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Modernization of the district heating system in Timisoara through the integration of RES in heat points. Case study

Modernizarea sistemului de termoficare din Timisoara prin integrarea RES in punctele de caldura. Studiu de caz

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Abstract. *The increase in global temperature and the current energy context have brought the district heating system in Timișoara (partialy renovated) to the brink of collapse. Therefore, major investments and orientation towards the integration of renewable energy sources (RES) are required. The article analyzes, by exemplifying a case study, the integration of photovoltaic technologies at a heat point that supplies the buildings of the Faculty of Construction (CT) in Timișoara. The study was carried out with the help of Polysun software. The results obtained indicate a reduction in thermal and elctrical energy costs of 38.51% by installing a number of 1095 photovoltaic (PV) panels on the roof of 4 building bodies (ASPC, Deposit, CT and Metal).*

Key words: *heating system, RES*

1. INTRODUCTION

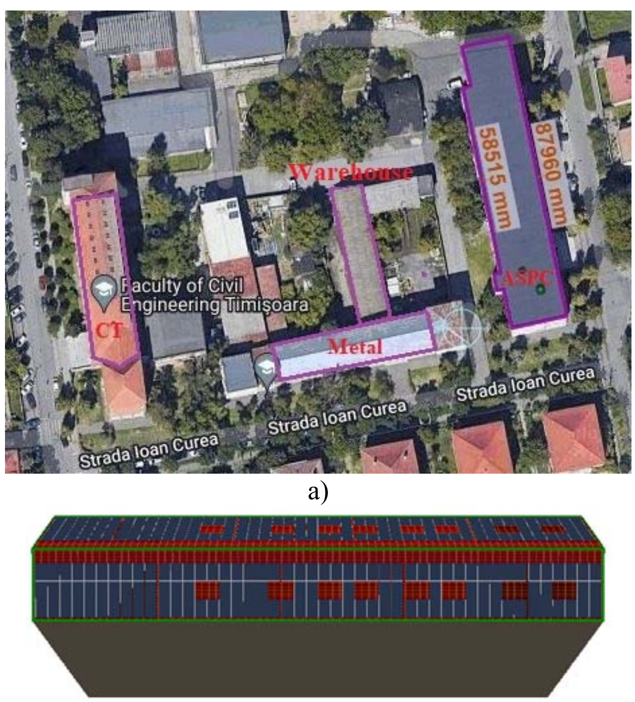
In Romania, heating systems represent one of the most polluting public services through the large amounts of CO_2 emissions per Gcal [1], [2], [3], [4]. By particularization, regarding the heating system in Timișoara (completely unrenovated), the problems of the global context related to the increase in global temperature and the current energy crisis have brought this system to the brink of collapse. The abandonment of heating systems cannot be questioned because the main energy supply networks (electrical and thermal) in Romania (the electricity supply network and the combustible natural gas supply network) cannot take over the provision of thermal energy, not being dimensioned for such a high consumption, a fact that requires the upgrading of heating systems [5].

So, overcoming the crisis in which the district heating system in Timișoara is, and not only, requires major investments and orientation towards the integration of renewable energy sources (SRE).

Therefore, the article presents a case study applied to a heat point that supplies thermal energy to the heating installations related to the building bodies (Main Building, Warehouse, Metal Building and ASPC) of the Faculty of Construction in Timișoara. The heat point is connected to the centralized heating system in Timișoara through the secondary thermal network to the final consumers [4], [6], [7]. The energy efficiency solution consists in the installation of photovoltaic panels on the roof of the buildings that are part of the Faculty of Construction, in order to reduce thermal and electrical energy costs.

2. SIMULATION OF THE PHOTOVOLTAIC SYSTEM. CASE STUDY

The ensemble of buildings within the Faculty of Construction (Faculty of Construction main building body (CT), warehouse building body (W), Metal building body (M) and ASPC building body (ASPC) that were the subject of the study and the positioning of the photovoltaic panels (PV) on the roof of the 4 building bodies are shown in Figure 1 [8].



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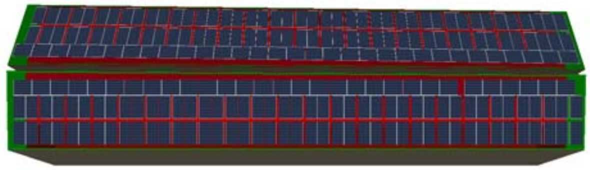

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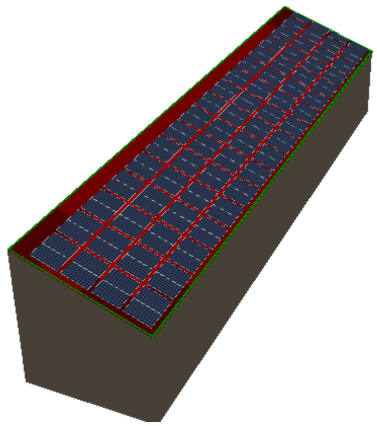

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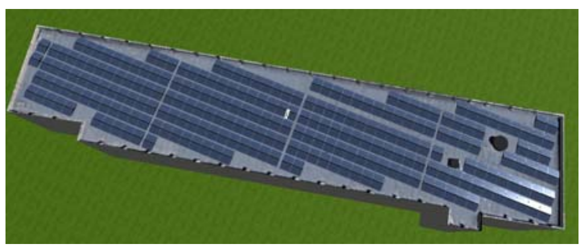

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Figure 1. The ensemble of buildings of the Faculty of Construction
a) Overview, b) PV positioning on CT body, c) PV positioning on Metal body, d) PV positioning on Warehouse body, e) PV positioning on ASPC body

To carry out the study, with the help of Polysun SPTX Constructor [8] and Polysun Designer [9] programs, the possibility of installing a 200kW air-water heat pump and a photovoltaic system to supply electricity to the heat pump was simulated. In the existing situation, the four building bodies are supplied with thermal agent for heating and domestic hot water from the heat point which is connected to the secondary circuit of the heating network of the city of Timișoara.

Table 1 presents the input data on the basis of which the simulation was performed.

Table 1 Input data – available surfaces, consumption and heat demand (existing situation)

Building	Roof surface [m2]	Electricity consumption [MWh/an]	Electricity consumption from NES [MWh/an]	Thermal requirement for heating [MWh/an]
ASPC	1850	60	57,3	58,50
M	660	25	23,88	19,15
D	420	10	9,55	3,50
CT	600	120	114,60	95,73
Total	3530	215	205,325	176,87

According to Table 2, the simulation showed that it is possible to install a photovoltaic system with a total installed power of 194.4 MW by mounting 1095 EvoloCells 400 MIB 400W photovoltaic panels covering a total surface of 3530m2 of roof. Four SMA Sunny Tripower CORE2 STP 110-60 inverters (maximum efficiency of 98.6%) and 20 REACT-3.6TL 6kWh type storage batteries were chosen for the photovoltaic system.

Table 2 Output data – photovoltaic system [8], [9]

Building	Number of panels [buc]	Installed power [MW]	The amount of electricity produced [MWh/an]
ASPC	486	194,4	64,50
M	233	52,8	17,52
D	132	93,2	30,92
CT	244	97,6	32,38
Total	1095	438	145,32

The principle diagram of the existing heat supply system of the building complex is presented in Figure 2, and that of the proposal for the modernization of the thermal point, in Figure 3.

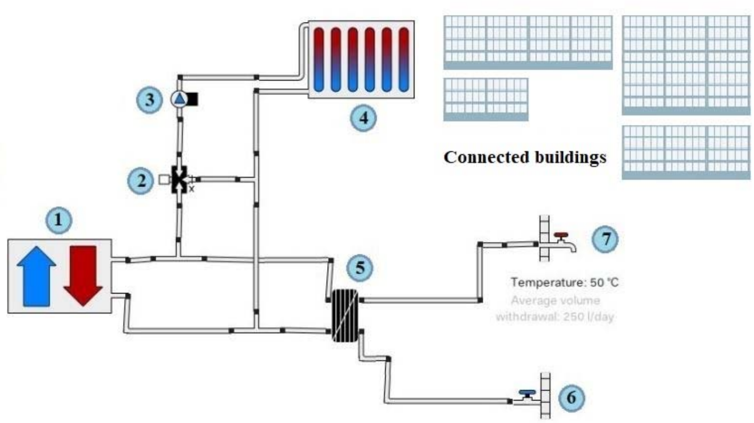

Figure 3. Principle diagram of the existing system [9]
1 – Heating network, 2 – Mixing valve, 3 - Circulation pump, 4 - Internal heating installation, 5 - Hot water heat exchanger, 6 - Cold water supply, 7 - Hot water consumers

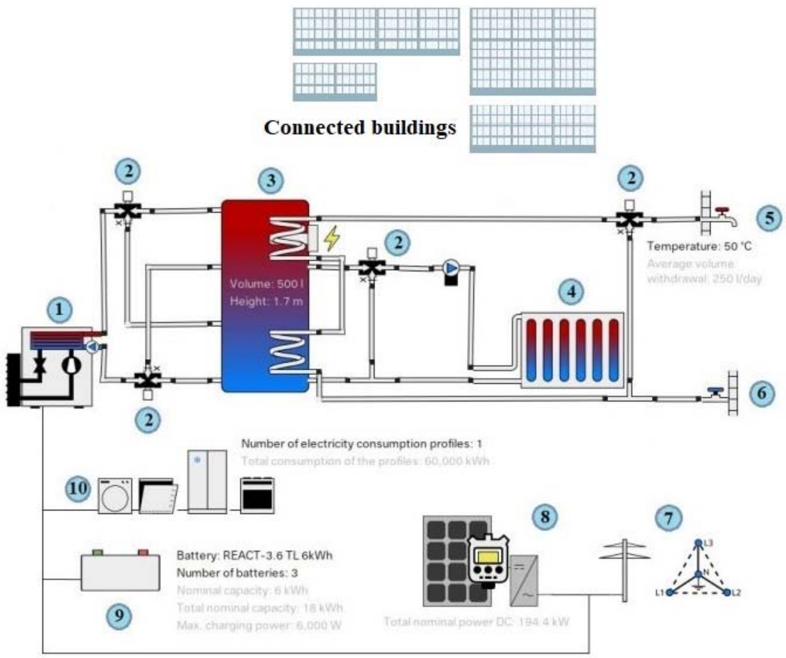

Figure 3. Principle diagram of the proposed system [9]
1 - Heat pump, 2 - Mixing valve, 3 - 1000 liter storage tank, 4 - Indoor heating system, 5 - Hot water consumers, 6 - Cold water supply, 7 -NES, 8 - PV system, 9 - Storage batteries, 10 - Electricity consumers

3. COMPARATIVE ANALYSIS OF COSTS. EXISTING SITUATION VS. MODERNIZATION

For the comparative analysis between the two situations of the system (existing vs. modernized), the consumption of thermal energy from the local heating system and the consumption of electricity from the SEN were taken into account for all four buildings considered (Table 3).

For the calculations, a price of 1008.65 lei/MWh (205.85 Euro/MWh) was considered for thermal energy and respectively 1500 lei/MWh (306.12 Euro/MWh) for electricity.

Table 3 Total costs existing system vs. modernized

Type and source of energy	System status	Consumption [MWh]	Price [Euro]	Total cost [Euro]
ASPC building				
From district heating	E	58,50	12.042,05	30.409,39
Electricity from NES		60	18.367,35	
From district heating	M	0	0,00	17.540,82
Electricity from NES		57,3	17.540,82	
Metal building				
From district heating	E	19,15	3.941,03	11.594,09
Electricity from NES		25	7.653,06	

Type and source of energy	System status	Consumption [MWh]	Price [Euro]	Total cost [Euro]
From district heating	M	0	0,00	7.308,67
Electricity from NES		23,88	7.308,67	
Warehouse building				
From district heating	E	3,50	720,46	3.781,69
Electricity from NES		10	3.061,22	
From district heating	M	0	0,00	2.923,47
Electricity from NES		9,55	2.923,47	
CT building				
From district heating	E	95,73	19.705,17	56.439,86
Electricity from NES		120	36.734,69	
From district heating	M	0	0,00	35.081,63
Electricity from NES		114,60	35.081,63	

Note: E - Existing, M - Modernized

From the cost analysis presented in Table 3, it can be seen that a reduction in energy costs is obtained, of 42.32% for the ASPC building, 36.96% for the M body, 22.69% for the D body and 37.84% for the body CT, which will represent a reduction of 38.51% for the heat point feeding the four building bodies.

Also, for the proposed photovoltaic system, an electricity flow diagram was generated (Figure 4) based on the monthly electricity consumption/surplus of the proposed photovoltaic system for installation.

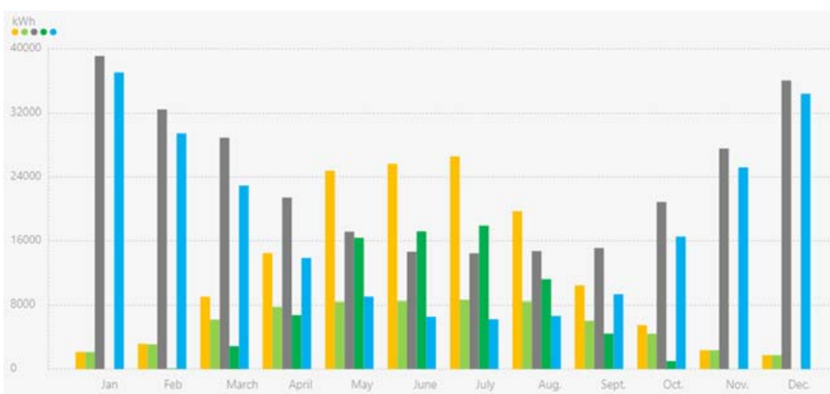

Figure 4. Annual energy flow diagram for the photovoltaic system [8]

	Energy production [kWh]
	Total consumption [kWh]
	Consumption from NES [kWh]
	Consumption from the PV system [kWh]
	Injection into NES [kWh]

From the analysis of Figure 5, it can be seen that during the summer months the energy surplus generated by the photovoltaic system is considerable.

Considering the injection problems in the SEN, as a future research direction, an analysis of the use of the surplus for cooling the spaces or use for other purposes is proposed, considering that in these spaces, during the summer, the activity is restricted.

4. CONCLUSIONS

The proposed measures aim at the sustainable rehabilitation of heating networks, in accordance with the policy of reducing energy consumption and CO_2 emissions.

The solutions analyzed through the case study have as main conclusions:

- SRE integration at the level of heat points, which is a necessity for the rehabilitation of heating systems;
- the hybrid system: heat pump and photovoltaic panels, is a viable system for the rehabilitation of heat points considering the reduction of annual costs by 38.51% obtained through simulation.
- expanding the prosumer concept, respectively the hot water supplier concept, as a storage solution for the surplus of captured photovoltaic energy.

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