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D8.11 Újpest Replication Plans and City-Vision for 2050

WP8: Replication Plans and 2050 Vision by Fellow Cities

T8.6: Újpest Replication Plans and City-Vision for 2050

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Technical references

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* PU = Public

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

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

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v2	22.06.2022	ÚJP, ÉMI	update based on V4 template	
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Disclaimer

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Executive Summary

POCITYF is a European Union founded Horizon 2020 project with the aim to create and support Smart Cities. 8 European cities are taking part in the project since its launch in October 2019. Two of them are lighthouse cities, Évora in Portugal and Alkmaar in the Netherlands where innovative solutions will be implemented by the end of the project in order to create positive energy districts (PEDs) while respecting the cultural heritage and involving the citizens. The innovative elements are grouped in 4 Energy Transition Tracks (ETTs) such as

- ETT#1 Positive Energy Buildings and Districts
- ETT#2 P2P energy storage and management
- ETT#3 E-mobility integration into smart grid
- ETT#4 Citizen-driven innovation in cocreating smart city solutions.

While lighthouse cities will implement those solutions, the 6 fellow cities will replicate these solutions and adopt them to their own specific circumstances and create a possible and feasible replication plan which could be used in the future and would help them as well to turn into smart cities. Beside Granada from Spain, Bari from Italy, Celje from Slovenia, Ioannina from Greece, and Hvidovre from Denmark, Újpest is taking part in the project as the fellow city from Hungary.

In the case of Újpest the PED 1 area detailed below is to become a positive energy district (as pilot) by 2040 while Újpest at large by 2050.

The main purpose of POCITYF is to help decarbonization process within the PED 1 area, as well as in cooperation with end-use energy consumers, increasing climate awareness (meaning to get into new habits; advanced customs and protocols saving energy and using new technologies) among local population.

Within the project in total 73 Innovative Elements (IEs) have been listed and all grouped into the 4 ETTs.

The specific POCITYF IEs for Újpest were selected strictly considering the fulfilment of decarbonization. However, as they alone are not enough to insure all this but to enable the transition and to pave the way for other relevant technologies, further important means and tools are indicated in this plan. It is important to highlight that the below outlined IE-portfolio has been discussed internally and also with some key stakeholders' professionals.

As a result, to maximize the possible outcome of the PED1 / Újpest ecosystem, the following major sets of tasks / means and tools are suggested:

1. Reducing energy demand (upgraded building envelope, heat recovery ventilation, energy conscious Domestic Hot Water, smart lighting, circular economy in choosing materials and structure)

2. Decarbonizing end-use heat energy (waste heat utilization, 5th generation District Heating, Heat Pump, biomass)

3. Producing Renewable Energy Sources electricity (onsite-offsite Photo Voltaic)

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4. Energy-management and smaller scale technologies (Vehicle-to-Grid, waste management, city energy management, Direct Current lighting with Electric Vehicle charging, smart lamp post, solar road etc.)

5. Digital Platform and Information, Stakeholder's and citizen engagements

Some key points and factors:

Reducing energy demand is calculated/estimated in a conservative way and not including the impacts of the changing human behaviour through awareness campaign and smart control.

The Primary Energy Factor (*in Hungarian PEÁT)-*, the rate of fossil fuel content of the supplied heat, is currently 0,755 in the District Heating system of Újpest. PEF will/would be decreased to 0,7 with the short- or middle-term development of the planned waste incineration plant "HUHA", and it will/would be decreased to 0,5 with other middle- or long-term developments (such as geothermal or other RES) conducted by the public utility provider of Budapest and its district heating division BKM-FŐTÁV.

To terminate natural gas as fossil fuel energy source in the PED area, the replacement of gas heating with air/water heat pump will be required. A necessary precondition of this replacement is the renovation of secondary (inside) heating system too. Use of Variable Refrigerant Flow/Variable Refrigerant Volume systems – as HP - is welcome.
Also, in buildings with central heating system, the installation of an innovative, building size biomass boiler instead of HP might be important. In this way decarbonization is ensured, but no additional electricity is generated.

To achieve the goal of making Újpest's PED 1 area positive energy district, renewable electricity must be generated locally, in higher quantity than the electricity demand. The nominal value of electricity which could be produced by PV solar panels on the buildings and parking areas is not enough to cover the electricity demand. Therefore, installation of other off site solar power plants will be necessary.

The emission and energy consumption of transport and public lighting are not part of our PED calculation as it is the competence of Capital Budapest, while building energy systems are included.

Finally, building- and ecosystem (community)-centered energy management will be vital to implement and to successfully manage energy transition, from the monitoring of public and private buildings' energy consumptions with various smart metering tools to the citizen engagement tools in order to precisely research and analyse local behaviour and preferences and also to personalize functions accordingly.

Nevertheless, the Municipality of Újpest is to play a key role to support and orchestrate this process. There is a strong "*orgware*" capacity at hand that shall be deployed by the public leaders and legislative bodies. Even though some of the relevant regulations go beyond their competency, there is a lot they can do locally. It is basically two-fold. One is to make all necessary field work in residents' engagement and local businesses to partner up in this comprehensive transition.

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Secondly, the Municipality may deploy its organising power to bring together and sync up external stakeholders' and service providers' capacities. For this purpose, the Municipality may apply several best practices of co-creation methods from the fellow cities within the EU and the global scene. Co-creation refers to participatory decision making and funding, too. There are promising and well documented good practices also in the domain of progressive public funding, from local innovations funds co-managed by service providers to civic crowdfunding.

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Abbreviations and Acronyms (in alphabetical order)

Abbreviation	Definition
5GDHC	5th Generation District Heating and Cooling
ATES	Aquifer Thermal Energy Storage
DC	direct current
DH	District Heating
DHW	Domestic Hot Water
EE	Energy efficiency
ESCO	Energy Service Company
ETT	Energy Transition Track
EV	Electric Vehicle
HP	Heat Pump
ICT	Information and Communications Technology
IE	Innovative Element
IS	Innovative Solution
PEF	Primary Energy Factor
PED	Positive Energy District
POCITYF	A POsitive Energy CITY Transformation Framework
PV	Photovoltaic
RES	Renewable Energy Sources
ROI	Return Of Investment
SECAP	Sustainable Energy and Climate Action Plan
V2G	Vehicle to Grid
VRF/VRV	Variable Refrigerant Flow/Variable Refrigerant Volume
WP	Work Package

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1 Introduction

Within the project's structure a separate work package is dedicated to the Replication Plans and 2050 Vision by Fellow Cities (WP8). This deliverable D8.11 is the first comprehensive outcome of the work done, bringing together the status of local infrastructure, professional calculations, and international best practices (primarily from the two "Lighthouse cities" in the program and from global sources of technology).

This deliverable therefore has been completed by the experts of the Municipality of Újpest and with the support of its technical partner ÉMI. It is composed by 5 chapters, where Chapter 1 Introduction gives an overall background information about the document, Chapter 2 Benchmark framework presents the city, the planned replication area and solutions and the challenges and barriers what have been or might be faced. Chapter 3 gives insights into the creation process of the replication plan while Chapter 4 lists the selected innovative solutions and gives and estimation about their financial needs. Chapter 5 closes the document with a wrap up and the list of references.

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2 Benchmark Framework

In this section we give a general description about the city and some Smart City indicators where known. We also present here the dedicated replication area and explain our concept how to turn it to a Positive Energy District. Further we enumerate the experienced barriers from legal, technical, financial and social point of view.

2.1 General description of the city

The replication area refers to Újpest, 4th district of Budapest. It has been incorporated in the capital of Hungary in 1950 and counts around 1116.000 inhabitants today. Its territory was inhabited already before Christ but the first real settlement has been founded in the middle of 19th century by vincellers and not much later the first tannery was also opened. By the end of the century Újpest tented to become an industrial settlement: Factories that were increasingly displaced from downtown areas of Pest also found a place for themselves here. By 1910, Újpest got ranked fourth among the Hungarian cities in terms of industrial production. [1]

The metro stations have been recently renovated in the area and the conversion of buses into electric ones will have an impact already in the next five years. There are several emblematic and protected buildings in the area with residential, administrative, educational, and commercial function. The energetic retrofitting of some of these buildings has been already started, but most of them are in a rather deprived state. There are though some good examples for retrofitting. The most important task is the policy making, which could result in a more intensive retrofitting.

Category	Indicator	Description
Socio-cultural	Healthcare delivery	• Percent of population with access to primary health care facilities (100 %) • Immunization against infectious childhood diseases (95%) • Contraceptive prevalence rate
	Quality drinking water	• Population with access to safe drinking water (100%)
	Individuals' health monitoring	• Number of services integrated in a singular operation center leveraging real-time data. 1 point for each: ambulance, emergency/disaster response, fire, police, weather, transit, air quality: Fire Authority - Ambulance and Policy integrated in 112 emergency call • Percent of residents w/ single, unified health histories facilitating

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Category	Indicator	Description
		patient and health provider access to complete medical records EESZT as an integrated Health System platform is operating nationwide
	Quality food	• Nutritional status of children • Nutritional status of population
	Education funding	• Number services and resources for education fund Some University act as Fundation, The most important non governmental school operators are the Churches and the Waldorf /(Steiner School) network
	Free education	• Children reaching grade 5 of primary education: Education is free from the nursery to the university • Adult secondary education achievement level
	Low crime rate	• Violent crime rate per 100,000 population
	Population density	• Population-weighted density (average densities of the separate census tracts that make up a metro)
	Population growth rate	• Population growth rate
	Investment in culture	• Percent of municipal budget allocated to culture
	Civic engagement	• Number of civic engagement activities offered by the municipality last year • Voter participation in last municipal election (percent of eligible voters) Újpest: 51,40 %, Budapest 51,47 % [2]
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
	Start-ups	• Number of new opportunity-based startups/year
	International collaboration	• Number of international congresses and fairs attendees.
	Low poverty rate	• Poverty rate
	Job opportunities	• Employment rate • Percentage of labor force (LF) engaged in creative industries

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Category	Indicator	Description
Environmental	Green spaces	• Green areas per 100,000 (in m^2)
	Air quality	• Ambient concentration of air pollutants in urban areas
	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

	Energy use	*Data in 2018 based on SECAP of Újpest* 1./ Energy use Buildings: Residential buildings: *47,406 flats* - District Heating: 254 GWh/y - Natural gas: 193 GWh/y - Electricity: 105 GWh/y Total residential: 552 GWh/y Municipality's buildings: 1.87 GWh/y (73% heat, 27% electricity) Service sector: 557 GWh/y Industry (without the ETS): 162 GWh/y Transport (without public transport): 289 GWh/y Total energy use in 2018 based on SECAP of Újpest: **1,562 GWh/y; 340,146 tCO_{2eq}** (*without industry in ETS, public transport and public lighting*) 2./ Local energy production Local RES (PV power): 752 kW_p, 828 MWh/y Local CHP (based on natural gas):111 MW_e and 342 MW_{th} built capacity (working for DH system) Sewage water based biogas CHP in sewage water plant: (inside use) Sewage water based HP for building energy (heating and cooling): 1.7 MW_{th}
	Waste generation	• Generation of industrial and municipal solid waste • Generation of hazardous waste • Generation of radioactive waste • Waste recycling and reuse
	Sustainability-certified buildings	• Number of LEED or BREAM sustainability-certified buildings in the city • Percent of commercial and industrial buildings with smart meters :100% (meaning of data collection – 15' remote metering) • Percent of commercial buildings with a building automation system :40% (rough estimation) • Percent of homes (multifamily & single family) w/ smart meters :0% (no 15' remote metering no data registering)

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Governance	E-governance	• Open data use • Number of mobile apps available (iPhone) based on open data • Existence of official citywide privacy policy to protect confidential citizen data
	Real-time data monitoring	• Presence of demand-based pricing (e.g., congestion pricing, variably priced toll lanes, variably priced parking spaces). Y/N variable priced parking place • Percent of traffic lights connected to real-time traffic management system • 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) local and regional bus, tram, Metro/subway, car sharing • Availability of multimodal transit app with at least three services integrated (Y/N) Yes Subway/Metro, Bus, Train
	Internet and Wi-Fi coverage	• Number of internet subscribers per 1000 inhabitants • Percent of commercial and residential users with internet download speeds of at least 2 Mbit/s • Percent of commercial and residential users with internet download speeds of at least 1 gigabit/s
	Disaster preparedness	• Economic and human loss due to natural disasters
	Public transport	• Annual # of public transport trips per capita • % non-motorized transport trips of total transport • Integrated fare system for public transport
	Clean-energy transport	• Kilometers of bicycle paths and lanes per 100,000 (ISO 37120: 18.7) • of shared bicycles per capita • Number of shared vehicles per capita • Number of EV charging stations within the city Újpest: 27

2.2 Defined Replication Areas

There are 2 specific PEDs planned in this project, whereas PED 2 is an extension of PED 1. The figure 1 presents the location of these PED areas.

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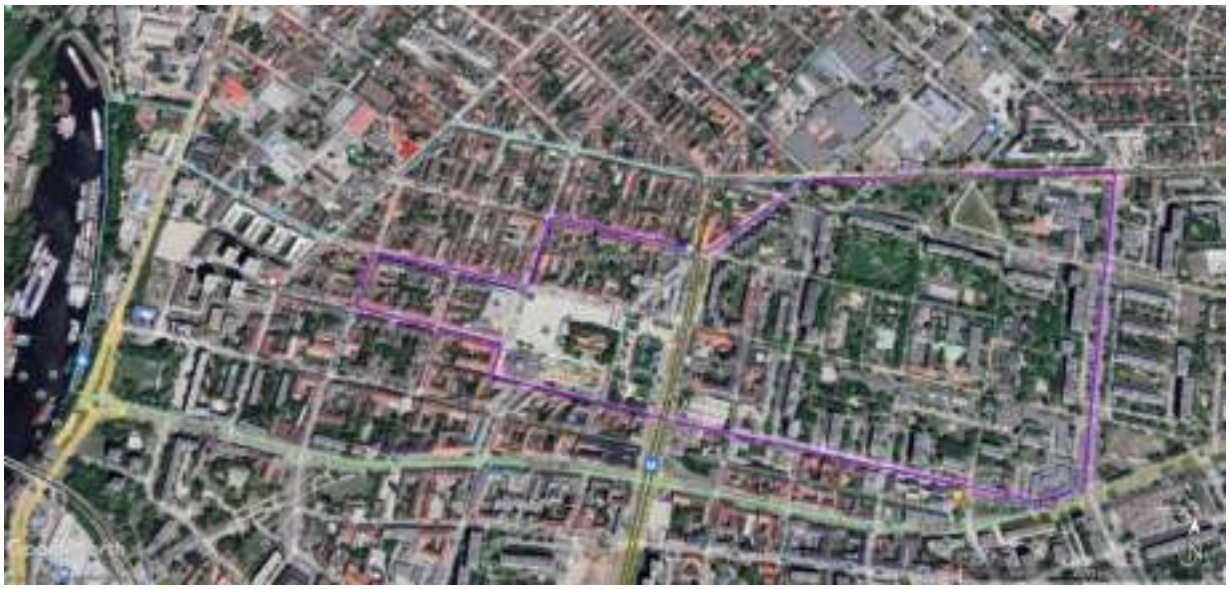

Figure 1: PED 1 (purple line) and PED 2 (green line) areas

PED 1 and PED 2 areas, both are further divided into two parts, namely:

- **„West-side”:** The historic Main Square and its surroundings with traditional housing units and the City Hall, which is one of the most beautiful areas in Budapest. A “green passage” between the Main Square and the Danube is also foreseen and pat of the city development plans. There are other remarkable historical buildings situated in the area, such as the Post Office, the Synagogue, the Bródy Imre Secondary School, the Catholic parish, the Újpest Storehouse and some historical residential buildings. On the West side of the area, a new residential development has been finished and is waiting for integration into the city texture. Currently the heating is solved mainly by natural gas. However, a low temperature network with heat pumps on sewage waste heat already exists connecting some buildings of the Municipality and the event hall (marked with black in Figure 2), which represents an extension of this opportunity.

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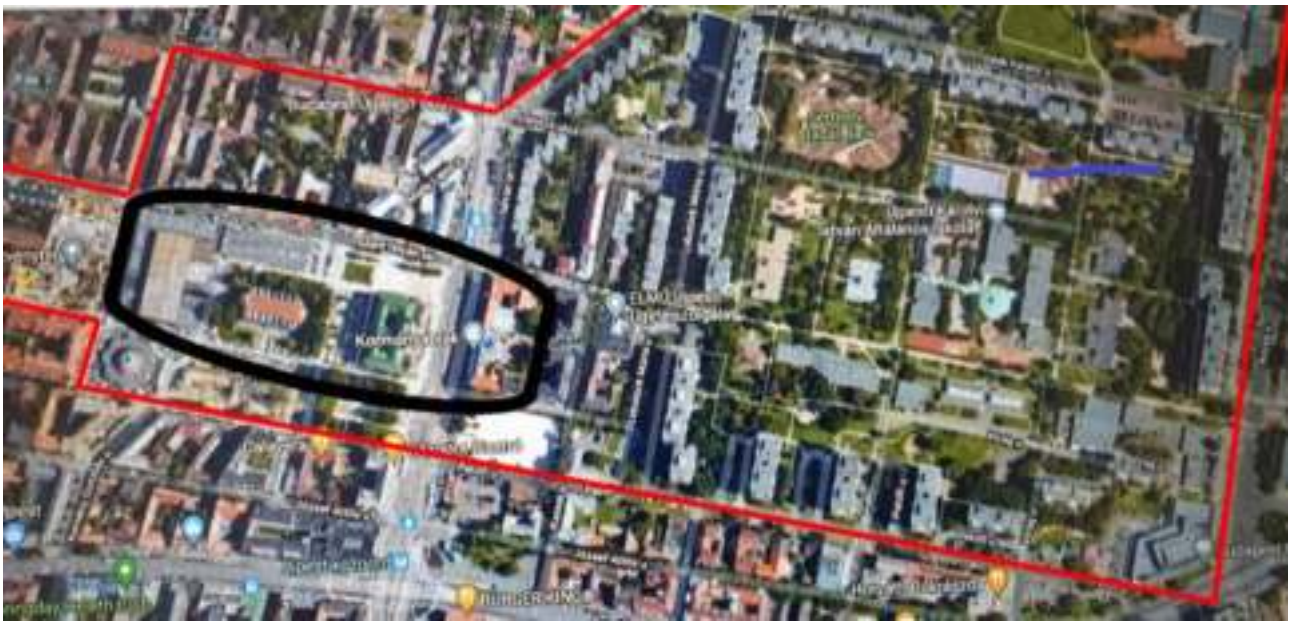

Figure 2: Low temperature network within the PED 1 area

- **„East-side”:** An example of pre-fabricated housing block units, with supplementary - educational, medical and commercial - buildings. The residential block units are typically set of 5 and 10 storey buildings, while the supplementary buildings are between 1 and 3 storey. Only 3 of the block units were renovated so far. In the other residential buildings only partial works were carried out by the tenants, such as window replacements or wall insulation improvements. The residential buildings and most of the other buildings are connected to the DH grid, which is loaded by a waste incineration plant and by some natural gas fired CHP plants and boilers.

The designated PED 1 area - besides being located in a significantly frequented area of the city (district) - is composed of all kinds of buildings, both in terms of architectural design, age, function and mode of energy supply as well. The technical solutions to be used in the PED buildings might be replicated in Újpest at large so it can be considered as an excellent “pilot” field. The replication would reach out the residential buildings, but not to the industrial areas.
Consequently, the development solutions applied in the PED 1 area can be further extended to other parts of Újpest.

The PED 1 area in numbers

Logically, „ PED 1 area can be divided into four zones: the West-side is composed by 3 zones and the „East-side” is one zone (see **Figure 2**)

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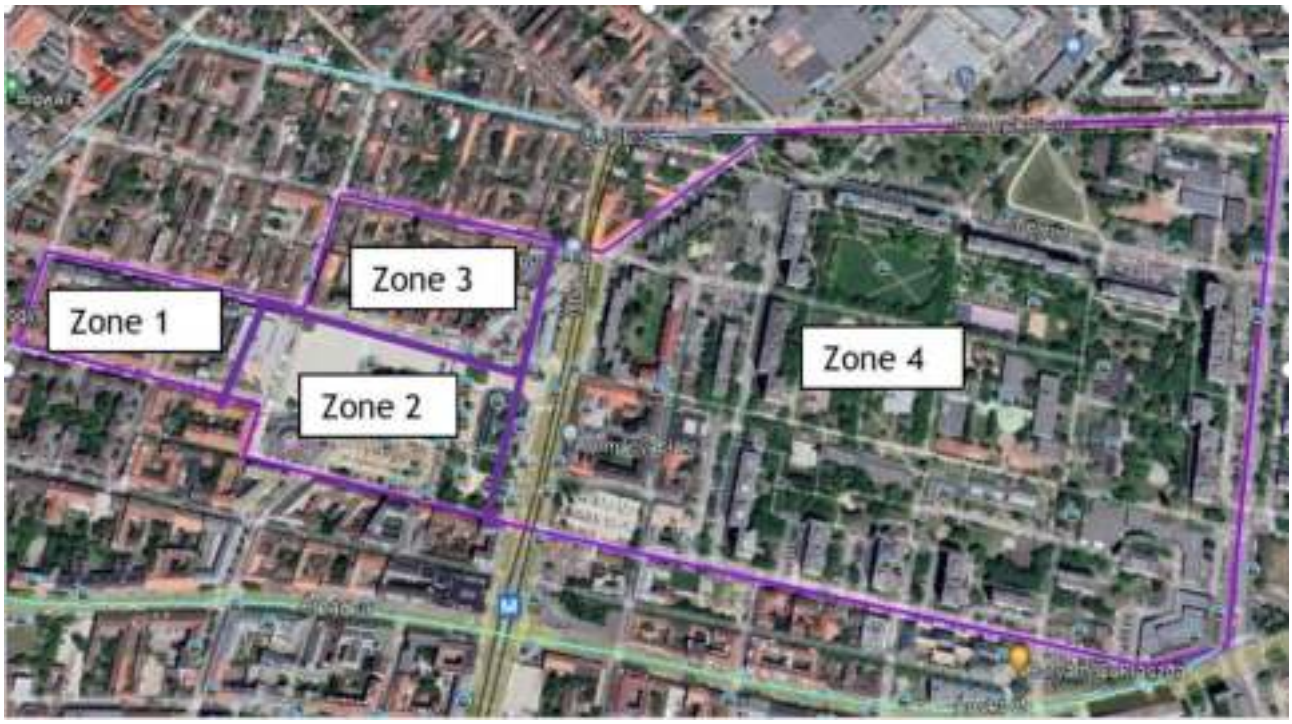

Figure 3: The 4 zones of the PED 1 area

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Zone 1:

Type and function	Building ID	Current heating type	Flat number equivalent
1 storey residential	Liszt Ferenc u. 16.	Natural gas	10
1 storey residential	Venetiáner u. 9.	Natural gas	3
1 storey residential	Venetiáner u. 11.	Natural gas	5
1 storey residential	Venetiáner u. 13.	Natural gas	7
4 storey residential + commercial, office	Károlyi István u. 27-29.	Natural gas	35
4 storey residential + commercial, office	Liszt F. 12-14. (Venetiáner corner)	Natural gas	35
5 storey residential + commercial, office	Liszt F. u. 10.	Natural gas	30
4 storey residential + commercial, office	Liszt F. u. 8. (Berzeviczy corner)	Natural gas	49
3 storey residential	Berzeviczy Gergely u. 9-11.	Natural gas	13
3 storey residential + commercial, office	Berzeviczy Gergely u. 13.	Natural gas	17
4 storey residential + commercial, office	Károlyi István u. 19.	Natural gas	35
4 storey residential + commercial, office	Károlyi István u. 21-23.	Natural gas	51
4 storey residential + commercial, office	Károlyi István u. 25.	Natural gas	51
New Market and Event Centre	Szent István tér 13-14.	HP based sewage water	
City Hall	István út 14.	HP based sewage water and natural gas	

Table 1: Buildings of Zone 1

Remark: 1 storey residential buildings are very old-style, others are quite new

Total number of flats $_{equivalent}$:	341
Total floor area of flats $_{equivalent}$:	~20 500 m^2
New Market and Event Centre:	~8 000 m^2

Zone 2: Historic Main Square

Type and function	Building ID	Current heating type
City Hall	István út 14.	HP based sewage water and natural gas
Church (roman catholic)	Szent István tér	Natural gas
"Flowers" hall	Szent István tér	belongs to New market and Event Centre

Table 2: Buildings of Zone 2

City Hall:	3 114 m^2
Church:	1 250 m^2
„Flowers" hall:	1.017 m^2
Total:	5 381 m^2

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Zone 3:

Type and function	Building ID	Current heating type	Flat number equivalent
1-3 storey residential	Templom u. 1.	Natural gas	15
1-3 storey residential	Szent István tér 16.	Natural gas	10
1-3 storey residential	Szent István tér 17.	Natural gas	9
1-3 storey residential	Szent István tér 18.	Natural gas	12
1-3 storey residential	Szent István tér 19.	Natural gas	12
1-3 storey residential	Szent István tér 20.	Natural gas	10
1-3 storey residential	Szent István tér 22.	Natural gas	8
1-3 storey residential	Templom u. 3.	Natural gas	3
1-3 storey residential	Lőrinc u. 27.	Natural gas	1
1-3 storey residential	Lőrinc u. 29.	Natural gas	3
1-3 storey residential	Lőrinc u. 31.	Natural gas	3
1-3 storey residential	Lőrinc u. 33.	Natural gas	3
1-3 storey residential	Lőrinc u. 39.	Natural gas	3
1-3 storey residential	Lőrinc u. 41.	Natural gas	4
1-3 storey residential	Lőrinc u. 43.	Natural gas	10
1-3 storey residential	Mády Lajos u. 2.	Natural gas	9
1-3 storey residential	Mády Lajos u. 2/a	Natural gas	9
Notarial Chamber	Mády Lajos u. 4.	Natural gas	
Post Office	Mády Lajos u. 6.- Lőrincz 47.-István 18.	Natural gas	
Pécsi Sebestyén Music School	Lőrincz u. 35-37.	Natural gas	
Presbytery (roman catholic)	Szent István tér 21.	Natural gas	6
Church (roman catholic)	Szent István tér	Natural gas	8
Church, reformed pastoral office, shop	Szent István tér 24.	Natural gas	10
István office building and shops	Szent István tér 25.	Natural gas	26

Table 3: Buildings of Zone 3

Remark: Residential buildings represent old style.

Total number of flats $_{equivalent}$:	166
Total floor area of flats $_{equivalent}$:	~10 000 m^2
Notarial Chamber:	1 100 m^2
Post Office:	2 850 m^2
P.S. Music School:	3 350 m^2
Total:	17 300 m^2

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Zone 4:

Type and function	Building ID	Current heating type	Flat number equivalent
11 storey residential	Deák Ferenc utca 51-61.	DH	192
11 storey residential	Deák Ferenc utca 63-73.	DH	192
11 storey residential	Deák Ferenc utca 75-81.	DH	128
11 storey residential	Lebstück Mária utca 47-53.	DH	256
11 storey residential	Lebstück Mária utca 55-61.	DH	256
11 storey residential	Lebstück Mária utca 63-69.	DH	256
4-5 storey residential	Lebstück Mária utca 48-56.	DH	48
11 storey residential	Petőfi utca 12-14.	DH	120
11 storey residential	Petőfi utca 16-18.	DH	120
11 storey residential	Petőfi utca 20-22.	DH	120
11 storey residential	Petőfi utca 24-26.	DH	64
11 storey residential	Virág utca 35-37.	DH	64
11 storey residential	Virág utca 39-41.	DH	64
11 storey residential	Rózsa utca 50-56.	DH	256
11 storey residential	Rózsa utca 42-48.	DH	256
4-5 storey residential	István út 23-27.	DH	56
4-5 storey residential	Lőrinc u. 49.	DH	9
4-5 storey residential	Király u. 2.	DH	9
4-5 storey residential	Bercsényi út 1-11.	DH	58

Table 4: Buildings of Zone 4 - pre-fabricated block houses

Total number of flats $_{equivalent}$:		2 524
Total floor area:		~151 000 m^2

Type and function	Building ID	Current heating type	Flat number equivalent
3 storey residential	Jókai u. 2/B.	Natural gas	8
3 storey residential	Jókai u. 4.	Natural gas	18
Youth hostel	Jókai u. 5.	Natural gas	25
3 storey residential	Jókai u. 6. - Kassai u. 39.	Natural gas	20
4 storey residential	Petőfi u. 8.	Natural gas	25
3 storey residential	Kassai u. 41.	Natural gas	9
4 storey residential	Kassai u. 46.	Natural gas	20
1 storey residential	Kassai u. 47.	Natural gas	1
4 storey residential	Kassai u. 48.	Natural gas	18
4 storey residential	Kassai u. 48/A.	Natural gas	11
4 storey residential	Kassai u. 49.	Natural gas	10
3 storey residential	Kassai u. 51.	Natural gas	12
3 storey residential	Kassai u. 50-52/A-B.	Natural gas	34
3 storey residential	Kassai u. 53.	Natural gas	11
3 storey residential	Kassai u. 54.	Natural gas	10
4 storey residential	Kassai u. 56-58.	Natural gas	37
3 storey residential	Kassai u. 60.	Natural gas	8
4 storey residential	Kassai u. 60/A.	Natural gas	10
3 storey residential	Király u. 10.	Natural gas	10

Table 5: Buildings of Zone 4 - classical old and quite new residential buildings

Total number of flats $_{equivalent}$:		297
Total floor area:		~18 000 m^2

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Type and function	Building ID	Current heating type
Mayor's Office	István út 15.	HP based sewage water and natural gas
Újpest Culture Centre	István út 17-19.	Natural gas
Szabó Ervin Library	Király u. 5.	Natural gas
Mixed commercial building	Király u. 23.	Natural gas
"Árpád" shopping centre	Árpád út 112.	Natural gas
Mixed commercial building	Petőfi u. 28.	Natural gas
"Koktél" shopping centre	Király u. 9. - Kassai u. 43-45.	DH
"Király 11" commercial centre	Király u. 11.	DH
Fitness centre	Király u. 13.	DH
Government's and Municipality's Building	Király u. 12-14.	DH
"Bársonyszívek" elderly home	Király u. 15.	DH
"Újpest Király" pharmacy	Király u. 17.	DH
"Királykerti" kindergarten	Király u. 18.	DH
Medical centre	Király u. 19.	DH
Mixed commercial building	Király u. 25.	DH
Mixed commercial building	Király u. 27.	DH
Mixed commercial building	Deák F. u. 47.	DH
"Liget" kindergarten	Rózsaliget köz 1.	DH
IV/12. nursery	Rózsaliget köz 3.	DH
"Újpesti Károlyi István" school centre	Erzsébet u. 69.	DH
"Kozma Lajos" school centre	Deák Ferenc u. 40.	DH

Table 6: Buildings of Zone 4 - supplementary educational, medical, commercial and public buildings

Total floor area:	~49 500 m^2

Summary data of the PED 1 area

Area	Character	Total number of $flats_{equivalent}$	Total floor area m2
ZONE 1	Residential buildings with offices, commercial area	341	20 500
	New Market and Event Centre	-	8 000
ZONE 2	Historic Main Square	-	5 381
ZONE 3	Residential buidings and offices, scool, church	166	17 300
ZONE 4	Pre-fabricated block house	2 524	151 000
ZONE 4	Classical old and quite new residential buildings	297	18 000
ZONE 4	Supplementary educational, medical, commercial and public buildings	-	49 500
			269 681

Table 7: Summary data of the PED 1 area

PED 1 area is to become a positive energy district (as pilot) by 2040 and the whole Újpest by 2050, while creating as much similar PED areas as possible in Újpest, in parallel with the development of PED 2 and others.

Expectation from POCITYF is to help the decarbonisation process on PED 1 area providing with technical samples. Decarbonisation process in cooperation with end-use energy consumers increases climate awareness among local population.

It is important to mention that according to our method, the emission and energy consumption of transport and public lighting are not included in the calculation of positive energy district (only building energy is included).

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Nevertheless, with regards to SECAP and bold vision of Újpest, some innovative solutions are going to be used/replicated, in relation with e-transport, public lighting, waste management, energy management and their combination.

2.3 Envisioned Replication Area and city needs towards Smart City

The main purpose of the POCITYF project is to make a positive energy district (PED). We have defined a PED area (see 2.2), which is rather huge, containing more than 3,300 flats, meaning around 270,000 m^2 heated area.

These buildings have a high energy demand:

- electricity demand ~ 13.5 GWh/y,
- total heat demand ~ 43.1 GWh/y
    - based on DH ~ 29.4 GWh/y,
    - based on natural gas ~ 11.9 GWh/y,
    - based on sewage water heat ~ 1.8 GWh/y,
- cooling demand ~ 4 GWh/y.

Being PED means to produce more renewable energy on site than energy demand. Using of innovative elements (IEs) of the 4 ETTs offered by POCITYF is not enough on its own to create a PED area.

In this way our conception is:

- reducing energy demand,
- decarbonizing end-use heat energy and
- producing RES electricity.

The specific POCITYF IEs were selected primarily considering the fulfilment of decarbonization. However, as they are alone not enough to secure all this, other important complementing means and tools are involved in this plan. It is important to note that the below outlined IE-portfolio has been discussed internally and with some key stakeholders' professionals.

The selected and **planned interventions (Int)** are presented in the list below and in **Figure 10 (4.2.1)**. POCITYF **ISs/IEs selected to be replicated** are presented in 4.2.2. The energy demand and mode of supply of the buildings in the PED 1 area are presented in 4.3.1. The IEs selected to be replicated are paired with the planned interventions in 4.3.1

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IE code	Technology Name	Motivation / Target output
IE-1.1.8	Building Management System	After - complex renovation of energy efficiency in buildings (Intervention 1.1, 1.2), - expansion of the heat production provided by the sewage water based HP(Int.2.2), - replacement of gas heating with air/water HP (Int.2.3) BMS helps to reduce both heat and electricity demand in the buildings.
IE-1.1.9	Home Management System	After - complex renovation of energy efficiency in buildings (Intervention 1.1, 1.2), - expansion of the heat production provided by the sewage water based HP (Int.2.2), - replacement of gas heating with air/water HP (Int.2.3) HMS helps to reduce both heat and electricity demand in the buildings.
IE-1.1.12	Insulation with circular materials	Applied in complex renovation of energy efficiency in buildings (Intervention 1.1). It helps to reduce heat demand in the buildings and contributes to the transition to a circular economy .
IE-1.1.13	Triple glazing	Applied in complex renovation of energy efficiency in buildings (Intervention 1.1). It helps to reduce heat demand in the buildings.
IE-2.2.5	Low temperature waste heat	A sewage water based HP is installed under historic main square, which produces heat (heating and cooling) to 3 buildings. Intervention 2.2 means expansion of its production in the surrounding buildings. A sewage water based HP utilizes low temperature waste heat.
IE-2.2.3	Low-temperature heat grid	It's a basic element of a 5th Generation District Heating and Cooling (5GDHC) system. In the long term, BKM-FŐTÁV is going to create a 5GDHC system on PED 1 area in cooperation with Újpest in order to help its decarbonization process (Int.2.4). In a 5GDHC system the temperature of the pipelines is extremely low (ambient temperature).
IE-2.2.6	ATES	It's a basic element of a 5th Generation District Heating and Cooling (5GDHC) system. In the long term, BKM-FŐTÁV is going to create a 5GDHC system on PED 1 area in cooperation with Újpest in order to help its decarbonization process (Int.2.4). In a 5GDHC system seasonal (as ATES) and daily-weekly heat storages are required.
IE-1.2.3	Smart Distribution Energy System	In a 5GDHC system consumers are also producers ("prosumers"), so, a smart distribution of the energy and the costs among them is required.
IE-1.2.4 and IE-2.1.5	P2P energy trading platform	In a 5GDHC system consumers are also producers ("prosumers"), so, a smart distribution of the energy and the costs among them is required. A P2P energy trading platform can be a basic element of the trade of the electricity produced in PV solar panels (Int. 3.1) or in PV power plants (Int. 3.2).

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IE-1.1.2	PV Canopy	It's an innovative element of the solar RES electricity production on buildings (Int. 3.1) which can help to increase the useful surface of a building.
IE-1.1.5	Traditional PV Shingle	It's an innovative element of the solar RES electricity production on buildings (Int. 3.1) which can help to increase the useful surface of a building. It can be used on a roof where normal solar panel can't.
IE-1.1.6 and IE-3.1.3	Bidirectional Smart Inverters	It's a very important, innovative auxiliary tool of the solar RES electricity production (Int. 3-1 and 3.2) helping to avoid technical and balance problems in the grid.
IE-1.1.7 and IE-1.2.2	Energy Routers	It's a very important, innovative auxiliary tool of the solar RES electricity production (Int. 3-1 and 3.2) helping to avoid technical and balance problems in the grid.
IE-1.1.14	Solar roofs and facades	It's an innovative element of the solar RES electricity production on buildings (Int. 3.1) which can help to increase the useful surface of a building.
IE-1.1.17 and IE-1.2.8	Li-ion/Li-metal stationary batteries	Energy storage is an essential condition of the operation of PVs (Int. 3-1 and 3.2) to avoid technical and balance problems in the grid.
IE-1.2.5	Community Solar farm	Community solar farm is an innovative tool (opportunity) of an integrated solar RES electricity production and trade in an energy community. It helps to increase the capacity of the solar RES electricity production in Újpest.
IE-1.3.1 and IE-2.1.1	2nd life batteries	Energy storage is an essential condition of the operation of PVs (Int. 3-1 and 3.2) to avoid technical and balance problems in the grid.

In our method, the emission and energy consumption of transport and public lighting are not included in the calculation of positive energy district (only building energy is included) because it is not the competence of the District but the Capital.
Nevertheless, with regards to SECAP and bold vision of Újpest, some innovative solutions are going to be used/replicated referring to **e-transport**, **public lighting**, **waste management**, **energy management** and **their combination**. These are the followings:

IE-1.2.1 and IE-3.1.5	Smart Lamp Posts with EV charging and 5G functionalities	combination of public lighting and e-transport
IE-1.2.9 and IE-3.1.9	DC lighting with EV charging	combination of public lighting and e-transport
IE-1.2.10	Solar road	combination of transport and energy production
IE-1.2.11 IE-2.1.10 IE-3.1.4	V2G	combination of e-transport and energy storage
IE-1.3.2	PAYT	waste management
IE-1.3.3	Reverse collection of waste	waste management
IE-1.3.7	Waste management tools	waste management
IE-2.1.3	Flexibility Control Algorithms	energy management
IE-2.1.6	City Energy Management System	energy management
IE-3.2.1	EV sharing	e-transport

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2.4 Challenges & Barriers

2.4.1. Legal

Legal barriers mean in Újpest's case the lack of appropriate legislations rather than such existing rules which prevent to create the PED 1. There is an assumption that the appropriate legal framework will be passed by that time, thus "the lack of rules" aren't holding back us from planning the PED 1 accordingly.

It's a general issue in relation with the regulatory system that Újpest is a district of Budapest whereas many decisions are made on Budapest or even central government level.

The main legal challenges & barriers are as follows:

1. According to the legislation on the outside insulation and the protected facades of the historic buildings are mostly prohibited, while inside insulation is too expensive, and risk of condensation could easily occur. It could be a barrier in complex EE renovation of buildings, but in our plan there are no protected buildings.

2. According to the existing regulation, "Household Size Small Power Centre" means a power center under 50 kW_p connected to one electricity meter, and the settlement of production and purchase is based on the "net metering system". It is the same with PV power centers as well. In a multi-flat building, each flat has an electricity meter. So, the condominium community can install PV only under 50 kW_p on the roof of the building, and this is only for the electricity consumption for common purpose such as lighting in common places, elevators, etc. The consumption of the flats under the limit of 50 kW_p can't be combined or summed up. It is a big barrier in the installation of PVs regarding the possible numbers implemented on the roof of multi-flat buildings. A relevant change of regulation is assumed in the plan. According to the planned technical solution we planned as many PVs installed on the buildings as technically possible.

3. The regulation of renewable electricity energy community is existing (few sentences are in the electricity law), but the enacting clauses of the law are still to come. As a result, there isn't any relevant practice as of yet. It is also a barrier to create energy communities and to maintain peer-to-peer trading. We assume that relevant regulations on energy communities and the practice (based on the practice of other EU's countries) will come into force in due course. Same with the legal regulations on P2P trading.

4. Regulations on energy storage, hybrid PV system, V2G and most of all flexibility services are also missing. In the plan, we assume that relevant legal conditions are also coming in due course.

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Nevertheless, challenges arising from the lack of knowledge, awareness and interest of costumers are perhaps bigger than legal barriers, in these cases.

2.4.2 Technical

Some important technical barriers which can prevent the implementation of the planned PED 1 are as followings:

5. the electricity grid is out of date, therefore there are limitations in developing smart public lighting systems (info from BDK).
6. the central and local regulation may limit the opportunity to use PV on roofs and façade most probably in cultural heritage buildings (for example: roofs of the churches)
7. there are needs to upgrade the secondary DH systems belonging to the dwellings itself
8. the sewage heat source potential is not stable, its investigation is ongoing
9. the potential of geothermic sources is not investigated in detail
10. the good results of retrofitting and the advantage of using RES is not well monitored or documented
11. the institutional clients and the citizens are not well informed about the opportunities of Energy Efficiency and RES
12. monitoring and data collection (as open data sources) are not organized up to now

2.4.3. Financial

As shown in **Figure 4**, some planned technical solutions (interventions) are going to be made by professional stakeholders like BKM-FŐTÁV / BDK, the operator company of the existing sewage water-based HP, etc. Please note that lack of a certain standards of Return of Investment might be a constraint and hold back these innovations on their end as well as the consumers' end.
Currently, a subsidized energy price system (far away from market prices) exists for residential consumers, which makes unfeasible these EE investments from an economic point of view if this system remains

2.4.4. Social

Economic and environmental awareness is key for all energy efficiency transition implemented in residential buildings though. Therefore, engaging residents and increasing their awareness and consent rate may be a huge challenge along the way.

Project Development Assistance are rare and unique, however the scale of residential retrofitting of Block Unit is more widespread in Budapest's other districts (Óbuda, Újbuda). Co creation and co development processes have been started.

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3 Processes towards the implementation of the Replication Plan

In this chapter we give an overview about the administrative and bureaucratic procedures which have been followed while putting together the replication plan. We present the groups and methods who and how we consulted or would have been useful to consult with in order to identify and engage the potential stakeholders and to define the selected innovative solutions. We also present the planned key performance indicators from technical and social point of view.

3.1 Governance and administrative processes for planning solutions

Upon deciding to implement a smart ecosystem that includes different smart technologies, the Municipality has to set up some dedicated internal capacity and team for this purpose. Dealing with operational efficiency, finding a good balance between agility and competency is crucial.

Ideally, there will be an ambitious and committed in-house champion and sponsor of this topic with clearcut authorisation and capacity (legal, financial, etc.) to engage and work with external partners and agencies to deliver the best possible results.

The Municipality then sets up clearly divided business and respective operation lines to make sure the community goals are on track in terms of functions and time scale.

In order to do so, the Municipality is to meaningfully internalise these efforts and capacities into the operational powerhouse of the city management, also making it part of the culture, expectations, daily routine and mindset at large.

3.2 Work Groups supporting the planning processes

The above-mentioned in-house agency or project management capacity shall be a value-driven organisational unit, being able to manage and to systemically reach out and work with experts from the following functional areas:

- project management on multiple layers, Project Development Assistance
- energy-related legislative issues and trends, green initiatives and regulatory frameworks at local and international level
- energy efficiency technology strategist
- specific technology experts (in relation with the prospective technologies to be deployed)
- financial & investment management experts
- corporate engagement (potential service providers)
- public (residential) engagement experts

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- others

Depending on the actual workload and intensity, dedicated work groups shall be built around these domain leaders which include necessary municipality authorities in the steering committee.

3.3 Local Stakeholders‘ engagement

Stakeholder engagement shall be subject of a long-term learning and transition process for the community at large. It might be gradually carried out, making it part of the culture and daily routine. As per participatory decision-making and governance, not swiping away any responsibility in action from the elected leadership, a fair share in decision-making is to be given for the stakeholders though, in order to integrate public opinion, public will, as well as acceptance and recognition from the public.

Once having accepted the idea and concept of public engagement, respective methods shall be embraced and personalised to specific issues and target groups. Also, respective tools, in on- & offline balance, are to be created or obtained for regular use. However, local engagement policies shall be embraced and formalised by passing through local legislation and practice.

In line with the Lighthouse Cities’ plans and the provision of the “Citizen Engagement Plan Guide Book” made by Újpest, relevant engagement strategies and methods, protocols and tools are to be defined as briefly summarised below:

Actions and tools:

- Identification of the subject of public decision to be made.
- Identification of costs & benefits, roadmaps (technical & financial & legal actions) and impact.
- Identification of support in implementation and administration for various stakeholder groups.
- Measuring public awareness, acceptance & willingness.
- Identification of uncovered / unknown part of information needed for decision.
- Identification of a set of information needed for each stakeholder groups.
- Identification of different stakeholder groups whereas respective engagement policies are to be designed.
- Identification of respective strategy and action plan for engaging
    - residents
    - local associations
    - service providers
    - administrative bodies

13. Identification of respective methods & tools
    - geolocated & thematic urban labs, word caffe, hackathon
    - digital platform & app with personalized functions

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- obstacles

14. Identification of supporting functions
    - urban energy management platform
    - apartment level energy management app / dashboard (giving real-time feedback on how much energy the resident uses)

15. Identification of specific action plans (for each public decision) applying the most useful mix of methods & tools.
16. Identification of a measurement system
    - KPIs
    - action by action / event by event evaluation
    - data management
    - automatic feedback for the leadership (so that they know what / when to change)
    - impact modelling - sharing capacities with the public

3.4 Replication Tools utilization

3.4.1 Workshops

We have participated in all (online) workshops the project management and the Lighthouse Cities organised for this reason. They were rather useful and would be even more so, occasionally in person, in place.

3.4.2 Capacity building

We are delighted to see the Lighthouse cities building their capacities when entering the implementation phase. We plan to focus on the various functions needed so that we can adjust and personalise capacity building plans for the specific situation of Újpest.

3.4.3 Knowledge Transfer from LHs

In many cases, these knowledge transfer events are quite useful to see if we are behind in any of the functional areas, as well as to analyse the approaches, technologies and underlying thoughts of the various innovative solutions. After covid we hope to have more visits in the LH cities to meet the stakeholders and make familiar with the results and special challenges.

3.4.4 Factsheets

Factsheets are most useful in the description of various innovative solutions as local professionals may make comparative studies to find the local optimum.

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3.4.5 Synergies with other SCC EU projects

We are continuously monitoring other locally implemented SCC EU projects, and certainly, make use of possible synergies if any. ÉMI is involved in two new European CSA projects such as **NEBULA** and **CAPACITIES, with the aim to help the** implementation of European Bauhaus and Digital Urban Transition. Újpest is a part of European City Facility (EUCF [3] with the municipality of Óbuda and Szentendre. A stronger cooperation is planned with the SCC Lighthouse project **ATELIER** and Budapest as capital is participating in the 100 smart and climate neutral city project.

3.4.6 Work groups

Working groups are one of the most frequent, practical and useful platforms for exchanging experiences and ideas within the project, the Lighthouse Cities and other Fellow Cities.

3.4.7 ICT Tools

We are delighted to see the details of these tools implemented by the Lighthouse cities when happening.

3.4.8 Suggested by energy experts at the Municipality of Újpest and professionals stakeholders/ service providers

As a result, our local energy- and engagement experts carefully read through all tender materials and Lighthouse Cities specific documents to conclude a just local version of all this and to successfully target a positive energy or net zero district area.

IEs have also been selected by Újpest's energy experts in cooperation with experts of stakeholders.

The Újpest Replication Plan therefore has a broader meaning and perspective above the selection and application of IEs for replication purposes. It also includes other technological solutions required for the decarbonisation process.

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

3.5.1 Social compatibility

The aim to be a smart city for Újpest is deriving from different dimensions. Újpest is one of the leading districts in Budapest, the capital of Hungary while Budapest is engaged for SCC concept through being FC in ATELIER SCC Lighthouse project and selected as one of the 100 Smart and Climate Neutral Cities. Some main aspects belong to the capital’s responsibility such as transport, public lighting and DH systems, meanwhile the others remain the competence of the Local Government of the district. Therefore a close cooperation with the capital is a must. Beside it is utmost important to raise the awareness of the local citizens, and other stakeholders for the closer cooperation to increase the attractiveness of the living environment, energy efficiency and renewable utilisation and moving towards digital urban transition. Co-creation and participative decision making is starting a good habit and rule for the municipality actions and processes, best practices shows the growing acceptance of the need and opportunity for change. Nature Based Solutions open again new dimensions and options for the community.

3.5.2 Technical compatibility

The establishment of a demo PED area is an essential step to achieve the climate neutrality of the district by 2050. For this aim traditional and innovative technical solutions should be implemented in a context of the existing standards and barriers. As District Heating has a leading role in the area introducing the 5th generation low temperature system as a pilot in Újpest has absolute priority. Regarding the electricity consumption and generation, architectural integrated onsite and well defined offsite PV solutions should be incorporated with active energy community approach in strong cooperation of the relevant stakeholders as DSO and institutions. Smart operation tools and the POCITYF’s Innovative solutions will integrate the low emmission transport options via V2G and RES utilisation. An active Project Development Assistance should be developed to boost the EE retrofit in the residential and public building sector and to learn the best practice from the LHs and other FCs.

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4 Building up the Replication Plan

In this section we present concrete proposal how to turn Újpest to a PED area, what are the most relevant innovative solutions and other methods and how they could be financed and get accepted by the citizens.

4.1 Building up the Smart City Vision and Plan

Just like the other Fellow Cities Újpest is also aiming to fulfil the decarbonisation process at mid and long term through nature-based solutions, digitalisation and circular economy. The concept has been set in the Sustainable Energy and Climate Action Plan of Újpest:

Climate protection and energy efficiency bold vision of Újpest for 2050

„Within the City of Budapest, Újpest (4th district) is a sample district with a low-emission local economic environment that utilizes local resources. The public institutions of the district are 100% energetically renovated, their energy use is covered by more than 50% renewable sources. The climate awareness of the population is considerably increasing, and the use of energy-efficient means of transport and buildings are constantly expanding. Ideally, 90% of the local population will switch to public transport and/or other alternative, non-fossil vehicles."

The possible concrete steps are detailed in the coming sections. Beside this commitment it is important to mention that Budapest capital has been selected into the 100 climate neutral cities by 2030 which initiative will be certainly reflected in Újpest as well.

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

As the main goal is to transform the PED 1 area into a positive energy district, our first task is to decarbonise the energies delivered by energy suppliers in PED 1 area.

Újpest energy experts have calculated the decarbonization demand, have defined the technical and technological requirements of the decarbonization process, consulted with experts/representatives of some technical stakeholders (DH, HP, PV, building energy).

Selection of POCITYF IEs for replication has been subordinated to the main goal, the implementation of decarbonization. The replication of POCITYF ISs and IEs is however, not enough to reach the main goal, although they can enable it, while also paving the way for other relevant technologies.

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The technical solutions required to reach the main goal (decarbonization) in the PED 1 area are complex, the main steps of the energy efficiency (EE) interventions are as follows:

1. **Reducing energy demand**
2. **Decarbonizing end-use heat energy**
3. **Producing RES electricity**
4. **Using the energy-management and smaller scale technologies**
5. **Creating a Digital Platform and Information** and **stakeholder's and citizen engagements**

Detailed technical solutions are contained in **Figure 4.**

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The planned technical solutions in PED 1 area of Újpest	
1.	**Reducing energy demand**
1.1	**Complex renovation of energy efficiency in some buildings of the PED 1 area**
	Wall and roof insulation with circular material
	Changing windows to type of triple glazing
	Building shading
	Heat recovery ventilation (where it exist)
	Renovation of secondary heating system (low temperature and EE by effective hydraulic control)
	Heat storage system
	Building Energy Management System (BEMS) (see in 1.2 too)
1.2	**Electricity demand decreases by 10%**
	As a result of the increasing use of EE domestic equipments and the renovation of lighting, the electricity demand is expected to be reduced by at least 15%. Taking into account the increase in cooling and its surplus electricity demand, the total electricity demand decrease is 10%.
2.	**Decarbonization of end use heat energy**
2.1	**Developments by BKM-FŐTÁV, PEF will/would be decreased to 0,5 from 0,755**
	The supplied heat by BKM-FŐTÁV (Budapest District Heating) in Újpest originates different sources: natural gas fired CHP plants and boilers, waste incineration plant. *Primary Energy Factor (PEF; in Hungarian PEÁT), which means the rate of fossil fuel content of the supplied heat, is 0,755 currently in Újpest. PEF will/would be decreased to 0,7 with short-middle term development in the HUHA (waste incineration plant), and it will/would be decreased to 0,5 with other middle-long term developments (geothermal or other RES) by BKM-FŐTÁV.*
2.2	**Expansion of the heat production of the sewage water heat based HP**
	A sewage water based HP is installed under historic main square, which supplies heat (heating and cooling) to the City Hall, Mayor's Office and New Market and Event Centre. It's operates by 1,7 MW heat capacity, but installed capacity is 4 MW. So, there are 2,3 MW reserve heat capacity which able to supply ~4.000 MWh heat a year.
2.3	**Replacement of gas heating with air/water HP**
2.4	**Creation a 5th Generation District Heating and Cooling (5GDHC) system on the site** *5GDHC is both theoretically and logically a new system in the development of DH history. The physical realization of 5GDHC can no longer be considered a "district" („distance") service, but rather a "local community" energy service, as it breaks with the classical practice of transporting heat via a transmission pipeline (grid) from one or more different heat sources (away from consumers) to the end-users. In the 5GDHC solution, consumers are connected to each other by 2 closed loops one for warm and the other for cold energy. Consumers are also producers (so called: „prosumers"), all consumers "take out" and "put in" energy into the loops. The temperature of the pipe lines is very low (ambient temperature). In end-user buildings, heat pumps provide heating and cooling. Seasonal and daily-weekly heat strorages are required. Long term development.*
3.	**Production of RES electricity**
3.1	**Installation of PV solar panels on the buildings on site**
3.2	**Installation of PV solar power plant off site**
4.	**Energy-management and smaller scale technologies**
	e-transport
	Public lighting
	Waste management
	City energy management

Figure 4: The planned technical solutions in PED 1 area of Újpest

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4.2.2 List of POCITYF ISs selected to be replicated

In the POCITYF project 4 Energy Transition Tracks (ETT), 10 Integrated Solutions and some Innovative Solutions (IS), Innovative Elements (IE) have been identified. Their structure (POCITYF Integrated Solutions Matrix) can be seen in 7.1. The following IEs have been selected to be replicated which can be inserted/incorporated into the planned technical solutions in PED 1 area of Újpest (Figure 10).

- PV Canopy IE-1.1.2[1]
- Traditional PV Shingle IE-1.1.5
- Bidirectional Smart Inverters IE-1.1.6 and IE-3.1.3
- Energy Routers IE-1.1.7 and IE-1.2.2
- Building Management System - BEMS IE-1.1.8
- Home Energy Management System – HEMS IE-1.1.9
- Insulation with circular materials IE-1.1.12
- Triple glazing IE-1.1.13
- Solar roofs and facades IE-1.1.14
- Li-ion/Li-metal stationary batteries IE-1.1.17 and IE-1.2.8
- Smart Lamp Posts with EV charging and 5G functionalities IE-1.2.1 and IE.3.1.5
- Smart Distribution Energy System IE-1.2.3
- P2P energy trading platform IE 1.2.4 and IE-2.1.5
- Community Solar Farm IE 1.2.5
- ATES IE-1.2.7; IE-1.3.5 and IE-2.2.6
- DC lighting with EV charging IE-1.2.9 and IE-3.1.9
- Solar road IE-1.2.10
- V2G IE-1.2.11; IE-2.1.10 and IE-3.1.4
- 2nd life batteries IE-1.3.1 and IE-2.1.1
- PAYT IE-1.3.2
- Reverse collection of waste IE-1.3.3
- Waste management tools IE-1.3.7
- Flexibility Control Algorithms IE-2.1.3
- City Energy Management System IE-2.1.6
- Low-temperature heat grid IE-2.2.3
- EV sharing IE-3.2.1
- In relation with the City Energy Management system (to be defines also based on LH-cities' best practices):
    - Urban community platform – open innovation, citizen engagement
    - City app with energy consumption & metering and tourist functions & features
    - Smart cloud and (wifi) data acquisition / analytics system

[1] These codes are the identification codes of the IEs defined within the POCITYF project

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

In order to achieve the ambitious vision formulated in the SECAP and to turn Újpest to a smart city, the following EE and development programmes have to be accomplished based on the experience of the POCITYF project.

- Complex renovation of energy efficiency of all residential and public (operated by municipality) buildings.
- PV solar program. PVs installation on the buildings as much as technically possible.
- Development and decarbonization of DH system throughout Újpest.
- Realization of the decarbonization of building's heating systems in all buildings.
- Use of electric or low-emission vehicles.
- Use of public / shared car services and car-pool systems.
- Development of recycling infrastructure, promotion of recycling.
- Creation of some PED areas – based on the sample of development of the PED 1 area – in whole Újpest.

4.3 Designing the replication of ISs

4.3.1 Planning the implementation of the selected technical solutions and ISs in the defined Replication

The area of replication/innovation/development activity has been defined in detail in Section 2.2, itis the PED 1 area. To achieve the main goal – decarbonization of the area, the current energy consumption/demand of the PED 1 area's buildings has been defined.
The detailed data of the buildings can be seen in 7.2.

Summary data of the PED 1 area

Area	Character	Total number of flats equivalent	Total floor area m2	Heat demand MWh/a	Electricity demand MWh/a
ZONE 1	Residential buildings with offices, commercial area	341	20 500	5 350	3 584
	New Market and Event Centre	-	8 000		
ZONE 2	Historic Main Square	-	5 381		
ZONE 3	Residential buildings and offices, scool, church	166	17 300	3 225	596
ZONE 4	Pre-fabricated block house	2 524	151 000	25 587	5 755
ZONE 4	Classical old and quite new residential buildings	297	18 000	3 181	677
ZONE 4	Supplementary educational, medical, commercial and public buildings	-	49 500	5 758	1 421
			269 681	43 082	12 033

Figure 5: Summary data of energy demand of the buildings of the PED1 area

Electricity demand of the HP based on sewage water heat: **1.425 MWh/a.**

Total electricity demand in the PED 1 area: **13.458 MWh/a.**

The selected and planned EE interventions are presented in **Figure 10** (4.2.1).

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POCITYF ISs/IEs selected to be replicated are listed under 4.2.2

As the main goal is to transform the PED 1 area into a positive energy district, so the energies supplied into PED 1 area to be decarbonized. In the coming lines t**he planned energy efficiency interventions** (according to **Figure 4**) and the associated IEs to be replicated will be presented. The wished impact (regarding to energy savings) can be also seen in our calculations.

1. Reducing energy demand

Intervention 1.1: Complex renovation of energy efficiency in some buildings of the PED 1 area

- Wall and roof insulation with circular material
- Changing windows to triple glazing
- Building shading
- Heat recovery ventilation (where it exist)
- Renovation of secondary heating system (low temperature and EE by effective hydraulic control)
- Heat storage system
- Building Energy Management System (BEMS)

Replicated POCITYF ISs/IEs

- Building Management System - BEMS IE-1.1.8
- Home Energy Management Sytem – HEMS IE-1.1.9
- Insulation with circular materials IE-1.1.12
- Triple glazing IE-1.1.13

Detailed calculation of energy savings – building by building – can be seen in 7.3

Remark: Not all buildings of PED 1 area are going to be renovated.

Impact of the intervention:

Total heat demand of the buildings of the PED 1 area - currently:	**43.082 MWh/a**
Total heat demand of the buildings of the PED 1 area - after renovation:	**32.720 MWh/a**
Heat energy savings by complex building renovation:	**10.362 MWh/a**

Intervention1.2: Electricity demand decreases by 10%

As a result of the increasing use of EE domestic equipments and the renovation of lighting, the electricity demand is expected to be reduced by at least 15%. Taking into account the increase in cooling and its surplus electricity demand, the total electricity demand decrease is ~10%.

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Replicated POCITYF ISs/IEs

- Building Management System - BEMS IE-1.1.8
- Home Energy Management System – HEMS IE-1.1.9

Impact of the intervention:

Total electricity demand of the buildings of the PED 1 area - currently:	**13.458 MWh/a**
Total electricity demand of the buildings of the PED 1 area - after decrease:	**12.112 MWh/a**
Power energy savings:	**1.346 MWh/a**

2. Decarbonization of end-use heat energy

Intervention 2.1: Developments by BKM-FŐTÁV, PEF decreased to 0,5 from 0,755 in DH system

The supplied heat by BKM-FŐTÁV (Budapest District Heating) in Újpest are from different sources such as natural gas fired CHP plants and boilers and the waste incineration plant.

Primary Energy Factor (PEF; in Hungarian PEÁT), which means the rate of fossil fuel content of the supplied heat, is 0,755 currently in Újpest. PEF will/would be decreased to 0,7 with short-middle term development in the HUHA (waste incineration plant), and it will/would be decreased to 0,5 with other middle-long term developments (geothermal or other RES) by BKM-FŐTÁV.

Replicated POCITYF ISs/IEs

- The intervention takes place in the BKM-FŐTÁV DH system, there isn't any POCITYF IEs which could be used

Total heat demand of the buildings of the PED 1 area supplied by DH - currently:	**29.451 MWh/a**
Total heat demand of the buildings of the PED 1 area supplied by DH - after building renovation:	**20.238 MWh/a**
Fossil fuel content of DH currently:	**22.235 MWh/a**
Fossil fuel content of DH after building renovation:	**15.280 MWh/a**

Impact of the intervention:

Fossil fuel content of DH after building renovation and BKM-FŐTÁV's middle-long term developments:	**10.119 MWh/a**

Intervention 2.2: Expansion of the heat production of the sewage water heat based HP

A sewage water based HP is installed under the historic main square, which produces heat (heating and cooling) to the City Hall, to the Mayor's Office and to the New Market and Event Centre. It operates by 1,7 MW heat capacity, but its nominal / installed capacity is 4 MW. So, there are 2,3

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MW reserve heat capacity which is able to generate ~4.000 MWh heat a year. Some of the buildings currently supplied by natural gas can be converted to a sewage water heat based HP's usage.

Replicated POCITYF ISs/IEs

- Building Management System - BEMS IE-1.1.8
- Home Energy Management System – HEMS IE-1.1.9
- Low temperature waste heat IE 2.2.5

Buildings converted to sewage water heat based HP's supply in detailed can be seen in 7.4.

Total heat demand of the buildings of the PED 1 area supplied by natural gas currently:	**11.876 MWh/a**
Total heat demand of the buildings of the PED 1 area supplied by natural gas after building renovation:	**10.727 MWh/a**
Fossil fuel content of natural gas supply - currently:	**11.876 MWh/a**
Fossil fuel content of natural gas supply - after building renovation:	**10.727 MWh/a**

Impact of the intervention:

Total heat demand and fossil fuel content of natural gas supply after expansion of the heat production by the sewage water heat based HP:	**6.462 MWh/a**
Decarbonized heat energy:	**4.265 MWh/a**
Surplus electricity (driven energy of HP):	**1.422 MWh/a**

Intervention 2.3: Replacement of gas heating with air/water HP

In order to terminate natural gas as a fossil fuel energy source in the PED area, the replacement of gas heating with air/water HP is required, and it's also an opportunity. Necessary precondition of the replacement is the renovation of secondary (inside) heating system too. Use of VRF/VRV systems – as HP - is welcome.

Buildings where a switch to air/water HP's supply are recommended can be seen in **Figure 14.**, in 7.6.

Replicated POCITYF ISs/IEs

- Building Management System - BEMS IE-1.1.8

- Home Energy Management System – HEMS IE-1.1.9

The total heat demand (and its fossil fuel content) of the buildings of the PED 1 area supplied by natural gas after building renovation and after expansion of the heat production by the sewage water heat based HP:	**6.462 MWh/a**

Impact of the intervention:

Decarbonized heat energy:	**6.462 MWh/a**
Surplus electricity demand (driven energy of HPs):	**2.154 MWh/a**

Also, an alternative solution could be – in buildings with a central heating system – the installation of an innovative, building size biomass boyler instead of HP. In this case decarbonization is ensured, but no additional electricity is generated.

Intervention 2.4 : Creation a 5th Generation District Heating and Cooling (5GDHC) system on PED 1 area

In the long term, BKM-FŐTÁV is going to create a 5GDHC system on PED 1 area in cooperation with Újpest in order to help its decarbonization process.
5GDHC is both theoretically and logically a new system in the development of DH history. The physical realization of 5GDHC can no longer be considered a "district" („distance") service, but rather a "local community" energy service, as switching from the classical practice of transporting heat via a transmission pipeline (grid) from one or more different heat sources (away from consumers) to the end-users.
Applying 5GDHC solution, consumers are connected to each other by 2 closed loops one for warm and the other for cold energy. In addition, consumers are also producers (so called: „prosumers"), all consumers "take out" and "put in" energy into the loops. The temperature of the pipe lines is very low (ambient temperature). In end-user buildings, heat pumps provide heating and cooling. Seasonal and daily-weekly heat storages are required.

Replicated POCITYF ISs/IEs

- Low-temperature heat grid IE 2.2.3
- ATES IE-1.2.7; IE-1.3.5 and 2.2.6
- Smart Distribution Energy System IE-1.2.3
- P2P energy trading platform IE 1.2.4 and IE-2.1.5

5GDHC system - very low grid temperature with seasonal heat storages - much more innovative than IE 2.2.3 and IE 2.2.6, but it includes them. Clear settlement among the prosumers is an

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essential precondition of the operation of a 5GDHC system. An energy community must be created, so, the Smart Distribution Energy System and P2P energy trading platform are welcome.

Total heat demand of the buildings of the PED 1 area supplied by DH currently:	**29.451 MWh/a**
Total heat demand of the buildings of the PED 1 area supplied by DH after building renovation:	**20.238 MWh/a**
Fossil fuel content of DH - currently:	**22.235 MWh/a**
Fossil fuel content of DH - after building renovation:	**15.280 MWh/a**
Fossil fuel content of DH after building renovation and BKM-FŐTÁV's middle-long term developments:	**10.119 MWh/a**

Impact of the intervention:

Fossil fuel content of DH energy[2]:	**0 MWh/a**
Decarbonized heat energy:	**10.119 MWh/a**
Surplus electricity demand (driven energy of HPs):	**4.048 MWh/a**

Summary of the impact of the planned development interventions (1-2.)

Baseline data:

- Total heat demand: 43.082 MWh/a (emission: 8.143 $tCO_{2equivalent}$/a)
  - DH based heat: **29.451 MWh/a** (emission: **5.308 $tCO_{2equivalent}$/a**)
  - Natural gas based heat: **11.876 MWh/a** (emission: **2.835 $tCO_{2equivalent}$/a**)
  - Sewage water based heat: **1.755 MWh/a** (emission: **0 $tCO_{2equivalent}$/a**)[3]
- Total electricity demand: **13.458 MWh/a** (emission: **4.977 $tCO_{2equivalent}$/a**)

Impact of the interventions[4]

- The current total heat demand decreases by **10.362 MWh**/a, from **43.082** to **32.720 MWh/a** (**Int.1.1**).
  - DH based heat: from 29.451 to 20.238 MWh/a
  - Natural gas based heat: from 11.876 to 10.727 MWh/a

[2] Surplus electricity demand of necessary driven energy of HPs is calculated in total electricity demand.

[3] Electricity demand of necessary driven energy of HP is calculated in electricity demand.

[4] The impacts of development interventions are built on each other, so order is also important!

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  - Sewage water based heat: no change

- The current electricity demand decreases by **1.346 MWh**/a, from **13.458** to **12.112 MWh/a** (**Int.1.2**).
- The current fossil fuel content of DH decreases from **22.235** to **15.280 MWh**/a (**Int.1.1**), than to **10.119 MWh/a** (**Int.2.1**).
- The current natural gas demand and its fossil fuel content (100%) decreases from **10.727** to **6.462 MWh/a** (**Int.2.2**).
- The current natural gas demand and its fossil fuel content (100%) decreases from **6.462** to **0 MWh/a** (**Int.2.3**).
- The fossil fuel content of DH after the Int.2.1 decreases from **10.119** to **0 MWh**/a (**Int.2.4**).
- As a result of interventions 2.2, 2.3 and 2.4, natural gas demand ceases, fossil fuel content of DH becomes zero, but the electricity demand grows owing to the driven energy of HPs. The reduced (**Int.1.2**) electricity demand increases from **12.112 MWh/a** to **13.534** (Int.2.2), **15.687** (**Int.2.3**), **19.735 MWh/a** (**Int.2.4**).

- At the end of the process of the development interventions, PED 1 area will be supplied by electricity only: **19.735 MWh/a** (emission: **7.298 $tCO_{2equivalent}$/a**)
  the savings of GHG: 5.822 $tCO_{2equivalent}$/a.

The process of the development interventions and its summarized data can be seen in 7.6.

It can be seen that the decarbonisation of thermal energy can be achieved with the previous interventions, electricity remained the only end-use energy source for the buildings of PED 1, although it has been increased. In order to achieve the goal of making the PED 1 area positive energy district, a **renewable electricity must be generated locally.** It must be **more than** the electricity demand: **19.735 MWh/a**.

3. Production of RES electricity

Intervention 3.1: Installation of PV solar panels on the buildings on site

RES electricity produced by PVs on buildings (and in a parking area) is presented in 7.7.

The maximum electricity that can be produced by PV solar panels on the buildings (and in a parking area) on site: **5.097 MWh/a.** It seems that **this is not enough to cover the electricity demand.**

Replicated POCITYF ISs/IEs

- PV Canopy IE-1.1.2
- Traditional PV Shingle IE-1.1.5
- Bidirectional Smart Inverters IE-1.1.6 and IE-3.1.3
- Energy Routers IE-1.1.7 and IE-1.2.2
- Solar roofs and facades IE-1.1.14

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- Li-ion/Li-metal stationary batteries IE-1.1.17 and IE-1.2.8
- P2P energy trading platform IE 1.2.4 and IE-2.1.5
- Community Solar Farm IE 1.2.5
- 2nd life batteries IE-1.3.1 and IE-2.1.1

Energy storage is an essential condition of the operation of PVs to avoid technical and balance problems in the grid. At the same way, the operation of an energy community system is required.

Intervention 3.2: Installation of PV solar power plant off site

Seeing that the production of PV solar on the buildings is not enough to cover the electricity demand of PED 1 area (5.097 MWh/a versus 19.735 MWh/a), the installation of other solar power plants off site is necessary. Their production can be accounted within the energy community created in the PED 1 area. The required total installed capacity is **~14 MW**, space requirement is **~21 ha**, production **~15.000 MWh/a**.

Replicated POCITYF ISs/IEs

- P2P energy trading platform IE 1.2.4 and IE-2.1.5
- Community Solar Farm IE 1.2.5

4. Energy-management and smaller scale technologies

In our method, the emission and energy consumption of transport and public lighting are not included in the calculation of positive energy district (only building energy is included).

Nevertheless, with regard to SECAP and bold vision of Újpest, some innovative solutions are going to be used/replicated referring to **e-transport**, **public lighting, waste management**, **energy management** and **their combination**.

Prospectively replicated POCITYF ISs/IEs

- Smart Lamp Posts with EV charging and 5G functionalities IE-1.2.1 and IE.3.1.5 – **combination of public lighting and e-transport**
- DC lighting with EV charging IE-1.2.9 and IE-3.1.9 - **combination of public lighting and e-transport**
- Solar road IE-1.2.10 – combination of transport and energy production
- V2G IE-1.2.11; IE-2.1.10 and IE-3.1.4 – combination of e-transport and energy storage
- PAYT IE-1.3.2 – **waste management**
- Reverse collection of waste IE-1.3.3 - **waste management**
- Waste management tools IE-1.3.7 - **waste management**
- Flexibility Control Algorithms IE-2.1.3 – **energy management**

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- City Energy Management System IE-2.1.6 – **energy management**
- EV sharing IE-3.2.1 – **e-transport**

4.3.2 Social acceptance considerations

As the project itself is a preparatory work for later implementation, we only have indirect knowledge / data on social acceptance. In addition, we did not make a specific survey or other relevant inquiry either.

However, data available suggests that the application of any innovative solution is primarily a financial issue for the residents, and financial and regulatory issue for the institutions and service providers. Also, it may not be an overestimation of the current situation and to state that in case residents and / or institutions are equipped with necessary means (funding), they are rather willing to make / help these changes.

Obviously, various financial supports and policies will be vital to make projected changes happen. Residents will need a well-diversified intervention policy, while public institutions and service providers will definitely need grants, external fundings, etc. in a purposeful mix at an acceptable IRR and ROI.

4.4 Financial estimation and resources allocation of the Replication Plan

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

As there is a real need for these changes - detailed in the draft - to make Újpest and Budapest climate resilient, we need to find the “modus operandi” in financial terms, too. This means, it requires an enormous CAPEX which has to be allocated among players and years to come.

The first steps indicate a systemic decrease in consumption and preferable in cost of energy resulting in a feasible net zero status, while all additional layers of this transition process are targeting reproduction of energy on all fronts possible, resulting in self-maintenance at large.

As the projected changes are systemic and are down to a significant upgrade of the running district heating (DH) system, there are many (if not all Újpest residents and institutions) users / beneficiaries of this process.

This comprehensive transition will not be limited just for Újpest, as this DH system is in operation throughout Budapest. As a consequence, the funding of this transition points beyond Újpest or even Budapest. Given the fact that this is a future or an “ASAP” project, it is hard to make an exact forecast for CAPEX and OPEX, although to our best knowledge, we give a rough indication

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on present value. Most probably, some ESCO or ESCO-type funding will be required / applied when implementing this modernisation.

As per the other and more segmented innovative solutions in residential areas, various co-funding policies are to be deployed, including different civic crowd-funding policies (for example for local energy communities) in which the municipality is also a co-funding partner.

Funding of the planned energy efficiency (EE) interventions/investments are presented in Figure 4, 4.2.1- including the associated IEs - is possible according to the table below:

	The planned technical solutions in PED 1 area of Újpest	Feasible financier-investor
1.	**Reducing energy demand**	
1.1	Complex renovation of energy efficiency in some buildings of the PED 1 area	Building owners (condominium community) in the frame of a subsidy investment program
1.2	Electricity demand decreases by 10%	Flat owners
2.	**Decarbonization of end use heat energy**	
2.1	Developments by BKM-FŐTÁV, PEF will/would be decreased to 0,5 from 0,755	BKM-FŐTÁV (DH company)
2.2	Expansion of the heat production of the sewage water heat based HP	The operator company of the existing HP as a DH supplier
2.3	Replacement of gas heating with air/water HP	Building owners (condominium community) in the frame of a subsidy investment program
2.4	Creation a 5th Generation District Heating and Cooling (5GDHC) system on the site	BKM-FŐTÁV (DH company)
3.	**Production of RES electricity**	
3.1	Installation of PV solar panels on the buildings on site	Building owners (condominium community) as an energy community
3.2	Installation of PV solar power plant off site	Business energy investor
4.	**Energy-management and smaller scale technologies**	
	e-transport	Municipality and/or business energy investor
	Public lighting	Municipality and/or BDK (public lighting company in Budapest)
	Waste management	BKM - Budapest Public Utilities Ltd.
	City energy management	Municipality

Figure 6: Possible financing of the technical solutions

4.4.2 Holistic cross-ETT-sectional feasibility study

Although the process will have to move step by step, all innovative solutions have to be orchestrated in one “holistic” system. Consequently, cross-ETT studies will have to take place later on, when other layers of solutions will be identified. (Because of the impacts, costs, etc.)

4.5 Long-term planning towards a Smart City Vision 2050

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There are some complementary studies in Újpest and Budapest, like the SECAP, The Budapest Mobility Plan, but as of today we do not know about any other comprehensive "smart city" proposition or study available. Thus, the POCITYF replication plan together with the EUCF grant outcomes, will play a vital role, around which other future smart concepts and solutions might be built.

Climate protection and energy efficiency bold vision of Újpest for 2050 (based on SECAP of Újpest):

Within the City of Budapest, Újpest (4th district) is a sample district with a low-emission local economic environment that utilizes local resources. The public institutions of the district are 100% energetically renovated, their energy use is covered by more than 50% renewable sources. The climate awareness of the population is considerably increasing, and the use of energy-efficient means of transport and buildings are constantly expanding. Ideally, 90% of the local population will switch to public transport and/or other alternative, non-fossil vehicles.

Main mitigation measures (in Újpest):

- Újpest Green Bond program
- Energy efficiency renovation of residential buildings
- PV solar panel program
- Assessing the potential of geothermal heating
- Establishment and operation of carpool systems for the employees of the municipal offices and institutions
- Development of cycling infrastructure
- Promotion of cycling
- Traffic calming with transport management tools and the development of public transport
- Support for the design of e-chargers
- Establishment and maintenance of a „district energy real estate database"
- Attitude formation - energy savings competition for residential buildings
- Attitude formation - energy savings competition for public and office buildings

Vision 2030 of Budapest (based on SECAP of Budapest):

In 2030, Budapest will have been prepared for the adverse effects of climate change; by ensuring the protection of its natural and built values, by providing energy efficiency improvements, it provides a healthy, green, liveable and attractive environment for its inhabitants, workers and visitors, its sustainable energy use and its innovative and climate-conscious attitude are exemplary for the whole country.

Cornerstones of the Vision 2030 of Budapest:

- one third of the flats in Budapest are undergoing major energy renovation,
- the total capacity of solar panels operating in Budapest will increase to 1500 MW,

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- district heating is supplied using at least 50% renewable energy, 50% waste heat, 75% cogeneration or 50% combinations of such energy and heat,
- the proportion of car users is reduced to at least 30%
- the size of green areas increases by 1 m^2 per person,

Main mitigation measures (in Budapest):

- Energy modernization and energy-conscious operation of the buildings and facilities of the Municipality of Budapest and companies providing public services
- Reconstruction of public lighting network, energy modernization
- Energy modernization of residential buildings
- Promoting PV's developments
- Development of district heating system, making it more environmentally friendly (reconstruction, increasing the share of renewable energy sources, etc.)
- Carrying out basic surveys and research on the feasibility and application of sustainable energy management and the circular economy
- Facilitate mitigation and decarbonization of industrial production and service facilities
- Development of public transport with attractive vehicles and services, better infrastructure
- Development of cycling and walking infrastructure
- Promotion of the use of electric or low-emission vehicles
- Promoting the use of public car and carpool systems

Defined goals in the Balázs Mór Plan- Budapest Mobility Plan 2014-2030 (SUD of Budapest):

The Balázs Mór Plan - Budapest Mobility Plan [4] in 2014-2030 defines as a comprehensive goal that "the transport system of the Capital should improve the competitiveness of Budapest and its City Area and contribute to the creation of a sustainable, liveable, attractive and healthy urban environment". It quotes from the White Paper on transport of European Commission [0] as follows:

„The challenge is to break the transport system's dependence on oil without sacrificing its efficiency and compromising mobility. In line with the flagship initiative 'Resource-efficient Europe' set up in the Europe 2020 strategy and the new 'Energy efficiency plan 2011', the paramount goal of European transport policy is to help establish a system that underpins European economic progress, enhances competitiveness and offers high-quality mobility services while using resources more efficiently. ***In practice, transport has to use less and cleaner energy, better exploit a modern infrastructure and reduce its negative impact on the environment*** *and key natural assets like water, land and ecosystems."*

Cornerstones of Vision for 2050 based on SECAP of Újpest and Budapest (as a harmony of the two SECAP):

- Energy efficiency renovation of residential and public (operated by municipality) buildings

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- PV solar panel program
- Development and decarbonization of DH system
- Promoting the decarbonization of building's heating systems
- Promotion of the use of electric or low-emission vehicles
- Promoting the use of public / shared car services and car-pool systems
- Development of recycling infrastructure, promotion of recycling
- Promoting the creation of PED areas in Újpest

PED 1 area is to become a positive energy district (as pilot) by 2040 and the whole Újpest by 2050, while creating as much similar PED areas as possible in Újpest, in parallel with the development of PED 2 and others.

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5 Conclusions

As a conclusion we can say that following the steps presented in detail in Chapter 4 of our document, we would be able to achieve the goals set at the beginning of this deliverable such as turning a part of Újpest to a Positive Energy District. Nevertheless, we have to keep in mind that we can implement the necessary technical transformations only if all legal, technical, financial and social barriers would be wiped out and with all this we still have to take into consideration the constantly changing socio-economic environment of nowadays. Most of all:

- Background technological conditions are struggling to keep pace with the growing demand for renewable energy development, especially for solar installations. Beside the best practices and experiences with energy communities could serve as a drive of the energy transition.
- Uncertainty about the availability of funds to support energy efficiency improvements, while central and local government financial commitments/supports are inevitable.
- Record-high energy price increases at the end of 2021 and beginning of 2022 put significant pressures on the purchasing power of consumers, however it may have positive impact on payback time of energy savings.
- Legislation needs to be adapted to a constantly changing energy market and technological environment.

With all these challenges already visible and countless more to come, the project may achieve its goal as the PED 1 area of Újpest becoming a positive energy district (as pilot) by 2040 while Újpest at large by 2050.

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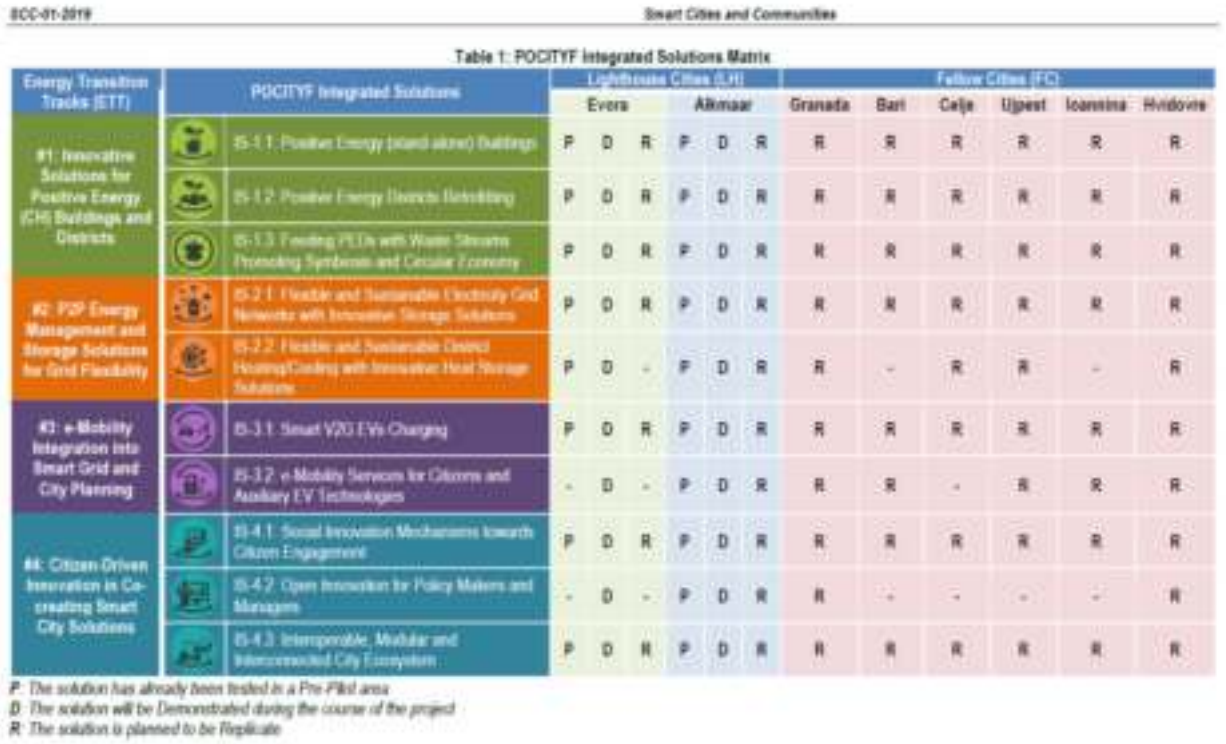
7 Annexes

7.1 Annex 1:

Integrated Solutions Matrix



SCC-01-2019 Smart Cities and Communities

Table 1: POCITYF Integrated Solutions Matrix

Energy Transition Tracks (ETT)	POCITYF Integrated Solutions	Lighthouse Cities (LH)						Fellow Cities (FC)					
		Evora			Alkmaar			Granada	Bari	Celje	Ujpest	Ioannina	Hvidovre
#1: Innovative Solutions for Positive Energy (CH) Buildings and Districts	I5-1.1: Positive Energy (stand-alone) Buildings	P	D	R	P	D	R	R	R	R	R	R	R
	I5-1.2: Positive Energy Districts Retrofitting	P	D	R	P	D	R	R	R	R	R	R	R
	I5-1.3: Feeding PEDs with Waste Streams Promoting Symbiosis and Circular Economy	P	D	R	P	D	R	R	R	R	R	R	R
#2: P2P Energy Management and Storage Solutions for Grid Flexibility	I5-2.1: Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions	P	D	R	P	D	R	R	R	R	R	R	R
	I5-2.2: Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions	P	D	-	P	D	R	R	-	R	R	-	R
#3: e-Mobility Integration into Smart Grid and City Planning	I5-3.1: Smart V2G EVs Charging	P	D	R	P	D	R	R	R	R	R	R	R
	I5-3.2: e-Mobility Services for Citizens and Auxiliary EV Technologies	-	D	-	P	D	R	R	R	-	R	R	R
#4: Citizen Driven Innovation in Co-creating Smart City Solutions	I5-4.1: Social Innovation Mechanisms towards Citizen Engagement	P	D	R	P	D	R	R	R	R	R	R	R
	I5-4.2: Open Innovation for Policy Makers and Managers	-	D	-	P	D	R	R	-	-	-	-	R
	I5-4.3: Interoperable, Modular and Interconnected City Ecosystem	P	D	R	P	D	R	R	R	R	R	R	R

P: The solution has already been tested in a Pre-Pilot area
D: The solution will be Demonstrated during the course of the project
R: The solution is planned to be Replicate

Figure 7: Integrated Solutions Matrix defined in POCITYF project

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

7.2 Annex 2:

			End-use energy demand			
Type and function	Building ID	Current heating type	Heating MWh/a	DHW MWh/a	Total heat MWh/a	Electricity MWh/a
1 storey residential	Liszt Ferenc u. 16.	Natural gas	87,0	13,2	100,2	11,8
1 storey residential	Vereblényi u. 9.	Natural gas	36,1	6,7	42,8	6,9
1 storey residential	Vereblényi u. 11.	Natural gas	43,5	11,1	54,6	11,4
1 storey residential	Vereblényi u. 13.	Natural gas	60,9	15,6	76,5	16,0
4 storey residential + commercial, office	Károlyi István u. 27-29.	Natural gas	274,1	77,8	351,8	79,9
4 storey residential + commercial, office	Liszt F. 12-14. (Vereblényi corner)	Natural gas	274,1	77,8	351,8	79,9
5 storey residential + commercial, office	Liszt F. u. 10.	Natural gas	234,9	66,7	301,6	68,4
4 storey residential + commercial, office	Liszt F. u. 8. (Berzsenyi corner)	Natural gas	383,7	108,9	492,6	111,7
3 storey residential	Berzsenyi Dergely u. 9-11.	Natural gas	103,8	28,8	132,7	29,6
3 storey residential + commercial, office	Berzsenyi Dergely u. 13.	Natural gas	136,1	37,8	173,9	38,8
4 storey residential + commercial, office	Károlyi István u. 19.	Natural gas	274,1	77,8	351,8	79,9
4 storey residential + commercial, office	Károlyi István u. 21-23.	Natural gas	399,3	113,3	512,7	116,3
4 storey residential + commercial, office	Károlyi István u. 25.	Natural gas	399,3	113,3	512,7	116,3
New Market and Event Centre	Szent István tér 15-16.	HP based sewage water			950	2 517,4
City Hall	István út 14.	HP based sewage water and natural gas			950	289,7
					5 350	3 584

Figure 8: Energy demand of the buildings of Zone 1-2

			End-use energy demand			
Type and function	Building ID	Current heating type	Heating MWh/a	DHW MWh/a	Total heat MWh/a	Electricity MWh/a
1-3 storey residential	Templom u. 1.	Natural gas	147,9	20,0	167,9	34,2
1-3 storey residential	Szent István tér 16.	Natural gas	98,6	22,2	120,8	22,8
1-3 storey residential	Szent István tér 17.	Natural gas	88,7	15,6	104,3	20,5
1-3 storey residential	Szent István tér 18.	Natural gas	118,3	20,0	138,3	27,4
1-3 storey residential	Szent István tér 19.	Natural gas	118,3	6,7	125,0	27,4
1-3 storey residential	Szent István tér 20.	Natural gas	98,6	17,8	116,4	22,8
1-3 storey residential	Szent István tér 22.	Natural gas	78,9	13,3	92,2	18,2
1-3 storey residential	Templom u. 3.	Natural gas	28,6	3,3	32,9	6,8
1-3 storey residential	Lőrinc u. 27.	Natural gas	9,9	1,1	11,0	2,3
1-3 storey residential	Lőrinc u. 29.	Natural gas	29,6	3,3	32,9	6,8
1-3 storey residential	Lőrinc u. 31.	Natural gas	29,6	3,3	32,9	6,8
1-3 storey residential	Lőrinc u. 33.	Natural gas	29,6	3,3	32,9	6,8
1-3 storey residential	Lőrinc u. 39.	Natural gas	29,6	3,3	32,9	6,8
1-3 storey residential	Lőrinc u. 41.	Natural gas	39,4	8,9	48,3	9,1
1-3 storey residential	Lőrinc u. 43.	Natural gas	98,6	22,2	120,8	22,8
1-3 storey residential	Mikly Lajos u. 2.	Natural gas	88,7	20,0	108,7	20,5
1-3 storey residential	Mikly Lajos u. 2/a	Natural gas	88,7	20,0	108,7	20,5
Notarial Chamber	Mikly Lajos u. 4.	Natural gas			200	40
Post Office	Mikly Lajos u. 6. - Lőrinc z 47.-István 18.	Natural gas			420	118,2
Pécsi Sebestyén Music School	Lőrinc z u. 35-37.	Natural gas			688,6	96,7
Presbytery (roman catholic)	Szent István tér 21.	Natural gas	59,2	6,7	65,8	35.202
Church (roman catholic)	Szent István tér	Natural gas	78,9	0	78,9	
Church, reformed pastoral office, shop	Szent István tér 24.	Natural gas	98,6	11,1	109,7	17,5
István office building and shops	Szent István tér 25.	Natural gas	256,4	28,9	285,2	45,5
					3 225	596

Figure 9:Energy demand of the buildings of Zone 3

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

Type and function	Building ID	Current heating type	End-use energy demand			
			Heating MWh/a	DHW MWh/a	Total heat MWh/a	Electricity MWh/a
11 storey residential	Deák Ferenc utca 51-63.	DH	1 591	668	2 259	438
11 storey residential	Deák Ferenc utca 63-73.	DH	1 405	662	2 067	438
11 storey residential	Deák Ferenc utca 75-83.	DH	1 012	462	1 474	292
11 storey residential	Lebstück Mária utca 47-53.	DH	1 568	789	2 357	584
11 storey residential	Lebstück Mária utca 55-61.	DH	841	740	1 582	584
11 storey residential	Lebstück Mária utca 63-69.	DH	1 863	780	2 643	584
4-5 storey residential	Lebstück Mária utca 48-56.	DH	259	140	399	109
11 storey residential	Petőfi utca 12-14.	DH	878	288	1 166	274
11 storey residential	Petőfi utca 16-18.	DH	851	477	1 328	274
11 storey residential	Petőfi utca 20-22.	DH	827	368	1 195	274
11 storey residential	Petőfi utca 24-26.	DH	277	227	504	146
11 storey residential	Virág utca 35-37.	DH	523	207	730	146
11 storey residential	Virág utca 39-41.	DH	630	188	798	146
11 storey residential	Rózsa utca 50-56.	DH	1 850	825	2 675	584
11 storey residential	Rózsa utca 42-48.	DH	1 701	830	2 532	584
4-5 storey residential	István út 21-27.	DH				128
4-5 storey residential	Lőrinc u. 89.	DH	753	242	995	21
4-5 storey residential	Király u. 2.	DH				21
4-5 storey residential	Berzsenyi út 1-11.	DH	659	224	883	132
					25 587	5 755

Figure 10: Energy demand of the buildings of Zone 4 – pre-fabricated block houses

Type and function	Building ID	Current heating type	End-use energy demand			
			Heating MWh/a	DHW MWh/a	Total heat MWh/a	Electricity MWh/a
3 storey residential	Jókai u. 2/B.	Natural gas	73,1	17,8	90,9	18,2
3 storey residential	Jókai u. 4.	Natural gas	140,9	40,0	180,9	41,0
Youth hostel	Jókai u. 5.	Natural gas	195,8	55,6	251,3	57,0
3 storey residential	Jókai u. 6. - Kavsai u. 39.	Natural gas	174,0	44,4	218,4	45,6
4 storey residential	Petőfi u. 8.	Natural gas	217,5	55,6	273,1	57,0
3 storey residential	Kavsai u. 41.	Natural gas	78,3	20,0	98,3	20,5
4 storey residential	Kavsai u. 46.	Natural gas	156,6	44,4	201,0	45,6
1 storey residential	Kavsai u. 47.	Natural gas	9,9	2,2	12,1	2,3
4 storey residential	Kavsai u. 48.	Natural gas	140,9	40,0	180,9	41,0
4 storey residential	Kavsai u. 48/A.	Natural gas	86,1	24,4	110,6	25,1
4 storey residential	Kavsai u. 49.	Natural gas	104,4	22,2	126,6	22,8
3 storey residential	Kavsai u. 51.	Natural gas	104,4	26,7	131,1	27,4
3 storey residential	Kavsai u. 50-52/A-B.	Natural gas	266,2	75,6	341,8	77,5
3 storey residential	Kavsai u. 53.	Natural gas	95,7	24,4	120,1	25,1
3 storey residential	Kavsai u. 54.	Natural gas	87,0	22,2	109,2	22,8
4 storey residential	Kavsai u. 56-58.	Natural gas	338,0	82,2	420,2	88,4
1 storey residential	Kavsai u. 60.	Natural gas	69,6	17,8	87,4	18,2
4 storey residential	Kavsai u. 60/A.	Natural gas	91,4	22,2	113,6	22,8
3 storey residential	Király u. 38.	Natural gas	91,4	22,2	113,6	22,8
					3 181	677

Figure 11: Energy demand of the buildings of Zone 4 – classical old and quite new residential buildings

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

			End-use energy demand			
			Heating	DHW	Total heat	Electricity
Type and function	Building ID	Current heating type	MWh/a	MWh/a	MWh/a	MWh/a
Mayor's Office	István út 15.	HP based sewage water and natural gas			504	176,4
Újpest Culture Centre	István út 17-19.	Natural gas			247,3	76,4
Szabó Ervin Library	Király u. 5.	Natural gas			203,9	31,9
Mixed commercial building	Király u. 23.	Natural gas			170	25
"Árpád" shopping centre	Árpád út 112.	Natural gas			700	150
Mixed commercial building	Petőfi u. 20.	Natural gas	49,3	0,0	49,3	9,9
"Kokté" shopping centre	Király u. 9. - Kossuth u. 43-45.	DH	184,8	0,0	184,8	17,6
"Király 11" commercial centre	Király u. 11.	DH	59,6	0,0	59,6	9
Fitness centre	Király u. 13.	DH	30,6	10,9	41,5	9
Government's and Municipality's Building	Király u. 12-14.	DH	144,6	17,7	162,3	24,2
"Bársonyvirág" elderly home	Király u. 15.	DH	380,6	39,5	420,1	21,4
"Újpest Király" pharmacy	Király u. 17.	DH	47,4	0,0	47,4	24,6
"Királykert" kindergarten	Király u. 18.	DH	78,3	15,7	98,9	8
Medical centre	Király u. 19.	DH	136,7	21,4	158,1	35
Mixed commercial building	Király u. 25.	DH	54,3	40,4	94,8	25
Mixed commercial building	Király u. 27.	DH	95,4	69,4	164,8	25
Mixed commercial building	Deák F. u. 47.	DH	34,2	0,0	34,2	14
"Liget" kindergarten	Rózsaliget köz 1.	DH	117,8	15,6	133,4	14,1
IV/12. nursery	Rózsaliget köz 3.	DH	144,7	21,6	166,3	11,5
"Újpesti Károlyi István" school centre	Erzsébet u. 69.	DH	1 055,6	58,0	1 113,6	577,6
"Kozma Lajos" school centre	Deák Ferenc u. 40.	DH	913,8	75,2	989,1	138,1
					5 728	1 425

Figure 12: Energy demand of the buildings of Zone 4 – supplementary educational, medical, commercial and public buildings

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

7.3 Annex 3

Complex renovation of energy efficiency in some buildings of the PED 1 area					
Type and function	Building ID	Current heating type	Heating demand before MWh/a	Heating demand after MWh/a	Heating demand savings MWh/a
11 storey residential	Deák Ferenc utca 51-61.	DH	2 259	1 474	785
11 storey residential	Deák Ferenc utca 63-73.	DH	2 067	1 368	699
11 storey residential	Deák Ferenc utca 75-81.	DH	1 474	971	502
11 storey residential	Lebstück Mária utca 47-53.	DH	2 357	1 573	784
11 storey residential	Lebstück Mária utca 55-61.	DH	1 582	1 523	59
11 storey residential	Lebstück Mária utca 63-69.	DH	2 643	1 724	919
4-5 storey residential	Lebstück Mária utca 48-56.	DH	399	388	11
11 storey residential	Petőfi utca 12-14.	DH	1 166	739	427
11 storey residential	Petőfi utca 16-18.	DH	1 328	899	430
11 storey residential	Petőfi utca 20-22.	DH	1 195	785	410
11 storey residential	Petőfi utca 24-26.	DH	504	486	18
11 storey residential	Virág utca 35-37.	DH	730	473	257
11 storey residential	Virág utca 39-41.	DH	798	502	295
11 storey residential	Rózsa utca 50-56.	DH	2 675	1 758	917
11 storey residential	Rózsa utca 42-48.	DH	2 532	1 683	849
4-5 storey residential	István út 23-27.	DH			
4-5 storey residential	Lőrinc u. 49.	DH	995	630	366
4-5 storey residential	Király u. 2.	DH			
4-5 storey residential	Bercsényi út 1-11.	DH	883	562	321
3 storey residential	Jókai u. 6. - Kassai u. 39.	Natural gas	218	135	84
4 storey residential	Petőfi u. 8.	Natural gas	273	169	104
3 storey residential	Kassai u. 41.	Natural gas	98	61	38
3 storey residential	Kassai u. 54.	Natural gas	109	67	42
4 storey residential	Kassai u. 56-58.	Natural gas	420	258	162
3 storey residential	Király u. 10.	Natural gas	114	70	44
1-3 storey residential	Templom u. 1.	Natural gas	168	126	42
Notarial Chamber	Mády Lajos u. 4.	Natural gas	200	150	50
Post Office	Mády Lajos u. 6. - Lőrinc u 47.	Natural gas	420	315	105
Pécsi Sebestyén Music School	Lőrinc u. 35-37.	Natural gas	639	479	160
István office building and shops	Szent István tér 25.	Natural gas	285	228	57
Újpest Culture Centre	István út 17-19.	Natural gas	247	161	87
Szabó Ervin Library	Király u. 5.	Natural gas	204	133	71
Mixed commercial building	Király u. 23.	Natural gas	170	136	34
"Király 11" commercial centre	Király u. 11.	DH	60	32	27
Fitness centre	Király u. 13.	DH	41	27	15
Government's and Municipality's Building	Király u. 12-14.	DH	162	94	68
"Bársonyszívek" old people's home	Király u. 15.	DH	420	242	178
"Újpest Király" pharmacy	Király u. 17.	DH	47	26	22
"Királykert" kindergarten	Király u. 18.	DH	94	75	19
Medical centre	Király u. 19.	DH	158	93	65
Mixed commercial building	Király u. 25.	DH	95	76	19
Mixed commercial building	Király u. 27.	DH	165	132	33
Mixed commercial building	Deák F. u. 47.	DH	34	27	7
"Ujpet" kindergarten	Rózsaliget köz 1.	DH	133	107	27
IV/12. nursery	Rózsaliget köz 3.	DH	166	133	33
"Újpesti Károlyi István" school centre	Erzsébet u. 69.	DH	1 114	891	223
"Kozma Lajos" school centre	Deák Ferenc u. 40.	DH	989	563	426
1 storey residential	Liszt Ferenc u. 16.	Natural gas	109	82	27
2 storeys residential + commercial, office	Berzeviczy Gergely u. 13.	Natural gas	171	128	43
			33 112	22 750	10 362

Figure 13: List of buildings where complex renovation is recommended

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

7.4 Annex 4

Buildings converted to sewage water heat based HP's supply			
Type and function	Building ID	Current heating type	Heating demand after building renovation MWh/a
Presbytery (roman catholic)	Szent István tér 21.	Natural gas	66
Church (roman catholic)	Szent István tér	Natural gas	79
Church, reformed pastoral office, shop	Szent István tér 24.	Natural gas	110
István office building and shops	Szent István tér 25.	Natural gas	228
4 storey residential + commercial, office	Károlyi István u. 27-29.	Natural gas	352
4 storey residential + commercial, office	Liszt F. 12-14. (Venetiáner corner)	Natural gas	352
5 storey residential + commercial, office	Liszt F. u. 10.	Natural gas	302
4 storey residential + commercial, office	Liszt F. u. 8. (Berzeviczy corner)	Natural gas	493
3 storey residential	Berzeviczy Gergely u. 9-11.	Natural gas	131
3 storey residential + commercial, office	Berzeviczy Gergely u. 13.	Natural gas	128
4 storey residential + commercial, office	Károlyi István u. 19.	Natural gas	352
4 storey residential + commercial, office	Károlyi István u. 21-23.	Natural gas	513
4 storey residential + commercial, office	Károlyi István u. 25.	Natural gas	513
City Hall	István út 14.	Natural gas	490
Mayor's Office	István út 15.	Natural gas	159
			4 265

Figure 14: List of buildings where switch to sewage water heat based HP is recommended

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

7.5 Annex 5

Buildings converted to air/water HP's supply			
Type and function	Building ID	Current heating type	Heating demand after building renovation and expansion of sewage water heat based HP MWh/a
3 storey residential	Jókai u. 2/B.	Natural gas	91
3 storey residential	Jókai u. 4.	Natural gas	181
Youth hostel	Jókai u. 5.	Natural gas	251
3 storey residential	Jókai u. 6. - Kassai u. 39.	Natural gas	135
4 storey residential	Petőfi u. 8.	Natural gas	169
3 storey residential	Kassai u. 41.	Natural gas	61
4 storey residential	Kassai u. 46.	Natural gas	201
1 storey residential	Kassai u. 47.	Natural gas	12
4 storey residential	Kassai u. 48.	Natural gas	181
4 storey residential	Kassai u. 48/A.	Natural gas	111
4 storey residential	Kassai u. 49.	Natural gas	127
3 storey residential	Kassai u. 51.	Natural gas	131
3 storey residential	Kassai u. 50-52/A-B.	Natural gas	342
3 storey residential	Kassai u. 53.	Natural gas	120
3 storey residential	Kassai u. 54.	Natural gas	67
4 storey residential	Kassai u. 56-58.	Natural gas	258
3 storey residential	Kassai u. 60.	Natural gas	87
4 storey residential	Kassai u. 60/A.	Natural gas	114
3 storey residential	Király u. 10.	Natural gas	70
1-3 storey residential	Templom u. 1.	Natural gas	126
1-3 storey residential	Szent István tér 16.	Natural gas	121
1-3 storey residential	Szent István tér 17.	Natural gas	104
1-3 storey residential	Szent István tér 18.	Natural gas	130
1-3 storey residential	Szent István tér 19.	Natural gas	125
1-3 storey residential	Szent István tér 20.	Natural gas	116
1-3 storey residential	Szent István tér 22.	Natural gas	92
1-3 storey residential	Templom u. 3.	Natural gas	33
1-3 storey residential	Lőrinc u. 27.	Natural gas	11
1-3 storey residential	Lőrinc u. 29.	Natural gas	33
1-3 storey residential	Lőrinc u. 31.	Natural gas	33
1-3 storey residential	Lőrinc u. 33.	Natural gas	33
1-3 storey residential	Lőrinc u. 39.	Natural gas	33
1-3 storey residential	Lőrinc u. 41.	Natural gas	48
1-3 storey residential	Lőrinc u. 43.	Natural gas	121
1-3 storey residential	Mády Lajos u. 2.	Natural gas	109
1-3 storey residential	Mády Lajos u. 2/a	Natural gas	109
Notarial Chamber	Mády Lajos u. 4.	Natural gas	150
Post Office	Mády Lajos u. 6. - Lőrinc 47.-István	Natural gas	315
Pécsi Sebestyén Music School	Lőrinc u. 35-37.	Natural gas	479
Újpest Culture Centre	István út 17-19.	Natural gas	161
Szabó Ervin Library	Király u. 5.	Natural gas	133
Mixed commercial building	Király u. 23.	Natural gas	136
"Árpád" shoping centre	Árpád út 112.	Natural gas	700
Mixed commercial building	Petőfi u. 28.	Natural gas	49
1 storey residential	Liszt Ferenc u. 16.	Natural gas	82
1 storey residential	Venetiáner u. 9.	Natural gas	33
1 storey residential	Venetiáner u. 11.	Natural gas	55
1 storey residential	Venetiáner u. 13.	Natural gas	76
			6 462

Figure 15: List of buildings where switch to air/water HP is recommended

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

7.6 Annex 6

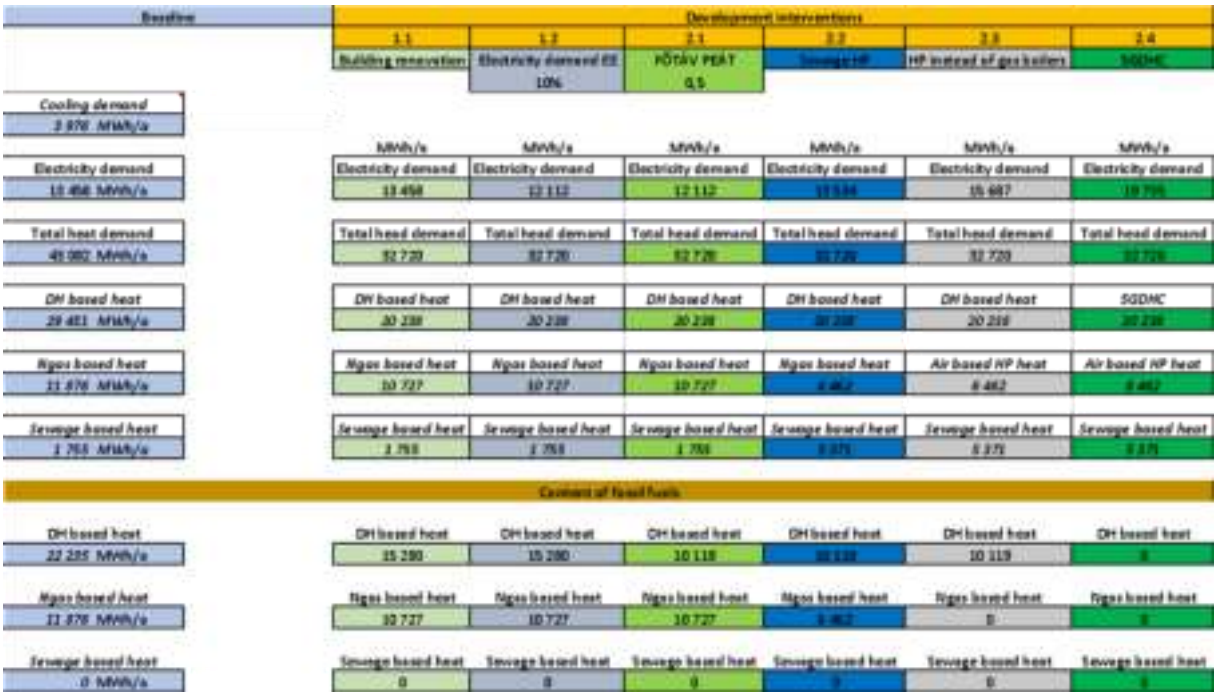


Figure 16: Process of the development interventions

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

7.7 Annex 7

PV solar on the buildings and (in a parking area) of PED 1 area		
Type and function	Building ID	Produced electricity by PV MWh/a
11 storey residential	Deák Ferenc utca 51-61.	228
11 storey residential	Deák Ferenc utca 63-73.	228
11 storey residential	Deák Ferenc utca 75-81.	152
11 storey residential	Lebstück Mária utca 47-53.	193
11 storey residential	Lebstück Mária utca 55-61.	193
11 storey residential	Lebstück Mária utca 63-69.	193
4-5 storey residential	Lebstück Mária utca 48-56.	102
11 storey residential	Petőfi utca 12-14.	100
11 storey residential	Petőfi utca 16-18.	100
11 storey residential	Petőfi utca 20-22.	100
11 storey residential	Petőfi utca 24-26.	78
11 storey residential	Virág utca 35-37.	78
11 storey residential	Virág utca 39-41.	78
11 storey residential	Rózsa utca 50-56.	193
11 storey residential	Rózsa utca 42-48.	193
4-5 storey residential	István út 23-27.	108
4-5 storey residential	Lőrinc u. 49.	36
4-5 storey residential	Király u. 2.	36
4-5 storey residential	Bercsényi út 1-11.	108
Notarial Chamber	Mády Lajos u. 4.	45
Post Office	Mády Lajos u. 6. - Lőrincz 47.-István 18.	110
Pécsi Sebestyén Music School	Lőrincz u. 35-37.	80
Újpest Culture Centre	István út 17-19.	90
Szabó Ervin Library	Király u. 5.	78
Mixed commercial building	Király u. 23.	97
"Árpád" shoping centre	Árpád út 112.	259
Mixed commercial building	Petőfi u. 28.	27
"Koktél" shoping centre	Király u. 9. - Kassai u. 43-45.	50
"Király 11" commercial centre	Király u. 11.	27
Fitness centre	Király u. 13.	42
Government's and Municipality's Building	Király u. 12-14.	80
"Bársonyszívek" old people's home	Király u. 15.	99
"Újpest Király" pharmacy	Király u. 17.	32
"Királykert" kindergarten	Király u. 18.	55
Medical centre	Király u. 19.	74
Mixed commercial building	Király u. 25.	35
Mixed commercial building	Király u. 27.	48
Mixed commercial building	Deák F. u. 47.	65
"Liget" kindergarten	Rózsaliget köz 1.	49
IV/12. nursery	Rózsaliget köz 3.	80
"Újpesti Károlyi István" school centre	Erzsébet u. 69.	385
"Kozma Lajos" school centre	Deák Ferenc u. 40.	307
New Market and Event Centre	Szent István tér 13-14.	245
Main squire parking area	Szent István tér	185
		5 097

Figure 17: RES electricity produced by PVs on buildings and a parking area

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