D8.9 Celje Replication Plans and City-Vision for 2050

WP8: Replication Plans and 2050 Vision by Fellow Cities

T8.5: Celje Replication Plans and City-Vision for 2050

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Executive Summary

In order to achieve environmental goals by 2050, EU cities will have to transform and become energy neutral. POCITYF envisages to achieve this energy transition by adding layers of smartness to the participating cities, increasing the energy systems integration and achieving positive energy districts (PEDs). However, it is not easy to incorporate buildings, the users and the energy, the mobility and ICT system, as well as find an appropriate approach including technology, spatial, regulatory, financial, legal, social and economic perspectives. This is why the project envisages a development of holistic replication plans (RP) for the fellow cities (FCs), that are based on the capacity-building activities and on the lighthouse cities' (LHCs) gained experiences, lessons learnt and knowledge brought to the POCITYF project.

This deliverable - D8.9 Celje Replication Plan and City-Vision for 2050 – presents a first outcome of Task 8.5 Celje Replication Plan and City-Vision for 2050. In this context the deliverable provides general description of the city with the main characteristics, presentation of its state of the art and goals. Furthermore it describes the two replication areas that the RP considers to become PEDs and the main objectives of the replication activities within the project.

Based on the analysis of the current situation in FC Celje, and on the information obtained from LHCs and their technical partners, this document provides the description of innovative solutions that are of interest to be installed in the city, and a brief overview of the possible challenges and barriers, including legal, technical and financial ones. Furthermore it describes the processes towards the implementation of the RP, among them the decription of general governance and administrative processes for planning solutions, analysis of work groups supporting the planning processes and possibilities for local stakeholders' engagement and replication tool utilization.

The main part of the deliverable is the Replication Plan and City Vision 2050 which gives an approach of how the Smart City Vision and Plan will gradually be built. This chapter is less detailed, as not everything has been decided yet and the content will be upgraded and refined for the final report. In accordance with the analyses and activities carried out so far, the document presents a list of POCITYF innovative elements selected to be replicated, rough financial estimation of the two RES technologies application and anticipation of long-term planning towards a Smart City Vision 2050.

Early conclusions suggest that the city of Celje tends to choose relatively reliable and efficient project solutions. A considerable barrier to use them can be represented by legislation and by very traditional mindset. However, new financial solutions and business models will definitely have to be employed.

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Abbreviations and Acronyms (in alphabetical order)

Abbreviation	Definition
AC	Alternating current
ARSO	Slovenian Environment Agency
ATES	Aquifer thermal energy storage
BMS	Building management system
BREEAM	Building Research Establishment Environmental Assessment Method
BTES	Borehole thermal energy storage
DC	Direct current
DGNB	German Sustainable Building Council
DHC	District Heating and Cooling
DHW	Domestic hot water
DK	Denmark
DSO	Distribution System Operator
ES	Spain
ETT	Energy transition track
EV	Electric Vehicle
FC	Felow city
GDPR	General Data Protection Regulation
GHG	Greenhouse gasses
GIS	Geographic information system
GR	Greece
GURS	Slovenian Surveying and Mapping Authority
HU	Hungary
IT	Italy
ICT	Information and communication technology
IE	Innovative element
IS	Integrated solution
KPI	Key performance indicator
LED	Light-emitting diode
LEED	Leadership in Energy and Environmental Design

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Abbreviation	Definition
LEK	Local Energy Concept
LHC	Lighthouse city
MOC	Municipality of Celje
MZI	Ministry of Infrastructure of Republic of Slovenia
NECP	National Energy and Climate Plan
NL	Netherlands
OŠ	Primary School
P2P	Peer to peer
PAYT	Pay-as-you-throw
PED	Positive energy district
PHPP	Passive House Planning Package
PT	Portugal
PV	photovoltaic
RES	Renewable energy source
RP	Replication plan
SCC	Smart cities and communities
SEAP	Sustainable Energy Action Plan
SECAP	Sustainable Energy and Climate Action Plan
SI	Slovenia
SUDS	Sustainable Urban Development Strategy
SURS	Statistical Office of the Republic of Slovenia
TSO	Tansmission system operator
V2G	Vehicle to grid
WP	Work package
ZAG	Slovenian National Building and Civil Engineering Institute
ZVKDS	Institute for the Protection of Cultural Heritage of Slovenia

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1 Introduction

POCITYF is an EU Horizon 2020 funded project concerning smart cities and communities with the aim to help cities to become greener, smarter, more sustainable and more suitable for living while respecting their cultural heritage. This can be achieved by implementing and integrating innovative technologies and concepts from a variety of fields, i.e. from building renovation, renewable energy, circular economy practices to flexible energy distribution networks, e-mobility and citizen-driven innovation. These solutions at building and district level enable the decrease of energy use, increase the energy savings and the share of locally produced renewable energy. As a result, they lead to the development of Positive Energy Districts (PEDs) located in mixed-use neighbourhoods, including those that are cultural heritage sites.

Innovative solutions are being implemented and tested in selected districts of the two lighthouses Evora (PT) and Alkmaar (NL). These demonstrations allow them to become Positive Energy Districts (PEDs), which means that they produce more energy from renewable sources than they consume. Based on their knowledge and experience, six fellow cities from different parts of Europe are developing their smart transition strategies: Bari (IT), Celje (SI), Granada (ES), Hvidovre (DK), Ioannina (GR) and Ujpest (HU). The fellow cities are preparing the plan to adopt the demonstrated approach, aiming to replicate a selection of innovative solutions, which are suitable for the local environment, and establish their own PEDs.

POCITYF has identified 10 integrated solutions (ISs), made up of 73 innovative elements (IEs), each of which are a technology, tool, or method. Four Energy Transition Tracks (ETTs) were defined to encompass the 10 ISs:

- *ETT#1 Positive Energy Buildings and Districts*: Solutions that transform existing and new buildings, as well as city districs, to energy positive.
- *ETT#2 P2P Energy Storage and Management*: Solutions that offer energy management services, grid flexibility and optimization of energy flows to maximize self-consumption and reduce grid stress.
- *ETT#3 E-mobility Integration into Smart Grid*: Solutions that promote sustainable e-mobility.
- *ETT#4 Citizen Driven Co-creation*: Solutions which focus on citizen driven innovation in the co-creation of smart city solutions.

Each of the 73 IEs categorized within the four ETTs have been tested in the two LHCs and can be replicated in the FCs.

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This deliverable D8.9 is a replication plan for the fellow city Celje. The purpose of the document is to show how the research, analyses and procedures took place, that is, all the replication activities, for the creation of the Replication Plan for the future transition of Celje to a smart city. In addition to the described framework, the state of the city and the considered areas of replication, the document contains the specific needs, challenges and obstacles, tools and ways to transform the city. It also describes the replication proposal with suggested integration of innovative elements that are contextualized with local ecosystems according to the specifics of the city.

The D8.9 deliverable is structured in five sections:

- Section 1, **Introduction**, introduces the general scope of the document, including relevant background information and objectives.
- Section 2, **Benchwork Framework**, describes fellow city Celje and the two areas in the municipality districts that has been identified as the replication areas. Furthermore it identifies the innovative elements (IEs) which FC Celje is motivated to replicate and defines challenges and barriers to the replication activities.
- Section 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 planning the replication activities, and the local stakeholders who have been engaged. It also describes the proposed use of IEs chosen to be replicated, and the processes behind their selection to be used in FC Celje.
- Section 4, **Building up the Replication Plan**, provides a final report of the planning of solution implementation, the final selection of IEs to be replicated, and of the replication design. To some extent it also addresses the financial aspects of implementing the Replication Plan.
- Section 5, **Conclusion**, summarizes the effort of FC Celje in the POCITYF project, provides the main findings, observed during the preparation of the Replication Plan and highlights the key elements that are important for the transition of Celje to a smart and friendly sustainable green city.

2 Benchmark Framework

2.1 General description of the city

Celje is a historic town at the confluence of the rivers Savinja and Voglajna in the eastern part of Slovenia, see Figure 1. It is the third largest city in Slovenia with 37.872 inhabitants spread over 22.7 km^2. In the area of the municipality of Celje, which covers 95 km^2, there are 49.069 inhabitants.

It features a hidden history treasure trove including the ancient Celeia and the exciting Middle Ages. For more than half a millennium, the town has been marked by three stars, the symbol of the Counts of Celje, the most powerful noble and ruler family who has ever lived in Slovenia. Even today, their castle, the country's largest medieval fort, rises above the town.

Figure 1: Physical map of Slovenia (source: www.worldometers.info/maps/slovenia-map/) with indicated location of Celje

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Figure 2: A view of the city from the medieval castle

It is a major business, educational, cultural, and healthcare hub of the Savinja region. The biggest economic impact in the city and its surroundings has Cinkarna Celje, which is the most important chemical processing company in Slovenia, specializing in the production of titanium dioxide, while the most important among non-economic activities are services and trade. The city is also known for its annual International Trade Fair, which is the largest business fair in this part of Europe.

Celje is part of the Green Tool of Slovenian Tourism, a tool developed at national level to support sustainable development of tourism in Slovenia. The goal pursued by the city of Celje in the field of tourism is to become a recognizable destination in Slovenia and Europe for leisure and business city breaks with high added value of experiences in the old city center and green hinterland.

Celje with its latitude 46°14N and longitude 15°14E is located at an altitude of about 242 meters. Its climate is quite mixed with continental characteristics such as warm summers and moderately cold winters. According to the Köppen-Geiger system [1] the climate in Celje is classified as Cfb. The average annual temperature is 10.4 °C, the annual rainfall is 1031 mm. July and August are the warmest months with daily average temperatures between 19.0 and 18.3°C; January is the coldest (0°C). The amount of precipitations in Celje is significant, yet they are evenly distributed throughout the seasons, with somewhat drier winter and spring than summer and autumn. The long-term average duration of annual solar radiation is 1950 hours, and the average annual insolation is 1181 kWh/m2. The average daily wind speed is between 2-16 km/h.

In 2019 the Local Energy Concept for Municipality of Celje (hereinafter LEK) [2], which is a comprehensive document that analyses energy use and supply in the municipality and proposes solutions to improve the current state and sustainable energy development of the municipality, was adopted. Moreover, Celje approved its Sustainable Energy Action Plan (SEAP) [3] in 2015, defining strategies to reach the goal of reducing CO_2 emissions in the city.

In addition, a Sustainable Urban Development Strategy [4] (SUDS) of Celje for the period 2015-2030 was confirmed by the city council in 2017. It provides support for prioritisation, planning and realisation of different development activities which will address the challenges and problems of the urban area. The main problems and challenges, identified in SUDS, include: reduced number of available jobs; insufficient opportunities for career development; lack of communally equiped areas to attract new businesses; remaining consequences of industrial soil pollution in the past; improvement of public transport and reduction of personal car transport in the city; providing communally equipped areas, suitable for construction of individual houses, to prevent migration to neighbouring municipalities; ageing of the population; reduction of energy consumption; increasing the share of renewable energy sources; improvement of air quality, particularly reduction of PM10 pollution.

Figure 3: Some of the highlights of the city

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The challenges could be addressed through different lines of action, e.g. improving the energy efficiency of public and private buildings by supporting their retrofitting (improvement of the building envelopes, replacement of inefficient heating devices), expanding and optimising of the distance heating network, supporting sustainable mobility by improving the functionality of the public transport, providing new bicycle paths and pedestrian areas, upgrading the infrastructure for electric vehicles, increasing the total area of green surfaces in the city, providing suitable housing for young families, raising awareness about the environmental issues, sustainable energy use, sustainable mobility, etc.

Progress of the transition process can be evaluated using performance indicators which allow quantification of the defined general goals and monitoring of the efficiency of undertaken measures. Table 1 contains a selection of general smart city indicators, somewhat suited to the specifcs of FC Celje within the POCITYF project. The current values of the indicators, constituting the baseline, were obtained from the following sources: Statistical Office of the Republic of Slovenia (SURS) [5], Slovenian Environment Agency (ARSO) [6], Municipality of Celje [7], and Ministry of Infrastructure of the Republic of Slovenia (MZI) [8].

Table 1: Smart city indicators in Celje, obtained from the following sources: Statistical Office of the Republic of Slovenia [5], Slovenian Environment Agency [6], Municipality of Celje [7], Ministry of Infrastructure of the Republic of Slovenia [8]

Category	Indicator	Description
Environmental	Green spaces	**Green areas per 100,000 (in m^2)** In Celje, we maintain 662.000 m^2 of public green areas, which amounts 1.750.000 m^2 green areas per 100,000 inhabitants.
	Low pollution	**Measurement of particulate matter ($PM_{2.5}$ and PM_{10}), Ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and carbon monoxide (CO) emissions** Air quality control is performed on site - Gaji automatic measuring station. Measurements of the following pollutants are performed: SO2; NO; NO2; NOx; PM10. Current values of individual concentrations in the air are also available on the website: www.okolje.info/(Mestna Celje). In addition, within the national measurement networks, the Slovenian Environment Agency (ARSO) performs systematic measurements of the level of outdoor air pollution at two measuring points: Celje - Hospital in Celje - Mariborska street. The results are worth presenting every year in the ARSO annual report. The air quality is most problematic in the winter due to the increased sources of pollution (small fireplaces using fossil fuels, in addition to traffic) and unfavourable climate conditions. Occasionaly, the limit values of PM10 particles are exceeded. The maximum and average monthly values of individual parameters for January 2022, as the coldest month of the year, are presented in Table 2.

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Table 2: Average and max concentrations of air pollutants in Celje for Jan 2022

	monthly average	max.
	μm/m^3	
SO_2	2	8
NO_2	18	61
NOx	59	132
PM10	20	46

Energy use

Annual energy consumption per capita

Annual energy consumption per capita is 21.419MJ (5.949,7kWh). Distribution of energy consumption by sectors:

- Industry: 28,3%
- Traffic: 35,9%
- Economy: 24,2
- Other: 11,6%

Share of consumption of renewable energy resources

Share of consumption of renewable energy resources is 24,16%. The Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources [9] obliges Slovenia to achieve a 25% share of energy from renewable sources in gross final energy consumption for 2020.

To achieve the set goal, Slovenia had to provide the missing share of energy from renewable sources through the mechanism of statistical transfer of renewable energy from another EU Member State. Therefore, based on an agreement with the Czech Republic, Slovenia carried out a statistical transfer of 465 GWh of energy from renewable sources. Considering the statistical transfer of renewable energy, the share of energy from renewable sources in gross final energy consumption in Slovenia in 2020 was 25%.

The share was 32.1% in the heating and cooling sector, 35.1% in the electricity sector and 10.9% in the transport sector.

The breakdown by renewable energy sources is as follows:

- 48% Wood and Woody biomass
- 34% Hydro power
- 8% Bioliquids
- 5% Geothermal
- 3% Solar power
- 2% Biogas

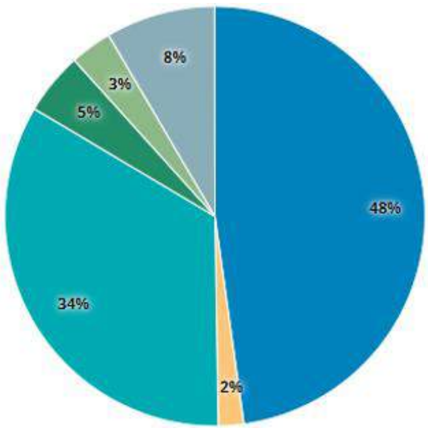

Figure 4: Use of renewable energy in Slovenia - shares of different RES

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		Intensity of energy use The intensity of energy consumption in 2021 was 75 toe/pps.
	Waste generation	**Generation of solid waste per capita:** Municipal solid waste: 412kg Non-municipal solid waste: 140kg
		Generation of hazardous waste per capita Municipal hazardous waste: 2,2kg Non-municipal hazardous waste (asbestos): 23kg
		Generation of radioactive waste There is no radioactive waste generated in the Celje area
		Waste recycling and reuse per capita 181kg (44% of Municipal solid waste)
	Sustainability-certified buildings	**Number of LEED, BREEAM or DGNB sustainability-certified buildings in the city** To our knowledge in Celje are not certificated buildings with LEED [10], BREEAM [11] or DGNB [12] certificate.
		Percent of commercial and industrial buildings with smart meters According to available data from the gas distributor and the heat supply contractor via district heating, smart meters are installed in 25% of commercial and industrial buildings.
		Percent of commercial buildings with a building automation system According to available data, 40% of office buildings are equipped with a building automation system.
		Percent of homes (multifamily & single family) w/ smart meters According to the estimate, approx. 15% of homes are equipped with smart meters.
Socio-cultural	Quality drinking water	**Population with access to safe drinking water** 98.8% of the population in the Municipality of Celje is connected to the public water supply network, which provides access to a safe and reliable drinking water supply. Drinking water supply is provided by a public company, which is 100% owned by the municipality. The rest of the facilities have a supply of drinking water from their own water sources, for which they must obtain a concession on the state level.
	Free education	**Reaching of primary or less education (work active population)** 9,3% elementary or lower education **Secondary education achievement level (work active population)** 56.1% secondary education, 34.6% higher education
	Low crime rate	**Violent crime rate per 100,000 population** 280 per 100,000 inhabitants is the number of convicted persons (adults and minors) with permanent residence in Celje for all types of criminal offenses, not specifically for violent crime
	Population density	**Population-weighted density (average densities of the separate census tracts that make up a metro)** Celje City area: 1.700 population/km^2 Celje Municipality area: 517 population/km2
	Population	**Population growth rate per 1.000 population**

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	growth rate	Natural population growth rate in 2020: -3,2 Mitigation population growth rate in 2020: -6,8 Total population growth rate in 2020: -10,1
	Investment in culture	**Percent of municipal budget allocated to culture** 4,2% are percent of whole municipal budget allocated to culture (includes founds to culture associations, salaries, operation costs, regular maintenance costs without investments costs into cultural infrastructure)
	Civic engagement	**Number of civic engagement activities offered by the municipality last year** Youth and Media Project: Development of Youth Media Literacy Skills Project Mission Man: a youth initiative project aimed at raising awareness of the importance of solidarity and charity within the local community and the wider. **Voter participation in last municipal elect ion (percent of eligible voters)** In the last municipal elections (2018), turnout was 39.71% of eligible voters.
Economic	Affordable housing	**Percentage of inhabitants with housing deficiency in any of the following 5 areas: potable water, sanitation, overcrowding, deficient material quality, or lacking electricity.** We do not have reliable data, if there are any, it can only be very old buildings. There are no illegal settlements in the Municipality of Celje, individual illegal constructions are supervised by the Construction Inspectorate. Every facility used for living must be supplied with drinking water, have properly solved cleaning and drainage of municipal sewage. In the process of obtaining a use permit, it must be proven that it was built safely and with appropriate materials.
	Start-ups	**Number of new opportunity-based startups/year** Between 200 and 350 companies are established in Celje every year (not specifically start-ups). The data show that after three years of their establishment, about 50% are still active. Reliable data on newly established start-ups are not available
	International collaboration	**Number of international congresses and fairs attendees.** In Celje, 20 different fairs are organized annually, some of which take place every year, and some are biennial. The annual fair at the Celje fairgrounds is visited by more than 230,000 visitors.
	Low poverty rate	**Poverty rate** 12.4% of the population lives in households with an equivalent disposable income below the at-risk-of-poverty threshold.
	Job opportunities	**Employment rate** The average unemployment rate in Celje in 2021 was 9.1%. In March 2022, unemployment rate was 7.2% **Percentage of labor force (LF) engaged in creative industries** Data is not available
Governance	E-governance	**Open data use** The National Open Data Portal of Slovenia (OPSI) [13] has been established, which is built on open source software, as is the EU Open Data Portal. OPSI is a single national web point for publishing open data for the entire public sector. Link: https://podatki.gov.si/ The data are divided into 15 thematic areas, which currently include a total of 5039 different collections. **Number of mobile apps available (iPhone) based on open data** There are currently 15 applications available which are based on open data.

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		https://podatki.gov.si/aplikacije/vse?title=&sort_by=created&sort_order=DESC **Existence of official citywide privacy policy to protect confidential citizen data** The protection of confidential citizen data is in accordance with the General Data Protection Regulation (GDPR) [14] and the Slovenian Personal Data Protection Act (ZVOP-1) [15]
	Real-time data monitoring	**Presence of demand-based pricing (e.g., congestion pricing, variably priced toll lanes, variably priced parking spaces).** No **Percent of traffic lights connected to real-time traffic management system** We have real-time traffic management system at the 3 busiest points in Celje, which represents 10% of traffic lights in the City. **Number 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)** Real-time information about the arrival of the local bus to station is available at all bus stops. On the bicycle rental system - KolesCE, data on the number of free bicycles at an individual stop are available via the mobile application in real time. You can book a free bike at the station for 15 minutes. **Availability of multimodal transit app with at least three services integrated** No
	Internet and Wi-Fi coverage	**Number of internet subscribers per 1000 inhabitants** In January 2021, there were 840 subscribers per 1000 inhabitants in Celje. **Percent of commercial and residential users with internet download speeds of at least 2 Mbit/s** No data avaliable **Percent of commercial and residential users with internet download speeds of at least 1 gigabit/s** No data available
	Public transport	**Annual # of public transport trips per capita** 7.9 km / inhabitant is performed annually in public passenger transport. In total, 239,769 passengers are transported annually. **% non-motorized transport trips of total transport** Based on the conducted survey, the values of use non-motorized transport are: - walking: 3% for daily way to work/school, 17% for other purposes (chores, trade, recreation, events), - Cycling: 18% for daily way to work/school 11% for other purposes (chores, trade, recreation, events) **Integrated fare system for public transport** Public passenger transport in the Municipality of Celje (Celebus) is included in the integrated public passenger transport of the Ministry of Infrastructure. Through it, beneficiaries (schoolchildren, students, pensioners over the age of 65...) can claim lower ticket prices or free transport.
	Clean-energy transport	**Kilometers of bicycle paths and lanes per 100,000 (ISO 37120: 18.7)** The existing network of cycle paths in Celje covers 65 km. Currently, additional 30.4 km of two-way bicycle paths and bicycle paths with Sharrow space system are under construction. **Number of shared bicycles per capita** There are 223 bicycles available in the KolesCE bicycle rental system (including

		two tandems), which is 0.006 bicycles per capita. **Number of shared vehicles per capita** There is no sharing system with EV in the city. Arrangements are currently underway to set up the EV sharing system with one of the providers. **Number of EV charging stations within the city** There are 15 AC charging stations for EVs in Celje, which have a total of 37 charging stations.

2.2 Defined Replication Areas

The Municpality of Celje has defined two replication areas shown in Figure 5. The first area (PED 1), named „Old City", is the historical city centre, located at the confluence of the rivers Savinja and Voglajna, and sheltered by the neighbouring hills. It is rich with cultral heritage and historical buildings from different periods of history from the Roman empire, through the middle ages, to the 19th century Austro-Hungarian empire. The Old City covers an area of 0,44 km^2 and has approximately 3100 inhabitants. Besides residential buildings, it contains a wide range of cultural institutions, such as theatres, museums, etc., schools and kindergartens, as well as the local government – the municipality, the court of law, etc. The central part of PED 1 is closed for the traffic. This replication area is very attractive for tourists and also offers a wide range of services from the hospitality industry, e.g. hotels, restaurants, bars, etc.

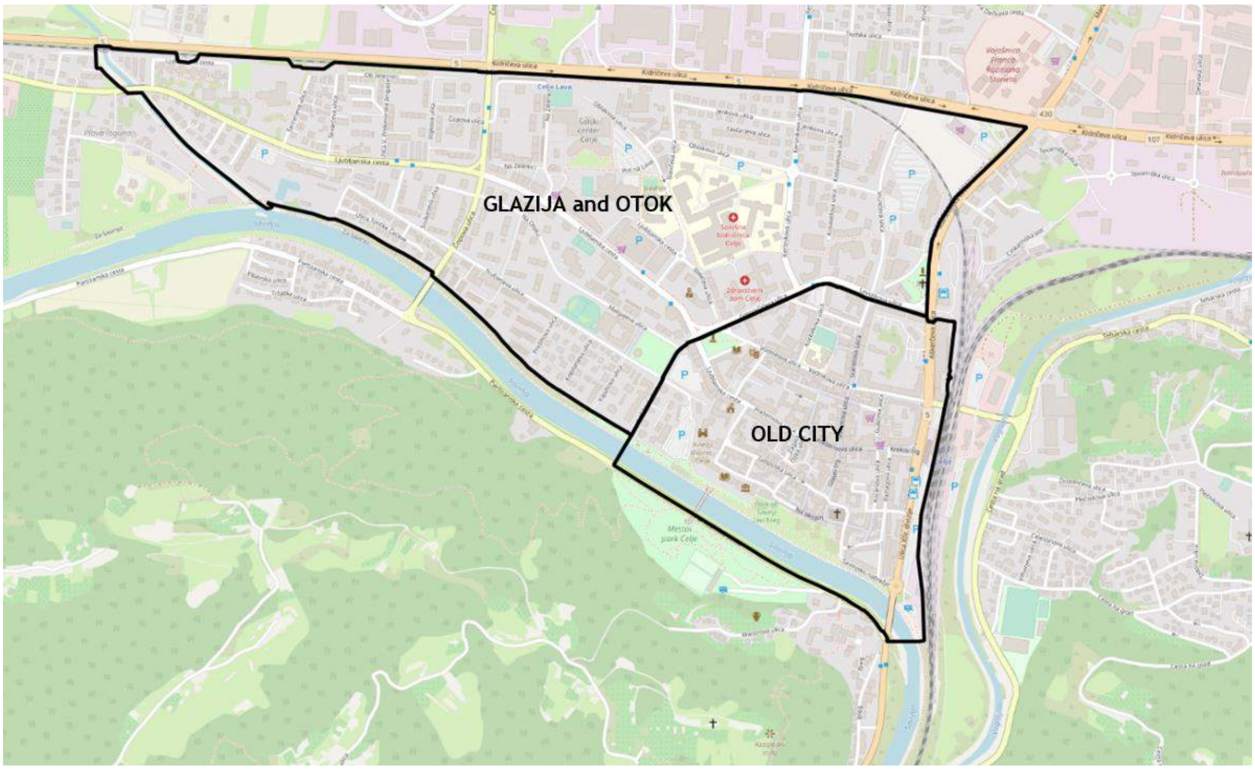

Figure 5: Replication areas in Celje: PED 1 "Old City" and PED 2 "Glazija and Otok"

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The second replication area (PED 2) is called „Glazija and Otok" and extends to the west and to the north from the Old City. It covers an area of 1,03 km^2 and has approximately 7300 inhabitants. It contains mainly residential and tertiary sector buildings. Different types of residential buildings are represented in different parts of the area, ranging from stand-alone houses, terraced houses, villas to blocks of flats and high-rise buildings. Some types are strongly associated with a certain time period, in which they were constructed on a larger scale, e.g. the blocks of flats from the 60s and 70s of the 20th century. The area also contains office buildings, educational buildings, sports facilities, shopping centres, as well as the complex of the city hospital.

A bike sharing system with a total of 12 stations operates in both areas. There is a Smaller Park&Ride station at one of the entry points to the „Old City". In the „Old City" and „Glazija and Otok" five charging stations for electric vehicles are currently available with a total of 11 charging points. One charging point is DC type, the others are AC. There are no PV power plants in the „Old City" area. In the area of „Glazija and Otok" there are only a few smaller ones.

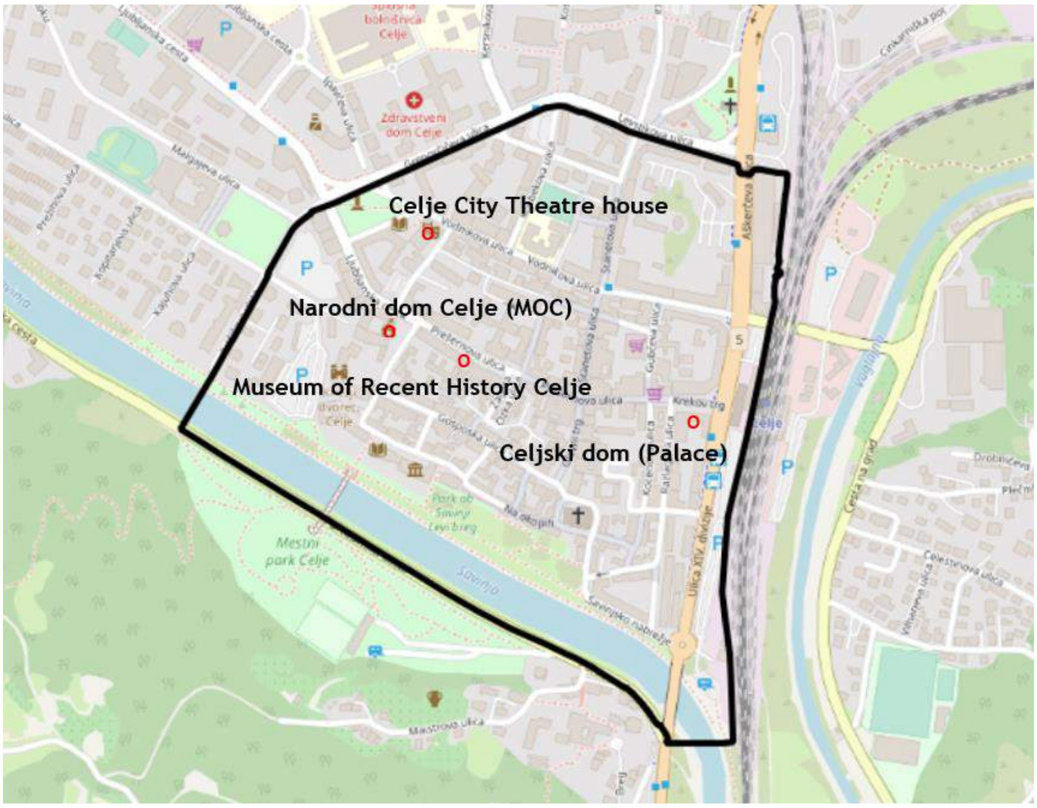

Figure 6: The "Old City" replication area with four historical buildings to be considered within the POCITYF project

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Eight buildings, all of them owned by the Municipality of Celje, have been identified as best candidates for case studies in the POCITYF replication activities. Four historical buildings from 18th and 19th century have been selected in the Old City, see Figure 6. These are the Celjski dom palace, the Museum of recent history, the SLG Celje theatre building, and the building of Narodni dom, which is also home to the Municpality of Celje. The buildings are depicted in Figure 7.

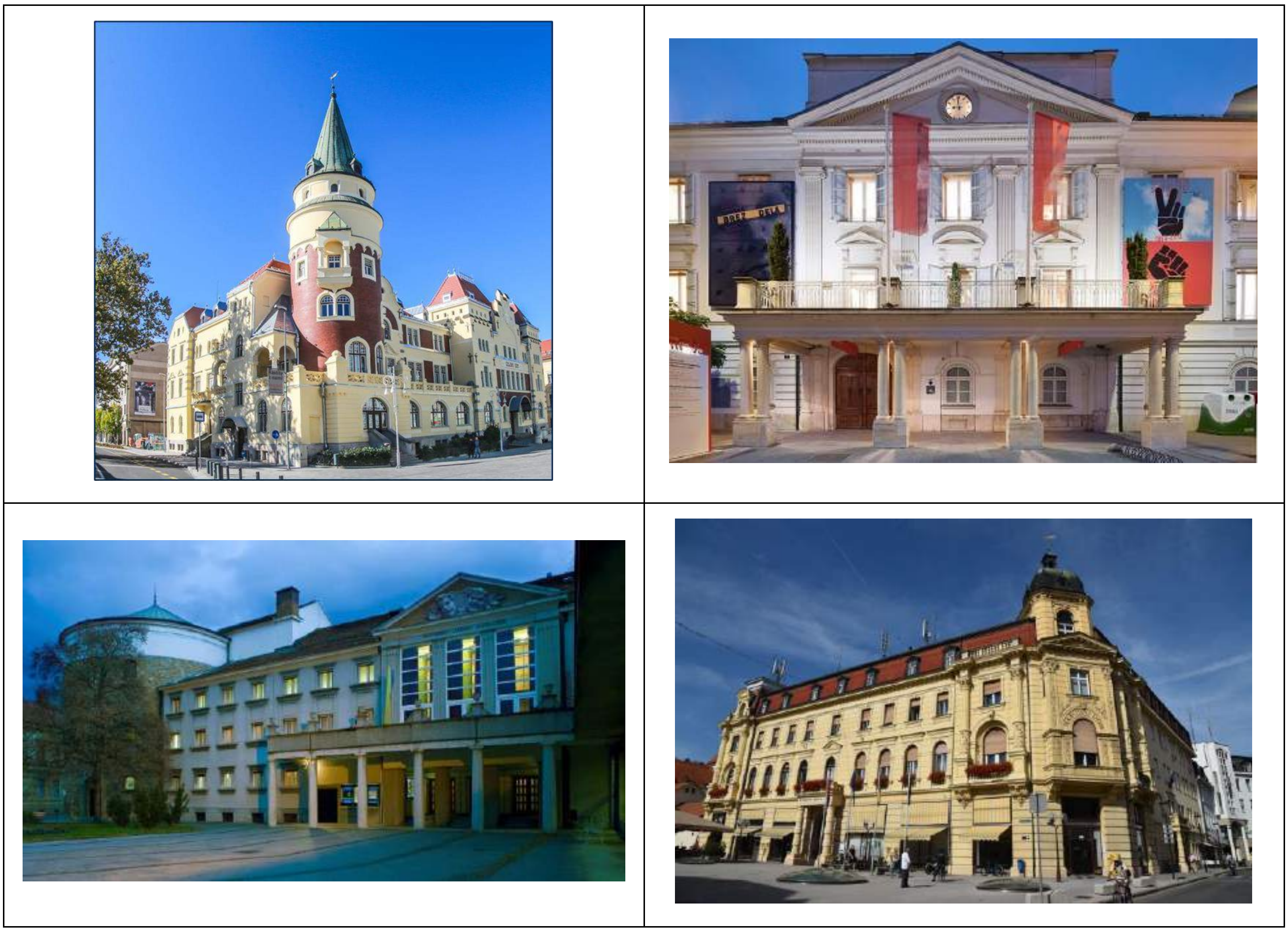

Figure 7: The case-study historical buildings in “Old City”: Celjski dom (top left), Museum of recent history (top right), SLG Celje theatre (bottom left), Narodni dom (bottom right).

Four additional buildings have been chosen for replication activities in Glazija and Otok, see Figure 8. All are from the 20th century, but ranging from the beginning of the century to the 80s. The buildings differ in size, construction, purpose, etc. They are: kindergartens Luna and Sonce, a faculty and office building, located at Mariborska ulica 7, and Celje youth centre (CMLC), see Figure 9.

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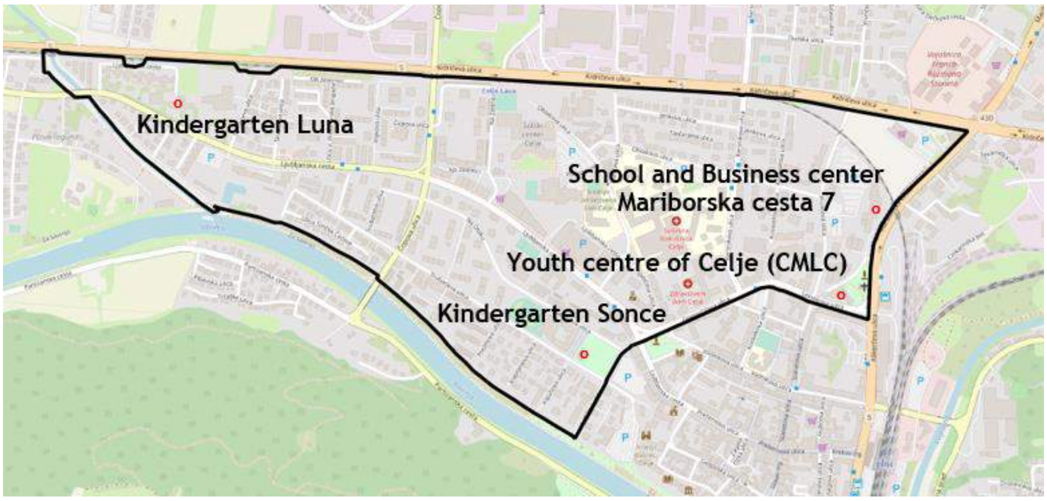

Figure 8: The "Otok and Glazija" replication area with four buildings to be considered within the POCITYF project

Figure 9: The case-study buildings in "Glazija and Otok": Kindergarten Luna (top left), Kindergarten Sonce (top right), Faculty and office building at Mariborska ulica 7 (bottom left), Celje Youth centre – CMLC (bottom right).

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The objective of the replication activities, planned in the POCITYF project, is to support the two replication areas on their way to becoming greener, more sustainable, more livable and friendly to their citizens. Specifically, one of the main objectives is to improve the energy efficiency of individual buildings, thereby reducing their operational costs and improving the living comfort. The latter is particularly important in the case of kindergartens, schools, etc. Additional cost reductions will come from the increased share of locally produced energy from renewable sources. While the replication will focus on municipal buildings, adoption of similar actions will be encouraged also for privately owned buildings, by increasing the public awareness of their necessity and by providing examples of good practice.

Another objective is to expand the concept of energy efficiency and sustainability from an individual building to a block of buildings and further to a city district. This will require improving and upgrading the city infrastructure so that it will allow individual buildings to connect into a flexible network. Advanced energy management on the district level will facilitate efficient energy exchange and maximise the exploitation of RES. This will increase the share of locally produced energy and reduce the dependence of the city on the grid power. Again, the concept will be initially demonstrated on a group of buildings, owned by the municipality.

A special focus is given to cultural heritage buildings, whose preservation is necessary not only for their historical importance, but also for their role in the identity of the city and its citizens. The possibilities for retrofitting historical buildings are usually severly limited by the legislation for protection of cultural heritage. Nevertheless, innovative solutions, developed in POCITYF, promise to overcome some of the barriers, either by introducing customised technologies to be applied in the buildings themselves, or by connecting them to other buildings in the city district, whose retrofitting is not hindered by legislation.

Another subject to be addressed by the replication is urban transportation. The city wishes to expand the existing network of EV charging stations and upgrade it by connecting it to local RES energy production systems. This will also require an advanced charging management system. The improved infrastructure will stimulate the use of EVs which in turn will help improve the quality of air in the city, reduce the noise caused by traffic, reduce the cost of transportation, etc. If viable, the city would like to introduce an EV sharing service in order to provide flexible and affordable personal transportation.

The municipality wants to modernise and upgrade the public lighting system which presents a significant part of the energy use and expenses in the city. The first step will be to replace the regular light bulbs with LEDs, which will reduce the energy consumption and the expenses. Additionally, introduction of smart lamps would allow advanced features, such as improved management, adaptable brightness, integrated EV charging, 5G functionalities, etc.

All aforementioned actions will reduce the carbon footprint and the emissions of other pollutants, originating from fossil fuels. In addition to the long-term beneficial impact on the environment, this will immediately reflect in a higher air quality, which will improve the quality of life in the city. Another set of environmental objectives is related to material resources and waste management: to reduce the quantity of produced waste, increase the share of recycled waste, and promote circular economy practices, all of which will help preserve the natural resources and relieve the burden on the environment.

Finally, a strong emphasis will be given to citizen engagement. Here, the main objectives are to increase the public awareness about environmental issues, and to demonstrate the importance of sustainable energy solutions. This should encourage people to change their energy related behaviour/habits and strengthen the acceptance of the solutions. A further objective is to reinforce the interaction with the city's inhabitants and visitors through existing channels and new services. On the one hand, this will improve the quality of life for the citizens and the visiting experience for the tourists. On the other hand, the feedback will allow the city to constantly improve and become even more attractive both as a place to live and as a tourist destination.

2.3 Envisioned Replication Area and city needs towards Smart City

Based on the analysis of the current situation in FC Celje, and on the information obtained from LHCs and their technical partners, the following POCITYF innovative technologies have been identified as interesting for the city. Innovative elements (IEs) associated with transition tracks ETT#1, ETT#2, ETT#3, and ETT#4 are collected in Table 3, Table 4, Table 5, and Table 6, respectively. Each innovative element is accompanied by a short description of the expected results, and motivation for including it in the replication plan.

Table 3: Selection of innovative elements from ETT#1, identified as interesting for implementation in FC Celje, and motivation for their implementation

ETT#1: Innovative Solutions for Positive Energy (CH) Buildings and Districts		
Selected Innovative Elements (IEs)		Expectations/Needs
IS-1.1: Positive Energy (stand-alone) Buildings		
IE 1.1.1	PV glass	Solar energy is one of the most promising RES regarding its usability in Slovenia and PV technology is expected to be widely implemented in the future. Innovative PV solutions will allow addressing a wide range of goals in various

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		applications. The main objectives are: - Increase local energy production - Increase the share of energy obtained from RES - Improve the energy independency of individual buildings and the city district by increasing self-consumption - Reduce the emissions of CO2 and other pollutants by reducing the use of fossil fuels - Improve the air quality in the city - Reduce the cost of heating, cooling, operating the buildings - Improve the climate inside the building, prevent overheating
IE 1.1.2	PV canopy	See IE 1.1.1 - Provide shade and shelter for cars in a parking lot or for people in open areas
IE 1.1.3	PV skylight	See IE 1.1.1
IE 1.1.4	Tegosolar PV	See IE 1.1.1 - Preservation or improvement of the visual appearance of buildings in comparison with standard PV systems - Applicability to various roof shapes
IE 1.1.5	Traditional PV shingle	See IE 1.1.1 - Preservation of the original visual appearance of heritage buildings, or at least a good approxiamtion for the part of the roof that does not face the street
IE 1.1.6	Bidirectional smart inverters	This solution provides support for establishing a local system for energy production from RES by simplifying the connection between the individual components (PV elements, local batteries, grid) which are also IEs in this project. Main objectives: - Facilitate the introduction of local RES systems - Increase the number and efficiency of new RES systems
IE 1.1.7	Energy router	Similar function as IE 1.1.6. - Also allows a combination of multiple different RES - Includes smart algorithms for optimising the energy flow between the connected components - Similar objectives as with IE 1.1.6
IE 1.1.8	BMS (Building Management System)	MOC is interested in introducing a BMS in some of the buildings, owned by the municipality. The main objectives are: - Improve the collection and monitoring of information about the buildings - Improve the management of the buildings - Reduce the energy use, resulting in reduced costs and emission of pollutants - Reduce the production of waste
IE 1.1.9	2nd life residential batteries	See IE 2.1.1

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IE 1.1.12	Insulation with circular materials	MOC supports the transition towards circular economy. This can also reflect in using circular materials for the insulation of buildings. The main objectives are: - Reduce heat loss through the building envelope - Reduce the use of raw materials - Increase and endorse the use of recycled materials
IE 1.1.13	Triple glazing	Triple glazing is a well known and widely used solution in Slovenia. The benefits of its application have been verified in many applications. MOC intends to use this IE in retrofitting of buildings, unless it is prevented by legal or technical issues. The main objectives are: - Reduce heat loss through the building envelope - Consequently, reduce energy use, emissions of pollutants, and costs of heating and cooling - Improve the climate inside the building
IE 1.1.14	Solar roofs and facades	See IE 1.1.1 MOC is already researching the best options for setting up solar powerplants on the roofs of municipal buildings, which could also provide RES energy for other buildings, where this is not possible (see IE 2.1.5), and for EV charging stations (see IE 3.1.1)
IE 1.1.17	Li-ion batteries	Power production from RES is often distinctly intermittent and the peaks usually do not coincide with the highest energy demand. Using RES for the purpose of self-consumption therefore requires adequate energy storage on the level of an individual building or a block of buildings. This IE is a necessary component of any such systems. Goals: - Increase the efficiency of the local system for production of energy from RES bi providing energy storage and maximising self-consumption
IE 1.1.18	Cascaded heat pumps	Heat pumps are a well known and commonly used solution for heating and cooling of buildings. However, their power is limited and might not suffice for certain applications. Cascading the heat pumps could be an interesting solution, so MOC is interested in this solution. The main envisioned application is for the buildings with a high temperature heating system, where cascading would enable the use of heat pumps as an energy source without changing the complete system. - Increase the range of possible applications of heat pumps as the main heating/cooling system - Allow the use of heat pumps for heating in buildings with high temperature heating system by providing a higher water temperature than the heat pump alone - Main focus is on the shallow geothermal energy heat pumps, which are strongly represented in Slovenia
IS-1.2: Positive Energy Districts Retrofitting		
IE 1.2.1	Smart lamp posts with EV charging and 5G functionalities	Public lighting presents a significant part of the energy use and expenses in the municipality. It is therefore sensible to optimise the lighting systems, as well as their management.

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		MOC has already prepared a plan for renovation of the street lighting, mainly replacing the regular light bulbs with LEDs. Introduction of smart lamps could be a welcome and useful addition. Main objectives: - Reduce the energy use for public lighting - Consequently, reduce the expenses - Improve the management of public lighting, e.g. adjusting the brightness depending on the ambient light an the presence/absence of people
IE 1.2.2	Energy Routers	Energy routers are indispensable for the management of energy transfer between the grid, local RES production, the local storage, and the loads. The objectives are: - Facilitate the implementation of local energy production from RES with all associated benefits – reduced use of energy from non-renewable source, improved self-consumption, reduced pollution, reduced costs, etc.
IE 1.2.4	P2P energy trading platform	See IE 2.1.5
IE 1.2.5	Community Solar Farm	The community solar farm introduces energy production from RES on a district level, allowing more flexibilty. It can be located on a remote location which is convenient for application in areas under heritage protection where on-site installation of RES technology is very limited. Main objectives: - Enable energy production from RES for the buildings in the old city centre under heritage protection - Include a greater number of consumers which results in more flexibility - Reduce the price of installation of RES and the price of energy due to the larger scale of production - Increase self-consumption and reduce energy use from the grid
IE 1.2.6	DHC (District Heating and Cooling, biomass, waste, geothermal)	There is an existing district heating system in Celje, powered by a waste incineration power plant which provides heat and electricity. It is of interest of Celje to learn about similar solutions in different cities, in order to improve their own system. Main objectives: - Gain experience about similar solutions from other cities - Improve, optimise, upgrade the existing system
IE 1.2.8	Li-ion / Li-metal batteries	See IE 1.1.17
IE 1.2.9	DC lighting with EV charging	See IE 1.2.1
IS-1.3: Feeding of PEDs with Waste Streams (heat/materials) promoting Symbiosis and Circular Economy		
IE 1.3.1	2nd life residential batteries	See IE 1.1.17 - Additionally, 2nd life residential batteries reduce the waste production by extending the life of used-up EV batteries - At this moment, the solution is probably not very relevant in Slovenia, because the EVs are still relatively new. But their number is growing increasingly, so the used-up

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		batteries will become an issue in the coming years
IE 1.3.2	Pay-as-you-throw (PAYT)	Celje has a well established system for separated collection of household waste. The system could be improved by a PAYT concept, which would stimulate people to further decrease the total amount of waste, especially residual waste, and increase the share of recyclable waste. Main objectives: - Reduce the total amount of waste, especially residual waste - Increase the share of recyclable waste
IE 1.3.4	Circular economy building practices	Circular economy building practices are a hot topic in Slovenia with numerous projects focusing on this subject, e.g. reuse of concrete, asphalt, etc. from demolition in the construction of new buildings and other urban infrastructure. Main objectives: - Reduce the amount of waste from demolition of old buildings and infrastructure - Increase the share of demolition waste, that is used for construction of new buildings and infrastructure - This also applies to reuse of products outside of construction sector, e.g. reuse of furniture etc.
IE 1.3.7	Waste management tools	The city of Celje is interested in new tools and experiences of other cities related to waste management. Main objectives: - Optimise the management of waste - Reduce the amount of waste and increase the share of recycled waste - Introduce waste management to new fields of application

Table 4: Selection of innovative elements from ETT#2, identified as interesting for implementation in FC Celje, and motivation for their implementation

ETT#2: P2P Energy Management and Storage Solutions for Grid Flexibility		
Selected Innovative Elements (IEs)		**Expectations/Needs**
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 2.1.5	P2P energy trading platform	There is at least one energy provider in Slovenia which offers the service of P2P trading. The RES production of prosumers is documented during the year. The surplus over the consumption can be sold, donated or transferred to the next year. Furthermore, the energy can be produced on one location and used on the other by the same prosumer. Main objectives: - Facilitate the use of energy from RES for municipal buildings, where local exploitation of RES is not possible, or is very limited, due to technical limitation or due to protection of cultural heritage - This would be achieved by installing a larger RES system

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		on other municipal buildings with a larger RES potential and making use of the service mentioned above - Inform citizens about this service and motivate them to participate - Increase the share of energy from RES - Reduce the costs of heating etc. - Increase the flexibility of energy consumption within a group of buildings (or wider)
IE 2.1.6	City Energy Management System	All newly renovated municipal buildings in Celje are equiped with different sensors and connected to a central monitoring system/platform, which also allows management of (some) systems in those buildings. In the future, all municipal buildings are planned to be included in the system. It would be useful to learn about other similar systems in order to optimise the existing one, introduce new features, etc.
IE 2.1.8	Stationary Batteries	See IE 1.1.17
IS-2.2: Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions		
IE 2.2.3	Low temperature heat grid	Celje has an existing district heating system which provides heating for a large part of residential and non-residential buildings in the city. It would be beneficial to learn good practices from elsewhere, which would facilitate the improvement, optimisation, upgrade of the system.
IE 2.2.5	Low temperature waste heat	See IE 1.2.6 and IE 2.2.3

Table 5: Selection of innovative elements from ETT#3, identified as interesting for implementation in FC Celje, and motivation for their implementation

ETT#3: e-mobility Integration into Smart Grid and City Planning		
Selected Innovative Elements (IEs)		**Expectations/Needs**
IS-3.1: Smart V2G EVs Charging		
IE 3.1.1	EV charging management platform	There is a small network of existing EV charging stations in Celje. They are connected to municipal buildings' meters, but operated by an external operator (an energy provider). MOC intends to enlarge the network of charging stations, which might also benefit from an improved management platform. Furthermore, MOC is considering changing the operator in order to improve the conditions for the users (EV owners). This could be an additional reason/opportunity for an improvement of the whole system. Main objectives: - Enlarge, upgrade, optimise the existing system of EV charging stations - Integrate RES energy production - Improve the experience for the users (EV owners) - Provide the infrastructure for an EV sharing service
IE 3.1.2	EV charger prototype with PV integration	See IE 3.1.1
IE 3.1.5	Smart lampposts with EV	See IE 1.2.1

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	charging and 5G functionalities	
IE 3.1.6	Intelligent and optimal control algorithms	Similar to IE 3.1.1
IE 3.1.7	Smart solar charging	Similar to IE 3.1.2
IS-3.2: E-mobility Services for Citizens and Auxiliary EV technologies		
IE 3.2.1	EV sharing	In the past, MOC has considered introducing the EV sharing service in the city. However, at the time, the investment was not economically viable, mainly because the city is relatively small. This is also the reason, why none of the IEs from IS-3.2 were selected in the project proposal. Recently, the interest for EV sharing has risen again. The socio-economic situation has been changing, the EV technology is developing, the number of EVs and the supporting infrastructure is expanding rapidly. The general acceptance of EVs is rising constantly. Car sharing is also more and more recognised, especially in larger cities. The concept can be expected to grow, especially with the recent growth of the energy prices. The envisioned strategy for introduction of EV sharing in Celje is that MOC will take the role of enabler (provide locations, permissions, etc.), while the EV sharing service will be financed, established and operated by a subcontractor company. The main goals are: - To reduce the number of cars in the city centre - To mitigate the problems with parking - To reduce pollutant emissions and thus improve the air quality in the city - To reduce the noise pollution - To provide a flexible personal transport service at an economical price

Table 6: Selection of innovative elements from ETT#4, identified as interesting for implementation in FC Celje, and motivation for their implementation

ETT#4: Citizen-Driven Innovation in Co-creating Smart City Solutions		
Selected Innovative Elements (IEs)		**Expectations/Needs**
IS-4.1: Social Innovation Mechanisms towards Citizen Engagement		
IE 4.1.3	Tourist apps	Main objectives: - Improve the experience of tourists in the city by providing real-time information about relevant information, e.g. the city's points of interest, parking, waiting times, tourist services, etc. - Provide information about the city, e.g. about history - Prevent overcrowding at points of interest, parking lots, etc. - Attract more tourists and increase the income from this

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		source
IE 4.1.4	Cultural experiences market (mobile app)	Similar to IE 4.3.1
IE 4.1.5	Mobile apps on energy consumption	Main objectives: - Provide real-time information about energy consumption to building occupants and users, educating them and allowing them to modify their behaviour and habits - Reduce energy use - Demonstrate the importance and promote the acceptance of sustainable energy solutions
IS-4.2: Open Innovation for Policy Makers and Managers		
FC Celje has not selected any solutions from IS-4.2.		
IS-4.3: Interoperable, Modular and Interconnected City Ecosystem		
IE 4.3.1	City Urban Platform	Celje has an existing public platform, where citizens can report various issues, problems, malfunctions in the city. They can also provide suggestions on how to improve different aspects of life in the city. The municipality handles the complaints and proposals within 48 hours. There is a great potential for improving the platform by adding new features, including real-time date from different services in the city, etc. Therefore, MOC would like to learn about similar platforms in other cities, good practices, problems, included features, etc.
IE 4.3.2	Wi-fi data acquisition systems	At the moment there are no public wi-fi hot spots in Celje, but the project of establihing the wi-fi network is already in progress. One of the envisioned uses is to facilitate the sharing of real-time information about available parking spaces all over the city. The main objectives of the wi-fi data acquisition system are: - Facitlitate real-time data sharing from different services (available parking spaces, air quality, other services of urban infrastructure...) to users and managers/operators - Consequently, improve the city services and user experience - Optimise the management of different systems, allowing for the reduction of energy use and waste production
IE 4.3.3	Data lake intelligence for positive communities	Similar to IE 4.3.2

2.4 Challenges & Barriers

The main envisioned challenges and barriers for replication activites are related to the legal protection of cultural heritage and the regulation of energy production and trading. Financial limitations may prove an important factor for certain solutions, as well as the acceptance from citizens and other local stakeholders.

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Legal challenges and barriers

The *Cultural Heritage Protection Act* [16] states that integrated heritage preservation is implemented in the planning and actions of the state, provinces and municipalities by incorporating the heritage into sustainable development, respecting its special nature and social importance. Integrated heritage preservation is a set of measures to ensure the continued existence and enrichment of the assets: Its maintenance, restoration, renovation, use and revival. The Institute for the Protection of Cultural Heritage of Slovenia (ZVKDS) issues cultural protection conditions and consents for undertakings to immovable heritage. Usually, there are quite severe restrictions regarding the renovation of the cultural heritage buildings; particularly the appearance of, amongst others, front (street) façades, windows, roofs. Solutions must always be agreed on a case-by-case basis. Installation of technologies that do not visually disturb is possible in minimal intervention. Some technologies may be installed on specific micro-locations, which are not visually exposed (such as backyard, roof, and attic).

The *Cultural Heritage Protection Act* [16] affects (to a certain extent) the requirements of the main building code in Slovenia, the *Construction Act* (also *Building Act*) [17], which regulates the conditions for the construction and renovation of buildings and other issues related to the construction of buildings. The purpose of this Act is to protect the public interest, including the protection of cultural heritage and the promotion of sustainable construction. The Construction Act has recently been updated. The new act has entered into force with the beginning of 2022, and has been applied in June 2022. It still has to be studied in order to assess its influence on the replication activities.

In 2022, new *Rules on efficient use of energy in buildings* (PURES 2022) [18] were adopted together with the relevant Technical Guideline (TSG-004) [19]. Both documents, which are already in force (from June 4^{th}), set even higher requirements regarding energy use in buildings, both for the design of new buildings and renovations of existing ones. The requirements are related to zero energy standards as agreed by the European Union, which is particularly difficult to achieve in dense building structures of urban areas and in accordance with other legislative restrictions. However, PURES 2022 allows exceptions for existing buildings if they are protected according to the regulations on the protection of cultural heritage (only for parts of the building and/or premises defined by the service responsible for the protection of cultural heritage).

Therefore, when planning solutions, especially for PED 1, it will be necessary to establish very good communication with ZVKDS and obtain relevant information for individual buildings. ZVKDS representatives will have to be informed in detail about the technologies. It will be necessary to coordinate with them regarding the planned

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interventions on the building and, in specific cases, to find solutions outside the historical building volume in question (extensions, canopies, courtyards, etc.).

The national energy regulations are also developing continuously, along with the development of energy policies and strategies on the EU level. In 2022, the *Decree on self-supply of electricity from renewable energy sources* [20] was updated in accordance with the new *Act on the Promotion of the Use of Renewable Energy Sources* (ZSROVE) [21], which was adopted in July 2021 and is in force since August 2021. The old version of the decree (from 2019) posed some important limitations, e.g. not allowing the owner of a self-supply device to market or sell the electricity produced on that device (instead, the surplus of the produced energy over the consumed energy in the accounting period was handed over to the supplier), disallowing district-level electricity storage, etc. The new decree still has to be studied more thoroughly, but some general observations can already be made. It maintains and upgrades the concept of individual and common self-supply, introduces some additional benefits for users, simplifies some procedures, broadens the group of consumers that can enter the self-supply system, etc. The changes follow the Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources [9].

The legislation may also pose indirect obstacles, for instance, the energy grid must be operated by a DSO, and cannot be privately owned. Therefore, the cooperation of the DSO is necessary which may complicate the procedures. Also, the DSO might not see sufficient benefit in the implementation of certain solutions to invest their time and finances. In such cases, it will be necessary to approach with a detailed analysis, lead a discussion with arguments and use all means to establish a positive relationship with the final result, a solution for a successful business plan. Examples of good practice from the project will play an important role in this process.

Technical challenges and barriers

The first set of technical limitations is related to geological and other natural conditions, described in section 2.1, which limit the effectiveness of some RES technologies. In Celje, the solar energy and the shallow geothermal energy are considered the most appropriate RES for application in the built environment. Furthermore, Borehole Thermal Energy Storage (BTES) systems are widely used and are deemed more appropriate than the Aquifer Thermal Energy Storage (ATES), which is one of the POCITYF solutions.

Another group of technical barriers is related to the present state of the city's infrastructure which may not be adequate for the implementation of certain advanced technologies/solutions, e.g. large numbers of small and dispersed energy producers, complex systems of energy exchange between them, the intermittent nature of the RES

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which causes instability in the grid, etc. A great part of the electricity distribution network is relatively old and has not been built with such solutions in mind, therefore it cannot support them. Considerable upgrade of the infrastructure is required, however, this will take time and financial resources.

Assuring energy independence of a city district by introducing local energy production from RES, and the accompanying energy storage and flexible grid services, may require a critical mass of buildings connected to the system. Otherwise, the system might not be technically or financially feasible, i.e. it might not produce enough energy with sufficient constancy, or might not be profitable. Since Celje is a small city, such concerns are in place.

Some of the POCITYF innovative solutions seem more appropriate for new buildings than for retrofitting of the existing ones. For instance, they may require a reconstruction of the existing interior heating/cooling systems which could be technically or financially challenging.

Essential information for planning the future production of energy from RES in a city district is the total amount of required energy. However, it is not straightforward to evaluate it. In buildings the energy use mainly comprises the energy for heating and cooling, the energy for operation of buildings, and the energy for preparation of domestic hot water. A methodology for evaluation of these energy needs is already in development, and will be further refined in the course of the project.

Technical challenges related to buildings will be addressed on a case-by-case basis, while the PED will be considered as a unit in which a holistic approach strives to achieve the goal. Obstacles will be tackled by carefully choosing innovative solutions that are relevant to the local environment and that can be combined or upgraded in a smart way regarding technical, financial and business aspects.

Financial challenges and barriers

Some of the POCITYF solutions are associated with relatively high investment costs and long periods for the return of the investment. Here, suitable financing schemes will be required, e.g. incentives, subsidising… Participation of industrial partners could also be efficient, however, they need to see sufficient benefit in it. Well defined business models will therefore be necessary.

The financial aspect is often the deciding factor for the citizens when they are deciding about implementing a new, more sustainable solution. Environmental incitives have proven quite succesful in addressing this issue, e.g. for improving the efficiency of the building envelope, installing PV panels, etc. However, this year, the funds allocated for

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one of such incentives have run out in February due to the recent enormous increase of the energy prices.

Financial limitations may prove even more important in the near future as the consequences of COVID-19 begin to have a big impact on the national and EU economy. The associated energy crisis, on the other hand, should provide an additional stimulation and prove the necessity of the energy transition.

The aforementioned problems could be avoided by suggesting to adopt or develop business models that do not financially burden the end user in a one-off amount, but instead involve gradual payment, rental or leasing.

Social challenges and barriers

One of the main challenges is to motivate the local stakeholders to actively participate in the energy transition. This is particularly true for the engagement of citizens because they are usually less informed and may feel less associated with the issues at stake than the business stakeholders, such as DSOs, transport companies, etc. The citizens are also more used to a top-down approach, i.e. the command must come from the top, instead of trying to make the change themselves with an initiative coming from the bottom.

In Slovenia, the residential building stock is predominantly privately owned. For this reason, some problems are expected with the implementation of new, sustainable solutions in multifamily buildings. It could be difficult to persuade enough owners in the building to agree on the intended action, especially if a 100% agreement is required by law (interventions in the load bearing structure).

A specific obstacle might be a public objection to a particular solution. For example, demonstrations against 5G networks have taken place in the past years in Slovenia.

Social challenges and obstacles will be addressed with various campaigns, events and promotions that will help to find a way to better understand the project proposals and create an atmosphere for accepting innovations that lead to multiple benefits - for both individuals and society. The key is to increase mutual trust between organizations/services and individuals, confidence in progress and improvement in local environment that will make life easier for the individual, along with a sense of positive contribution to the community.

3 Processes towards the implementation of the Replication Plan

3.1 Governance and administrative processes for planning solutions

3.1.1 General procedure for project management at MOC

Municipality of Celje uses a project approach to implement and manage all projects, following a well defined project management methodology. The general basic structure of the project implementation is as follows:

Start of a project

The following points are considered when starting a project:

- Definition of the basic purpose and goals of the project (why it should be implemented it and what should be achieve with it).
- Engagement of users and other stakeholders to identify opportunities that could be addressed by the project.
- Depending on the way the project is launched; offering appropriate support and identification of all stakeholders in the project.
- Formation of a project team.

Project activity planning

In order to achieve the set goals of the project, the implementation of the necessary activities is planned in advance. The activities are planned in a logical sequence, therefore a framework is used in which general and specific objectives, expected results, key activities to be implemented and their sequence are defined. Based on this, a time and financial plan for the implementation of the project is prepared. The necessary financial resources are also determined.

Project implementation

During the implementation of the project, monitoring is constantly performed to check whether all set goals and results are being achieved. If necessary, the project plan is adapted to the circumstances. The implementation phase is the most important part of the project and the main reason why the project is planned. In this phase teamwork, problem solving and information management are key competencies.

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Project evaluation

During the implementation of the project, the achievement of results and the quality of the project are monitored in various ways.

3.1.2 Administrative procedures and spatial planning measures for the use of renewable energy

General procedures for issuing permits for the construction of infrastructure and facilities

The procedures for issuing permits for the construction of infrastructure and facilities are regulated by the following legal regulations:

- The Construction Act [17] regulates the procedures for obtaining a building permit for devices and infrastructure and determines the conditions for its acquisition.
- The Environmental Protection Act [22] regulates the procedures for obtaining an environmental permit for installations and infrastructure and sets out the requirements for obtaining it. This Act also regulates the procedures for issuing an environmental consent for the installation of equipment and infrastructure in space, if their construction could have an impact on the environment.
- The Nature Conservation Act [23] regulates the procedure for issuing a nature protection consent to a building permit for placement in the space of a device or infrastructure, if their construction could endanger biodiversity, natural value, or a protected area.
- The Water Act [24] regulates the procedures for obtaining a water permit or concession in the case of a device that uses a water resource and sets out the requirements for obtaining a water permit or concession. This Act also regulates the procedures for issuing a water permit for a building permit for placement in the space of a device and infrastructure, if their construction could affect the water regime.
- The Mining Act [25] also regulates the manner of granting mining rights, competencies and the manner of issuing individual permits, as well as the organization and manner of performing the inspection service in the field of mining.

Special procedures for issuing permits for smaller, decentralized installations

It is not necessary to obtain a building permit for the installation of small, decentralized installations (such as PV power plants, solar collectors on buildings or biomass boilers in buildings…) on or next to buildings.

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It is also not necessary to inform the administrative body if we are carrying out investment maintenance work on the facility that does not interfere with its construction and does not change its capacity, size, purpose, and appearance. Exceptions are buildings with the status of cultural heritage property. The conditions for investment maintenance work on facilities are specified in more detail in the regulations in the field of energy infrastructure.

3.2 Work Groups supporting the planning processes

3.2.1 POCITYF work groups in FC Celje

The project management processes, described in the previous section, must consider various aspects of planning and implementation of new solutions, such as technical constraints, legal requirements, and financial limitations. Therefore, they need to be supported by expert teams that possess the required knowledge and experience.

A well defined organisational structure is key for successful and efficient management of large projects. Different structures were examined in the initial phase of the project, and presented in deliverable D1.13 [26]. The proposed hierarchical structure comprises the site manager, responsible for overall coordination, four ETT leaders (intermediate entities), and integrated solution (IS) leaders, who are in direct communication with the engineers of the local ecosystem's partners. Such structure is appropriate for the LHCs that are already in an advanced stage of the energy transition process. They have previous experience from the pre-pilot projects, a clearly defined selection of innovative elements, adequate personnel, identified partners and collaborators, etc.

Celje, as one of the FCs, is just beginning this journey, and does not yet have the capacity for such an elaborate management structure. Instead, the core work group consists of the employees of the two Slovenian POCITYF partners, MOC and ZAG, who are actively involved with the project. They are the first to learn from the LHCs and other consortium partners. By acquiring the general overview of the POCITYF's demonstration and replication activities, they can identify which tasks they can handle by themselves and where they need help from external partners.

The first step in expanding the work group was to involve co-workers with knowledge and experience in project-related fields, e.g. heating systems, protection of cultural heritage, public relations, etc. For the fields that could not be covered internally, external assisstance was requested. Mainly, personal and business acquaintances from local stakeholders or other related companies were asked to provide information.

Provisional work groups for replication activities in Celje have been identified in accordance with the template, prepared by the horizontal partners of the project. The groups are shown in Table 7. General management is carried out by the members of the

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POCITYF team (MOC and ZAG). Realisation of any larger projects in the municipality must be approved by the City council. However, they are not involved in project preparation.

Table 7: Provisional work groups in FC Celje

General	FC manager	Tadej Vunderl (MOC)
	Member from R&D - academia	dr. Sabina Jordan (ZAG)
	Member from lobby groups	/
	Assessor / Municipal in charge	City council
ETT #1	Field expert	mag. Evgen Zgoznik (Energetika Celje d.o.o.)
	Enterprise	Energetika Celje d.o.o.
	Citizen	Primož Posinek (representative of local community)
ETT #2	Field expert	Jure Ocvirk (MOC)
	Enterprise	Elektro Celje d.d.
	Citizen	Primož Posinek
ETT #3	Field expert	Miran Gaberšek (MOC)
	Enterprise	Nomago d.o.o.
	Citizen	Primož Posinek
ETT #4	Field expert	Alja Tihle (MOC)
	Enterprise	Mediana d.o.o.
	Citizen	Primož Posinek

In relation to ETT #1, Energetika Celje d.o.o. was identified as the most relevant local stakeholder. The company is the regional DSO and supplier of natural gas, producer and DSO for district heating, and also performs thermal processing of municipal waste. Their representative was also chosen for the field expert for this ETT. Elektro Celje d.d. was identified as the most relevant stakeholder for ETT #2. They are the regional DSO and supplier of electricity. Company Nomago d.o.o. was selected as the most suitable stakeholder in relation to ETT #3. They are the public transport provider in the municipality of Celje, with a bus fleet powered by compressed natural gas. The company also manages the bike sharing service KolesCE. In regard to ETT #4, Mediana d.o.o. was recognised as the most relevant stakeholder. The company offers market research services, public opinion polls, etc. Field experts for ETTs #2, #3, and #4 were chosen from MOC's related departments. All the work groups also confer with a representative of the local community.

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3.2.2 Description of the planning processes

At the moment, the replication activities are mainly performed by the core work group. The external collaborators are involved as needed, to provide expert knowledge and opinion. The work is not strictly divided between the different ETTs. This is the most sensible approach, given the limited human resources and the initial stage of the replication. In the future, however, the work group should be expanded with suitable personnel to lead individual ETTs or ISs, if the replication activites are to be carried out on a similar scale as in the LHCs.

In the first half of the POCITYF project (up to M36) the following work was carried out by the work group of FC Celje. The group was familiarised with the structure of the project – the four transition tracks, divided into ten integrated solutions, which are very interconnected and comprise 73 innovative elements (IEs). The IEs (technologies, solutions, concepts) were studied and assessed regarding their suitability for replication in Celje. This was done based on the information obtained from the LHCs and the technical partners, responsible for individual IEs. Special attention was given to solutions that seem most suitable, easiest, and most likely to implement in the near future. Relevant legislation was studied in parallel, resulting in a general overview of the legislation, pertaining to energy production and trading, building processes, cultural heritage, and environment protection. Another task, carried out in the initial phase of the project, was to compose a list of local stakeholders in FC Celje that are related to the four ETTs, or could be in the future. Their roles and relations in the local ecosystem were further explored within the work package, dedicated to development of business models for the implementation of innovative solutions.

All the obtained knowledge was combined to compose an initial city vision and master plan – a description of the current situation, the issues to be addressed in the scope of POCITYF, envisioned ways to achieve the goals, and possible obstacles on that course. The first, rudimentary vision evolved with the advancement of the project and the gathering of new knowledge, and serves now as the basis for the development of replication plans. All the aforementioned activities ran in parallel and in several iterations because they affect each other. For instance, learning about new technical solutions may promote new, bolder objectives; newly discovered legislative restrictions may prevent the implementation of previously selected solutions; etc. The development of the city vision was facilitated by the exchange of knowledege and experience with the LHCs and other FCs in regular meetings, dedicated workshops, including workshops with other smart city projects, and by establishing/strenghtening two-way communication with the local stakeholders.

An essential step in creation of the replication plan, aligned with the city vision, is the assessment of energy needs in the selected replication areas. Such information is not

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readily available, so the work group had to develop a methodology for this purpose. The methodology considers the energy required for the heating of buildings (in current state and after energy retrofitting), the energy for use and operation of buildings, preparation of domestic hot water, and public lighting. It is described in more detail in section 3.4.8.

3.3 Local Stakeholders' engagement

Identification of the local stakeholders was largely supported by the analyses, carried out by consortium partners at the start of the project. Table 2 in deliverable D1.1 (End-User and Stakeholders Requirements Definitions) [27] sums up the different stakeholder groups (energy utilites, consumers, technology and service providers, etc.), their typical members (energy suppliers, energy grid operators, local business, etc.), and their roles in the ecosystem (end user, utilizer, enabler, etc.) According to this information, the following local stakeholders, related to the POCITYF energy transition tracks, have been identified in FC Celje:

MOC – Municipality of Celje (enabler, facilitator, end user)
The central stakeholder. It has interactions with most of the listed stakeholders. It is an end user of different services, e.g. supply of energy (electricity, natural gas, district heating) and drinking water; municipal waste and wastewater treatment and disposal for the buildings in the ownership of MOC. It provides different services for the citizens, manages and maintains the city infrastructure, etc.

ZVKDS - Institute for the Protection of Cultural Heritage of Slovenia (enabler)
The institute has many tasks related to protection of cultural heritage. In the scope of the POCITYF project, its main role is to make sure that the cultural heritage legislation is respected during the renovation of culturally protected buildings.

EKO Sklad - Eco Fund, Slovenian Environmental Public Fund (enabler)
Its main purpose is to promote development in the field of environmental protection by offering financial incentives such as soft loans and grants for different environmental investment projects.

Nepremičnine Celje (service provider)
A non-profit public company, established by MOC for the purpose of improving the accessibility of housing. The company manages approx. 10 % of flats in the municipality, provides non-profit rent housing, renovates and builds new residential capacities, and implements local housing policies.

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Elektro Celje d.d. (supplier, DSO)
Electricity supplier and operator of the regional distribution system on behalf of SODO d.o.o., the national DSO. The company supplies electricity to public and private buildings, companies etc.

SODO d.o.o. (DSO)
Slovenian national distribution system operator for electricity. Five regional distribution system operators perform the distribution services on its behalf. Indirectly connected to end users via the electricity suppliers.

ELES d.o.o. (TSO)
Slovenian transmission system operator for electricity. Indirectly connected to end users via DSOs and the electricity suppliers.

Energetika Celje d.o.o. (supplier, DSO, producer)
Supplier and operator of the regional distribution system for natural gas, producer and operator of the distribution system for district heating, also performs thermal processing of municipal waste. The company supplies natural gas and district heating to public and private buildings, companies etc.

Plinovodi d.o.o. (TSO)
Slovenian transmission system operator for natural gas. Indirectly connected to end users via DSOs and the natural gas suppliers.

Vodovod kanalizacija Celje (supplier, service provider)
The company provides drinking water, as well as the service of wastewater treatment and disposal for private and public end users. It also maintains the roads and public areas in municipal jurisdiction.

Simbio (service provider)
Public company, owned by four municipalities (majority owner is MOC), providing the services of municipal waste treatment and disposal, cleaning of public areas, and managing the regional center for waste management, which includes waste separation and recycling.

KSSENA (service provider)
Energy agency that provides different services in the field of energy management and development of local communities, with emphasis on energy efficiency, renewable energy, sustainable transport and GHG emission mitigation. Their services include energy modelling and monitoring, strategy and policy development, investment facilitation, etc.

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ENSVET – energy consulting office (service provider)
A network of independent energy experts that offer individual and independent energy consulting for citizens and performs informing, educational and awareness-raising activities.

Nomago CELEBUS (service provider)
Public transport provider in the Municipality of Celje. The bus fleet is powered by compressed natural gas. The company also manages the bike sharing service KolesCE.

ZPO Celje (service provider)
Public company for management of car parks and parking garages, public sport and tourist facilities (sports halls, stadiums, ice skating rink, swimming pools, adrenalin park, etc.).

Citizens (end users)
Citizens are the end users of most services, mentioned above, e.g. supply of energy (electricity, natural gas, district heating) and drinking water; municipal waste and waste water treatment and disposal; use of public areas such as parks, pedestrian areas, roads, car parks, sports facilities etc; use of public transport; management of residential buildings. Other, less obvious relations exist as well, e.g. protection of cultural heritage, overseen by ZVKDS, helps preserve local culture and tradition, thus reinforcing the local identity. The citizens also have their district level representatives, which help in the interaction with the municipality.

EV owners (end users)
A sub-group of citizens listed explicitly because they are the end users of the EV charging points in the Municipality of Celje, where charging is free for a limited time (2 hours).

All the listed stakeholders were invited to the workshop, organised by the work group of FC Celje, where they were introduced to the POCITYF project, its objectives and proposed innovative approaches to reach them. The innovative technologies and concepts, which are being considered for replication, were presented. Their suitability for implementation in Celje was discussed and assessed. After the final selection of the IEs is made, further discussions will be held with the stakeholders regarding the feasibility of their implementation. The workshop also attempted to strengthen the communication with the local stakeholders, especially the citizens of Celje.

A survey was conducted among the citizens of Celje, in which they were informed about the most suitable IEs for implementation in Celje. The survey also noted their interest and general awareness of climate change, reducing greenhouse gas emissions, energy

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efficiency and measures for energy self-supply of buildings and districts from renewable energy sources.

In order to determine the current use of electricity in the considered replication areas and to estimate future needs for electricity supply, data on electricity consumption for all households and companies in both replication areas were obtained from the regional DSO for electricity, Elektro Celje. To assess the current use of heating energy the data on energy sources for individual areas of PEDs was obtained from Energetika Celje, which is the supplier and operator of the regional distribution system for natural gas and producer and operator of the distribution system for district heating. The role of both players in the city is crucial in the planning the RES, so the development of the replication plan will require deepening cooperation with them.

For the establishment of an EV sharing system, discussions are already underway with an interested provider. The EV sharing contractor should provide vehicles and all support functions for the system operating needs, while the municipality of Celje would provide the required space and establish charging and other infrastructure.

3.4 Replication Tools utilization

Different tools have been used to obtain and improve the knowledge and experience, required for successful planning of replication activities. Some of them were developed specifically for these activities, or were adapted to this purpose. Some were developed or modified by the work group of FC Celje to suit better to the local needs. The utilisation of these tools (realised and planned) is described below.

3.4.1 Workshops

Several workshops have been organised in the scope of the project. In regard to FCs, most of them were organised within the work package, dedicated to the replication activities. They supported the development of a common approach of the FCs to replication, introduced the replication roadmap, provided guidance and support for the FCs. They facilitated regular and efficient communication with other FCs, LHCs, and horizontal partners in the project. A separate workshop was organised in the WP related to citizen engagement. It provided very useful guidance, support, suggestions, templates, etc. to enhance the two-way communication with the citizens. Another workshop addressed the legislative aspects and issues, related to the planned actions both in LHCs and FCs.

Workshops dedicated to knowledge exchange between LHCs and FCs, and to cooperation with other smart city projects, are described in sections 3.4.2 and 3.4.4, respectively. A workshop for the local stakeholders, organised by FC Celje, is described in section 3.3.

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Workshops are one of the most efficient tools for knowledge transfer and will be used throughout the remaining two years of the project. This holds for the workshops, organised within the consortium, as well as for local workshops in the FCs.

3.4.2 Knowledge Transfer from LHCs

Knowledge and experience, already gained in the LHCs, is probably the most valuable source of information for the FCs that are embarking on a similar journey. They are facing similar initial challenges, such as conception of the general approach to the energy transition, identification of the objectives and the associated problems, learning about new technologies and concepts to solve them, legal and technical obstacles, etc. Making use of the experience from the LHCs, the FCs do not have to go through the whole process from scratch. Instead they can learn from their mistakes and good practices. At the same time it is beneficial to have several FCs in the project because they are all in the same situation at the same time, addressing the same issues. They can support each other, share their experience, provide new ideas, etc.

Knowledge exchange between LHCs and FCs was largely supported by the dedicated workshops, organised separately with Evora and with Alkmaar, where the LHCs presented their progress with the implementation of the POCITYF technologies and concepts. Furthermore, representatives of LHCs are generally present at all project meetings, and share their experience with FCs in relation to the specific subject of the meeting.

3.4.3 Factsheets

Innovative elements (technologies, concepts, solutions) are at the heart of the demonstration and replication activities in LHCs and FCs. They have been developed and tested in collaboration between the individual LHC and its partners. Most of them are relatively new to the FCs. The FCs must get to know them before they can decide whether they are suitable for adoption in their ecosystem, and include them in the replication plan in the most rational way. In addition to the experience with the IEs from the LHCs, factsheets are an indispensable source of information. The factsheet of an individual IE contains the most relevant information about it – general description of the product/solution, intended use, essential technical information (e.g. dimensions, power …), estimated costs, etc. This not only provides information for the FCs, but is also handy for passing the knowledge to the relevant local stakeholders.

3.4.4 Synergies with other SCC EU projects

There are a number of ongoing EU smart city projects, each focusing on a different topic or aspect of smart cities, but with the common thread of aspiring towards smarter, more sustainable cities of the future. Thanks to this variety, the projects can complement each other by showing different perspectives on the common theme and helping each other to think outside the box. A few workshops were organised in cooperation with other smart city projects (SPARCS, ATELIER, MAKING-CITY, etc.) which provided additional insights from other cities and their partners.

3.4.5 Work groups

A well structured working team is essential for efficient management of large projects, especially if they require a wide range of knowledge and expertise. The whole project is divided in a number of sections and subsections, each of them assigned to the relevant work group. Such approach facilitates the distribution of assignments, control over their execution, quality control, risk management, etc. At the moment the replication activities in FC Celje are still in an early stage, and do not require such a complex team, as described in more detail in section 3.2. In the future, however, the work group should become larger and more structured, if the replication activities are to be carried out on a similar scale as in the LHCs.

3.4.6 ICT Tools

Various ICT tools are being used for the purposes of this project. A dedicated replication tool is being developed by consortium partners. It provides an interactive map of each FC. The cities will customise the map by including their specific planned innovative solutions to be replicated. The map can be shared with local stakeholders for a more descriptive presentation of the solutions. FC Celje plans to make use of this tool in the follow up of the project, when it is finalised. Additional functionalities of the replication tool are under development, e.g. an online forum area.

An existing citizen information platform in Celje, Servis 48 (www.servis48.si), is one of the channels for communication with citizens. It allows them to report any issues, and put forward their ideas and suggestions for improving the city. The replication activities will consider the possibilities for upgrading the platform with new functionality, looking for inspiration in related POCITYF IEs.

Social media (mainly the city's Facebook profile) is used to inform the citizens about current affairs and also to receive their feedback. It has been, and will be in the following years, used to keep the citizens updated on the POCITYF activities and receive some general feedback. Additional, more detailed feedback has been obtained using online polling tools for distribution of questionnaires, described in the following section.

The methodology for assessment of energy needs in a city district, developed for the needs of replication activities in Celje, makes use of several ICT tools as well. Google Maps is used to obtain a better overview of the replication areas – online inspection of the building stock and planning of field inspection. A public geographic information

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system (GIS) is used as well to obtain the IDs of individual buildings, their addresses (house numbers), number of residents, etc. Based on the building ID, additional information is obtained from the national database, managed by the Slovenian Surveying and Mapping Authority (GURS), e.g. height of the building (in meters and number of floors), usable area, number of residential units, etc.

The database of the Statistical Office of the Republic of Slovenia was utilised to improve the assessment of the benchmark status of Celje. Some of the smart city KPIs described in section 2.1 were obtained from this database.

3.4.7 Questionnaires

Two questionnaires regarding the IEs, introduced in POCITYF, were prepared by consortium partners in the initial phase of the project. One of them was for the citizens, presenting the most relevant IEs from each ETT, as selected by the work group of FC Celje. The questionnaire enquired about the citizens' interest and support for the chosen innovative solutions. Compared to the other FCs, Celje was very successful in obtaining the response from its citizens. A more elaborate version of the questionnaire, containing all IEs, was prepared for the remaining (more technical) local stakeholders, e.g. DSOs for electricity, natural gas and district heating, public transport operator, housing companies, company for waste treatment, etc. in order to receive their opinion about the innovative solutions, e.g. their suitability for the local ecosystem, envision problems, priorities, etc. Additional questionnaires will most likely be required in the following years, but they are not specified yet.

3.4.8 Methodology for assessment of energy needs in a city district

In order to estimate the annual energy use in the replication areas, a new methodology was developed by the work group of FC Celje. It focuses on the building stock and considers the energy required for the heating of buildings (in current state and after energy retrofitting), the energy for use and operation of buildings, preparation of domestic hot water, and public lighting. It does not include the energy, used for transportation.

The heating energy is estimated from the total heated area and the average energy use of typical residential and non-residential buildings. The heated areas of buildings are obtained from the database of the Slovenian Surveying and Mapping Authority (GURS) [28]. The typical energy use for the heating of residential buildings is determined based on their age and typology according to the study TABULA [29] (e.g. single-family house, block of flats, high-rise building). The age of the building is determined either from the year of completion or from the year of the energy retrofitting of the building envelope. A correction due to the energy retrofitting, not documented in GURS, is estimated from the field inspection of a representative sample of buildings. Non-residential buildings

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are divided in the same age groups as the residential ones. The typical heating energy needs of each group are estimated based on the information from the energy performance certificates of selected representative buildings.

The energy for preparation of domestic hot water (DHW) is evaluated based on the number of residents in the district and the expected annual use of hot water per person and its temperature according to the recommendations of the Passive House Planning Package (PHPP) [30] energy efficiency planning tool.

Data about the actual use of electricity in the district (for specified streets and house numbers) is obtained from the distribution system operator, separately for household customers, business customers, and public lighting. The values are determined as the average over the last three whole years. A correction due to the preparation of hot water is applied by estimating the share of households that prepare DHW with electricity (as opposed to natural gas, district heating, etc.)

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

3.5.1 The main KPIs

The success of the implementation of IEs in the context of smart cities is highly dependent on the Propagation KPIs as described in deliverable D2.2 [31], section 3.5.8. The replication of selected IEs in the FCs also depends on them, except that in this case only two KPIs, Social compatibility (P.1) and Technical compatibility (P.2), can be investigated and evaluated. They are presented and described in Table 8.

Table 8: The two most important Propagation KPIs for FCs.

Propagation KPIs	Description
P.1 Social compatibility	Indicator P.1 Social compatibility aims to show the extent to which an innovative solution is mentally and socially accepted in the Celje community. This is essential for the replication dimension, as community acceptance is one of the most critical requirements for implementing a specific solution in the city.
P.2 Technical compatibility	Indicator P.2 Technical compatibility represents the level of compliance of innovative solutions with all technical regulation requirements. Therefore, for selected innovative solutions for the city of Celje, it is necessary to check compliance not only with European but also with specific Slovenian regulations and standards.

The purpose of Social compatibility is to assess the status of the city context and to determine how the IE is consistent with this context. The assessment takes place mainly

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from a social, economic and environmental point of view. This KPI is therefore very much linked also to the mindset, tradition and habits of the citizens. Evaluation of Technical Compatibility refers to the level of compliance of IEs with all technical requirements. Therefore, for selected innovative solutions for the FC, it is necessary to check compliance with European and with specific national regulations and standards.

In the case of the city of Celje, the process of evaluation and selection of IEs according to both KPIs took place gradually, step by step, in accordance with the growing knowledge of solutions and based on experience from the demonstration LHCs Evora and Alkmaar. The process will continue in the further stages of the project (will be given in the last report), which will define more precisely all the boundary conditions and possibilities for the implementation of the IEs.

3.5.2 The preliminary identification of IEs

The first selection of IEs was determined based on the initial information about the solutions and according to the specific situation of city Celje. The IEs were assessed and categorized by two POCITYF partners, MOC and ZAG. The main evaluation criteria that were important for the decision to select specific IEs were:

- Maturity of technical solution,
- Consideration of the geographical situation and micro-location conditions,
- Predicted type of energy needs and energy sources,
- Roughly estimated potential for the implementation with regards to already existing solutions (such as compatibility with existing energy sources, distribution grids)
- The way the urban ecosystem functions,
- Product efficiency,
- Market availability,
- Expertise in terms of installation,
- Service and procurement options for spare parts,
- Management and service life.

Experience from previous analyses of individual larger public buildings, e.g. studies on cultural-historical buildings in the city center or educational buildings, were of great help.

Possible project solutions were **divided in three categories**, suitable, potentially suitable, and unsuitable for implementation in FC Celje. This gave provisional list that will definitely change with more detailed evaluation of technical information and of local requirements and limitations. The list will be further influenced by the analysis of legislation addressing the implementation of innovative solutions.

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3.5.3 Methods and processes to locally investigate and evaluate the IEs according to Social Compatibility Propagation (P.1)

With the aim to evaluate the scalability and replicability potential of the solutions in the city of Celje, the service providers, the city representatives and all other relevant stakeholders were involved in the activities. For this purpose, a **Citizen Engagement Plan** was prepared, which includes a general strategy and approach to stakeholders, identifies citizen engagement initiatives and target groups. First responses regarding social acceptance of the proposed IEs by the local community, were achieved through the online surveys of citizens and meetings with key stakeholders.

Structured workshops are planned for the next phase of the project in order to inform citizens in detail about possible solutions and goals, motivate them and actively involve them in the planning process. Our target groups are residents and users of buildings from the proposed PEDs and other important stakeholders such as energy operators, distributors, services…

Detailed information on the ways of involving stakeholders, as planned for implementation by the end of the project, is described in the Citizen Engagement Plan for Fellow City of Celje. The document also describes the social KPIs associated with the initiatives that will be used for metrics under POCITYF.

3.5.4 Methods and processes to locally investigate and evaluate the IEs according to Technical Compatibility Propagation (P.2)

As far as compliance of project IEs with legislation is concerned, a general approach to the review of legislative requirements was established. The review included Construction Act [17], Cultural Heritage Protection Act [16], Act on the Promotion of the Use of Renewable Energy Sources [21], Decree on self-supply of electricity from renewable energy sources [20], etc. In the continuation of the process, it will be necessary to thoroughly review the energy trading requirements, which limit in particular the integration of the technical innovations themselves and the business models associated with them. It is obvious that these conditions are now changing relatively quickly and that (to a certain extent) the market is already prepared for them.

Regarding compliance with standards, Slovenia applies the principle of comprehensive adoption of European standards. Therefore, all products manufactured according to European standards also comply with Slovenian standards.

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4 Building up the Replication Plan and City Vision 2050

4.1 Building up the Smart City Vision and Plan

Smart City vision and Replication plan requires a comprehensive approach that will connect and coherently address the field of energy, environmental protection, including climate, as well as economic and regional development in connection with spatial planning of the environment.

The vision of the Municipality of Celje is to offer a pleasant and stimulating living environment, to support development with an emphasis on innovation, and at the same time to preserve its historical and traditional characteristics and to ensure a healthy living environment.

For this purpose, numerous documents have been prepared in the municipality of Celje and at the state level, which deal with the planned development of the city, its priorities, and strategic goals.

The replication plan has been prepared in accordance with the Sustainable Energy and Climate Action Plan of Celje (SECAP) [3], Integrated National Energy and Climate Plan of the Republic of Slovenia (NECP) [32], the Energy Act [33] and other legal acts regulating the field of energy.

The Local Energy Concept [2] is the basic document for the local community regarding the strategy of supply, energy use, introduction of renewable energy sources and measures to reduce energy use and increase energy efficiency in the entire community. It specifies the following goals:

- reduction of energy consumption costs and maintenance costs of energy devices in public buildings and institutions such as schools, kindergartens, health centers, etc. and managing these costs;
- introduction of renewable energy sources in areas where this is sensible, technically feasible, geographically possible and economically justified;
- introduction of energy efficiency in public buildings, public companies and public institutions;
- promotion of energy efficiency in the private sector (industry and services);
- ensuring the highest possible level of sustainable transport and reducing the negative effects of transport on the environment;

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- introduction of district heating systems from renewable sources where possible;
- reducing the use of non-renewable resources to the lowest possible level;
- introduction of energy accounting, energy monitoring and management, including preventive energy maintenance of devices and systems for the provision and use of energy in public buildings, institutions and companies and institutions;
- reducing the final energy consumption of all consumers in the local community, including public lighting;
- promoting, educating and raising the awareness of public sector employees, citizens, pupils, students and others in the direction of efficient energy use, energy efficiency and renewable energy sources;
- Involvement of all stakeholders in the local community in joint efforts to increase energy efficiency and the use of renewable energy sources;
- meeting the objectives set out in the adopted action plans and the Long-Term Strategy for Encouraging Energy Renovation Investments in Buildings [34];
- compliance with the objectives of the operational programs for the protection of ambient air against PM10 pollution (OP PM10) [35] and the reduction of greenhouse gas emissions (OP GHG) [36];
- fulfilment of international commitments from the EU Directives in the field of efficient energy use and renewable energy sources.

In the initial phase of the POCITYF project, a preliminary city vision and master plan was conceived. It comprised a basic description of the envisioned replication areas, as well as their needs, opportunities, and objectives associated with each individual ETT. A provisional list of the specific IEs to be replicated was included as well. Towards the middle of the project, these documents were revised and updated in accordance with the newly obtained knowledge, and a long term city vision was added. The content of the revised documents served as the basis for the creation of the replication plan, presented in this deliverable.

A year into the project, a dedicated work package introduced a more structured approach to the replication activities of the FCs. Horizontal partners of the project developed a general replication strategy and a roadmap for preparation of replication plans. The process was additionally supported by the development of different replication tools, organised training and knowledge transfer, etc. A common structure was defined for the deliverables, presenting the replication plans, but each FC could tailor it according to its specific needs. Constant and active guidance and support were provided by the WP leader in the development of this deliverable.

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In the final two years of the project, after the submission of this deliverable, the replication plan will be constantly upgraded and finally submitted as a new deliverable at the end of the project.

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

Evaluation of the innovative technologies regarding their suitability for the replication in FC Celje was performed based on different criteria. One of the most important factors for is the suitability of a certain technology for the local climate, geographical, geological conditions etc. Due to the predominantly hilly terrain in Slovenia, wind is generally not constant and of even strength. Instead, it is often too weak or too strong for the wind turbines to operate efficiently, or at all. So the wind turbines most likely cannot offer a sufficient and reliable source of power. Solar power, on the other hand, is quite appropriate for the local climate. PV panels and solar thermal collectors are already well known and are becoming more and more popular, especially with the rising prices of energy. Exploitation of the shallow geothermal energy is also relatively common. It is mainly used for heating and cooling of buildings with heat pumps. The suitability of a specific technology can be evaluated by estimating the expected yearly energy production and the period of return on investment.

The technology, selected for replication, must also be compatible with the existing infrastructure in the city. For example, a large part of the city is heated by natural gas or by district heating. These two distribution systems will remain in use at least for a certain transition period, even if they might be replaced in the future. Therefore, the new technology must be able to connect to the existing systems. Another thing to be observed is the capacity of the existing distribution networks. Problems are already arising in Slovenia because of an increasing number of new small solar powerplants providing power to the grid which was not designed for this purpose. As a result, the electricity transport in the grid is reaching the technical limits in some areas and additional local powerplants cannot be connected. In such case the powerplant can only be used for self-consumption, which can severely affect the business case. A related issue could be the distance of an envisioned location for a community solar farm from the buildings where the energy would be used.

Priority is given to the innovative solutions that are relatively simple for installation or implementation, i.e. they do not require excessive adaptations of the existing situation, complicated or time consuming procedures, etc. This usually goes hand in hand with lower costs of the initial investment. More complex and more expensive solutions

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require more careful planning, and are adopted at a slower pace. However, they might be more efficient in the long run.

Another point to consider is the presence of a similar, related technology in the local market. If the innovative solution is too exotic, it might be difficult to find an appropriate service provider with all the required knowledge and equipment for a successful and quality installation, management, maintenance, etc. This also affects the financial aspect of the implementation. A service provider that is already familiarised with the technology can offer a better price than a provider that has to learn it first, acquire new equipment, etc. The presence of a certain technology on the market can be relevant in another way. For example, reusing the used-up EV batteries for household storage of electricity is not very relevant in Slovenia at the moment, because the EVs are still relatively new. They are not on the market long enough and in large enough numbers to create a significant number of used-up batteries.

4.2.2 List of POCITYF IEs selected to be replicated

At the current stage of the POCITYF project and the replication activities in FC Celje, the selection of the suitable technologies is still provisional. They have been selected to the best of our knowledge using the available information. For the time being, the list of the solutions to be replicated is the same as described in the section 2.3. See Table 9, Table 10, Table 11, and Table 12 for IEs associated with transition tracks ETT#1, ETT#2, ETT#3, and ETT#4, respectively. In the remaining two years of the project, when more information and experience about the solutions becomes available, they will be studied more thoroughly. The list is expected to shorten, focusing on the most favourable solutions.

Table 9: Preliminary selection of innovative elements from ETT#1 for replication in FC Celje

ETT#1: Innovative Solutions for Positive Energy (CH) Buildings and Districts	
Selected Innovative Elements (IEs)	
IS-1.1: Positive Energy (stand-alone) Buildings	
IE 1.1.1	PV glass
IE 1.1.2	PV canopy
IE 1.1.3	PV skylight
IE 1.1.4	Tegosolar PV
IE 1.1.5	Traditional PV shingle
IE 1.1.6	Bidirectional smart inverters
IE 1.1.7	Energy router
IE 1.1.8	BMS (Building Management System)

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IE 1.1.9	2nd life residential batteries
IE 1.1.12	Insulation with circular materials
IE 1.1.13	Triple glazing
IE 1.1.14	Solar roofs and facades
IE 1.1.17	Li-ion batteries
IE 1.1.18	Cascaded heat pumps
IS-1.2: Positive Energy Districts Retrofitting	
IE 1.2.1	Smart lamp posts with EV charging and 5G functionalities
IE 1.2.2	Energy Routers
IE 1.2.4	P2P energy trading platform
IE 1.2.5	Community Solar Farm
IE 1.2.6	DHC (District Heating and Cooling, biomass, waste, geothermal)
IE 1.2.8	Li-ion / Li-metal batteries
IE 1.2.9	DC lighting with EV charging
IS-1.3: Feeding of PEDs with Waste Streams (heat/materials) promoting Symbiosis and Circular Economy	
IE 1.3.1	2nd life residential batteries
IE 1.3.2	Pay-as-you-throw (PAYT)
IE 1.3.4	Circular economy building practices
IE 1.3.7	Waste management tools

Table 10: Preliminary selection of innovative elements from ETT#2 for replication in FC Celje

ETT#2: P2P Energy Management and Storage Solutions for Grid Flexibility	
Selected Innovative Elements (IEs)	
IS-2.1: Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions	
IE 2.1.1	2nd Life Batteries
IE 2.1.5	P2P energy trading platform
IE 2.1.6	City Energy Management System
IE 2.1.8	Stationary Batteries
IS-2.2: Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions	
IE 2.2.3	Low temperature heat grid
IE 2.2.5	Low temperature waste heat

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Table 11: Preliminary selection of innovative elements from ETT#3 for replication in FC Celje

ETT#3: e-mobility Integration into Smart Grid and City Planning	
Selected Innovative Elements (IEs)	
IS-3.1: Smart V2G EVs Charging	
IE 3.1.1	EV charging management platform
IE 3.1.2	EV charger prototype with PV integration
IE 3.1.5	Smart lampposts with EV charging and 5G functionalities
IE 3.1.6	Intelligent and optimal control algorithms
IE 3.1.7	Smart solar charging
IS-3.2: E-mobility Services for Citizens and Auxiliary EV technologies	
IE 3.2.1	EV sharing

Table 12: Preliminary selection of innovative elements from ETT#4 for replication in FC Celje

ETT#4: Citizen-Driven Innovation in Co-creating Smart City Solutions	
Selected Innovative Elements (IEs)	
IS-4.1: Social Innovation Mechanisms towards Citizen Engagement	
IE 4.1.3	Tourist apps
IE 4.1.4	Cultural experiences market (mobile app)
IE 4.1.5	Mobile apps on energy consumption
IS-4.2: Open Innovation for Policy Makers and Managers	
FC Celje has not selected any solutions from IS-4.2.	
IS-4.3: Interoperable, Modular and Interconnected City Ecosystem	
IE 4.3.1	City Urban Platform
IE 4.3.2	Wi-fi data acquisition systems
IE 4.3.3	Data lake intelligence for positive communities

4.3 Designing the replication of IEs

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

At the moment, the replication planning in FC Celje is still in a conceptual phase. The innovative solutions have been evaluated on the basic level and general ideas have been formed about which of them are considered appropriate for replication. Initially, more focus was given to the more familiar technologies whose application is easier to envision. This refers particularly to the innovative elements from the integrated solution

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IS-1.1 that are applied mostly to individual buildings. For these IEs, a list of proposed locations for their implementation has been composed. They are described in the following paragraphs. A visual representation of the considered locations for installation of PV canopies (Figure 10, Figure 11) was prepared with the help of the Replication Tool, developed by consortium partners. Implementation of other IEs has been considered more generally, on the level of the whole replication areas.

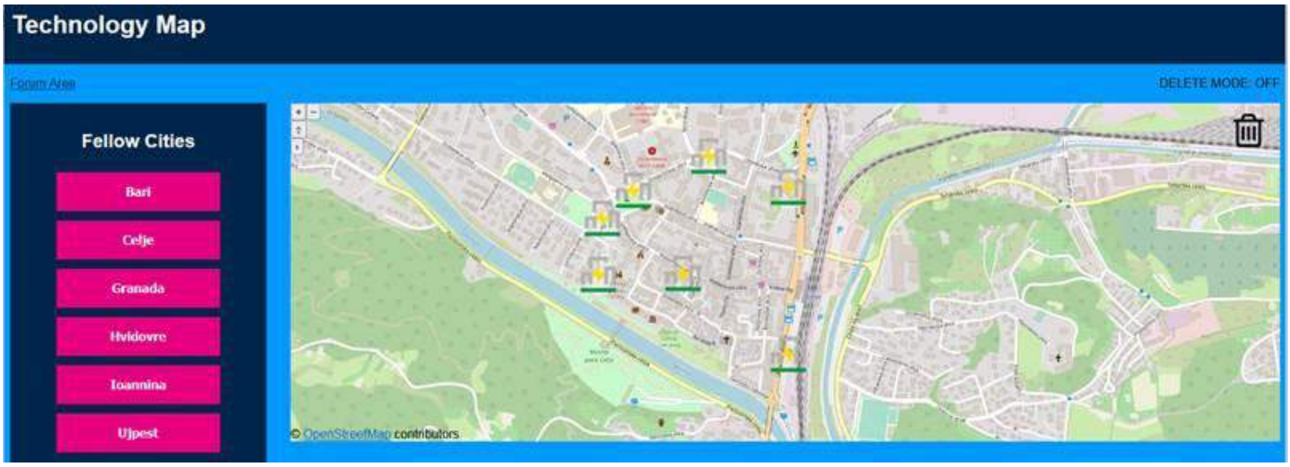

Figure 10: Map of considered locations for installation of PV canopies in PED 1 “Old City”, prepared with the Replication Tool, developed by consortium partners

As already mentioned in section 4.2.1, PV solutions will be an important part of the replication activities in Celje. PV canopies, which combine the functions of shelter (for cars in parking lots or for people in pedestrian areas) and power production, are a versatile and relatively simple solution. Several parking lots have been identified as candidates for installation of PV canopies. In PED 1 (Old City) two of them are at the Museum of recent history and in front of the Theatre house; a large parking lot in the eastern end of the PED between the street Ulica XIV divizije and the railroad; two more in the western end of the PED, behind Knežji dvor and by the Jurčičeva street; in the northern part of the PED there are two parking lots, one near the Celeiapark parking garage and the other near Gimnazija Celje Center highschool; another one is located near the MOC building at the square Trg celjskih knezov (Figure 10). In PED 2 (Glazija and Otok) the following parking lots were selected as candidates for installation of PV canopies: parking lot by the swimming pool and hotel Faraon; parking lots by the elementary school II OŠ Celje, by the high school centre Celje, and by the I Gimanzija Celje high school; two parking lots at streets Oblakova ulica nad Vrunčeva ulica; and finally a parking lot by the Lidl store (Figure 11).

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Figure 11: Map of considered locations for installation of PV canopies in PED2 “Glazija and Otok”, prepared with the Replication Tool, developed by consortium partners

Solar roofs are also a very interesting solution. The PV panels are mainly planned to be installed on the horizontal roofs of buildings in both PEDs. In PED 1 they could be installed on the modern annexes to the historical buildings of Celjski dom and the Museum of recent history, as well as on the roof of the city marketplace. In PED 2 there are many possibilities for solar roofs: the elementary school II OŠ Celje, the high school centre Celje; the high-rise buildings in the Lava area (between the streets Čopova, Ljubljanska and Trubarjeva), at the street Na otoku, at Trubarjeva ulica 53, and at the streets Na zelenici, Čopova ulica, Kajuhova ulica and Jurčičeva ulica; the student home at Ljubljanska cesta 21; the shopping centre Glazija; the faculty and office building at Mariborska cesta 7.

Traditional PV shingles, designed to replicate the appearance of traditional roofing, is of great interest as well because the cultural heritage protection requires preservation of the traditional appearance of buildings. The shingles, developed in POCITYF for the application in Evora are not suitable for application in Celje because of their curved shape. They would only be applicable in the coastal region of Slovenia. However, a flat version of the traditional shingle with integrated PV cells could be used in Celje as well. In PED 1, they could be installed on the historical buildings of Celjski dom and the Museum of recent history, Narodni dom, and the Celje theatre house. In PED 2 the high schools Gimnazija center and I. Gimnazija and the kindergartens Luna and Sonce are considered appropriate, as well as the Celje Youth Centre (CMLC).

PV skylights, covering internal courts of historical buildings, are also an appealing solution because they create a new (indoor) area and improve its versatility. However, they are not as easily implemented as some of the above IEs. For the time being, only one suitable location was identified. It is the court of the Narodni dom building which is already covered with a regular skylight, but could be replaced/upgraded with a PV

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version. This does not seem very likely because the current skylight serves its purpose well and does not yet require replacement.

Circular insulation materials and triple glazing are generally appropriate for wider application, but have to be used in line with the requirements of cultural heritage protection. In PED 1 this means that they can mainly be applied on the walls facing the internal courts, not the facades facing the street.

Public lighting is already planned to be renovated, principally to reduce the use of energy. Smart lamp posts could offer additional functionality, such as the automatically adaptable brightness, wi-fi in the city centre, charging points for EVs, 5G functionalities, etc. Specific locations for their installation have not been defined at the moment, but they are definitely an attractive and easily applicable solution. It is planned to be implemented in both PEDs, perhaps with different additional functionalities to serve specific needs, such as wi-fi coverage in the city centre.

A community solar farm is also under consideration. It could provide renewable energy for the old city centre. However, an appropriate location has not been found yet. Similarly, the possibilities for a P2P trading platform are being investigated. Some of its functionalities are already commercially available from certain electricity providers, but this has to be researched more.

EV sharing system has been considered in the past in Celje, but was discarded as non-viable due to the small distances in the city, insufficient infrastructure, and low acceptance of the concept by the targeted users. However, it has become more interesting again in recent period, so negotiations are already in course with potential service providers to establish EV sharing in the city. In relation to this service and to the growing number of privately owned EVs, the municipality plans to enlarge and upgrade the existing EV charging network. It could be connected directly to the newly installed PV powerplants on the canopies and on the roofs of buildings. The solutions will be applied in both PEDs.

Building management systems will be first implemented in the buildings, owned by the municipality, along with other innovative solutions. As described in section 2.2, the selected buildings are: Celjski dom palace, the Museum of recent history, the SLG Celje theatre building, and the building of Narodni dom in PED 1; kindergartens Luna and Sonce, the faculty and office building at Mariborska ulica 7, and Celje youth centre (CMLC) in PED 2. Application of the BMS in privately owned buildings will be promoted among citizens and other stakeholders.

Energy management on the city level is also an important goal, but the solution is still in conception. More information about the city energy management platform, implemented in the LHCs, is awaited to support the process.

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Supporting technologies, such as bidirectional inverters, energy routers, batteries, charging control algorithms, etc. will have to be installed on different locations to facilitate the application of primary technologies, e.g. the solutions for production of energy from RES.

4.3.2 Social acceptance considerations

The general reaction of citizens to the project can be assessed as positive. In general, people are quite familiar with some well-known solutions that are also used in Slovenia: for example triple glazing is used as standard, great emphasis is placed on thermal insulation of the building envelope, PV panels are installed by individuals on their houses. Quite a few of these measures are subsidized by the state (regular tenders), so they are on the rise. The current energy crisis and the ever-increasing prices of energy products are also the drivers. On the other hand, there is energy poverty in a certain segment of the population, which is why many cannot afford the implementation of technologies.

However, in general, awareness of energy saving and the use of renewable resources is growing - this content is already discussed in primary schools, and the understanding of environmental issues among people is increasingly accepted. Additional stimulation on the level of integrated solution of energy challenges in the wider urban community and systemic comprehensive addressing to achieve smart city goals will be possible through the activities of the POCITYF project.

The citizens of Celje are also aware of the importance of their tourism activity, so they welcome POCITYF ICT solutions that enable improvements to their work in this area, easier communication and direct assistance for tourists.

4.4 Financial estimation and resources allocation of the Replication Plan

Proper financial assessment of the replication activities is not possible at this stage of the planning process, because the solutions are still taking form. Some elements can be evaluated, however. In the following sections, a rough assessment is shown on the examples of two parking lots, where PV canopies will be installed. It includes surface of PV canopies, installed power, estimation of the costs of installation, and the expected annually production of energy.

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

An analysis of IEs and the technological and legal situation in PED 1 showed that the options for selecting between a set of POCITYF IEs are very limited. The existing densely

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built-up urban context and culturally protected buildings allow construction interventions on street facades and on roofs to a very limited extent. At the same time, these are mostly very old and high energy-consumption buildings. Therefore, the production of electricity with integrated PV on canopies at the location of a nearby parking lot is a good solution for the parking lot's own needs in combination with the supply for a certain amount of the building stock from PED 1. Technically, the solution is known in the Slovenian environment, but it is not widely used. Typically, the energy obtained in this way is used specifically for one owner. The combined solution as mentioned above is not yet in use in the city of Celje. The economic aspect of such a combination for the Slovenian market still needs to be investigated together with the grid operator, but the current price situation is very dynamic. The solution as such will not reduce the use of electricity, while the impact on the price may only be seen in the long term. For this IEs the mixture of private and public funding is not supported. State co-financing is provided only for the installation of self-sufficient micro solar power plants.

The remainder of this section shows a rough analysis of a few specific IEs from the financial perspective. Since the replication activities are still in an initial phase, this information is only provided for the IEs, for which the planning is already in progress because they are familiar and relatively easy to implement, namely PV canopies over two larger public parking lots and PV panels on the roofs of buildings in replication area PED2. For each of these IEs, the total installed electric power, the expected yearly production of electricity, and approximate installation costs are estimated based on the total surface, on which the PV panels are installed.

In the remaining two years of the POCITYF project, as additional information is obtained about other innovative solutions from the producers/suppliers and from the LHCs, the business cases will be elaborated in more detail, and for additional IEs. The level of detail will be suited to each individual solution based on the likelihood and ease of its implementation.

PV CANOPIES

PV canopies would be installed above the larger parking lots, shown in Figure 12 and Figure 13, which are intended for longer-term parking on the outskirts of the replication area “Old City”. The energy thus produced would cover the energy needs for EV charging and supply the building stock from PED 1. The estimated technical characteristics and preliminary financial estimation of the investment are collected in Table 13.

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Table 13: Preliminary technical and financial assessment of installation of PV canopies on two parking lots in replication area PED 1 “Old City”

Parking lot	Main technical characteristics
Spodnji grad	- Surface: 2.000 m2 - Installed electric power: 285 kW - Annually production of energy: 313.500kWh - Estimation of the costs: 600.000EUR
Railway station	- Surface: 3.000 m^2 - Installed electric power: 430 kW - Annually production of energy: 473.000kWh - Estimation of the costs: 900.000EUR

Figure 12: Parking lot “Spodnji grad” in replication area PED 1 “Old City” – a site considered for installation of PV canopies

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Figure 13: Parking lot "Railway Station" in replication area PED 1 "Old City" – a site considered for installation of PV canopies

PV PANELS ON ROOFS IN PED 2

It is estimated that 15,000 m2 of roof area on multi-apartment buildings, and 12,000 m2 on individual houses, are suitable for the installation of PV panels in PED 2. Their

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installation could provide 3.8 MW of power and produce 4,180 MWh of electricity annually. The total cost of the installation is estimated at EUR 4,750,000.

EV SHARING

The establishment of the EV sharing system is envisaged in cooperation with the provider of this type of service. The municipality will enable the use of parking lots and the installation of charging equipment, while the provider will provide the vehicles and comprehensively take care of the operation of the system. The municipality does not anticipate additional financial resources for the implementation.

4.4.2 Exploitation of resources deriving from ongoing and already planned projects

In addition to the MOC's own funds, foreign funds are also provided for ongoing and already planned projects. In most cases, additional funds are provided by national or EU institutions. For this purpose, the "Local Energy Concept" [2] for the field of energy and the "Comprehensive Transport Strategy" [37] for the field of transport and mobility were developed. Additional funds allow MOC to carry out more projects than it could, if limited to its own funds. The receipt of additional financial resources for already planned projects from the areas of efficient energy use, utilization of renewable energy sources and sustainable mobility is planned through the envisaged tenders of the Ministry of Infrastructure, which includes tenders from the EU Cohesion Policy and REPowerEU Plan.

4.4.3 Holistic cross-ETT-sectional feasibility study

The use of canopies with integrated PV in the parking lot is a technical solution from ETT1 for the direct acquisition of electricity that is transmitted to the grid. The same amount of electricity is then used from the grid to cover the needs of the parking lot and e-mobility: e.g. parking lot lighting, ramp management, operation of automatic cash registers, e-charging stations (connection to ETT3). Part of the electricity is also intended for buildings in the nearby city center, where the integration of technological solutions is not possible for objective reasons (link to ETT1). For electricity management various ETT2 technological solutions are deployed (routers, management platforms, etc.). Furthermore, IEs from ETT4 allow users to monitor the occupancy of parking lot, e-charging stations, etc. via apps.

4.5 Long-term planning towards a Smart City Vision 2050

With the implementation of individual energy concepts, Celje took its first steps in the transition to a smart city several years ago. However, the greatest contribution in the process of transition to a smart city will be the preparation of the Replication plan

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within the framework of the POCITYF project, as it will comprehensively address key aspects that will support the requirements of Smart City Vision 2050.

The activities envisaged in the replication plan (RP) coincide with the vision of the city's development and also correspond to the vision and climate goals of Slovenia until 2050. Slovenia's goal, which is consistent with the Paris Agreement, is to achieve net zero emissions by 2050, or achieve climate neutrality. By 2050, Slovenia will reduce GHG emissions by 80-90% compared to 2005, while at the same time speeding up the implementation of climate change adaptation policies and ensuring the climate security of the population [38].

The first and key measure is the improvement of energy efficiency in all sectors and therefore the reduction of the use of energy and other natural resources. However, the goal for building sector is to reduce the use of final energy by 20% by 2030 compared to 2005 and to ensure a reduction of GHG emissions by at least 70% by 2030 compared to 2005. In addition, the goal is to achieve at least a 27% share of RES by 2030 [32].

The replication plan designed as part of the POCITYF project will be fully or partially included in the strategic documents of the sustainable development of the city of Celje. Individual conceptual solutions of the replication plan, or concrete measures, within the framework of the planned activities in the municipality, will start to be implemented already during the POCITYF project. After the completion of the project the partnership (MOC and ZAG) will constantly look for opportunities for financial support, either for a new research and demonstration project in which the concepts would be realized (demonstration), or from state support mechanisms. Also, the development of innovative technologies will be continuously checked, and the selected concepts will be corrected and upgraded accordingly. Special attention will be paid to innovations in the area of solutions for the citizen engagement.

In addition to fulfilling the goals from the vision, Celje also wants to become a role model for other cities in the region, demonstrating a successful transformation into a city of the future. So after the project is finished, the city plans to expand the replication plan to other urban areas. Therefore, for the considered concrete PEDs in the RP, the innovative solutions are selected that are in the context of the city and are appropriate for the given boundary conditions of the operation of the entire city. In addition, both analysed PEDs are representative for related districts in the city of Celje itself and also for other Slovenian cities. The enlargement of the concepts to other parts of the city should therefore not pose major obstacles, especially since the knowledge will already be adopted.

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5 Conclusions

Celje is a Slovenian city that participates as a fellow city (FC) in the POCITYF project. The city wishes to create new opportunities for effective development in business, educational, cultural and touristic sphere while taking into account environmental, energy and social concerns. This will be achieved by introducing new concepts and innovative solutions, investigated and demonstrated in the lighthouse cities (LHCs). The main objective of Celje in this project is therefore to prepare a Replication Plan (RP) that will support the city in its transition to a more sustainable, smart and people-friendly city in line with the City-Vision for 2050.

Deliverable D8.9 is the first version of the RP, produced approximately half-way through the project. At this stage, the innovative solutions are still being developed and tested in the LHCs, but useful information and experience is already arriving to FCs. With the support of horizontal consortium partners, who developed a general replication framework and roadmap, the partners of FC Celje began with the analyses, procedures and activities presented in this document.

The replication process should make the most of the previous activities and strategic documents of the municipality, e.g. Sustainable Energy and Climate Action Plan [3], Local Energy Concept [2], etc. These constitute the foundation, upon which the RP is built. The city of Celje has already begun the green transition. Participation in POCITYF will support further development of already initiated activities and broaden their range by providing specific knowledge, ideas, and good practices from the LHCs.

The research for the RP so far has shown that many innovative solutions from the LHCs could be integrated into the selected replication areas in Celje. Preferring reliable and efficient project solutions, the city will initially focus on more familiar and well tested solutions, which are also easier to implement. The selection is certainly connected with additional factors, e.g. compatibility with the existing infrastructure, presence of the technology on the local market, associated with the level of expert knowledge of the installers and availability of servicing and maintenance, etc.

It was also established that legislation could pose a considerable barrier for implementation of innovative solutions. Legislation is often rigid and strict and does not allow the use of all available options. Apart from that, the procedures for changes in legislation are lengthy. On the other hand, the current situation in the energy market indicates a necessity, perhaps even urgency, for significant legislatory changes in favor of efficient energy solutions, energy independence, the use of a larger share of RES, and more proactive and advanced management of energy flows.

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Another important observation of the research so far is the great importance of social engagement. Introduction of innovative solutions can only be successful if they are generally accepted and adopted, which requires participation of all local stakeholders, including the citizens. Slovenian society is very traditional and the adoption of new solutions and technologies is relatively slow. Therefore, it is important to involve all stakeholders early and intensively, down to the citizens as end users, who can even become a driving force of the transition if they recognize its necessity and benefits.

One of the key findings of the replication plan development process is also that it is necessary to support the planned replication activities with appropriate financial solutions and new business models, which will be of interest to the relevant stakeholders. Innovative business models are explored in the scope of the project, and will be applied and tested in the LHCs, providing valuable information for the FCs.

Obtaining information for the development of a methodology for estimating energy needs in both PEDs has initiated a more intensive relationship with service organizations (e.g. DSO...) and it is expected that this will give a clearer insight into the possibilities of planning changes that will also include their interest.

When planning future activities for the transformation of Celje into a smart city, the main focus will be on deeper involvement of all stakeholders in the process, obtaining missing data for planning and concretizing the replication plan.

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6 References

[1] "Köppen-Geiger classification system," [Online]. Available: https://www.weatherbase.com/weather/weather-summary.php3?s=145041&cityname=Celje%2C+Celje%2C+Slovenia.

[2] "Lokalni energetski koncept Mestne občine Celje za obdobje 2019-2028 (Local Energy Concept of Municipality of Ce for the period 2019-2028)," 2019. [Online]. Available: https://moc.celje.si/images/Datoteke/Okolje/Lek/LEK-MOC 2019.pdf.

[3] "Trajnostni energetski akcijski načrt Mestne občine Celje (Sustainable Energy Action Plan of the Municipality of Cel SEAP)," 2015. [Online]. Available: https://mycovenant.eumayors.eu/docs/seap/20002_1438252911.pdf.

[4] "Trajnostna urbana strategija Mestne občine Celje za obdobje 2015-2030 (Sustainable Urban Development Strategy the Municipality of Celje for the period 2015-2030)," 2015. [Online]. Available: https://moc.celje.si/images/Datoteke/Novice_in_obvestila/TUS_2017/TUS_MOC.docx.

[5] "Statistični urad republike slovenije (Statistical Office of the Republic of Slovenia)," [Online]. Available: www.stat.s

[6] "Agencija republike Slovenije za Okolje (Slovenian Environment Agency)," [Online]. Available: www.arso.gov.si.

[7] "Mestna občina Celje (Municipality of Celje)," [Online]. Available: https://moc.celje.si.

[8] "Ministrstvo za infrastrukturo republike Slovenije (Ministry of Infrastructure of the Republic of Slovenia)," [Online]. Available: www.gov.si/en/state-authorities/ministries/ministry-of-infrastructure.

[9] "Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources," [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001.

[10] "LEED rating system," [Online]. Available: https://www.usgbc.org/leed.

[11] "BREEAM certification system," [Online]. Available: https://bregroup.com/products/breeam/.

[12] "DGNB certification system," [Online]. Available: https://www.dgnb.de/en/council/certification/.

[13] "Odprti podatki Slovenije - OPSI (The National Open Data Portal of Slovenia)," Ministrstvo za javno upravo Republike Slovenije, [Online]. Available: https://podatki.gov.si/.

[14] "Regulation (EU) 2016/679 on the protection of natural persons with regard to the processing of personal data and the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)," [Online] Available: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679&from=SL.

[15] "Zakon o varstvu osebnih podatkov (Uradni list RS, št. 94/07 – uradno prečiščeno besedilo in 177/20) - Personal Dat Protection Act," [Online]. Available: http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO3906.

[16] "Zakon o varstvu kulturne dediščine (Uradni list RS, št. 16/08, 123/08, 8/11 – ORZVKD39, 90/12, 111/13, 32/16 in 21/18 – ZNOrg) - Cultural Heritage Protection Act," [Online]. Available: http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO4144.

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

POCITYF

[17] "Gradbeni zakon (Uradni list RS, št. 199/21 in 105/22 – ZZNŠPP) - Building Act," [Online]. Available: http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO8244.

[18] "Pravilnik o učinkoviti rabi energije v stavbah (Uradni list RS, št. 70/22) - Rules on efficient use of energy in buildin [Online]. Available: http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV14331.

[19] "Ministrstvo za okolje in prostor Republike Slovenije: Tehnična smernica za graditev TSG-1-004: Učinkovita raba energije," 2022. [Online]. Available: https://www.gov.si/assets/ministrstva/MOP/Dokumenti/Graditev/TSG-1-004_2022_ure.pdf.

[20] "Uredba o samooskrbi z električno energijo iz obnovljivih virov energije (Uradni list RS, št. 17/19, 197/20 in 121/21 ZSROVE) - Decree on the self-supply of electricity from renewable energy sources," [Online]. Available: http://www.pisrs.si/Pis.web/pregledPredpisa?id=URED7867.

[21] "Zakon o spodbujanju rabe obnovljivih virov energije (Uradni list RS, št. 121/21 in 189/21) - Act on the Promotion c the Use of Renewable Energy Sources," [Online]. Available: http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO8236.

[22] "Zakon o varstvu okolja (Uradni list RS, št. 44/22) - Environmental Protection Act," [Online]. Available: http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO8286.

[23] "Zakon o ohranjanju narave (Uradni list RS, št. 96/04 – uradno prečiščeno besedilo, 61/06 – ZDru-1, 8/10 – ZSKZ-B, 46/14, 21/18 – ZNOrg, 31/18, 82/20, 3/22 – ZDeb in 105/22 – ZZNŠPP) - Nature Conservation Act," [Online]. Availab http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO1600.

[24] "Zakon o vodah (Uradni list RS, št. 67/02, 2/04 – ZZdrI-A, 41/04 – ZVO-1, 57/08, 57/12, 100/13, 40/14, 56/15 in 65 - Water Act," [Online]. Available: http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO1244.

[25] "Zakon o rudarstvu (Uradni list RS, št. 14/14 – uradno prečiščeno besedilo, 61/17 – GZ in 54/22) - Mining Act," [Onli Available: http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO5706.

[26] *POCITYF 864400 D1.13 Holistic Smart City Vision and Master Planning for Demonstration and Replication.* [Film]. 2

[27] "POCITYF 864400 D1.1 End-User and Stakeholders Requirements Definition," 2020.

[28] "Portal prostor, Geodetska uprava Republike Slovenije (Slovenian Surveying and Mapping Authority)," [Online]. Available: https://www.e-prostor.gov.si/.

[29] *Gradbeni ištitut ZRMK, Evropski projekti, TABULA,* https://episcope.eu/fileadmin/tabula/public/docs/brochure_until2012/SI_TABULA_TypologyBrochure_ZRMK_2012.

[30] "Passive House Planning Package," [Online]. Available: https://passivehouse.com/04_phpp/04_phpp.htm.

[31] "POCITYF 864400 D2.2 Test and Evaluation Plans," 2020.

[32] "Integrated National Energy and Climate Plan of the Republic of Slovenia," [Online]. Available: https://ec.europa.eu/energy/sites/ener/files/documents/si_final_necp_main_en.pdf.

[33] "Energetski zakon (Uradni list RS, št. 60/19 – uradno prečiščeno besedilo, 65/20, 158/20 – ZURE, 121/21 – ZSROVE, 172/21 – ZOEE, 204/21 – ZOP in 44/22 – ZOTDS) - Energy Act," [Online]. Available:

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

http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO6665.

[34] "Long-term energy renovation strategy for 2050," [Online]. Available: https://energy.ec.europa.eu/system/files/20
08/sl_ltrs_2020_en_0.pdf.

[35] "Operativni program varstva zunanjega zraka pred onesnaževanjem s PM10 (OPPM10) - Operational Programme for
Protection of Ambient Air Against PM10 Pollution," [Online]. Available:
https://www.gov.si/assets/ministrstva/MOP/Dokumenti/Zrak/zrak-emisije/operativni_program_pm10.pdf.

[36] "Operativni program ukrepov zmanjšanja emisij toplogrednih plinov do leta 2020 - Operational Program for the
Reduction of Greenhouse Gas Emissions by 2020," [Online]. Available:
https://www.gov.si/assets/ministrstva/MOP/Dokumenti/Podnebne-spremembe/optgp2020.pdf.

[37] "Celostna prometna strategija Mestne občine Celje - Comprehensive Transport Strategy of the Municipality of Celje
[Online]. Available: https://moc.celje.si/images/Projekti_v_teku/CPS/publikacija-CPS-CE-low-res.pdf.

[38] "Resolucija o Dolgoročni podnebni strategiji Slovenije do leta 2050 (Uradni list RS, št. 119/21 in 44/22 – ZVO-2) -
Resolution on the Slovenian climate long-term strategy 2050," [Online]. Available:
http://www.pisrs.si/Pis.web/pregledPredpisa?id=RESO131.

This project has received funding from the European Union's Horizon 2020 research
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