TIMEPAC The new EPC for Europe

Identification of energy efficiency measures and renewable energy system integration

Ružica Jurjević

Consultant, Energy Insitute Hrvoje Požar

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- **Implementation EE measures – neighbourhood level**
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- *Neighbourhood (Veslačko naselje) – EE measures implementation*
- *Technical evaluation of EE measures*
- *Economic evaluation of EE measures - CBA analysis*

Introduction

Implementation of energy efficiency measures

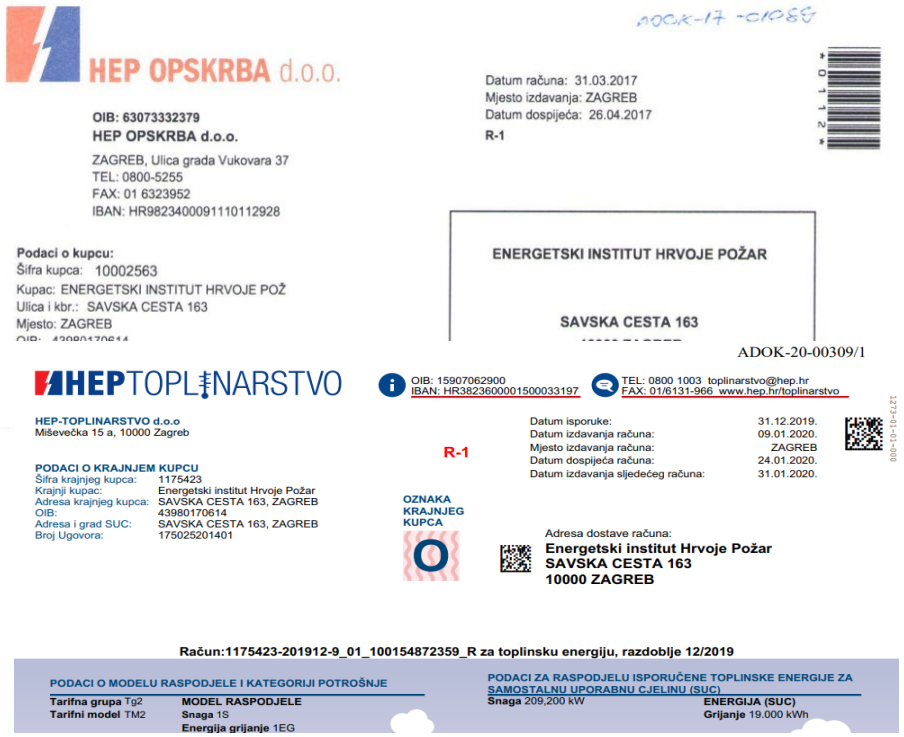
Introduction

Current state

Implementation of energy efficiency measures

Input data

1 Energy consumption
Technical data, occupancy, usage schedules



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ADOK-17 -01089

Datum računa: 31.03.2017
Mjesto izdavanja: ZAGREB
Datum dospijeća: 26.04.2017
R-1

Podaci o kupcu:
Šifra kupca: 10002563
Kupac: ENERGETSKI INSTITUT HRVOJE POŽ
Ulica i kbr.: SAVSKA CESTA 163
Mjesto: ZAGREB

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PODACI O KRAJNJEM KUPCU
Šifra krajnjeg kupca: 1175423
Krajnji kupac: Energetski institut Hrvoje Požar
Adresa krajnjeg kupca: SAVSKA CESTA 163, ZAGREB
OIB: 43980170614
Adresa i grad SUC: SAVSKA CESTA 163, ZAGREB
Broj Ugovora: 175025201401

R-1

Datum isporuke: 31.12.2019.
Datum izdavanja računa: 09.01.2020.
Mjesto izdavanja računa: ZAGREB
Datum dospijeća računa: 24.01.2020.
Datum izdavanja sljedećeg računa: 31.01.2020.

OZNAKA KRAJNJEG KUPCA
O

Adresa dostave računa:
Energetski institut Hrvoje Požar
SAVSKA CESTA 163
10000 ZAGREB

Račun:1175423-201912-9_01_100154872359_R za toplinsku energiju, razdoblje 12/2019

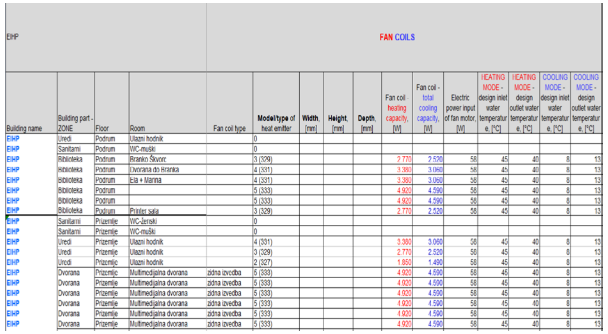
PODACI O MODELU RASPODJELE I KATEGORIJI POTROŠNJE
Tarifna grupa Tg2
Tarifni model TM2
MODEL RASPODJELE
Snaga 1S
Energija grijanje 1EG

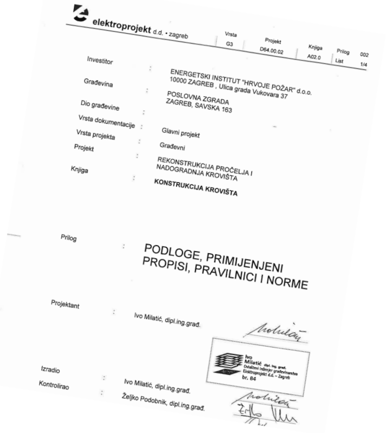
PODACI ZA RASPODJELU ISPORUČENE TOPLINSKE ENERGIJE ZA SAMOSTALNU UPORABNU CJELINU (SUC)
Snaga 209,200 kW
ENERGIJA (SUC)
Grijanje 19.000 kWh

Input data

1 Energy consumption
Technical data, occupancy, usage schedules

2 Construction and technical building system data





Input data

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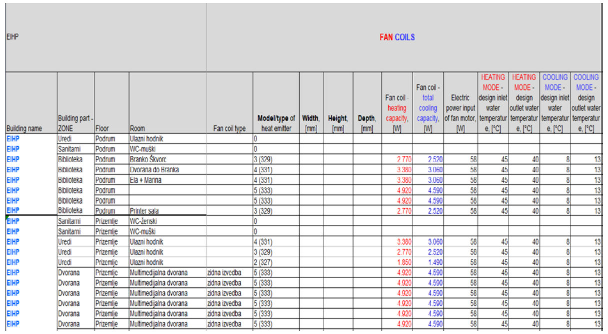
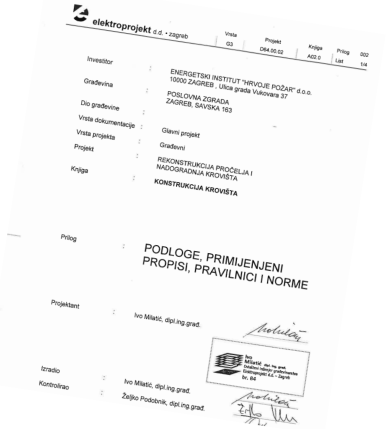
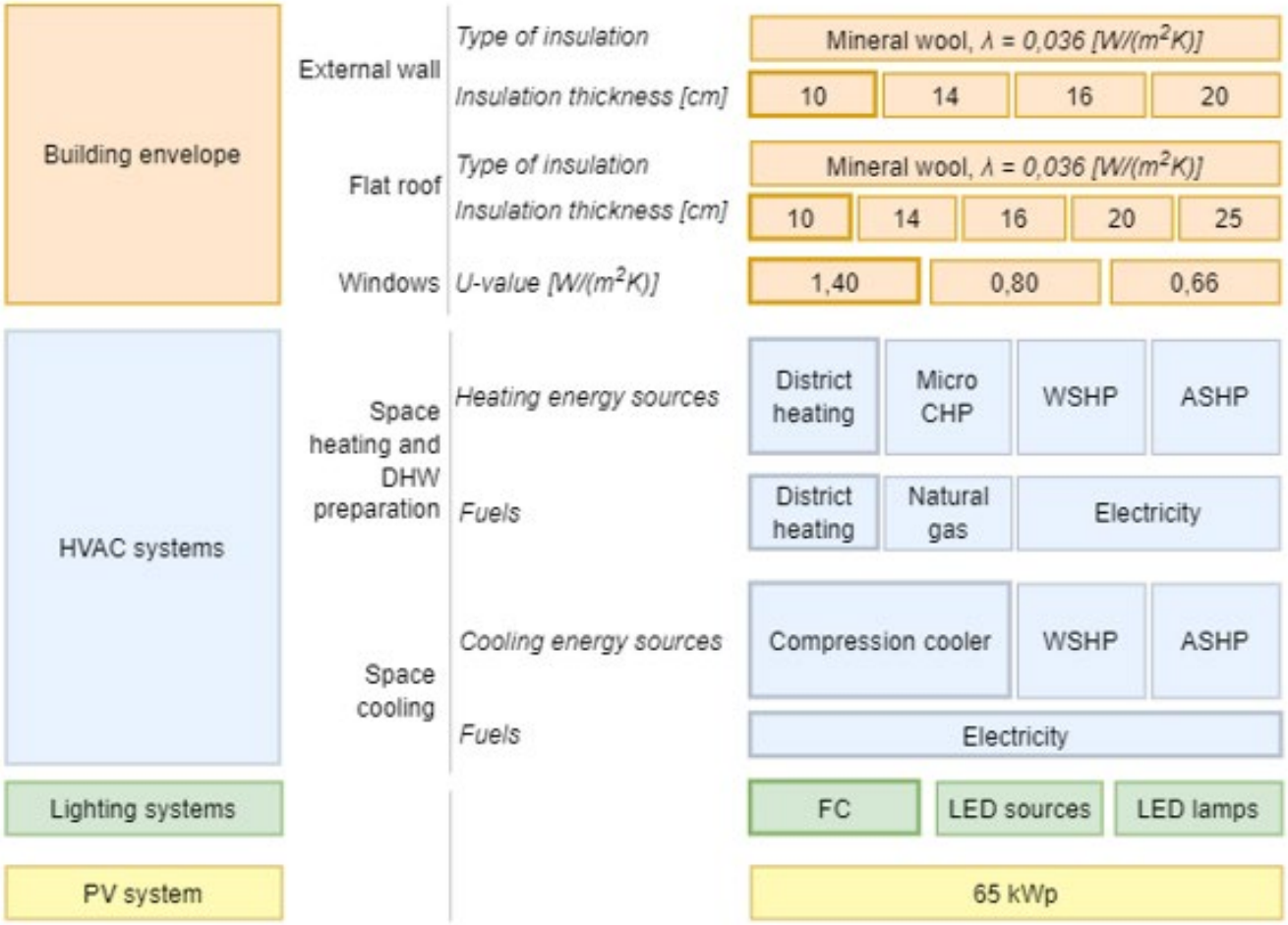




3 Weather data

Energy efficiency measures – office building EIHP



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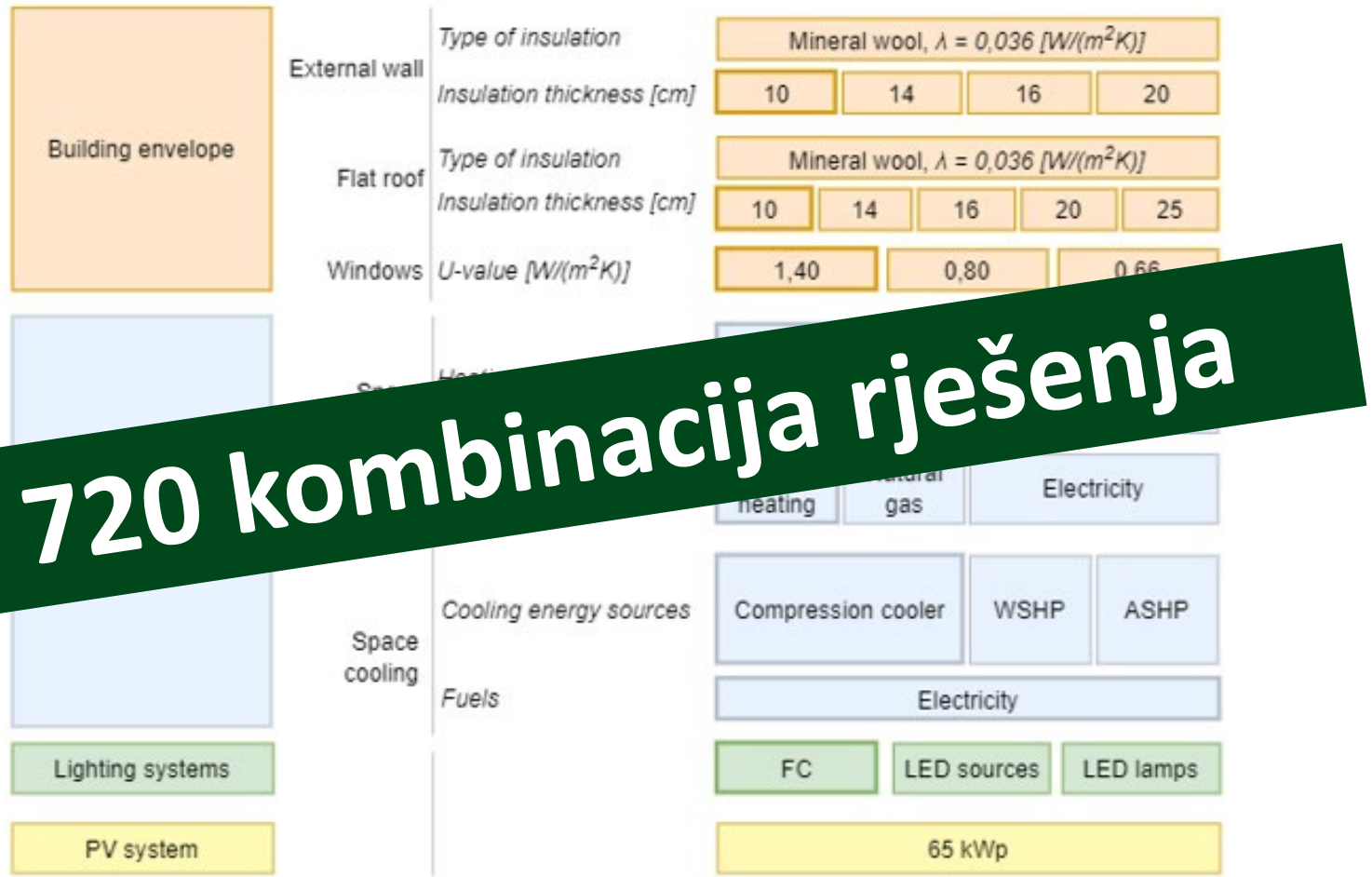
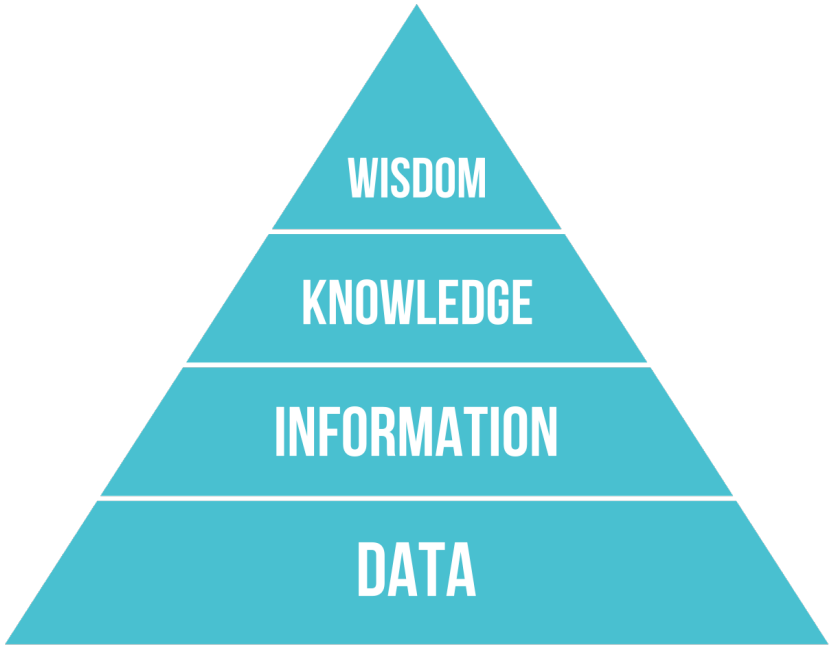


Automation method and results analysis →
NEXT PRESENTATION

Energy efficiency measures – neighbourhood level

1. **Data:** known or assumed fact
2. **Information:** processed data
3. **Knowledge:** organised information that can be used to create new meanings and data
4. **WISDOM!**



Energy efficiency measures – neighbourhood level

1. **Data:** known or assumed fact
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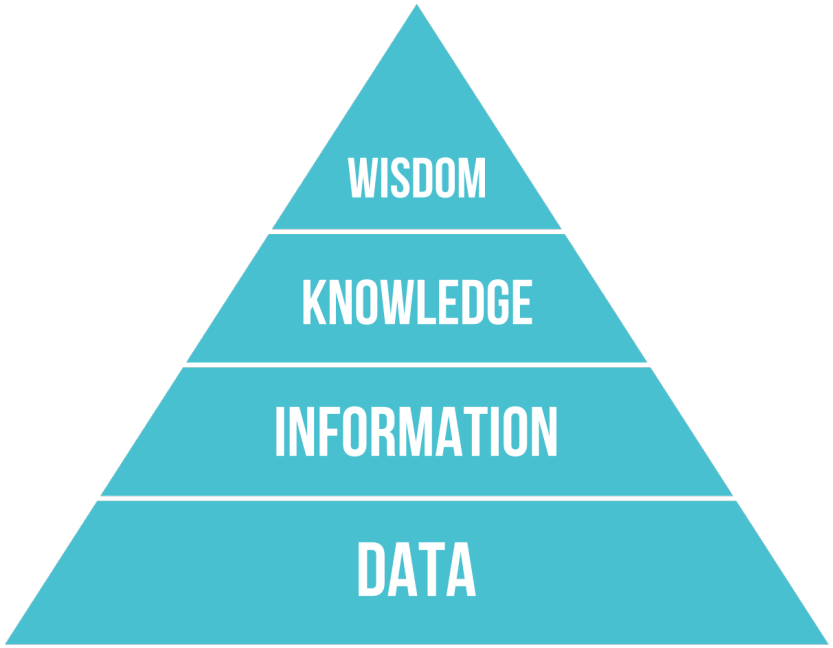

Nearly 80% of the time is spent in the preparatory phase of the process *(data collection, cleaning and organisation of data)*

Energy efficiency measures – neighbourhood level

Sources of building data:

1. **Real, measured data**

- Project documentation (data on areas, geometry, physics of the building, building technical system,…
- Measured energy consumption data

2. **Assumed data**

- Energy simulations, reference buildings, surveys, inferences based on similar building samples,…

Energy efficiency measures – neighbourhood level

Sources of building data:

1. **Real, measured data**

User behaviour is considered!

- Project documentation (data on areas, geometry, physics of the building, building technical system,…
- Measured energy consumption data

2. **Assumed data**

- Energy simulations, reference buildings, surveys, inferences based on similar building samples,…

Energy efficiency measures – neighbourhood level

Database structure:

The data should be presented uniformly as values within relations, or tables, in a clear and consistent manner!

Each piece of data in the table must be logically accessible through a combination of table names, primary key values, and attribute names.

Energy efficiency measures – neighbourhood level

Database 1

ID Building	Building area, m2
53	685,00

Database 2

Building area, m2	Building heated floor area, m2
685,00	2500,00

Database 3

ID Building	Year	Energy source	Consumption, kWh
53	2021	Prirodni plin	38.950,00

Database 4

ID Building	X-coordinate	Y - coordinate
53	45.789946793771996	15.956142341347396

Energy efficiency measures – neighbourhood level

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ID Building	Building area, m2
53	685,00

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Building area, m2	Building heated floor area, m2
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ID Building	X-coordinate	Y - coordinate
53	45.789946793771996	15.956142341347396

New database– Database 5

ID Building	X-coordinate	Y - coordinate	Building area, m2	Building heated floor area, m2	Year	Energy source	Consumption, kWh
53	45.789946793771996	15.956142341347396	685,00	2500,00	2021	Prirodni plin	38.950,00

Energy efficiency measures – neighbourhood level

Database – Energy consumption in buildings						
ID Building	Consumption_Heat_ 2019 [kWh]	Consumption_Heat_ 2020 [kWh]	Consumption_Natural gas_2019 [kWh]	Consumption_Natural gas_2020 [kWh]	Consumption_Electricity_ 2019 [kWh]	Consumption_Electricity _2020[kWh]
53	65.000,00	68.325,00	0	0	23.000,00	25.000,00

Energy efficiency measures – neighbourhood level

Database – Energy consumption in buildings						
ID Building	Consumption_Heat_ 2019 [kWh]	Consumption_Heat_ 2020 [kWh]	Consumption_Natural gas_2019 [kWh]	Consumption_Natural gas_2020 [kWh]	Consumption_Electricity_ 2019 [kWh]	Consumption_Electricity _2020[kWh]
53	65.000,00	68.325,00	0	0	23.000,00	25.000,00

Database – Energy consumption in buildings			
ID Building	Year	Energy source	Consumption, kWh
53	2019	Heat	65.000,00
53	2020	Heat	68.325,00
53	2019	Natural gas	0
53	2020	Natural gas	0
53	2019	Electricity	23.000,00
53	2020	Electricity	25.000,00

Energy efficiency measures – neighbourhood level

The scope of analysis:

What is the goal of data analysis?

What data is needed to achieve the goal?

What is the reliability of the available data?

How much does the data affect the result?

Energy efficiency measures – neighbourhood level

Neighbourhood (Veslačko naselje):

What is the goal of data analysis?

Define EE measures to achieve nZEN neighbourhood

What data is needed to achieve the goal?

Analyse the current state of consumption
Define EE measures
Quantify the effect of measures

nZEN (nearly zero energy neighbourhoods)

- A broader view of consumption
- Resource optimization
- Expense reduction
- More sustainable urban projects
- Greater collective benefits
- Synergistic effects
- Energy communities

Energy efficiency measures – neighbourhood level

Neighbourhood (Veslačko naselje):

DATA: Data on energy consumption, building footprint (for defining the potential of PV)

Energy efficiency measures – neighbourhood level

Neighbourhood (Veslačko naselje):

DATA: Data on energy consumption, building footprint (for defining the potential of PV)

In case of data uncertainty???

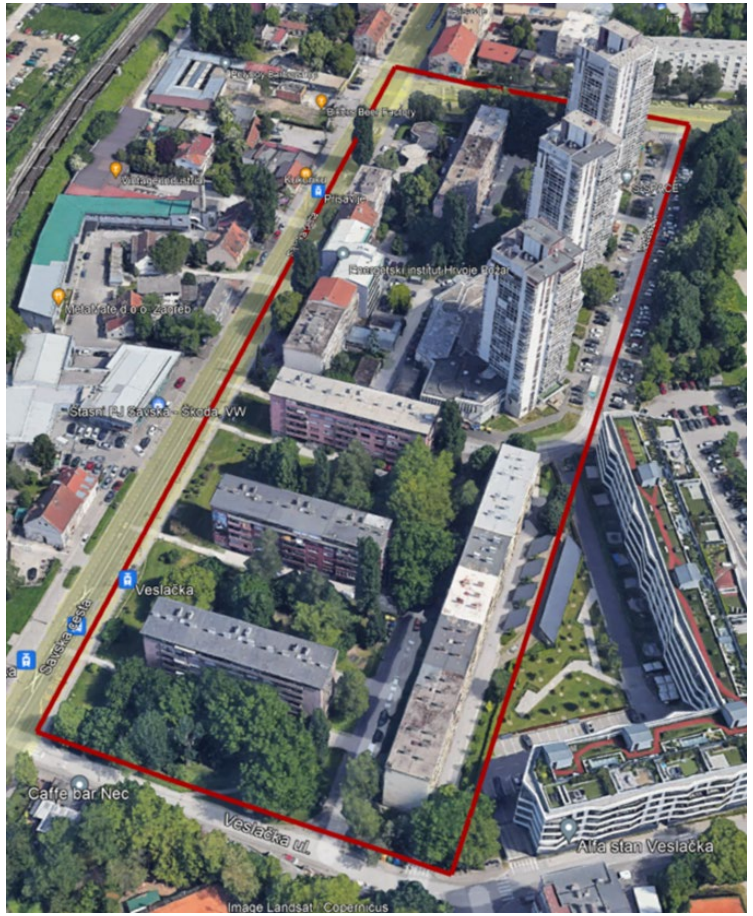
Carry out **SENSITIVITY ANALYSIS** - the impact of the data on the result!

Energy efficiency measures – neighbourhood level

Neighbourhood (Veslačko naselje) - current state analysis:

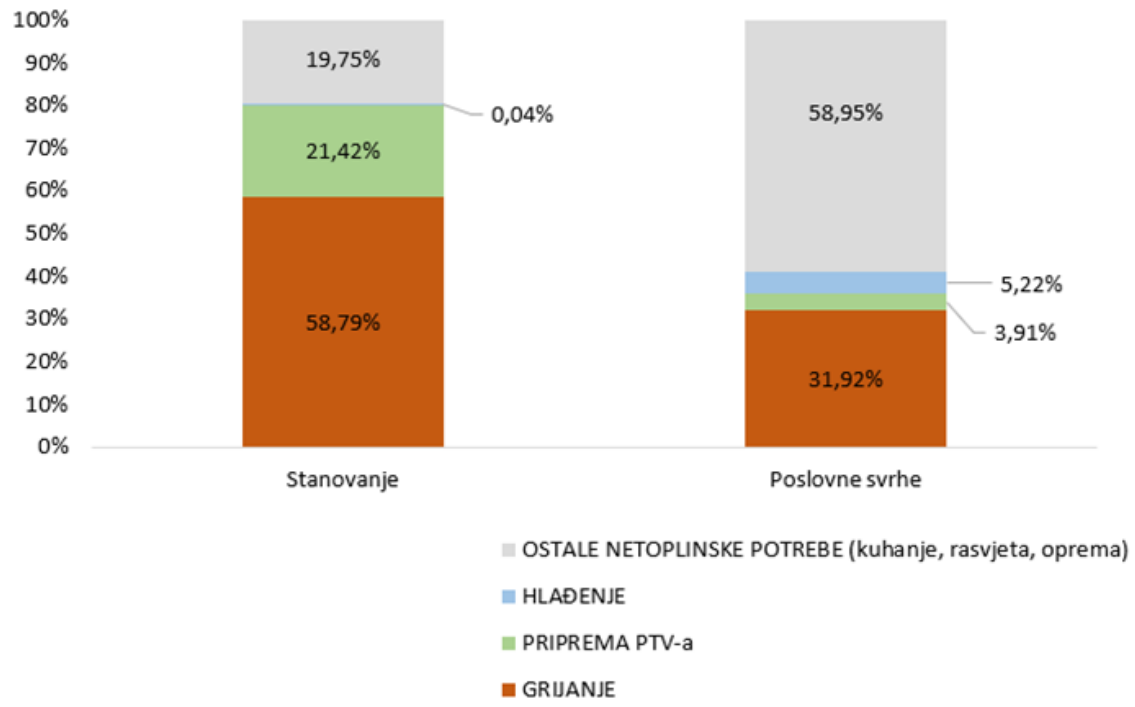
27% - business building

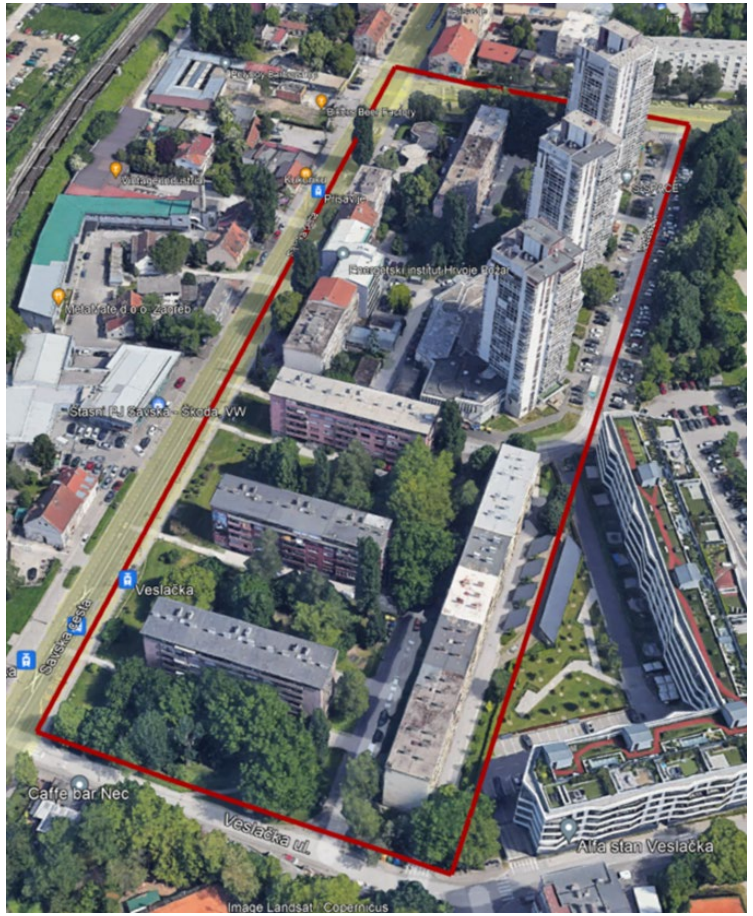
73% - residential building



Energy efficiency measures – neighbourhood level

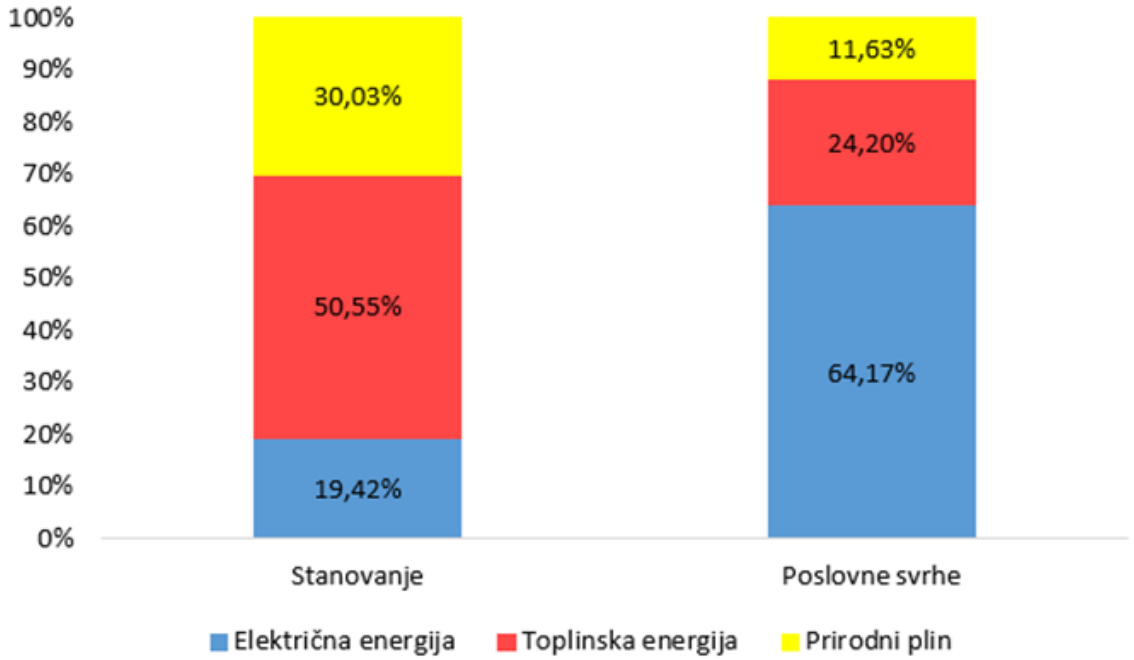
Neighbourhood (Veslačko naselje) - current state analysis:

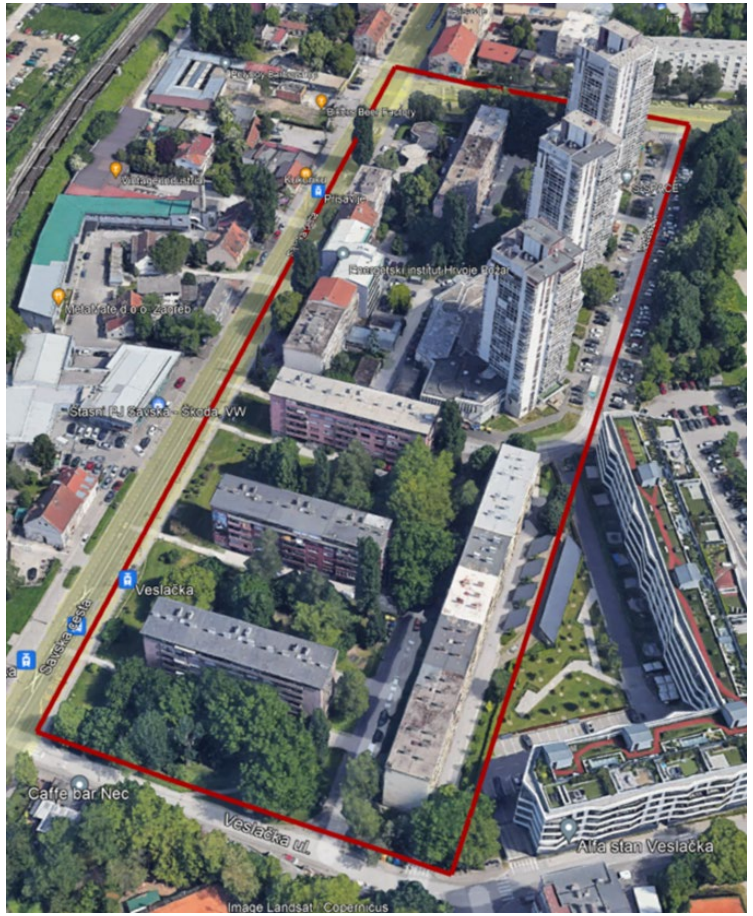




Energy efficiency measures – neighbourhood level

Neighbourhood (Veslačko naselje) - current state analysis:





Energy efficiency measures – neighbourhood level

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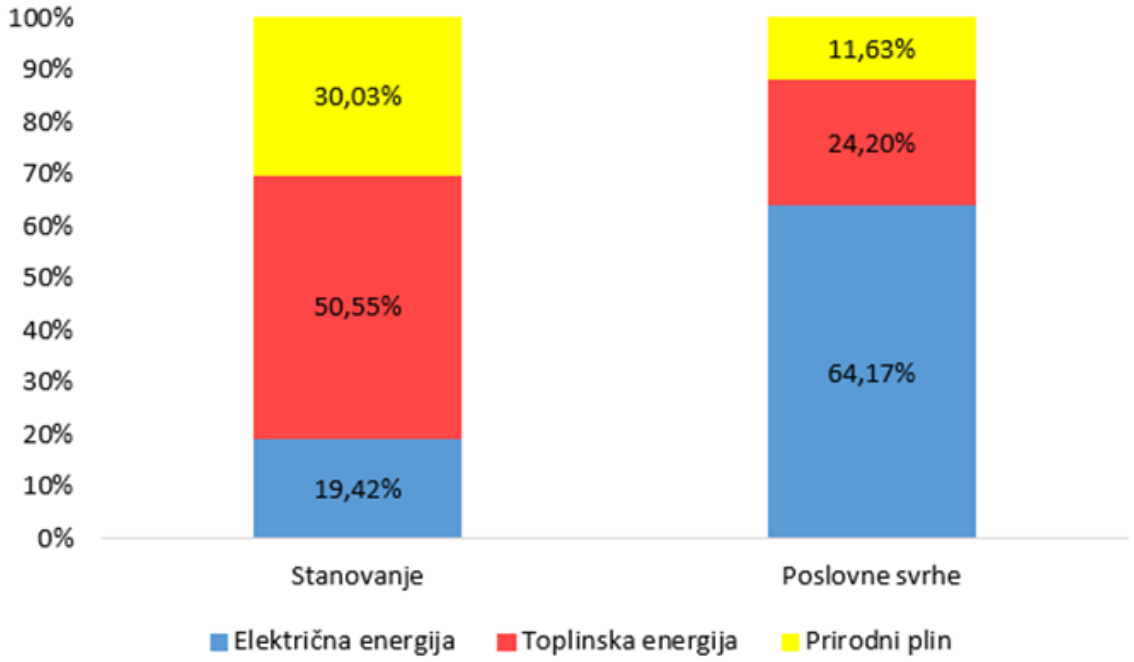

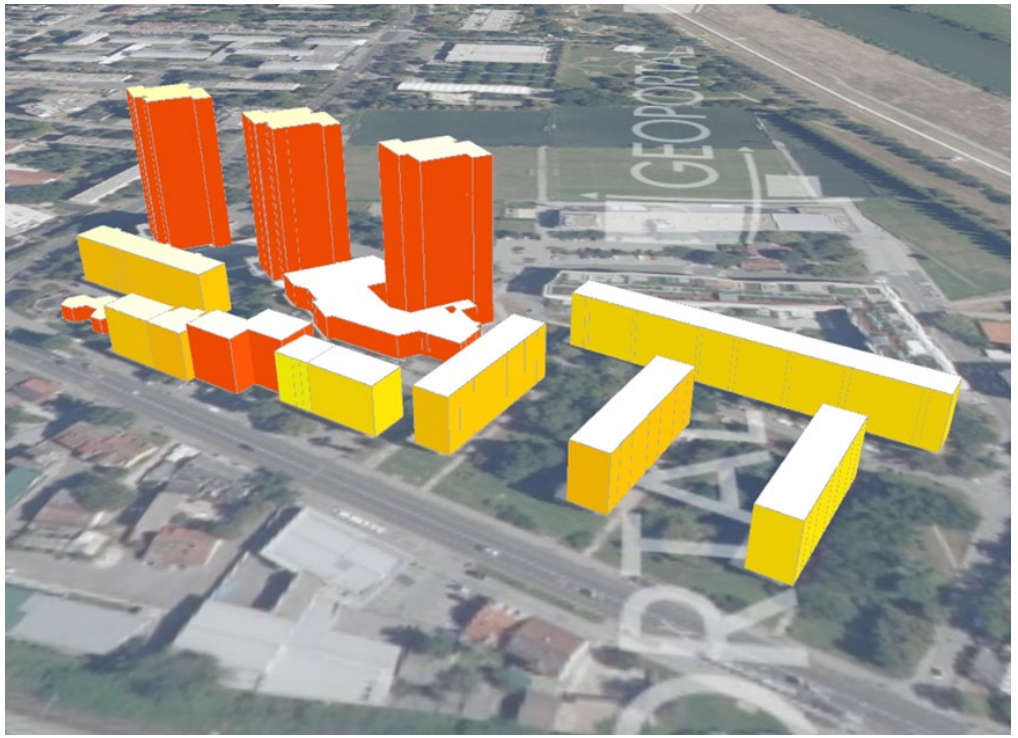

Energy efficiency measures – neighbourhood level

Neighbourhood (Veslačko naselje) - current state analysis:

EE measures:

1. Renovation of building envelope
2a. Replacement of natural gas boilers and thermal substations with heat pumps
2b. Replacement of natural gas boilers with thermal substations
3. Installation of photovoltaic modules
4. Replacement of household appliances
5. Replacement of lighting fixtures

Energy efficiency measures – neighbourhood level

Neighbourhood (Veslačko naselje) - current state analysis:

EE measures:

1. Renovation of building envelope
2a. Replacement of natural gas boilers and thermal substations with heat pumps
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3. Installation of photovoltaic modules
4. Replacement of household appliances
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Scenario1 : Electrification scenario

Scenario2 : District heating scenario

Energy efficiency measures – neighbourhood level

EE 1: Renovation of building envelope

Consumption →	Electricity [kWh]	Heat energy [kWh]	Natural gas [kWh]
Current state	1.794.698	3.450.203	2.026.246
After EE 1: Renovation of building envelope	1.794.698	1.763.772	1.422.586

Energy efficiency measures – neighbourhood level

EE 1: Renovation of building envelope

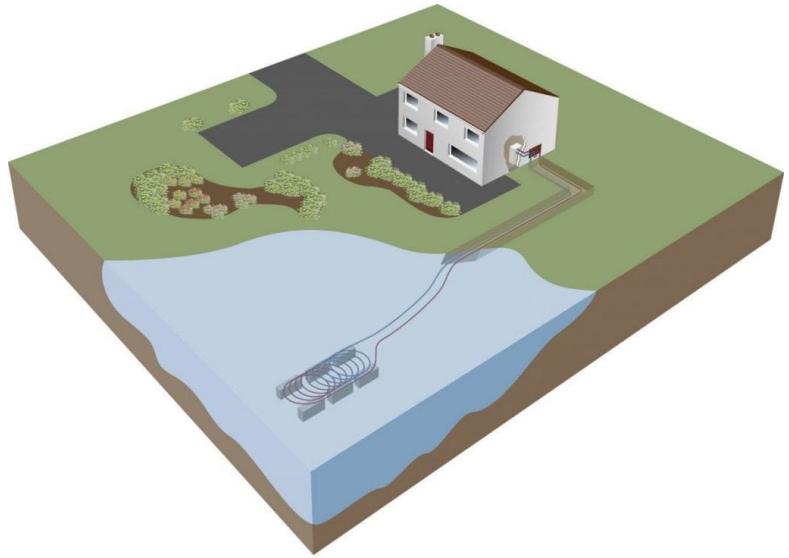
Consumption →	Electricity [kWh]	Heat energy [kWh]	Natural gas [kWh]
Current state	1.794.698	3.450.203	2.026.246
After EE 1: Renovation of building envelope	1.794.698	1.763.772	1.422.586

↓ **32%**

Energy efficiency measures – neighbourhood level

EE 2a: Replacement of natural gas boilers and thermal substations with heat pumps

Consumption →	Electricity [kWh]	Heat energy [kWh]	Natural gas [kWh]
Current state	1.794.698	3.450.203	2.026.246
After EE 2a: Replacement of natural gas boilers and thermal substations with heat pumps	3.132.460	0	0

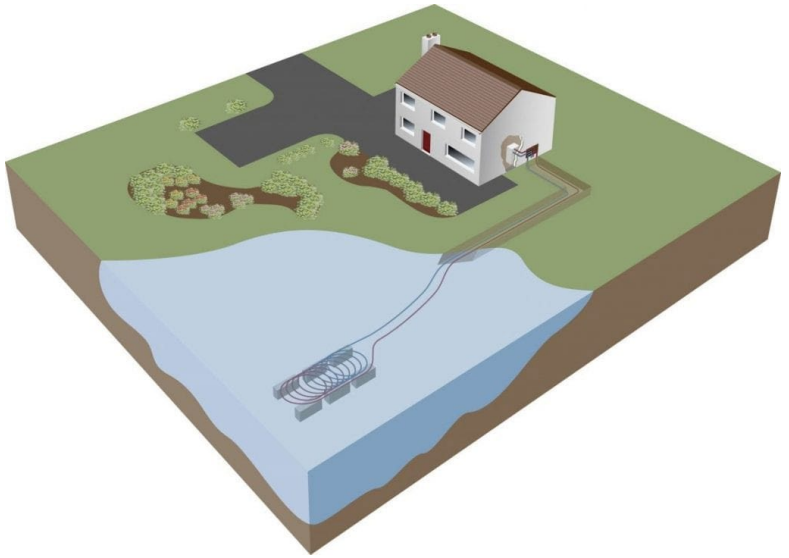


Energy efficiency measures – neighbourhood level

EE 2a: Replacement of natural gas boilers and thermal substations with heat pumps

Consumption →	Electricity [kWh]	Heat energy [kWh]	Natural gas [kWh]
Current state	1.794.698	3.450.203	2.026.246
After EE 2a: Replacement of natural gas boilers and thermal substations with heat pumps	3.132.460	0	0

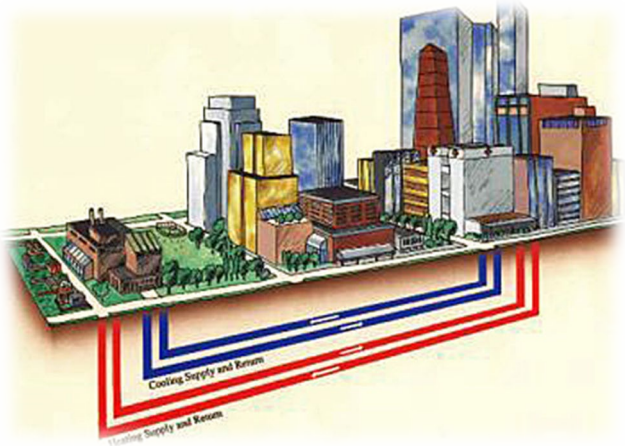
↓ **57%**



Energy efficiency measures – neighbourhood level

EE 2b: Replacement of natural gas boilers with thermal substations

Consumption →	Electricity [kWh]	Heat energy [kWh]	Natural gas [kWh]
Current state	1.794.698	3.450.203	2.026.246
After EE 2b: Replacement of natural gas boilers with thermal substations	1.794.698	5.187.242	0

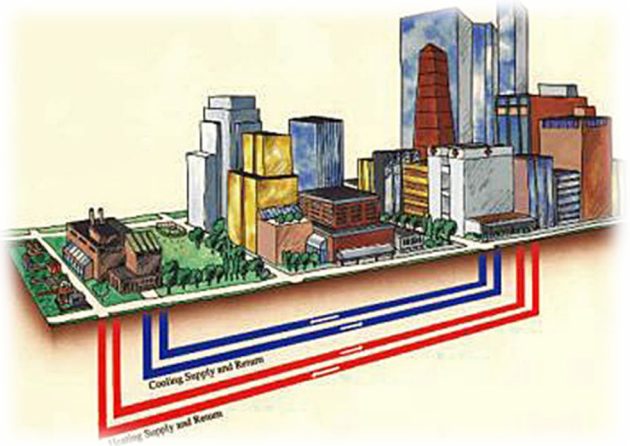


Energy efficiency measures – neighbourhood level

EE 2b: Replacement of natural gas boilers with thermal substations

Consumption →	Electricity [kWh]	Heat energy [kWh]	Natural gas [kWh]
Current state	1.794.698	3.450.203	2.026.246
After EE 2b: Replacement of natural gas boilers with thermal substations	1.794.698	5.187.242	0

↓ **4%**



Energy efficiency measures – neighbourhood level

EE 3: Installation of photovoltaic modules

Consumption →	Electricity [kWh]	Heat energy [kWh]	Natural gas [kWh]
Current state	1.794.698	3.450.203	2.026.246
After EE 3: Installation of photovoltaic modules	1.214.183	3.450.203	2.026.246

Energy efficiency measures – neighbourhood level

EE 3: Installation of photovoltaic modules

Consumption →	Electricity [kWh]	Heat energy [kWh]	Natural gas [kWh]
Current state	1.794.698	3.450.203	2.026.246
After EE 3: Installation of photovoltaic modules	1.214.183	3.450.203	2.026.246

↓ **8%**

Energy efficiency measures – neighbourhood level

EE 4: Replacement of household appliances

Consumption →	Electricity [kWh]	Heat energy [kWh]	Natural gas [kWh]
Current state	1.794.698	3.450.203	2.026.246
After EE 4: Replacement of household appliances	1.751.768	3.450.203	2.026.246

Energy efficiency measures – neighbourhood level

EE 4: Replacement of household appliances

Consumption →	Electricity [kWh]	Heat energy [kWh]	Natural gas [kWh]
Current state	1.794.698	3.450.203	2.026.246
After EE 4: Replacement of household appliances	1.751.768	3.450.203	2.026.246

↓ **< 1%**

Energy efficiency measures – neighbourhood level

EE 5: Replacement of lighting fixtures

Consumption →	Electricity [kWh]	Heat energy [kWh]	Natural gas [kWh]
Current state	1.794.698	3.450.203	2.026.246
After EE 5: Replacement of lighting fixtures	1.740.408	3.450.203	2.026.246

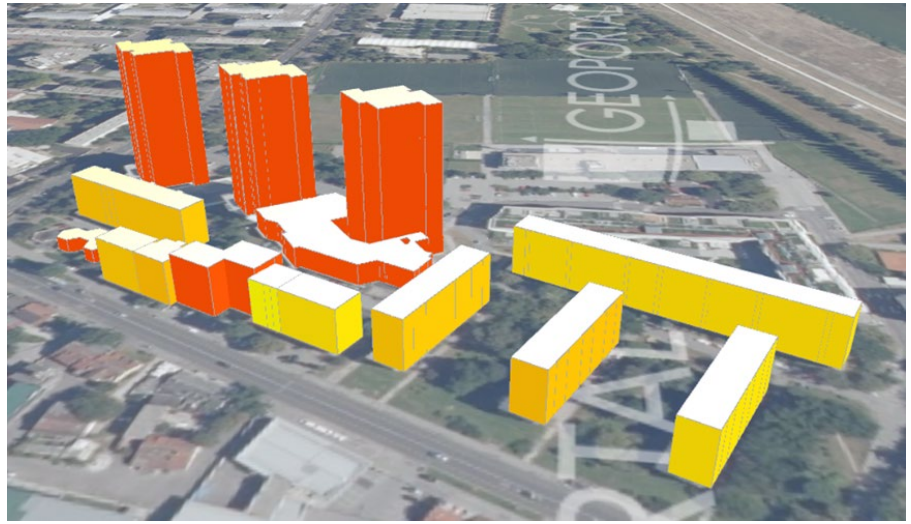
Energy efficiency measures – neighbourhood level

EE 5: Replacement of lighting fixtures

Consumption →	Electricity [kWh]	Heat energy [kWh]	Natural gas [kWh]
Current state	1.794.698	3.450.203	2.026.246
After EE 5: Replacement of lighting fixtures	1.740.408	3.450.203	2.026.246

↓ **< 1%**

Energy efficiency measures – neighbourhood level

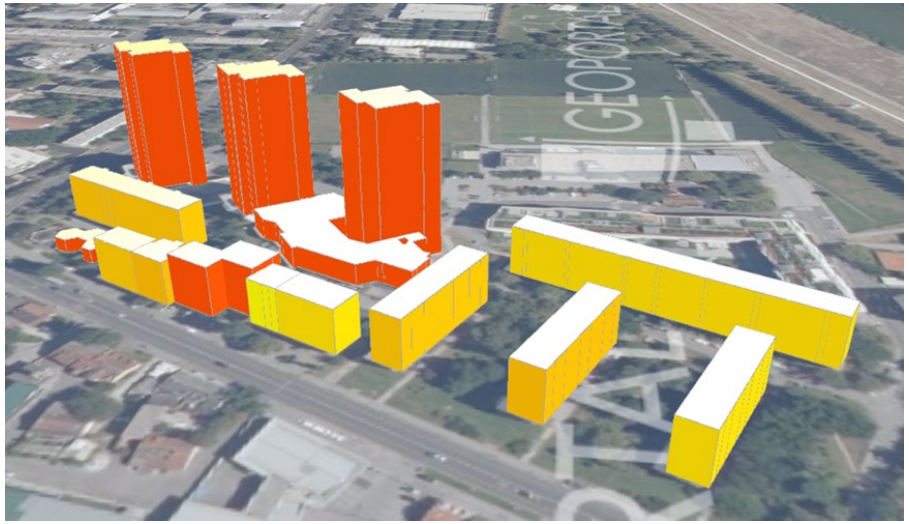


E_{TOT} = 7.271.147 kWh

E_{TOT_spec} = 174,50 kWh/m^2

E_{HEAT_DHW} = 130,86 kWh/m^2

Energy efficiency measures – neighbourhood level



E_{TOT} = 7.271.147 kWh

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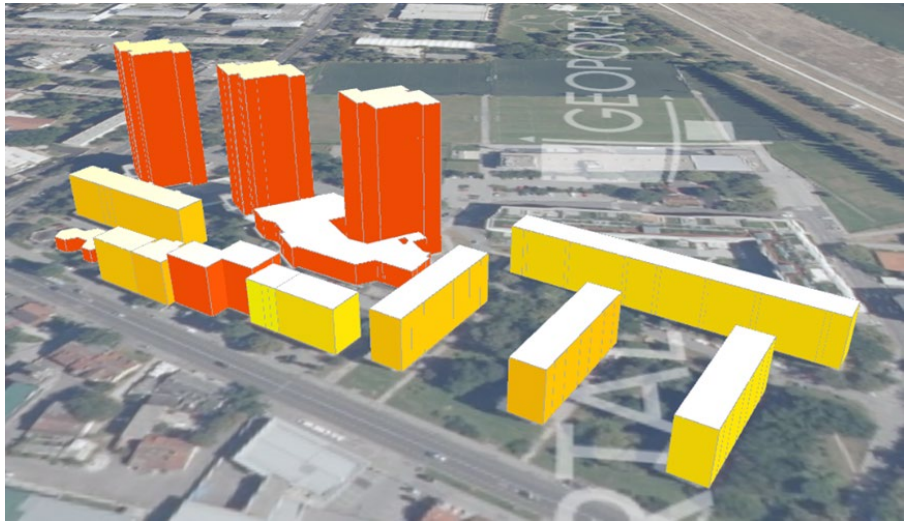
E_{HEAT_DHW} = 130,86 kWh/m^2

E_{TOT} = 1.908.357 kWh

E_{TOT_spec} = 45,80 kWh/m^2

E_{HEAT_DHW} = 18,43 kWh/m^2

Energy efficiency measures – neighbourhood level



E_{TOT} = 7.271.147 kWh

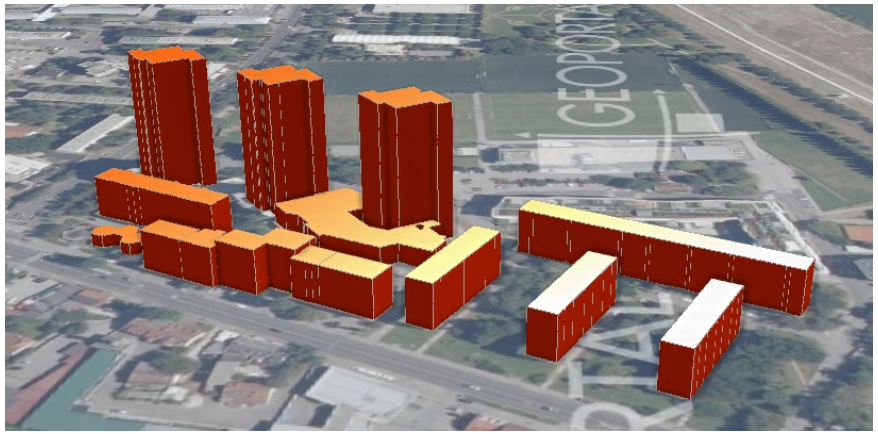
E_{TOT_spec} = 174,50 kWh/m^2

E_{HEAT_DHW} = 130,86 kWh/m^2

E_{TOT} = 1.908.357 kWh

E_{TOT_spec} = 45,80 kWh/m^2

E_{HEAT_DHW} = 18,43 kWh/m^2



E_{TOT} = 4.248.414 kWh

E_{TOT_spec} = 101,96 kWh/m^2

E_{HEAT_DHW} = 71,45 kWh/m^2

Energy efficiency measures – neighbourhood level

Energy efficiency measures – neighbourhood level

Quantifying the profitability of energy efficiency measures:

COSTS

- CAPEX
- OPEX
- Energy costs
- CO_2 costs

BENEFITS

- Energy costs savings
- CO_2 costs savings

Energy efficiency measures – neighbourhood level

Costs:

Technology	Unit price [EUR/kW]	Maintenance cost [EUR/kW]
Building envelope	200,00***	-
Natural gas boiler	100,00	7,00
Thermal station with distribution pipes and heating bodies	450,00	10,00
Heat pump with distribution pipes and heating bodies	720,00	16,00
PV modules	1.300,00	10,00

*** price expressed in EUR/m^2

Energy efficiency measures – neighbourhood level

Costs:

Energy source / Energy price [EUR/kWh]	2024.	2030.	2035.	2040.	2045.	2050.	2055.
Electricity – households	0,0794	0,1005	0,1136	0,1267	0,1398	0,1530	0,1668
Electricity – entrepreneurship	0,2291	0,1030	0,1160	0,1268	0,1376	0,1484	0,1597
Heat – households	0,0529	0,0678	0,0720	0,0761	0,0802	0,0843	0,0885
Heat – entrepreneurship	0,1058	0,1357	0,1439	0,1521	0,1604	0,1686	0,1770
Natural gas	0,0637	0,0817	0,0866	0,0916	0,0965	0,1015	0,1066
Solar energy	0	0	0	0	0	0	0

Energy efficiency measures – neighbourhood level

Costs:

Energy source	2024.	2030.	2035.	2040.	2045.	2050.	2055.
CO_2 emission [EUR/tCO_2]	43,0217	65,2988	71,7452	78,1916	84,6380	91,0844	97,8138

Energy efficiency measures – neighbourhood level

Quantifying the profitability of energy efficiency measures:

ENPV		
+	Subsidizing the implementation of the measure is proposed!	The measure is financially justified!!
-	The measure isn't financially justified!	The measure is financially justified, but it has negative social impacts!

\- FNPV

Energy efficiency measures – neighbourhood level

RESULTS OF CBA ANALYSIS - RESIDENTIAL BUILDINGS:

Measure	FNPV [EUR/kWh]	ENPV [EUR/kWh]
Renovation of building envelope (for buildings connected to the district heating system)	-0,92	-0,78
Renovation of building envelope (for buildings that use natural gas for heating and DHW preparation)	-1,85	-1,62
Replacement of heat substations with heat pumps	0,49	0,49
Replacement of natural gas boilers with heat pumps	0,47	0,47
Replacement of natural gas boilers with heat substations	0,05	0,06
Installation of PV modules	0,17	0,18

Energy efficiency measures – neighbourhood level

RESULTS OF CBA ANALYSIS - RESIDENTIAL BUILDINGS:

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Energy efficiency measures – neighbourhood level

EXTENDED CBA ANALYSIS

Increase in the price of the building → **50 EUR/m^2**

Energy efficiency measures – neighbourhood level

EXTENDED CBA ANALYSIS

Increase in the price of the building → **50 EUR/m²**

Measure	FNPV [EUR/kWh]	ENPV [EUR/kWh]
Renovation of building envelope (for buildings connected to the district heating system)	**-0,92**	**2,46**
Renovation of building envelope (for buildings that use natural gas for heating and DHW preparation)	**-1,85**	**3,91**

Energy efficiency measures – neighbourhood level

EXTENDED CBA ANALYSIS

Increase in the price of the building → **50 EUR/m²**

Measure	FNPV [EUR/kWh]	ENPV [EUR/kWh]
Renovation of building envelope (for buildings connected to the district heating system)	**-0,92**	**2,46**
Renovation of building envelope (for buildings that use natural gas for heating and DHW preparation)	**-1,85**	**3,91**

The renovated building envelope reduces the risk of fungus and mildew, which significantly affects the health of the building's users.


For Example!

Conclusion

- A broader view of energy planning and EE measures implementation
- Resource optimization
- Expense reduction
- More sustainable urban projects
- Greater collective benefits
- Synergistic effects
- Energy communities

Conclusion

- A broader view of energy planning and EE measures implementation
- Resource optimization
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More detailed approach to a specific building and analysis of EE measures → next lecture!

TIMEPAC The new EPC for Europe

If you would like more information, please visit www.timepac.eu or contact us at

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