IRIS

Integrated and Replicable Solutions for Co-Creation in Sustainable Cities

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Authors

Surname	First Name	Beneficiary
Minciuc	Eduard	UPB
Patrascu	Roxana	UPB
Darie	George	UPB
Ban	Diana	UPB
Vasile	Elena	UPB
Nicola	Nicoleta	UPB
Cazaciuc	Dan	Focsani
Imireanu	Adrian	Focsani
Purece	Cristian	ICEM
Adam	Adrian Andrei	ICEM
Mandrean	Cristian	ICEM
Ligda	Silvia	ICEM

In case you want any additional information or you want to consult with the authors of this document, please send your inquiries to: irissmartcities@gmail.com.

Reviewers

Surname	First Name	Beneficiary
Pels	Muriel	UTR
Tsarchopoulos	Panagiotis	CERTH

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Disclaimer

Preface

The city of Focsani is known to be the Union City of the two Romanian Principalities - Moldova and Muntenia, back in 1859.

Since then, Focsani serves as a multicultural link between these two historic regions.

The Municipality of Focsani has been developing and implementing different projects to increase quality of life and to be in line with global challenges, to reduce climate changes. In this respect the projects developed and implemented by the Municipality of Focsani are related to four main directions: energy, mobility, environment and social.

The IRIS project came as a very suited possibility for us to develop new links and collaboration with other European cities and to profit from their experience and knowledge. The smart city concept is now our priority for future development. The cooperation within IRIS project was, and shall continue to be beyond IRIS, a good opportunity to exchange ideas and experience, and to strengthen links between European cities.

We shall continue to disseminate our experience in IRIS project to other cities from this European region and not only and hope that it will be helpful to others in implementing smart city concept, which shall contribute on mitigating climate changes.

Executive Summary

The Municipality of Focsani is partner in the IRIS project as a Fellow city. The Municipality has set multiple long-term goals/objectives towards implementation of the smart city concept in Focsani.

The Municipality of Focsani has taken many steps towards a smart city concept and in recent years there have been implemented (or there are in the implementation phase) many projects in different areas, e.g., building retrofitting, transportation, etc. The city has gained a lot of experience due to its participation in IRIS project, and due to implementation of different projects.

Reference to relevant inputs and outputs from other deliverables: D8.10 Focani replication plan and D8.3 replication toolbox, as well as deliverables D8.6, D8.7.

The 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”.

The primary goal of this deliverable is to share experience and knowledge with other cities and Municipalities, particularly in South-Central Europe.

The main part of the document presents the journey of Municipality of Focsani, including the activities implemented or being developed in the city within the 5 Transition Trancks of IRIS. The experience that Municipality of Focsani gained during this period of being part IRIS project and developing and implementing smart city solutions is of great value and being shared to other cities that intend to pursue towards smart city concept. So, based on that experience general guidelines and South-Central region-specific guidelines are presented that can be used for development and implementation of smart city projects.

General guidelines:

- Understand the needs and challenges of the city.
- Define city objectives and targets for the long term.
- Identify local and regional stakeholders.
- Identify and connect with other cities that have already taken steps towards smart city.
- Identify and contact consulting companies, research institutes, universities that can provide valuable information on smart city solutions and help in elaborating a master plan.
- Increase citizen’s awareness.
- Involve citizens into process of project development.
- Allocate resources, including human resources.
- Elaborate a master plan / program based on city needs and objectives.
- Identify national and EU funding programs.
- All implemented projects should improve quality of life.

South-Central region-specific guidelines:

- Since most of apartments are owned by residents, citizens engagement and their support is very important, especially in building rehabilitation projects.
- Ensure financing for building retrofitting, if possible 100 % from Municipality or other funds since there might be problems when citizens should also fund the project.
- Ensure local support and legislation for development of district heating network before implementing projects on district heating system.
- Increase quality of services of district heating system.
- Increase citizens awareness about advantages of district heating compared to separate heat generation.
- The Municipality is responsible for municipal waste management and district heating – combining these two, e.g., using wastes for heat generation can solve both problems.
- In the latest developments on energy markets, but also moving towards mitigating climate changes, the use of renewable energy sources (solar, biomass, geothermal) in district heating system should a must.
- Improve knowledge about innovative city mobility.
- Increase citizens awareness regarding innovative mobility services.
- Increase citizens awareness regarding advantages of digitalization, urban monitoring, and city digital platform.
- Increase citizens awareness of energy efficiency effects on entire community.

Both sets of guidelines can be used by Municipalities and stakeholders to shorten the path towards projects implementation, avoiding common mistakes and increasing the efficiency.

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List of Abbreviations and Acronyms

Abbreviation	Definition
CHP	Combined heat and power
CIM	City Information Model
CIP	City Information Platform
DESS	Distributed energy storage solutions
DG	Distributed generation (power)
DH	District Heating
DHN	District Heating Network
DHS	District Heating System
EEA	European Economic Area
ESS	Energy storage solutions
EU	European Union
EV	Electric vehicle
ICT	Information Communication and Technology
IoT	Internet of Things
FC	Fellow/follower city
IS	Integrated solution
LH	Lighthouse city
MDRAP	Ministry of Regional Development and Public Administration
PIEE	Energy Efficiency Improvement Program
PNRR	National Recovery and Resilience Plan

POCA	Operational Program Administrative Capacity
POIM	Large Infrastructure Operational Program
POR	Regional Operational Program
RES	Renewable energy sources
SC ENET SA	Local district heating company
SDS	Sustainable Development Strategy
SME	Small and medium enterprises
SUMP	Sustainable Urban Mobility Plan
TT/T.T.	Transition track
V2G	Vehicle-to-grid
WP	Work Package

1 Introduction

The Municipality of Focsani is partner in the IRIS project as a Fellow city. The Municipality has set multiple long-term goals/objectives towards implementation of the smart city concept in Focsani.

The Municipality of Focsani has taken many steps towards a smart city concept and in recent years there have been implemented (or there are in the implementation phase) many projects in different areas, e.g., building retrofitting, transportation, etc. The city has gained a lot of experience due to its participation in IRIS project, and due to implementation of different projects. So, the main reason for elaborating this deliverable is to share experience and knowledge with other cities and Municipalities. The major objectives include reaching out to cities in the region, showing them the Focasni Municipality experience in IRIS project, sharing different case studies, knowledge transfer and providing them a guide for implementing/replicating smart city related projects.

The main part of the deliverable includes the description of different projects that have been implemented in Focsani. There are also separate chapters that describes lessons learned through participation in IRIS projects and guidelines for projects implementation for different cities located in South-Central European region.

The deliverable is highly connected with WP8 and with other deliverables elaborated within this work package.

The deliverable includes 6 main chapters, including Introduction (Chapter 1) and References (Chapter 6). Chapter 2 is dedicated to smart city concept and solutions. There are described solutions for Focsani city linked with the 5 Transition Tracks of the IRIS project. Chapter 3 is fully dedicated to describing the solutions that the Municipality of Focsani intends to implement or that are under implementation or already have been implemented. Every Transition Track has been presented with every Integrated Solution that Municipality is aiming to develop and implement. Chapter 4 is dedicated to Guidelines for smart city concept implementation for different cities located in the South-Central European region, including different specific aspects of the region. Chapter 5 is the Conclusions of the deliverable.

The document should serve as a primary guide for cities in the South-Central European region for developing and implementing different projects linked to smart city concept. The main beneficiary/audience/target should be personnel from Municipalities and local stakeholders who can participate in different projects' implementation.

2 Focşani and the IRIS project

2.1 Why Focsani started work on smart city solutions

Currently, more than 50% of the world's population is concentrated in large cities, or in their close proximity. It has been estimated, that by 2050 the amount of people living in these mega cities has risen by additional 20%. Urbanization is a global megatrend, which has direct effects on the climate change, rising emission and pollution levels, as well as on the energy production, distribution and consumption. Additionally, urbanization bears direct impacts on urban infrastructure requirements, land use, residential and transport requirements, and sustainability on all of its levels: environmental, economic, social, and cultural. The accelerated urbanization and growing environmental awareness have risen concerns and demands to develop cities to become smarter, with the ability to be constantly evolving. There is a grave need for ambitious sustainability strategies and projects, which can aid cities intelligently and comprehensively in this task. By promoting innovative, efficient, far-reaching and replicable solutions, from the fields of smart energy production and consumption, traffic and mobility, information communication technology, and citizen engagement, the objectives of the strategies can be achieved. Smart city development promotes innovative energy solutions, smart grid and RES development, and strives to advance sustainable transport modes, thus affecting on economic and social levels, and enhancing quality of life (QoL). A smart city utilizes ICT to reach more efficient and intelligent standards in achieving carbon neutrality. It preserves natural resources and reduces land use by mature and jointly executed coordination and planning of infrastructure and transport design. A smart city strives for implementation of green and innovative technical solutions, leading to savings in costs and energy, and promoting better service delivery. The smart city advancement should have a holistic approach on sustainability. Measures to reduce a city's impact on environment and to expedite the integration of intelligent and efficient use of technologies with the urban infrastructure outright form the backbone of environmental sustainability. Economic sustainability signifies attempts to develop a city's economic potential, new financial and business models and innovations, and advance more efficient and annexed service and infrastructural solutions. 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. In order to plan, capitalize, and implement the best operating smart city solutions, new methods, technologies, and innovations are required. These include efficient and affordable energy production based on RES, and promoting sustainable mobility solutions, smart charging and innovative energy storage schemes, and advanced ICT solutions. Additionally, key stakeholder engagement is relevant, including political leaders, government and city officials, organizations, service operators and solution providers, investors and consumers. Indeed, local level citizen engagement has a paramount role in any smart city development strategy. By these means, the continuance of the smart city development can be secured, including the optimal end-result of citizen-awareness and attractive city environment.

2.2 Smart city concept Focşani

The smart city concept for the City of Focșani is drawn from the experiences of several different Lighthouse cities and projects. Our ambition has been to find a way to build up a smart city without a need for a heavy investment up front. Therefore, we have looked into smart solutions which are fast to implement and where the investment has short pay-back times. We have also focused a lot of our attention on a centralized IoT platform for the city. So instead of making one IoT platform for different functions (building energy optimization, traffic optimization etc.), we aim to operate different use cases on the same IoT platform. We also feel that we do not understand the full potential of real-time data collection if we do not engage different user groups to tell what needs they have in terms of data analytics and visualization and/or the need for simulations. Bringing different stakeholders together and discussing our ideas of real-time data collection and a joint IoT platform with them has therefore been an approach of how we build up the concept of a smart city in Focsani. We now have a large consensus within the city administration, with academia and many private companies, that real-time data collection and an IoT platform are needed in Focșani.

We are designing our project to implement our first sensors to measure both real-time energy data and traffic data into an IoT platform. This is done both with our own funding and external project funding. Based on the piloting phase and the results, we aim to define an organization, a funding scheme and a concrete plan for upscaling the smart city concept to the full city scale by 2025 at the latest.

2.3 The IRIS project

The IRIS smart city project is an international project initiated in 2017. The project is funded by the European Union's Horizon 2020 program, with a duration of five and half years (2017-2021).

The IRIS project supports the Lighthouse cities of Utrecht (NL), Göteborg (SE) and Nice Côte d'Azur (FR) and their Follower cities Vaasa (FI), Alexandroupolis (GR), Santa Cruz de Tenerife (ES), and Focsani (RO) to address their urgent need to deliver energy and mobility services in their cities that are cheaper, better accessible, reliable, and that contribute to a better and more sustainable urban quality of life. By demonstrating smart solutions that integrate energy, mobility and ICT, rooted in a City Innovation Platform, IRIS quantifies their value, and connects interests of many different stakeholders in innovative business models, allowing for upscale and replication of integrated solutions for sustainable cities across Europe and world-wide.

During the project, the LH cities act as living laboratories for demonstration, integration and implementation of innovative energy efficient areas, flexible smart energy solutions and applications, incrementing the utilization of RES and ESS, e.g. battery-energy storage solutions with first and 2nd life batteries, heat energy-storages, and EVs' energy storage capacity via V2G and PV integrated systems.

To achieve this, IRIS works along five Transition Tracks based on common challenges, encompassing 16 integrated solutions that cities can mix and match according to their characteristics and district specific needs. Tracks 1, 2 and 3 enhance energy efficiency and utilize grid flexibility by balancing supply and demand dynamically and by 2nd life battery and V2G storage, to increase renewable energy production and roll-out of e-cars and e-buses. Track 4 supports this by data sharing, a common architecture, the use

of standards, and governance practices accelerating innovation, standardization and implementation of affordable smart applications. Track 5 integrates interdisciplinary citizen engagement and co-creation in Tracks 1 to 4, connecting the needs of end-users with those of other stakeholders, in further support of innovative business models. The five IRIS Transition Tracks and integrated solutions are further specified in Annex 1.

Once a Lighthouse city has successfully demonstrated an activity of an innovative smart city solution in its environment, a follower city is able to create a replication plan for the chosen integrated solutions and determine their schedule, resources, and partners, which are the requirements for successful implementation. Not all of the solutions demonstrated by the LH cities are required or even can be replicated by a follower city. Each participating city, from the 3 LH cities and the 5 Felow cities, has its own baseline, needs, framework and goals when starting the IRIS Smart City endeavour, determining which integrated solutions form its replication plan.

Also, within the project, the LH cities strive for intelligent use of state-of-the-art ICT solutions, sustainable mobility schemes and services, and interactive citizen engagement. The paramount goal is to improve urban life and to ensure sustainable, secure and affordable energy for living and mobility for all citizens and businesses. To achieve this, a coalition of universities, research organization innovation agencies, local authorities and private expertise joined forces in collaboration. To enforce this, the LH cities cooperate actively with the follower cities: Alexandroupolis (Greece), Focsani (Romania), Santa Cruz de Tenerife (Spain) and Vaasa (Finland).

The expected impacts of IRIS are an open innovation ecosystem motivating citizens to act as prosumers; more effective urban planning and governance of integrated solutions; exploitation of validated innovative business models based on multi-stakeholder collaboration; more stable, secure and affordable energy and mobility services for citizens, with improved air quality.

2.4 Smart city solutions Focsani prioritized from IRIS

In Table 1 are presented solutions chosen for replication by Focsani Municipality, and the demonstrating LH city/cities.

Table 1. Solutions chosen for replication by Focsani Municipality, and the demonstrating LH city/cities.

FOCSANI		
TT#1: Smart renewables and closed-loop energy positive districts		
Integrated Solution	**City, Demonstration Project and/or Organization**	**Replication Project**
IS-1.1: Positive Energy Buildings		
IS-1.2: Near zero energy retrofit district	Utrecht & Gothenburg	Retrofitting of residential and public buildings
IS-1.3: Symbiotic waste heat networks		
TT#2: Smart Energy Management and Storage for Grid Flexibility		

Integrated Solution	City, Demonstration Project and/or Organization	Replication Project
IS-2.1: Flexible electricity grid networks		
IS-2.2: Smart multi-source low temperature district heating with innovative storage solutions	Nice & Gothenburg	Smart district heating
IS-2.3: Utilizing 2nd life batteries for smart large scale storage schemes		
TT#3: Smart e-Mobility Sector		
Integrated Solution	**City, Demonstration Project and/or Organization**	**Replication Project**
IS-3.1: Smart solar V2G EVs charging	Utrecht	V2G EV charging
IS-3.2: Innovative Mobility services for the Citizens	Utrecht & Gothenburg	Bike sharing
TT#4: City Innovation Platform (CIP)		
Integrated Solution	**City, Demonstration Project and/or Organization**	**Replication Project**
IS-4.1: Services for Urban Monitoring	Nice	Street lighting
IS-4.2: Services for City Management and Planning	Nice & Gothenburg	District heating system automation, monitoring & control
IS-4.3: Services for Mobility	Gothenburg	Traffic lights management
IS-4.4: Services for Grid Flexibility		
TT#5: Citizen engagement		
Integrated Solution	**City, Demonstration Project and/or Organization**	**Replication Project**
IS-5.1: Changing everyday energy use	Nice & Utrecht	Citizen engagement
IS-5.2: Participatory city modelling		
IS-5.3: Living labs		
IS-5.4: Behaviour changing Information	Nice & Gothenburg	Apps for energy efficient behavior

3 Smart City Journey of Fellow City Focşani

Focșani is a medium-sized city – the capital of Vrancea County. Focsani City is situated at the border between Moldova and Muntenia historical regions of Romania. Focșani City needs to react both to its local internal cross-sectorial challenges and to the external pressure related to the economic disparities between western and eastern European countries, recently more influenced by the geopolitical context with our neighbour Moldova and Ukraine.

The city is committed to become a smart and sustainable urban centre, starting from efficiently tackling all local issues (economic, social, administrative, environmental etc.) through an integrated innovative approach. Together with its citizens, the key stakeholders and urban utilities' providers, the municipality is focused on: increasing buildings' energy efficiency and the living standards; mitigating CO_2 footprint by reducing primary energy resources consumption and implementing adequate RES in areas of interest with no DHS; developing an eco-smart public transport, efficiently managed and monitored; implementing an ICT decision-based management tool in order to develop a transparent and efficient public administration process; securing its citizens' safety and enhancing their level of knowledge, awareness and engagement; maintaining a low unemployment rate by increasing the economic potential of the city (SME development; attracting foreign investment; tourism). As the Municipality gained experience in running several investment projects financed by Pre-accession and Structural Funds, is being prepared to submit new project proposals for the next period.

Figure 1- Emblem of Focşani Municipality

3.1 Needs, challenges, and priorities of Focsani

The sustainable development concept of Focsani city has been proposed, developed and analyzed in different official documents elaborated by the Municipality. The concept of sustainable development includes different city areas/domains, like buildings/districts sustainable development, efficient utility networks, smart and sustainable mobility sector, digitalization, citizen involvement and co-creation and many others.

One of the main objectives of the Municipality of Focsani within the IRIS project is to take advantage and prepare a replication plan for projects in different city areas to be implemented in Focsani. This objective is achieved through the elaboration of the Focsani replication plan.

The Municipality of Focșani is a signatory member of the Covenant of Mayors, with Energy Efficiency Improvement Program (PIEE) [1] under Local Council approval. In 2015 the City Local Council approved the Municipality of Focșani Sustainable Development Strategy for 2014–2023 (SDS) [2] In July 2020 the strategy was updated, and in 2016 the Sustainable Urban Mobility Plan (SUMP) was approved [3]. In 2020, a project request was submitted regarding the development of a coherent strategic plan designed to ensure a sustainable vision for the development of sustainable urban mobility in Focșani by elaborating the new Sustainable Urban Mobility Plan (SUMP). New SUMP will have to meet the financing needs and requirements for the programming period of European funds 2021-2027, relevant approved plans (part of its PIEE), and already allocated available budget.

The strategic objectives of Focsani SDS will be reached through concrete measures and actions in the following fields:

Energy

a) district heating system upgrading and retrofitting ongoing program,

b) an Eco-efficient public lighting, including a telemanagement system,

c) energy efficient buildings (public buildings, residential - single-family homes, condominiums).

All the above will be connected with smart metering and a dispatching centre for field data collecting; electricity, heat, natural gas and water consumption, and water – air – soil pollution.

Transport sector

a) a Multi-modal transport infrastructure at the metropolitan level,

b) an intelligent traffic management, including video surveillance,

c) an Eco-smart public transport, including the acquisition of 36 electric busses (small and medium capacity) and the development of the charging infrastructure (36 slow and 10 fast stations),

d) Green parking areas will be designed and constructed.

In addition, a **Smart ICC decision-based management tool** will be implemented in order to develop a transparent and efficient public administration process, including non-bureaucratic proficient public services. The tool is designed, to gather data collected in field, process them and draw reports / assess KPIs, while ensuring a user interface at the general public level and b) to ensure open access to different type of information, thus enhancing the level of citizens' trust and understanding challenging them to action and rational use of resources.

The financial means to be used by the Municipality of Focşani in achieving the objectives of the Energy Efficiency Improvement Program are both from its own budget (own revenues from local taxes, business activities, subsidies from the state budget), as well as those attracted from external sources.

In order to use the external financing opportunities for energy efficiency programs, the local administration has made efforts to know the procedures of the financial instruments and of the innovative financial schemes used at international level.

The capacity to ensure the implementation of the measures proposed by PIEE [1] will be achieved through an activity of attracting funds from various financial sources and through various financial mechanisms/instruments

Considering the new legal and regulatory framework regarding the energy efficiency in buildings - National Law no.121/2014 [4] transposing the Directive 2009/27/UE [5], buildings constructed before 2005 are not thermally insulated, building constructed between 2005 and 2014 are poorly thermally insulated and starting with 2014 buildings are adequately thermally insulated. It has to be mentioned that after implementing the new national regulation on buildings' energy performance, all new buildings have to be properly thermally insulated according to the relevant European Directive.

The IRIS project, with its main objectives and goals, has many parallels with Focsani's sustainable strategy and, therefore, greatly contributed to city sustainable development. The Municipality of Focsani experienced numerous and great advantages of being part of the IRIS project, of which the most important ones are:

- Connection with other EU cities that implement sustainable development concept.
- Replication of already implemented projects in different cities, partners within IRIS.
- Knowledge exchange, including new ideas and project ideas.
- Capacity building at Municipality of Focsani, including with help and experience from Lighthouse cities.

3.2 Replication activities in Focsani per Transition Track

3.2.1 Transition Track 1 - Renewables and energy positive districts

The Municipality of Focsani is set to develop smart city districts based on renewable energy sources. In this context, buildings can represent a specific target for decreasing energy consumption, thus increasing energy efficiency. The integrated solution chosen by the Municipality of Focsani from this transition track to be replicated is related to retrofitting residential and administrative buildings in Focsani city. The process has already started with elaborating a set of technical documentation for different residential and administrative buildings. For each analyzed building there have been elaborated the following set of documents:

- Energy audit of the building assessing all energy demands and proposing energy efficiency measures for reducing energy consumption.
- Technical documentation for proposed energy efficiency measures.

The next major steps of the replication process include the following:

- Public procurement procedure for selection of construction works providers.
- Implementation on-site at each analyzed building of every energy efficiency measure proposed in technical documentation.
- Reception of works.

The buildings shall be rehabilitated based on a well-planned schedule, one by one, and not all of them at a time. However, there might be two-three buildings (residential or/and public) that undergo the rehabilitation process at the same time.

The implementation of this integrated solution shall lead to different energy, financial, environmental, social, etc., benefits at the level of the Municipality of Focsani, i.e.:

- Energy benefit – reducing energy consumption in buildings.
- Financial benefit – reducing financial resources allocated for energy bills for citizens and Focsani Municipality itself.
- Environmental - reducing environmental pollution through reducing Green House Gasses (GHG) emissions.
- Social – increasing citizen comfort and their affordability to pay energy bills.

For Transition track 1 the Municipality of Focsani has targeted for retrofitting both residential and public buildings. There have been chosen 9 residential buildings with different characteristics (height, number of apartments, etc.) and 7 public buildings, all of them being schools, colleges, etc.

3.2.1.1 IS-1.2: Near zero energy retrofit district

The Municipality of Focsani intends to replicate IRIS Integrated Solution regarding retrofitting several buildings, including utilising renewable energy sources. This project can lead to the development of a near zero energy district. The Municipality targets through this project two types of buildings: residential and public buildings. There have been retrofitted and/or chosen for retrofitting 21 residential and 3 public buildings [6].

The residential buildings can be divided into three categories depending on the number of floors as follows:

- Basement + ground floor + 4 floors, B+GF+4F.
- Basement + ground floor + 8 floors, B+GF+8F.
- Basement + ground floor + 3 floors, B+GF+3F.

The analysis of each building has been performed based on the following energy, economic and environmental criteria:

- Energy performance certificate of the building.
- Energy class of the building.
- Total specific annual primary energy consumption.
- Total specific annual final energy consumption.
- Total specific annual final energy consumption for heating.
- Total specific annual final energy consumption for warm water preparation.
- Total specific annual final energy consumption for heating for lighting.
- Equivalent CO_2 emissions factor.

All these criteria have been calculated for all residential buildings before and after implementation of specific energy efficiency measures.

There have also been calculated for each building the following criteria:

- Annual energy savings.
- Annual financial savings.
- Estimated investment for the energy efficiency measures.
- Simple Pay Back Period for the proposed energy efficiency measures.

The main energy efficiency measures proposed for residential buildings include the following:

- Thermal insulation of the exterior walls.
- Changing the windows with new more energy efficient ones.
- Insulating/closing the balconies.
- Thermal and hydro insulation of the building terrace.
- Thermal insulation of the ground floor.
- Retrofitting of the warm water system.
- Retrofitting of the lighting system.

The 3 public buildings chosen for retrofitting are all from the education sector and include schools, colleges, etc. These public buildings can be divided into two categories depending on the energy efficiency measures proposed:

- Public buildings analyzed for retrofitting including only energy efficiency measures.
- Public buildings analyzed for retrofitting including energy efficiency measures and utilization of renewable energy sources.

The analysis of each building has been performed based on the following energy, economic and environmental criteria [7-10]:

- Energy performance certificate of the building.
- Energy class of the building.
- Total specific annual primary energy consumption.
- Total specific annual final energy consumption.
- Total specific annual final energy consumption for heating.
- Total specific annual final energy consumption for warm water preparation.
- Total specific annual final energy consumption for heating for lighting.
- Equivalent CO_2 emissions factor.

All these criteria have been calculated for all public buildings before and after the implementation of specific energy efficiency measures and solutions for the utilization of renewable energy sources.

There have also been calculated for each building the following criteria:

- Annual energy savings.
- Annual financial savings.
- Estimated investment for the energy efficiency measures.
- Simple Pay Back Period for the proposed energy efficiency measures.

The main energy efficiency measures proposed for public buildings include the following:

- Thermal insulation of the exterior walls.
- Changing the windows with new more energy efficient ones.
- Insulating/closing the balconies.
- Thermal and hydro insulation of the building terrace.
- Thermal insulation of the ground floor.
- Retrofitting of the warm water system.
- Retrofitting of the lighting system.
- Utilization of renewable energy sources for heat generation.

The implementation of this specific Integrated solution can face several barriers and drivers, as presented below.

1. Technical Bounds & Drivers: One bound can be due to different specific issues for any analyzed case/building the utilization of a certain technology cannot be possible. A driver, in this case, can be the fact that in Romania, these solutions have not been implemented before on a large scale, so today there can be used the best available technologies on the market.

2. Legal: There are still Bounds regarding the legal framework, especially with the lack of some secondary legislation. On the other hand, the Romanian legal framework should completely align with EU legislation, which can be considered as a Driver for future project development.

3. Social: There is still a need to increase the awareness of population regarding the energy efficiency concept and utilization of renewable energy sources.

4. Financial: On the local/national level, there is a bound regarding the available financing from the Government. On the other hand, there is available financing through different EU funded programs.

5. Environmental: All energy efficiency measures and utilization of renewable energy sources can surely lead to reducing pollutant emissions and thus reducing environmental impact.

There should be mentioned that this project regarding the rehabilitation of buildings in Focsani city started already in 2020.

Figure 2 shows the example of the retrofitting building in Focsani city before and after the rehabilitation.

Figure 2 - Rehabilitated building in Focşani

Regarding the financing schemes and financial sources for this project, there can be mentioned the following aspects:

- There has been signed the financing contract for the first 6 blocks of buildings (1 phase) – 1012800.45 euros. The financing is ensured through the Regional Development Agency that uses EU funds with the Municipality of Focsani participating with 2%.
- There has been signed the financing contract for the next 9 blocks of buildings (2nd phase) – 1292872.89 euro. The financing is ensured through the Regional Development Agency that uses EU funds with Municipality of Focsani participating with 2%.
- There have been signed the financing contracts for 8 public buildings (mainly schools and kindergartens) – 6723200.64 euro. The financing is ensured through Regional Development Agency that uses EU funds with Municipality of Focsani participating with 2%.

Figure 3 - Rehabilitated the Technical College "Gheorghe Asachi" Focșani

Figure 4 - Rehabilitated the Gymnasium School "Ion Basgan" Focșani

Figure 5 - Rehabilitated the Gymnasium School "Duiliu Zamfirescu" Focșani

3.2.2 Transition Track 2 - Flexible energy management and storage

The Municipality of Focsani is the legal owner of the district heating company SC ENET SA, which operates the entire district heating system of the city. The district heating system was developed in the 1970's and since then undergone through several major modernization phases. Initially, the cogeneration plant was designed to supply heat to industrial and residential consumers. Over the years, the industrial consumption of heat went down, thus having a major negative impact on cogeneration plant. Today, the cogeneration plant supplies heat to residential consumers only. The integrated solution chosen by the Municipality of Focsani from this transition track to be replicated refers to the modernization of the entire system, including the energy generating facility and district heating network. The modernization of the district heating system is a continuous process. The Municipality of Focsani has already implemented several measures for increasing energy and economic efficiencies. To continue with the modernization of the district heating system, there have been elaborated following technical documents:

- District heating business strategy for the city of Focsani [11].
- Feasibility study for modernization of Focsani district heating system [12].

There should also be mentioned that SC ENET SA district heating company has been involved in a research project together with the University Politehnica of Bucharest. The project analyzed the operation of the energy generating facility and included several proposals for increasing its efficiency. These proposals can also be taken into consideration within this replication activity.

The next major steps of the replication process should include the following:

- Find and secure financing sources.
- Rehabilitation/modernization of district heating system. This shall be done in steps, gradually rehabilitating/modernizing different parts of the system.

The implementation of this integrated solution shall lead to achieving different benefits at the level of Focsani city, i.e.:

- Energy benefit – reducing primary energy consumption (mainly fossil fuel – natural gas) at the energy generating facility.
- Financial benefit – reducing financial resources allocated to district heating company, and the long-term goal is to generate profits from this activity.
- Environmental benefit – reducing environmental pollution through reduction of GHG emissions at the energy generating facility.
- Social – increasing citizen comfort and their affordability to pay energy bills.

For Transition Track 2 the Municipality of Focsani aims at rehabilitating the following parts of the district heating system:

- Transportation network.
- Thermal substations.
- Distribution network.

There can also be implemented several energy efficiency measures at the energy generating facility, including:

- Installation of a heat storage tank.
- Trigeneration - combined production of power, heat and cold.

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

The replication project, matching this integrated solution that Municipality of Focsani intends to implement, refers to the increasing energy efficiency of the district heating system through implementation of different measures at energy generation facility and within the district heating network.

The district heating system (DHS) of Focsani city was developed and put into operation in 1970's. Back then, the system has been primarily designed to generate energy for industrial purposes to cover the energy demand of the wood processing factory and, at the same time to cover city heat needs for domestic warm water and heating. Initially, the energy generating facility was set up as a boiler house generating only heat for industrial and urban needs. However, shortly after being put into operation, the energy generating facility was transformed into a combined heat and power (CHP) plant. Back then, the cogeneration plant was equipped with steam turbine technology, mainly using natural gas, but sometimes, especially during wintertime, also uses fuel oil as primary energy source.

In 2001 SC ENET SA incorporated both energy generation and transportation/distribution/supply to become a horizontally integrated company for heat supply in Focsani city.

In 2013 the CHP plant underwent a major rehabilitation process allowing it to increase its energy and financial efficiency and, at the same time, to reduce its environmental impact. As a result, the old steam turbine-based technology has been replaced with internal combustion engines. So, today, the cogeneration plant of the Municipality, administrated by SC ENET SA, includes the following main equipment:

- 2 internal Rolls Royce combustion engines of 6.8 MWe of electric power and about 7 MWth of heat installed each.
- 1 10 t/h steam boiler used especially for internal purposes (degassing of the makeup water).

- 2 50 Gcal/h hot water boilers, each used for covering heat peak demand, especially during the wintertime for covering heating demand.

The internal combustion engines operate to cover base load demand, which usually consists of domestic warm water preparation. During the wintertime, engines can also be used to cover parts of the heating demand. Hot water boilers are usually used during the wintertime to cover heating demand.

The district heating system of Focsani city includes the following parts:

- Primary/transportation district heating network linking heat generating facility and thermal substations.
- Thermal substations are used for changing the parameters of the district heating working fluid.
- Secondary/distribution district heating network linking thermal substations and final consumers.

SC ENET SA confronts with several problems/issues in the operation of the district heating system. Some of them are presented below:

- High disconnection rate of domestic consumers, which leads to different technical and economic operational issues.
- High rates of heat losses (about 37 %, of which about 17 % in the primary/transmission network and about 20 % in the secondary/distribution network) in the district heating network.
- Low operation time of cogeneration equipment, especially during summertime it is operated only one internal combustion engine.
- Operation of cogeneration equipment in periods when electricity tariffs are low, resulting in low revenues and sometimes even financial losses.
- High variation of heat demand leading equipment operation at partial loads with low efficiency.

All these issues lead to poor technical and economic efficiency of the entire district heating system and at the same time, increase the environmental impact compared to an efficient operation.

To tackle all the above-mentioned problems, the Municipality of Focsani have come up with a plan/strategy that includes two main directions:

- Rehabilitation of the district heating network.
- Optimization/improvements/modernization of the cogeneration plant.

There should be mentioned that the Municipality of Focsani city is rehabilitating and modernizing the district heating system constantly. There can be mentioned that about 2.8 km of the primary/transportation network, 9 thermal substations and about 11 km of secondary/distribution network have already been rehabilitated and modernized.

The rehabilitation of the district heating network includes the following activities:

- Rehabilitation of 3.635 km of the primary/transportation network.
- Rehabilitation of 7.170 km of the secondary/distribution network.
- Rehabilitation and modernization, including automation and monitoring equipment of 6 thermal substations (PT19, PT29, PT45, PT47, PT48 and PT57).
- Connection of social housing buildings to the district heating system (ANL buildings located in the districts Sud and Democtratiei). This activity includes a new district heating network of about 3 km and individual thermal substations at each building. There should be mentioned that this

activity shall increase heat demand and, therefore, equipment time operation, and technical and economic efficiency of the district heating system.

The proposed energy efficiency measures to be implemented within the district heating network shall lead to the following technical, economic and environmental advantages:

- Reduction of heat losses in the district heating system with 22.11 TJ/year, leading to fuel savings of 691512 Nm^3 of natural gas.
- Connection of the ANL social housing buildings to the district heating system shall lead to improving overall efficiency of the cogeneration plant with about 3 %, and to increasing the operational load, operational time and economic efficiency of the SC ENET SA Focsani.
- Increasing the overall energy efficiency of the entire district heating system shall lead to total fuel (natural gas) savings of about 58 TJ/year.
- The fossil fuel (natural gas) savings shall lead to decreasing of the pollutant emissions, such as:
    - CO_2 emissions decrease – 3265 t/year.
    - NO_x emissions decrease – 2.473 t/year.
    - SO_2 emissions decrease – 0.573 t/year.
    - Dust particles decrease – 0.081 t/year.

The planning of the activities for the rehabilitation of the district heating network is divided into two parts:

- Activities for rehabilitation of the district heating network.
- Activities for connection to the district heating system of ANL social housing buildings.

The activities for rehabilitation of the district heating network include the following:

- Acquisition and installation of the new pre-insulated pipes for the primary and secondary district heating networks, including special automation/early fault detection wires along all pipes (heating, domestic warm water and recirculation of domestic warm water).
- Acquisition and installation at the consumers' limit of property of monitoring equipment.
- Acquisition and installation at the consumers' limit of property of hydraulic equilibration equipment for good operation of the entire district heating system and for ensuring high quality of the district heating service provided to costumers.
- Acquisition and installation of automation and monitoring equipment for the district heating network.
- Acquisition and installation of valves and other fitting equipment needed for primary and secondary district heating networks.
- Acquisition and installation of valves and other fitting equipment needed for all rehabilitated thermal substations and new individual thermal substations.

The activities for connection to the district heating system of ANL social housing buildings include the following:

- Acquisition and installation of the new pre-insulated pipes for the primary and secondary district heating networks, including special automation/early fault detection wires along all pipes (heating, domestic warm water and recirculation of domestic warm water).

- Acquisition and installation of 37 individual thermal substations fully automated. Each individual thermal substation shall include 2 heat exchangers for covering heating demand and 2 heat exchangers for covering domestic warm water demand.

The investment for rehabilitation of the district heating network has been estimated at about 26 million euros. The payback period for this investment has been calculated at about 8 years.

The optimization/improvements/modernization of the cogeneration plant include two activities:

- Implementation of a heat storage tank at the cogeneration power plant site.
- Implementation of an absorption chilling machine at the cogeneration plant site.

A technical analysis of the cogeneration plant operation has been performed. The main conclusion of the analysis is that during the wintertime, the operation of cogeneration equipment is at full capacity. However, the analysis of the operation of the cogeneration plant during the summertime revealed the following issues:

- There is only one internal combustion engine in operation, which can cover the heat demand. The operation of internal combustion engines is cyclical; one engine is operated for a certain period, then it is stopped, and the other engine is put into operation. So, there can be said that during the summertime, only half of the cogeneration capacity is used.
- There are great fluctuations in heat demand during the day, which makes the operation of cogeneration equipment quite inefficient. The decreased heat demand during certain daily hours also leads to reduced electricity generation and, thus electricity sells. This leads to reducing financial revenues, and this is especially important since during the day the electricity tariffs are high. During the night, when the electricity tariffs are low, the cogeneration equipment should operate, especially in the morning hours, to meet the heat peak demand of the morning.

So, taking into consideration the conclusions of the technical analysis of cogeneration plant operation during the summer time there have been proposed a couple of measures to be implemented at the S. C. ENET S. A. Focsani that can lead to increasing the efficiency of the whole system (cogeneration plant and district heating network). The first measure is related to the implementation of a heat storage unit that can optimize the operation of the cogeneration plant during the summer season. The measure is designed to reduce the cogeneration unit operation hours during the night-time, when electricity tariffs are low, by using a heat storage tank. The second measure analyses the opportunity of coupling of an absorption chilling machine to a cogeneration unit for producing cold that can be used in fruits and vegetables storage facility. This measure can lead to increasing the operation time of the cogeneration equipment and, thus, to all advantages of combined energy generation (power, heat and cold).

The implementation of heat storage at a cogeneration plant used in the district heating system has been proved very efficient due to the increasing of flexibility and security of energy supply and due to increasing the financial revenues of district heating companies. The main advantages of heat storage implementation at a cogeneration plant within a district heating system are the following:

- Higher global energy efficiency of fossil fuel utilization.
- Optimal, close to full load, operation of cogeneration equipment.
- Reduced environmental impact.
- Electricity generation during the high tariff's periods.

- More stable operation of district heating networks.

The implementation of an absorption chilling machine can lead to the utilization of both cogeneration units almost all year long. This fact can lead to some advantages, like:

- Diversifying the portfolio of the district heating company (another customer and sales of heat, electricity and cold).
- Improving the cash flow during summertime.
- Increasing the annual turnover of the district heating company.
- Improving the financial efficiency of the district heating company.

The technical and economic analysis has been performed for three scenarios:

- Scenario 1 – implementation of only heat storage tank.
- Scenario 2 – implementation of only absorption chilling machine.
- Scenario 3 – implementation of both heat storage tank and absorption chilling machine.

The implementation of this specific Integrated solution can face several barriers and drivers, as presented below.

1. Technical Bounds & Drivers: There can be said that there are no major technical barriers for the implementation of this integrated solution. However, there might be some technical issues regarding absorption chilling machine since SC ENET SA has no experience with this type of equipment. A driver in this case can be the fact that SC ENET SA, together with the Municipality of Focsani, have already started rehabilitation and modernization of the district heating system.

2. Legal: There can be some legal barriers, especially with the lack of some secondary legislation, that put some difficulties with project implementation, e.g. equipment installation at consumers' property limit. However, this barrier can be overcome through Local Council implication and the creation of a local legal framework.

3. Social: There is a great need to increase the awareness of the population regarding all benefits of a district heating system. Of course, such a system should be modernized, well-operated and efficient from all points of view.

4. Financial: On the local/national level, there is a bond regarding the available financing from the Government. On the other hand, there is available financing through different EU funded programs.

5. Environmental: All measures proposed within this transition track can reduce pollutant emissions and thus reduce environmental impact.

Regarding the financing schemes and financial opportunities for this project, there should be mentioned the following:

- There has been signed the financing contract for the rehabilitation and modernization of the district heating system with a total value of 14379936.98 euros. The financing shall be ensured through the Regional Development Agency with 2% participation of the Municipality.

3.2.3 Transition Track 3 - Intelligent mobility solutions

The Municipality of Focsani has been analyzing the issues regarding mobility in the city for quite a long time. This high interest is due to its strong determination to develop the city in a sustainable manner, and the mobility sector is one of the major components of its sustainable development plan. Therefore, the Municipality of Focsani is interested in replicating both integrated solutions within this transition track. These integrated solutions are related to electric vehicle/bus use and charge and different innovative mobility services for citizens. Several major projects are already under analysis. For each of these major projects, there has been elaborated different technical documentation, as presented below:

- Opportunity study, including traffic management study for modernization of the public transportation in Focsani [13-15].
- Feasibility study for developing bicycle tracks and implementing a bike-sharing system in the city [16-17].
- Technical documentation for re-systematization of the public transportation infrastructure to increase attractiveness [18-19].

The next major steps of the replication process include the following:

- Public procurement procedure for selection of equipment/works/services providers.
- Implementation on-site of each major mobility project.
- Reception of works.

The implementation of all major projects in the mobility sector of Focsani city has the following goals/objectives/aims:

- Development of the public transportation infrastructure, including special lanes for busses.
- Stimulation of utilization of public transportation by citizens through the limitation of vehicles access into the downtown city.
- Utilization of electric buses, including implementing electric bus charging stations using photovoltaic solar panels.
- Development of bicycle tracks and implementation of a bike-sharing system in the city.
- Extension of the parking areas within the city.

The implementation of the smart mobility integrated solutions in Focsani city shall lead to different benefits, such as:

- Environmental - reducing environmental pollution through reducing Green House Gases (GHG) emissions.
- Social – increasing citizen comfort and satisfaction.

For transition track 3 the Municipality of Focsani intends to implement 4 major projects, each of them including several components:

- Electric vehicle/bus charging stations, including:
  - Slow charging stations for electric buses.
  - Fast charging stations for electric buses.
  - Fast charging stations for electric vehicles.
- Modernization of public transportation and acquisition of electric busses, including:

- Acquisition of 9 electric buses with 70 seats and 7 electric buses with 25 places.
- Implementation of an e-ticketing system for the entire public transportation fleet.
- Implementation of an information system for citizens in major bus stations.
- Development of a software application for urban mobility for facilitating access to public transportation (citizens and tourists), including ticketing. The application shall also be used as a travel system for route optimization.
- Monitoring and management system for buses' fleet.
- Passengers' safety and security system in busses.

- Modernization and re-systematization of the public transportation infrastructure:
  - Rehabilitation of road infrastructure.
  - Special lanes for public transportation.
  - Rehabilitation of sidewalks.
  - Bicycle tracks.
  - Smart bus stations.
  - Preparation of the infrastructure for smart mobility management system.
- Implementation of a bike-sharing system, including:
  - Smart bicycles fleet with on-board computer and smart access.
  - Smart docking stations for bicycles.
  - Bike renting terminal.
  - Bike repairing stations.
  - Common ticketing system with public transportation.

3.2.3.1 IS-3.1: Smart Solar V2G EVs charging

The Municipality of Focsani is in the process of implementing an infrastructure for electric vehicles/busses charging stations. This infrastructure shall include 46 charging stations placed throughout the city. The electric charging stations shall be of two types: slow charging stations and fast charging stations. The strategy for bus charging shall be developed based on the technical specifications of electric buses and the specificity of public transportation routes/lines. This replication integrated solution includes 3 types of charging stations:

- Slow charging stations for electric busses.
- Fast charging stations for electric busses.
- Fast charging stations for electric vehicles.

Slow charging stations for electric busses

The slow charging stations for electric buses will be designed in such a way that they can ensure at least 40 kW per bus. The slow charging is designed to take place during the night by coupling the electric bus to the low-voltage network (400 V). The full charging shall take up to 6 hours depending on the battery stack capacity. The charging stations shall be equipped with standardized coupling equipment and a friendly user interface allowing bus drivers to take all necessary individual steps for bus charging. The process of slow charging shall lead to 100 % of the battery stack. The main characteristics of a slow charging station shall include:

- Possibility for charging 24 hours 7days a week.
- Possibility for decoupling in emergency cases.
- Electric equipment protection level at least IP 44.

- Charging tension 400 V.
- Charging power 40 kW/bus at minimum 100 A.
- User friendly interface.
- Energy monitoring system.
- High energy efficiency class.
- Power factor at least 0.98.

Fast charging stations for electric busses

The fast charging stations for electric buses shall be able to deliver at least 300 kW for battery charging within 2 to 10 minutes. The main characteristics of a slow charging station shall include:

- Possibility for charging 24 hours 7 days a week.
- Possibility for decoupling in emergency cases.
- Electric equipment protection level at least IP 44.
- Charging tension 400 V.
- Charging power 300 kW/bus at minimum 750 A.
- User friendly interface.
- Energy monitoring system.
- High energy efficiency class.
- Power factor at least 0.98.

The fast charging process should be simple allowing bus driver to operate it easy and fast. Figure 5 shows the location of 5 fast charging stations for electric busses.

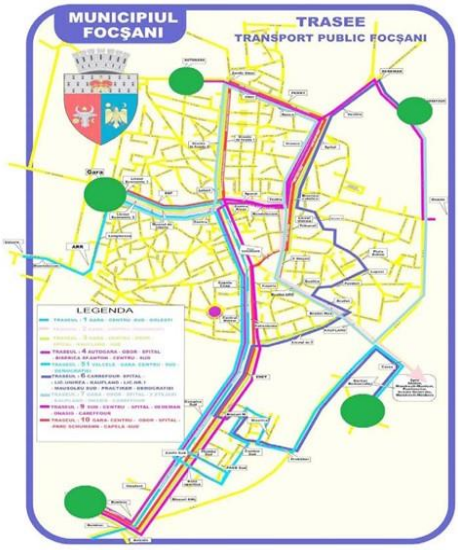

Figure 6 - Location of 5 fast charging stations for electric busses

Taking into consideration all specific characteristics of bus lines in Focsani city, there can be said that one bus line has a length between 135 and 276 km. This leads to the conclusion that there shall be enough 2 fast charging per day per bus.

Fast charging stations for electric vehicles

The Municipality of Focsani intends to install 4 fast charging stations for electric vehicles. This measure aims at stimulating the utilization of electric vehicles. The fast charging stations shall be located along the following main routes: Bd. Cuza Voda, Bd. Unirii, Bd. Bucuresti and Bd. Independentei. The locations for fast charging stations have been chosen in such a way that they can be easily accessible with the minimum supplementary movement for potential users.

This specific project shall lead to increasing the number of electric vehicles in Focsani city, reducing environmental pollution and traffic agglomeration, especially in the downtown city, and improving the social satisfaction of citizens.

The implementation of this specific Integrated solution can face several barriers and drivers, as presented below.

1. Technical Bounds & Drivers: Different technical barriers/issues can exist along project implementation. The main identified technical barriers are regarding to power infrastructure needed to be in place for electric charging stations, compatibility of electric charging stations with the local power network, and availability of power in the local network. All these technical barriers can be overcome with good planning and analysis of the project.
2. Legal: There can be legal barriers regarding the location and operation of electric charging stations. However, these barriers can be overcome through Local Council implication and the creation of a local legal framework.
3. Social: There is a great need to increase the population's awareness regarding all benefits of an innovative mobility system in Focsani city. This can be done through information and citizens' involvement.
4. Financial: On the local/national level, there is a bond regarding the available financing from the Government. On the other hand, there is available financing through different EU funded programs.
5. Environmental: All measures proposed within this integrated solution can reduce pollutant emissions and thus reduce environmental impact.

3.2.3.2 IS-3.2: Innovative Mobility Services for the Citizens

Another project within this integrated solution relates to bike-sharing. The main components of this integrated solution are as follows:

- Modernization of public transportation, including the acquisition of electric buses.
- Modernization and re-systematization of public transportation infrastructure.
- Implementation of bike-sharing concept.

The main goals/objectives of this integrated solution are as follows:

- Increasing the attractiveness utilization of public transportation system.
- Increasing the efficiency of the public transportation system and, at the same time, decreasing fossil fuel consumption.
- Implementation of special lanes for public transportation.

- Improving transportation in the city of Focsani.
- Increasing safety of all traffic participants.
- Increasing the attractiveness of bicycle utilization through the development of specific infrastructure.
- Reduction of pollutant emissions.
- Promotion of urban public transportation as a viable solution for citizens.
- Reduction of the number of accidents and increasing traffic safety for all traffic participants.

Modernization of public transportation, including the acquisition of electric busses

Today the public transportation of Focsani city consists of 9 lines having a total length of 143 km. The modernization of public transportation system includes creation of 2 new lines. Another innovative solution refers to acquisition of electric busses. Figure 6 presents the public transportation system of Focsani city.

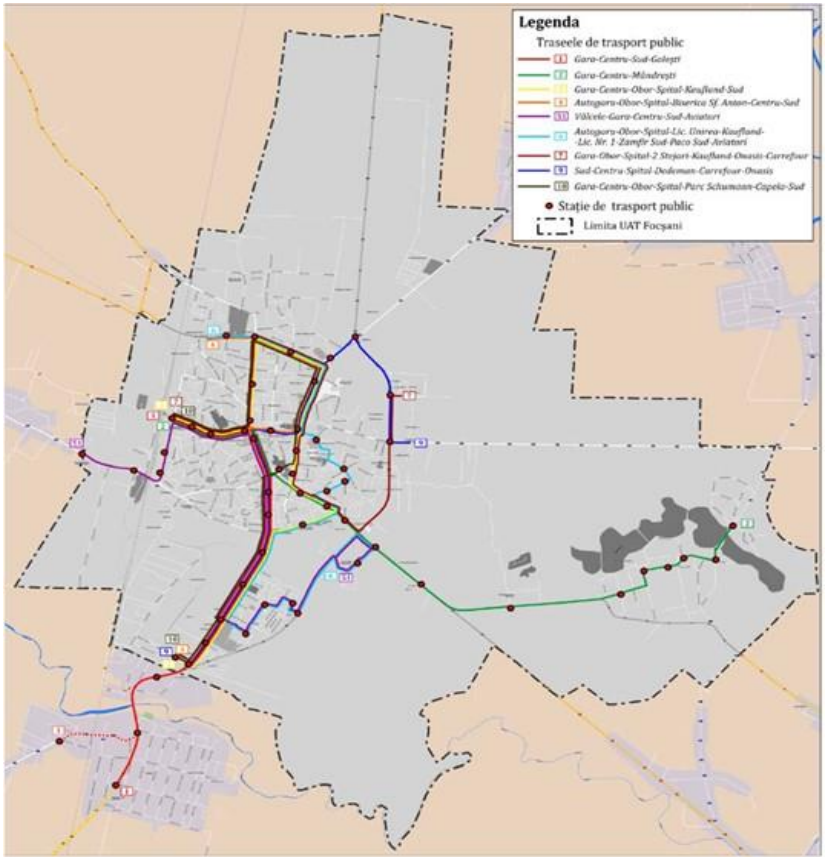

Figure 7 - Public transportation system of Focşani city

The technical study has included a detailed calculation of the number of busses needed for each line, the time between two busses, bus passenger capacity, maximum number of passengers, time duration for a complete round-up, resulting the exact number of needed buses for a specific transportation line. Analyzing the performed technical study there can be drawn the following conclusions:

- The average operation load of the public transportation system is 76 %, which can be considered efficient and, at the same time, comfortable for citizens.

- For some bus lines, there can be crowding times at the end of the line; in this case, there should be an increased number of busses, and this can be done through bus fleet management.
- In the downtown area, for 5 different bus lines, there can be times with low passengers' flow, which shall lead to decreasing the number of busses, and this can also be done through bus fleet management, including changing the bus with 70 passenger capacity with one with 25 passenger capacity.

The implementation of this project within this integrated solution can lead to the following results:

- Ensuring transportation capacity with 30 % greater than in 2018.
- Ensuring public transportation in areas where there is no such option today through the introduction of 2 new lines.
- Increasing the frequency of busses by at least 20 % on lines 1, 2, 3, and 6, considered as being a priority for Focsani city, the first 3 ones are the most crowded ones.
- Increasing the quality and attractiveness of public transportation.
- Improving the connectedness of the public transportation system due to the introduction of two new lines.

So, in order to achieve all modernization purposes of the public transportation system, the Municipality of Focsani decided to acquire electric buses. There shall be acquired 9 electric busses with 70 passenger places and 7 electric busses with 25 passenger places capacity.

Modernization and re-systematization of public transportation infrastructure

One component of this integrated solution that the Municipality of Focsani intends to implement is related to the modernization and re-systematization of public transportation infrastructure. The main goal of this project is to increase the attractiveness and accessibility of citizens to public transportation. Figure 8 shows the re-systematization of the public transportation infrastructure in Focsani city.

Figure 8 - Re-systematization of public transportation infrastructure in Focsani city

Modernization and re-systematization of public transportation infrastructure in Focsani city include the following main components:

- Modernization and re-systematization of about 19 km of road/routes.
- Arranging approximately 33,000 m^2 of green areas.
- Secondary works on modernized roads.
- Installation of 61 smart public transportation stations.
- Installation of anti-parking bollards, including retractable bollards for some areas with weekend access.
- Preparation works for all communication infrastructure used throughout the city.

Implementation of bike-sharing concept

The Municipality of Focsani has already started implementing projects to create an infrastructure dedicated to bicycles. Today, two bicycle tracks can be used in Focsani city, see Figure 9.

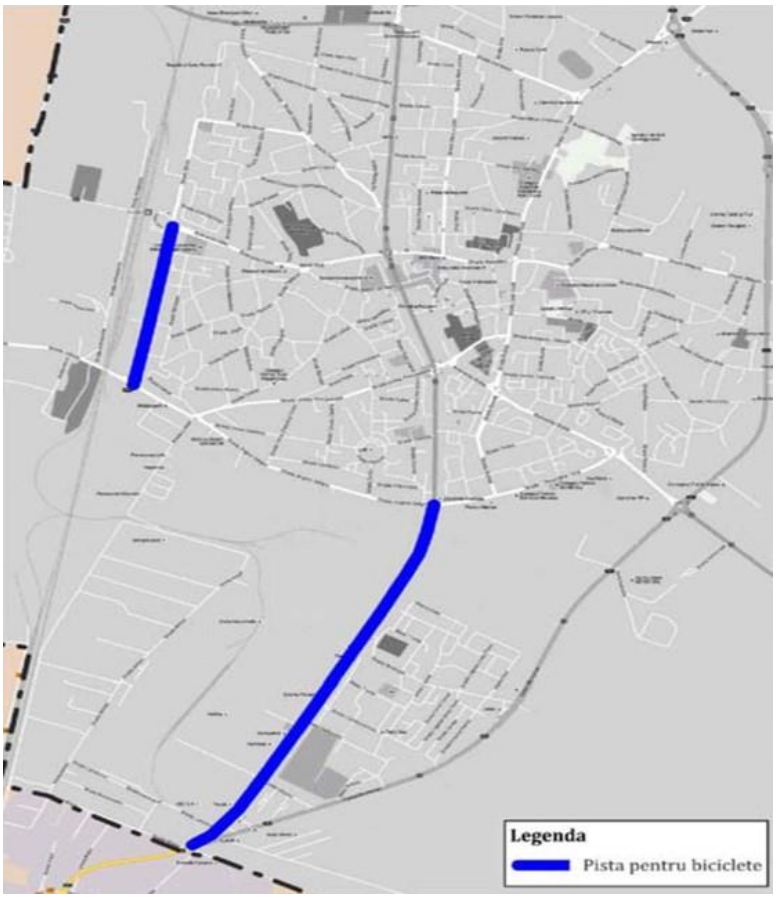

Figure 9 - Bicycle tracks in Focsani city

However, these existing bicycle tracks are stand alone, not connected to a network that would allow access on a bicycle into different parts of the city. Moreover, there is neither a bike renting system implemented in Focsani city. So, considering all above the Municipality of Focsani intends to implement an intelligent bicycle transportation system that would be very well integrated into the concept of Smart City / Smart Mobility and Sustainable Development.

The Municipality of Focsani has elaborated a feasibility study regarding the development and implementation of bicycle tracks and a bike-sharing system. The main problems revealed regarding these issues are the following:

- Reduced safety of bicycle riding, especially due to fact that today bicycle riding is done on the sidewalk and there are cars parked there and the lack of special signs for the bicycle.
- There is no bicycle network in Focsani city.
- There is no bike-sharing system in the city that can stimulate and attract bicycle riding.

Considering all mentioned above, the Municipality of Focsani intends to develop the bicycle-based transportation system further. In this regard, there are two distinctive projects:

- Development of bicycle infrastructure, including bicycle tracks.
- Implementation of a bike-sharing system.

The development of the bicycle infrastructure in the city of Focsani is planned to be done in different parts of the city, and shall include the following areas with bicycle tracks:

- Str. Republicii between Str. Cuza Voda and Bd. Garii.
- Bd. Garii between Str. Republicii and Str. Prof. Gheorghe Longinescu.
- Str. Aurora between Bd. Independentei and Str. Mare a Unirii.
- Str. Ana Ipatescu between Str. Mare a Unirii and Str. Cuza Voda.
- Str. Mare a Unirii between Str. Aurora and Str. Marasesti.
- Str. Maior Gheorghe Pastia between Bd. Unirii and Str. Cuza Voda.
- Bd. Brailei between Str. Maior Gheorghe Pastia and Str. 1 Decembrie 1918.

Figure 10 shows the city areas where the bicycle tracks shall be implemented.

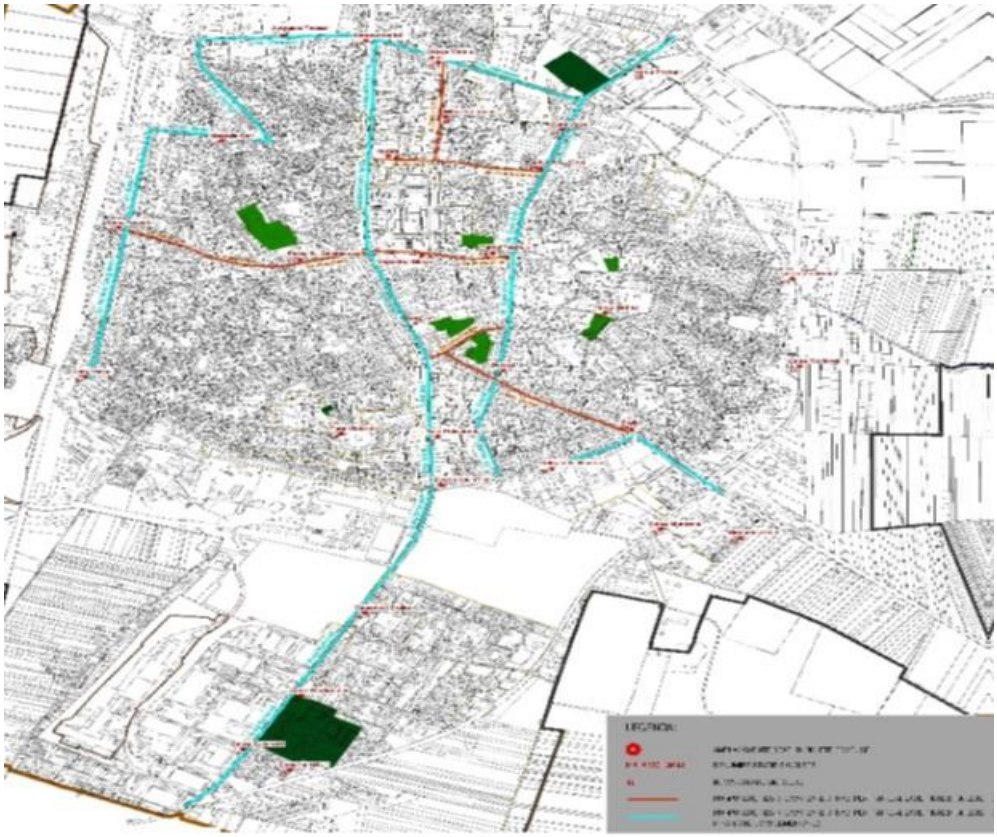

Figure 10 - Location of bicycle tracks in Focsani

The bike-sharing system shall include the following components:

- Intelligent terminals for bike renting.
- Intelligent bike returning stations.
- Intelligent bicycles with on-board computer.
- Intelligent tricycles with on-board computer.
- Communication and operation center.
- Software application with multi-language support.
- Bicycle repair stations.
- Repair kits.

The bike-sharing system shall include an integrated ticketing system, which shall allow utilization parallel to the bike-sharing system and public transportation system.

The implementation of this specific Integrated solution can face several barriers and drivers, as presented below.

1. Technical Bounds & Drivers: Different technical barriers/issues can exist along project implementation. The main identified technical barriers are related to choosing electric buses, bike-sharing system, and software application for innovative mobility. All these technical barriers can be overcome with knowledge exchange and capacity building, which has already started on some issues.

2. Legal: There can be some legal barriers regarding electric buses and bike-sharing. However, these barriers can be overcome through Local Council implication and the creation of a local legal framework.

3. Social: There is a great need to increase the population's awareness regarding all benefits of an innovative mobility system in Focsani city. This can be done through information and citizens' involvement. There should also be mentioned that through the implementation of a bike-sharing system there can be created some additional jobs in Focsani city

4. Financial: On the local/national level, there is a bond regarding the available financing from the Government. On the other hand, there is available financing through different EU funded programs.

5. Environmental: All measures proposed within this integrated solution can reduce pollutant emissions and thus reduce environmental impact.

The Municipality of Focsani has signed the financing contracts for the following parts of this complex project:

- Re-Systematization of public transportation infrastructure – 15121508.51 euro.
- Modernization of public transportation – 7889423.10 euro.
- Bike-sharing project – 22483700.74 euro.
- 36 electric busses – 11160551.13 euro.

These signed financing contracts shall be financed through the Regional Development Agency. The electric busses project shall be implemented in partnership with Ministry of Regional Development.

3.2.4 Transition Track 4 - Digital transformation and services

The issue of digitalization is a very important matter for the Municipality of Focsani since it can support and contribute to the implementation of the sustainable development concept. The Municipality of Focsani aims to replicate 3 of 4 integrated solutions. The integrated solutions that the Municipality of Focsani is interested in are related to:

- Services for urban monitoring.
- Services for city management and planning.
- Services for mobility.

For each integrated solution, there is a project that is being developed by the Municipality of Focsani. The first steps taken for projects implementation refer to technical documentation elaboration, and there has been elaborated different documentation, as presented below:

- Feasibility study for rehabilitation, modernization, and extension of the public lighting system in Focsani city [20].
- District heating business strategy for the city of Focsani.
- Feasibility study for modernization of Focsani district heating system.
- Feasibility study for the implementation of traffic management and monitoring system [21-22].

The projects being developed under this transition track are at different stages of implementation. Two of them, the rehabilitation of the lighting system and traffic management and monitoring system, have already financing contracts signed and are ready to be implemented. Other projects are still in the technical documentation preparation phase and search for financing sources.

The implementation of projects within this transition track shall lead to different benefits for Focsani city and its citizens, i.e.:

- Energy benefit – reducing primary energy consumption due to more efficient street lighting, traffic management system and more efficient operation of district heating system.
- Financial benefit – reducing financial resources allocated to street lighting and district heating company.
- Environmental benefit – reducing environmental pollution through reduction of GHG emissions throughout the city due to lower traffic.
- Social – increasing citizen comfort and safety.

There should be mentioned that project proposals are being developed and implemented under this Transition Track. These project proposals are intended to be financed through EU funds, 2021-2027 financing program, but also through Intelligent Growth, Digitalization and Financial Instruments Operational Program - POCIDIF [23], National Recovery and Resilience Plan PNRR [24].

The Municipality of Focsani is developing and implementing the following projects within this transition track 4:

- Rehabilitation, modernization, and extension of the public lighting system in Focsani city.
- Installation of local and centralized monitoring and management system for the district heating system of Focsani city.
- Implementation of traffic management and monitoring system.

The project proposals that are considered for implementation are the following:

- Safe School - Pro-active system for access control to schools.
- Safe City – video surveillance monitoring system including an intelligent App for citizens.
- Center for Integrated Management of public services.
- Digital Municipality – an integrated e-platform for Municipality.
- Geospatial management of Focsani Municipality area.
- Citizen Innovation Platform.

Some of these project proposals have been inspired by the IRIS experience.

3.2.4.1 IS-4.1: Services for Urban Monitoring

The Municipality of Focsani has analyzed the operation of the lighting system of the city and the analysis has shown the following deficiencies:

- Poor quality of street lighting.
- Reduced lighting efficiency in some areas.
- Reduced energy efficiency of the system.
- Increased maintenance costs of the system.
- Old technology.

There are also other factors that can support the rehabilitation and modernization of the lighting system of the city:

- Urban development of the city, including the appearance of new neighbourhoods.
- Traffic changes.
- An increasing number of tourists.

All the above-mentioned deficiencies and factors led to the decision of Focsani Municipality to develop and implement a project for rehabilitation, modernization, and extension of the public lighting system. The main goals of the project are listed below:

- Modernization of the lighting system according to the highest national and EU standards.
- Centralized real-time management of the lighting system that can lead to reducing operation and maintenance costs.
- Implementation of dynamic lighting based on city needs that can lead to electricity and, thus, financial savings.
- Reduction of power consumption and thus achieving financial savings through the utilization of new lighting technologies.
- Reduction of pollutant emissions associated with energy savings.

The project for rehabilitation, modernization and extension of the lighting system of Focsani city includes several components:

- Rehabilitation and modernization of the lighting system, including changing the aerial cables with underground ones and installing LED-based lighting devices.
- Installation of a centralized monitoring and management system for the lighting system of Focsani city.
- Extension of the lighting system to newly developed areas.
- Installation of lighting pols for pedestrian crossings.
- Utilization of renewable-generated electricity for powering lighting system.

There have been analyzed two solutions for the implementation of this project:

- Solution 1: rehabilitation, modernization and extension of the public lighting system and implementation of an intelligent monitoring and management system.
- Solution 2: rehabilitation, modernization and extension of the public lighting system and implementation of an intelligent monitoring and management system, and, in addition to the first solution, utilization of renewable-generated electricity for powering lighting system and installing lighting pols for pedestrian crossings.

Solution 1, rehabilitation, modernization and extension of the public lighting system and implementation of an intelligent monitoring and management system includes the following steps:

- Modernization/extension of the power network for the public lighting system.
- Installation of new lighting pols, including all needed equipment.
- Installation of new LED-based lighting bulbs.
- Installation of an intelligent monitoring and management system.

Solution 2, rehabilitation, modernization and extension of the public lighting system and implementation of an intelligent monitoring and management system, and, in addition to the first solution, the utilization of renewable-generated electricity for powering lighting system and installing lighting pols for pedestrian crossings includes the following steps:

- Modernization/extension of the power network for the public lighting system.
- Installation of new lighting pols, including all needed equipment.
- Installation of new LED-based lighting bulbs.
- Installation of an intelligent monitoring and management system.
- Installation of new lighting pols for pedestrian crossings equipped with photovoltaic panels for power generation and batteries for electricity storage.

The specific technical indicators for the project are presented below:

- Increasing the public lighting system from about 26 km today to about 36 km after project implementation.
- Increasing the light level.
- Installation of 1056 new lighting pols.
- Installation of 1123 new lighting bulbs.
- Installation of 66 photovoltaic panels and power storage batteries.

The estimated investment costs are presented below for both solutions:

- Solution 1 investment cost: about 4.013 million Euro.
- Solution 2 investment cost: about 4.243 million Euro.

The project implementation shall lead to the following technical, energy and environmental criteria:

- Increasing the number of lighting devices by about 23 %.
- Reducing the power installed capacity by 44 %.
- Reducing electricity consumption from about 586 MWh/year today to about 327 MWh/year after project implementation, thus leading to energy savings of about 259 MWh/year, corresponding to a reduction of electricity consumption of about 44 %.
- Reducing CO_2 emissions due to energy savings from about 36 tons/year of CO_2 equivalent to about 20 tons/year of CO_2 equivalent, corresponding to a reduction of CO_2 emissions of about 44 %.

The implementation of this specific Integrated solution can face several barriers and drivers, as presented below.

1. Technical Bounds & Drivers: Different technical barriers/issues can exist along project implementation. The main identified technical barriers are related to photovoltaic panels utilization for power generation and monitoring and management system for public lighting. All

these technical barriers can be overcome with knowledge exchange and capacity building, which has already started on some issues.

2. Legal: There can be some legal barriers regarding photovoltaic panels utilization. However, these barriers can be overcome through Local Council implication and the creation of a local legal framework.

3. Social: From the social point of view, no barriers were identified. The social advantages of the implementation of this project constitute in improving the living standards of the citizens of Focsani. There should also be mentioned that through this project implementation, there can be created some additional jobs in Focsani city.

4. Financial: On the local/national level, there is a bond regarding the available financing from the Government. On the other hand, there is available financing through different EU funded programs.

5. Environmental: All measures proposed within this integrated solution can reduce pollutant emissions and thus reduce environmental impact.

The Municipality of Focsani has signed the financing contract for the implementation of this project. The financing contract has a value of 4053576.40 euros. The financing shall be ensured by Regional Development Agency with 2% participation of the Municipality.

The Municipality of Focsani is developing the following project proposals that can be implemented within this Integrated Solution:

- Safe School - Pro-active system for access control to schools.
- Safe City – video surveillance monitoring system including an intelligent App for citizens.

The estimated value of the project is 3000000 euro and the financing source shall be EU funds, 2021-2027 financing program.

The Safe City project includes the following objectives:

- Intelligent systems for early public safety dangers detection.
- Analytics type video surveillance.
- Integration with public transportation management system.
- Integration with the traffic management system.
- Integration with the public lighting system.
- App for citizens (front office).
- App for Municipality (back office).

3.2.4.2 IS-4.2: Services for City Management and Planning

The installation of local and centralized monitoring and management system for the Focsani district heating system is part of a complex project for the implementation of a smart multi-sourced low-temperature district heating with innovative storage solutions, which is part of transition track 2. The components of the complex project aiming at the modernization of the district heating system that is related to this integrated solution include the following activities:

- Installation of a system for primary/transportation network for monitoring the state of pipes' insulation.
- Installation of special automation/early fault detection wires along all pipes (heating, domestic warm water and recirculation of domestic warm water) for transportation and distribution networks.
- At thermal substations there shall install:
    - Pressure regulators and variable speed pumps for optimizing the operation of the system and increasing the comfort for heat consumers.
    - Changing the monitoring system and installing an equilibration system.
- Installation at the consumers' limit of property of:
    - Monitoring equipment for each specific consumer for heat consumption for heating and domestic warm water preparation.
    - Hydraulic equilibration system for each specific consumer.
    - Fault detection and monitoring system for each specific consumer.

The implementation of the above-mentioned solutions is very strongly linked with the complex project of modernization of the entire district heating system, and thus, they shall be implemented together with the integrated solution I S 2.2.

Apart from the installation of the monitoring system at different parts of the district heating systems, the Municipality of Focsani, together with SC ENET SA (the local district heating company) are willing to implement a SCADA system for the entire district heating system, including energy generating facility. However, the implementation of the SCADA system is yet in a very early/conceptual stage and needs to be analyzed through a feasibility study and then to take further steps for its implementation.

The Municipality of Focsani is developing the following project proposals that can be implemented within this Integrated Solution:

- Center for Integrated Management of public services.
- Digital Municipality – an integrated e-platform for Municipality.
- Geospatial management of Focsani Municipality area.

Center for Integrated Management of public services includes the following objectives:

- Management of public safety, energy monitoring, traffic and transportation, public lighting, and environmental protection.
- Citizens information system.
- Parking systems management.
- Ticketing in public transportation.
- Management of bike sharing system.
- Smart mobility apps.
- Waste management system.

The estimated value of the project is 8.000.000 euros and the financing source shall be EU funds from the 2021-2027 financing program.

Digital Municipality – an integrated e-platform for Municipality projects includes the following components:

- Digitalization of all processes within the Municipality.
- Encoded communication system within the Municipality.
- A unique integrated management platform.
- A unique digital counter for citizens.
- App E-Citizen.

The estimated value of the project is 10.000.000 euros and the financing source shall be EU funds from the 2021-2027 financing program.

Geospatial management of the Focsani Municipality area project includes the following components:

- Standardization of urban and cadastral data.
- Integration of all urban and cadastral data for the Municipality of Focsani.
- A unique informational system for all urban and cadastral data.
- Procedures for data acquisition and actualization in real time.

The estimated value of the project is 3.000.000 euros and the financing source shall be EU funds from the 2021-2027 financing program.

3.2.4.3 IS-4.3: Services for Mobility

The Municipality of Focsani has analyzed and evaluated the traffic in the city and there resulted the following conclusions from the analysis:

- There is no traffic management and monitoring system in the city of Focsani, which can contribute to reducing traffic congestion and ensuring priority for public transportation for promoting it.
- Due to the inexistence of the traffic management and monitoring system, there have been identified some dysfunctionalities:
  - Overlapping of intranational, national and local roads leading to high traffic.
  - Lack of city bypass belt.
  - Overlapping of urban, local and national public transportation lines.
  - Safety issues for pedestrians due to illegally parked vehicles on the walk sides.
  - An insufficient number of parking spaces.
  - Inexistence of bike lanes.
  - Inexistence of a traffic management system.

The analysis of the situation led to the conclusion of implementing a traffic management and monitoring system in Focsani. The main objective of the project is to promote sustainable urban mobility, based on innovative and efficient solutions, and to reduce pollution in the city of Focsani. The goals of the projects are the following:

- Reduce traffic congestion.
- Reduce pollution in the downtown city.
- Increase citizens' safety.

For analyzing the implementation of the project, there has been performed a feasibility study for the implementation of the traffic management and monitoring system. In the study, there have been analyzed two scenarios (scenario 1 and scenario 2), while scenario 0 represents the actual situation.

Both proposed scenarios have the following common components:

- Implementation of a traffic management system for adaptation of traffic lights in real time according to traffic data.
- Implementation of a prioritization system for public transportation for adaptation and reducing times for public buses.
- Implementation of a monitoring system for video monitoring of crossroads to increase the safety of all traffic participants.
- Implementation of an information system for allowing transit transport to choose alternative routes, leading to reducing traffic in the downtown city.
- Implementation of automatic identification of vehicle plates system in six locations for increasing traffic safety and for decision making process regarding traffic management.

The difference between the two scenariosexists in the re-systematization of road infrastructure and reorganization of traffic in the city of Focsani. The re-systematization of road infrastructure and reorganization of traffic in the city of Focsani for both scenarios is presented below:

- Scenario 1 – installing traffic lights at all crossroads and pedestrian crossings on the following main roads: Unirii – Independentei – Cuza Voda – Bucegi. At the same time, it is proposed to abolish all existing roundabouts.
- Scenario 2 - installing traffic lights at all crossroads and pedestrian crossings on the following main roads: Unirii – Independentei – Cuza Voda – Bucegi. At the same time, it is proposed to abolish all existing roundabouts with the exception of the one at the crossroad Independentei - Marasesti, and introduce one-way roads in the city, as follows:
  - Unirii - Independentei one-way from South to North.
  - Cuza Voda – Bucegi one-way from Nord to South.

  There shall also be implemented special lanes for public transportation in the counter sense of general traffic presented above.

There should be mentioned that the present project for the installation of a traffic management and monitoring system is part of a more complex project that includes the re-systematization of the entire traffic system and modernization of public transportation in the city of Focsani. The other components of the complex mobility project have been presented in the chapter related to Transition Track 4.

The traffic management and monitoring system shall have the following components:

- Traffic management system.
- Video monitoring system.
- Public transportation prioritization system.
- Automatic identification of vehicle plates system.
- Information system.
- Integrated control center.
- Communication network.

There has been performed technical, economic and environmental analysis of both scenarios. The main criteria are presented below.

The investment costs for both scenarios have been estimated as presented below:

- Scenario 1 – investment cost – 4.16 million Euros.

- Scenario 2 – investment cost – 4.43 million Euros.

The annual operation costs, including utility costs, repair and maintenance costs and salary costs, are presented below for both scenarios:

- Scenario 1 – annual operation costs – 229.000 Euros.
- Scenario 2 – annual operation costs – 263.000 Euros.

The implementation of this specific Integrated solution can face several barriers and drivers, as presented below.

1. Technical Bounds & Drivers: Different technical barriers/issues can exist along project implementation. The main identified technical barriers are related to traffic management system and integrated control center. All these technical barriers can be overcome with knowledge exchange and capacity building, which has already started on some issues.

2. Legal: There can be some legal barriers regarding video monitoring system utilization and automatic identification of vehicle plates system. However, these barriers can be overcome through Local Council implication and the creation of a local legal framework.

3. Social: From the social point of view, no barriers were identified. The social advantages of the implementation of this project constitute in improving the living standards of the citizens of Focsani. There should also be mentioned that through this project implementation, there can be created some additional jobs in Focsani city.

4. Financial: On the local/national level, there is a bond regarding the available financing from the Government. On the other hand, there is available financing through different EU funded programs.

5. Environmental: All measures proposed within this integrated solution can reduce pollutant emissions and thus reduce environmental impact.

The Municipality of Focsani has signed the financing contract for this project with a value of 4590109.61 euros. The financing shall be ensured through the Regional Development Agency with 2% participation of the Municipality.

The Municipality of Focsani is also developing the following project proposal that is related to this Integrated Solution:

- Citizen Innovation Platform.

The Citizen Innovation Platform include the following objectives:

- Improvement of urban mobility.
- Integration with the traffic management system.
- Monitoring of parking lots.
- Monitoring of bike parking lots.
- Implementation of a waste management system.
- Creation of a Smart City Focsani platform.

The estimated value of the project is 2500000 euros, and the financing source shall be EU funds from the 2021-2027 financing program.

3.2.5 Transition Track 5 - Citizen Engagement and Co-creation

The Municipality of Focsani has always tried to involve citizens into city development and decision making process. The Municipality already has good examples of information campaigns and citizens' involvement in city projects.

For several years now, The Municipality of Focsani, through its Mayor, has organized yearly meetings with citizens entitled “Tell what you want for your city”. The aims of these meetings are the following:

- To involve citizens in debates regarding the city budget.
- To allow citizens to explain their problems, which can be related to the neighbourhood or the city.
- To allow citizens to come up with new ideas and project proposals for city development.

The Municipality of Focsani has also tried to develop new and to improve existing communication channels between Municipality and citizens. There have been developed, and used the following communication channels:

- Municipality’s website.
- Annual Mayor’s letter and report are available on Municipality’s website.
- Municipality’s e-mail.
- Citizen telephone line.
- Focsani magazine dedicated to issue of Focsani city.
- Leaflets, flyers, etc.

There has also been established communication center within the Municipality. The objectives of this communication center are the following:

- To facilitate the flow of information.
- To allow citizens access to a different database.
- To shorten document trials.
- To reduce redundant activities.
- To create a friendly environment for the citizens of Focsani.

All these activities allowed citizens engagement in city life and decision making. They showed that citizens are willing to get involved in this activity, can point out different problems/issues in different city areas and can come up with interesting and creative ideas/projects.

For this transition track, the Municipality of Focsani is willing to replicate two integrated solutions regarding citizens' co-creation and development of different applications for encouraging energy efficiency behaviour.

There should be mentioned that till now, no study has been elaborated regarding citizen engagement and co-creation. However, it is also true that the Municipality of Focsani and the Mayor of Focsani city fully understand the importance of this issue for the sustainable development of the city, and are willing to take further steps and engage citizens and allow their co-creation to take part in city development.

There should be mentioned that due to the COVID-19 pandemic citizens' engagement into the Municipality's project development and implementation have been very low. Nevertheless, there are some examples of citizen engagement that have been implemented in Focsani.

For transition track 5 the Municipality of Focsani is willing to replicate the following integrated solutions within this transition track:

- Co-creating the energy transition in your everyday environment.
- Apps and interfaces for energy efficiency behaviour.

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

The COVID-19 pandemic has had a great negative influence on citizen engagement for consultation and active participation of citizens of Focsani in the project development and implementation in Focsani area. However, even in this today's context, the Municipality of Focsani has tried to involve citizens as much as possible in the process of making decisions regarding the sustainable development of Focsani city.

Today the Municipality of Focsani is in the process of elaborating two main strategic documents:

- Strategy for development of Focsani city for 2021-2027.
- Sustainable urban mobility plan for Focsani Municipality.

For the elaboration of both documents, the Municipality has tried as much as possible to involve citizens in the elaboration process of these documents and take into consideration all proposals/comments that come from citizens. Almost all activities for citizens consultation took part using online resources.

The Municipality has prepared and addressed to citizens online questionnaire for collecting proposals and comments regarding the above-mentioned documents. There have also been organized online presentations regarding the steps of elaboration of these documents, and citizens have had the possibilities to comment, address questions, and come with proposals online using available chat or via e-mail. For the sustainable urban mobility plan there has also been prepared and sent via e-mail for consultation a questionnaire regarding the mobility preferences of citizens in Focsani. At the same time, to increase citizens' awareness and their implication and engagement in city life and development, there have prepared and distributed throughout the city posters, flyers, leaflets, and video clips in local media channels.

All these actions are directed towards citizens and have as their main objective to try to engage more citizens in city life, development and decision-making process.

There should be mentioned that for this Transition Track and Integrated Solution there are still some gaps and difficulties that need to be challenged and overtaken. Hopefully, in the near future, once the pandemic shall decrease in intensity and knowledge transfer within IRIS project shall increase, regarding this matter, the Municipality of Focsani shall be able to engage and involve more citizens into public life.

3.2.5.2 IS-5.4: Apps and interfaces for energy efficient behavior

The development and implementation of different apps and interfaces in Focsani city depend very much on the implementation of different projects, i.e. bike-sharing concept, sustainable mobility project, city innovation platform, etc. Some of these projects are already in a very advanced phase, i.e. looking for financing or already having ensured funding, and some of them are still in an early development stage.

But these projects also have components regarding the development and implementation of different apps and interfaces for energy efficient behaviour and other specific issues.

The Municipality of Focsani has prepared a list of projects to be implemented in the next EU financing period 2021-2027. Among those projects, there are also proposed apps and interfaces to be developed and implemented. Below is presented the list of proposed projects and apps and interfaces within each project.

- Integrated management and operational center.
  - Interfaces for all public and local authority institutions.
  - Interface for traffic management.
  - Interface for a smart lighting system.
  - Interface for EV charging stations.
  - Interface for waste management
- Citizen innovation platform:
  - Interface and app for parking lots.
  - Interface and app for public transportation ticketing and passenger information.
  - Interface and app for the bike-sharing concept, including bike parking lots.
  - Smart City Focsani platform.
- Digital Municipality.
  - Digitalization of Municipality's internal procedures/processes.
  - Encoded communication system.
  - Unique integrated management platform.
  - A unique digital counter.
  - E-Citizen app.
- Safe School.
  - Front office app for parents.
  - Back office app for internal school management.
- Safe City.
  - Analytics type video surveillance interface.
  - Public transportation management interface.
  - Front office app for citizens.
  - Back office app for operational management.

All these projects shall be developed and implemented in the coming years using EU funds from 2021-2027 budget.

3.3 Status of implementation

Transition Track # 1 and # 2 - Focșani Municipality's good practices in the smart and sustainable urban development field are related to retrofitting both residential and public buildings. The "low carbon districts" mainly include an upgraded district heating system, a highly efficient cogeneration plant and a DHN, supplying about 40% of Focșani city. The cogeneration plant and district heating network are in administration of ENET SA, which is owned by Focsani Municipality. The highly efficient centralized heating system includes:

- a cogeneration source for heat and power, operating on natural gas [2 x high-efficiency CHPPs - internal combustion engines (2 x 6.8 MWe); 2 x hot water boilers (2 x 50 Gcal / h); a hot water boiler (1 x 25Gcal / h)];
- transport network with a length of 23.21 km;
- 57 thermal substations connected to the transport network and supplying homeowners' association (single-family homes, condominiums), private companies, public institutions and social-cultural entities;
- distribution network in the length of 59.08 km;
- heat meters installed for condominiums (apartment buildings), inside the staircases of the block of flats, on the heating and hot water distribution networks.

All these technological improvements are possible through a major retrofitting and upgrading project managed by Focșani Municipality, aiming at compliance with national environmental standards on air pollution and energy efficiency for heat supply systems. Also, a new project targeting the rehabilitation of the district heating system at the level of Focsani Municipality was submitted.

Transition Track #3: Municipality of Focsani has many road links at the national and Vrancea County level, being an important road junction in the south-east part of Romania. Of the Municipalities' major roadways 70% is oriented from North to South. According to data from the National Institute of Statistics, the total road length of the city is about 123 km, of which about 84% already modernized (103 km). Related to public transport, according to the scheduled traffic, nine routes of buses for public transportwere approved, with a total length of 160 km roundtrip, but still there are areas with no such public transport services for the citizens.

Several projects were implemented and other are being implemented at the date of the present document, in line with the approved SUMP, for upgrading and extending the green areas; repairing streets network, sidewalk, access alleys, parking areas, bus stations; construction of new parking areas and bikes tracks; intermodal knots; EV charging infrastructure both for e-cars and e-buses of medium and small capacity, etc.

Transition Track # 4: The municipality has an ICT system, based on a GeoMedia platform for Integrated Accounting and Financial Management - for all local subordinated public institutions and services (buildings; services such as social, population register, street sanitation, green public spaces, street lighting, parking, markings / road signs, local police, culture, etc.). This ICT system gathers data from purchased or internally developed applications in Visual Basic, Access, Php, and Macromedia or from files built with AutoCAD, Microsoft Office, CorelDraw, and Adobe. All Software is licensed and enables specialists to develop new projects in various fields. The Main IT software used, at this moment, is based on this GeoMedia platform, with access rights for the subordinated companies / utilities providers already connected to this communication network: tax collectors, agricultural evidence, urban planning, human resources and Public Domain Inventory. The main challenge and step forward will be to interconnect data from all software used by the city and the other public services transport, public lighting and utility providers not yet integrated - heating, water, sewerage, natural gas, communication, electricity, etc. Additionally, the municipality implemented a surveillance and crime prevention system in the following districts: Sud, Laminorul and Mandresti. The Municipality of Focsani has been

implemented a project (WIFi4EU) aimed at promoting the internet connectivity of the local community. Through this project, the municipality used a grant to install 15 access points for free internet access in crowded areas of the city.

Transition Track #5: Focsani has always been a city orientated to the future in relation with the efficiency and transparency of the municipal management process, keeping close connections with the civil society representatives. In 2002, Focsani was one of the first cities that implemented the “Communication Centre for Citizens” concept, long before the Romanian legislative framework was in force. Based on citizens involvement in the decision-making process, Focsani has drawn out the city Development Strategy (2017), being one of the first document of this type performed in Romania. Focsani developed several analyses and implemented, together with a European consultant in the field, a management system for a dynamic and transparent public administration, which became a model for other local municipalities.

4 Guidelines for smart city concept implementation for South-Central European region

The smart city concept is gaining more and more interest across Europe, especially in today's energy prices environment. European cities and towns are developing and implementing different projects that improve life quality, reduce energy bills, and reduce climate change. Even though the solutions for projects are pretty similar in different parts of Europe, there are specific issues for different EU regions.

The specific characteristics affecting implementation of smart city solutions in the South-Central European region are presented below. These aspects are presented for each Transition Track for those Integrated Solutions that are developed by Focsani Municipality.

TT#1: Smart renewables and closed-loop energy positive districts

IS-1.2: Near zero energy retrofit district

- In Romania, most apartments are owned by residents, and this can sometimes lead to different problems for project implementation, e.g., all owners should agree on building retrofitting, which sometimes is quite difficult.
- The stock of apartment building is quite old, and thus, almost all the buildings need retrofitting, leading to very high investment costs for Municipality.
- The financing schemes for building retrofitting also include the participation of apartment owners. However, even though their financial participation is quite small, some citizens might have a problem financing the rehabilitation.

TT#2: Smart Energy Management and Storage for Grid Flexibility

IS-2.2: Smart multi-source low temperature district heating with innovative storage solutions

- The district heating concept was largely developed in Romania in 1970-1980, but due to the lack of investment many district heating systems are not in operation anymore.
- The disconnection rate from the district heating system is relatively high.
- The quality of service can be improved.
- The citizens awareness about the advantages of district heating compared to separate heat generation can be improved.

TT#3: Smart e-Mobility Sector

IS-3.1: Smart solar V2G EVs charging

- A new concept with very low experience in the region.

- Need knowledge transfer.

IS-3.2: Innovative Mobility services for the Citizens

- Low citizens' awareness regarding innovative mobility services.
- Sometimes low quality of public transportation services.

TT#4: City Innovation Platform (CIP)

IS-4.1: Services for Urban Monitoring

- Street lighting systems need more investments.

IS-4.2: Services for City Management and Planning

- Difficulties in engaging different stakeholders.

IS-4.3: Services for Mobility

- Usually high traffic, congestions.

TT#5: Citizen engagement

IS-5.1: Changing everyday energy use

- Low citizens' awareness of energy efficiency effects on the entire community.
- Low citizens' engagement in project development and implementation.

IS-5.4: Behavior changing Information

- Low citizens' utilization of apps for energy efficient behavior.

The IRIS Lighthouse cities have developed and implemented different projects linked to the smart city concept. The Fellow cities prepared replication plans and went even further developing and even implementing/replicating smart city projects. During this process, all IRIS partners have gained experience. The Municipality of Focsani has benefited from Lighthouse cities' experience and projects and tried to improve the knowledge on how to develop and implement projects on the smart city concept. So, based on this experience, there are some general guidelines that cities can use to develop and implement smart city concept projects.

- Understand the needs and challenges of the city.
- Define city objectives and targets for the long term.
- Identify local and regional stakeholders.
- Identify and connect with other cities that have already taken steps towards smart city.
- Identify and contact consulting companies, research institutes, and universities that can provide valuable information on smart city solutions and help elaborate a master plan.
- Increase citizen's awareness.
- Involve citizens in the process of project development.

- Allocate resources, including human resources.
- Elaborate a master plan / program based on city needs and objectives.
- Identify national and EU funding programs.
- All implemented projects should improve the quality of life.

Besides the general guidelines, there are some guidelines specific for South-Central European region that should be taken into consideration when developing and implementing smart city projects.

- Since most of the apartments are owned by residents, citizens' engagement and support are very important, especially in building rehabilitation projects.
- Ensure financing for building retrofitting, if possible, 100 % from Municipality or other funds since there might be problems when citizens should also fund the project.
- Ensure local support and legislation for development of the district heating network before implementing projects on the district heating system.
- Increase the quality of services of the district heating system, e.g reducing the number of hours for maintenance works, reducing the supply interruptions, improving monitoring.
- Increase citizens' awareness about the advantages of district heating compared to separate heat generation.
- The Municipality is responsible for municipal waste management and district heating – combining these two, e.g., using wastes for heat generation, can solve both problems.
- In the latest developments in energy markets, but also moving towards mitigating climate changes, the use of renewable energy sources (solar, biomass, geothermal) in district heating system is a must.
- Improve knowledge about innovative city mobility, e.g. car sharing, bike sharing.
- Increase citizens' awareness regarding innovative mobility services.
- Increase citizens' awareness regarding the advantages of digitalization, urban monitoring, and city digital platform.
- Increase citizens' awareness of energy efficiency effects on the entire community, e.g. improving air quality, reducing energy bills, increasing the quality of services.

5 Conclusions

The Municipality of Focsani has taken many steps towards a smart city concept, and in recent years, has implemented (and is implementating) many projects in different areas. The city has gained a lot of experience due to its participation in IRIS project, and due to implementation of different projects.

The most important takeaways and lessons learned within the IRIS project are the following:

- Smart city concept can be different from city to city
- Solutions are quite specific for each case
- Great intercity connections
- Great opportunity for knowledge exchange
- Great opportunity for site visits of already implemented projects
- Local stakeholders are very important for project development and implementation
- Increasing people's awareness can lead to better project development and implementation
- Citizen’s engagement can lead to new ideas/projects, but it is difficult to develop
- Utilization of smart apps can improve the overall citizen involvement

Based on this wealth of experience, Municipality of Focsani and local IRIS partners elaborated guidelines for the development and implementation of smart city projects. The guidelines are divided into two categories: general guidelines and guidelines specific for this region. Municipalities and stakeholders can use both sets of guidelines to shorten the path towards projects’ implementation, avoiding common mistakes and increasing the efficiency.

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Annex 1-Five Transition Tracks

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. Within these five tracks, IRIS envisions to demonstrate a set of integrated solutions built on top of both mature and innovative technologies. The integrated solutions are defined on the basis of a common-shared know-how interchange among the lighthouse and followers cities, and planning of replication from the early beginning of the project.

IRIS Transition Track #1: Renewable and energy positive districts

Integrating:

- high share of locally produced and consumed renewable energy at district level
- energy savings at building level reducing the citizens' energy bills
- energy savings at district level

IRIS Transition Track #2: Flexible energy management and storage

Integrating smart energy management and renewable energy storage for:

- maximum profits of renewables power/heat/gas
- maximum self-consumption reducing grid stress and curtailment
- unlocking the financial value of grid flexibility

IRIS Transition Track #3: Intelligent mobility solutions

Integrating electric vehicles and e-cars sharing systems in the urban mobility system offering:

- local zero-emission mobility
- lower household mobility costs
- smart energy storage in V2G car batteries

IRIS Transition Track #4: Digital Transformation And Services

Cutting edge information technology and data framework enabling:

- Urban monitoring
- City management and planning
- Mobility services
- Energy management

The above mentioned solutions maximizing cost-effectiveness of the integrated infrastructure
Next, the City Innovation Platform with open, standards based application program interfaces (APIs) provides meaningful data and information services for households, municipality and other stakeholders, allowing for a Data Market with new business models.

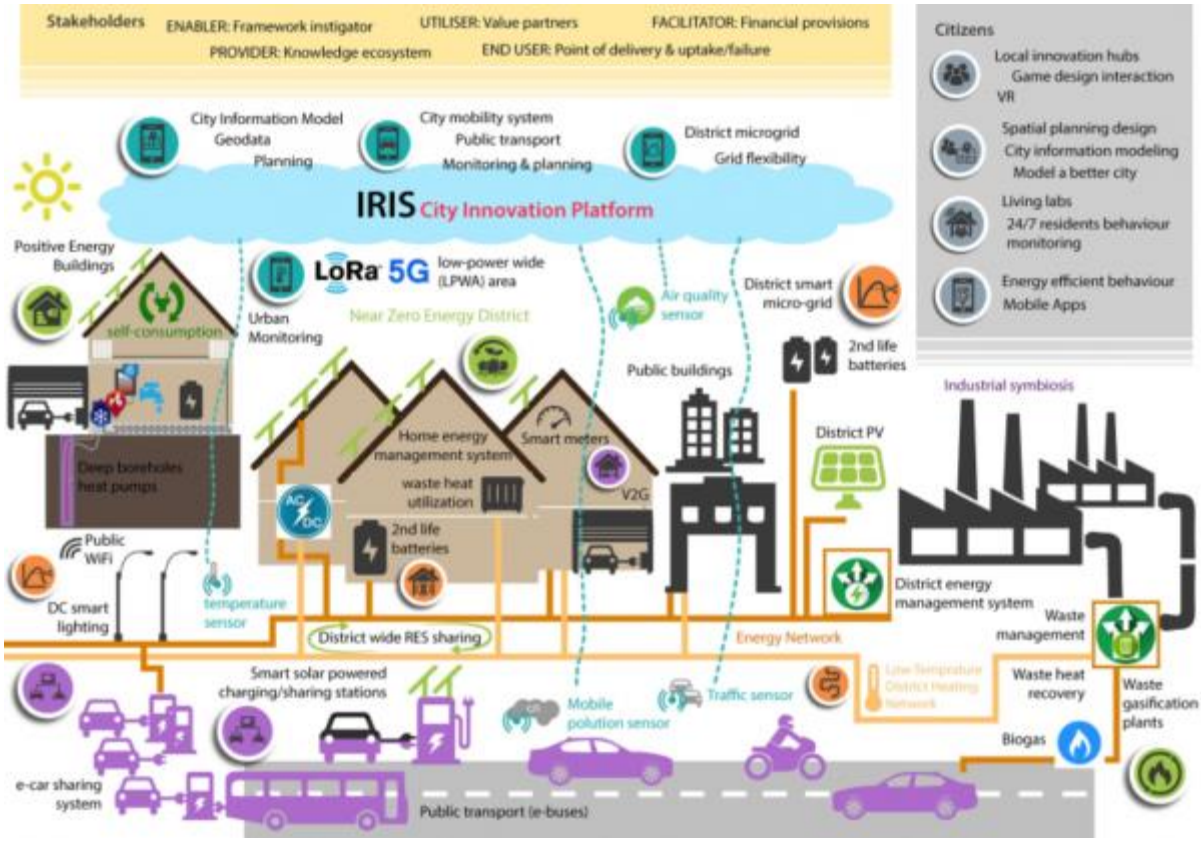
IRIS Transition Track #5: Citizen Engagement and Co-creation

Design and demonstration of feedback mechanisms and inclusive services for citizens to achieve that they are intrinsically motivated to:

- save energy
- shift their energy consumption to periods with redundant renewables
- use electric vehicles
- change the vehicle ownership culture towards a use or common mobility assets culture

OVERVIEW OF THE IRIS INTEGRATED SOLUTIONS

The below figure of IRIS illustrates the integration of the various elements (both very near-to-market and innovative), composing all IRIS solutions, as foreseen to be demonstrated and further replicated among the participating cities and beyond them. Energy elements (e.g. DC smart lamping, waste heat generation, near zero and positive energy buildings) along with storage solutions (deep boreholes, PCM, 2nd life batteries) for increasing grid flexibility and promotion of RES, integrated with mobility aspects (e.g. solar powered V2G) in a district level will in the very near future allow the EU citizens to be autarchies, without experiencing any grid stress problems. Through the supervision of solutions by the developed open-access City Innovation Platform citizens will be healthier and bi-directionally engaged with their cities. In that aspect, IRIS will demonstrate the integrated, intrinsically motivated by their citizens (through a list of services), operation of all these individual key-elements at the demonstration districts of the three LHs.



https://irissmartcities.eu/five-transiition-tracks/