IRIS

Integrated and Replicable Solutions for Co-Creation in Sustainable Cities

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Disclaimer

Preface

The city of Alexandroupolis is a medium-sized coastal city in Greece, that administratively belongs to the Region of Eastern Macedonia and Thrace. It is of extremely strategic importance for Greece and Europe due to its geographical position since it constitutes an interconnection gate between the Mediterranean and the Asian countries, while it is considered as an emerging energy hub of Europe, due to the Transadriatic pipeline (TAP) and the under construction Floating Storage Regasification Unit (FSRU)

The municipality is committed to carbon reduction goals through its participation in Covenant of Mayors initiative and has a vision to become a sustainable, green municipality with increased usage of Renewable Energy Sources and environmentally aware citizens.

The development of urban energy and mobility local systems resilient to economic and climate change requires a continuous, laborious, and integrative effort. Recognizing the value of knowledge exchange, the municipal council initially approved the participation in IRIS project, which finally proved to be an important decision that supported the required local strategy swift from sustainable city target to sustainable and smart city target.

The IRIS project five years journey paved the way for the sustainable and smart city efforts of the city of Alexandroupolis and enhanced the already in place political and social enthusiasm towards carbon neutrality. The transition of Alexandroupolis to a sustainable and smart city is still at its infancy and there is a lot to be accomplished. Nevertheless, important projects, such as the utilisation of low-enthalpy geothermal field and the energy refurbishment of school buildings, are already under implementation, while more are expected to be implemented in the coming years.

Do not hesitate to set ambitious goals, rely on strong sectors, be flexible and perform a thorough baseline analysis are my advises toother cities. I hope this "Alexandroupolis South-Eastern Europe Implementation Guideline" will motivate and inspire you to innovative actions and activities towards carbon neutrality.

Eleni Intzepelidou-Sytmalidou
Deputy Mayor for Energy and Natural Resources
City of Alexandroupolis

Executive Summary

The Alexandroupolis South-Eastern Europe implementation guideline presented in this deliverable aims to provide information, experiences, and knowledge in order to support other cities located in this region to kick-start a journey towards smart city transition. It will act as an implementation guideline including valuable information and experiences on replication activities for smart city solutions. It is highly emphasized that the local context may significantly alter the smart city process. Climate and other disparities across EU countries influence the replicability of smart city solutions.

Based on Alexandroupolis's smart city journey, the document highlights drivers, needs, challenges and lessons learned from the participation of the city of Alexandroupolis in the IRIS smart cities project.

The information included in this deliverable may be more valuable to cities located in the South-eastern region of Europe and have similarities to Alexandroupolis, such as population, climatic conditions, market conditions, innovation status, socio-economic inequalities. The targeted audience includes decision makers, municipal employees, external experts and stakeholders, while it can be insightful for the citizens of cities located in the specific region.

- It goes without saying that the active participation in IRIS project has been extremely valuable for the formation of the smart city strategy for the city of Alexandroupolis and facilitated the transition of the city's target from sustainable city to sustainable smart city. Important lessons have been learned, such as the value of efficient and effective knowledge exchange, the need to engage municipal employees to smart city vision and the difficulties to engage citizens. The experiences of Alexandroupolis resulted in the following evidence- based and practically useful guidelines: Create a strong core local team comprising political representatives, municipal employees from different departments, local experts, and stakeholders.
- Create a baseline of the city highlighting specific need and challenges, as well as specific competences.
- Network and where possible collaborate with other cities on national and international level.
- Familiarize with smart city solutions by investigating best practices, participating in webinars and workshops, and by organizing study visits when possible.
- Join initiatives such as Covenant of Mayors and develop a Sustainable Energy and Climate Action Plan, as well as a Sustainable Urban Mobility Plan and similar action plans.
- Design and execute citizen engagement activities at the very beginning of the project.
- Prioritize the smart city interventions, selecting at first the "easiest" ones.
- Continuously map collaboration opportunities and available funding with regional and central government offices in order to prioritize measures.

The deliverable presents the knowledge and experiences gathered and gained by Alexandroupolis during the IRIS journey and thus contributes to the dissemination of the IRIS Fellow city results. It is considered an advanced summary of the Replication Plan of Alexandroupolis (Deliverable D8.6).

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List of Abbreviations and Acronyms

Abbreviation	Definition
AI	Artificial Intelligence
BESS	Battery Energy Storage
BSS	Bike Sharing System
CIP	City Information Platform
DHN	District Heating Network
EC	European Commission
EU	European Union
EV	Electric Vehicles
FC	Follower or Fellow cities
HVAC	Heating Ventilation Air Condition
ICT	Information Communication Technologies
IS	Integrated Solution
LH	Lighthouse cities
NZEB	Near Zero Energy Building
PCM	Phase Change Material

PV	Photovoltaics
RES	Renewable Energy Sources
TT	Transition Track
V2G	Vehicle to Grid
WP	Work Package

1. Introduction

IRIS is a smart city HORIZON 2020 EU funded project that was initiated in 2017. The Lighthouse (LH) cities of the project are Gothenburg (Sweden), Nice Cote d'Azur (France), and Utrecht (The Netherlands). Within the duration of the project the LH cities demonstrated the integration and implementation of innovative smart city solutions. Each LH city is supported by local stakeholders such as universities, research organization innovation agencies, local authorities and private expertise that joined forces in collaboration. The overall concept of IRIS is the Transition Strategy comprising five (5) Tracks that together provide a universal yet versatile framework to address both common and district specific challenges. Innovative energy efficient systems, flexible smart energy solutions and application, storage solutions, increased RES utilization, sustainable mobility schemes and service, city information platforms and interactive citizen engagement are included in IRIS solutions that are being demonstrated by LH cities and further replicated among the Fellow cities: Alexandroupolis (Greece), Focsani (Romania), Santa Cruz de Tenerife (Spain) and Vaasa (Finland).

The main objective of this deliverable is to support other cities located in South-eastern Europe to initiate a journey towards smart city transition. It will act as an implementation guideline including valuable information and experiences on replication activities for smart city solutions. As highlighted by the replication activities performed by Alexandroupolis, local context adaptation is key for successful implementation. Therefore, smart city solutions may significantly differ between different areas of Europe.

1.1. Structure of the deliverable

This deliverable (D8.7) 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 T8.4 "Alexandroupolis Follower City replication activities" and its Deliverable D8.6 "Replication plan of Alexandroupolis".

Chapter 2 provides an overview of the smart cities concept within IRIS project and includes information about the smart city solutions. Chapter 3 presents the smart city journey of Fellow city Alexandroupolis by highlighting drivers, needs and challenges, as well as lessons learned. It also provides a short description of the Alexandroupolis' replication projects, more information is available in public deliverable D8.6 "Replication plan of Alexandroupolis". Chapter 4 includes a set of guidelines for smart city concept implementation in South-Eastern Europe. Chapter 5 holds the conclusions.

2. Smart Cities and Alexandroupolis in the IRIS project

2.1. Why Alexandroupolis started work on smart city solutions

Half of the world's population is living in cities, and it is expected to increase even more up to 75% by 2050. In Europe, cities are currently responsible for more than 70% of the global CO_2 emissions and are home to approximately 75% of EU citizens, which is project to rise to 80% by 2050. Urbanization is a megatrend that will define the future and affect the efforts towards climate neutrality.

It goes without saying that cities and communities, will have an important role in EU's transition towards a carbon-neutral economy as they are 'a locus for innovation, they provide great opportunities for learning and networks, and they offer the possibility of achieving whole system change at local scales' [2].

Therefore, cities need to provide solutions to satisfy the growing demand for energy, resources, land use and transport, while at the same time address the need to reduce greenhouse gas emissions and promote sustainability.

In such a transiting environment, the importance of smart cities is more and more apparent, as highlighted also by the European Strategic Energy Technology Plan [3]. Smart city is a place where digital solutions are used to improve daily life of citizens and visitors. Smart is the city that has realized the technology advances to improve energy efficiency, use of resources, mobility networks, water supply and waste disposal facilities, as well as to improve heating and lighting systems. Smart is a city that provides security, support, and care to socially vulnerable groups, such as elderly and disabled.

Smart city development promotes innovative energy solutions, smart grid, and RES integration, and strives to advance sustainable transport modes. A smart city utilizes digital technologies to reach more efficient and intelligent standards to achieve carbon neutrality. A smart city strives for implementation of integrated solutions for energy efficiency, RES technologies and new mobility schemes and services.

A smart city's attractiveness for people, businesses, and capital improves the overall employment, business, and service possibilities, when social and cultural sustainability levels are functioning properly. Thus, cost reductions, higher stability and security, and enhancement of quality of life can be achieved.

2.2. Smart city concept Alexandroupolis

The smart city concept for the City of Alexandroupolis is mainly based on the previous efforts of the municipality on the energy sector. Building on the experiences of the IRIS Lighthouse cities, Alexandroupolis gained significant knowledge and "non-public" information for sustainable mobility, smart integrated energy solutions including RES utilization, as well as for digital technology solutions. The

participation of Alexandroupolis as a Fellow city in a smart city project, supported the required swift of local strategy from an aim towards sustainable city to a clear target of smart city.

Alexandroupolis is currently experiencing a rapid urbanisation process that can be considered a continuation of the rapid urbanization process that started between 2000 and 2010. The city of Alexandroupolis is the biggest city of the Region of East Macedonia and Thrace and it is considered the main economic driving force for the prefecture of Evros.

The smart city concept for the City of Alexandroupolis includes the development of a role medium-sized Greek city model, that is efficient, socially stable and has the capacity to preserve itself and adapt to continues changes. Energy transition is the main pillar of the city's smart city transformation, supported by the implementation of smart and sustainable mobility solutions and ICT solutions aiming to improve the citizens' quality of life.

The smart city concept will pave the way towards the ultimate target of Alexandroupolis for climate neutrality. The municipal authority recognizes its key role in this transformation process and aims to collaborate with stakeholders and citizens in order to pilot new solutions.

2.3. The IRIS project

The IRIS project consists 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. Each TT includes the so-called IRIS smart city solutions (IS) which have been demonstrated by the lighthouse cities and will be or being replicated by the Fellow cities. Not all solutions will be replicated due to different local context, while the ones that will be replicated need to be adapted in the local context. The Fellow cities developed a replication plan that includes the IS to be replicated. The five TT of IRIS projects and the included IS are presented below. More information about the IRIS Transition Tracks and Integrated Solutions can be found on the project's website.

Transition Track 1

Smart Renewables and Closed-loop Energy Positive Districts:

- IS-1.1 Positive energy buildings
- IS-1.2 Near zero energy retrofit district
- IS-1.3 Symbiotic waste heat networks

Transition Track 2

Smart Energy Management and Storage for Grid Flexibility:

- IS-2.1 Flexible electricity grid networks
- IS-2.2 Smart multi-sourced low temperature heat networks with innovative storage solutions
- IS-2.3 Utilizing 2nd life batteries for smart large-scale storage schemes

Transition Track 3

Smart e-Mobility Sector:

- IS-3.1 Smart solar V2G EVs charging
- IS-3.2 Innovative mobility services for the citizens

Transition Track 4

City Innovation Platform (CIP) Use Cases:

- IS-4.1 Services for urban monitoring
- IS-4.2 Services for city management and planning
- IS-4.3 Services for mobility
- IS-4.4 Services for grid flexibility

Transition Track 5

Citizen Engagement & Co-creation:

- IS-5.1 Co-creating the energy transition in your everyday environment
- IS-5.2 Participating city modelling
- IS-5.3 Living labs
- IS-5.4 Apps and interfaces for energy efficient behaviour

2.4. Smart city solutions Alexandroupolis prioritized from IRIS

Solutions that offer stable, secure, and affordable energy and mobility services for citizens and visitors of a city can be considered as smart city solutions. Among the smart city solutions already demonstrated across Europe are: energy renovation of buildings with increased RES integration along with storage solutions (deep boreholes, PCM, 2nd life batteries), intelligent sustainable mobility solutions such as solar power V2G, e-cars and e-buses, as well as digital intelligent solutions such as data driven traffic management for air quality improvement, smart lampposts, AI district heating network control, and city information platform. More information on smart city solutions can be found at the inspiring Smart Cities Marketplace of the European Commission.

IRIS project and particularly the demonstrations of the Lighthouse cities highlighted the importance of integration in terms of smart city solutions implementation. The integration of various elements is required for successful smart city transformation, as presented in figure 1 by IRIS project. A smart city concept includes the implementation of smart city measures in all sectors, namely buildings, energy grids, public lighting, mobility, RES, digital technologies, and citizens engagement. The integration of innovative technologies in the above sectors and particularly the utilization of cutting-edge digital technologies such Internet of Things facilitate the development of a smart city.

Besides integration, replicability has been recognised as an important characteristic for the smart city solutions. Replication of integrated smart city solutions is more than a direct copy of the solution and requires taking local context into consideration. Each city has specific local needs and challenges, and the smart city strategy or solution replication should be adapted to address these needs and challenges.

A working procedure for the selection of smart city solutions that was used within IRIS project and is being used for further replication projects by Alexandroupolis is presented in figure 2. As shown, the assessment of local framework conditions and potential for replication is part of the selection process and it is considered important for successful implementation.

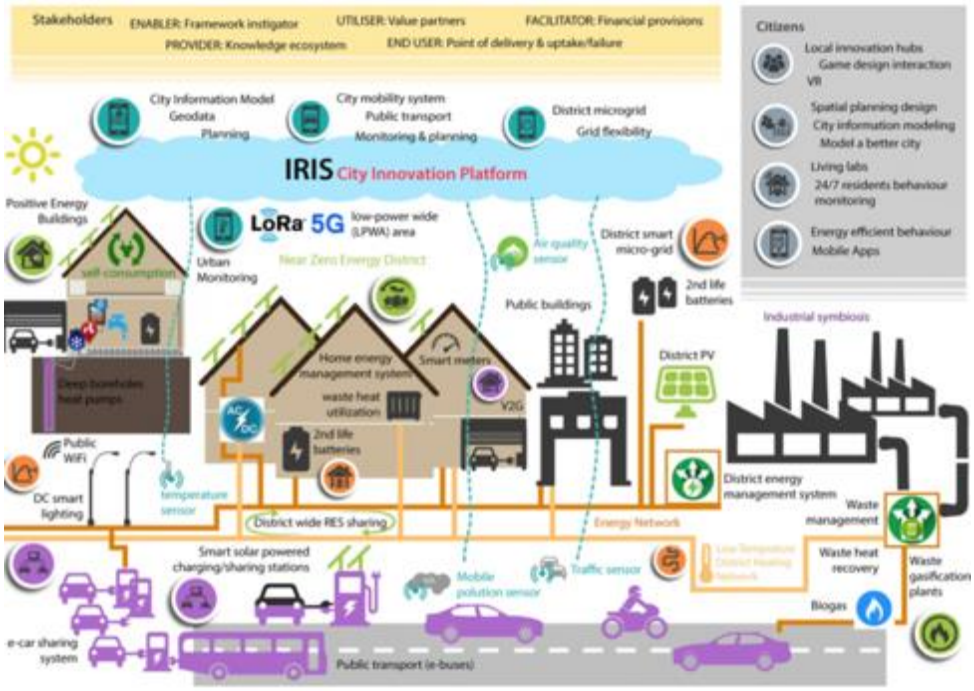

Figure 1. Integration of various elements comprising IRIS solutions (source: irissmartcities.eu)

Figure 2. Selection process followed by FC of Alexandroupolis

Identifying the most applicable actions that respond to the local reality and local challenges, Fellow city Alexandroupolis aimed to replicate IRIS integrated solutions from all transition tracks.

Table 1 indicates the solutions, LH city demonstrating, and the replication project in Alexandroupolis.

Table 1. Solutions chosen for the replication by Alexandroupolis Municipality and the demonstration LH city/cities

Transition track	Integrated solution	Measures	City, Demonstration Project and/or Organization
#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	• Utrecht & Nice
		• Measure 2: New-built positive energy neighbourhood	• Utrecht & Nice
		• Measure 3: Positive energy city hall	• Utrecht & Nice
		• Measure 4: NZEB refurbishment	• Utrecht
		• Measure 5: Retrofitting towards NZE district	• Utrecht & Nice
#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	• Nice
#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	• Utrecht & Gothenburg
		• Measure 2: E-bikes sharing system	• Utrecht
#4 City Innovation Platform (CIP)	IS-4.1: Services for Urban Monitoring IS-4.2: Services for City Management and Planning IS-4.4: Services for Grid Flexibility	• Measure 1: Smart Street Lighting with multi-sensoring	• Utrecht
		• Measure 2: Energy cloud	• Gothenburg
		• Measure 3: Fighting Energy Poverty	• Utrecht, Nice & Gothenburg

#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	• Utrecht
		• Measure 2: Campaign District School Involvement	• Utrecht
		• Measure 3: Minecraft as a dialogue tool for citizen engagement	• Gothenburg

3. Smart City Journey of Fellow City Alexandroupolis

3.1. The reasons Alexandroupolis started to work with smart city solutions

As early as in 2010, the Municipal Authority of Alexandroupolis decided to update its governance structure and create an autonomous office for energy and natural resources, assigning its supervision to a new deputy mayor with specific responsibilities for energy transition. The motivation behind this governance adaptation was the need to exploit the very important, in terms of energy, low-enthalpy geothermal field located within the administrative boarders of the municipality of Alexandroupolis. The available geothermal energy is estimated at above 30MW, while the relatively low depth of the geothermal reservoir (approx. 500m) and the high temperature of the geothermal water (99oC) offer significant techno-economic advantages for its exploitation in applications such as district heating/cooling, industrial process heat, greenhouses, etc. The municipality of Alexandroupolis has successfully managed to lease the right to explore and exploit the geothermal field and has developed the first geothermal district heating of Greece. At the same time, the autonomous office of energy and natural resources was engaged in several other energy projects and started the development of its energy transition strategy through the participation to the Covenant of Mayors initiative. It is shortly after when the municipality realized that there is need to develop a smart city concept that will support its efforts towards low carbon economy. By deep diving into smart solutions that will support the functionality of the authority in terms of economic viability and citizens' services. It will also support local growth, which is very much needed due to the economic recession that spread across Greece after 2010.

The Fellow city of Alexandroupolis joined IRIS with the ambition to prepare the ground for smooth, efficient, and innovative transition to a sustainable, green municipality. The smart city journey of the city of Alexandroupolis has been paved by the experiences of IRIS Lighthouse cities and other EU smart city projects. The five years of collaboration and co-creation within IRIS project developed a strong political and social enthusiasm to support the process and eventually reach the ultimate target of energy resilient smart city.

3.2. Needs, challenges and priorities of Alexandroupolis

The vision of Alexandroupolis is to develop a sustainable, green municipality with increased usage of RES and environmentally aware citizens. To realize this vision the municipality has recognized the main needs and challenges and through IRIS project participation has developed the main prioritizations to foster the transition towards a low-carbon and smart economy. The municipality is committed to meet the objectives of the Paris Agreement, as these have been included in the new Greek National Strategic Energy

and Climate Action Plan. Despite the long-term commitment of the municipal authority there is strong need for further actions in order to achieve increased CO_2 reduction and improve energy efficiency.

The municipality understands that the transition to a smart city is embedded in a series of life interactions and experiences, taking into consideration the ecological transformations that depend on varying politics and embedded cultures, which have coevolved with the built environment.

Therefore, the challenges encompass technological, societal, cultural, economic, and environmental aspects. Fragmented market and lack of new business models is recognized as the main challenge for Alexandroupolis. Disruptive innovation requires solid markets and new business models that are difficult to be found in regions of Greece, such as Alexandroupolis. This halters the process towards smart city. There is lack of local expertise that is required to support innovation or even replication of innovative solutions. In addition, citizen engagement is recognized as an important challenge. Inactive citizens, absence in the decision-making process and lack of confidence are the main issues that need to be addressed in order to upscale smart city innovative solutions.

Mapping the local context during the replication plan development process has been of great importance for the Alexandroupolis smart city strategy. The city chose to build on its strong competences, particularly the development of innovative energy projects, having as a flagship project the exploitation of low-enthalpy geothermal field of Antheia-Aristino for district heating of municipal and public building, social housing, and greenhouses. Taking into account the lack of personnel, the municipality of Alexandroupolis prioritized the implementation of smart city measures considering the ease of implementation both technologically and regulatory. In addition, the limitations in financial capacity of the municipality result in strong dependency on European Structural and Investment Funds or other EU funding tools, which also affects the prioritization of the smart city projects that are being promoted.

3.3. Replication projects in FC Alexandroupolis according to transition tracks

3.3.1. Transition Track 1 – Renewable and energy positive districts

Transition track #1 is focused on renewables and positive energy districts and Alexandroupolis' aim within this TT is to implement four replication projects that will integrate measures of selected IRIS solutions. The objective of the TT#1 replication projects is to increase energy performance of buildings. Through different energy refurbishment projects, the city targets to promote innovative energy renovation measures and strategies that will support the efforts in achieving the city's energy efficiency targets.

The replication projects of TT#1 are presented below in short; more details can be found in Replication Plan of Alexandroupolis (Deliverable D8.6).

- Measure 1: Retrofitting towards positive energy buildings (I.S. 1-1)

Measure 1 is about the energy refurbishment of six municipal buildings to become "energy positive". The selected buildings have already installed RES technologies such as PVs, solar thermal, air-sourced heat pumps, and ground-sourced heat pumps. Their energy condition is upgraded, and their typical energy label is C or D. These buildings constitute a suitable business to economically achieve the positive energy

target and are considered as typical public-municipal buildings offering a great replication potential in other medium-sized Greek cities. The desirable outcome is minimizing the energy and HVAC needs of the buildings while producing enough energy through RES combined. The selected buildings are:

- 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).

The selected interventions to achieve positive energy target include internal and external thermal insulation of walls and ceiling, replacement of windows, ground-source heat pumps, photovoltaics, improvements of the heating systems, smart meters/sensors and building management systems.

This measure is part of an overall effort made by the municipality to energy renovate all municipal building stock and will act as an example for promoting positive energy renovations. The lack of personnel in combination with challenges in financing and alterations in city planning and political support halted the development of this project. These 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. Measure 1 replicates technologies and services demonstrated mainly in LH Utrecht, as well as in LH Gothenburg.

- Measure 2: Positive energy city hall (I.S. 1-1)

Measure 2 is about the energy refurbishment of the city hall of Alexandroupolis. The city hall is located in the very city center and constitutes a highly visited building. 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 and has a total area of is 2,336.23 m^2. 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. The objective of this measure is to replicate the interventions that is being tested in Nice Meridia. 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.

The project maturity progressed during IRIS project duration and currently, a feasibility study and an energy performance study have been completed. The appropriate interventions to achieve the positive energy target have been selected. As it is the case in Nice, a technical challenge has been recognized on how to integrate a large-scale battery storage within the building mainly due to lack of specific fire protection guidelines. More effort is required to complete licensing of this project in order to achieve the required maturity for apply for ERDF funding.

Figure 3. City hall of Alexandroupolis (left) – thermal image of city hall (right)

- Measure 3: NZEB refurbishment (I.S. 1-2)

Measure 3 is about the energy refurbishment of the indoor gym of Alexandroupolis "Michalis Paraskevopoulos" that aims to achieve the target of near zero energy building (NZEB). The indoor gym is located close to the city center and was constructed in 1977. Although energy audit categorized the building to a D labelled building, it has a significantly low energy performance due to the uninsulated envelope and its low efficiency and old heating system. It has a total area of 1,774.58 m^2 and since it is the sole indoor gym of the city, it is extensively being used by approximately 60,000 end-users per annum. This measure is currently under implementation and the next step is to issue the tender for the construction works of the renovation activities. The increased bureaucratic procedures of the selected funding tool, as well as the lack of personnel of the municipality delayed the implementation process quite significantly.

According to the detailed design study, the proposed interventions will 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. All measures are selected specifically for this project and are partially inspired from the energy efficiency interventions demonstrated in Lighthouse cities of IRIS project. Due to the specific use of the building a direct replication or an adapted replication was not possible, therefore, the selected measures are only inspired by IRIS solutions.

- Measure 4: Retrofitting towards NZE neighborhood (I.S. 1-2)

Measure 4 is an innovative proposal to develop a near-zero energy neighborhood within the city of Alexandroupolis. Getting inspiration from the Utrecht's demonstration in Kanaleneiland-Zuid district, the city initially targeted the development of a NZE neighborhood located in the western side of Alexandroupolis. The neighborhood comprises of 95 terrace and mid-terrace houses grouped together in several blocks within a total area of approximately 22,500 m2. The houses are 1-storey buildings (each with a ground floor and a first floor) with a total heated floor area of about 73 m2 and were built in the 1970s as social housing. The project includes the replication of a number of technologies demonstrated by all IRIS Lighthouse cities and has been assessed by a feasibility study, that has been published by Sougkakis et al [1].

Currently, the project has been updated with a new target to achieve positive energy neighborhood while integrate the utilization of sea-water heat pumps for the proposed district heating and cooling network. The municipality is putting efforts to realise this innovative project; thus, it has recently applied for funding

of the development studies at ELENA technical assistance tool of EIB. The recent energy crisis highlights the need to develop efficient district heating/cooling networks support by RES technologies in order to stabilize energy costs, as well as provide with energy security.

Figure 4. Front view of buildings of the neighbourhood (drawing and photo)

3.3.2. Transition Track 2 – Flexible energy management and storage

The activities of transition track #2 in Alexandroupolis attempt to significantly increase Renewable Energy Sources utilization locally. Assessing the local replication potential, the city aims to further exploit the low-enthalpy geothermal field of Antheia-Aristino by adopting and adapting the specific measures demonstrated in Nice Cot' Azur. TT #2 includes a sole replication project, which, however, is considered as the flag project for the city of Alexandroupolis.

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 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. The construction of phase A is almost completed and the operation of the DHN is expected in early 2023. Phase B includes the expansion of the DHN to local households. The project initially aimed to deliver renewable heat to 622 houses and approximately 1,600 citizens of the area and has now been updated to about 1,000 houses and 2,500 citizens. The construction activities of phase A are presented in Figure 5, while Figure 6 includes a schematic overview of the geothermal district heating network that has been developed in phase A.

Alexandroupolis also aims to expand the utilisation of the low-enthalpy geothermal field of Aristino, by extending the existing geothermal district heating network. The project is part of the investment programme submitted for funding by ELENA technical assistance program of the European Investment Bank. The city aims to secure funding for the required development studies (i.e. topographic surveys, DHN design studies, MEP studies, etc) in order to realize phase B of the project.

Figure 5. Geothermal district heating network (phase A) during construction

This project embraces the development of a DHN to supply heat to settlements of Antheia, Aristino, Doriko, Aetochori, Agnantia and Loutros. The expanded geothermal DHN (energy efficient DH according to EIB's ELP and EU definition) will incorporate innovative technological solutions, such AI driven supervision platform and smart thermal energy storage, demonstrated in LH city of Nice. The expanded geothermal DHN will cover thermal needs of about 17,5GWh/y and will require a consumption of approx. 400 MWh/y of electricity for pumps and auxiliary equipment. About 10MW of peak geothermal power and 300 m^3/h of geo-fluid is required, to cover the thermal needs of the houses. The current situation comprises the use mainly of heating oil, as well as wood in very small percentage. The expected future energy heat tariff is 45 €/MWh. The required investment is estimated at 8.5 million €. Taking into consideration other expenses such as maintenance, personnel cost, and leasing cost (approx. 100,000 €/y) it is possible to calculate the simple payback period at approximately 12 years. The calculated IRR is approx. 4%.

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. 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.

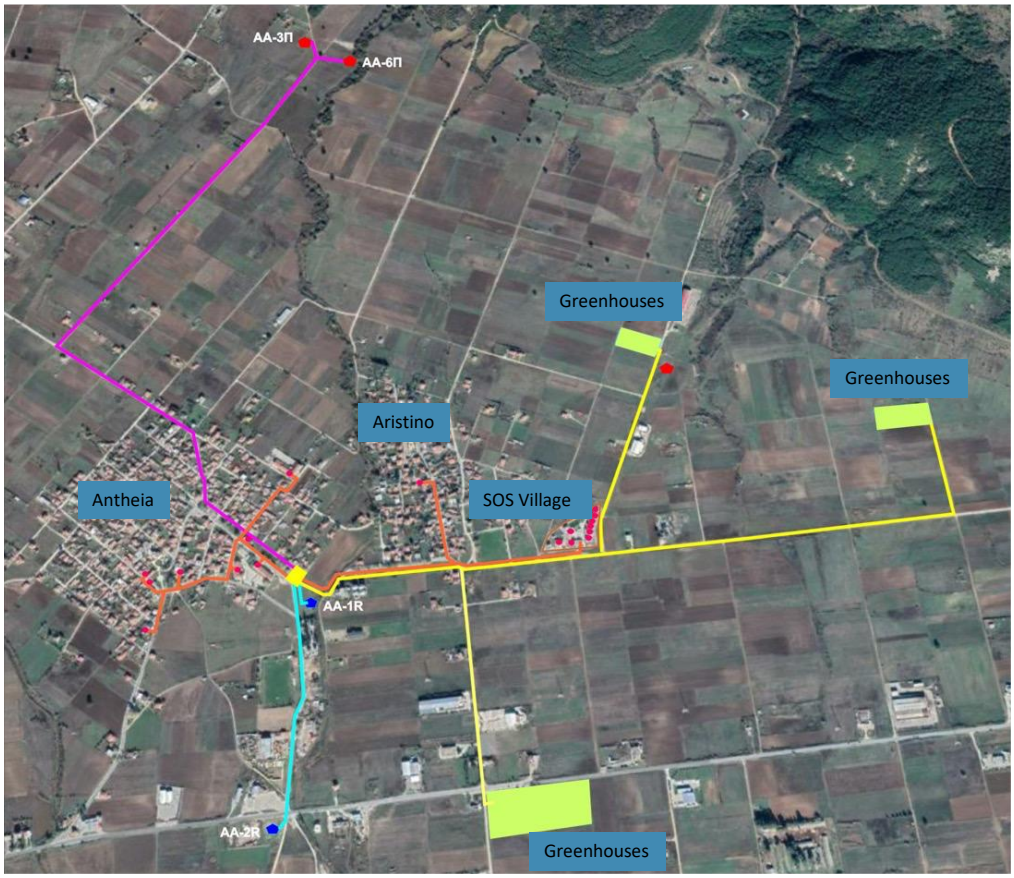

Figure 6. Geothermal district heating network – phase A

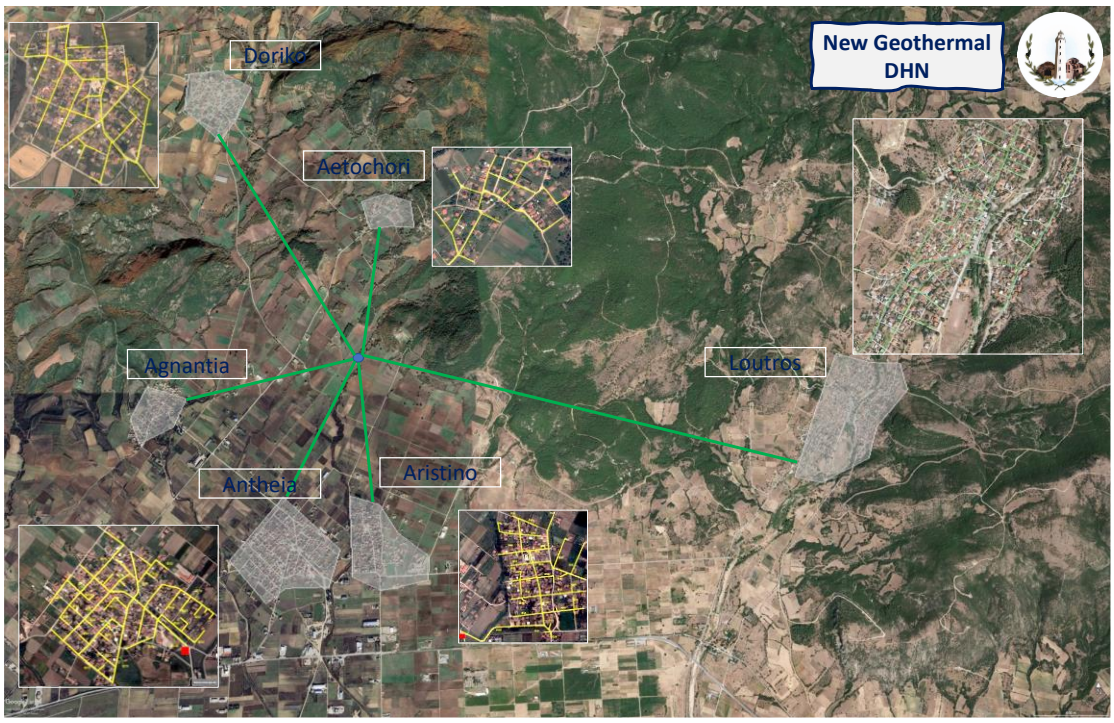

Figure 7. Geothermal district heating network – phase B

3.3.3. Transition Track 3 – Intelligent mobility solutions

Transition track #3 is focused on the implementation of replication activities within the frame of sustainable urban mobility plan. 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 of Alexandroupolis has a target to increase the level of sustainability and efficiency in urban mobility. Within IRIS project, the FC of Alexandroupolis selected to implement two specific measures as presented below. More details can be found in Replication Plan of Alexandroupolis (Deliverable D8.6).

- Measure 1: E-buses

This replication activity includes the transition of two conventional buses to electric ones, in order to promote e-mobility and initiate the transition to electrification locally. To do so, one of the most crowded bus line is selected, the one that connects the city centre (Eleutherias square) with the facilities of Democritus University of Thrace. Nowadays, this service is facilitated with fuel power buses. Within IRIS project, the parameters were 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.

The local bus company the last few years and in collaboration with the municipality of Alexandroupolis operates three shuttle bus lines that have been very successful and present increased usage by citizens and visitors. Within IRIS project it is prosed to replace a conventional shuttle bus with an electric one and thus promote sustainable e-mobility as well as enhance the park and ride service of the local bus company.

Figure 8. Fuel-powered shuttle buses parked in front of the city hall of Alexandroupolis

Both replication activities for Alexandroupoli, are based on the experience that Gothenburg and Utrecht provided in the framework of IRIS project. Gothenburg bus line 55 connects Campus Johanneberg with Gothenburg City centre and Campus Lindholmen.

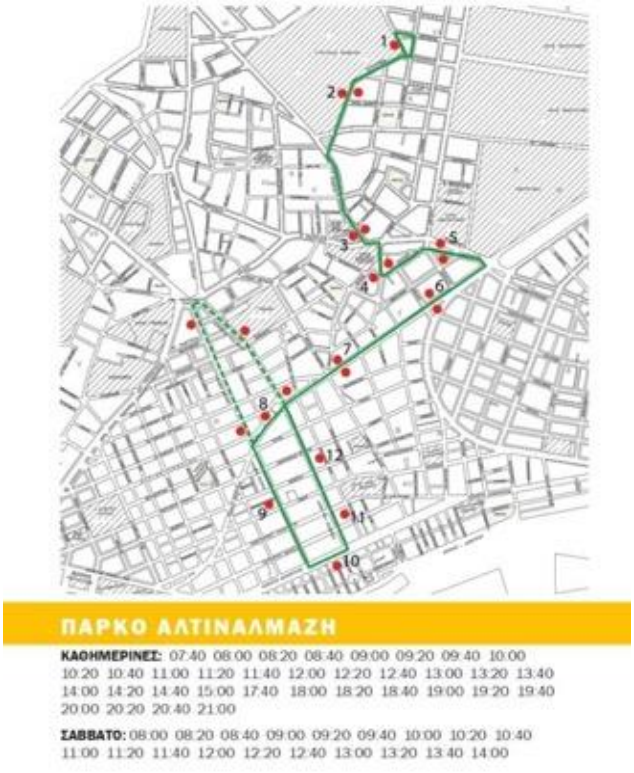

Figure 9. Shuttle bus route – Alexandroupolis city centre

Both solutions were investigated in terms of their techno-economic feasibility. For the first step of the investigation, questionnaire to the bus stakeholders were asked. The key points from the interview are presented below.

1. Timetable for the service
    a. 30 scheduled routes during working days
    b. 12 scheduled routes on Saturdays
    c. 10 scheduled routes on Sundays
2. Every 15 minutes the bus starts from the city center
3. Duration of the journey is 30 minutes
4. Service facilitates approximately 2500 users per day

As a Fellow city, Alexandroupolis implementation plan included the investigation of an electric bus, based on the technical needs of the examined area and the lighthouse city of Gothenburg. Trip distance between the university and the city center of the city of Alexandroupolis is 9km. the feasibility study contains the installation of an opportunity charging station at the campus terminal stop. This location was selected due to the availability of available space for installing a station, regarding country's legislation code for electric stations. The power of the charging stop is taken into the consideration as a 150kW. The methodology followed for the feasibility study is following the linear approach [5]. Based on the technical details of the study the payback time for the electric bus, is calculated as 10 years of operating the service. It is proposed that an efficient business plan can be followed in order to reduce the depreciation time. It was estimated that the transition from the conventional to an electric bus in Alexandroupolis will lead to a 50% of reduction of the emissions (CO2, Nox, PM10).

The technical requirements taken into account for the investigation of the park and ride shuttle bus in Alexandroupolis include the cost of purchasing of the charging applicable for the specific shuttle bus used for testing. The average cost for a charging station applied to the shuttle bus is close to 1250 €, based on market prices at the time of the investigation. Trip distance is calculated 20 km per day. Considering an average consumption of the conventional bus operating now at 25lt/100km. for the feasibility study of the shuttle bus the price of electricity used was 0.50 kWh/km while the diesel's at 1.569 €/lt. Based on the feasibility study, depreciation time for the electric bus, is calculated as less than 5 years of operating the service of one bus.

- Measure 2: E-bikes sharing system

Aiming to the gradual decarburization and sustainability of urban mobility, the city of Alexandroupolis is aiming to develop a large sharing bike system. Within IRIS project the municipality proceeded with the investigation of the potential implementation of an electric bike-sharing system (BSS). The study examined 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. A questionnaire was released on social media and local media of Alexandroupolis, aiming to quantify the demand for the BSS and the level of acceptance of the intervention from residents of the city. An analytical discussion on the results of this questionnaire is presented in IRIS Deliverable D8.6 "Replication plan of Alexandroupolis".

The proposed bike share system includes a network of stations, a fleet of bicycles, a software back-end and maintenance/redistribution teams that operate the system. Bicycle share fleets typically consist of upright bicycles, with step through frames and adjustable seats to allow use by persons of any height. 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.

Figure 10. On filed photos from bicycle network

Alexandroupolis has an extensive bicycle network and plans to even further expanding it. Thus, the city is considered as bike friendly. Nevertheless, 55% of the responders, answered that car is the most frequently mean they travel, an issue that is recognized as a challenge towards smart city transition. According to the implementation plan scenario, 7 locations, 8 stations, 153 docking places and 90 bicycles could efficiently support a large-scale BSS for the city of Alexandroupolis.

The municipality of Alexandroupolis has recently launched a pilot phase for the BSS, by installing conventional as well as electric bicycle. These dockless bicycles are placed in specific points in the city. At the end of the pilot period, this action will be evaluated with KPIs such as number of kilometers for each bike for the pilot period number of people using each bike.

Figure 11. Conventional bicycles of the Bicycle Sharing System of Alexandroupolis

Figure 12. Electric bicycles of the Bicycle Sharing System of Alexandroupolis

3.3.4. Transition Track 4 – Digital transformation and services

According to the city's baseline analysis, it is apparent that Alexandroupolis lacks digital infrastructure and thus its efforts to replicate solutions within TT #4 are limited. Identifying the most applicable actions Alexandroupolis is aiming to develop three IRIS replication projects in TT #4. 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. However, the city is aiming to initiate the digital transformation and do so has signed two Memorandum of Understanding with CISCO's International Digital Transformation and Digital Skills Center (DT&S). The latest MoU refer to the support of DT&S by providing "smart" infrastructure, all applications and software necessary for the implementation and support of the "Help at Home" tele-assistance program. A broader in scope MoU was signed in 2021 with an overall goal being the joint development, research, dissemination and training in digital transformation technologies, the creation of innovative solutions to everyday problems related to the functioning of society, as well as cooperation with relevant bodies abroad.

Figure 13. Photo of Mayor of Alexandroupolis and CISCO representative during the MoU signing

- Measure 1: Smart Street Lighting with multi-sensoring

The proposed measure, as demonstrated by LHC of Utrecht, is considered as a feasible replication project, considering the limited assets that the city has to support urban monitoring activities. The replication area for this measure is the city center.

It important to mention that the city center, as well as the whole city are equipped with LED street lighting, as a result of a 3.6 million EUR project funded by Consignment Deposits and Loans Fund in collaboration with European Investment Bank.

Thus, the next step in city's street lighting is to smarten the infrastructure. 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. 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 concept of smart pedestrian crossing was also included in reconstruction project for the Northern part of Alexandroupolis, among other interventions such as bicycles network extension, new pavements with cool materials, LED street lighting and green works.

- Measure 2: Energy Cloud

As already mentions, Alexandroupolis does not have any ICT urban data platform, as well as any data collection systems and relies only on the governmental activities. Thus, the replication capacity for IS-4.4 Services for Grid Flexibility is limited. Nevertheless, in order to support the early steps of digital transformation the city aims to replicate the energy cloud measure for selected municipal buildings. 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.

The collection of energy data is targeted for three municipal buildings and will include micro-production, EV-charging, building control systems, smart meters and user and the data that will be categorized according to a unified semantic, such as RealEstateCore[1], enabling 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.

The continuous effort of the municipality to proceed with digital transformation led to the successful application for funding of a four-pillar project that includes the installation of energy metering devices for 30 municipal building. Other measures included in this project are installation of smart parking system for 620 parking spots, municipal fleet management, e-government, and civil protection services.

- Measure 3: Fighting Energy Poverty

The Region of East Macedonia and Thrace has the highest percentage (51,30%) of households with a percentage of heating costs below 80% of the total family income among the 13 regions of Greece, according to the Energy Poverty Observatory of Centre of Renewable Energy Sources (CRES) of Greece. These data are not recently updated and considering the nowadays energy crisis it is believed that the percentage is even higher.

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.

The baseline analysis within Alexandroupolis underlined the insufficiently knowledge and awareness of citizens about the concept of energy poverty, thus the causes and factors are not widely known. The local authorities could take the initiative to inform and raise awareness of the citizens, as well as provide services to support the fight against energy poverty. 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.

The city of Alexandroupolis is aiming willing to act 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. At the initial stage of this project the municipality aims to engage at least 20 dwellings with different building typologies and family members and install data collection systems, such as TOONS proposed by IRIS LH city of Utrecht. Due to COVID-19 and lack of personnel the project's implementation has been postponed.

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

3.3.5. Transition Track 5 – Citizen engagement and co-creation

The municipality of Alexandroupolis, as it is usually the case for other Greek municipalities, has established processes to involve citizens into city development and decision making. In more detail, the tools that the city is using include a) the Municipal Advisory Committee, b) Supporter of the citizen and the business, and c) open consultation processes through its website. More details about these processes are included in IRIS Deliverable 8.6.

Based on the familiarization with the IRIS LH cities' demonstrations and the past, current, and planned future activities, projects, and strategies within the city of Alexandroupolis, the municipality aims to implement three measures within TT #5, as described below.

The participation of Alexandroupolis in IRIS project highlighted the strong differences between Alexandroupolis and the Lighthouse cities in terms of citizen engagement approach followed in recent years. 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. Thus, the participatory approach that has been followed in the recent years is characterized by the low participation rates. It is now recognized that citizen engagement is an important challenge due to inactive citizens, absence in the decision-making process, and lack of confidence among citizens.

- Measure 1: Community building by Change agents

Considering the baseline analysis for Alexandroupolis, this measure is considered as a promising tool to successfully engage citizens and stakeholders in the implementation of smart city projects. The measure is expected to be used in the implementation of the geothermal DHN for residential buildings and in the implementation of the near zero energy district. Both these energy projects are currently at the development phase and as soon as the initial studies are completed, the municipality aims to proceed with this citizen engagement measure. A first step is 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 has been already performed to identify a candidate list with suitable profiles as change agents. Next step is to train the selected change agents and formulate the communication messages for citizens and stakeholders.

- 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 local academia partners 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.

This measure has already been successfully implemented during the implementation of REIS2 project that was funded by EEA Grants and includes the installation of Renewable Energy Technologies in eight

municipal and public buildings in Alexandroupolis. Five educational seminars were performed for students of primary and secondary schools of Alexandroupolis with specific theme the utilization of Renewable Energy Sources and their important role in low carbon future.

Figure 14. School involvement during EEA Grants project implementation.

- Measure 3: Minecraft as a dialogue tool for citizen engagement

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. 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.

4. Guidelines for smart city concept implementation for South-eastern Europe

The experiences of the city of Alexandroupolis during its participation in IRIS smart city project resulted in the following findings and guidelines for smart city concept implementation that can be considered as regionally specific for the South-eastern Europe.

A distinct differentiation for smart city solutions implementation in the region of South-eastern Europe is the specific local climate conditions. Climate conditions are the main parameter that requires an adaptation of the demonstrated solutions, the targeted area of this deliverable is defined according to the climatic zone set by EC 811/2013 along with the geographical specification. It is obvious that the different climate conditions of the area require different approach for the smart city energy solutions. For example, cooling needs are an important share of final energy consumption and improvements in cooling systems have increased impact in this region. Also, solar energy availability is significantly higher, and its utilisation is more cost-efficient than in northern part of Europe.

Although climate is an important factor that needs to be taken into consideration when smart city solutions are being designed, there are more disparities across EU countries that are important for replication of smart city strategies and solutions.

Cities of this region usually have fragmented markets, lack of innovation eco-system and socio-economic inequalities. In addition, infrastructure is of lower quality as mentioned in the report of European Investment Bank for smart cities in Central, Eastern and South-Eastern Europe [4]. The same report pinpoints the smartness gaps in this region utilizing a Smart Region Index and besides the disparities recognized in EU level, concluding that the intra-country disparities are much wider than those within other EU countries.

The local context mapping of Alexandroupolis during the development of the Alexandroupolis replication plan within the IRIS project brought into light more differences as compared to the Lighthouse cities of Utrecht, Nice and Gothenburg. Innovation that requires political and regulatory stability that is usually at lower level in the southern part of Europe. In addition, non-capital cities and regions of the South-eastern Europe usually lack of technical and technological capacity to implement innovative measures. In addition, availability of private or public funds hinders the investments required for smart city development.

These significant gap shows that cities in the South-eastern Europe struggle to follow the developmental pace of EU cities, which is important acknowledge in order to develop a successful and efficient smart city strategy and unlock the potential that south-eastern cities have to accelerate energy transition.

The above analysis is crucial, as it defines in a way the smart city solutions that South-eastern European cities are capable of implementing. Therefore, the specific smart city solutions for South-eastern EU cities are solutions that answer the specific needs and challenges of these cities, as well as solutions that are taking advantage of the specific competences and at the same time their implementation can be supported by the local ecosystem.

Based on the Alexandroupolis' experiences and lessons learned, guidelines for smart city concept implementation in South-eastern Europe are listed below. The guidelines are not limited to South-eastern EU cities and may be applied to other EU cities or beyond.

- Create a strong core local team comprising political representatives, municipal employees from different departments, local experts, and stakeholders. It is usually suitable to create sub-teams for specific smart city projects if required. Consider potential governance restructure that will support smart city strategy implementation.
- Create a baseline of the city highlighting specific need and challenges, as well as specific competences.
- Network with other cities on national and international level and pursue participation in collaborative projects or other consortiums.
- Familiarize with smart city solutions by investigating best practices, participating in webinars and workshops and by organizing study visits when possible.
- Join initiatives such as Covenant of Mayors and develop Sustainable Energy and Climate Action Plan, as well as Sustainable Urban Mobility Plan and similar action plans to support the smart city concept.
- Design and execute citizen engagement activities at the very beginning of the project.
- Prioritize the smart city interventions by selecting at first the "easiest" ones. A smart city measure can be considered as "easy" when the solution's implementation can be supported technologically, financially, and regulatorily. In addition, citizens potential acceptance must be assessed, and prioritization should take that into consideration.
- Continuous mapping of the available funding opportunities and continuous collaboration with regional and central governmental offices in order to prioritize the development of smart city measures that could be eligible for funding.

5. Conclusions

IRIS is a smart city HORIZON 2020 EU funded project that was initiated in 2017. Alexandroupolis participated in the IRIS project as a Fellow city aiming to replicate integrative and innovative smart city solutions proposed and demonstrated by Lighthouse cities.

The smart city journey of Fellow city of Alexandroupolis has just started. The active participation in the implementation of the IRIS project has been extremely valuable for the formation of the smart city strategy for the city of Alexandroupolis and facilitated the transition of the city's target from sustainable city to sustainable smart city. The development of the IRIS replication plan, as well as the implementation of some replication projects resulted in lessons learned for the city of Alexandroupolis.

At first it is highly recognized that sharing insights, methods, processes, and results of the demonstration activities of LH cities supports decision making process and political commitment in Fellow cities. During the implementation IRIS project, the city of Alexandroupolis faced a change in the political representatives, which for sure affected the energy transition process. Since political representatives will continue to change, it is important to engage employees to smart city vision. It goes without saying that personnel are the biggest enabler, thus the creation of a strong team comprising of political representatives, municipal employees, local experts, and stakeholders is important. Relying solely on external experts should be avoided, since it may lead to projects with limited political support or non-realistic projects, e.g., projects with increased technological innovation that can be supported by local experts and municipal employees.

Picking the "easiest" measure to implement first is an efficient way to kick-off the smart city strategy implementation. Relying on the strong sectors and performing a thorough baseline analysis are important for successful smart city strategy development.

Citizen engagement is proved to be more difficult activity than in other EU cities. More effort is required and is never too early to start communication activities, since they are integral to successful implementation of smart city projects.

Finally, the implementation of smart city projects in Alexandroupolis also highlighted some more key lessons-learned that might be similar to other EU cities. Financing barriers are mostly found on the development costs rather than the construction costs. Additionally, collaboration with central governmental agencies is important due to the top-down policy that is usually in place for the energy and mobility sector.

Based on the smart city journey of the city of Alexandroupolis, the deliverable provides specific guidelines to support other cities located in South-eastern Europe to initiate a journey towards sustainable and smart city transition. These guidelines include the formation of strong local team comprising of political representatives, municipal employees from different departments, local experts, and stakeholders, the development of thorough baseline analysis, the networking with other cities on national and international level, the participation in joint EU or international initiatives, the design of specific citizen engagement activities at the very first of each project and the continuous mapping of available funding opportunities.

The replication activities performed by Alexandroupolis within the IRIS project underlined that the smart city solutions may significantly differ across different parts of Europe. It highlighted that the key to successful implementation can be found in adaptation to the local context. With this document Alexandroupolis shares valuable information for cities located in the South-eastern part of Europe with similar climatic conditions and other similarities willing to develop a smart city strategy or a replication plan for smart city solutions.

6. References

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