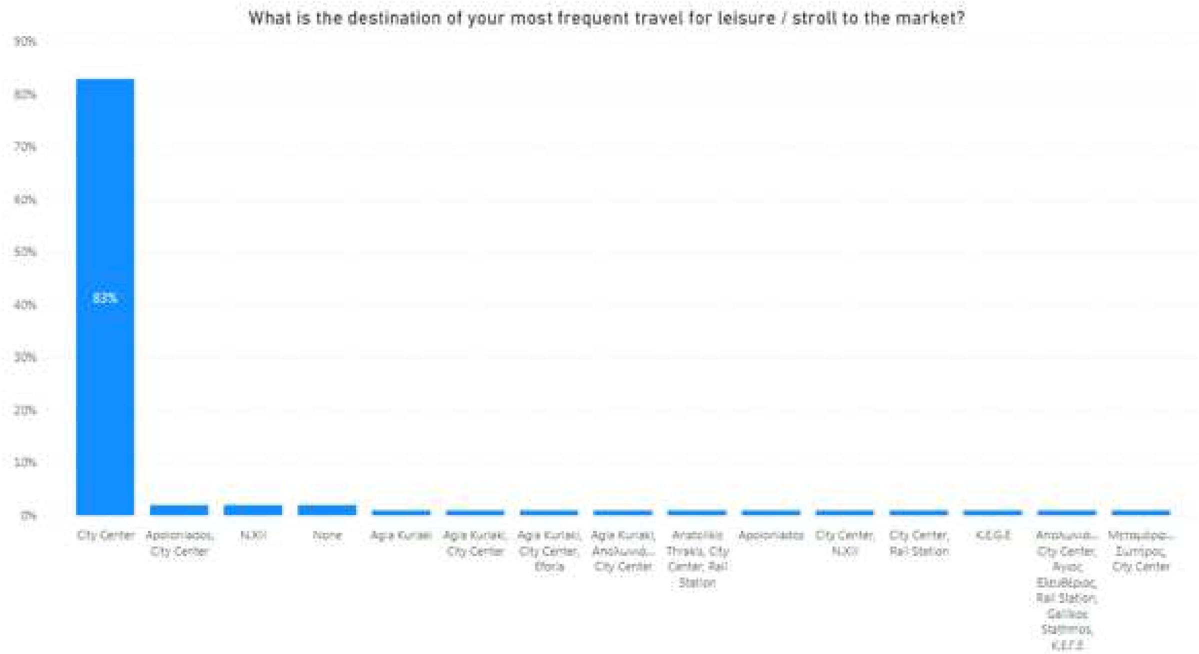

Figure 48: Most frequent destinations for leisure

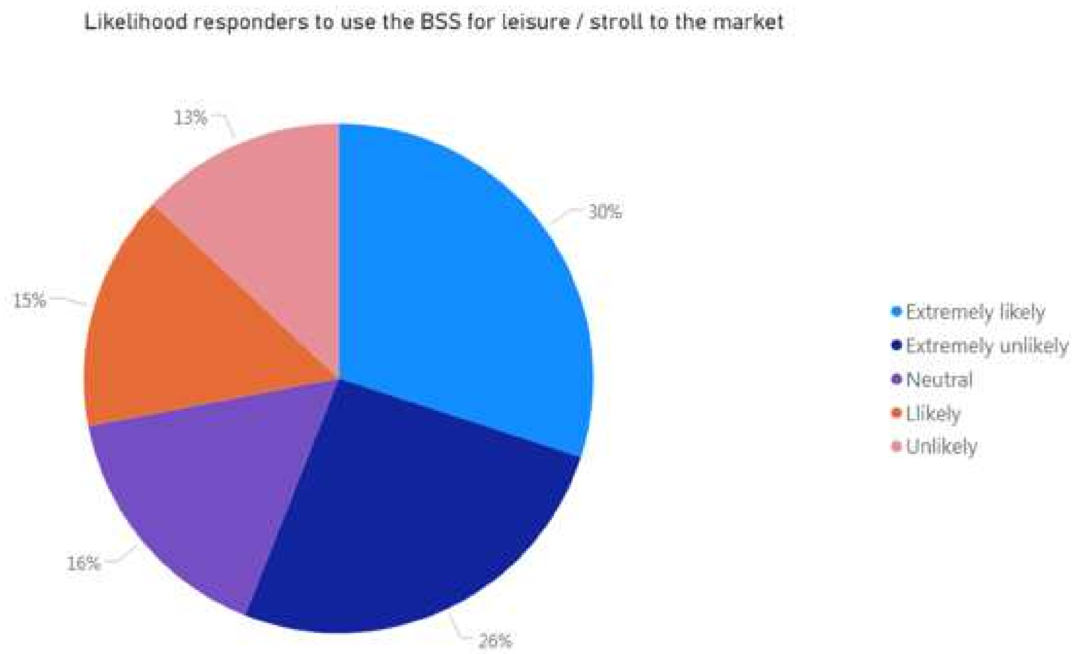

Figure 49: Likelihood to use BSS for leisure

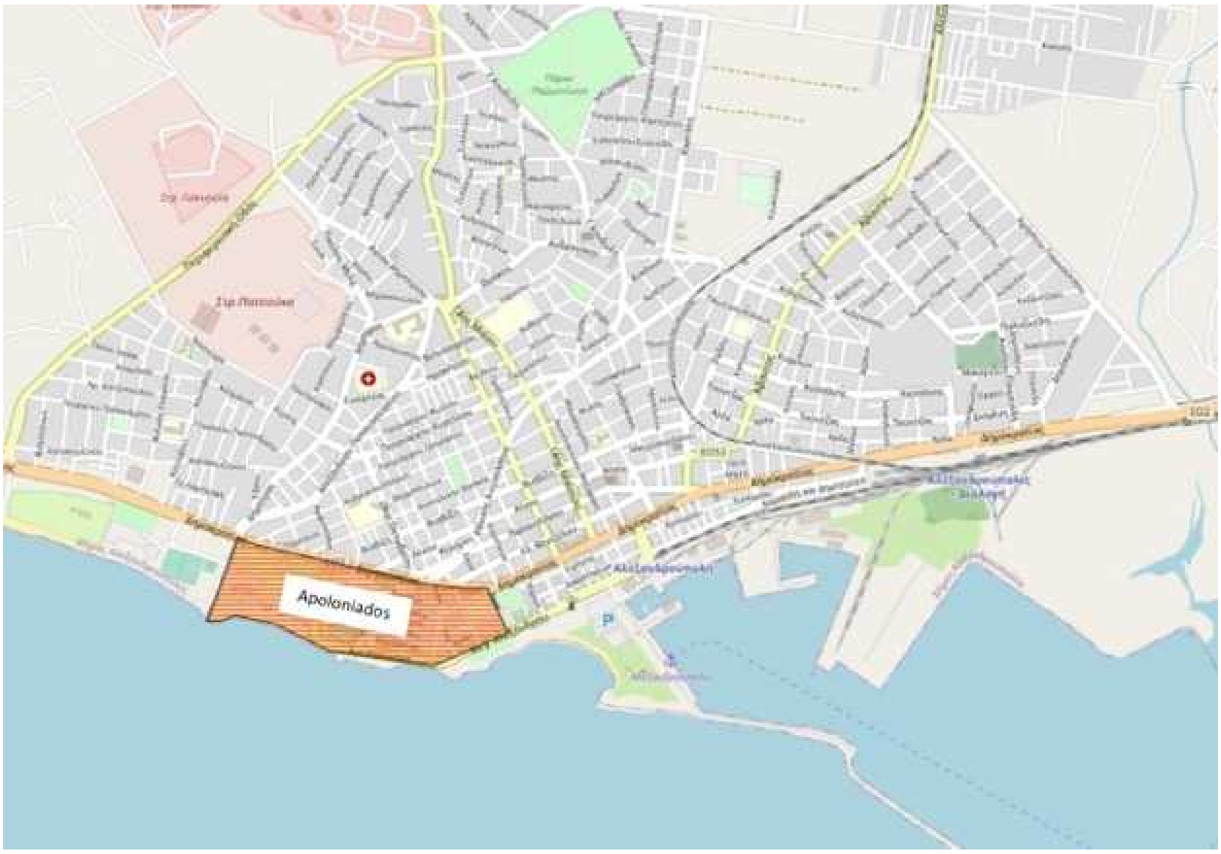

Figure 50: Apoloniados Area

83% of the people participated in the questionnaire, answered that the destinations they prefer for leisure is the city center and 35% answered that they are willing to use bikes to reach their destination

	Agia Kiriaki	Agios Vasilios	Metamorfosi Sotiros	Rail Station	Gymnasia Lykeia	Y.E.B	K.E.G.E	Agios Eleutherios	Cicty Center	N.Xili	Eforia	Anatolikis Thrakis	Gllikos Staymos	Mana toy nerou	Apoloniados	Kalithea	None
Agia Kiriaki	0	0	0	0	0	0	0	0	12	1	0	0	0	0	0	0	0
Agios Vasilios	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0
Metamorfosi Sotiros	0	0	0	0	0	0	0	0	17	0	0	0	0	0	1	0	1
Rail Station	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Gymnasia Lykeia	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Y.E.B	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
K.E.G.E	0	0	0	0	0	0	1	0	10	0	0	0	0	0	0	0	1
Agios Eleutherios	0	0	0	0	0	0	0	0	8	1	0	0	0	0	0	0	0
Cicty Center	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0
N.Xili	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0
Eforia	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Anatolikis Thrakis	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
Gllikos Staymos	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Mana toy nerou	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Apoloniados	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Kalithea	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Total	***1***	***0***	***0***	***0***	***0***	***0***	***1***	***0***	***83***	***2***	***0***	***0***	***0***	***0***	***1***	***0***	***2***
Percentage	1%	0%	0%	0%	0%	0%	1%	0%	92%	2%	0%	0%	0%	0%	1%	0%	2%

Table 26: Distribution of responders for leisure

Willingness for Bus users to switch to a BSS

As part of the questionnaire, six different scenarios were available to the users of the survey, in order to quantify their intention to switch from using bus to bikes.

Scenario 1	Travel Time	Cost	People answered	Percentage
Bus	20 min	0.80 €	0	0%
BSS	13 min	0.30 €	5	100%

Scenario 2	Travel Time	Cost	People answered	Percentage
Bus	13 min	0.80 €	1	20%
BSS	13 min	0.30 €	4	80%

Scenario 3	Travel Time	Cost	People answered	Percentage
Bus	10 min	1.00 €	0	0%
BSS	10 min	0.30 €	5	100%

Scenario 4	Travel Time	Cost	People answered	Percentage
Bus	10 min	0.80 €	3	60%
BSS	10 min	1.00 €	2	40%

Scenario 5	Travel Time	Cost	People answered	Percentage
Bus	14 min	0.80 €	0	0%
BSS	30 min	Free of charge	5	100%

Scenario 6	Travel Time	Cost	People answered	Percentage
Bus	30 min	0.80 €	0	0%
BSS	10 min	0.30 €	5	100%

Results of willingness for bus users to switch to a BSS

Each case scenario was compared to the relevant trip with bikes from a shared bike system, so that preferences of the surveyed people can be identified. The results from this part of the survey are listed below.

- The majority of users took part in the survey, claimed that pricing system is the key element to choose transport mode
- When travel time is the same for the two transport modes, users prefer the cheapest way to commute

Willingness for Private Vehicle users to switch to a BSS

As part of the questionnaire, seven different scenarios were available to the users of the survey, in order to quantify their intention to switch from using cars to bikes. For the purpose of these scenarios, different costs and travel time were calculated:

1. Cost of fuel consumption in urban mobility conditions,
2. Estimation of travel time
3. Maintenance cost of the car
4. Quantified cost of parking time

Scenario 1	Travel Time	Cost	People answered	Percentage
Private vehicle	17 min	0.26 €	33	60%
BSS	13 min	0.30 €	22	40%

Scenario 2	Travel Time	Cost	People answered	Percentage
Private vehicle	17 min	0.26 €	36	65%
BSS	17 min	0.30 €	19	35%

Scenario 3	Travel Time	Cost	People answered	Percentage
Private vehicle	10 min	1.00 €	10	18%
BSS	10 min	0.30 €	45	82%

Scenario 4	Travel Time	Cost	People answered	Percentage
Private vehicle	10 min	0.30 €	43	78%
BSS	10 min	1.00 €	12	22%

Scenario 5	Travel Time	Cost	People answered	Percentage
Private vehicle	17 min	0.26 €	9	16%
BSS	13 min	Free of charge	46	84%

Scenario 6	Travel Time	Cost	People answered	Percentage
Private vehicle	14 min	0.26 €	23	42%
BSS	30 min	Free of charge	32	58%

Scenario 7	Travel Time	Cost	People answered	Percentage
Private vehicle	30 min	0.26 €	23	42%
BSS	10 min	0.30 €	32	58%

Results of willingness for Private Vehicle users to switch to a BSS

Each case scenario was compared to the relevant trip with bikes from a shared bike system, so that preferences of the surveyed people can be identified. The results from this part of the survey are listed below.

- For trips less than a 30min, people tend to prefer the cheapest way for commuting
- When journey time is the same between the two means of transport, people choose the mean of transport with less operational cost
- When travel time is greater with cars and the cost of the service lower than the BSS, people tend to prefer the less time-consuming option

Willingness for Bike users to switch to a BSS

Half of the people using bicycles as means of transport, answered that they are very willing to use a bike sharing system in case it will be installed in Alexandroupoli, while 27% claimed that it is very likely to use BSS. On the other hand, 23% of the responders answered that probably will not use the provided service of shared bicycles in the city.

Willingness for pedestrians to switch to a BSS

77% of the pedestrians, responded that they are willing to switch from walking pattern of commuting to the BSS, while 23% claimed that the probably will not use the bike sharing system for their trips.

Results of willingness for bike and pedestrians to switch to a BSS

In this section the explanations of the people answered the questionnaire will be presented. The answers for both cycling and walking users are combined to one section, as reasons are similar in both cases.

Reasons why users answered that they will use the BSS are:

- Flexible mobility and improve multimodality
- Easy access for “pick up” and “drop off” bicycles
- Accessible, efficient, cheap and convenient
- I used to use a BSS, before moving here

While people who are not willing to use the BSS answered that reasons are:

- I have my own bicycle
- Limited cycling infrastructure in the city

Conclusions

At this part of the study, the key points derived from the questionnaire will be presented. It goes without saying that more focused analysis can be found in each section of the report, depending on the examined transport mode.

- ✓ The majority of the people participated in the questionnaire, are using cars for their everyday journeys
- ✓ Users commuting with private vehicles, tend to change their preferences and willing to use the bike sharing system

- ✓ More than half of the people participated in the survey have bicycles and more than half of the total of responders claimed that they are in favor of using a bike sharing system in Alexandroupoli
- ✓ Pricing policy of the BSS has a great impact on the feasibility of the project. As mentioned before, responders of the survey, tend to prefer the cheapest way to commute even though the travel time would be greater
- ✓ People with average (for country's income standards) monthly income, strongly believe that they would like to be part of a potential installation of a bike sharing system
- ✓ The majority of the activities in the city of Alexandroupoli are concentrated in two areas: City center and Apoloniados area.
- ✓ Half of the people participated in the questionnaire, claimed that they are willing to switch from the transport modes they use today, to the bike sharing system
- ✓ Close to half of the total of responders answered that they do not use cycling today due to the lack of infrastructure (integrated cycling network, secure docking places etc) and absence of public electric / conventional bicycles

Annex 3 – Description of indicators

Payback Period

The payback period is defined in Deliverable 1.1 'Report on the list of selected KPIs for each Transition Track' as *'the time it takes to cover investment costs. It can be calculated from the number of years elapsed between the initial investment and the time at which cumulative savings offset the investment'.*

The Static Payback Period was used in the analysis, determined as:

$$EPP = \frac{EPI_{BR}}{m} \qquad (1)$$

Where,

EPI_{BR} = Energy related investment (€).
m = TAC_{after} – TAC_{before} (€/year)
TAC_{after} = Total annual costs after the energy related investment (€/year). This is the annual cost (or even revenue from electricity sales) of the retrofit measures.
TAC_{before} = Total annual costs before the energy related investment (€/year). This is the annual costs of the base case (pre-retrofit)

Net Present Value

Net Present Value (NPV) is the present value of future cash flows (inflows and outflows including the initial capital cost of the investment) over a period of time. It is commonly used to evaluate the viability of an investment, as:

- NPV > 0 suggests a profitable investment (the higher the NPV the greater the profitability) and the investment is considered acceptable.
- NPV = 0 is a neutral investment
- NPV < 0 suggests a non-profitable investment. The investment is therefore considered unacceptable

The NPV formula is as follows:

$$NPV = (\sum_{t=1}^{n} \frac{Net\ Cash\ Inflow_t}{(1+i)^t}) - Initial\ Investment \qquad (2)$$

Where,

t = time (years)
i = discount rate
n = number of years

Internal Rate of Return

Internal Rate of Return is the minimum discount rate that is considered acceptable so that an investment is profitable. The IRR for a specific project is the discount rate that makes the NPV of all future cash inflows equal to zero.

Degree of Energetic Self-Supply

The Degree of Energetic Self-Supply by RES (DE) is defined in Deliverable 1.1 'Report on the list of selected KPIs for each Transition Track' as the '*ratio of locally produced energy from RES and the energy consumption over a period of time (e.g., month, year). DE is separately determined for thermal (heating or cooling) energy and electricity*'.

$$DE_T = \frac{LPE_T}{TE_C} \tag{3}$$

Where,

DE_T = Degree of thermal energy self-supply based on RES
LPE_T = Locally produced thermal energy (kWh/month or kWh/year)
TE_C = Thermal energy consumption (kWh/month or kWh/year)

$$DE_E = \frac{LPE_E}{EE_C} \tag{4}$$

Where,

DE_E = Degree of electrical energy self-supply based on RES
LPE_E = Locally produced electrical energy (kWh/month or kWh/year)
EE_C = Electrical energy consumption (kWh/month or kWh/year)

Emissions Reduction

The CO_2 emissions reduction is defined as the amount of CO_2 emitted post retrofit less the CO_2 emitted in the base case (pre-retrofit).

$$EM_R = EM_{PR} - EM_{BC} \tag{5}$$

Where,

EM_R = CO_2 emissions reduction from the retrofit measures
EM_{PR} = CO_2 emissions post retrofit
EM_{BC} = CO2 emissions from the base case (pre-retrofit)

Annex 4 – Gantt charts

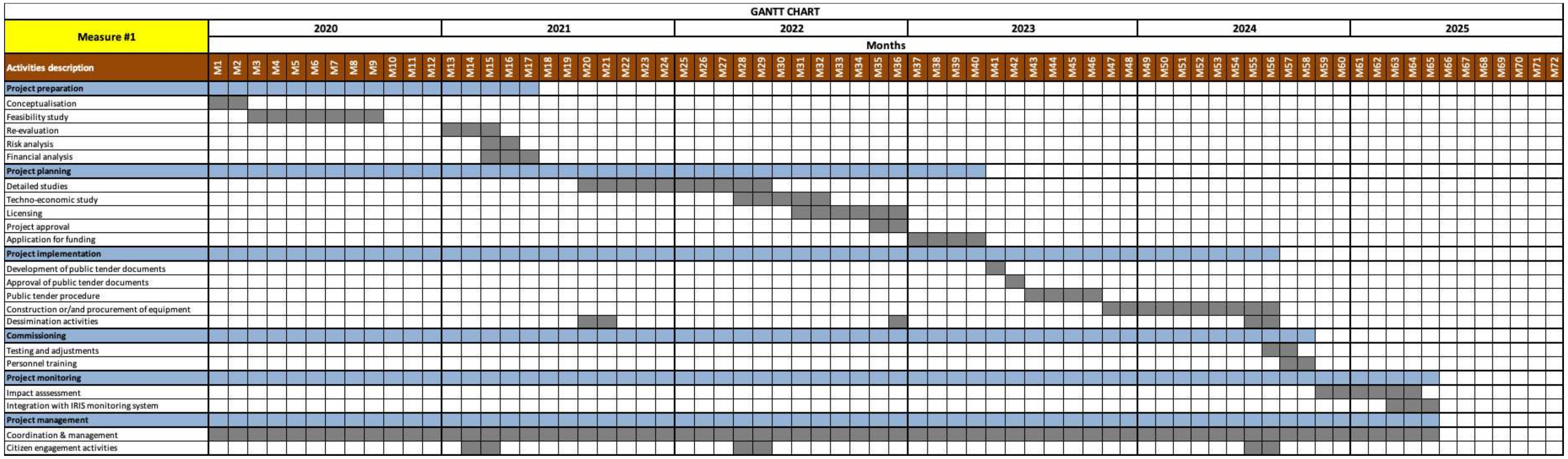

Figure 51: Gantt chart – measure #1, IS-1.1

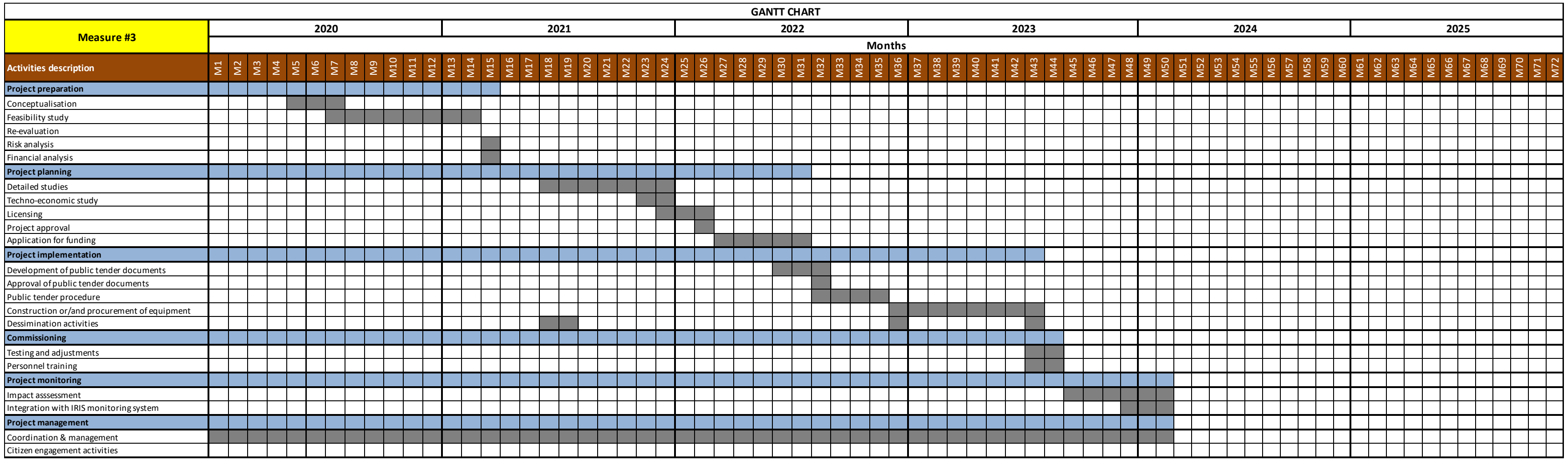

Figure 52: Gantt chart – measure #2, IS-1.1

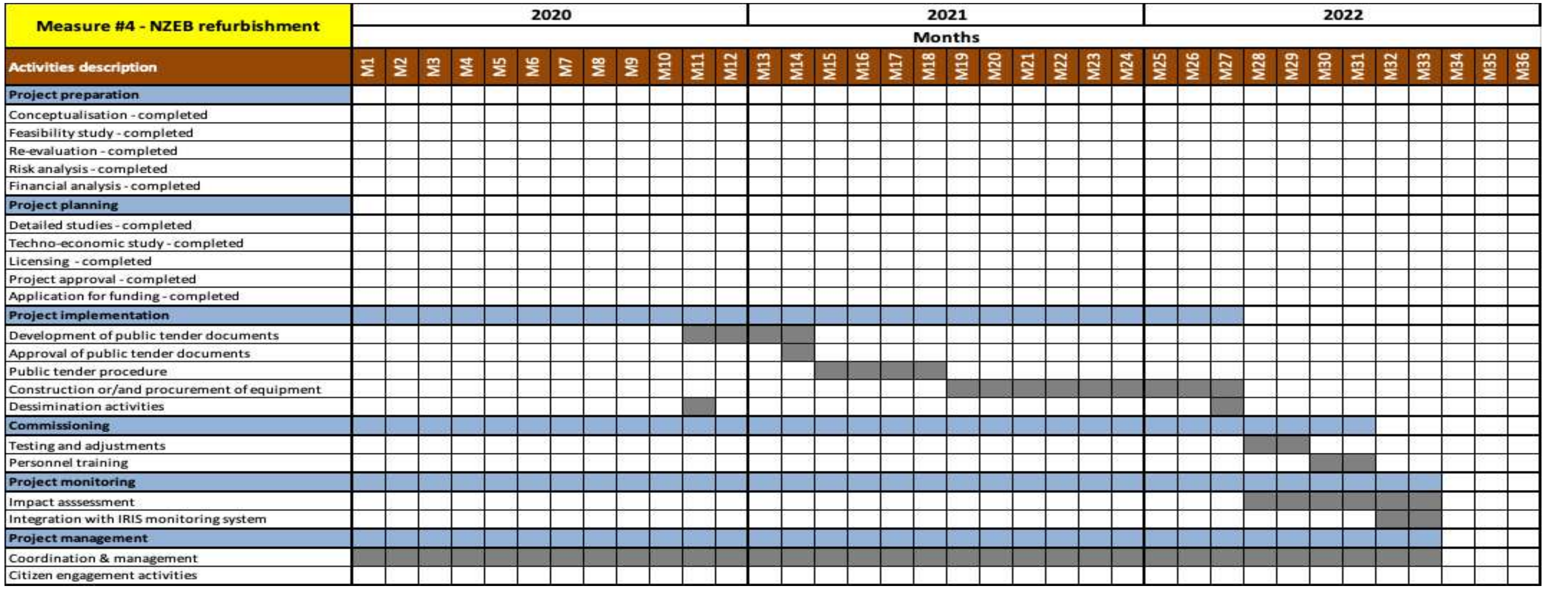

Figure 53: Gantt chart – measure #3, IS-1.1

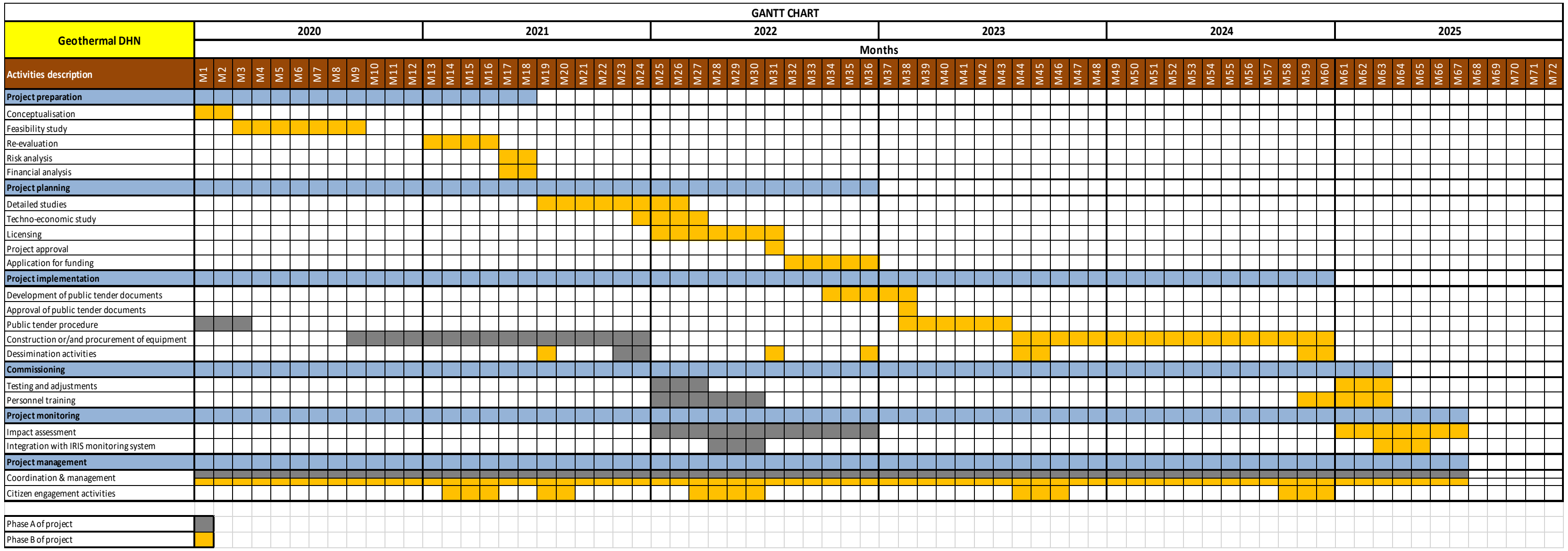

Figure 54: Gantt chart – measure #1, IS-2.2

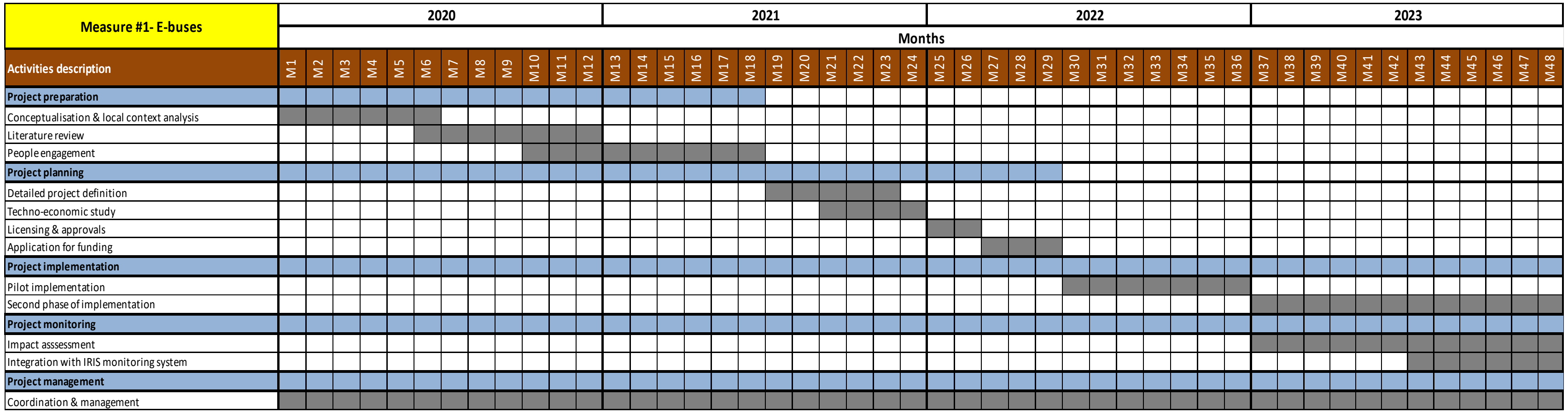

Figure 55: Gantt chart – measure #1, IS-3.1

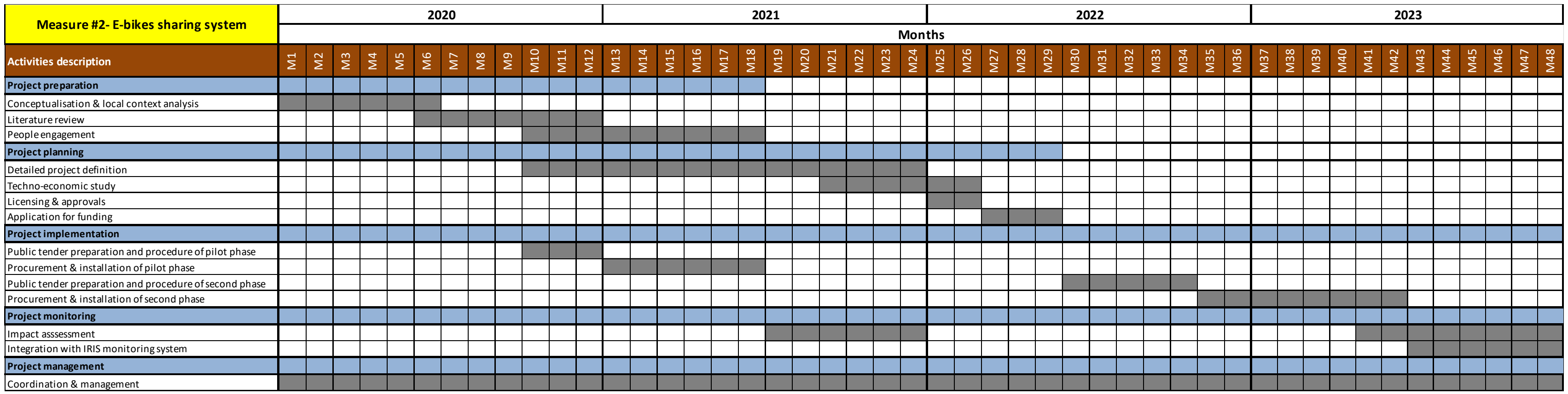

Figure 56: Gantt chart – measure #2, IS-3.2

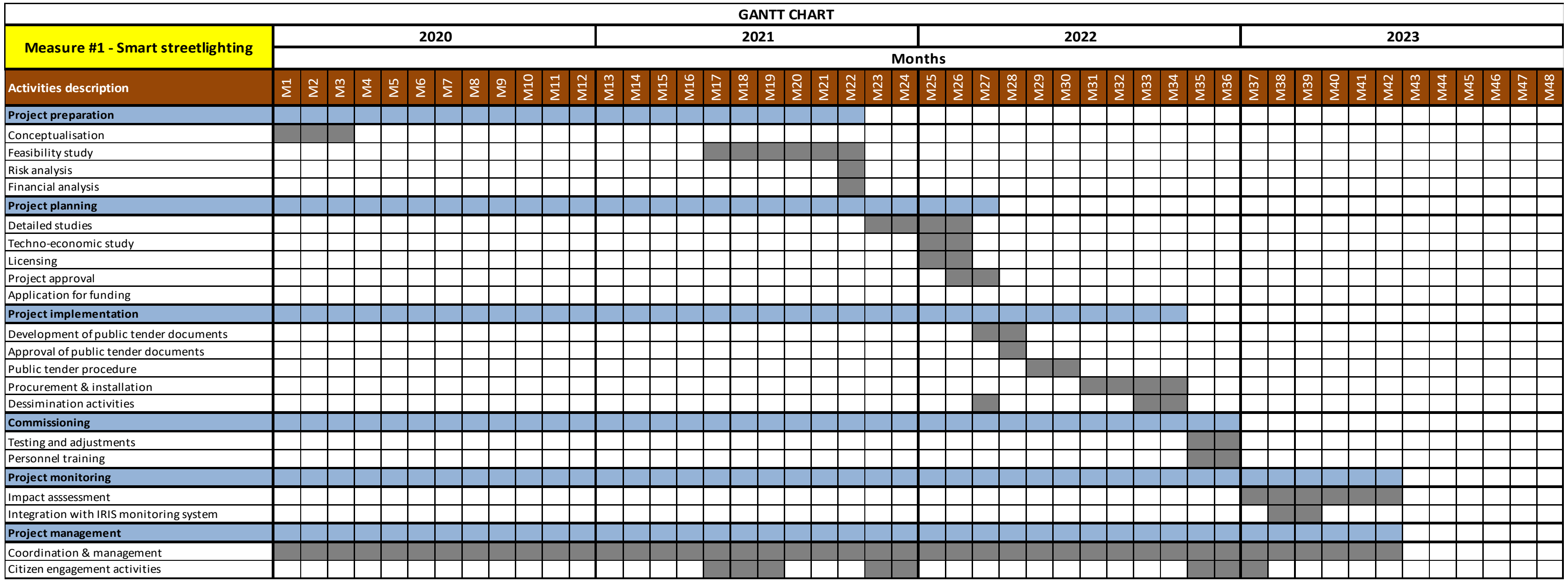

Figure 57: Gantt chart – measure #1, IS-4.1

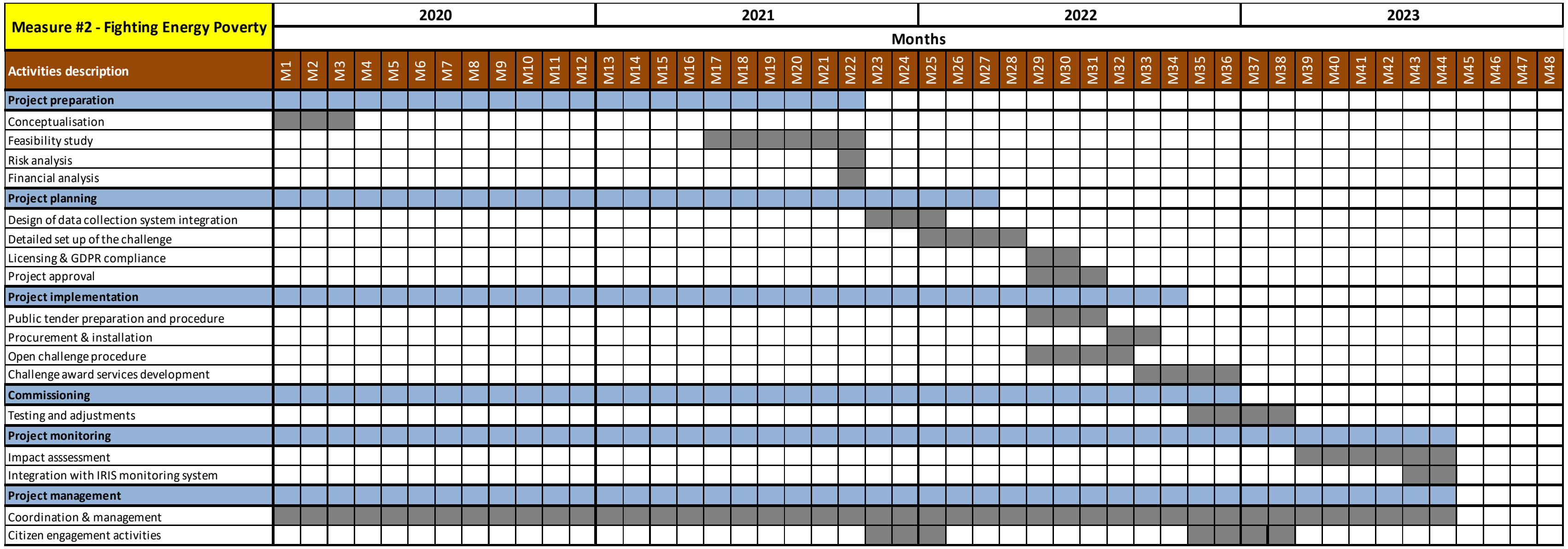

Figure 58: Gantt chart – measure #2, IS-4.2

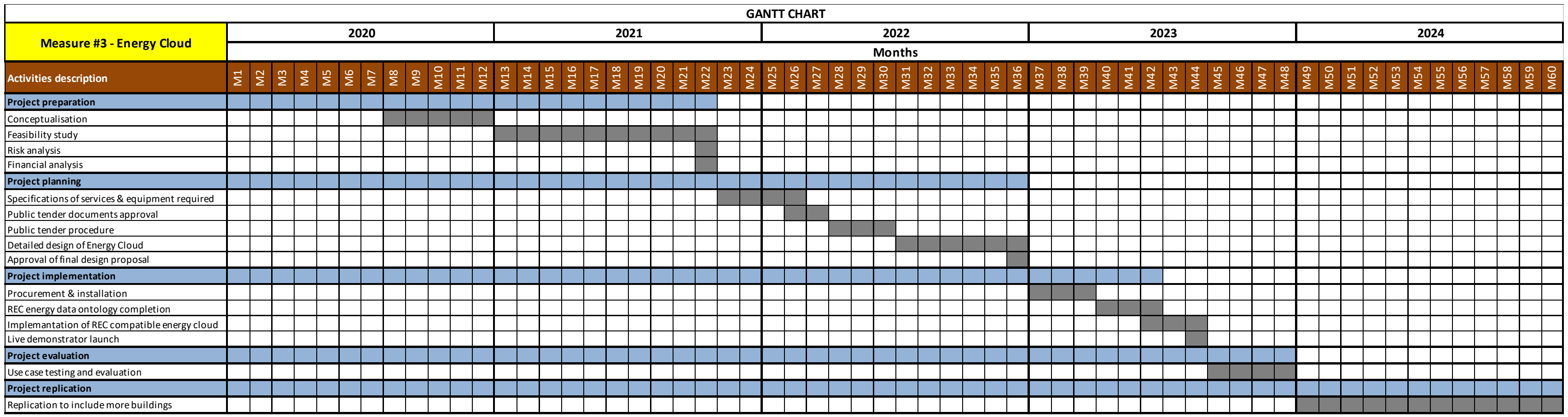

Figure 59: Gantt chart – measure #3, IS-4.4

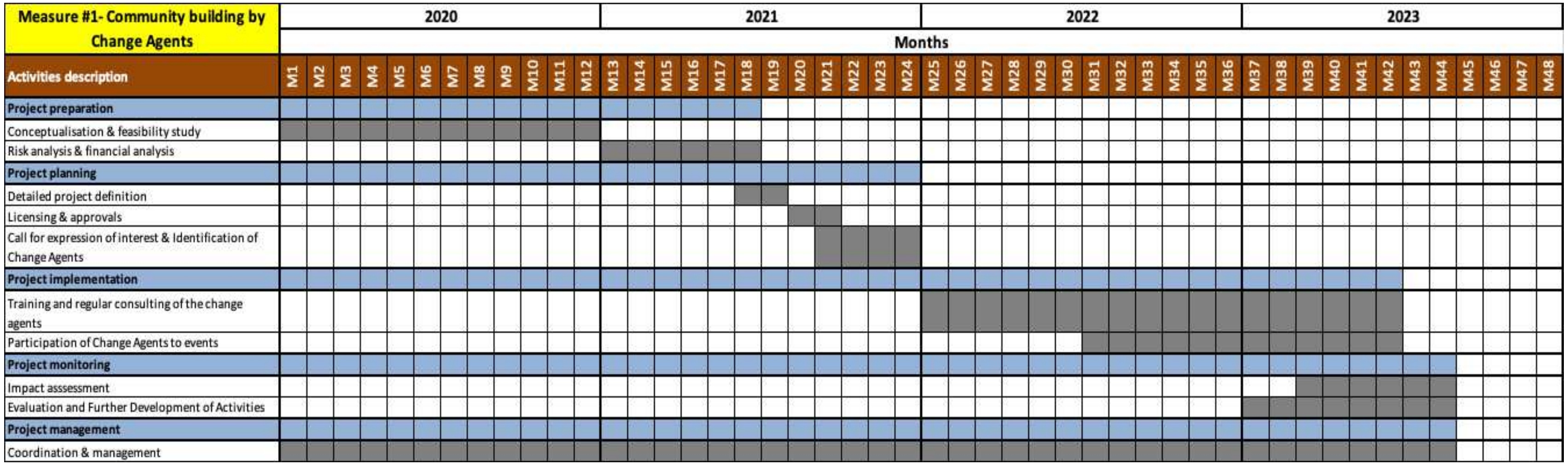

Figure 60: Gantt chart – measure #1, IS-5.1

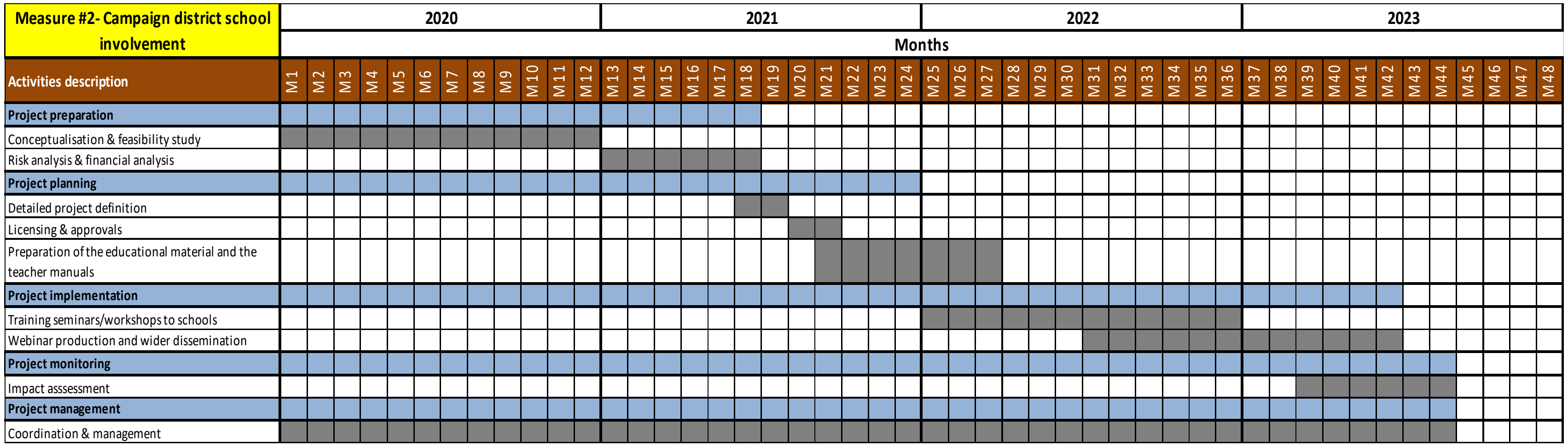

Figure 61: Gantt chart – measure #2, IS-5.1

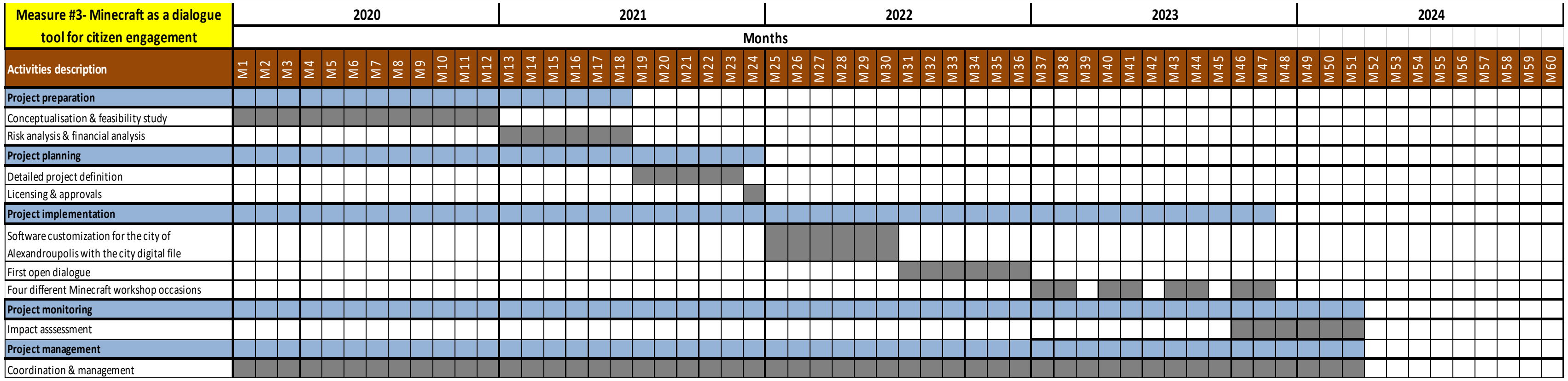

Figure 62: Gantt chart – measure #3, IS-5.4