POCITYF

D8.13 Ioannina Replication Plans and City-Vision for 2050

WP8: Replication Plans and 2050 Vision by Fellow Cities

T8.7: Ioannina Replication Plans and City-Vision for 2050

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PP = Restricted to other programme participants (including the Commission Services)

RE = Restricted to a group specified by the consortium (including the Commission Services)

CO = Confidential, only for members of the consortium (including the Commission Services)

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Version History

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Disclaimer

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Executive Summary

POCITYF, a 5-year project co-financed by the European Union's Horizon 2020 programme, supports the Lighthouse Cities of Evora (PT) and Alkmaar (NL) and their Fellow Cities Granada (ES), Bari (IT), Celje (SI), Ujpest (HU), Ioannina (GR) and Hvidovre (DK) in their urgent need to deliver Positive Energy Blocks and Districts in their cities, to render their mixed urban environment, including cultural heritage buildings, into a cheaper, better accessible, healthier and more reliable place to live. In the frame of the project, each Fellow City must study the innovative technologies, tools, and methods demonstrated in the Lighthouse Cities in order to perform feasibility studies and deliver Replication Plans adapted to their local context, which will act as roadmaps for sustainable cities across Europe and world-wide.

This document is the first edition of the Ioannina Replication Plan and City Vision for 2050 and has the aim to present the work performed by the Municipality of Ioannina in collaboration with CERTH in the frame of POCITYF project until September 2022. The document is structured upon a general replication framework and roadmap defined by POCITYF consortium partners and represents only the basis of further replication related activities that will take place in the Municipality of Ioannina in the next two years. The final version of the Replication Plan will be delivered as an updated version of this document in September 2024.

The Replication Plan begins with the definition of the Ioannina city framework in relation to the smart city indicators (benchmarking). This preparatory activity, which demanded great effort in collecting at least 65 indicators and related information from various fragmented sources, has led to the identification of the city needs and key priority areas in relation to these indicators and in alignment with the city's Strategic Plans for sustainable urban development, energy and mobility. The replication areas and the case-study buildings and districts are also defined, the set of innovative solutions to be replicated is finalised and the expectations, opportunities, but also possible barriers and challenges related to their implementation are identified.

Due to the complexity of the project, a crucial factor in creating validated Replication Plans and Smart City roadmaps towards 2050 is considered the engagement of many different stakeholders early in the planning process. The creation of the local Work Group consisting of representatives from the City Council, utility companies, citizen associations, users, private entities, internal POCITYF consortium partners and the city administration staff, together with all the activities performed with them until today are presented in a dedicated section. The local Work Group will be supporting the planning process until the end of the project and for this reason will be further developed, and more detail will be brought into the respective role of each stakeholder.

The document continues with a description of all the replication tools and resources made available by the consortium and were exploited by the Municipality of Ioannina for the knowledge transfer from the Lighthouse Cities to the Fellow Cities, for deepening the technical knowledge on the solutions demonstrated in the Lighthouse Cities, for evaluating social acceptance by citizens and local stakeholders, and for sharing knowledge, insights and best practices with other Smart City Projects and related work groups.

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The final part of the document focuses on designing the actual Replication Plan. At this stage only analysis at building level for determining the baseline energy condition of the case-study buildings was performed and is presented. The methodology for the evaluation of the energy upgrade of the individual buildings towards achieving positive energy performance and the simulation tool used for the buildings analysis are described, and a report of the results from the analysis for each separate building follows. Comparison of the simulated results with data from actual electricity and fuel consumption bills suggests that the simulation models of the buildings provide an adequate representation of the current performance of the buildings and are suitable for the next step of the analysis. The results also verify the need for interventions to improve the energy efficiency of the buildings and the conditions for people working in them.

The document ends with a summary of some key findings from the feasibility study (SWOT analysis), including technological and legislative considerations, results on the research on the existing marketplace, assessment of the required staff and the organizational structure transformation needed and some preliminary funding and financing recommendations, followed by some early suggestions for scale-up and expansion of the Replication Plan. Conclusions include a self-assessment of the progress achieved until today and the activities planned to be carried out in the next phase of the project in order to define a realistic business plan to support the Replication Plan, to engage more efficiently with external stakeholders and to involve citizens in the definition of a commonly accepted Smart City Vision for 2050.

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Abbreviations and Acronyms (in alphabetical order)

Abbreviation	Definition
BMS	Building Management System
CCG	City Coordinators Group
CEC	Citizen Energy Community
CO_2	Carbon dioxide
EC	European Commission
ELSTAT	Hellenic Statistical Authority
ETT	Energy Transition Track
EV	Electric Vehicle
EVCP	Electric Vehicle Charging Plan
FC	Fellow City
HEDNO	Hellenic Electricity Distribution Network Operator
HEMS	Home Energy Management System
ICT	Information and Communications Technology
IE	Innovative Element
IPTO	Independent Power Transmission Operator
IS	Integrated Solution
KENAK	Regulation of Energy Performance of Buildings
Km^2	Square kilometer(s)
kWh	Kilowatt hour
LHC	Lighthouse City
LV	Low voltage
MoI	Municipality of Ioannina
MSW	Municipal Solid Waste
MV	Medium voltage
NiMH	Nickel-metal hydride
NSB	National Standard Bodie
O.P.	Operational programme
P2P	Peer-to-Peer
PAYT	Pay-As-You-Throw
PEB	Positive Energy Block
PED	Positive Energy District
POCITYF	A POsitive Energy CITY Transformation Framework
PPP	Public-Private Partnership

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Abbreviation	Definition
PV	Photovoltaic
REC	Renewable Energy Community
RES	Renewable Energy Source
RP	Replication Plan
RRF	Recovery and Resilience Fund
SEAP	Sustainable Energy Action Plan
STEP	Epirus Science and Technology Park
SUDP	Sustainable Urban Development Plan
SUMP	Sustainable Urban Mobility Plan
TEI	Epirus Technological Educational Institution
TOTEE	National technical directives for the calculation of the energy efficiency of buildings and the issuance of the Energy Performance Certificate
UGS	Urban Green Space
V2G	Vehicle-to-Grid

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1 Introduction

1.1 Scope, objectives and expected impact

POCITYF is a consortium of 46 partners from 13 countries co-financed by the European Union's Horizon 2020 programme to create Positive Energy Blocks (PEB). PEBs are geographically delimited areas where local renewable energy production is higher than consumption. Within the scope of POCITYF, the Positive Energy Block (PEB) concept is being demonstrated in two lighthouse cities - Évora, in Portugal, and Alkmaar, in the Netherlands - and six fellow cities in Europe – Bari in Italy, Granada in Spain, Celje in Slovenia, Ujpest in Hungary, Ioannina in Greece, and Hvidovre in Denmark. To create PEBs, the POCITYF project considers various innovative economically, socially and environmentally beneficial solutions, allowing the conservation of the cultural heritage of the cities while becoming more self-sustainable and environmentally friendly, with the ultimate goal of improving citizens' wellbeing [1].

POCITYF will demonstrate 10 integrated solutions (ISs), built on top of 73 Innovative Elements (IEs). The solutions are grouped, according to the challenges they address, into four (4) Energy Transition Tracks (ETTs):

- ETT#1 - Innovative Solutions for Positive Energy Buildings and Districts: Includes solutions at building and district level that enable the increase of energy self-consumption, energy savings and high share of locally produced renewable energy. This will lead to the deployment of positive energy districts (PEDs) located in mixed use urban districts, including cultural heritage areas.
- ETT#2 - P2P Energy Management and Storage Solutions for Grid Flexibility: Includes P2P energy management and storage solutions supporting grid flexibility and curtailment reduction.
- ETT#3 - E-Mobility Integration into the Smart Grid & City Planning: Proposes solutions for the integration of electro-mobility solutions as an enabler to grid flexibility.
- ETT#4 - Citizen-Driven Innovation in Co-creating Smart City Solutions: Includes solutions for the integration of the latest generation of ICT solutions within existing city platforms and proposes active citizen engagement services and solutions providing an open innovation ecosystem for citizens to participate in co-creation, decision making, planning and problem solving.

Each of the 73 IEs categorized within the four ETTs will be tested in the two LHCs and will be replicated by the FCs in their local context. One of the project targets is to document the replication of the IEs in the FCs in the form of local Replication Plans. The main objectives of the Replication Plans are:

- to demonstrate the implementation of the IEs at both a building and district level, creating energy positive districts and enabling increased energy self-consumption, energy savings, and an increased share of locally produced renewable energy

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- to demonstrate active citizen engagement services and solutions providing an open innovation ecosystem for citizens to participate in co-creation, decision making, planning and problem solving within the Smart Cities'
- to test the business models and investment concepts developed and discovered in the LCs, that consider the whole lifecycle of the Positive Energy District (PED)
- to develop feasibility studies and business plans for the IEs in a range of cities with different sizes, geographies, climatic zones and economic situations
- to further develop the IEs alongside the other FCs so that they are market-ready by the end of the project
- to identify regulatory barriers, legal aspects and data security/protection issues and test the proposed solutions to these barriers.

Ioannina FC intends to perform feasibility studies and replication plans for all 4 ETTs and most of the respective IS categories (except: IS-2.2: Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions and IS-4.2: Open Innovation for Policy Makers and Managers). A holistic cross-ETT-sectional feasibility study together with the respective applicable replication plans according to the specific Ioannina local conditions, needs and necessities will be carried out in the scope of this deliverable. Moreover, this task will elaborate on identifying quantified goals and ambitions of Ioannina to deliver a roadmap towards the bold city vision for 2050.

1.2 Structure of the deliverable

This deliverable is structured in five sections:

- Chapter 1 – Introduction: Introduces the general scope of the document, including relevant background information and objectives.
- Chapter 2 - Benchwork Framework: Introduces Municipality of Ioannina as an FC, describes the replication areas, identifies the IEs which Ioannina FC is motivated to replicate in these replication areas, and defines possible challenges and barriers to the replication activities.
- Chapter 3 - Processes towards the implementation of the Replication Plan: Describes the governance and administrative processes related to planning the replication activities, the work groups involved in the planning process of the replication activities, and the local stakeholders who have been engaged until today. Further, this section describes the proposed use of IEs chosen to be replicated, and the processes behind the selection of these IEs for replication in Ioannina FC.
- Chapter 4 - Building up the Replication Plan: Provides a final report of the planning of solutions' implementation, the final selection of IEs to be replicated, and addresses the financial aspects of implementing the Replication Plan.

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2 Benchmark Framework

2.1 General description of the city

Located in the North-western part of the country, on 480 m altitude among high mountain peaks, Ioannina is a “lake city” built on the west coast of Lake Pamvotida. The town was built on the famous ‘Egnatia Odos’, the road that connects Europe with Asia, one of the most ancient routes in history, spanning over 2,000 years, once used by the Persians and ancient Greeks. Ioannina is the capital and largest city of the north-western Region of Greece, Epirus, which combines its long history with a social, cultural, and economic activity and prosperity. It is an attraction and reference point for many visitors.

Figure 1 Photo of the castle settlement and the Ottoman monuments

Its history starts as a city developed in the walls of a castle, right next to the lake. The same walls, even today, host a traditional settlement as well as the main cultural landmarks of the city, which reveal all historical periods of the city. The castle of Ioannina was built approximately during the 10th century. The city outside the walls of the castle started to expand only after the 15th century. The main expansion includes the historical centre of the city and areas around the castle, where the first market in the form of an open market (bazaar) appeared. Until 1912, most of the buildings in the city were made of wood and were mainly family houses. The first concrete historical buildings of the city started appearing in 1930, after World War I. The city’s central square, which hosts today the building of the Regional Government, was built in 1870, ruined in

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1930 and re-constructed later. Other important buildings are the Town Hall, built in 1938, and the Zosimaia Library.

Figure 2 Highlights of the city

Ioannina is a fast-developing urban city with an increasing population of currently 112,486 people (EL.STAT. 2011 demographic census). Its population has increased 12% in the decade 2001-2011, a phenomenon which goes hand in hand with the city's general development at the level of infrastructure, employment and mainly in the tertiary sector of services and businesses, but also with the general tendency of Greek residents to move to large urban centres, like the city of Ioannina is for the surrounding mountainous areas and the smaller cities of the Region of Epirus. The proximity to Albania and the cross-border maritime area of Greece - Italy (via the port of Igoumenitsa), creates for the city of Ioannina a strong interregional/transnational profile as an "urban centre - pole" with strong potential for achieving a high quality of life and a wider-range influence [2].

Regarding the building stock, as seen in Table 1, most of the buildings in the Municipality were built before 1985. The suburban and peri-urban settlements in the immediate perimeter of the city are relatively newly built. According to the latest census, 75.3% of the buildings in the wider area of the Municipality are used exclusively as residences. It appears that in the Municipality of Ioannina there are 717 exclusively public buildings, while 43 are jointly owned by the State and

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private individuals [3]. The total number of households in the MoI is 43,488, with the average household size being 2.59 members/household (Source EL.STAT., 2011).

Table 1 Age of buildings

Municipality of Ioannina	Total number	Time of building construction											
		Before 1919	1919 - 945	1946 -1960	1961 - 970	1971 - 980	1981 - 985	1986 - 990	1991 - 995	1996 -2000	2001 - 005	After 2006	Under construction
	28,527	650	791	3,035	3,979	5,215	2,847	2,339	2,056	2,169	2,643	2,448	355

The Prefecture of Ioannina belongs to climate zone C, according to the Regulation of Energy Performance of Buildings (KENAK) [4]. Affected by the terrain relief, the climate of the prefecture of Ioannina is characterised as continental, with a lot of rainfall and low temperatures in winter and high temperatures in summer. The intense rainfall and humidity of the area are among the highest in Greece.

Table 2 Ioannina climate data

CLIMATE DATA FOR IOANNINA - Altitude 500m, latitude 39.40'N, longitude 20.51'A [5] (Average values over a period of at least 40 years)					
	JAN	**APR**	**JUL**	**OCT**	**YEAR**
Average Temperature (C)	5	12	25	15	14
Maximum Temperature (C)	10	18	31	21	20
Minimum Temperature (C)	0	6	15	9	8
Relative humidity (%)	77	68	52	71	68
Cloudiness (eighths)	5	5	2	4	4
Sunshine (hours)	93	166	316	158	2153
Rainfall (mm)	124	78	32	100	1082
Precipitation (days)	12	13	5	10	120
Snowfall (days)	2	0	0	0	6
Frost (days)	15	1	0	1	50
Storms (days)	2	2	5	3	40
Fog (days)	5	2	0	5	36
Prevailing Wind	S-E	N-W	W	S-E	

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Ioannina is a Covenant of Mayors signatory and has already prepared its Sustainable Energy Action Plan (SEAP), its Sustainable Urban Mobility Plan (SUMP) and its Sustainable Urban Development Plan (SUDP).

A description of the status of the city of Ioannina in reference to the Smart City Indicators (environment, mobility, governance, economy, people and living) can be summarised in Table 3. Data is collected mainly from the SEAP, SUMP, SUDP, the official site of the Municipality of Ioannina and other internal sources, IPTO, HEDNO, police etc. The Smart City Indicators used are adapted from the Cohen B. Smart City Index Master Indicators Survey [6].

Table 3 Smart City Indicators for Municipality of Ioannina

Criteria	Indicator	Sub-indicator	Description
ENVIRONMENT	Smart buildings	Sustainability-certified buildings	**Number of LEED or BREEAM sustainability-certified buildings in the city (if your city uses another standard please indicate).** At the moment there are no LEED [7] or BREEAM [8] sustainability-certified buildings in the city. According to the passive house database [9], there are also no Passive House or EnerPHit certified buildings in the city. According to the Green Building Information Gateway [10], there are 3 hotels following the Trip Advisor GreenLeader programme.
			Number of commercial and industrial buildings with smart meters. Telemetering of Medium Voltage Customers was completed in 2009 [11] and of large Low Voltage Customers with power higher than 55 KVA in 2016 [12].
			Number of commercial buildings with a building automation system. From an online research, the following commercial buildings have been found to have BMS: The Airport, the University Hospital, the Regional Hospital, the University Library, various buildings in the university campus, the Municipal Swimming Pool, at least 3 hotels, supermarkets, the «Arsakeio» private school, the Museum of Silversmith, the central car park, and the IKEA/JUMBO shopping park (in the outskirts of the city).
		Smart homes	**Number of homes with smart meters** Since the last few years, every new residential building is equipped with a digital meter but the replacement of the 7,500,000 existing analogue meters with "smart meters" is still pending. Gradual replacement of all existing electricity meters with smart meters is on track for implementation with 2030 being the completion horizon for the low voltage (under

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Criteria	Indicator	Sub-indicator	Description
			55kVA). The new digital meters already installed will also need to be retrofitted to become «smart».
	Resources Management	Energy	**Energy derived from renewable sources (ISO 37120: 7.2) [13]** The energy mix in Greece consists of natural gas (ca. 40%), renewables (ca. 30%), hydropower (ca. 10%), lignite (ca. 10%), and net imports (ca. 10%). In Q1 2021, 46,1% of the energy produced in Greece came from RES & hydro [14].
			Total residential energy use per capita (in kWh/yr) According to the SEAP, the total energy consumption of the residential sector is: Electricity: 125,473,064 kWh/year; Thermal energy (Oil): 213,819,284 kWh/year; Thermal energy (Biomass): 63,799,863 kWh/year; Thermal energy (LPG): 20,755,466 kWh/year. Given a population of the Municipality of Ioannina amounting to 112,486 permanent residents (Source ELSTAT 2011), it appears that the average energy use per capita is about 3,768 kWh/year/resident [3]. The national campaign «SAVE (EXOIKONOMO)» for improving the energy efficiency of households is now on its 4th round. The "SAVE" Programme is part of the flagship projects subsidized by EU Funds for improving the energy class of households by at least 3 energy categories (over 30% Primary Energy Saving). The investment includes separate incentives to support the poor and vulnerable households in the form of an increased subsidy rate and budget [15]. Regarding natural gas, the region of Epirus is not connected to the National Pipeline System yet, but the construction of a 119 km low-pressure and 10 km medium-pressure natural gas network is tendered and by 2026 there will be at least 2,650 consumer connections of all categories (residential, commercial, industrial). Until the city network is connected to the National Pipeline System, the city will be supplied through two liquefied natural gas (LNG) stations [16]. Natural gas is expected to bring substantial benefits for the community in terms of heating
			% of municipal grid meeting all of following requirements for smart grid: (1) 2-way communication; (2) Automated control systems for addressing system outages; (3) Real-time information for customers; (4) Permits distributed generation; (5) Supports net metering Electricity in Greece is being distributed through the Independent Power Transmission Operator (IPTO) and not by municipal grids. The national grid supports distributed generation as well as net-metering and virtual-net metering.

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			Currently in Greece, approximately 50% of the consumed electricity is recorded by telemetry. Of this percentage, almost 15% concern High Voltage (IPTO) and approximately 35% Medium Voltage and large Low Voltage consumers (read about smart meters and telemetry above).
		Carbon footprint	**Greenhouse gas emission measured in tons per capita (ISO 37120: 8.3) [13]** According to the SEAP, the total annual CO_2 emissions of the Municipality of Ioannina amount to 552,427 tons of CO_2 (2018): 32% from transport; 30.5% from the residential sector; 19.1 % from the tertiary sector; 12.2% from the secondary sector; 0,8% from the primary sector; 5.4% from activities of the Municipality (pumping stations, lighting, municipal buildings and facilities etc) [3]. According to the first progress report of the SEAP (06/2021), no action or project has been completed in the context of the implementation of the SEAP that has led to reductions in either energy consumption or gas emissions.
		Air quality	**Fine particular matter 2.5 concentration (μg/m3) (ISO 37120: 8.1) [13]** There is one air pollution measurement station (IOII) installed in the city and operated by the Ministry of Energy measuring CO, NO, NO_2, O_3, $PM_{2.5}$, PM_{10} and SO_2 [17]. Concentration of $PM_{2.5}$ (particulate matter less than 2.5 microns) is ca. 10.28 μg/m3 (Good) [18]. Awareness is needed on the matter of open wood-burning fireplaces, which has become particularly intense in the last 10 years.
		Waste generation	**Waste Management** In March 2019 commenced its commercial operation the Municipal Solid Waste Treatment Plant of Epirus Region (1.5 MW), one of Europe's most modern waste treatment plants, which serves the city of Ioannina as well. The unit includes a recyclable sorting plant, a biogas power plant and a low-quality compost plant (for quarry remediation). The unit will also undertake the composting of Ioannina city (up to 10,000 tons per year), provided that there is a separate collection from the municipality, for the production of high-quality soil conditioner. 8 waste transfer stations, which have not yet started their operation, will create an integrated waste management system in the Region. This innovative "green" project not only brings multiple benefits for the ecosystem, the economy and the upgrading of the quality of life of the people in the Region of Epirus but was also an exemplary project of Private Public Partnership (PPP).

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Criteria	Indicator	Sub-indicator	Description
			In accordance with the specifications of the current National Waste Management Plan [19], the Municipality of Ioannina has recently prepared its Local Plan, in order to integrate the whole new institutional framework for solid waste management, emphasizing innovative actions, adapted to the city's characteristic features. Main objective is the development of prevention actions (reduction of production), separate collection and sorting at the source, reuse and recycling of municipal solid waste with the aim of reducing waste that ends up in landfills and their management based on the principles of the Circular Economy. The system «Pay-as-you-Throw» is included under the proposed innovative interventions. According to recent Law 4819/2021, as from 01/01/2023 the system becomes obligatory for Municipalities with population over 100.000 citizens [20].
			Total collected municipal solid waste in city per capita (in kg) (ISO 37120: 16.2) [13] 48,151.86 tons of Municipal Solid Waste (MSW) was collected in 2019 and 46,994.71 tons in 2020. Taking into account as the most representative year due to covid-19 the year 2019 and given a population of MoI amounting to 112,486 permanent residents (Source ELSTAT 2011), it appears that the average production per capita is about 1.15 kg/day or 419.4 kg/year/inhabitant [21].
			% of city's solid waste that is recycled (ISO 37120: 16.3) [13] Taking into account as the most representative year due to covid-19 the year 2019, it is observed that 78% of the total MSW produced is collected through the green bin network (general waste). Also, looking into the average for the last three years it appears that from the recyclables of the blue bin, only 59% constitutes recyclable materials while the rest is waste [21].
		Water consumption	**Commercial buildings with smart water meters** There are no smart water meters in place yet in Ioannina. A pilot installation of "smart" digital water meters in the Castle settlement with real-time recording and data collection/management through the GIS database is planned.
			Total water consumption per capita (liters/day) (ISO 37120: 23.5) [13] According to the National Operational Plan for Drinking Water [22] the current daily consumption per inhabitant in the Region of Epirus is ca. 265 litres/inhabitant/day (Status 2021). In the Region of Epirus there is a shortage of drinking

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Criteria	Indicator	Sub-indicator	Description
			water in some areas mainly due to the large losses of the water grids. This shortage affects the water supply of 60 communities/settlements in Ioannina too. It is considered necessary to upgrade-replace the grids (external-internal) in order to deal with local degradation of the quality of water for consumption, while several pumping stations show a significant consumption of electricity with a simultaneous large loss of water due to the outdated technology.
	Sustainable urban planning	Climate resilience planning	**Does your city have a climate resilience strategy/plan in place? If yes, provide a link.** MoI does not have a climate resilience plan. The vision and strategy of the Municipality of Ioannina for climate resilience are reflected in its Sustainable Energy Action Plan (SEAP) [3]. The final text was submitted in 2019, without revision until today, and is the result of the commitment of the Municipality of Ioannina to the goals of the Covenant of Mayors to reduce CO2 and other greenhouse gas emissions by at least 40% by 2030 and complete detoxification by 2050, to enhance its resilience by adapting to climate change and to enable citizens to have access to safe, sustainable, and affordable energy. MoI has also been selected as one of the "100 Energy Neutral and Smart Cities" pilot programme, with the support of the University of Patras [23].
		Density	**Population weighed density** The Municipality of Ioannina is the most urbanized and numerous of the Epirus Region, as it is inhabited by ca. 1/3 of the Region's total population. Its area is 403.32 km^2 and its population according to the 2011 ELSTAT results amounts to 112,486 permanent residents. It is, therefore, a fairly densely populated municipality with a population density of 277.05 inhabitants/ km^2 [3].
		Green space per capita	**Green areas per 100,000 population (in m2) (ISO 37120: 21.1) [13]** According to research conducted by the Agricultural University of Athens in 2010 and concerned the mapping and comparative analysis of the spatial distribution of the urban green space (UGS) of 11 Greek cities, in Ioannina the percentage of urban green in its total area is 4.76% below the overall average of the cases under study, while the ratio of urban green per inhabitant in the Municipality of Ioannina is 5.80 m^2/inhabitant [24]. The goal of MoI is to approach 9.00 m^2/resident of green space, which is the minimum ratio of free and planted area per inhabitant that a city must provide to be sustainable according to the World

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Criteria	Indicator	Sub-indicator	Description
			Health Organization [25]. It is important to mention that the WHO considers ideal a UGS value of 50 m^2 per capita.
MOBILITY	Efficient transport	Clean-energy transport	**Kilometers of bicycle paths and lanes per 100,000 population (ISO 37120: 19.4) [13]** According to SUMP, there are currently 6,6km of fragmented bicycle paths in the city [26]. The use of bicycle is very limited and mainly for exercise purposes. The only dedicated bicycle road can be found around the lake where the main recreational area (promenade) of the city is. According to the SUMP, the short-term target is to increase to 45 km and mid-term to 52 km.
			# of shared bicycles per capita There is no bike-sharing or scooter-sharing scheme in the city.
			# of shared vehicles per capita There is no EV-sharing scheme in the city.
			# of EV charging stations within the city According to the Hellenic Institute for EVs (HELIEV), there are currently ca. 15 EV charging stations available in the city (Watt+Volt, Blink by WE Energy, ΔΕΗ, ELPEfuture). 3 of them are fast charge or supercharge stations [27]. MoI has recently prepared its Electric Vehicle Charging Plan (EVCP), according to which up to 112 charging points can be integrated in Ioannina. The implementation of the EVCP project will be funded through the Green Fund.
	Multimodal access	Public Transport	**Modal split of passenger transport** According to the SUMP, the modal split for passenger trips within the city is: Car as a driver 51%; Car as a passenger 2%; Public transport 8%; Cycling 3.5%; Walking 29% [26].
			Annual # of public transport trips per capita (ISO 37120: 19.2) [13] No data available.
			% non-motorized transport trips of total transport According to SUMP, walking and cycling constitute 32.5% of total transport, which is considered very low keeping in mind that, according to SUMP, the average distance for traveling between one's home place and place of work on a regular basis is 3 km [26].
			Integrated fare system for public transport There is no integrated ticket system for public transport.
	Technology infrastructure	Smart cards	**% of total revenue from public transit obtained via unified smart card systems** There is no smart card system in place.

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Criteria	Indicator	Sub-indicator	Description
		Access to real-time information	**Presence of demand-based pricing (e.g., congestion pricing, variably priced toll lanes, variably priced parking spaces). Y/N** No.
			% of traffic lights connected to real-time traffic management system There is no real-time traffic management system in place. In the Smart City context, a complete intervention at the traffic lights system is planned (now at contracting stage). With this project, the equipment of the light signalling facilities of MoI will be upgraded, an extensive traffic metering system and a Control Centre will be installed and an information system for mobile Cooperative Intelligent Transport Systems will be developed.
			# of public transit services that offer real-time information to the public: 1 point for each transit category up to 5 total points (bus, regional train, metro, rapid transit system (e.g. BRT, tram), and sharing modes (e.g., bike sharing, car-sharing) Except for buses, there is no other public transportation means available.
			Availability of multimodal transit app with at least 3 services integrated (Y/N) There is no mobile app available offering multimodal transit with at least 3 services. There is also no taxi app available in the city.
GOVERNANCE	Online services	Online procedures	**Government services that can be accessed by citizens via web or mobile phone** Citizens have access to a number of online services through the platform 'gov.gr' [28]. 'Gov.gr' started its operation in recent years and was expedited due to the pandemic. Through this portal, citizens can access 19 Ministries, 9 Independent Authorities and 70 Bodies and Organizations. Examples of services include COVID-19 coronavirus vaccination certificates, statutory declarations, municipal registration certificates, authorisations, deeds, documents issued upon request by the gov.gr to the Citizens' Service Centre ("KEP"), criminal record copies, free parking permits for electric vehicles, statement of loss of identity card etc. In the local context, MoI has created an e-services platform where citizens at the moment are offered 2 online services: 1) Application for the payment of Gross Revenue Fee for Stores of Hygiene Interest and 2) Certificate of non-indebtedness of the Real Estate Tax [29]. In the frame of Smart City the Project "Pilot Digital Smart City Applications for the Municipality of Ioannina" will

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Criteria	Indicator	Sub-indicator	Description
			implement a unified platform, which will integrate data and functions from individual "smart" applications and services and will provide structured data and services to citizens, visitors, businesses and municipal officials, for areas such as waste collection, environmental data, parking spaces, public electricity, electricity consumption in public buildings, urban planning data and tourist promotion.
		Electronic benefits payments	**Existence of electronic benefit payments (e.g., social security) to citizens (Y/N)** Yes.
	Infrastructure	Wi-Fi coverage	**Number of Wi-Fi hotspots per km^2** MoI provided wireless user access network (WiFi) to 69 points of public interest in the basin [30] and last summer 12 more points were added under the support of the EU project WIFI4EU [31].
		Broadband coverage	**% of commercial and residential users with internet download speeds of at least 2 Mbit/s** No data available.
			% of commercial and residential users with internet download speeds of at least 1 gigabit/s No data available.
		Sensor coverage	**# of infrastructure components with installed sensors. 1 point for each: traffic, public transit demand, parking, air quality, waste, H2O, public lighting** In the frame of a pilot action of the "MOTIVATE" project 100 parking control sensors were installed. There is one air pollution measurement station (IOII) installed in the city and operated by the Ministry of Energy.
		Integrated health & safety operations	**# of services integrated in a singular operation centre leveraging real-time data. 1 point for each: ambulance, emergency/disaster response, fire, police, weather, transit, air quality** In Greece the European emergency call number 112 is active. 112 operates 24 hours a day, 7 days a week and connects the caller, depending on the emergency they report to the Police, the Fire Brigade, the ambulance, the Coast Guard, the National Telephone Line SOS 1056, the European Hotline for Missing Children 116000. Calling 112 allows to locate the caller and can be used free of charge even without a SIM card or from public telephone booths without a calling card. Through 112 citizens can also receive alerts through various technologies and communication channels, for a threatening or ongoing catastrophic event or dangerous situation that poses an immediate threat to one's life, health or safety, in order to receive instructions for self-protection measures [32].

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Criteria	Indicator	Sub-indicator	Description
	Open government	Open Government	Citizens can access Decisions of the City Hall and the Financial Committee as well as Financial Information through the official Municipality Website
		Open data	Urban Planning; Data.gov.gr [33]
		Open apps	**# of mobile apps available based on open data** Intelligent Transportation System; Novoville Platform; Public Consultation Platform; FollowGreen (recycling initiative); Digital archive (since 1913).
		Privacy	**Existence of official citywide privacy policy to protect confidential citizen data** MoI complies with the national GDPR policy [34].
	Global and cross-city co-operation	EU-funded projects	The EU Projects and Initiatives related to POCITYF in which MoI is currently participating are presented under Section 3.4.3 Synergies with other EU Projects.
ECONOMY	Entrepreneur-ship and innovation	New start-ups	**Number of new opportunity-based startups/year** According to the Elevate Greece database, the registered start-ups in the Region of Epirus are 4, counting a total of 37 employees [35]. On the StartupBlink Global Startup Ecosystem Map there is a sample of 3 start-ups in Software & Data based in Ioannina, no accelerators, no co-working spaces and no leaders [36].
		R&D	**% GDP invested in R&D in private sector** Only national data available. According to the EC Smart Specialisation Platform, universities and public research institutes are the main R&D performers in Greece. Although business R&D intensity has almost doubled in the past decade, the national innovation system is still not business driven. Government funding, particularly from the EU, and publicly performed research dominate the national R&D effort. There are encouraging signs that the recovery from the major economic crisis is more knowledge-intensive, as business R&D intensity increased considerably and now accounts for 0.55% of GDP (2017 figure, versus 0.27% in 2013). There are however large territorial disparities in income levels and innovation capacities. For instance, the region of Attica (including the capital city Athens) accounted for more R&D expenditures (966m €) in 2015 than all the other Greek regions put together [37].
		Employment	**% of persons in full-time employment (ISO 37120: 5.3) [13]** 42% of the total permanent population of the city is active and 53% inactive. 82.6% of the active population is

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			employed and 14.4% is unemployed. Women have a much lower participation in employment than men [38].
		Innovation	**Innovation cities index** Ioannina is not listed in the 500 cities' list of the Innovation Cities Index. As indicative of the innovation status of Greece could be mentioned Athens at position 224 (score 40) and Thessaloniki at position 383 (score 35) in 2021 [39]. Ioannina hosts the Epirus Science and Technology Park (STEP), the main support body for the introduction of new and innovative technologies in both the private and public sectors. The main role of STEP is to disseminate the know-how produced in the academic community and research centres/institutes, with the aim of creating a new pole of development in Epirus. STEP also aims to act as an "Incubator" for new businesses in all four capitals of the Peripheral Units of Epirus, where small but dynamically emerging companies aim to promote innovation in collaboration with research institutes to develop new products and services [40]. The University of Ioannina engages also in high quality interdisciplinary applied research activities of high importance to the Greek industry, economy and society. The University has created a Research Centre with currently over 1,700 doctoral students enrolled.
	Productivity	GRP per capita & Productivity	**Gross Regional Product per capita (in EU €)** The per capita GDP in the Epirus Region in 2016 was 11,875 €, which was the second lowest in Greece, almost 50% of the corresponding in Attica and about 5,000 € below the per capita GDP of the country. The Region produces 2,2% of the national GDP and 0.04% of the GDP of EU27. The city of Ioannina produces almost half of the GDP of the Region of Epirus (50.7%). The Prefecture of Ioannina covers 4.990 km2 and its population is 158,193 inhabitants, representing 1.7% of the total population of the country and 1.4% of national GDP. 85.28% of the total area is mainly mountainous, 11.38% semi-mountainous and only 3.34% is characterized as flat. Therefore, agriculture and livestock are considered the most important areas in the economic life of the Prefecture, which is the first in cheese production and meat processing in the country. The growth rate of trout farming units in the Prefecture is also the highest in the country. The largest part of the population is mainly employed in sectors such as agriculture, livestock, trade and services. 22% of the workforce of the Prefecture is employed in the primary sector, 25% in the secondary sector and 50% in the

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Criteria	Indicator	Sub-indicator	Description
			tertiary sector. Small handicrafts, marble mining and processing companies, the winery and dairy industry and tourism play an important role in the structure of the local economy.
	Local and global connection	Connections	Ioannina is connected to the rest of Greece both by road (via road system connections that are symmetrically crossed in the city area), as well as by plane (via Ioannina airport). There is no railway connection, especially negative for the development perspective of the whole Epirus Region. The intercity transportation with the rest of the prefecture and the other urban centres of the country, is performed by buses. The major axes in the field of transport and transportation, in terms of foreign accessibility, include the city of Ioannina in the Main Trans-European Road Network (TERN) [2]. The Ioannina National Airport (King Pyrrus) operates since 1932 and connects the city directly with Athens twice a day all year round. The airport also hosts some international charter flights during the summer months.
		Exports	**% of GRP based on technology exports** No data available.
		International events held	**Number of international congresses and fairs attendees.** No data available yet. Ioannina aspires to be the third pole of conference tourism in Greece, after Athens and Thessaloniki, and for this purpose MoI has launched the process for the establishment of a Conference Bureau. The city has at least three hotel units with high quality conference rooms. The University of Ioannina has also an enviable infrastructure in large and smaller rooms, with a total capacity of hundreds of people, for hosting conferences, events, etc. The city due to its strategic geographical position, close to the mountains and the sea, has the potential to be a conference attraction 365 days a year.
	Attractiveness & Competitiveness	Prospects	Ioannina is one of the largest cities in Greece with potential and prospects that can make it highly competitive in the urban network. The development of the city of Ioannina affected and still affects a wider area and eventually the whole Lake Basin. MoI emerges as a geopolitical crossroads of the development axis of northern Greece. The completion of the two major Motorway projects, the Egnatia and the Ionian Motorways, which meet in Ioannina, has given a big boost in tourism over the last years. The traditional architectural ensemble of the old town in

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			combination with the castle fortification, the island, the scattered architecturally remarkable constructions, folklore features and local customs, form a unique background that provide increased support capabilities for further growth of tourism and highlight the cultural value of the whole Municipality. The aquatic ecosystem of the lake combined with the proximity of the city to the National Parks of Vikos-Aoos, Pindos and Tzoumerka are offering a potential for further growth of eco-tourism. The city of Ioannina is also a major destination all year round for sport events and conferences. Finally, the city meets the conditions for the promotion of religious tourism, serving as a base to access the numerous remarkable religious and byzantine monuments in the region.
PEOPLE	Inclusion	Internet-connected households	**% of internet-connected households** No local or regional data available. In a survey run by ELSTAT was found that 85.1% of households in Greece with at least one family member in the age group 16-74 had internet access in 2021. This percentage in Northern Greece (including the Region of Epirus) was 81.2% when in Attica it was 90.9%.
		Smart phone penetration	**% of residents with smartphone access** According to a 2019 research [41], only 59% of the population owns a smartphone. Specifically, only 29% of people over the age of 50 own smartphones in Greece when at the age of 18-34 the percentage is 95%. Respectively, those who have received higher education in the country are by 86% owners of smart phones compared to only 48% of those with lower education.
		Civic engagement	**# of civic engagement activities offered by the municipality last year** Only data regarding Public Consultations over the Public Consultation Platform of the Municipality of Ioannina [42] is currently available. No public consultations took place in 2021. In 2020 MoI published 2 public consultations for the: - Operational Programme of the Municipality of Ioannina for 2020-2023 - Pirsinela Park restoration In 2022 one (1) public consultation regarding the new controlled parking system in the city centre was completed. Finally, in 2022 two (2) citizen workshops were organised for the purpose of co-designing bicycle routes in the city and at least one more is planned until the end of the year.

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Criteria	Indicator	Sub-indicator	Description
			The workshops were organised in the frame of the initiative "100 Energy Neutral and Smart Cities by 2030", as described in Section 3.4.3.
			Voter participation in last municipal election (% of eligible voters) (ISO 37120: 10.4) [13] In the last municipal election in 2019, the participation in the first round was 65.52% and in the second round 48.69% (36,990 citizens out of 75,978 registered) [43].
	Education	Secondary and post-graduate education	**% of students completing secondary education (ISO 37120: 6.3) [13]** Ioannina has a special historical course in the establishment and operation of the Schools since Ottoman era. Schools were often the creation of the various benefactors of the city and today some schools still bear the name of their founder. The educational infrastructure of the modern Municipality of Ioannina provides free and equal access to all three levels of education according to the institutional framework of the Greek system. Education background of the economically active population: 38% hold a PhD/master's degree or University/TEI degree, 36% are graduates high-school or have completed post-secondary education, 13% are junior high-school or vocational school graduates and approximately the same percentage concerns other cases (primary school graduates, dropped out of primary school, do not know how to read/write etc.) [38]. The city hosts one of the biggest universities in the country. The University of Ioannina was founded in 1964, and today consists of 26 Departments in 11 Schools and hosts more than 20,000 undergraduate, ca. 1,500 post-graduate students, ca. 1,700 doctoral students and 473 members of teaching staff. Ioannina is also the seat of the Epirus Technological Educational Institution (TEI).
	Creativity	Ethnic plurality	**% of population born in a foreign country** Regarding the economically active population: 93% are Greek citizens and 7% have foreign or unspecified citizenship. Regarding the economically inactive population: 95% are Greek citizens and 5% have foreign or unspecified citizenship [38]. Third country nationals or stateless persons who have submitted a request for international protection in the Greek Territory, applicants for international protection as well as unaccompanied minors who are provided temporary

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Criteria	Indicator	Sub-indicator	Description
			accommodation in Structures for Immigrants and Refugees in the city have not been considered in this survey.
		Creative industry jobs	**Percentage of labor force (LF) engaged in creative industries** No data available.
LIVING	Culture and well-being	Life conditions	**Percentage of inhabitants with housing deficiency in any of the following 5 areas: potable water, sanitation, overcrowding, deficient material quality, or lacking electricity** No data available yet.
		Gini index	**Gini coefficient of inequality (ISO 37120:13.3) [13]** Only national data available. According to the most recent data available from the World Bank Poverty and Inequality Platform, the Gini coefficient for Greece in 2019 was 33.1 [44], which is considered medium (inequality above a Gini coefficient of 40 is frequently associated with political instability and growing social tensions).
		Quality of life ranking	**Mercer ranking in most recent quality of life survey** No Mercer ranking data for the city is available. In the OECD Better Life Index, Greece performs well in a limited number of dimensions of well-being relative to other countries. Greece outperforms the average in health, but underperforms average in income, jobs, education, environmental quality, social connections, civic engagement and life satisfaction [45].
		Investment in culture	**% of municipal budget allocated to culture** The total budget of MoI for 2022 is 157,168,000.00 Euros. For services of Culture, Sports and Social Politics Moi has reserved 6,206,217.09 Euros (ca. 4% of the total Budget) [46].
	Safety	Crime	**# of homicides per 100,000 population (ISO 37120: 15.5) [13]** The city of Ioannina is considered a safe place to live and raise children. Data on criminal activities is only available for the region of Epirus. According to Police statistics, in 2019 there were no homicides in the Region, one attempted homicide, 9 cases of rape, 485 thefts and burglaries, 15 robberies, 98 frauds, 337 cases related to drugs, 140 cases related to guns and other minor cases [47].
		Smart crime prevention	**# of technologies in use to assist with crime prevention. 1 point for each of the following: livestreaming video cameras, taxi apps, predictive crime software technologies** No data available.

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Criteria	Indicator	Sub-indicator	Description
	Health	Single health history	**% of residents with single, unified health histories facilitating patient and health provider access to complete medical records** No data available.
		Life expectancy	**Average life expectancy (ISO 37120: 11.1) [13]** Average life expectancy at birth in Greece is 81,4 years (Status 2020). The average expected healthy years are 66.8 for women and 65.0 for men (2020) [48].

2.2 Defined Replication Areas

The city centre of Ioannina was chosen as our basic Replication Area (PEB 1), where MoI plans to study all POCITYF solutions, and is depicted in the following map.

Figure 3 Ioannina's main replication area (PEB 1)

The area contains hundreds of residential, tertiary and public buildings, many of which are traditional, but there are newer buildings as well. Within this area eight buildings were identified as key replication study cases, each having unique characteristics that allow the evaluation of complementary POCITYF solutions:

- the Ioannina City Hall (listed monument) (PEB 1.1)
- the 'Pirsinela' traditional mansion (listed monument) (PEB 1.2)
- a group of six public school buildings that form the former 'Polikladiko' schools' complex, now hosting 3 different schools- and their auxiliary buildings (PEB 1.3-1.8)

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- MoI is also considering applying POCITYF EV solutions at the open-air municipal car park by the Traditional Crafts Centre (PEB 1.9).

The buildings considered for replication studies have been chosen in order to address the specific needs of historic buildings and public facilities.

MoI expanded the Grant Agreement's proposed PED area, to include a district of similar residential houses at the social housing area, 'Vrisoula', where MoI according to its SEAP intends to create a green neighbourhood. 'Vrisoula' area is a district which extends to about 22 acres, of which 4.5 acres are covered by buildings, 4 acres by the square and the rest are uncovered areas. 'Vrisoula' area won't necessary be a replication area during this phase of the project, but MoI definitely wants to gain knowledge from POCITYF about interventions in non-public spaces and engagement of private property owners. MoI will study in the next phase the possibility of replication to this area.

Figure 4 Extended Replication Area (PEB 2) ("Vrisoula" social housing area)

With the residential buildings/complexes of the social housing area ('Vrisoula') the total replication area will reach a total building area of more than 15,000m^2 and more than 11,500 residents.

Ioannina through POCITYF aims to create the masterplan for pilot positive energy building blocks that incorporate the advances in building RES, energy storage systems, smart energy management and sharing between buildings, novel business and funding models as well as introduction of e-mobility. In this first phase the feasibility of the technologies will be assessed using public buildings, and this pilot will act as a demonstrator for students, citizens, businesses and as a local lighthouse for local and national replication in the second phase.

More details can be found under Section 774.3.3 Buildings analysis.

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2.3 Envisioned Replication Area and city needs towards Smart City

The list of innovative elements (IEs) MoI has manifested interest for are summarised in Table 4. This is a pre-selection of solutions based on an initial feasibility assessment and will be finalised as replication related activities continue in the next two years.

Table 4 MoI Expectations from POCITYF solutions

Selected Innovative Elements (IEs)		Expectations/Needs
ETT#1: Innovative Solutions for Positive Energy (CH) Buildings and Districts		
IS-1.1: Positive Energy (stand-alone) Buildings		
IE 1.1.1 IE 1.1.2 IE 1.1.3 IE 1.1.5	PV solutions for heritage buildings	- Improve working conditions for people working in heritage buildings. - Increase energy efficiency in heritage buildings without altering their appearance. - Easy to install and scalable solution.
IE 1.1.7	Energy routers	- Increase self-production / energy efficiency of municipal buildings. - Reduce operational costs of municipal buildings and allocate savings to other projects.
IE 1.1.8	Building Management System (BMS)	- Optimization of the operation of the facility. - Reduction of building operating costs. - Improve energy performance of school buildings and improve comfort for pupils and teachers. - Well established technology. - Multiple manufacturers and suppliers available in the market.
IE 1.1.9	Home/Building Energy Management Systems (HEMS/BEMS)	
IE 1.1.12	Insulation with circular materials	- Improvement of energy efficiency of buildings (it is the easiest energy saving intervention, with substantial thermal benefits). - Has all the advantages of conventional thermal insulation materials, while promoting circular economy.
IE 1.1.13	Triple glazing	- The replacement of frames and glazing is generally the most painless energy intervention in the building, with very significant energy benefits. Together with thermal insulation, it is the first line of defense in an energy upgrade (building shielding). - They offer the best energy efficiency (all seasons). - They show excellent sound insulation performance. This makes them an ideal choice for noisy areas (e.g., for buildings in the city center, such as the City Hall, or for the school complex located on an avenue). - There is a variety of suppliers in the market.
IE 1.1.14	Solar roofs and facades	They will be considered only conditionally: if building roofs can't be used for PV installation (or just for demonstration purposes).

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Selected Innovative Elements (IEs)		Expectations/Needs
IS-1.2: Positive Energy Districts Retrofitting		
IE 1.2.1	Smart lampposts with EV charging and 5G functionalities	- It can integrate almost all infrastructure / functions offered at street level (lighting, electric vehicle charging, environmental / weather monitoring sensors, cameras, telemetry, telecommunication antennas) in a single device (sharing of infrastructure by various service providers). - The impact on the urban landscape from the spread of e-mobility will be reduced (objects placed on the pavements such as lighting masts and electric chargers will be reduced), ensuring better accessibility and maintaining / improving the aesthetics of the streets.
IE 1.2.2	Energy routers	See IE 1.1.7
IE 1.2.4	P2P energy trading platform	- MoI wants to support the implementation of collective systems, advanced energy management systems and trading systems that bring economic benefits to citizens and contribute to the fight against energy poverty. - In combination with the energy communities in which MoI participates, the Municipality could be the first donor of energy and set an example for the citizens. - Activates / strengthens the sense of social responsibility and the sense of community. - It will contribute to the creation of empowered citizens. - It will create new business models for prosumers.
IE 1.2.5	Community Solar Farm (CSF)	- MoI is already member of 2 energy communities (not in operation yet). - The Municipality will ensure economic benefits for the community through energy savings in municipal buildings. These financial benefits will be able to be channeled to other projects. - Solves the landlord/tenant issue by ensuring equal access to the benefits of RES production even for households with rent. - Solves the issue of apartment buildings, where not all owners may have the right to use the shared roof for PV installation. - The most promising and painless solution for the electricity bills of heritage buildings too. - Scalable solution for the entire city.
IS-1.3: Feeding of PEDs with Waste Streams (heat/materials) promoting Symbiosis and Circular Economy		
IE 1.3.1	2nd Life batteries	- Increase of self-consumption of the energy coming from the PV station (reduction of absorption from the Grid) and subsequent financial benefits from the reduction of regulated charges related to the absorbed energy from the Network. - It provides all the benefits of conventional battery systems (including power supply in black out situations without a diesel generator), while offering a solution to the problem of managing car batteries after the end of their useful life (when they are no longer useful for charging cars).

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Selected Innovative Elements (IEs)		Expectations/Needs
		- Combined with the use of the micro-grid controller platform they claim to offer up to 10% improvement in the overall energy efficiency of the building.
IE 1.3.2	Pay-as-you-throw (PAYT)	- It will provide an incentive for waste separation and recycling. - It will provide an incentive to reduce the of waste volumes (less production of waste) and contribute to changing of consumption habits. - Fairness in charging for waste (each household pays for the amount of waste it produces) and rewarding for those who recycle. With the current system, citizens who recycle, share the costs for those who produce large volumes of waste. Also, households that are illegally electrified and currently pay no municipal fees will be forced to pay for their waste. - Increase citizens' awareness on the issue of waste management and establish a recycling/reuse mentality. - From 01/01/2023 the PAYT system becomes mandatory for Municipalities larger than 100,000 inhabitants. - Scalable solution.
ETT#2: P2P Energy Management and Storage Solutions for Grid Flexibility		
IS-2.1: Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions		
IE 2.1.1	2nd Life Batteries	See IE 1.3.1
IE 2.1.2	Renewable Energy Communities Management Platform	- It will improve the performance of the Municipality's energy communities. - It will improve the management of the energy communities.
IE 2.1.4	P2P energy trading platform	See also IE 1.2.4
IE 2.1.6	City Energy Management System (CEMS)	- It will improve decision making. - It will improve the efficiency of the various separate systems. - It can be parameterized based on the expected result (e.g., lower operating costs for the Municipality, cheaper energy for the citizens, better air quality, reduction of CO2 emissions).
IE 2.1.8	Stationary Batteries	- It offers all the advantages that a storage system offers in a PV installation (increase of self-production, flexibility, shift of consumption, etc.), in a more environmentally friendly / sustainable battery. - Its DC operation (direct connection to PV and DC electric vehicle chargers without the use of an inverter) might be interesting. - In terms of fire safety, it offers increased safety compared to lithium batteries. - Scalable solution.
IE 2.1.10	V2G	See IE 3.1.4

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Selected Innovative Elements (IEs)		Expectations/Needs
IS-2.2: Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions		
MoI does not participate in IS-2.2.		
ETT#3: e-mobility Integration into Smart Grid and City Planning		
IS-3.1: Smart V2G EVs Charging		
IE 3.1.1	EV charging management platform	- It would be useful for the Municipality to manage the electric vehicle fleet (target of 50% of its vehicles to be hybrid/electric by 2030 according to SEAP). - The Municipality will be able to manage its own chargers (including V2G chargers and smart street lighting masts with electric vehicle charging capabilities).
IE 3.1.2	EV charger with PV integration	- Promotion of smart solutions for e-mobility.
IE 3.1.3	Bidirectional smart inverters for EV smart charging and V2G applications	They will be considered only as part of an integrated solution that will coordinate PV installation, energy storage, V2G-enabled EV chargers. It will be considered only for the school complex.
IE 3.1.4	V2G	- For operators of larger EV fleets (such as the municipal vehicles) the solution appears to be very beneficial. - If the owner can secure some revenues, the solution is an incentive to purchase e-vehicles. - The technology could also be used for the emergency supply of energy to a home in the event of a power outage (Vehicle-to-Home, V2H).
IE 3.1.5	Smart lampposts with EV charging and 5G functionalities	See IE 1.2.1
IS-3.2: E-mobility Services for Citizens and Auxiliary EV technologies		
IE 3.2.1	EV sharing	- It will contribute to the reduction of parked cars on the streets and the reclaiming of public space (a serious issue in the city). - It will be an alternative (low-carbon) transportation solution in areas and neighbourhoods where public transportation is insufficient (many areas are not covered by public transportation). - It will promote e-mobility and increase EV visibility and exposure. - It can offer the e-mobility experience to all citizens. - It is a service that is demonstrated with great success for many years in many European cities. - The size of the city is ideal for developing e-scooter and e-bike sharing services. - It is especially popular to students (who are an important part of life in the city) and visitors (use in tourism). - The reduction of CO2 emissions and sound pollution.

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Selected Innovative Elements (IEs)		Expectations/Needs
		- The sense of car ownership in Greece is still very strong and private cars are still seen as reflecting social status. This solution could substitute the need to own a car.
ETT#4: Citizen-Driven Innovation in Co-creating Smart City Solutions		
IS-4.1: Social Innovation Mechanisms towards Citizen Engagement		
IE 4.1.3	Tourist apps	- For the development of alternative ways of enhancing tourist experience (e.g., podwalks - dramatized narratives). - They enhance interactivity in the urban fabric and improve the experience. - Low cost, fast project execution and immediate implementation. - They can promote tourism in more markets.
IE 4.1.5	Mobile apps on energy consumption	- It will help users to understand better their energy needs and make more informed decisions regarding whether to choose or not some energy upgrade solutions or purchase certain electronic devices. - They will contribute to a conscious energy consumption. They help in realizing that small changes in lifestyle / behavior can have a big energy impact. Citizens could adopt new sustainable habits. - Low cost and simple design solution for energy consumption monitoring. It can be easily implemented. It is a scalable solution with many available service providers in the market.
IS-4.2: Open Innovation for Policy Makers and Managers		
MoI does not participate in IS-4.2.		
IS-4.3: Interoperable, Modular and Interconnected City Ecosystem		
IE 4.3.1	City Urban Platform	- It will allow the Municipality and decision makers an overview of all relevant city data from different sectors (traffic, air quality, waste collection, etc.) in a unified way. It will allow to shift from various fragmented operations to a unified platform. - If the information collected can be shared with citizens via an app, it could increase transparency and communication between city and community leaders. - It will significantly contribute to the monitoring of the objectives of the Municipality's Action Plans for sustainable development (SEAP, SUDP, SUMP). - It will contribute to reconfiguring urban infrastructure. - Engage and serve city stakeholders.
IE 4.3.2	Wi-fi data acquisition systems	- They will be used combined with the City Urban Platform. - The intended goal is to increase awareness of local environmental conditions, while allowing local authorities to act, based on real-time data, in the event that a site is not in compliance with defined environmental standards.

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Selected Innovative Elements (IEs)		Expectations/Needs
		- If placed in strategic locations in the city, they will create a map of environmental and climatic variables. - They will contribute to the objective monitoring of the effectiveness of the interventions implemented in the context of the Municipality's Action Plans for sustainable development with measurable results (increasing transparency). - Scalable solution. Easy implementation.
IE 4.3.5	Citizen Information Platform (lately added)	Candidate solutions. They will be analysed in the next phase of the project and as MoI proceeds with the Citizen Engagement Plan.
IE 4.3.7	City Data Hub (lately added)	

2.4 Challenges & Barriers

Barriers for each solution have been identified during a SWOT analysis and are summarised in Table 5 per IS category.

Table 5 Identified challenges per IS for implementation of POCITYF solutions

Barriers and Challenges	
ETT#1: Innovative Solutions for Positive Energy (CH) Buildings and Districts	
IS-1.1: Positive Energy (stand-alone) Buildings	• The only technical challenge identified at this stage related to solutions of this category are the restrictions from the Cultural Heritage Law (3028 3028/2002), article 10, which prohibits changes on the protected buildings, (such as façade changes), which can alter directly or indirectly its appearance, enforcing the use of specific materials in some situations. The law also requires approval for every technical work or change of use to a protected building from the Ministry of Culture and Sports after the opinion of the Central Archaeological Council or the Central Council for Newer Monuments (in the POCITYF case). These restrictions may forbid some kind of energy solutions to some buildings or may force alterations to the chosen solution. Though solutions can be found in most cases, the permission process can be very time-consuming. • The regulatory framework for constructions does not show likely of being a barrier for POCITYF.
IS-1.2: Positive Energy Districts Retrofitting	• Promotion is required for local authority acceptance of integration of EV chargers in the lighting system. • The success of the P2P trading platforms lies in the marketing strategy adopted by the utility companies, and the Municipality doesn't have any control on that.

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	• Licensing a large PV power plant for the Community Solar Farm (CSF) is currently a challenge due to the overburden of the distribution network. Large scale grid upgrades are needed to facilitate higher RES penetration.
IS-1.3: Feeding of PEDs with Waste Streams (heat/materials) promoting Symbiosis and Circular Economy	The main barriers identified in this category are general to the waste management problem in the city: • Lack of environmental awareness. • Promotion is needed to raise awareness for consumers and businesses. • Lack of technical knowledge and skilled workers for the practice of PAYT systems. • High investment and operational costs for the Municipality. • High operational costs for businesses combined with lack of economic and tax incentives. • Inadequate government policies. Lack of cooperation and coordination between businesses and local authority.
ETT#2: P2P Energy Management and Storage Solutions for Grid Flexibility	
IS-2.1: Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions	• Regarding P2P energy trading platform, at the moment the possibility of energy exchange between different users is possible only if the natural or legal persons who own the property, jointly participate in an energy community. • No smart energy meters are in place in Greece. HEDNO has the target of completing the replacement of analog meters with smart meters in the low voltage in five years, while the whole project is planned to be completed by 2030. • Barriers regarding solutions of this category (grid flexibility and storage) must be investigated together with HEDNO (HEDNO is at the moment the only electricity grid operator in Greece).
ETT#3: e-mobility Integration into Smart Grid and City Planning	
IS-3.1: Smart V2G EVs Charging	• Lack of consumer awareness. • Lack of car models offering EV-charging capabilities and availability of these models at dealership. • Underdeveloped EV-charging infrastructure in the country and lack of access to electric vehicle charging at or near home. • Difficulties in integrating e-mobility infrastructure in multi-apartment dwellings and high prices of electric cars exclude low-income buyers. • Lack of required knowledge/expertise from local industries.

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	• Lack of human resources and knowledge/expertise on part of city authorities.
IS-3.2: E-mobility Services for Citizens and Auxiliary EV technologies	• The sense for car ownership is still very strong and private cars are still considered to reflect social status. • Lack of knowledge and unfamiliarity with other sharing schemes like e-bike sharing or e-scooter-sharing, which were never successfully developed and adopted in the city. • Lack of EV-charging infrastructure. • Traffic and limited public parking space. • Lack of a secure digital system to check driver's license online. • High capital investment. • Potential competition and protest from local taxi-drivers. • Lack of national policies to reduce private car ownership and lack of traffic measures in the city center (e.g. ban private cars from entering the city center).
ETT#4: Citizen-Driven Innovation in Co-creating Smart City Solutions	
IS-4.1: Social Innovation Mechanisms towards Citizen Engagement	• Potential barriers in this category are related to the challenges MoI is facing with the existing citizen-engagement tools and online platforms, which face very low participation (ICT skills of citizens, communication strategy of the municipality etc).
IS-4.3: Interoperable, Modular and Interconnected City Ecosystem	• Interoperability with the existing smart city solutions and integration of existing infrastructure. • Training of personnel.

Apart from the above, several higher-level challenges and barriers which could affect the implementation timeframe and the success of POCITYF have been identified and are presented by category.

Technical and regulatory challenges and barriers:

- **Delays in the deployment of smart metering:** A fundamental pre-condition for almost all POCITYF technical solutions is the establishment of a smart system infrastructure, starting from smart metering, which is lagging behind expectations in Greece. Eight years after the announcement by HEDNO of the first tender for the installation of smart meters in Greece and after countless postponements, it seems that the ambitious project that will lead to the gradual replacement of all existing electricity meters with smart meters is on track for implementation, with 2030 being the completion horizon for the low voltage. The Automated Meter Infrastructure - AMI (Telemetry System) will transform the grid and will lead among others to the modernization of the operator's operating model and improvement of the efficiency and quality of its services, to the overall restructuring of

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the retail market and the strengthening of competition, to the creation of new business opportunities and commercial strategies for Energy Service Companies, will allow for effective demand response (EU Target Model) allowing to shift load from high to low cost hours and thus perform dynamic pricing, will facilitate smart EV charging and coordination of storage units (incl. car batteries) and their participation in the markets.

- **Barriers related to the development of RES:** The deployment of investment in variable renewables (RES) continues at an impressive pace pulled by the feed-in-premium (FiP) support schemes (terminating in 2025) but there are still many challenges in order to increase capacity to make up for retirement of the lignite-fired power plants. In the last years there was a significant slowing down of the development of home PV systems due to promotion of large-scale RES, low incentives for homeowners after the removal of the state subsidies and the tenant-landlord issue, which was excluding tenants from fair access to RES. Licensing of bigger RES projects is also challenging and bureaucratic and can currently take up to 5 years. A recently introduced legislative reformation promises completion of licensing for bigger RES projects within 14 months. At the same time, residents, municipalities, and environmental associations still hinder or prolong licensing and operation of large-scale RES facilities, as they don't see citizens somewhere in this very expensive energy transition (the investor seems to be the only one benefitting, receiving 100% of the profit margin). Finally, another barrier in the fast development of RES is slow development of mass electricity storage facilities (including hydro and batteries) due to institutional barriers. The current institutional framework for the development of electricity storage facilities is keeping trapped 170 projects (including emblematic investments) that have already been licensed for the installation of hybrid stations on non-interconnected islands and more than 50 projects awaiting evaluation because of the institutional gaps identified across the spectrum of storage activity in Greece.
- **Barriers related to RECs:** The current legislative framework, complex and fragmented into many different laws and ministerial decisions, causes costly and intensive administrative procedures for developing renewable energy projects by energy communities and results in distortions and grey areas, which have led to the concept of the energy community being hijacked by private investors. Moreover, starting from the beginning of 2022 all energy communities without an exemption should compete with private investors in bids to ensure operational reinforcement for RES projects, which is expected to hinder the participation of energy communities. On the same note, the requirement of proximity of energy communities, which aims to empower local communities, turns into a competitive disadvantage compared to private investors who are not subject to corresponding geographical constraints. Finally, significant delays are observed in the procedures of the full and effective integration of the EU Directives REDII, IEMD for RECs and CECs. The full integration of these directives will contribute to the removal of (administrative and other) obstacles faced by the energy communities, to the simplification of licensing procedures and to the strengthening of the direct participation of citizens in the country's energy transition.

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- **Slow development of the electrification of mobility in Greece**: Greece is one of the least prepared countries in EU-28 in terms of e-mobility, ranking in the top 5 EU countries with the lowest number of established EV chargers. This is due to delays presented in the programme of elaboration of the Electric Vehicle Charging Plans by the Municipalities (the initial deadline of 31/03/2021 for large and medium-sized municipalities has already been extended twice). In June 2020 was announced the new National Plan for E-mobility (in line with the EU Green Deal growth strategy and part of a ten-year climate protection plan) introducing a series of economic and other incentives, subsidizing the e-vehicle acquisition, with the goal 1 in 3 vehicles by 2030 to be electric. Finally, the recent increase in the average electricity prices, is expected to further hinder e-mobility growth.
- **Slow adoption of waste management related EU directives in the Greek legislation:** Greece ranks last among the EU 28 countries in terms of solid waste management, according to the Foundation for Economic and Industrial Research (IOBE). Most solid waste is disposed of in landfills, and reuse/recycling are extremely limited, not exceeding 18% (Greece ranked second from the end in solid waste recycling in 2020). Greece has paid over €100 million in fines imposed by the Court of Justice from 2014 until 2021 for non-compliance with EU law provisions in the fields of solid waste and urban wastewater. In this regard, the Greek government announced new legislation which unifies the laws for waste management and recycling incorporating EU Directives 2018/851 and 2018/852. At the same time, the regulatory framework for Alternative Management Systems (based on the principle of extended producer responsibility) is strengthened by reducing bureaucracy, enhancing transparency, and increasing accountability. Finally, a recently introduced legislation makes "Pay-as-much-as-you-throw" systems mandatory for all Municipalities with a population of more than 100,000 inhabitants from January 2023 and in Municipalities with more than 20,000 inhabitants from January 2028 [20].

Social Challenges and Barriers

- **Digitalisation and digital skills:** Greece ranks 25th of 27 EU Member States in the 2021 edition of the Digital Economy and Society Index (DESI) [49]. Compared to previous years, Greece continues to improve its performance in almost all DESI dimensions, however in most cases it still scores below the EU average, including integration of digital technologies into business activities, where Greece is well below the EU average. On the digitalisation of public services, in 2020 Greece scores above the EU average in the number of e-government users, while it far exceeds the EU average in open data readiness, having already implemented relevant legislation and policies.
- **Energy Poverty and Consumer Protection**: In Greece, the phenomenon of energy poverty has become a particularly serious problem, especially after 2011 due to the economic recession. In the frame of the National Plan for Energy and Climate (Ministerial Decision 4/2019), the fight against this phenomenon is a priority and a significant challenge for 2030, in order to reverse its effects on Greek society. The Ministry of Environment and Energy has launched the Plan for the Fight against Energy Poverty which provides high subsidies for the benefit of the poorest households for the installation of energy

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autonomous RES (photovoltaic systems on the roof), for energy upgrading of households and cheap electricity bills under the «Save» programme. Special care has been given to the lignite areas, where the subsidy rate will reach 90%.

- **Change of governance**: Moving towards a more collaborative governance at city-scale and developing innovative governance forms for integration of different stakeholders and citizens in the planning process and the decision-making might prove a critical challenge. To meet the project's targets, there is a need to motivate municipal employees and local governments to get actively involved, identify what works for the city and what doesn't, develop a vision for its buildings, streets, and neighbourhoods, and act on that vision. All projects related to mobility, air quality, quality of life, shared public spaces, urban planning and energy efficiency must be interrelated and inter-departmental coordination and communication must be considerably improved. Commitments in implementing and improving Action Plans must also be made by all parties.
- **Community involvement and citizen engagement**: All our existing citizen engagement platforms, social media channels and citizen engagement activities face very low participation. At the same time, there are very few citizen associations in the city, indicating a non-active community engagement attitude. Adopting a consistent structured approach to community engagement with strategic and resourcing plans, increasing transparency in our communication with citizens and overcoming fear that citizens will demand things that the Municipality can't deliver, could prove valuable in effectively engaging with our citizens and stakeholders.

Financial Barriers

The most critical financial barrier identified so far, relevant to most POCITYF solutions, is high up-front investment costs and insufficient cash-flows, combined with the limited households' and Municipalities' budgets, a situation which is expected to worsen in the coming years because of the energy crisis. Mixed financing from various sources and types of investors, innovative business models where operational cost savings finance higher investments, and PPPs will have to be investigated in order to provide a sustainable funding plan. A good quality cost-benefit analysis and technical feasibility based on realistic data, and a project life-cycle costs approach will be decisive in the funding decision. Finally, strong political support to the project is considered essential for securing funding and acceptance.

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3 Processes towards the implementation of the Replication Plan

3.1 Governance and administrative processes for planning solutions

Currently, the same administrative and bureaucratic procedures must be followed for Smart City projects as for any other project run by the Municipality. Smart City projects are mostly funded through national co-funded or EU-funded programmes, each of which has its own framework and requirements, but typically they are deployed as it is briefly described below (extensive descriptions are considered out of scope, only basic information is provided).

Procedure.01: Project Planning
P.01-01: Define project design and maturation requirements
P.01-02: Preparation of the required studies
P.01-03: Ensuring required licenses – property/land ownership etc.

All actions needed for project design and maturation are under the responsibility of the Directorate of Technical Services of the Municipality in cooperation with the Planning Service and the Directorates/Services of the Municipality that have proposed and/or implemented Projects.

The method of implementation (elaboration by the Service or assignment to a Contractor) is chosen under the responsibility of the Head of the Service involved in the planning. In case of assignment (e.g. in case of lack of human resources or expertise in a technological field), the assignment method is selected according to the relevant legislation and the steps of Procedure.02 are followed.

During the project planning, the existing archaeological, environmental and other commitments are investigated, and actions are taken to properly issue the required permits (archaeology, environmental assessment and environmental conditions, approval by the forest service, etc.). The Project Manager in collaboration with the responsible supervising Directorates also plans the implementation of all necessary land expropriations/acquisitions for the execution of the project.

Procedure.02: Tenders and Awarding of Contracts
P.02-01: Preparation and conduct of tenders - Evaluation of tenders - Implementation by own means
P.02-02: Handling of objections / appeals
P.02-03: Completion of tender - Signing of contract - Amendment of contract

The law defining the framework for all stages of conducting public tenders for projects, supplies and services currently in force is Law 4412/2016 [50], which is in harmonisation with EU-Directives 2014/24/EU and 2014/25/EU (the Law is being currently further specified by Law 4782/2021 [51]). The law is binding for all projects exceeding €20.000 (without VAT). For services which do not

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exceed €20.000 (without VAT) a "direct assignment" of a contract can also be applicable. A direct assignment is the procedure of outsourcing a service without prior publicity, in which the contracting authorities/entities award to the service supplier of their choice, following a market research and consultation with one or more suppliers of this service or through a list of interested contractors with electronic draw (if there is one).

Procedure.03: Project Monitoring and certification of the physical completion
P.03-01: Monitoring the progress of the Project and monitoring the schedule
P.03-02: Problem and change management - Risk management
P.03-02: Testing and acceptance of the project - Completion of a project

Monitoring the progress of a project is continuous and is about ensuring the right implementation based on the requirements/specifications set out in its official documents (approval decision to include the act, technical report of the act/sub-project, Technical Project Bulletin, signed contracts).

Procedure.04: Financial Management and Project Payments
P.04-01: Clearance of expenditure - Processing of payments

Ensuring compliance with the obligations of the Municipality, which relate to the financial management and monitoring of EU and co-financed projects, derive from the context of their financing mechanism (e.g. terms of financing of the Approval Decision, Management and Control System of the NSRF Programmes, etc.).

Ensuring required resources for the implementation of the Project (Financing)
Municipality projects can be funded through national co-funded programmes, private-public partnerships (PPP), banking schemes, own resources, as well as combinations of the above. There are various financial tools available but only a selection of those which will be used by MoI for financing the digital transformation and smart city actions included in the Digital Transformation Action Plan [38] (see Section 4.4.2) are presented here.

Recovery and Resilience Facility (RRF) [52]: The Information Society S.A. (a Greek State company that operates as an intermediary Body for the management of the NSRF funds that are available to Greek companies for subsidized actions related to ICT and innovations) addressed an invitation to 17 Greek Municipalities with population over 100.000 citizens a call for proposals for the "Smart Cities" programme, with a total budget of €90,000,000 from the Greek Recovery and Resilience Plan «Greece 2.0» (which includes the Smart Cities Investment Initiative). The main goal of the project is the development and use of new technological tools which will improve the management and functionality of the urban environment in Greek cities. The intervention also aims at the gradual transformation of Greek cities into "smart cities" through the development of new infrastructure, digital platforms and information systems. The proposed solutions allow cities to use technology and data to improve urban infrastructure, e-services, and stimulate the local economy.

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For the Municipality of Ioannina there is an amount of €3,069,000 including VAT (2,475,000 excluding VAT) reserved, which the city intends to fully absorb with the proposals incorporated in the Digital Transformation Action Plan.

"Antonis Tritsis" [53]: The main purpose of the new development programme for local governments run by the Ministry of the Interior is the implementation of a comprehensive strategic development and social solidarity plan through the bodies of local governments. Interesting for the digital and smart city actions of the Municipality is the AT08 Invitation, entitled: *"Smart cities, intelligent applications, systems and platforms for safety, health - care, e-government, education - culture - tourism and environment, policy actions and measures protection, protection of public health and the population from the spread of the COVID-19 coronavirus pandemic"*. The call is meant for intelligent technologies and actions which can provide numerous tools for safety and improvement of the quality of life of citizens, actions to facilitate their contact with municipal services, but also actions for the sustainable management of the natural environment, under the additional pressures of climate change and the pandemic. The total budget of the invitation amounts to €130,000,000 (€).

NSRF (National Strategic Reference Framework, "ΕΣΠΑ") [54]: It is the basic strategic plan for the development of the country with the assistance of significant resources coming from the European Structural and Investment Funds (GRNET) of the European Union. Through the implementation of the NSRF 2014-2020, the aim was to address the structural weaknesses of the country that contributed to the emergence of the economic crisis but also the problems, economic and social, that it created.

The finalization of the operational plans for the 2021-2027 programming period (NSRF 2021-2027) is still pending. An indication of the programmes for the integration of the actions is based on the programmes of the NSRF 2014-2020, as the finalization of the new ones is expected. Based on the available information, from the programmes of the new programming period, the following are of interest here:

- O.P. Digital Transformation
- O.P. Environment - Energy - Climate Change
- O.P. Civil Protection
- O.P. Epirus

Other financial tools available for Municipalities which could also be utilised are the **Philodemos Programme** ("Φιλόδημος") run through the Ministry of the Interior, the **Green Fund** ("Πράσινο Ταμείο") (a financial tool created by the Ministry for Energy and Environment with the purpose of management, financial, technical and financial support of programmes, measures, interventions and actions aimed at promoting and rehabilitating the environment, supporting the country's environmental policy and serving of public and social interest), the **Central Independent Resources of Municipalities** ("Κ.Α.Π.") financed through the State Budget, the **New Development Law** ("Νέος Αναπτυξιακός Νόμος"), as well as **Private and Public Sector Partnersips** - PPP ("ΣΔΙΤ").

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3.2 Work Groups supporting the planning processes

The local team

At the core of our local work group/ecosystem lies the City Administration and local staff. The composition of the local team was finalised to its current form with a Mayors' decision on 08/03/2021 and consists of 7 permanent municipal employees, an external partner acting as the MoI Site Manager in the Consortium and as the «Replication Manager» in the local work group/ecosystem, and the Scientific Consultant to the Mayor.

The permanent employees come from four (4) different departments of the Municipality Administration:

- Directorate of Technical Services: 4 team members
- Town Planning Service: 1 team member
- Planning department: 1 team member
- Financial Services: 1 team member

The Head of the Directorate of technical services acts in POCITY as the «Project (POCITYF) Coordinator», while the Head of the Department of Planning and Execution of Technical Works has the role of the «FC Manager». Another 4 employees are sharing the role of the «field expert» with CERTH in each ETT.

Internal POCITYF Consortium Partners

CERTH is providing MoI with scientific support during activities related to the Replication Plan, acting at the same time as the «Partner from R&D and Academia» and the ETTs «field expert» in our local work group/ecosystem. Monthly collaboration meetings are being carried out with CERTH since September 2021, to discuss the Replication Plan progress and suggest solutions to possible barriers.

Another POCITYF Consortium partner who joined our ecosystem is Kimatica, providing us with scientific support in the subject of P2P energy trading.

External stakeholders

A list of potential stakeholders was identified in order to perform the initial external stakeholders' survey and citizens' survey (see Section 3.4.6). This preliminary list included almost 40 representatives from energy utilities, consumers, technology and service providers, policy-making bodies and governance, related representatives from the permanent Consultation Committee and citizens' representatives. The City Council, comprising of 45 City Council Members was also included as key stakeholder. In all of the meetings that took place so far, all of them were officially invited to participate by the Mayor.

The following external stakeholders are also considered strategic for POCITYF but could not be contacted at this stage of the project: Regulatory Authority for Energy, Ministry of Environment, Ministry of the Interior, Information Society S.A. and the Fire Department.

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The local team, the internal POCITYF Consortium partners and the external stakeholders who have responded to our invitations so far constitute our local ecosystem, as it is presented in Figure 5. While only a limited number of stakeholders from the preliminary list has taken part in the local meetings, MoI's intention is to meet with most of them at least once until the end of the project to collect their views on the solutions and the project.

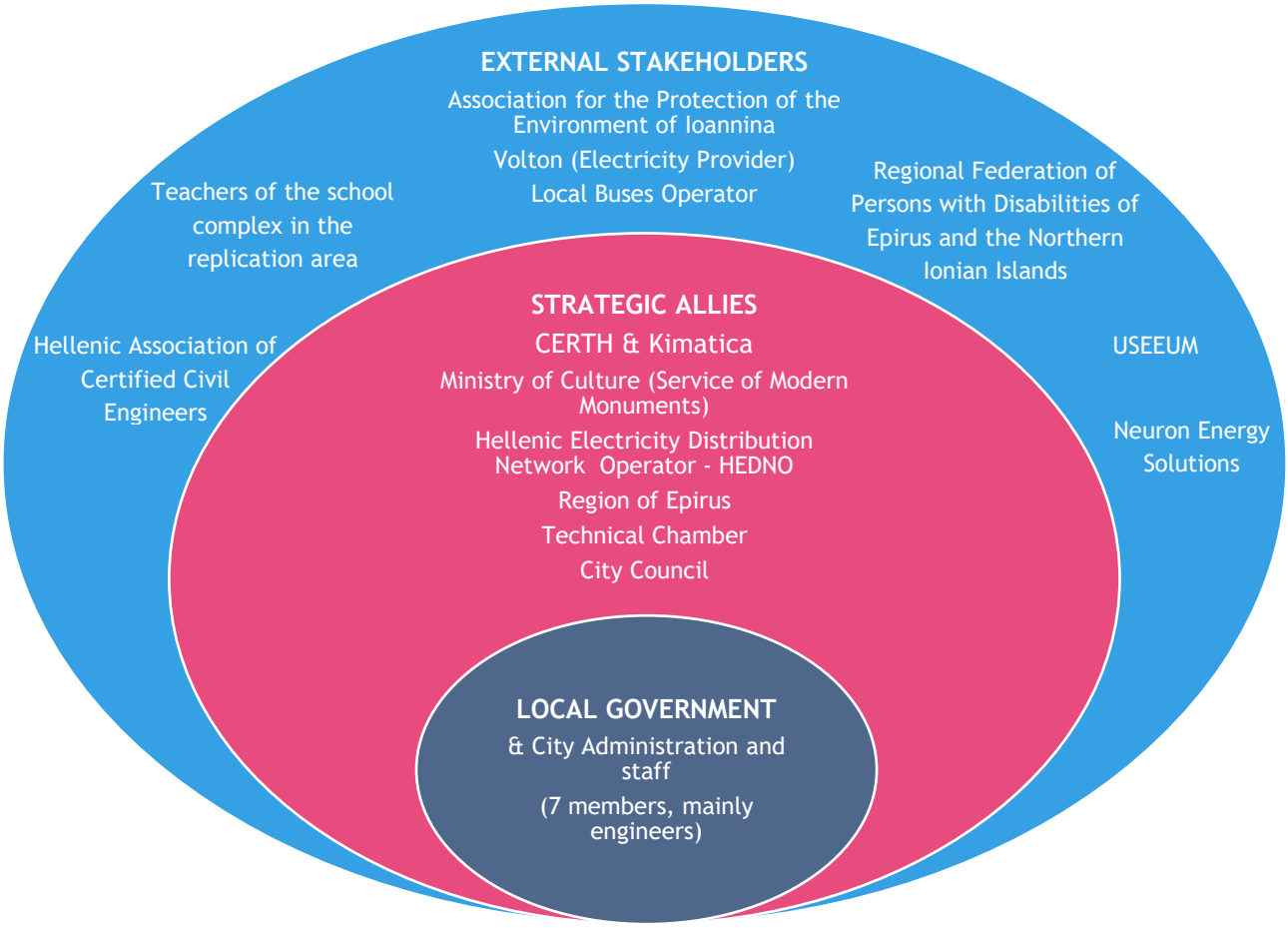

Figure 5 MoI ecosystem (until September 2022)

In order to facilitate stakeholders to participate in the online SWOT analysis (see Section 3.3), MoI created a separate **desired** ecosystem for each innovation element (IE) they intend to study for replication. These **desired** IE ecosystems are presented in ANNEX A. The Local Government (City Administration and staff) is not included but is considered the core of each IE ecosystem. In the second round of stakeholder meetings and as we proceed with the Replication Plan, we will try to engage also those stakeholders who have not responded to our invitations (e.g. EV charging service providers, Hellenic Institute of Electric Vehicles, Association of the Historic Centre "Ta Palia Giannina", local car dealers offering car models with V2G capabilities).

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3.3 Local Stakeholders‘ engagement

In this Section is presented in detail the work conducted by the workgroup until May 2022.

The first contact with the local stakeholders was made in the frame of an online survey in which external stakeholders were asked to assess their level of power and interest regarding the POCITYF solutions (see Section 3.4.6).

The first meeting of the working group was carried out on 30/03/2022. All stakeholders from the preliminary list (see Table 10 under Section 3.4.6) were invited and 19 people participated, including the Mayor, who opened the discussion, three Deputy Mayors, 4 POCITYF local Team members, 3 CERTH representatives, 1 KIMATICA representative and 6 external stakeholders' representatives. The meeting was carried out as a teleconference and the duration was 1.5 hours. During this first meeting CERTH and MoI presented the project and the ETTs to the stakeholders, while a representative from the local team presented the case studies (buildings and districts) selected by the Municipality, MoI’s expectations from the project, MoI’s obligations, the methodology for creating the local ecosystem and its role in the project, as well as the activities MoI is planning to carry out together with the stakeholders. A preliminary discussion was started during which the deputy Mayor of Technical Works also pointed out the importance of the project for the Municipality.

In order to facilitate co-operation but also in order to provide transparency and include those who expressed interest but couldn’t participate in the meetings in the morning hours, a shared folder was created after the 1st meeting, where all presentations, minutes of meetings, co-operation material (e.g., the factsheets), and webinars which could be interesting to the Work Group are being uploaded. Permission to access this folder was given to over 80 people.

The second meeting was carried out again as teleconference on 20/05/2022 and lasted 2 hours. 21 people participated in total including 6 representatives of the Municipal Government, 4 local team members, 2 CERTH representatives and 9 external stakeholders’ representatives. On this meeting, a representative from Kifissia Municipality (Attica) was invited to open the discussion presenting the work which is being done in Kifissia in the frame of the SPARCS project and the challenges they face. Municipality of Kifissia is a Fellow City in the SPARCS project and was awarded the Gold «Best City Award» 2022 by the Central Union of Greek Municipalities for their innovation work with SPARCS. Our aim was to show local stakeholders, who are mostly unfamiliar with such projects, the work that other cities are doing in the same direction, with the goal to strengthen their interest and create a sense of alignment, coexistence, and solidarity with other Municipalities.

During the second meeting the POCITYF solutions were presented at a deeper level, while explaining how these solutions are being demonstrated in Evora and Alkmaar. Because of the huge number of POCITYF solutions, only the solutions pre-selected by MoI during activities for the final versions of WP1 deliverables were chosen to be presented. Some factsheets and the way stakeholders can use them to better understand the solutions were also presented. In the shared folder was uploaded an overview list (excel file) with all the solutions demonstrated in the project and the solutions that the Municipality of Ioannina has pre-selected to study with direct hyperlinks

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to the factsheets, and the list of stakeholders involved in each solution (solution ecosystem). Participants were finally presented with a template of the SWOT analysis (excel file in the shared folder) and were asked to study the solutions in their own time and to fill out in this excel file their views on the advantages, disadvantages, opportunities for the city and potential threats. They were given a deadline until the 31/05/2022, while a reminder was sent on the 25/05/2022. At the time the reminder was sent, MoI had filled out as well the points they had identified as most important in the SWOT analysis they had performed with the local team internally.

Below is an example taken from the SWOT analysis for BMS/HEMS. On the top, the solution ecosystem was defined, based on the list of stakeholders from our preliminary list. Each stakeholder was asked to look for the body they represent and fill out their views only for those solutions. In the case where factsheets were available, people could find the link on the top and redirect directly to it. In the cases where no factsheet was available, a small description was provided on the top, and hyperlinks to surveys or other similar commercial products were provided.

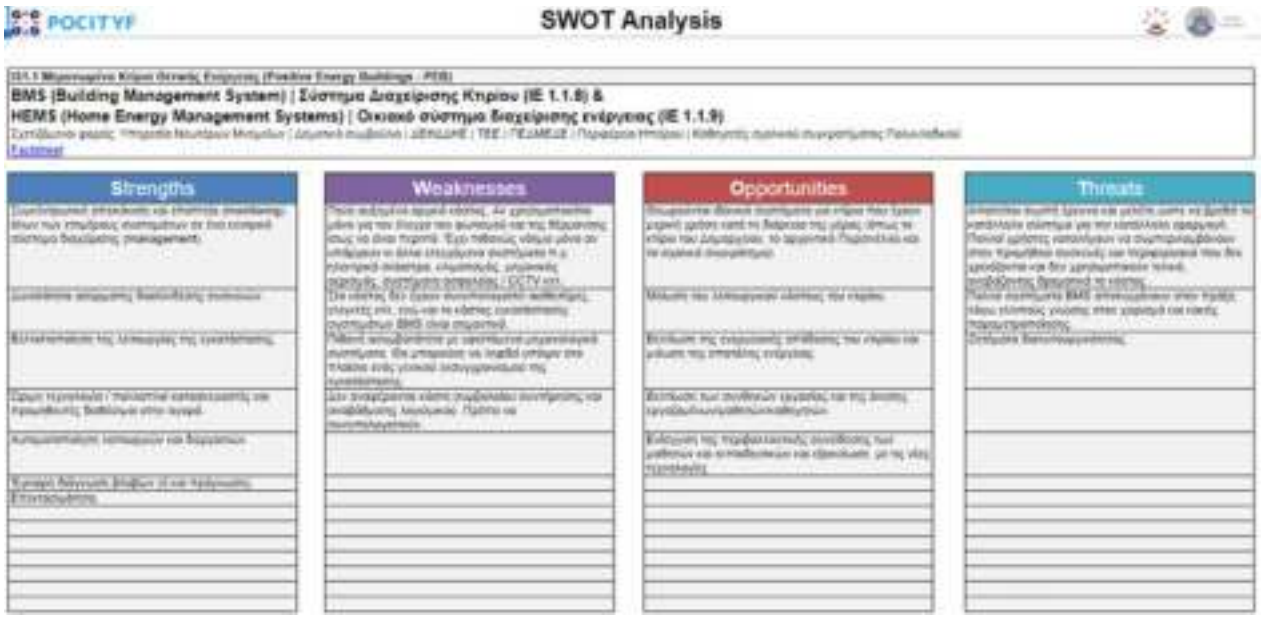

Figure 6 Example from the SWOT Analysis

Our target through this exercise, was to give everyone the opportunity to study and reflect on the solutions in their free time instead of pushing them to express opinions during a group meeting on subjects which might seem somehow distant for the city at first glance, to let them read our opinions and perspectives (and even disagree) and offer them the option to fill out their opinions anonymously, without feeling the pressure of representing officially their respective body/company/association.

After this exercise, one-to-one meetings with key stakeholders started being organised. Until today, 2 such meetings have been carried out (one with the local Service of Modern Monuments of the Ministry of Culture on 03/06/2022, and one with the local service of HEDNO on 08/06/2022).

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During these meetings, some specific solutions and some unclear points were discussed in greater detail.

The results of the SWOT analysis, after consultation meetings with CERTH in which the SWOT analysis results have been analysed, have led to the final selection of the solutions to be replicated in Ioannina (see Section 4.2). The solutions might be adjusted as MoI proceeds with the Replication Plan, but these are the ones for which a feasibility assessment for Ioannina will be conducted in this deliverable.

3.4 Replication Tools utilization

3.4.1 Knowledge Transfer from LHCs

Since the day activities regarding the Replication Plan have started, MoI has participated in all related LHCs-FCs Knowledge Transfer workshops made available through POCITYF.

A summary is presented in Table 6.

Table 6 LHCs-FCs Knowledge Transfer Workshops

Workshop	Context	Date
LHCs-FCs Knowledge Transfer	FCs were provided with the first detailed information on the solutions being implemented in Evora with the aim to facilitate FCs in selecting solutions for their replication plan.	26/10/2020
LHCs-FCs Knowledge Transfer	FCs were presented with solutions implemented in Alkmaar, including citizen engagement initiatives. Alkmaar provided also updates on the status of the project.	16/03/2021
LHCs-FCs Knowledge Transfer	Evora and Alkmaar presented specific solutions and best practices (interaction with authorities, legislative and regulatory barriers, energy poverty and energy communities, social innovation).	20/12/2021
LHCs-FCs Knowledge Transfer	Training Workshop for LHC-FCs on citizen engagement initiatives.	16/03/2022
Regulatory framework	As a follow-up of an earlier knowledge transfer workshop where the legal/regulatory considerations in LHC of Alkmaar were presented, this workshop was to further analyse the legal/regulatory considerations for each ETT relevant for FCs.	14/04/2022
LHCs-FCs Knowledge Transfer	Focus on Factsheets and technical solutions	10/2022 (planned)

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3.4.2 Factsheets

Factsheets in POCITYF have been created with the purpose to provide the FCs and their ecosystems with a catalogue of solutions available in POCITYF, including descriptions, performance and economic indicators. The factsheets report also details about requirements, demonstrations already performed and constraints that affect citizens and Cultural Heritage areas, in coherence with the objectives of the project.

Factsheets started becoming gradually available to FCs since 11/2021. Due to covid-related delays in the demonstration activities in LHCs, by the end of August 2022 only factsheets from the LHC Evora were available. The available factsheets were used by the local team to better understand application of the solutions in Evora and prepare the presentation for the 2nd meeting with stakeholders. The factsheets were also a valuable tool during the SWOT analysis performed by the local team in co-operation with the local ecosystem, which led to the final selection of solutions to be studied for replication in Ioannina. The factsheets were uploaded in pdf format in the shared folder and made available to all participants in the work group. Hyperlinks to the factsheets were used in the SWOT analysis, in order to facilitate stakeholders in better understanding the solutions.

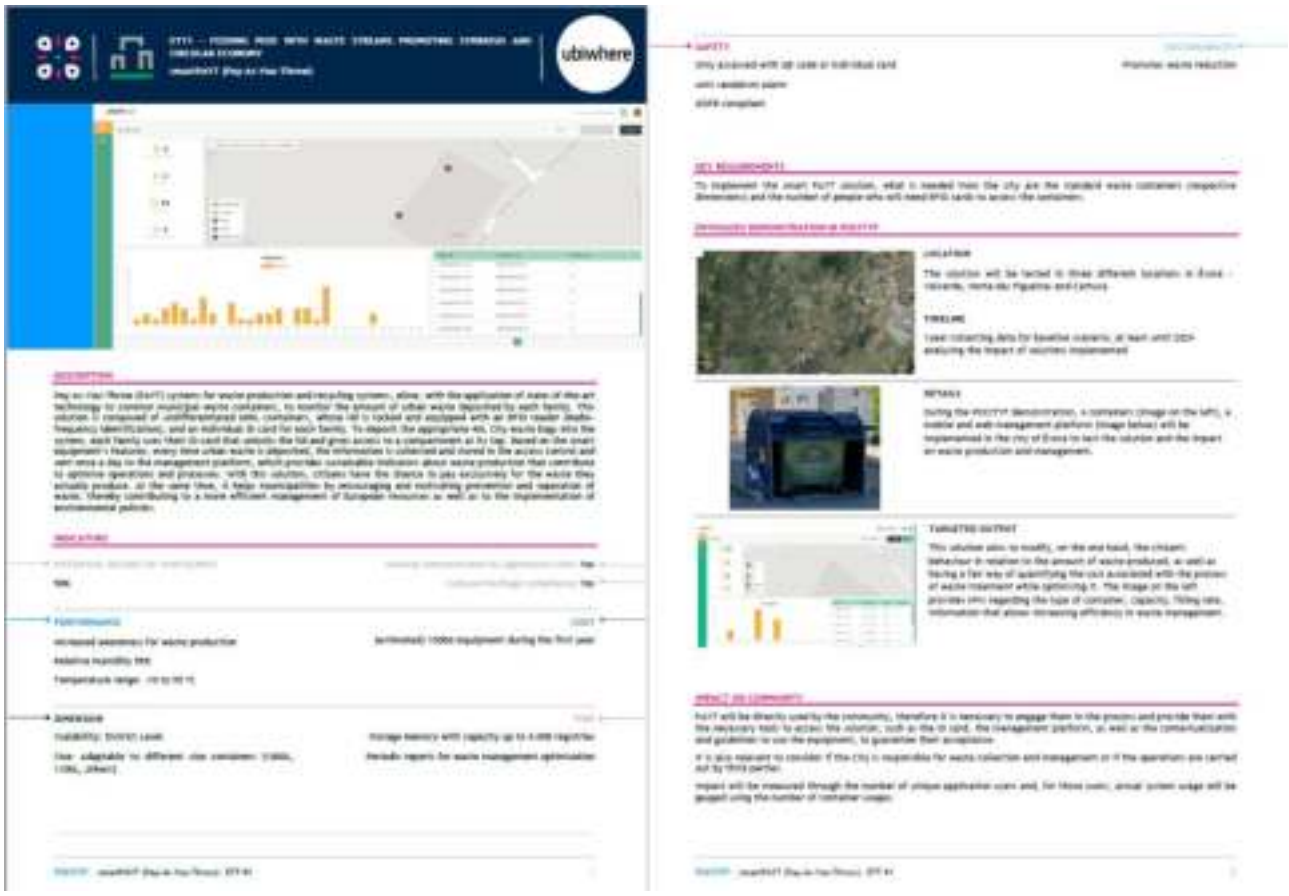

Figure 7 Factsheet for PAYT solution by UBIWHERE

To enhance co-operation between cities and their local ecosystems, there is a plan that factsheets will become available on the official POCITYF website.

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3.4.3 Synergies with other SCC EU projects

Ioannina is participating in various EU initiatives. Engagement with other similar initiatives will help us in achieving the objectives and maximising the impact of POCITYF project and facilitate demonstration and scale-up. Joint programming with these programmes could also facilitate access to additional funding/financing instruments.

In the frame of POCITYF collaboration with other similar EU projects, MoI has participated in the following SPARCS workshops:

Table 7 POCITYF and SPARCS workshops

Workshop	Subject	Date
POCITYF and SPARCS	Citizens Engagement	31/08/2021
EU Regions Week, Workshop "Fair and inclusive citizen engagement towards a new city vision in the energy transition"	Ioannina presented together with Kladno (SPARCS FC) a video Testimonial on the challenges we face in engaging with citizens.	13/10/2021
SPARCS Webinar (Espoo)	Citizen engagement in public-private partnerships for sustainable transition	19/11/2021
Knowledge exchange with SPARCS	FCs involvement and stakeholders' engagement.	15/02/2022
POCITYF and SPARCS	Digital solutions in supporting cities' energy transition to climate.	31/05/2022

MoI has also initiated a collaboration in the form of exchange of knowledge/experiences with the Municipality of Kifissia, a Fellow City of the SPARCS project. A representative of the Municipality of Kifissia has already participated in one our meetings with local stakeholders, presenting the work which is being done in the frame of SPARCS in Kifissia and their initiatives.

In Table 8 are presented all the relevant EU-funded projects in which MoI participates and have a close relationship to POCITYF, in areas related to sustainable urban development, mobility & energy efficiency. Through all these successive and parallel projects with alternative fundings MoI will work with joint and coordinated efforts to achieve greater impact and increase operations' efficiency towards the ambitious goal of climate neutrality by 2030. Knowledge exchange among these programmes is mainly achieved with Working Groups, workshops and participation in Think Tanks.

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Table 8 Synergies with other EU-funded projects

SCALE City Coordinators Group https://www.scalable-cities.eu/
Ioannina is member of the SCALE City Coordinators Group, as a fellow city of the POCITYF project. The City Coordinators Group (CCG) aims to gather all coordinators from the Scalable Cities Projects in order to address specific challenges and create a space for the co-design of shared approaches. The Group has 3 objectives: facilitate the knowledge sharing and knowledge exchange, promote the networking and cooperation among the Lighthouse and Fellow cities, other similar initiatives and projects, as well as other cities interested in replication of the Scalable Cities measures, and promote and lead advocacy actions at European level. Since the initiative was launched in October 2021, MoI has actively participated in 3 sessions, focused on cities' needs and priorities and on the systemic change of Governance. In the last session MoI actively participated in an advocacy meeting, aimed to collect key suggestions for the European Commission for transforming internal organization in Municipalities (bottlenecks, silos, processes).      Figure 8 Screenshot from the MiroBoard of the CCG online meeting on systemic change of Governance held on 07/04/2022

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100 Energy Neutral and Smart Cities by 2030 https://2030.ioannina.gr/ https://www.intelligentcitieschallenge.eu/
MoI is proud to have been selected as one of the "100 Energy Neutral and Smart Cities by 2030" pilot programme. The city will receive substantial funding from the Horizon Europe programme for the period 2022-2023, to start the innovation path towards climate neutrality by 2030. Ioannina will develop a Climate City Convention, which will include a comprehensive plan for climate neutrality in all areas such as energy, buildings, waste management and transport, along with relevant investment plans. Citizens, research organizations and the private sector will be involved in this process. The clear and visible commitments made by the city in the city' climate convention will enable us to work with the EU, national and regional authorities and our citizens to achieve this ambitious goal. MoI in collaboration with the University of Patras has recently published a Roadmap [23] describing proposed actions in order to achieve climate neutrality by 2030 in the fields of urban planning, sustainable urban mobility, nature-based solutions, smart city & waste management. Practically, all the results from the projects presented in this table, including POCITYF, will be exploited in the strategic planning for MoI's ambitious commitment for climate neutrality by 2030. POCITYF was represented at the 1st Workshop for project planning principles and policies for cycling, held in June 2022 in the frame of this initiative [55].    Figure 9 Workshop 'Ioannina designs for the bike' held on 04/07/2022 The next workshop is planned for 19/09/2022, with the focus of the discussion being in the problems for cycling in Ioannina.
Sustainable Policy RespOnse to Urban mobility Transition (SPROUT) | HORIZON 2020 | on-going [56] https://sprout-civitas.eu/?cn-reloaded=1
MoI participates in the European project "SPROUT", which is 100% funded by the HORIZON 2020 programme and has 29 partners. SPROUT is a project of real-life implementations, driven by six pilot cities backed by a robust academic support. The pilot cities will be testing different urban mobility solutions from which the project will create un understanding of the current state of urban mobility and of the main drivers of future change. The cities will look at likely impacts and operational feasibility, identify areas where policy interventions, such as revised regulations, will be needed and what policy response alternatives there are, and then test and validate the pilot solutions and assess their financial, environmental and social impacts. The overall objective is not just to prove out particular mobility

solutions, but to create real improvements in the capacity of cities worldwide to think through their current and future mobility issues and build policy-making capacity at urban, national and international level.

At local level, POCITYF and SPROUT share a common working group and knowledge exchange between the two projects is achieved through the common team members.

COproductioN with NaturE for City Transitioning, Innovation and Governance (CONNECTING Nature) | HORIZON 2020 | recently completed [57]
https://connectingnature.eu/

Connecting Nature was a €11.4m five-year project funded by the European Commission's Horizon 2020 Innovation Action Programme. The objectives of the Project were: Promotion and implementation of Nature-based solutions (NBS) in European cities; Development of urban development tools and good practices for the design, implementation and financing of NBS projects; Transfer of know-how from Guide Cities to Pilot Cities; Globalizing the Connecting Nature approach in cities outside Europe.

MoI has developed a General Programme Plan and will seek to implement city development projects through nature-based solutions, integrating the results and know-how of the lead cities and enriching them based on the particularities and opportunities that the special character of the city offers.

Of particular interest for MoI, are the co-creation activities with local stakeholders carried out in the frame of this project at local level. Any positive results from these activities will be studied and exploited.

Promoting citizens' active involvement in the development of Sustainable Travel Plans in Med Cities with Seasonal Demand (MOTIVATE)" | Interreg-MED 2014-2020 | completed
http://www.motivate.imet.gr/

MoI participated in the project "MOTIVATE" in the framework of the European programme Interreg-MED 2014-2020 with partners from Greece, Cyprus, Portugal and Italy. MOTIVATE promotes a new model for the development of Sustainable Urban Mobility Plans based on participatory design utilizing online social media and IT applications for data collection. Through the use of social media and crowdsourcing applications, citizens were asked to contribute to the decision-making procedure by: providing data for their daily trips, evaluating the current transport services and assessing the usefulness of proposed/planned mobility interventions. The ultimate goal is for these data to contribute to the design of policies focusing on citizens and the satisfaction of their needs.

MOTIVATE provided MoI with extremely useful data regarding mobility habits of the citizens of Ioannina. Also, in the frame of MOTIVATE, a smart parking application was developed.

LOCAL4GREEN+ | Interreg Mediterranean | on-going

MoI has joined the project as an associated partner in order to receive technical assistance from EGTC Efxini Poli (Network of European Cities for Sustainable Development for the development of local fiscal policies) that will promote RES in the geographical boundaries of the Municipality.

The group meets at regular intervals discussing possible ideas and their impact in order to select the most suitable ones for the Municipality.

MoI in the frame of this initiative has signed a memorandum of cooperation with local businesses for the integration of green local policies and the development of renewable energy sources, specific to the activities and the profile of each business.

"International Urban Cooperation (IUC)" and "International Urban and Regional Cooperation (IURC)" | on-going [58] https://iuc.eu/home https://www.iurc.eu/china/
MoI participates in the IUC programme funded by the European Union. The IUC programme started in 2016 and its activities will support the achievement of bilateral policy objectives as well as major international agreements on urban development and climate change, such as the Urban Agenda, the Sustainable Development Goals, and the Paris Agreement. The main thematic pillars of the IURC are cooperation between cities in the field of sustainable urban development and regional cooperation in the field of innovation. MoI participates in a thematic network with cities from China and of particular interest for POCITYF is the knowledge exchange in the field of Local Green Deal.
URBAN GreenUP consortium | HORIZON 2020 | on-going https://www.urbangreenup.eu/
MoI is part of the cluster of URBAN GreenUP consortium, which aims at developing, applying and validating a methodology for Renaturing Urban Plans to mitigate the effects of climate change, improve air quality and water management and increase the sustainability of our cities through innovative nature-based solutions.

3.4.4 Work groups

Apart from the work done by the POCITYF work group/ecosystem and is described in Section 3.2, Ioannina is also an active member of the Smart Heritage Working Group led by POCITYF and EURADA. The aim of the discussion group is to share knowledge on the topics of smart cities and communities in cultural heritage areas. The meetings MoI participated are briefly presented in Table 9.

Table 9 Smart Heritage Working Group meetings

Meeting	Subject	Location	Date
1st	Scope of the working group	Teleconference	24/11/2020
2nd	EU funding and other financing resources for smart innovation in historical cities	Teleconference	14/04/2021
3rd	Funding and Financing Opportunities: Public-Private Partnerships.	Teleconference	28/06/2021
4th	Energy Driven City Renovation	Agorada+ 21 in Valencia/hybrid	28/10/2021
5th	Energy Communities	Teleconference	04/03/2022
6th	Theoretical and practical discussions on Citizen Engagement	Teleconference	09/06/2022

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Meeting	Subject	Location	Date
7th	Lessons and experiences in Smart Heritage Transformations in the scope of legal and regulatory restrictions, new technological solutions and digitalisation	SSPCR 2022 in Bolzano	21/07/2022

3.4.5 ICT Tools

In the next phase of the project MoI is planning to use a software tool developed by consortium partners. The tool will support FCs during planning of the replication activities and will be utilised to enhance collaboration with stakeholders and citizens.

The tool makes it possible to simulate the installation of an existing solution by means of a drag-and-drop mechanism on the city map, and then a set of information on the solution taken from the corresponding factsheet can be viewed. The map tool is complemented by a forum created to foster co-creation, collaboration and co-development amongst citizens, stakeholders, and policy makers from both FCs and LHCs. An example from the current test version can be shown in Figure 10.

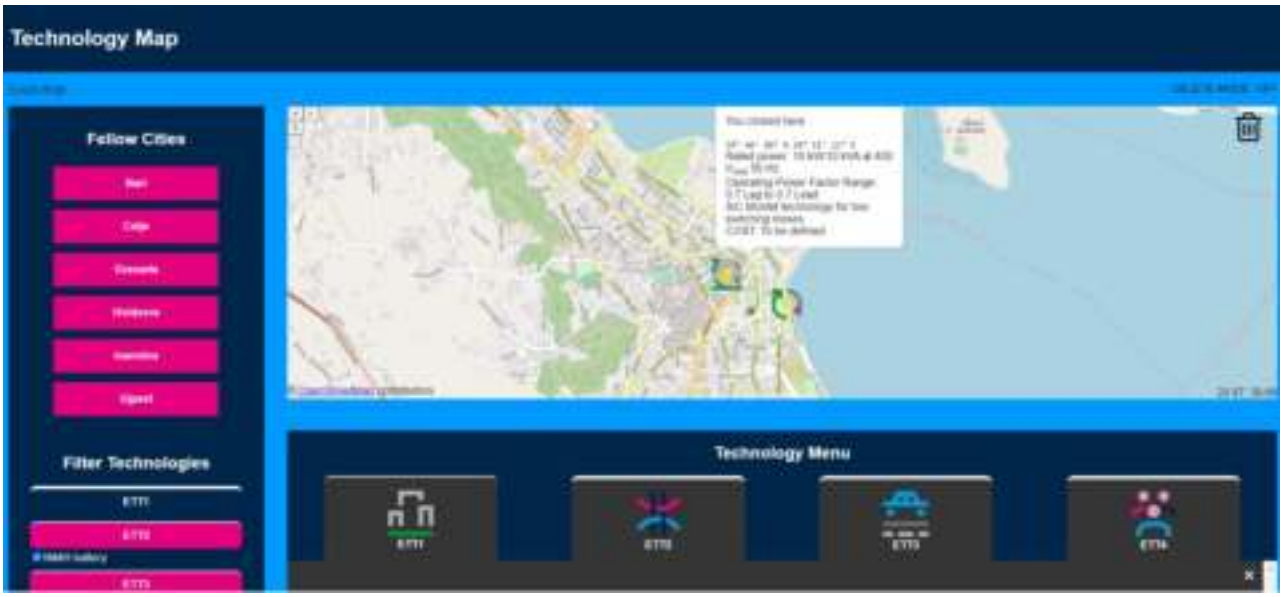

Figure 10 Screenshot from the replication tool

Finally, appropriate simulation software and ICT tools will be used for the buildings and district analysis (e.g. RETSCREEN, see Section 4.3.2).

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3.4.6 Questionnaires

Stakeholders' survey

MoI carried out in February 2022 a survey addressed to the local stakeholders. The survey was developed as an update of a survey carried out in 2020, but since Ioannina had received just one reply at that time, results from that first survey are not presented here.

The first step was the identification of the local external stakeholders of the city. The survey was then applied and answered by the external stakeholders presented in Table 10 during February and March 2022, in order to identify the perceived level of power and interest that the groups of stakeholders have in the different sets of solutions and the project as a whole. The survey was sent to the stakeholders directly per E-Mail by the Mayor.

Table 10 Preliminary list of relevant local External Stakeholders in Ioannina city

Stakeholders' Group	Relevant external stakeholders (with whom MoI is in contact with)
Energy Utilities	- Hellenic Electricity Distribution Network Operator (HEDNO) - Electricity Providers (e.g. DEH, Elpedison, nrg, Volterra, Protergia, Volton, Watt+Volt, ΗΡΩΝ, ZeniΘ)
Consumers	- Municipality of Ioannina - Local Bus Operator - Teachers of the school complex in the replication area
Technology and Services providers	- Technical Chamber of Greece, department of Epirus - Hellenic Association of Certified Civil Engineers - University of Ioannina - Municipal Solid Waste Treatment Unit of Epirus - EV Chargers Companies (Watt+Volt, Blink, NGR, ABB, ΔΕΔΔΗΕ) - Car companies offering car models with V2G capabilities (Nissan; Mitsubishi; Volkswagen) - Hellenic Institute of Electric Vehicles - Car rental businesses offering EV sharing (Brainbox, AVIS) - Epirus Science and Technology Park & ICT Consultants
Policy-making bodies and Governance	- Hellenic Ministry of Environment and Energy - Region of Epirus - Regulatory Authority for Energy - Municipal Council

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Stakeholders' Group	Relevant external stakeholders (with whom MoI is in contact with)
	- Ministry of Culture and Sports - Lake Pamvotida Management Body
Citizens	- Citizens of Ioannina, focused on those who live in the social housing ('Vrisoula') area - Professional drivers
Representative citizen groups	- Regional Federation of Persons with Disabilities of Epirus and the Northern Ionian Islands - Association for the Protection of the Environment of Ioannina - Epirus Youth Network - Association of the Historic Center "Ta Palia Giannina"

In the first question of this survey, respondents classified themselves as one of the following groups: Distribution grid operator; Energy suppliers; Heating/Cooling distributor; Energy producers; Non-Governmental Organizations; Industrial/Commercial Consumer; Academia and Research Institution; ICT consultants/developers; Technology and Service Provider; Local Regional Authority; Standardization/Regulation body; Representative Citizen Group; and Energy community/Cooperatives.

20 answers were received, and the results are presented in Figure 11.

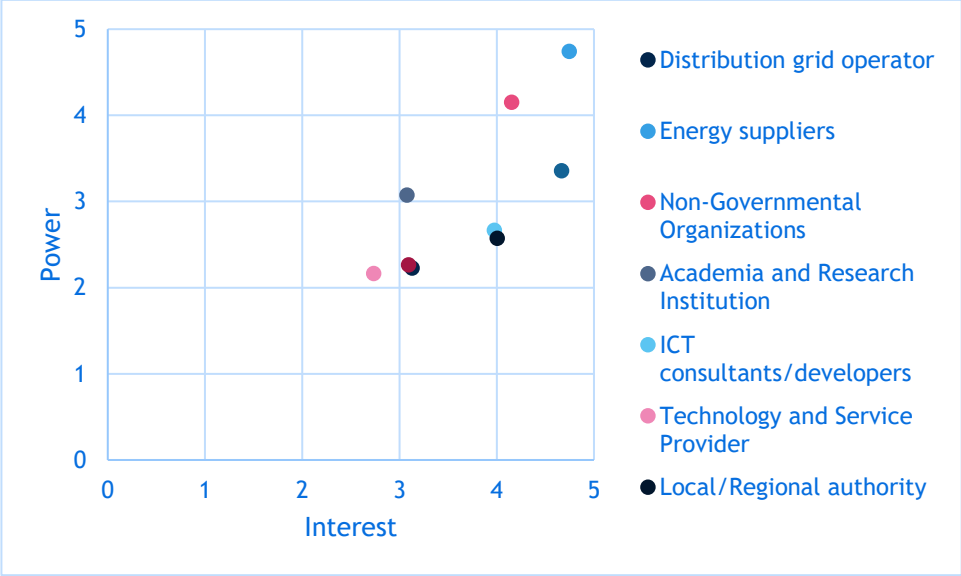

Figure 11 Ioannina Local External Stakeholders Power vs Interest matrix

Summarizing some key results from the analysis, it was possible to conclude that stakeholders considered to have less power than what was foreseen by the members of the consortium, except

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for energy suppliers (they considered to have a higher power than what the members of the consortium considered them to have). Also, some external city stakeholders, such as energy suppliers and energy producers and standardization/regulation bodies, who are highly interested in the smart city concept and the solutions that POCITYF advocates and are not part of the project, will be determinant for successfully implementing the smart city concept, especially after the project's conclusion and target of regular engagement and communication actions.

Citizens' Survey

MoI carried out an online survey addressed to Ioannina citizens on the use of sustainable solutions. The survey was answered by Ioannina citizens in January 2022 in order to assess the level of their awareness on approximately ten different IEs to be replicated in Ioannina and the level of their interest in using or participating in them. Ioannina received 186 replies while 25 citizens registered to participate in a citizens' panel.

FCs were asked to choose a maximum of 10-12 questions from a pool that addressed all the ISs predicted within the POCITYF project and, therefore, the knowledge and acceptance results gathered in the citizens' surveys are dependent on the questions selected by each city. Ioannina chose the solutions shown in the Table 11.

Table 11 Selection of questions from each city (taken from POCITYF D1.2 Deliverable on End-User and Stakeholders Requirements Definitions)

Question number	Évora	Alkmaar	Bari	Granada	Celje	Hvidovre	Újpest	Ioannina
3. Building Energy Management System, Energy router for buildings	✓	✓		✓	✓			✓
6. Building photovoltaic panels: roof or façade	✓	✓	✓	✓	✓	✓	✓	✓
7. Building integrated photovoltaic: shingles (traditional or flexible)	✓	✓					✓	✓
8. Glazing (skylight and/or windows) with photovoltaic films	✓	✓			✓			✓
10. Energy trading platform	✓	✓			✓	✓		✓
11. Community Solar Farm	✓	✓		✓		✓	✓	✓
15. Pay-As-You-Throw	✓	✓			✓			✓
16. Reverse collection of waste	✓	✓	✓					✓
29. Vehicle-to-grid: electric vehicle charges (outside)	✓	✓				✓	✓	✓
30. Smart solar charging // Electric vehicle charger prototype with PV integration	✓	✓	✓	✓		✓		✓

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Question number	Évora	Alkmaar	Bari	Granada	Celje	Hvidovre	Újpest	Ioannina
32. Tourist apps // Cultural experiences market (mobile app)	✓	✓	✓	✓				✓
39. City Information Platform (for municipalities or citizens) // Data acquisition systems	✓	✓	✓	✓	✓	✓	✓	✓

The results from the analysis show that Ioannina citizens have medium to medium-high levels of knowledge and medium-high to high acceptance levels. The analysis concludes that it is important that citizens feel they are included in the project and in the development of the solutions/replication plans and that the Municipality should try to understand citizens' concerns.

3.5 Integrated Solutions‘ evaluation criteria in coherence with the Propagation KPIs

Propagation is aiming at the improvement of the replicability and scalability of smart city solutions at wider city scale. Propagation is about the potential for dissemination to other locations, other contexts and other cities. Propagation depends in the first place on inherent characteristics of the (innovative) smart city solutions for transfers to other locations and countries, and for scaling-up from small single projects in the same city.

The success of the implementation and the replication of smart city solutions in the context of Ioannina smart city will be studied in terms of two propagation indicators (KPIs): the Social Compatibility KPI (P.1) and the Technical Compatibility KPI (P.2), as described in Table 12.

Table 12 Propagation KPIs for FCs (taken from POCITYF D2.2 Deliverable on Test and Evaluation Plans)

Propagation KPIs	Concepts, key aspects and process behind the variables used for the Propagation KPI	Scope/Objective
P.1 Social compatibility	This indicator aims to represent how much the innovative solution is mentally and socially accepted by a given community. This is fundamental for the replication dimension as the acceptance of a community is one the most critical requirement for driving a specific solution on a city.	Evaluate the acceptance response of citizens. This KPI is more contextually related to the replication as it is specifically related to the “forma mentis” (mindset) and traditions.
P.2 Technical compatibility	This indicator represents the degree of compliance with all the technical regulation requirements in place of a given country. Key aspects and elements behind P.2., are the degree of compliance with EU CEI-CENELEC-ETSI regulations as well as the compliance with specific NSB (National Standard	It is important to check if the product specifications are compliant with the regulations and standards of the export country, where the

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Propagation KPIs	Concepts, key aspects and process behind the variables used for the Propagation KPI	Scope/Objective
	Bodies) regulations: Does the solution comply with EU standards? And with specific national technical and legal standards? Although the compliance with EU regulations should be a "must" for the POCITYF ISs., the compliance with NSB regulation may be very specific according to the replication city.	product/service is intended to propagate).

3.5.1 Selection of IEs

During the first 2 years of the project the local team with the guidance of project partners conducted a preliminary analysis of the POCITYF solutions demonstrated in the LHCs which led to a pre-selection of solutions to be replicated in Ioannina. The criteria for the preliminary selection were the specific buildings' needs, local climate conditions and geographical constraints, SEAP targets, the strategic plan of the Municipality for the coming years, the available technical data on the solutions and some optimism about the grid upgrading progress and the technological advancements in Greece in the coming years. After this procedure, every POCITYF IE was marked with '*surely*', '*most probably*', '*maybe*' or '*interested*', depicting the degree of our interest in replicating the specific solution.

A set of these pre-selected solutions was used in the Citizens' and stakeholders' surveys (see Section 3.4.6). Following the surveys, MoI performed a SWOT analysis for all pre-selected solutions. The thorough study of the solutions led to the rejection of some of them, to their replacement with alternative ones and to a better identification of the possible barriers and threats.

Monthly meetings of the local team with CERTH, interaction with the local Work Group and the use of some replication tools described above (like the factsheets and the knowledge transfer workshops with LHCs) led to the better understanding of the solutions by the local team and to the finalisation of the set of solutions to be replicated.

The feasibility studies planned to be carried out in the next phase of the project will guide us in figuring out whether this specific set of the technical solutions will have the target results. Based on the feasibility study results, solutions might need to be replaced or different solutions might need to be added in our Replication Plan.

3.5.2 Evaluating Social Compatibility Propagation (P.1)

One of the preliminary tools used to evaluate social acceptance of the proposed IEs by the local community, was the online surveys described in Section 3.4.6. The first survey on the use of twelve pre-selected IEs to be replicated in Ioannina was addressed to Ioannina citizens with the aim to assess the level of their awareness and the level of their interest in using or participating in them. The second survey was addressed to external stakeholders in order to identify their perceived

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level of power and interest in the different sets of solutions and the project as a whole. The methodology and the results are briefly presented under Section 3.4.6.

The two sessions with the local Work Group and the meetings with key stakeholders were also utilised to collect insights and arguments on the use of the various proposed IEs and assess the acceptance by local stakeholders and citizen groups' representatives. Interactions with the local Work Group will be used throughout the project to collect social acceptance data. Social acceptance factors were also considered while carrying out the SWOT analysis (see Section 4.2.1), which the local team made available to the local Work Group.

In the next phase of the project structured Citizen Living Labs/Workshops are also planned in order to inform citizens on the project and our vision, motivate them and actively involve them in the planning process. Our target groups are residents from the proposed PEDs and users of the buildings, citizens and citizen groups' representatives, tourism operators and representatives of knowledge institutes and the university. Citizen Labs are expected to provide us with extremely useful data on the social propagation of the proposed POCITYF IEs.

All citizen engagement initiatives planned to be carried out or exploited until the end of the project and the associated social KPIs which will be used as metrics in the frame of POCITYF will be included in more detail in MoI's Citizen Engagement Plan, on which MoI is working in parallel with this Replication Plan and will be completed by the end of the POCITYF project.

3.5.3 Evaluating Technical Compatibility Propagation (P.2)

Replicability of solutions will be mainly assessed through the Technical Compatibility Propagation.

Technical compatibility for every IE was investigated during the SWOT analysis, performed by the local team with contribution from the local Work Group, as described in Section 3.3. The technical criteria considered for assessing the various innovation solutions are described in Section 4.2.1.

A general preliminary study of the regulatory framework and the legislative requirements was performed in the first phase of the project and presented in POCITYF Deliverable D1.4 Building & Grid Retrofit Regulatory Framework. Legal and regulatory factors were also considered in the SWOT analysis and will be investigated throughout the project.

A study of compliance of the IEs with NSBs was not carried out. Assuming compliance of all POCITYF solutions with EU Standards and CEI-CENELEC-ETSI regulations, all IEs are considered at this stage compliant with the national standards too. The use of other internationally (non-EU) recognized standards is also allowed (e.g., DIN, BS, etc), as a system of "parity" of standards is provided in the Greek legislation.

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4 Building up the Replication Plan and City Vision 2050

4.1 Building up the Smart City Vision and Plan

Ioannina Smart City Vision (as defined in the Digitalisation and Smart City Strategy 2030 [38])

The Municipality of Ioannina has emerged as a metropolitan area with a privileged location both in terms of geographical location and natural environment. It is a center for cultural activities and leisure with local and supra-local significance and dimension. The vision of the Municipality is to offer a modern and functional living environment, to support ist development and prosperity with an emphasis on innovation, while preserving its historical and traditional features and ensuring the protection of the environment.

At the same time, the Municipality wants to take advantage of its privileged geographical position and benefit from the expected development of the neighboring countries of the Western Balkans.

More specifically, the Municipality will invest in:

- The development of the Municipality, guided by climate neutrality, in the framework of the initiative '100 climate neutral cities by 2030'.
- The protection of the natural environment, citizens, residents and businesses and their property, in the event of emergencies and natural and man-made disasters.
- The protection of the environment, with reduction of energy consumption and alternative waste management actions and sustainable mobility.
- The use of innovation and technological developments with actions to better serve citizens and promote their active participation.
- The continuous upgrade of the quality of life, with the implementation of new infrastructures and the exploitation of new technologies for the further modernization of the provided services.
- Enhancing social cohesion by developing closeness and mutual respect among citizens.

The important role of ICT in the realization of the vision is widely recognized. The digital transformation offers important opportunities for modernization, economic growth and prosperity and in this context can support the vision of the Municipality.

The Municipality aspires to be leader and helper in the efforts of citizens and businesses for economic development and prosperity, through the increase of the efficiency of the municipal authority, the provision of digital value-added services, human resource empowerment, targeted investment and engagement of stakeholders.

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4.2 Final selection of technologies and assets to be included in the Replication Plan

4.2.1 Definition of the main technical specifications linked with the Replication Plan

The following technical criteria have been applied and will also be considered throughout the project to identify the best solutions for the city of Ioannina. These criteria are specific to Ioannina's local context and the problems that tend to appear when new technologies are introduced. Cost criteria (set-up, license and maintenance costs) have not been considered at this stage for selecting one solution instead of another. Data security criteria have also not been considered, under the assumption that all proposed solutions provide data security.

- Addressing city needs: After identifying the most urgent problems in the city, solutions were studied that best address these issues and technologies which we could not be associated with these needs or did not seem realistic were rejected. For example, the IE 4.4.1 - Digital Transformation in Social Innovation was rejected because it is a solution for empowered citizen participation, which was considered premature in our local context. Our target at this stage is to find appropriate tools to encourage citizens to move from a non-active participation (current situation) to an active participation (mid-term target).
- Technological maturity: Technological maturity constitutes for us a decisive social acceptance factor (see «demonstrated benefits»).
- Product/service availability: Availability of products from multiple suppliers/service providers is prerequisite for public tenders. The necessity for procurement of monopoly products and services must be justified and well documented.
- Technical Support/Availability: Unavailability of technical support by local service providers might cause long delays and unavailability of the service. Lack of technical support is considered to be a serious threat for the implementation and acceptance of a solution. Products with larger numbers of users might prove more valuable in this sense.
- Reliability as a factor for Scalability: High availability and reliability are required for achieving scalability of the solution. This requirement will be assessed in the next version of this document when such data becomes available from the LHCs.
- Availability of suitable technical staff: If special technical skills are needed for the use and operation of the solution, it should be clear if training of existing personnel is possible or specially trained personnel can be easily found and hired in the city. No solution was rejected because of its operational complexity, but has been identified as a threat in some cases (e.g., IE 2.1.2 Renewable Energy Communities Management Platform, IE 2.1.6 City Energy Management System)
- Simplicity and demonstrated benefits: For the acceptance of an innovative solution from the staff of the Technical Services, the Municipal Council and the local ecosystem, the design of the solution as well as its benefits compared to existing technologies must be clear. A non-ideal (but sufficient) solution that is easy to understand would most probably

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win over an ideal but hard-to-understand one in a public debate. An example of such solutions was for us the IE 1.1.15 Thermoacoustic heat pumps and IE 1.2.7 ATES (Aquifer Thermal Energy Storage, heat/cold). In both cases the local team had a difficulty in understanding the obvious benefits compared to alternative well-established technologies, like for example heat-pumps and geothermal heat pumps, respectively. These solutions will be further studied when more technical data and factsheets become available.

- Extendibility and interoperability: The technology must be easily extended to support new requirements that are anticipated in the next years (even decades, depending on the nature of the project). In the case of interconnected systems (like the City Platforms) it should also be possible to integrate (with only small-scale adaptations) existing systems and systems from different manufacturers and technology providers.
- Life expectancy: As it affects the investment plan. The continuous charging and discharging of the battery in V2G solutions, for example, might result in an earlier replacement of the car/home battery.

Finally, according to the law on «Public Procurement of Works, Goods and Services» [50] specific technical requirements of the goods to be procured must be defined in a public tender, so that they can be described in an objective way. These include definition of requirements in terms of quality levels, environmental and climate performance levels, conformity and suitability assessment procedures, safety, dimensions, material, packaging, labelling etc.

Unless justified by the contract, the technical specifications may not mention a specific construction or origin or particular manufacturing method or refer to a trademark, patent or type as well as to a specific origin or production which would have the effect of favouring or to exclude certain companies or certain products.

The above-mentioned requirements must also be available before final selection of a solution.

4.2.2 List of POCITYF ISs selected to be replicated

Table 13 summarizes the solutions MoI has manifested interest for and reflect the current status of our knowledge (until May 2022, when the SWOT analysis for this deliverable was completed, many factsheets were still not available) and the current planning stage. All POCITYF solutions will be further studied and analysed in the next 2 years and the list will be modified as more data from the LHCs become available. The list will be finalised in the next version of this document (September 2024).

In the last column are presented the buildings and districts in which MoI plans to study the solutions in the next phase. City-level solutions (e.g.: city management platforms and apps) have not been associated with specific buildings or districts. Some solutions are still marked with «to be defined», as it has not been clearly defined yet where they will be implemented.

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Table 13 List of POCITYF IEs selected by MoI to be studied for replication

ETT	IS	IE#	IE (Innovative Element)	PEB
ETT #1	IS1.1 - Positive Energy (stand-alone) Buildings (PEB)	1.1.1	PV Glass	PEB 1.1; PEB 1.2
		1.1.2	PV Canopy	(to be defined)
		1.1.3	PV Skylight	(to be defined)
		1.1.5	Traditional PV Shingle	PEB 1.1; PEB 1.2
		1.1.7	Energy routers	PEB 1.1; PEB 1.2; PEB 1.3-1.8
		1.1.8	BMS (Building Management System)	PEB 1.3-1.8
		1.1.9	HEMS (Home Energy Management Systems)	PEB 1.1; PEB 1.2; PEB 2 (potentially)
		1.1.12	Insulation with circular materials	PEB 1.1; PEB 1.2; PEB 1.3-1.8
		1.1.13	Triple glazing	PEB 1.1; PEB 1.2; PEB 1.3-1.8
		1.1.14	Solar roofs and facades	PEB 2 (only if the building roof can't be used for PV installation); PEB 1.3-1.8 (only for demonstration purposes)
	IS1.2 - Positive Energy Districts (PED) Retrofiting	1.2.1	Smart Lamp posts with EV charging and 5G functionalities	PEB 1.9 (municipal car park), PEB 2
		1.2.2	Energy routers	See IE 1.1.7
		1.2.4	P2P energy trading platform	
		1.2.5	Community Solar Farm	The location itself is found outside the boundaries of PEB 1 but users will be municipal buildings within PEB 1.
		1.2.11	V2G (Smart charging and V2G system connected to energy trading platform)	PEB 1.9 (municipal car park)
	IS1.3 - Feeding PEDs with waste streams promoting symbiosis and circular economy	1.3.1	2nd Life Batteries	PEB 1.1; PEB 1.2; PEB 1.3-1.8
		1.3.2	PAYT (Pay-As-You-Throw)	PEB 1, PEB 2

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POCITYF

ETT	IS	IE#	IE (Innovative Element)	PEB
ETT #2	IS2.1 - Flexible and sustainable electricity grid networks with innovative storage solutions	2.1.1	2nd Life Batteries	See IE 1.3.1
		2.1.2	Renewable Energy Communities Management Platform	
		2.1.4	P2P energy trading platform	See IE 1.2.4
		2.1.6	City Energy Management System (CEMS)	
		2.1.8	Stationary batteries	PEB 1.1; PEB 1.2; PEB 1.3-1.8
		2.1.10	V2G	PEB 1.9 (municipal car park), PEB 2
ETT #3	IS3.1 - Smart V2G EVs Charging	3.1.1	EV charging management platform	
		3.1.2	EV charger prototype with PV integration	(to be defined)
		3.1.3	Bidirectional smart inverters for EV smart charging and V2G applications	PEB 1.9 (municipal car park)
		3.1.4	V2G	PEB 1.9 (municipal car park)
		3.1.5	Smart lamp posts with EV charging and 5G functionalities	PEB 1, PEB 2
	IS3.2 - E-mobility Services for Citizens and Auxiliary EV technologies	3.2.1	EV sharing	PEB 1.9 (municipal car park)
ETT #4	IS4.1 - Social Innovation Mechanisms towards Citizen Engagement	4.1.3	Tourist apps	
		4.1.5	Mobile apps on energy consumption	
	IS4.3 - Interoperable, Modular and Interconnected City Ecosystem	4.3.1	City Urban Platform	
		4.3.2	Wi-fi data acquisition systems	
		4.3.5	Citizen Information Platform (lately added, not yet in the SWOT analysis)	(to be defined)
		4.3.7	City Data Hub (lately added, not yet in the SWOT analysis)	(to be defined)

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4.2.3 Guideline: High-level technical specifications for Ioannina Smart City

MoI recently completed the following two Municipal documents, which describe measures and processes to be followed to become a Smart City until 2030 [38]:

- *«Integrated Digital Transformation and Smart City Strategy for the Municipality Ioannina»*
- *«Action Plan for the implementation of the Digital Transformation and Smart City Strategy for the Municipality of Ioannina»*

The two documents define the "Smart City Strategy" of the Municipality of Ioannina as an administration plan, which will be constantly updated through consultation with the local community and will be the driver of its digital transformation. The POCITYF local team is aiming at the integration of the final version of the Replication Plan in the Smart City Strategy of the Municipality and even its adoption as a municipal guideline for smart city projects. For this reason, some key facts and guidelines which are described in this Strategy must be considered and are briefly presented in this Section.

Based on the objectives set by the City Vision (see Section 4.1), the Strategy describes an integrated plan with guidelines, axes and specialized actions, implementation schedule and funding sources, always considering the national strategy and needs of the local community. At the same time, a governance framework is included, to monitor the implementation of the project by the municipal authority. In this context, the possibility of identifying objective quantitative indicators, which will be in line with the strategic objectives, is particularly important. Through the indicators and their matching with specific actions, the expectations of all parties involved and the criteria for assessing the success of the actions can be made clear. In this way, possible deviations will also be immediately identified, and the corresponding corrective actions will be launched in a timely manner. Therefore, the definition of a representative set of indicators and their monitoring mechanism is an integral part of the Smart City Strategy. Without them and without reliable data, any modernization effort may not only not have beneficial results but may create additional workload for employees and inconvenience for residents and businesses.

The Strategy recognises the following two types of measurement indicators and presents indicative evaluation indicators per strategy axis.

- The indicators of actions, which aim to measure results in each distinct action of the smart city.
- The indicators of results, which measure the general impact that an action has on the course of the digital transformation.

From the analysis of the current situation in the city, conclusions emerge which imply the following challenges for the digital transformation of the Municipality:

- Transformation of the urban mobility model by utilizing new technologies.
- Extensive needs for the cultivation of digital skills, including staff and executives of the Municipality.

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- Strengthening of tourism by utilizing new technologies.
- Need for further improvement in the degree of digital maturity of the Municipality, with a parallel orientation in the provision of digital services to citizens and businesses.
- Protection of the natural environment of the Municipality through targeted actions.

The Strategy, both during its initial presentation and during its period of validity, should become property of the municipal employees, the citizens and the productive bodies of the city and should be a reference point for any action. Actions must in any case have a trial period in a productive environment, during which problems and omissions in the design will be identified. Finally, there should be a mechanism of communication and education of both municipal employees and citizens so that it is possible to assimilate in a short time the changes that the digital transformation will bring to their daily lives.

4.3 Designing the replication of ISs

4.3.1 Planning the implementation of the selected ISs in the defined Replication Areas

The Replication Plan for the Municipality of Ioannina will focus on the transformation of the city into a modern smart and sustainable ecosystem with respect to the culturally specific characteristics and the heritage of the city. To this end, the following directions will be taken into account (a detailed list of selected IEs is presented in Table 13):

- Buildings retrofitting according to energy efficient techniques and relevant materials, including RES and smart energy management systems.
- Interventions in city districts, towards PEDs including energy efficient solutions, smart electric mobility with EV charging stations and sustainability (e.g., sustainable waste management).
- Digital transformation in multiple aspects of citizens' involvement, ranging from energy communities and energy management (e.g., P2P energy trading) and including social innovation and citizen engagement.

The municipality of Ioannina has proceeded to a careful selection of POCITYF solutions for replication that are aligned to the specific environmental conditions of the city area, the cultural restrictions posed by the relevant city agencies (with respect to monuments and antiquities etc) and the local legal and regulatory restrictions. In addition, the desirable level of citizens participation and engagement in energy management behavioural change and involvement to the public space sets a challenging field for technical and social interventions which aim to transform the PEDs and chosen public buildings into vibrant energy efficient ecosystems.

POCITYF has raised important discussions and cooperation among the involved cities that helped in information sharing and knowledge transfer, regarding integrated solutions and replication planning activities, helping Fellow Cities to sketch their planning according to city capacities and the local conditions. However, the local restrictions and specific city features require careful

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consideration of the barriers, the technologies and stakeholders' involvement and the city vision for 2030 and 2050.

Towards replication of the technical interventions in the city, a careful analysis of the relevant technical capacities and specificities has been accomplished, showing the necessity for building and area retrofitting, along with energy transition related interventions for sustainability, mobility and social innovation. This analysis has been combined with feasibility studies regarding the compatibility of technologies and materials that can be used in coordination with the local conditions and the buildings/areas involved in the replication plans.

Relevant ICT tools have also been considered, promoting the combined online and offline activities of communities for social innovation and behavioural change towards energy transition. The ICT tools will provide the basis for information diffusion and knowledge transfer among distinct citizen communities and local city agencies, along with operational toolkits for digital transformation. Furthermore, city platforms will assist in city monitoring, from a KPI perspective, for both technical and social goals.

It is essential also to consider both administrative constraints and specificities, as well as financial support for the replication plans. An analysis of the administrative procedures is important to overcome non-technical barriers that may exist in local and national regulations. These procedures are further present in financial planning for replication, as most of the integrated solutions have to be aligned with external funding schemes that will support the final replication of the POCITYF innovative elements. Although it is not possible at the replication planning phase to accurately define the financial requirements, an initial estimation of the financial schemes that can support integration is considered.

The replication plan aims to be a holistic approach that is carried out in accordance with the city vision, in both operational level and technical design. Under this perspective, the selection of the integrated solutions proposed by POCITYF was made possible by taking into account the local conditions and the relevant feasibility studies, involving local stakeholders and working groups where this was possible.

4.3.2 Methodology

The Municipality of Ioannina has identified eight (8) buildings to demonstrate the renovation potential to achieve positive energy buildings through solutions of IS1.1 - Positive Energy (stand-alone) Buildings (PEB).

The Replication Plan conducted by MoI includes the following buildings in PEB 1, which were also presented in Section 2.2:

- The 'Pirsinela' Traditional Mansion (listed monument) (PEB 1.1)
- The City Council building (listed monument) (City Hall) (PEB 1.2)
- A school complex comprising of the following buildings:
    - 8th High School (GEL) and 1st Trade High School building (EPAL) (PEB 1.3)

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- School of Technical Education (PEB 1.4)
- Administration building (PEB 1.5)
- Library building (PEB 1.6)
- Sports Hall building (PEB 1.7)
- Multi-purpose Hall (PEB 1.8)

The location of the buildings in the city of Ioannina is shown in Figure 12.

Figure 12 Location of the municipal buildings identified within the city of Ioannina

Within POCITYF, the potential of these buildings to become Positive Energy Buildings will be investigated through the application of suitable energy efficiency and RES technologies that will be identified from: i) the innovative technologies demonstrated by the Lighthouse Cities of Evora and Alkmaar, and ii) technologies that are commonly used in Greece and are particularly suitable for the local conditions. During the proposal stage, some IS - 1.1 technologies that are of interest to the MoI have already been identified, i.e., insulation, solar roofs, facades as well as HEMS/BEMS and innovative PV solutions.

The methodology presented in this document describes the analysis performed only at building level. No results can be presented at this stage regarding the analysis at district level.

The methodology for the evaluation of the energy upgrade of the individual buildings towards achieving positive energy performance is as follows:

- Step 1: The current energy performance of the building is assessed through simulations to determine the baseline condition. This is done through a suitable energy analysis software.

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- Step 2: The baseline simulation results are compared to actual energy consumption data of the building under investigation in order to calibrate the model and validate the results obtained. Such calibration and validation increase confidence on the simulation model that will be then used to assess the performance of the energy upgrade measures.
- Step 3: The energy efficiency and RES technologies that will be considered in the energy upgrade of the buildings towards achieving positive energy status are identified.
- Step 4: The performance of the proposed energy upgrade of the building is assessed through simulations with the use of the same software and the model calibrated in the previous steps.

In order for this process to take place, a suitable energy analysis software able to conduct the simulations at the baseline stage to determine the current energy consumption but also assess the performance of the energy upgrade measures (energy efficiency and RES technologies) was required. The RETScreen Expert software tool was selected, '*a Clean Energy Management software*' that is used for the feasibility analysis and the performance analysis of projects in the fields of renewable energy and energy efficiency [59]. In addition to the ability to conduct the energy simulations of the baseline and the energy upgrade of the buildings, RETSCREEN is considered particularly useful for the assessment of energy renovation projects at the preliminary feasibility stage and particularly suitable for the POCITYF project to be used as a replication tool due to the following features:

- It is able to conduct simplified energy simulations including most of the commonly used energy efficiency and RES technologies for power, heating and cooling of buildings.
- It includes extensive databases for a range of technologies, allowing the user to conduct the analysis fast, even with the limited data availability that is common at the early stages of a project.
- It is user friendly and there are tutorials available for training. As such, even non-energy experts can use the software to conduct an energy analysis or evaluate a model.
- It produces results fast allowing the quick evaluation of alternative solutions and selecting those combinations of measures that achieve the performance targets set.
- In addition to the energy analysis, the software also includes additional functionalities such as of CO2 emissions analysis, financial analysis and Sensitivity and Risk analysis of renovation projects.
- It is cost effective; the tool is available at a low cost or even free in some cases (such as research centres and in 'viewer only' mode for evaluation purposes). This is particularly useful for projects with many stakeholders involved such as POCITYF.

In this first version of the Deliverable, RETSCREEN was used for conducting the energy analysis of the buildings and determining the current energy consumption. The process using the Energy Model of the tool is conducted in six steps:

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- Step 1: Selecting the building location and loading suitable climatic file. RETSCREEN includes a wide range of available climatic data to facilitate the analysis (Figure 13).
- Step 2: Defining the occupancy schedule(s) of the building (e.g., occupancy hours, thermostat settings during occupancy hours and the rest of the time etc.) and the fuel types that are considered (e.g., natural gas, biomass, heating oil, electricity etc.) (Box A in Figure 14)
- Step 3: Defining the HVAC system characteristics, i.e., type, efficiency etc. In addition, there is a database with indicative equipment specifications (boilers, heat pumps etc) available to facilitate the user in the analysis (Box B in Figure 14).
- Step 4: Defining end-use characteristics of the building under investigation. This step involves determining the building envelope characteristics (geometry, materials, infiltration and ventilation rates etc), the electricity consumption and gains (lights, equipment, occupants etc.) as well as any other load that may contribute to the building's consumption (Box C in Figure 14).
- Step 5: The user may determine any renewable energy systems installed for the production of electricity (such as PV or wind turbine) or thermal energy (solar thermal systems) (Box D in Figure 14)
- Step 6: The results of the analysis are presented (Box E in Figure 14)

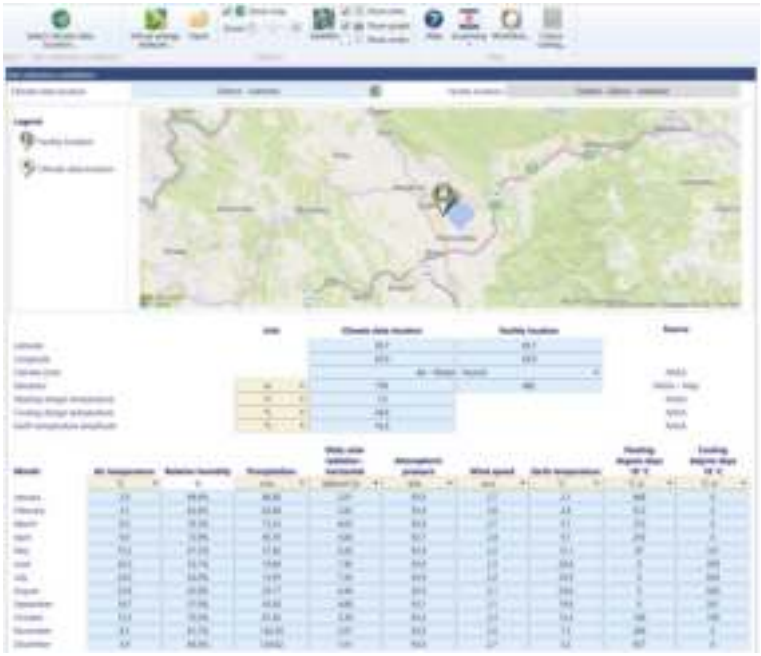

Figure 13 Selecting the location of the building under investigation and a suitable climate file

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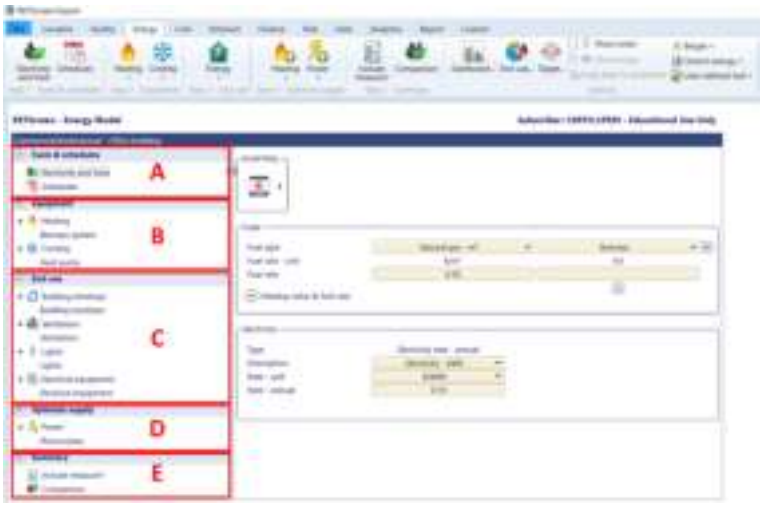

Figure 14 Overview of the RETSCREEN Energy Model analysis steps

Completing Steps 2 to 5 of the above process requires the use of several data that are used as inputs to the model regarding the function of the building. The use of reliable input data is essential for achieving consistent and reliable results that reflect the actual performance of the building. For this reason, collection of input was treated with due care and was based on: i) collection of data on site with the help of MoI staff (building plans and materials, equipment energy ratings and inspection sheets, inventory of installed capacity, previous bills, interviews with building managers etc.), ii) when data could not be collected on site these were supplemented by input data from relevant technical directives (TOTEE), iii) in case of more specialized data required (where guidance was not available in the technical directives) input data was also collected from literature.

Difference between the simulation results and the actual building energy consumption data is very common and can be attributed to a number of factors, such as i) difference in the thermal properties of the building materials considered and their actual thermal properties, ii) use of typical meteorological files in the simulations which are different from the actual weather conditions experienced in practice, iii) occupant behavior and gains cannot be fully accounted for by the model assumptions, iv) difference in the numerical methodology describing the heat transfer processes and the actual process taking places as well as various programming inconsistencies, etc [60]. For this reason, it is not realistic to expect that a simulation model will be able to match perfectly the simulated with the actual energy consumption of a building. Therefore, in order for a model to be considered calibrated, a specific threshold which should not be exceeded should be set. In this case, a maximum ±20% deviation threshold has been set, i.e., the simulation results should not exceed the actual consumption by more than ±20%. As mentioned before, in order to avoid large discrepancies, previous utility bills provided by MoI were used to calibrate the models and validate the results.

In the following paragraphs a brief description of the buildings is provided along with an initial estimation of the baseline energy demands.

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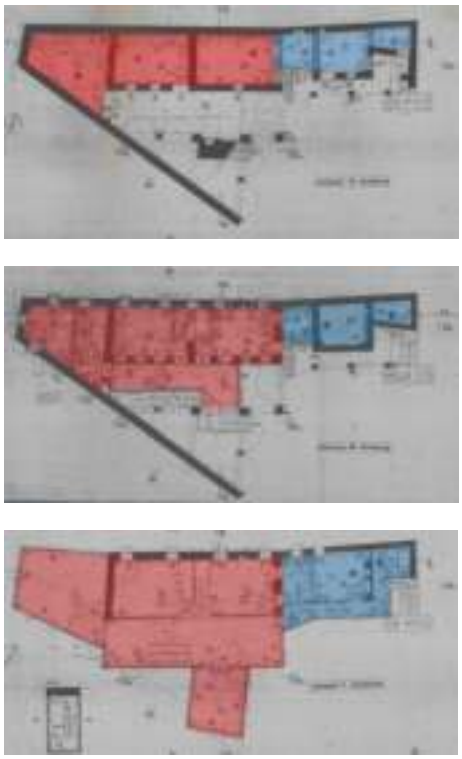
4.3.3 Buildings analysis

4.3.3.1 Pirsinela Traditional House (PEB 1.1)

The Pirsinela Traditional House is a historical dwelling built circa 1840s and is one of the last historical mansions in Ioannina. The building has an irregular shape and it appears to have been constructed in two phases as shown in Figure 15 below: At first, the triangular part of the building (marked in red) was constructed (Phase 1) whilst an extension was added later along the south west side giving it its unique elongated shape (Phase 2). The building had various uses in the past and is now used as an office building for the administration of the Ioannina Municipal Theatre. External views of the building are provided in Figure 16.



Ground floor

First Floor

Second Floor

Figure 15 2D Plans of the building showing phase 1 (red) and phase 2 (blue) of the building construction.

The building comprises three floors in total (ground and two additional floors) and is built with two different external wall construction types; the ground floor, first floor and part of the second floor were constructed with solid stone wall, whilst part of the second floor was also constructed with 'mpagdati-tsatmas' a traditional type of timber frame construction typical in such historical buildings. Floor plans and information on the building materials required for the analysis were provided by MoI. The thermal properties of the building elements are shown in Table 14 below and the relevant inputs at the RETSCREEN Graphical User Interface of the building envelope (wall, floor and roof areas and U-values, window areas and U-values, infiltration rate etc.) are provided

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in Figure 17. It should be noted that the building envelope characteristics were provided through the software GUI (and the resulting energy losses calculated by the software) for each floor separately.

Figure 16 External views of the Pirsinela building

Table 14 Basic thermal properties of the main building elements of the Pirsinela building

Element	Description	Nominal Thermal transmittance (W/m^2K)	Area
External walls – stone walls	Solid stone walls (varying thickness 50mm to 70mm)	2.13 – 1.70[1]	664.4
External walls – 'mpagdati/tsatmas'	Timber frame walls	2.24 [61]	
Roof	Flat ceiling under non-insulated roof	3.7	284.1
Floor	Non-insulated floor slab (on-grade)	3.1	189.3
Floor (above unheated space)	Non-insulated floor slab in contact to unheated space	2	26.0

[1] Depending on the thickness of the stone wall and considering the thermal conductivity of limestone of 1.67 W/mK. Relevant adjustments to the U-values were made when part of the wall was in contact to the ground or an unheated space according to the conventions of TOTEE 20701-1:2017.

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Element	Description	Nominal Thermal transmittance (W/m^2K)	Area
Floor (in contact to air)	Non-insulated floor slab in contact to air	2.75	68.9
Windows	Single glazed windows w/timber frame	4.3 - 5.0[2]	137.9

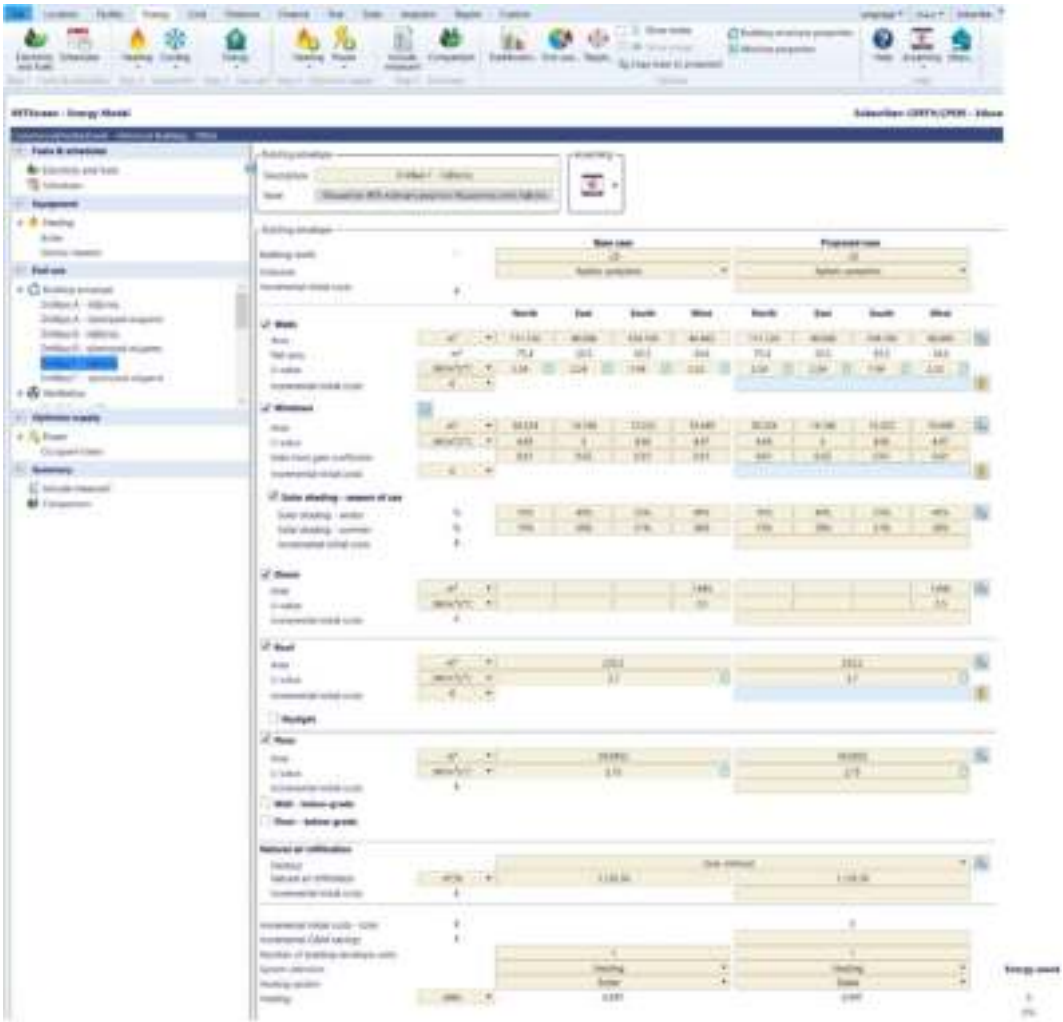

Figure 17 RETSCREEN inputs for assessing the heat losses (transmission and infiltration) through the building envelope

[2] Depending on the size of each window and the subsequent portion of the frame on the total window area (according to the assumptions in Table 3.13.a of Technical Regulation (TOTEE) 20701-1:2017)

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The energy analysis considered two main uses of the building areas: i) offices and ii) corridors and common auxiliary spaces. The type of usage of the spaces affects the energy demand of the building due to the different:

- Occupancy rate and subsequent occupancy gains
- Demand in fresh air according to the activity
- Demand in lighting levels and consequent lighting gains
- Equipment gains
- Building operation for 8 hours day, 5 days/week

During occupancy times the thermostat was set to 20ºC for the heating and 26oC for the cooling season. During times when the building was vacant typical thermostat settings were considered 10ºC for the heating and 36ºC for the cooling season (i.e., ±10ºC deviation from the occupancy schedule). These inputs are shown in Figure 18. The assumptions used in the analysis for the various gains and demand for each type of use is shown in Table 15 based on the recommended values set by the relevant Technical Regulation [62]. Indicative inputs for the lighting gains and equipment at the RETSCREEN Graphical User Interface based on the assumptions of Table 15 are shown in Figure 19 and Figure 20.

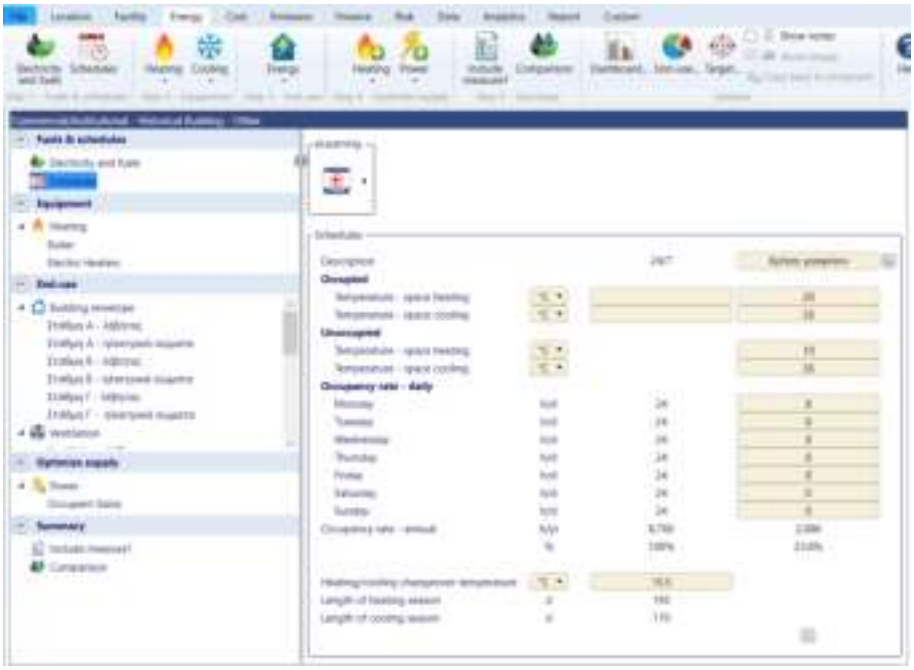

Figure 18 Thermostat settings and occupancy schedule for the Pirsinela Traditional House

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 864400.

Table 15 Areas and consumption/gain characteristic values for the two zones of the Pirsinela Traditional house

Type of use	Area (m^2)	Fresh air requirements ($m^3/h/m^2$)	Lighting gains (W/m^2)	Equipment gains (W/m^2)	Occupant gains (W/m^2)
Office space	380	3	16	4.5	8
Corridors and common auxiliary spaces	103.2	2.6	3.2	0	0

Figure 19 Lighting gains for the offices of the second floor

Figure 20 Equipment gains for the offices of the second floor

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 864400.

In addition, losses through ventilation were also determined. Since RETSCREEN does not account for the opening of windows, natural ventilation losses were considered following the methodology of the Greek Regulation on Energy Efficiency (KENAK) and the relevant guidance from the Technical Directive TOTEE 20701-1:2017 [62] for the implementation of KENAK. A theoretical mechanical ventilation system was considered to be providing 100% fresh air (without heat recovery) during the occupancy hours at a rate equal to the Building Regulation requirements for fresh air for the various zones in Table 15.

The building has a central heating system (heating oil boiler) whilst electrical heaters also provide auxiliary heating in some offices. In order to account for the periodical use of the electrical heaters, it was considered that 10% of the heated area was heated by electrical heaters. The heating oil boiler was found through an inspection to have seasonal efficiency of 91%. Considering the adjustments for the oversizing of the system and the seasonal use as well as accounting also for 4% distribution losses (for an insulated distribution network mostly running through internal building spaces) and 90% fan coil and radiator efficiency according to the guidance of TOTEE 20701-1:2017 (weighted average of the terminal units individual efficiency), the overall seasonal efficiency of the heating system was approximately 69% (Figure 21). The efficiency of the local electrical heaters that were used as auxiliary system was considered 100% as eventually all electricity consumption is converted to useful heat inside the treated space. Based on the above assumptions, the building's fuel and electricity consumption were determined and presented along with the actual energy consumption as determined through previous bills is presented in Table 16.

Figure 21 Main Heating system efficiency for the Pirsinela Building

Table 16 Total fuel/electricity consumption for the Pirsinela building

	Units	Simulation results	Actual consumption
Total fuel consumption	litres/year	1,767	-
Total electricity consumption	kWh/year	14,183	29,142

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 864400.

Simulation and actual data comparison

The actual consumption data from previous years were provided by MoI. At the time when these data were recorded there was no main heating system installed in the Pirsinela building and all space heating was provided through local portable electrical heaters. Therefore, electricity consumption accounted for both electrical loads and space heating loads. In order to be able to compare the simulation results against the actual consumption figure, the same model was considered, only this time all thermal demand was met through electrical heaters. The total electrical consumption was 26,354 kWh which is very close to the actual monitored consumption of the building (29,142 kWh), with 9.6% deviation. This difference is smaller than the ±20% deviation threshold; thus the model is considered to provide an adequate representation of the current building performance (baseline) and to be suitable for the next step of the analysis where the energy upgrade of the building will be examined and reported at the final version of this Deliverable.

The same methodology following the same steps and inputs was considered in the rest of the buildings. For reasons of space economy, the basic inputs for the models and the results will be presented in the following paragraphs without the relevant screenshots from the software.

4.3.3.2 City Hall (PEB 1.2)

The City Hall of Ioannina was built in 1928 in operating as a branch of the National Bank of Greece until the 1950s. The building was designed by architect Zoumpoulides and has a 'post-Byzantine' style. It has accentuated entrance with byzantine style column, whilst on the first floor the 'metope' is characterized by ceramic brick arches and marble columns. As from the 1960, the ground was used to host the 'Zosimaia' library, and first floor was used as a retreat to the then royal family when they visited the city. Eventually, the Zosimaia library was relocated, and the building is now used to host the services of the Municipality of Ioannina [63].

Figure 22 External view of the City Hall building

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The building has two floors, a ground and a first floor as well as a mezzanine between the two floors. The total heated floor area is approximately 865 m^2. In addition, there is an unheated basement. Part of the floor is slab on ground and part sits above the basement. Similar to other historical buildings of that era, the City Hall building has uninsulated solid stone walls and single glazed windows with timber frame. The main elements of the building and their thermal properties[3] that were used in the analysis of the heating and cooling loads of the building are presented in Table 17 below. Floor plans and information on the building materials required for the analysis were provided by MoI.

Table 17 Basic thermal properties of the main building elements of the City Hall building

Element	Description	Thermal transmittance (W/m^2K)
External walls	Solid stone walls (varying thickness 58mm to 70mm)	1.93 – 1.70[4]
Roof (first floor)	Flat ceiling under non-insulated roof	3.7
Roof (ground floor)	Conventional non-insulated flat roof	3.05
Floor	Non-insulated floor slab (on-grade)	3.1
Floor (above basement)	Non-insulated floor slab (above unheated basement)	2
Windows	Single glazed windows w/timber frame	4.3 – 5.0[5]

The building is used by the City Council of Ioannina and comprises office spaces and a conference hall for holding the council meetings. As such, three different types of use were considered to determine the internal heat gains and the ventilation requirements: i) offices, ii) conference room, and iii) corridors and common auxiliary spaces. The areas of the different room types and the relevant demands/gains according to the Technical Guide 20701 – 1/2017 are shown in Table 18. It was considered that the building operates for 8 hours per day, 5 days per week. During occupancy times the thermostat was set to 20ºC for the heating and 26ºC for the cooling season.

[3] Based on the assumptions of the Greek Regulation on the Energy Efficiency of Buildings (KENAK) anf the relevant TOTEE 20701-1:2017

[4] Depending on the thickness of the stone and considering the thermal conductivity of limestone of 1.67 W/mK

[5] Depending on the size of each window and the subsequent portion of the frame on the total window area (according to the assumptions in Table 3.13.a of Technical Regulation (TOTEE) 20701-1:2017)

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Table 18 Areas and consumption/gain characteristic values for the three zones of the City Council building

Type of use	Area (m^2)	Fresh air requirements ($m^3/h/m^2$)	Lighting gains (W/m^2)	Equipment gains (W/m^2)	Occupant gains (W/m^2)
Office	342.7	3	16	4.5	8
Conference room	205.2	27.5	16	0.6	83
Corridors and common auxiliary spaces	317.6	2.6	3.2	0	0

The main heating system is a heating oil boiler whilst auxiliary heating is also provided in parts of the building by air-conditioning units. Furthermore, the AC units provide cooling during the summer months. The seasonal efficiency of the main heating system was determined at 57% (considering the 80% efficiency for a typical boiler and adjustments based on seasonal use and oversizing of the system, as well as 8.5% distribution system losses and 90% efficiency of the terminal units[6]). In order to account for the partial use of the AC units, it was considered that 30% of the useful area was heated by these units. Furthermore, it was considered that these AC units were also providing cooling during the summer months. The units were considered to have a SCOP and a SEER of 2.5. All values for the seasonal of the heating and cooling equipment were based on the guidance from Directive TOTEE 20701-1:2017.

Based on the above assumptions, the building's fuel (heating oil) and electrical consumption were determined. These are presented in Table 19 and compared against the actual consumption of the building.

Table 19 Total fuel and electricity consumption for the City Hall building

	Units	Simulation results	Actual consumption
Total fuel consumption	Litres/year	3,294	3,633
Total electricity consumption	kWh/year	41,748	49,697

Simulation and actual data comparison

The actual consumption data from previous years were provided by MoI. The actual electricity consumption was 49,697 kWh/year, i.e. 16.5% higher than the electricity consumption calculated

[6] Weighted average of the efficiency of the terminal units

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by the simulation model. In addition, the actual fuel consumption was 3,633 liters/year which was 9.3% higher than the estimated consumption by the model. The simulation model is therefore considered to provide an adequate representation of the current building performance (baseline) and to be suitable for the next step of the analysis where the energy upgrade of the building will be examined and reported at the final version of this Deliverable.

4.3.3.3 School complex (PEB 1.3 – 1.8)

The school complex is located in the outskirts of the city and comprises several buildings of various uses, i.e., educational, administrative and others. The buildings of the school complex are:

- 8th General High School (GEL) and 1st Trade High School building (EPAL) (PEB 1.3)
- School of Trade/Technical Education building (PEB 1.4)
- Administration building (PEB 1.5)
- Library building (PEB 1.6)
- Sports Hall building (PEB 1.7)
- Multi-purpose Hall (PEB 1.8)

A general view of the arrangement of the various buildings is provided below.

Figure 23 Arrangement of the school complex buildings

The main characteristics of the various school complex buildings and the baseline assessment of the energy requirements is provided in the following paragraphs.

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8th General High School (GEL) / 1st Trade High School building (EPAL) (PEB 1.3)

The building is a two-storey building of complex and irregular shape with its main axis along the east-west axis and houses two schools: i) the 8th General Highschool and ii) the 1st Trade school. The layout of the schools in the building is shown in Figure 24. The 8th General Highschool is located in the Eastern part and the 1st Trade school is located in the Western part of the building. In the middle, a common entrance hall is connecting the two wings of the building.

The building has a total heated floor area of approximately 5,955m^2. The building comprises of a reinforced concrete frame structure and brick walls. It has south orientation and, as such, there is significant surface of glazed areas especially in the south façade. A detailed description of the thermal properties of the building elements considered in the analysis and the respective areas is provided in Table 20.

Figure 24 Layout of the schools in the 8th General Highschool (left) and 1st Trade school building (right)

Table 20 Basic thermal properties of the main building elements of the 8th General High School / 1st Trade High School building

Element	Description	Thermal transmittance (W/m^{2}K)[7]	Total Area (m^2)
External walls	Uninsulated cavity wall	2.2	2,464

[7] The thermal properties of the building elements were obtained from the Technical Directive (TOTEE 20701-1:2017) accompanying the Greek Regulation for the Energy Efficiency of Buildings (KENAK)

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Element	Description	Thermal transmittance (W/m^2K)[7]	Total Area (m^2)
Concrete frame	Reinforced concrete	3.4	
Roof	Inclined roof (tiles with concrete ceiling slab) uninsulated	4.7	3,963
Floor	Uninsulated floor slab (on-grade)	3.1	3,484
Floor (above unheated space)	Uninsulated floor slab in contact to unheated space	2	332
Floor (in contact to air)	Non-insulated floor slab in contact to air	2.75	147
Windows	Double glazed windows w/aluminium frame (no thermal break)	3.5 - 3.6[8]	1,117

The energy analysis considered three main uses of the building areas: i) classrooms, ii) offices and iii) the remaining area was considered as corridors and common auxiliary spaces. The type of usage of the spaces affects the energy demand of the building due to the different:

- Occupancy rate and subsequent occupancy gains
- Demand in fresh air according to the activity
- Demand in lighting levels and consequent lighting gains
- Equipment gains

The assumptions used in the analysis for the various gains and demand for each type of use is shown in Table 21 based on the recommended values set by the relevant Technical Regulation [62]. It was considered that the building operates on normal school hours, i.e., for 5 hours per day, 5 days per week. Furthermore, parts of the building are also operating during the evening to support the activities of the School of Technical Education (accounting for 16 classrooms, 1 laboratory room and 1 meeting room). For reasons of simplicity, it was considered that the ground floor area of the building (accounting for approximately the same surface area) is used during the evening hours as well for an additional 5 hours (for 5 days a week). During occupancy times the thermostat was set to 20°C for the heating and 26°C for the cooling season.

[8] Depending on the size of each window and the subsequent portion of the frame on the total window area (according to the assumptions in Table 3.13.a of Technical Regulation (TOTEE) 20701-1:2017)

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Table 21 Areas and consumption/gain characteristic values for the three zones of the 8th General Highschool/1st Trade School

Type of use	Area (m^2)	Fresh air requirements ($m^3/h/m^2$)	Equipment gains (W/m^2)	Occupant gains (W/m^2)
Classrooms	3,053	11	0.75	40
Offices	447	3	4.5	8
Corridors and common auxiliary spaces	2,216	2.6	0	0

The lighting gains were calculated based on the inventory of lighting fixtures installed in the building. According to this inventory there are 186 lamps of 72W each (2 x 36W) and 151 single lamps with 36W capacity each installed. This corresponds to a total installed capacity of 18.83 kW or 3.16 W/m^2. Lighting gains were then calculated assuming an average usage of 3 hours/day for the morning use) and additional 5 hours/day for the part of the building that is also operating during the evenings.

The main heating system comprises heating oil boilers whilst auxiliary heating is also provided in the offices by air-conditioning units. Furthermore, the AC units provide cooling during the summer months when the building is in use (June and September). The overall seasonal efficiency of the heating boiler following the methodology and the recommendations of TOTEE 20701-1:2017 was found to be approximately 60% whilst the SEER and SCOP of the AC units was 2.5. Based on the above assumptions, the building's fuel (heating oil) and electrical consumption were determined. These are presented in Table 22.

Table 22 Total fuel/electricity consumption for the 8th General High School / 1st Trade High School building

	Units	Simulation results
Total fuel consumption	Litres/year	10,990
Total electricity consumption	kWh/year	81,071

School of Technical Education Building (PEB 1.3)

The School of Technical Education building is a complex shape building comprising of three separate parts: i) a single storey rectangular part with its axis on the north-south direction, on the north side, ii) a two-storey part in the centre of complex shape with its main axis in the east-west direction and iii) a third part (two-storey) with a mostly rectangular shape and its axis in the

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east west direction on the south side. The latter was an addition to the existing building. An aerial view and the layout of the three separate parts comprising the building is provided in Figure 25.

The building has a total heated floor area of approximately 6,285m^2. The building comprises reinforced concrete frame structure and brick walls. The north and central part of the building were constructed circa 1980 whilst the southernmost part (marked in yellow in Figure 25) was constructed circa 1995. As such, the pre-existing building is considered to be uninsulated whilst the extension that was added later is partly insulated. A detailed description of the thermal properties of the building elements considered in the analysis and the respective areas is provided in Table 23 and Table 24.

Figure 25 Aerial view (left) and layout of the School of Technical Education building (right)

Table 23 Basic thermal properties of the main building elements of the School of Technical Education building

Element	Description	Thermal transmittance (W/m^{2}K)[9]	Total Area (m^2)
External walls	Uninsulated cavity wall	2.2	2,058

[9] The thermal properties of the building elements were obtained from the Technical Directive (TOTEE 20701-1:2017) accompanying the Greek Regulation for the Energy Efficiency of Buildings (KENAK)

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Element	Description	Thermal transmittance (W/m^2K)[9]	Total Area (m^2)
Concrete frame	Reinforced concrete	3.4	
Roof	Inclined roof (tiles with concrete ceiling slab) uninsulated	4.7	3,145
Floor	Uninsulated floor slab (on-grade)	3.1	3,068
Floor (in contact to air)	Non-insulated floor slab in contact to air	2.75	72
Windows	Double glazed windows w/aluminium frame (no thermal break)	3.5 - 3.6[10]	911

Table 24 Basic thermal properties of the main building elements of the extension building

Element	Description	Thermal transmittance (W/m^2K)	Total Area (m^2)
External walls	Insulated cavity wall	1.15	543
Concrete frame	Insulated Reinforced concrete	1.2	
Roof	Inclined roof (tiles with concrete ceiling slab) - partially insulated	1.2	342
Roof	Conventional concrete slab	1.1	71.3
Floor	Insulated floor slab (on-grade)	1.15	414
Floor (in contact to air)	Insulated floor slab in contact to air	1.1	6.85
Windows	Double glazed windows w/aluminium frame (no thermal break)	3.2	105.5

The energy analysis considered three main uses of the building areas: i) classrooms, ii) offices and iii) the remaining area was considered as corridors and common auxiliary spaces. The assumptions used in the analysis for the various gains and demand for each type of use is shown in Table 25 based on the recommended values set by the relevant Technical Regulation [62]. It was considered that the building operates on normal school hours, i.e., for 5 hours per day, 5 days per week.

[10] Depending on the size of each window and the subsequent portion of the frame on the total window area (according to the assumptions in Table 3.13.a of Technical Regulation (TOTEE) 20701-1:2017)

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During occupancy times the thermostat was set to 20ºC for the heating and 26ºC for the cooling season.

Table 25 Areas and consumption/gain characteristic values for the three zones of the School of Technical Education Building and its extension building

Type of use	Area (m^2)	Fresh air requirements ($m^3/h/m^2$)	Lighting gains (W/m^2)	Equipment gains (W/m^2)	Occupant gains (W/m^2)
Classrooms	3,509	11	9.6	0.75	40
Offices	339	3	16	4.5	8
Corridors and common auxiliary spaces	1,461	2.6	3.2	0	0

The main heating system comprises heating oil boilers whilst auxiliary heating is also provided in the offices by air-conditioning units. Furthermore, the AC units provide cooling during the summer months when the building is in use (June and September). Similar to the 1st General High-school/8th Trade High-school building, the average seasonal efficiency of the boiler was determined at approximately 60% and the average SCOP/SEER of the AC units at 2.5. Based on the above assumptions, the fuel (heating oil) and electrical consumption for the building were determined. These are presented in Table 26.

Table 26 Total fuel/electricity consumption for the School of Technical Education building

	Units	Simulation results
Total fuel consumption	Litres/year	6,032
Total electricity consumption	kWh/year	92,145

Administration building/library (PEB 1.5)

The administration/library building is a single storey building of rectangular shape with an internal atrium. It is currently used as a library for the schools of the complex. Due to inclinations of the ground and the external surroundings arrangements, the heated area of the building sits on the ground from the north side whilst on the south side it is sits above an unheated space (power facilities room) and partially in contact to air (PILOTIS)). A view of the north and south façade of the building are shown in Figure 26 below. The building was constructed in the 1980s and it comprises a reinforced concrete frame structure and brick walls. A detailed description of the thermal properties of the building elements considered in the analysis is provided in Table 27. The

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total area of the building is 610 m^2. An aerial view of the building as well as a sketch of the floor area is provided in Figure 27 below.

Figure 26 View of a) the North facade (left) and b) the South façade (right) of the building

Table 27 Basic thermal properties of the main building elements of the Administration/Library building

Element	Description	Thermal transmittance (W/m^2K)[11]	Total area (m^2)
External infill walls	Full fill cavity wall (render, brick 10mm, insulation 6mm, brick 10mm, render)	0.6	
Concrete frame	Reinforced concrete	3.4	252
Roof	Inclined roof (tiles with concrete ceiling slab) partially insulated	1.25	609.7
Floor	Partially insulated floor slab (on-grade)	1.15	168.5
Floor (above unheated space)	Partially insulated floor slab in contact to unheated space	1.0	359.3
Floor (in contact to air)	Partially insulated floor slab in contact to air (PILOTIS)	1.10	81.9

[11] The thermal properties of the building elements were obtained from the Technical Directive (TOTEE 20701-1:2017) accompanying the Greek Regulation for the Energy Efficiency of Buildings (KENAK). Based on Technical Regulation 0.2 W/m^2K was added to the U-value of the walls to account for the thermal bridges.

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Element	Description	Thermal transmittance (W/m^2K)[11]	Total area (m^2)
Windows	Double glazed windows w/aluminium frame (no thermal break)	3.7 - 4.5[12]	182

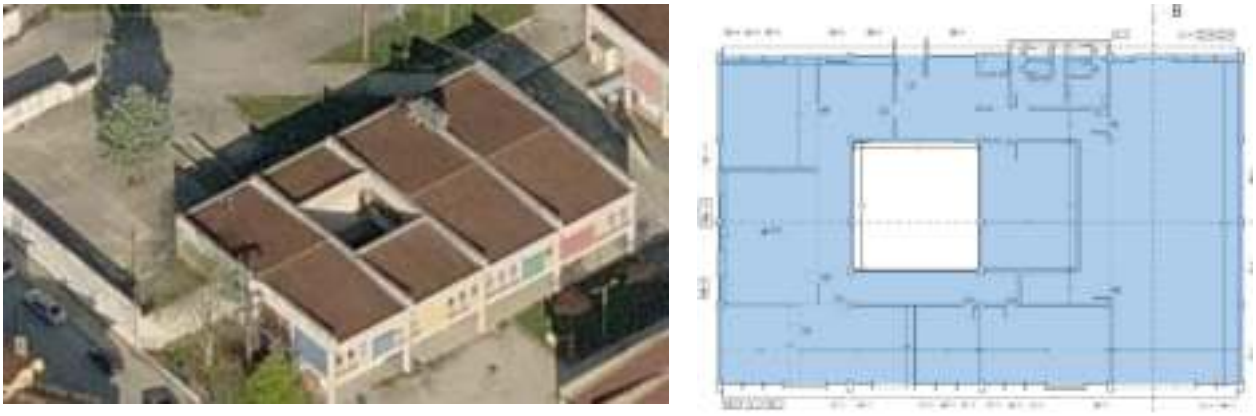

Figure 27 The administration/library building a) aerial view (left) and b) sketch of the heated floor area (right)

The energy analysis considered three main uses of the building areas: i) library for most of the rooms, ii) one room was considered as a conference/meeting room, iii) the remaining area was considered as corridors and common auxiliary spaces. The assumptions used in the analysis for the various gains and demand for each type of use is shown in Table 28 based on the recommended values set by the relevant Technical Regulation [62]. It was considered that the building operates on normal school hours, i.e. for 5 hours per day, 5 days per week. During occupancy times the thermostat was set to 20ºC for the heating season. It was considered that no cooling is provided. The main heating system comprises a central air-conditioning unit. The SEER of the AC unit was considered to be 2.5. Based on the above assumptions, the total electrical consumption for the building was determined and is presented in Table 29.

[12] Depending on the size of each window and the subsequent portion of the frame on the total window area (according to the assumptions in Table 3.13.a of Technical Regulation (TOTEE) 20701-1:2017)

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Table 28 Areas and consumption/gain characteristic values for the three zones of the administration/library building

Type of use	Area (m^2)	Fresh air requirements ($m^3/h/m^2$)	Lighting gains (W/m^2)	Equipment gains (W/m^2)	Occupant gains (W/m^2)
Library	398.7	6.6	16	0.5	17
Conference room	43.5	27.5	16	0.6	83
Corridors and common auxiliary spaces	167.5	2.6	3.2	0	0

Table 29 Total electricity consumption for the administration/library building

	Units	Simulation Results
Total fuel consumption	-	-
Total electricity consumption	kWh/year	7,074

Sports Hall (PEB 1.7)

The sports hall is a single storey building of rectangular shape. The building primarily consists of one large internal zone with few small changing rooms. A view of the building's facades is provided in Figure 28. The building construction comprises a load-bearing concrete frame with brick cavity infill walls. The thermal properties of the main building elements are provided in Table 30. The total area of the building is approximately 613 m^2. An aerial view of the building as well as a sketch of the floor area is provided in Figure 29 below.

Figure 28 View of a) the main entrance in the East facade (left) and b) the West façade (right) of the Sports Hall

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Table 30 Basic thermal properties of the main building elements of the Sports Hall building

Element	Description	Thermal transmittance (W/m^2K)	Total Area (m^2)
External walls	Uninsulated cavity wall (exposed concrete 15mm, cavity 3mm, brick 10mm, render)	1.52	544
Concrete frame	Reinforced concrete	3.4	
Roof	Inclined roof (tiles with concrete ceiling slab) uninsulated	4.7	613.4
Floor	Uninsulated floor slab (on-grade)	3.1	113.6
Floor (above unheated space)	Uninsulated floor slab in contact to unheated space	1.55	499.8
Windows	Single glazed windows w/aluminium frame	6.1	132.7

Figure 29 The Sports Hall building a) aerial view (left) and b) sketch of the heated floor area (right)

The energy analysis considered two types of use for calculating the energy demands and gains of the building: i) sports area and ii) corridors and common auxiliary spaces. The areas of the different room types and the relevant demands/gains according to the Technical Guide 20701 - 1/2017 are shown in Table 31. It was considered that the building operates partially during school hours, i.e. for 3 hours per day, 3 days per week. During occupancy times the thermostat was set to 18°C. The main heating system comprises a heating oil boiler with fan coils whilst no cooling was considered. Based on the above assumptions, the total fuel and electrical consumption for the building determined by the simulations is presented in Table 32.

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Table 31 Areas and consumption/gain characteristic values for the zones of the Sports Hall building

Type of use	Area (m^2)	Fresh air requirements ($m^3/h/m^2$)	Lighting gains (W/m^2)	Equipment gains (W/m^2)	Occupant gains (W/m^2)
Sports hall	480	33.75	9.6	1	90
Corridors and common auxiliary spaces	133.4	2.6	3.2	0	0

Table 32 Total fuel/electricity consumption for the Sports Hall building

	Units	Simulation Results
Total fuel consumption	Litres/year	743
Total electricity consumption	kWh/year	1,295

Multi-purpose Hall (PEB 1.8)

The multi-purpose hall is a single storey building of rectangular shape. The building primarily consists of one large internal zone with a storage room and a small changing room. A view of the building's facades is provided in Figure 30. The thermal properties of the main building elements are provided in Table 33.

Figure 30 View of the main entrance in the North facade of the Multi-purpose Hall

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Table 33 Basic thermal properties of the main building elements of the Sports Hall building

Element	Description	Thermal transmittance (W/m^2K)	Area (m^2)
External walls	Uninsulated cavity wall (either rendered on both sides or finished with gypsum board)	1.55 - 2.2	463.5
Concrete frame	Reinforced concrete	3.4	
Roof	Inclined roof (tiles with concrete ceiling slab) uninsulated	4.7	570.2
Floor	Uninsulated floor slab (on-grade)	3.1	352
Floor (above unheated space)	Uninsulated floor slab in contact to unheated space	2	218.2
Windows	double glazed windows w/aluminium frame (no thermal break)	3.7 - 4.5	118.2

With regard to the building usage, two different types of use were considered: i) multi-purpose hall and ii) corridors and common auxiliary spaces. The areas of the different room types and the relevant demands/gains according to the Technical Guide 20701 - 1/2017 are shown in Table 34. It was considered that the building operates partially during school hours, i.e., for 3 hours per day, 3 days per week. During occupancy times the thermostat was set to 18°C.

Table 34 Areas and consumption/gain characteristic values for the zones of the Multi-purpose Hall building

Type of use	Area (m^2)	Fresh air requirements ($m^3/h/m^2$)	Equipment gains (W/m^2)	Occupant gains (W/m^2)
Multi-purpose hall	422.4	22. 5	1	60
Corridors and common auxiliary spaces	177.8	2.6	0	0

The lighting gains were calculated based on the inventory of lighting fixtures installed in the building. According to this inventory there are 30 lamps of 72W each (2 x 36W) installed. This corresponds to a total installed capacity of 2.16 kW or $3.8W/m^2$. The main heating system comprises a heating oil boiler with fan coils whilst no cooling was considered. Based on the above assumptions the total fuel and electrical consumption for the building was determined and presented in Table 35.

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Table 35 Annual gains and total fuel/electricity consumption for the Multi-purpose Hall building

Fuel / electricity consumption	
Total fuel consumption	195 litres/year
Total electricity consumption	827 kWh/year

Total fuel and electricity consumption of the School Complex

In summary the fuel and electricity consumption of all buildings of the School Complex is presented in Table 36. In addition, a comparison is made between the simulated data and the recorded data from previous years bills in order to evaluate the results.

Table 36 Summary of results and comparison to recorded data

	Simulation Results		Recorded data	
	Fuel (litres)	Electricity (kWh)	Fuel (litres)	Electricity (kWh)
8th General / 1st Trade High School building	10,990	81,071		
School of Technical Education Building	6,032	92,145		
Administration building/library	-	7,074		
Sports Hall	738	4729		
Multipurpose Hall	195	827		
Total consumption for the School Complex	**17,955**	**185,846**	**16,875**	**215,410**

Simulation and actual data comparison

The actual consumption data from previous years were provided by MoI. The actual electricity consumption was 215,410 kWh/year, i.e., 13.7% higher than the 185,846 kWh calculated by the simulation model. In addition, the actual aggregated fuel consumption of all the buildings of the school complex was 16,875 liters/year. This was 6.4% higher than the estimated consumption by the model. The simulation models of the buildings are therefore considered to provide an adequate representation of the current performance (baseline) of the school block and to be suitable for the next step of the analysis where the energy upgrade of the buildings will be examined and reported at the final version of this Deliverable.

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4.3.4 Social acceptance considerations

As described in Section 3.4.6, the results from the citizens' survey analysis show that Ioannina citizens have medium to medium-high levels of knowledge and medium-high to high acceptance levels of the ten different IEs to be replicated in Ioannina. The analysis concludes that it is important that citizens feel they are included in the project and in the development of the solutions/replication plans and that the Municipality should try to understand citizens' concerns.

From the SWOT analysis was concluded that the factors affecting social acceptance of POCITYF solutions are related to high up-front costs, lack of environmental awareness, lack of digital skills in certain social groups, distortions of the energy market resulting in high energy prices for the final consumer, very slow penetration of e-mobility, and finally factors related to mentality like mistrust, strong traditions, and resistance to change.

Finally, from the activities with the local Work Group the following preliminary results regarding their acceptance can be presented at this stage:

- There was low interest from the side of the Members of the Municipal Council (40 were invited and only 8 participated)
- The participants in the two sessions of the Work Group expressed strong interest regarding the project but showed limited understanding of what was expected from them
- Lack of interest from the side certain citizens' associations, who were expected to show greater motivation.

Regarding activities of the Work Group, in the next phase of the project and as MoI proceeds with the Replication Plan, priority will be given in engaging with those key stakeholders and citizen groups who have manifested no interest so far, in-person meetings and interviews will be organised instead of teleconferences, and special effort will be given in communicating the project in a simpler and concise way.

Summarising, although the recent energy crisis is expected to facilitate the dialogue with citizens and stakeholders, promotion actions will need to be organised in the next phase of the project in order to increase social acceptance for POCITYF solutions. Social inclusion measures will also have to be taken to ensure that no-one affected by the implementation of POCITYF solutions will be marginalised during the planning process.

4.4 Financial estimation and resources allocation of the Replication Plan

4.4.1 Estimation of financial resources needed and economic sustainability of the Replication Plan

The Replication Plan is in August 2022 still at a very preliminary stage and no financial assessment or calculation of the economic sustainability of the project can be performed. Moreover, until

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August 2022 financial data for most of the proposed POCITYF solutions was not available. A financial assessment will be presented in the next version of this document (September 2024).

4.4.2 Exploitation of resources deriving from ongoing and already planned projects

There are several projects and actions planned by the Municipality, which could be either directly exploited or adapted/extended to include POCITYF solutions.

These projects are presented in Table 37 with reference to the associated POCITYF solutions and are either in the implementation phase or have been included in requests for funding in the framework of national or community programmes. For some of these actions a source of funding is sought.

Table 37 Exploitation of resources from already planned projects

Action Title	Description	Source of Funding (for details see Section 3.1)	Associated POCITYF IEs
Energy communities	MoI has initiated two energy communities (both formed and registered in the General Commercial Register). In the first one ('Ioannina Energy Community') MoI is holding 40% of the cooperative shares. The other partners of the initial scheme are another Municipality (40%) and a private investor (20%). 'Ioannina Energy Community' is planning to install 7x1MW RES units in total and aims at covering the electricity needs of municipal buildings, including schools. The second community is an exclusively municipal energy community (consisting of MoI and 4 legal entities supervised by the Municipality of Ioannina) and MoI holds 40% of the cooperative capital. The project consists of 1MW+1MW solar parks (the first park is planned to finance the construction of the second one). For both communities MoI is currently in search of financing mechanisms, with the most profitable being the RRF.	A mix of financial tools is under investigation (self-financing through own resources, & banking schemes, RRF)	IE 1.2.5 Community Solar Farm IE 1.2.4 P2P energy trading platform
Smart City Platform (IoT Middleware)	The smart city platform will integrate data and functions from individual "smart" applications and services, providing structured data and services to citizens, visitors, businesses and Municipality officials.	O.P. Epirus (NSRF)	IE 4.3.1 City Urban Platform IE 4.3.5 Citizen

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Action Title	Description	Source of Funding (for details see Section 3.1)	Associated POCITYF IEs
	Based on the logic of the internet of things (Internet of Things) it gathers data generated from various sources such as sensors, wireless network and various other applications and will then normalize them, turning them into a form that is suitable for further use and exploitation.		Information Platform
Collection and management of environmental data with the installation of environmental sensors	The Environmental Data Collection and Management Application will be an integrated Internet of Things (IoT) monitoring platform of multiple sizes, using intelligent sensor nodes, small and easy to be placed within the urban fabric.	O.P. Epirus (NSRF)	IE 4.3.1 City Urban Platform IE 4.3.2 Wi-fi data acquisition systems
Power consumption monitoring in public buildings using appropriate digital analysers (smart meters)	Four (4) municipal buildings have been selected to be monitored and this information will be transmitted to the Smart City Platform.	O.P. Epirus (NSRF)	IE 4.3.1 City Urban Platform IE 4.1.5 Mobile apps on energy consumption
Innovative tourism application (Mobile App) using smart "beacon" sensors	The tourist promotion application using beacons (Bluetooth low consumption) will allow implementation of innovative and interactive tourism thematic packages that include walking and cycling routes in Ioannina through an alternative type of tourism. On a second level, it will enable the connection of city visitors with local businesses, and the provision of complex promotions and offers.	O.P. Epirus (NSRF)	IE 4.1.3 Tourist apps
E-mobility infrastructure - Electric Vehicles - Charging stations of the Municipality of Ioannina	The proposed act for inclusion includes the supply of 10 Electric Vehicles, 10 EV-chargers, and a Management Platform of Electric Vehicles and Charging Stations and a hybrid RES unit.	Antonis Tritsis Programme (Call AT12)	IE 3.1.1 EV charging management platform IE 3.1.2 EV charger prototype

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 864400.

Action Title	Description	Source of Funding (for details see Section 3.1)	Associated POCITYF IEs
			with PV integration IE 3.2.1 EV-Sharing
Municipal Fee Calculation System (Pay-as-you-throw), Sorting at the source and Strengthening Recycling	Services and software implementation for support of PAYT system, for the entire Municipality.	Source of funding is sought	IE 1.3.2 PAYT (Pay-As-You-Throw)
Building energy management system (BEMS)	The action refers to a resource management & IoT platform with integrated smart building energy management system for eight (8) buildings. It includes the implementation of integrated intelligence solutions for continuous monitoring, management and upgrading of municipal buildings, improving work, hygiene and residence conditions, in parallel with the optimization of energy efficiency and facility management automation.	Source of funding is sought	IE 1.1.8 Building Management System

Finally, MoI intends to include various Municipal buildings and schools in the 'ELEKTRA' programme for the energy upgrading of public buildings [64]. The programme is co-financed by the Deposits and Loans Fund (own resources and resources derived from a loan agreement between it and the European Investment Bank), as well as from the Recovery and Resilience Fund. The interventions to improve the energy efficiency of buildings by two categories on average, in accordance with the Buildings Energy Performance Regulation, include the replacement of window frames, thermal insulation, heating, cooling and ventilation systems, room lighting systems, automation systems, electricity production and storage systems, installation of electric vehicle charging points, etc. The basic financing percentage for the energy upgrade of public buildings is set at 50% but can reach up to 95%, under specific requirements.

MoI is planning to include the former 'Polikladiko' school complex in the 'ELEKTRA' programme and is considering the Town Hall building too, depending on the available resources. In this case all IS1.1 POCITYF solutions (IS1.1 Positive Energy Buildings), under circumstances, could be integrated in this plan.

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4.4.3 Holistic cross-ETT-sectional feasibility study

During the first 2 years of the project MoI conducted a preliminary analysis of the POCITYF solutions demonstrated in the LCs, which led to a pre-selection of the solutions which appear to be feasible in Ioannina local context, and which addressed the city needs. Since no insurmountable barriers were identified during this analysis which could lead to a project failure, MoI carried on with a more in-depth feasibility study in the form of SWOT analysis for these pre-selected solutions. More details on the SWOT analysis can be found under Section 3.3.

In total 40 IEs from 8 ISs (MoI doesn't participate in 2 ISs) and all 4 ETTs were studied in this preliminary analysis. Technical, operational, legal, social, political, and financial factors were considered while carrying out the study. As mentioned in Section 4.4.1, a complete financial assessment will be performed at a later stage of the project, after the feasibility study is completed.

The results and findings of this analysis can be summarized in Table 38:

Table 38 Summary of feasibility study preliminary results

Feasibility study preliminary results	
Overall viability (summary)	The proposed project has been assessed to be a good use of public resources. When analysed for the local society as a whole, the value of the benefits generated by the project for the local community seem to exceed its economic costs. While a complete financial estimation has not been carried out yet, the benefits have been assessed to be much higher than the absolute revenues, as the project will enhance local and regional economic activity and quality of life for the people living and working in the buildings and areas affected by the project.
Return On Investment (ROI)	A complete economic analysis of the project will be carried out in the next phase of the project and will be included in the updated version of this document.
Technological and legislative considerations	While POCITYF solutions address the city needs towards climate neutrality until 2030, the following technological and regulatory factors have been identified as highly probable to affect the project in the near future: • Completion of the replacement of smart meters in the low voltage and realization of smart grids (see Table 3 Smart City Indicators for MoI). • The need for restructuring of the retail market which will allow new business models for electricity service providers (related to smart grids). • Completion of the smart city infrastructure in the city (Command and Control Center, extension of LoraWAN, G-Cloud etc) to allow for integration of smart city services. • Smart city, energy management and P2P energy trading platforms require prior implementation of other systems and services. The

Feasibility study preliminary results	
	scheduling of these projects will determine the implementation timeframe of these platforms. • Delays in licensing PV-installations may affect development of energy communities and solutions related to them. A new legislative reformation will ensure completion of licensing for RES within 14 months instead of the current 5 years (full digitalisation of the process, supporting documents that investors will be required to submit are drastically reduced from 91 to 54, procedures that until now were successive will become parallel, the stages of the licensing process are reduced from 7 to 5). • Significant delays are observed in the procedures of the full and effective integration of the EU Directives concerning Energy Communities (RECs, CECs). In particular, the legislation on energy communities (Law 4513/2018), which in some points is in line with European legislation, has not fully integrated the two Directives (REDII, IEMD). The full integration of these directives will contribute to the removal of (administrative and other) obstacles faced by the energy communities, to the simplification of licensing procedures and to the strengthening of the direct participation of citizens in the country's energy transition. • Availability and integration of data from various service providers (electricity, EV charging, EV sharing service providers etc). • For all solutions of IS3.1 the biggest obstacle / threat is the very slow development of the electrification of mobility in Greece (one of the least prepared countries in the EU) and the lack of adequate infrastructure. • Lack of car models offering V2G charging capabilities and availability of these models at dealership in Greece.
Existing marketplace	From the examined solutions «Insulation with Circular Materials» and «2nd Life Batteries» present a commercial complexity, due to the fact that Greece has in general a very low material reuse rate (as opposed to the Netherlands, for example, who have the highest in the EU-27 in 2020). It is considered highly unlikely that such materials will be available in the Greek market. Importing materials and services from an EU-country is not impossible but it must be well justified that there are no other technical solutions to achieve the same result. If further market research suggests that these products can't be procured over Greek suppliers/contractors, alternative solutions have been proposed (e.g. insulation with ecological materials and alternative POCITYF battery systems, respectively). Our research suggests that there is currently also no existing market in Greece for V2G and bidirectional inverters technology due to the technological and regulatory barriers mentioned above.

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Feasibility study preliminary results	
	Regarding PAYT, only one pilot application in the city of Elefsina in the frame of EU project LIFE could be found in Greece. However, multiple successful examples with various variable-rate pricing models could be found in the USA and many European countries. A newly introduced Law [20] makes obligatory for Municipalities over 100,000 inhabitants to adopt «Pay-as-you-throw» systems from 01/01/2023. This is expected to accelerate adoption of variable-rate pricing models.
Required staffing	No estimation has been done yet on the human capital needs for POCITYF project. The solutions which would demand hiring of specially trained staff (or training of existing) have been identified in the SWOT analysis (e.g. Renewable Energy Communities Management Platform, City Energy Management System, City Urban Platform). MoI's Integrated Strategy for the Digital Transformation and Smart City also describes the professional profile and skills of Smart Cities staff. The following factors regarding staffing could affect the successful implementation of the project [65]: • The Municipality and its Technical Services suffer from understaffing, both in number of employees as well in specific crucial specialisations (environmental engineers, landscape architect engineers etc) • There is an institutional weakness in recruiting new staff. • The lack of administrative staff leads to employment of the Technical Service with objects, which do not fall within its jurisdiction. • Important technological gap in a significant proportion of the existing staff • The lack of an evaluation and efficiency measurement system which leads to a lack of performance motivation. • Lack of open dialogue and cooperation spirit both in the internal environment and in the external environment of the Technical Service. • The institutional framework for the implementation of public projects, characterized as complex, labyrinthine and bureaucratic, requires significant human resources and causes delays in the implementation of its project service. • The Municipality has a standard siloed administrative organization. Before kick-off of a project, an interdepartmental working group is officially defined.
Schedule and timeline	For MoI the year 2030 has been set as a target for climate neutrality. In that sense all projects which add to this target will be prioritized in the next years. However, an exact timeline for the completion of the POCITYF project can't be

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Feasibility study preliminary results	
	presented at this stage. This information will be included in the next version of the document (September 2024).
Project financials	For the moment MoI hasn't approached this Replication Plan as a single unified project, rather tries to include the individual solutions in its business plan following national and EU calls for funding (see Section 4.4.2). Some solutions have also been incorporated in MoI's Action Plans. For example, turning the social housing area 'Vrisoula' into a green neighbourhood is included in MoI's SEAP, the City Information Platform (called Smart City Platform) and PAYT solutions are included in the Smart City Action Plan, EV sharing in the SUMP etc. At the same time, following the invitations from the national programme ELEKTRA for the energy upgrade of public buildings, MoI intends to include the energy upgrade of the former 'Polikladiko' school complex in its priority list (see Section 4.4.2). Funding individual actions of the project hasn't been assessed as a critical factor, since various financial tools are currently available for MoI, as described under Section 3.1 (e.g.: RRF, NSRF, Antonis Tritsis, Philodemos etc). The Municipality can also turn into banking schemes to finance projects of very high priority or for projects of great public benefit when no other funding tool can be used. The possibility of a Public-Private-Partnership will also be investigated after the economic analysis has been completed.
Findings and recommendations	Technology: Most POCITYF solutions are dependent from regulatory issues and the national strategy on energy transition, on which MoI has very little influence. Organization: Understaffing, training and education of the existing staff and the inherent systemic difficulties in hiring new staff are seen as great challenges. Financials: While revenues from a project are always desired, our main target through this project is to generate long-term benefits for our citizens and improve their living and working conditions in the city. Various suitable programmes and financing instruments are available and will be exploited.

4.5 Long-term planning towards a Smart City Vision 2050

As a smart city project, POCITYF is in alignment with the requirements of MoI's Smart City Vision. However, the POCITYF project includes only small-scale interventions and limited technology user interactions. Successful implementation of POCITYF solutions does not automatically guarantee broader social and institutional adoption, which is required for the solutions to reach their full innovative effect and foster transition towards urban sustainability and resilience. In the next phase of the project, the team must consider and include the following principles during preparation of the replication plan in order to achieve geographical expansion and scaling up:

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- Expand by increasing people involved and partnerships
- Co-operate with similar initiatives and activists on regional, national and international level
- Communicate & disseminate results (e.g., through public repositories, Smart City Information Platform, city networks, citizen ambassadors etc)
- Train/educate internal project partners to acquire new social and personal skills
- Improve governance practices
- Involve a variety of departments and units, institutions that are dealing with the dialogue with citizens and skilled project management staff, experienced in Smart City projects
- Define a plan on how to continue the existing collaboration between the Municipality and relevant stakeholders and develop a plan for wider collaboration
- Secure financial resources for the project's sustainability and maintenance
- Develop a business model for the project's expansion, scaling up and replication
- Investigate if the project principles and working procedures can be replicated in a completely different setting (different municipal departments, stakeholders etc).

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5 Conclusions

This deliverable is the first edition of the Ioannina Replication Plan and City Vision for 2050 and has the aim to present the progress achieved by Ioannina FC until September 2022 (end of the third year of the project). The final version of the Replication Plan will be delivered as an updated version of this document in September 2024.

The Replication Plan started with the benchmarking of Ioannina in relation to the smart city indicators, a process which revealed in a more concrete way interlinked problems, weaknesses, key priority intervention areas, challenges that the city actually wants to address with this smart city project and opportunities which should be seized. Though the city has in place a SEAP, SUMP and SUDP, where problems are identified and described in a rather accurate manner, current research suggests that no actions for the target year 2030 have been implemented yet and only very few are in course for implementation. The long-term objectives and the cross-sectoral nature of the issues to be addressed in the city demand strong political leadership and commitment from the side of the administration in achieving the goals set by its Strategic Plans. Quality monitoring of the progress achieved, and realistic updating of the Action Plans are seen as crucial steps towards making them useful tools for the city.

The involvement of local stakeholders in the project was only recently initiated in the form of a project Work Group, backed up by the necessary political support. Considering this unprecedented process, the participation so far could be seen as satisfying, but participants appear to be disengaged and confused about their role in the project. Activities with the local Work Group must intensify and become more personal and direct in the following two years and more effort must be given in identifying and assigning specific roles and responsibilities to each involved actor. The team must find a more effective way to consult in depth with stakeholders about the implications of the proposed plan for day-to-day operations, living environment and finances for them. In order to increase interest, collect as many useful insights as possible, align the various diverging interests, and create a commonly accepted City Vision for 2050 it is also very important to expand the group to include and motivate also those who have not responded to the invitations so far. Users of the buildings must also be actively involved in the planning process in the next phase. Finally, citizen engagement activities must be organised in order to inform citizens, increase awareness and social acceptance, and start cultivating a co-designing culture.

The cross-ETT feasibility study in the form of a SWOT analysis together with the various replication tools offered by the consortium helped us understand the solutions better, revealed opportunities, strengths, weaknesses, and possible threats and led to the finalisation of the innovative solutions to be replicated. As solutions are still being tested in the LHCs, this RP is based only on data currently available and might be updated as more knowledge becomes available from the LHCs. The team also explored resources already available in terms of finance and internal collaborations with other projects and initiatives and found various opportunities which could be exploited and integrated in the RP.

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The first step in designing the actual Replication Plan was also concluded with the collection of data to provide inputs for the baseline analysis of the case-study buildings. The results show that simulation models of the buildings are considered to provide an adequate representation of the current performance of the buildings and to be suitable for the next step of the analysis, when the energy upgrade of the buildings using the proposed innovative solutions will be examined and reported in the final version of the Replication Plan. The preliminary results also verified the need for interventions to improve the energy efficiency of the buildings. A suitable methodology for the analysis at district level still needs to be found and presented in the next version of the RP. Finally, a whole-life economic analysis of the project and a sustainable business plan to support it will have to be performed and presented in the next version of this document in September 2024.

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ANNEX A

Table 39 MoI desired IE ecosystems (until May 2022)

IS	IE#	Innovative Element (IE)	IE Ecosystem
IS1.1 - Positive Energy (stand-alone) Buildings (PEB)	1.1.1	PV Glass	Ministry of Culture, Ephorate of Newer Monuments | Municipal Council | HEDNO | Technical Chamber of Greece, department of Epirus | Hellenic Association of Certified Civil Engineers | Region of Epirus
	1.1.2	PV Canopy	
	1.1.3	PV Skylight	
	1.1.5	Traditional PV Shingle	
	1.1.7	Energy routers	Ministry of Culture, Ephorate of Newer Monuments | Municipal Council | HEDNO | Technical Chamber of Greece, department of Epirus | Hellenic Association of Certified Civil Engineers | Region of Epirus
	1.1.8	BMS (Building Management System)	Ministry of Culture, Ephorate of Newer Monuments | Municipal Council | HEDNO | Technical Chamber of Greece, department of Epirus | Hellenic Association of Certified Civil Engineers | Region of Epirus | Teachers of the school complex in the replication area
	1.1.9	HEMS (Home Energy Management Systems)	
	1.1.12	Insulation with circular materials	Ministry of Culture, Ephorate of Newer Monuments | Municipal Council | HEDNO | Technical Chamber of Greece, department of Epirus | Hellenic Association of Certified Civil Engineers | Region of Epirus | Teachers of the school complex in the replication area
	1.1.13	Triple glazing	Ministry of Culture, Ephorate of Newer Monuments | Municipal Council | HEDNO | Technical Chamber of Greece, department of Epirus | Hellenic Association of Certified Civil Engineers | Region of Epirus | Teachers of the school complex in the replication area
	1.1.14	Solar roofs and facades	Municipal Council | HEDNO | Technical Chamber of Greece, department of Epirus | Hellenic Association of Certified Civil Engineers | Region of Epirus | Teachers of the school complex in the replication area | Residents of the social housing area
IS1.2 - Positive Energy Districts (PED) Retrofiting	1.2.1	Smart Lamp posts with EV charging and 5G functionalities	Municipal Council | HEDNO | Technical Chamber of Greece, department of Epirus | Hellenic Association of Certified Civil Engineers | Region of Epirus | Regional Federation of Persons with Disabilities of Epirus and the Northern Ionian Islands | EV charging service providers | Hellenic Institute of Electric Vehicles | Association of the Historic centre "Ta Palia Giannina" | Association for the Protection of the Environment of Ioannina

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	1.2.2	Energy routers	See IE1.1.7.
	1.2.4	P2P energy trading platform	Kimatica | HEDNO | Technical Chamber of Greece, department of Epirus | Electricity Service Providers | Association for the Protection of the Environment of Ioannina
	1.2.5	Community Solar Farm	Municipal Council | HEDNO | Technical Chamber of Greece, department of Epirus | Hellenic Association of Certified Civil Engineers | Region of Epirus | Ministry of Culture, Ephorate of Newer Monuments | Association of the Historic Centre "Ta Palia Giannina" | Association for the Protection of the Environment of Ioannina
	1.2.11	V2G (Smart charging and V2G system connected to energy trading platform)	Local car dealers offering car models with V2G capabilities (Nissan; Mitsubishi; Volkswagen) | Kimatica | HEDNO | EV charging service providers | Hellenic Institute of Electric Vehicles
IS1.3 - Feeding PEDs with waste streams promoting symbiosis and circular economy	1.3.1	2nd Life Batteries	Municipal Council | HEDNO | Technical Chamber of Greece, department of Epirus
	1.3.2	PAYT (Pay-As-You-Throw)	Municipal Council | HEDNO | Technical Chamber of Greece, department of Epirus | Hellenic Association of Certified Civil Engineers | Region of Epirus | Municipal Solid Waste Treatment Unit of Epirus | Association for the Protection of the Environment of Ioannina
IS2.1 - Flexible and sustainable electricity grid networks with innovative storage solutions	2.1.1	2nd Life Batteries	See IE 1.3.1
	2.1.2	Renewable Energy Communities Management Platform	See IE 1.2.5
	2.1.4	P2P energy trading platform	see IE 1.2.4
	2.1.6	City Energy Management System (CEMS)	Municipal Council | ICT Consultants | Technical Chamber of Greece, department of Epirus | Hellenic Association of Certified Civil Engineers | HEDNO | Region of Epirus
	2.1.8	Stationary batteries	Municipal Council | HEDNO | Technical Chamber of Greece, department of Epirus | Hellenic Association of Certified Civil Engineers | Electricity Service Providers | Teachers of the school complex in the replication area
	2.1.10	V2G	See IE 3.1.4
IS3.1 - Smart V2G EVs Charging	3.1.1	EV charging management platform	Municipal Council | EV charging service providers | Hellenic Institute of Electric Vehicles
	3.1.2	EV charger prototype with PV integration	
	3.1.3	Bidirectional smart inverters for EV smart charging and V2G applications	Municipal Council | HEDNO | EV charging service providers | Hellenic Institute of Electric Vehicles
	3.1.4	V2G	HEDNO | EV charging service providers | Hellenic Institute of Electric Vehicles | Local car dealers

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			offering car models with V2G capabilities (Nissan; Mitsubishi; Volkswagen)
	3.1.5	Smart lamp posts with EV charging and 5G functionalities	Municipal Council | EV charging service providers | Hellenic Institute of Electric Vehicles | Professional taxi drivers
IS3.2 - E-mobility Services for Citizens and Auxiliary EV technologies	3.2.1	EV sharing	Municipal Council | Brainbox, AVIS (Car rental businesses offering EV sharing) | Association for the Protection of the Environment of Ioannina | Professional taxi drivers | Epirus Youth Network | Regional Federation of Persons with Disabilities of Epirus and the Northern Ionian Islands
IS4.1 - Social Innovation Mechanisms towards Citizen Engagement	4.1.3	Tourist apps	Municipal Council | Ministry of Culture | Local start-ups and SME in ICT | Epirus Youth Network | USEEUM
	4.1.5	Mobile apps on energy consumption	Municipal Council | Local start-ups and SME in ICT | ICT Consultants | Association for the Protection of the Environment of Ioannina | Epirus Youth Network
IS4.3 - Interoperable, Modular and Interconnected City Ecosystem	4.3.1	City Urban Platform	Municipal Council | University of Ioannina | Τοπικές start-up και SME σε ICT | Association for the Protection of the Environment of Ioannina
	4.3.2	Wi-fi data acquisition systems	

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