TIMEPAC
The new EPC for Europe

Challenges in deep renovation of buildings – from the idea to complex simulation model

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Introduction – nZEB vision

1975.

ZG Moderna

EPC rating F
Start of application of thermal insulation, glazing without shading, district heating, air conditioners

01

02

2001.

1st renovation

EPC rating B
Additional thermal insulation, district heating, heat pump for cooling, central monitoring and control system

2023.

03

nZEB + smart

EPC rating A+
Additional thermal insulation, geothermal heat pump, photovoltaics and batteries, electro-mobility, digitization, mechanical resistance and stability

04

2030.

nZEN + smart

2050.

05

Building Information

Office building (5 floors + basement)

85 employees

Usage time: 8-10 hours/day, 5 days/week

Useful heated area	A_k	m^2	2.061
The volume of the heated area	V	m^3	6.998,70
Heated air volume	V_e	m^3	5.670,25
Total area of building envelope	A_f	m^2	2.320,30
Building shape factor	f_0	m^{-1}	0,33

Thermal characteristics of the building envelope

Index	Surface area (m^2)	U (W/m^2K)	U_{max} (W/m^2K) According to legislation
VZ1 - exterior wall ventilated with glass paneling	400,70	0,37	0,30
VZ1 - external wall ventilated with sheet metal cladding	355,96	0,36	0,30
VZ2 - stone	99,70	0,36	0,30
ST - ceiling towards the unheated attic	395,9	0,29	0,25
SN - ceiling above unheated space	135,62	0,29	0,40
ZN - wall towards unheated space	25,63	0,32	0,40
ZT - wall to ground	130,76	4,08	0,40
PD - floor on the ground	256,15	0,59	0,40
PR1 - windows	461,60	1,43	1,60
PR2 - windows with fixed sunshades	15,20	1,43	1,60
VV - outer doors	29,30	1,43	2,00
VN - doors to unheated space	3,36	1,80	2,00

District Heating System

- nominal heat power of the building district heating substation 250 kW – plate heat exchanger Alfa Laval
- source of thermal energy for space heating and domestic hot water preparation (only for sanitary purposes)
- indirectly heated hot water storage heater of nominal capacity 120 L
- recirculation line with recirculation pump (56 W) operating 24 hours/day
- expansion vessel

Indirect type of district heating substation in the basement of the nominal heat power 250 kW (manufacture date 2000.)

Indirectly heated hot water storage heater of nominal capacity 120 L

Expansion vessel

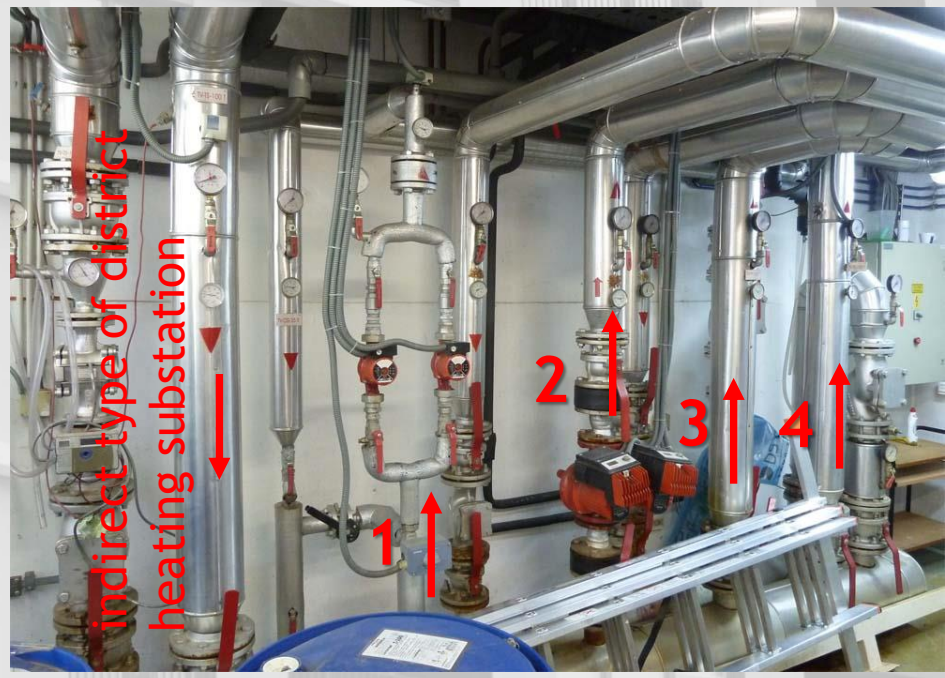
Heating system distribution and emission

- two pipe heating system with lower distribution piping
- main distributor in the building substation with 4 heating circuits:

  11 – radiators 22 – heaters of air handling units

  33 – fan coils - east 44 – fan coils - west

- fixed speed pumps
- 81 two-pipe fan coil units - thermal output 255,99 kW (45/40°C)
- 14 panel radiators without thermostatic valves – thermal output 11,20 kW (90/70°C)



Main hot water distributor in the building substation with 4 heating

Vertical exposed and concealed two-pipe fan coil units

Panel radiators in sanitary facilities

Cooling

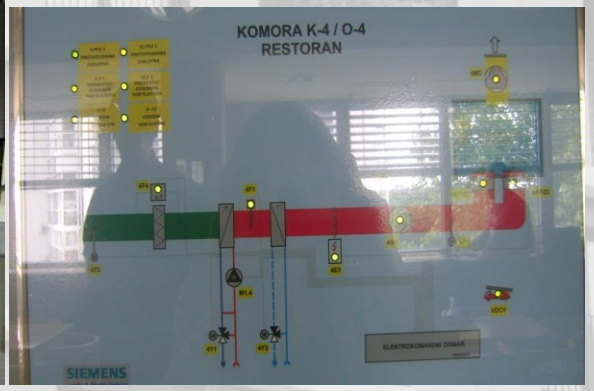
- air-cooled chiller, manufacturer CIAT model ILK 400A (build year 2000.) cooling capacity 99,6 kW, electrical power input 36,1 kW (EER = 2,76)
- R22 ----- R417A
- 4 individual air conditioners (split air conditioners)

4 split air conditioners

Air-cooled chiller, manufacturer CIAT model ILK 400A (build year 2000.) cooling capacity 99,6 kW, electrical power input 36,1 kW (EER = 2,76) Refrigerant R22 → R417A

Ice bank system→ 12 m^3

Ventilation



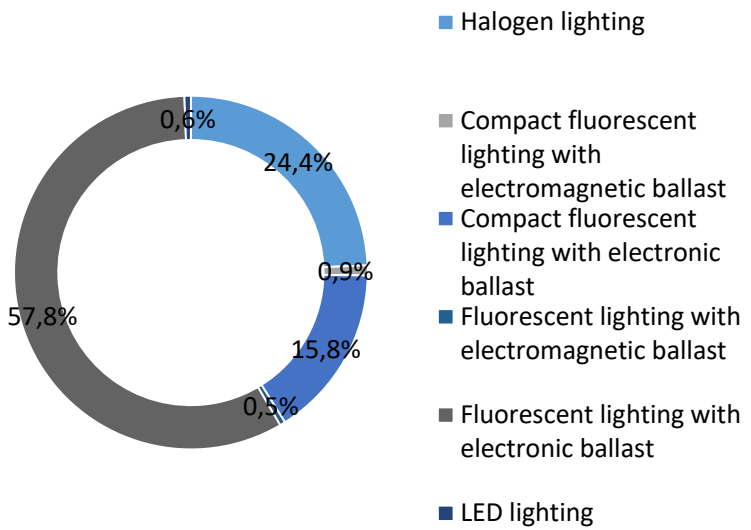
	AHU	Manufacturer	Design volume air flow rate – SUPPLY DUCT, [m³/h]	Design volume air flow rate – RETURN DUCT, [m³/h]	Heat recovery system YES=1, NO=0	Type of heat recovery system	Sensible heat recovery efficiency, [–]	Heating capacity of heating coil [kW]	Cooling capacity of cooling coil [kW]	El. power of supply air fan, [kW]	El. power of exhaust air fan, [kW]	Build year
1	KK Multimedijalna[1]	PROKLIMA	**3.500**	**3.500**	1	Cross-flow plate recuperator	0,63 – summer 0,703 winter	38,2	24	1,80	1,20	2000
2	KK Biblioteka	PROKLIMA	**1.500**	1.500	0	–	–	25	8	1,10	0,55	2000
3	KK Banka	PROKLIMA	**1.500**	1.500	0	–	–	25	8	1,10	0,55	2000
4	KK Restoran	PROKLIMA	**700**	700	0	–	–	8,8	5	0,25	–	2000
TOTAL			**7.200**	**7.200**	**1**			**97**	**45**	**4,25**	**2,30**	

Lighting System

Lighting system power [kW] 49,54

Lighting power density [W/m^2] Target 7

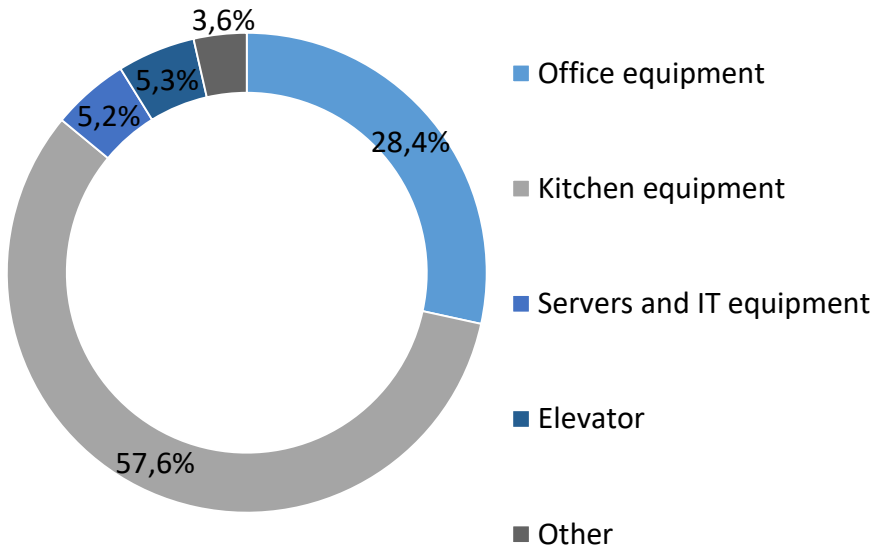
Type	Number	Power [kW]
Halogen lighting	234	12,06
Compact fluorescent lighting with electromagnetic ballast	12	0,46
Compact fluorescent lighting with electronic ballast	318	7,83
Fluorescent lighting with electromagnetic ballast	5	0,25
Fluorescent lighting with electronic ballast	541	28,65
LED lighting	34	0,29
Total	**1.144**	**49,54**



Other electrical equipment

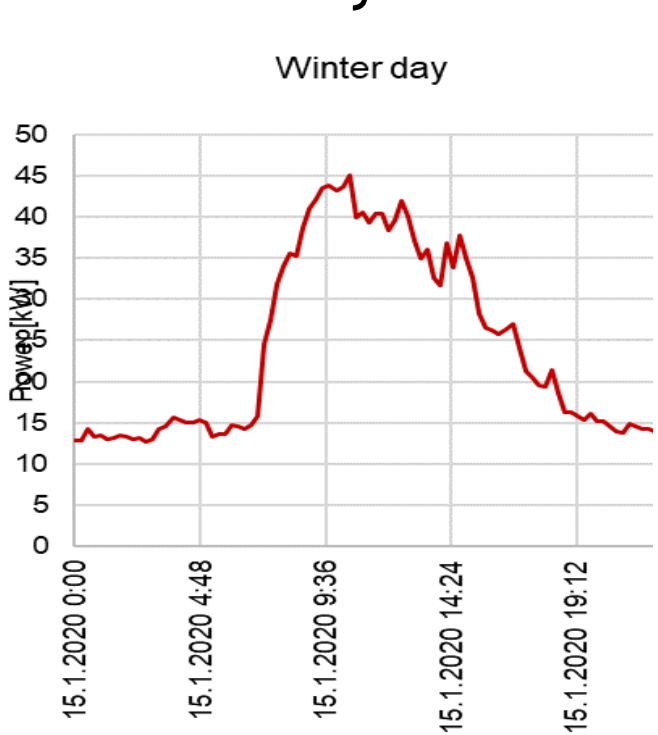
Power of other electrical equipment [kW]	68,50
Power density of other electrical equipment [W/m^2]	33,24

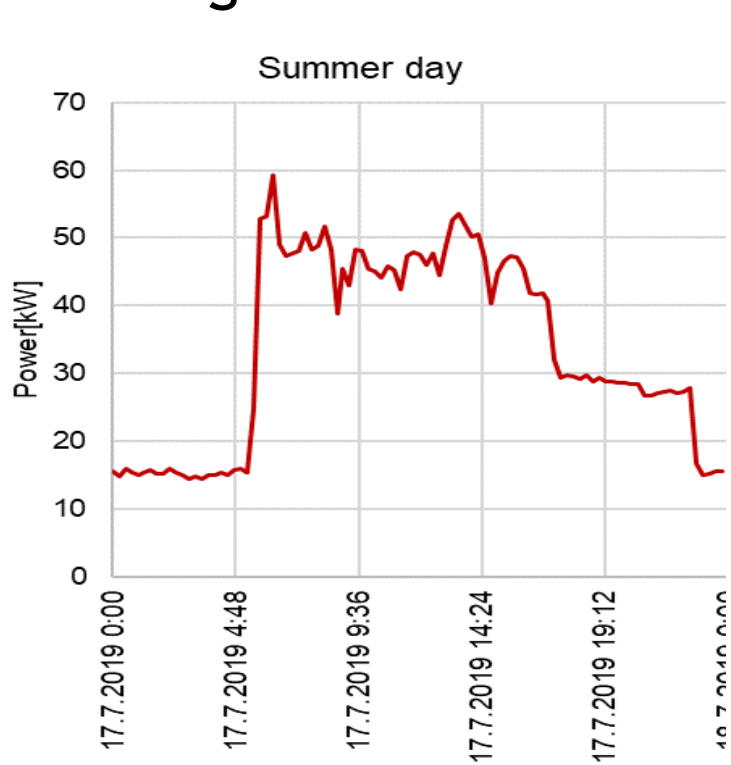
Type	Number	Power [kW]
Office equipment	213	19,47
Kitchen equipment	16	39,43
Servers and IT equipment	33	3,56
Elevator	1	3,60
Other	15	2,44
Total	**278**	**68,50**

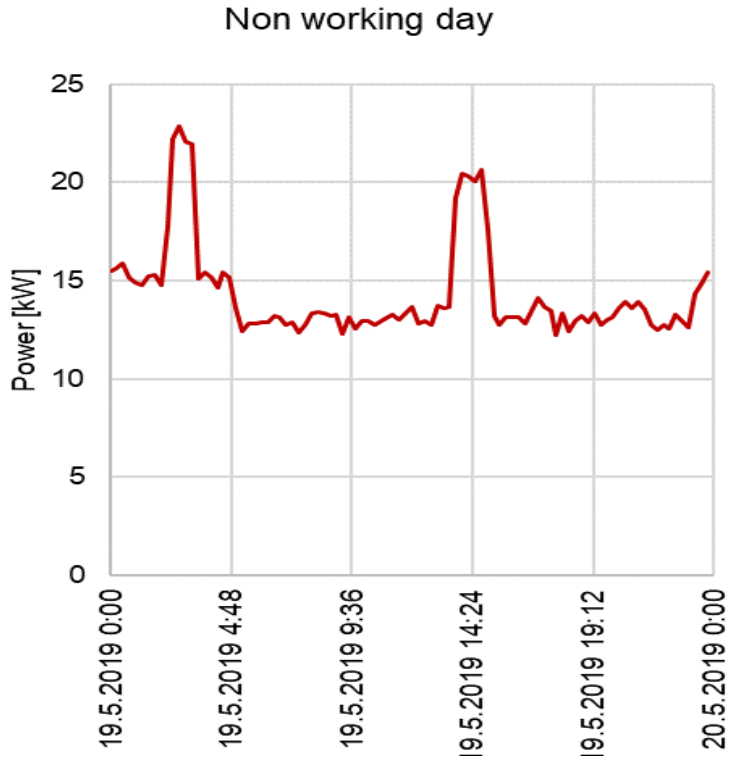


Consumption measurements

- Electricity for whole building



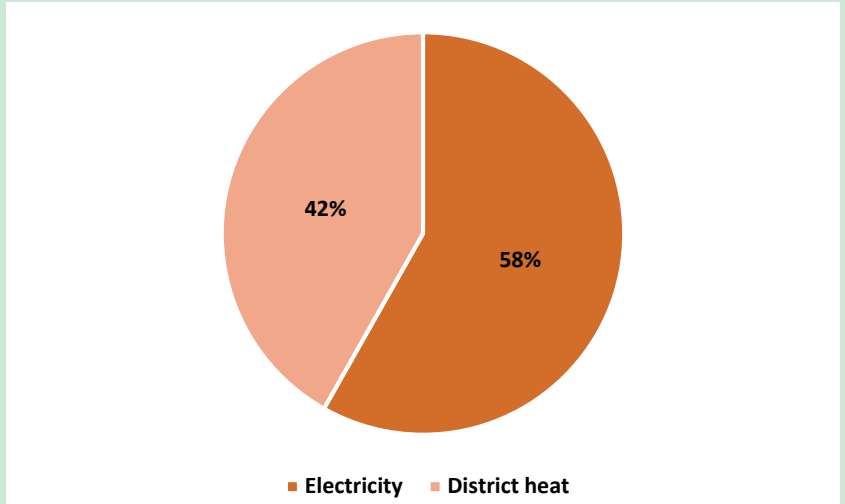


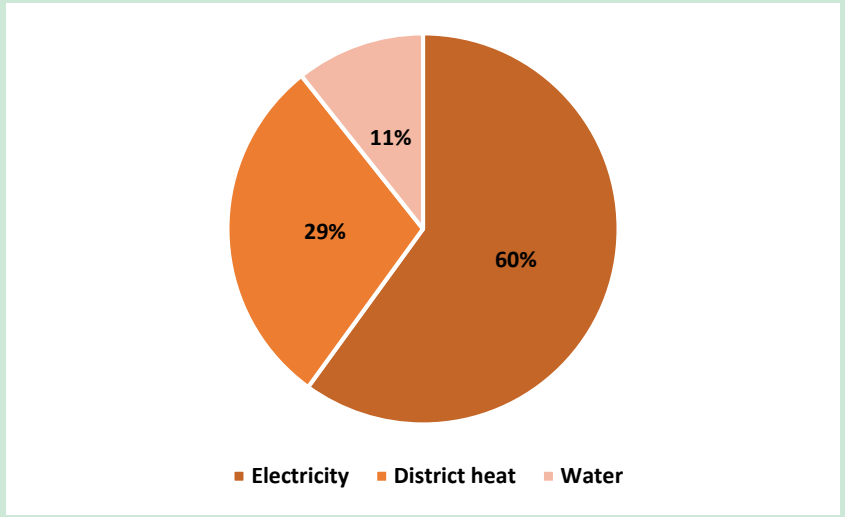


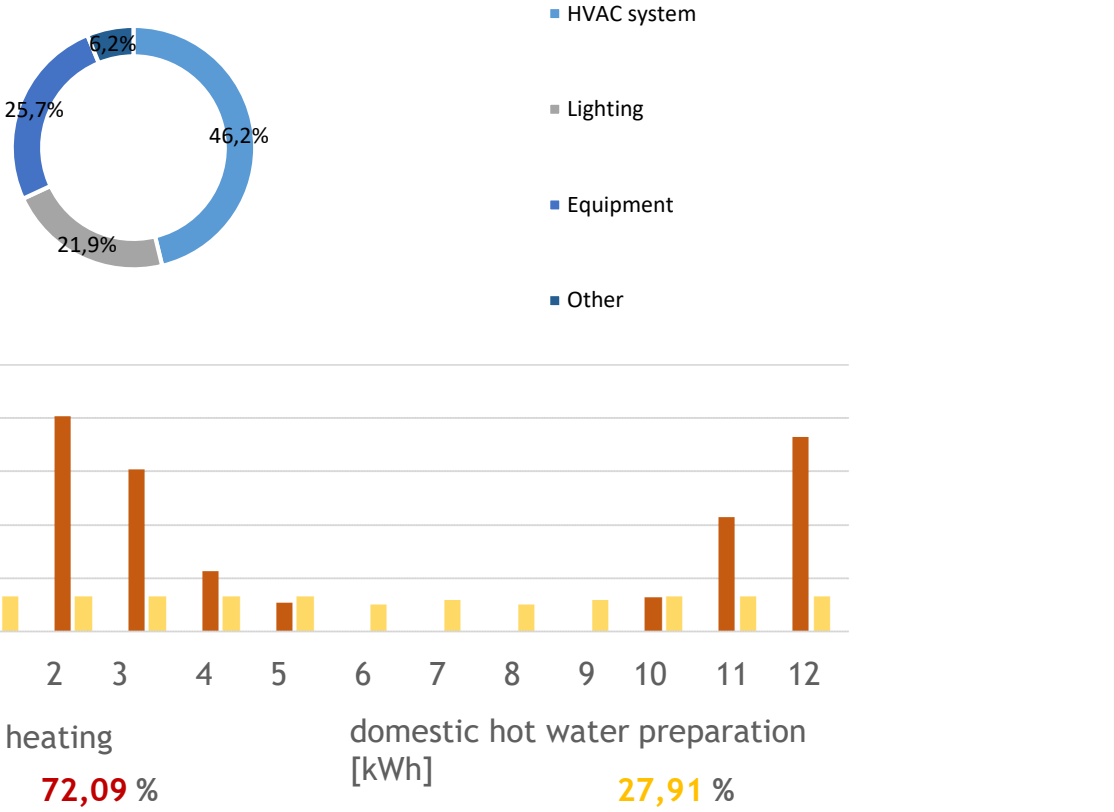
- Heating pumps, Lighting system in hallway, Lighting system for toilet, Fan coil, Printer and photocopier, Display (monitor), Laptop, Server

Energy Consumption

Energy	Unit	Baseline values			
		Consumption [unit/a]	Consumption [kWh/a]	Costs [kn/a]	CO_2 [t/a]
Electricity	kWh	186.539,00	186.539,00	155.200,23	43,837
District heat	kWh	134.000,00	134.000,00	75.844,35	46,364
Water	m^3	1.051,50	-	27.628,81	0,236
Ukupno			**320.539,00**	**258.673,39**	**90,437**







EPC

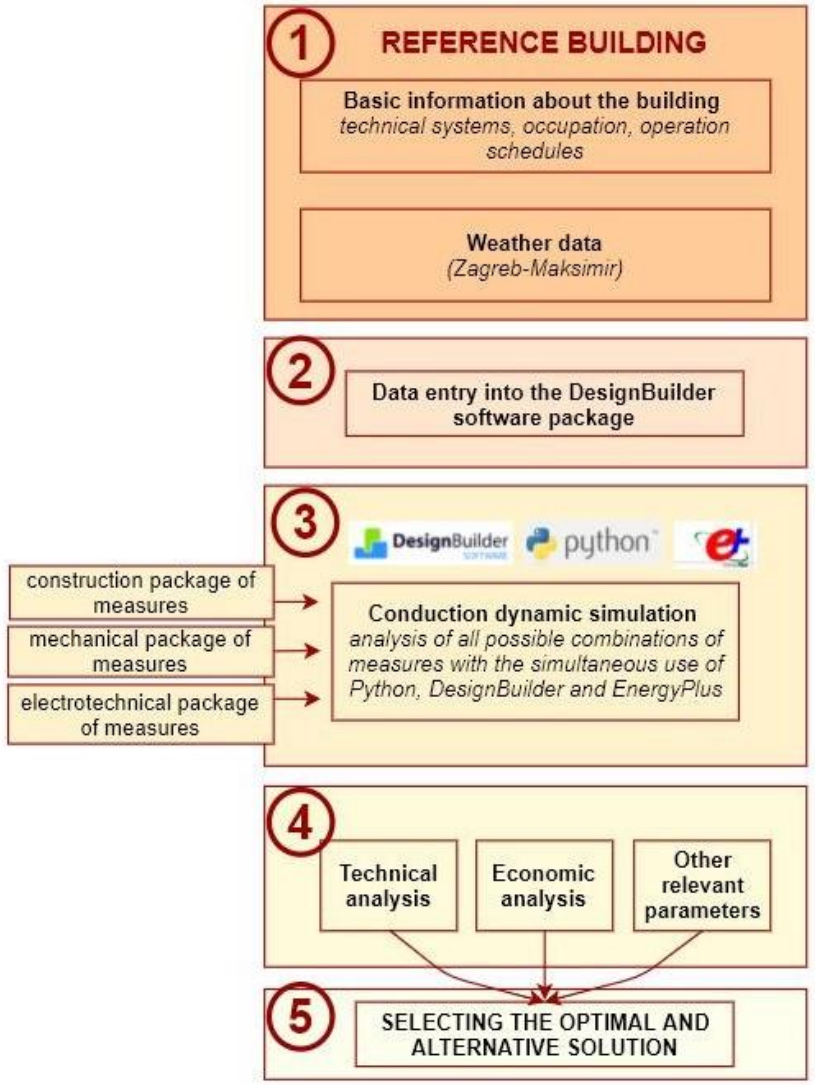
Energy performance certificate

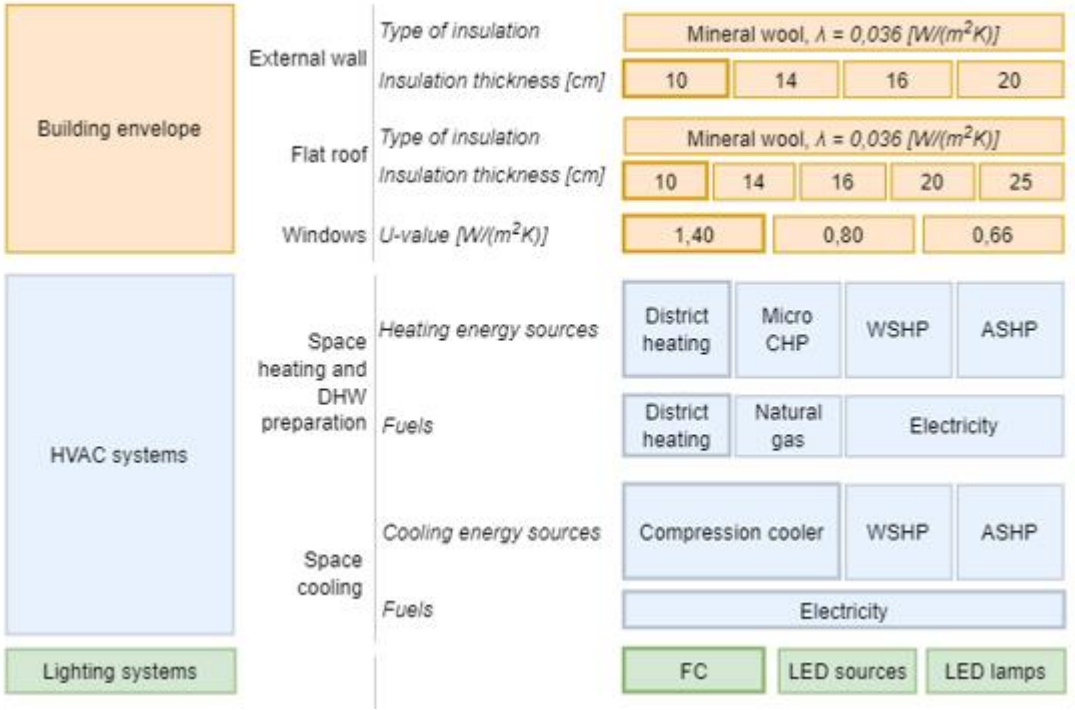
Needed energy for heating $Q''_{H,nd}$ [kWh/(m²a)]	Needed primary energy E_{prim} [kWh/(m²a)]	Energy performance rating – energy needed for heating $Q''_{H,nd}$	Energy performance rating – primary energy E_{prim}
38,66	***156,14***	**B**	**F**

- Energy needed for heating: 76.540,66 kWh/a
- Energy needed for cooling: 52.338,59 kWh/a
- Energy needed for DHW: 3.717,95 kWh/a
- Energy needed for lighting: 74.890,31 kWh/a

Energy simulations

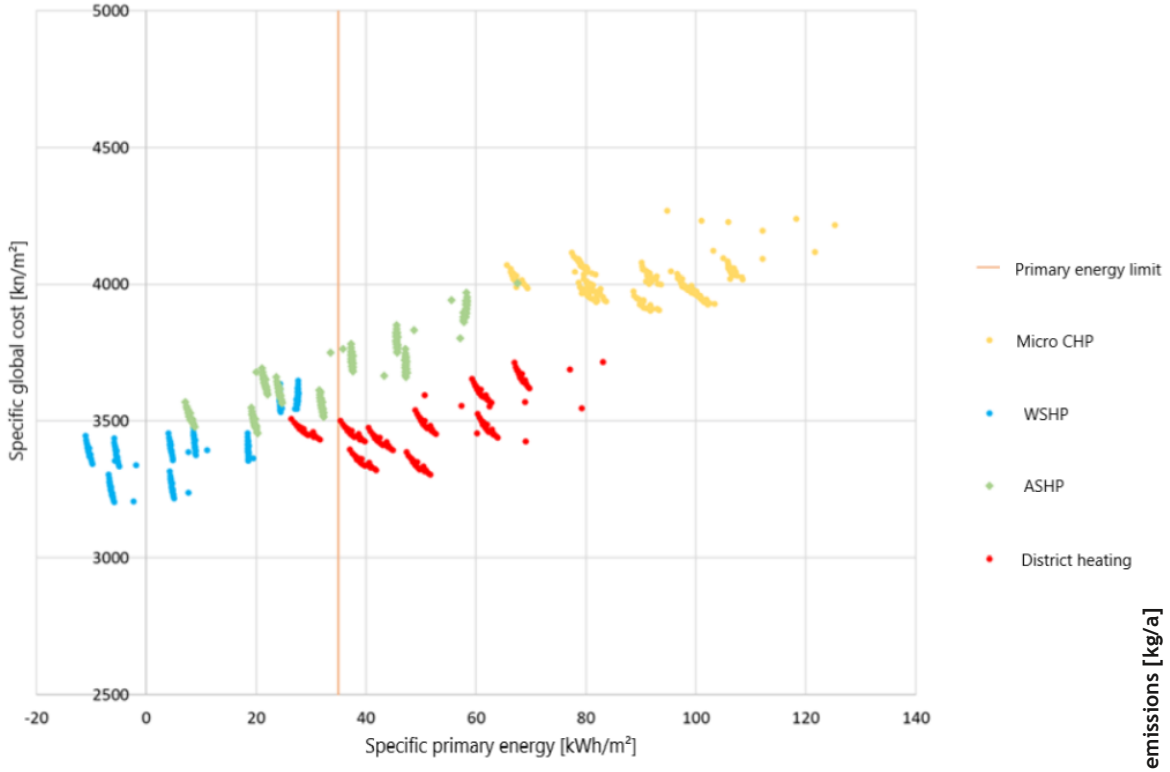
- Selection of the optimal technical solution of the HVAC system in a set of different variants of thermal protection of building envelope and lighting system solutions
- 720 combinations

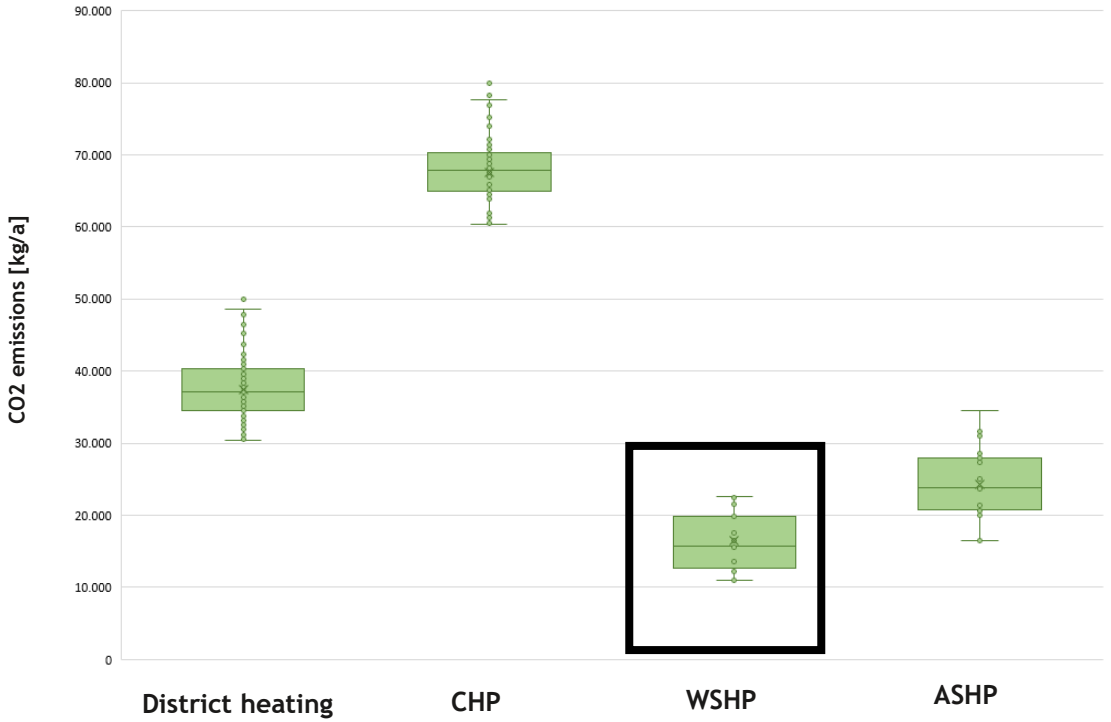




\+ PV system 65kW

Cost optimal analysis





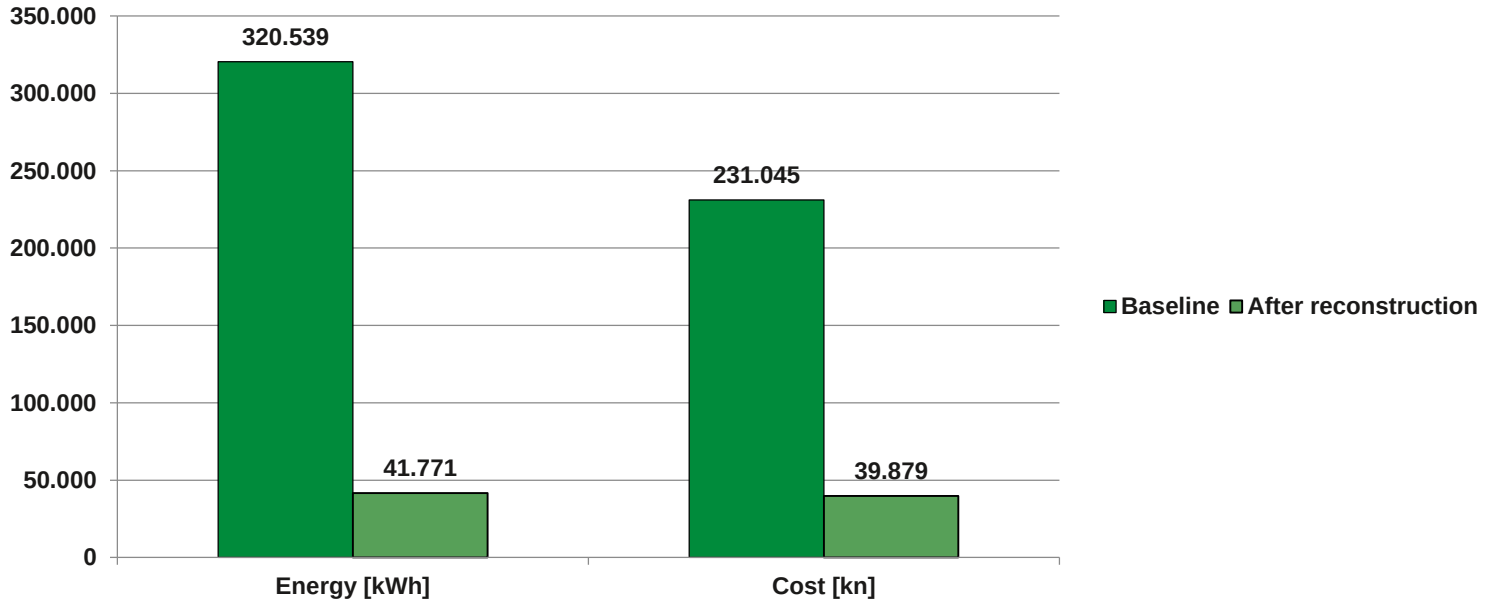
Results – multi-criteria analysis

Description	M.U.	Values
Heating / cooling system	-	Water source heat pump
Insulation thickness - walls	cm	16
Insulation thickness - roof	cm	25
U values for windows	$W/(m^2K)$	1,60
Lighting system	-	LED luminaries
Yearly heating need, $Q_{H,nd}$	kWh/m^2	21,98
Heating capacity	kW	119
Cooling capacity	kW	112
Electricity production	kWh	60.786
Electricity consumption	kWh	53.514
ECO_2 emissions	$kgCO_2/a$	12.566
Global cost	kn/m^2	3.476
Absolute global cost	kn	6.959.971

Expected EPC and consumption

Energy performance certificate

Needed energy for heating $Q''_{H,nd}$ [kWh/(m²a)]	Needed primary energy E_{prim} [kWh/(m²a)]	Energy performance rating – energy needed for heating $Q''_{H,nd}$	Energy performance rating – primary energy E_{prim}
12,86	***-29,09***	**A+**	**A+**



Thanks for your attention!

If you would like to have more information, please contact us:

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