DECENTRALIZED HEAT SUPPLY
FOR PRIMARY EDUCATIONAL INSTITUTION #22
IN KOROSTEN, UKRAINE

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PlanEnergi

CONTENTS

WHO WE ARE - PLANENERGI?

- Consulting engineering firm in the engineering field
- Over 38 years of working with sustainable and renewable energy
- 3 offices in Denmark
- Turnover in 2021: DKK 35 million
- Capital: DKK 8.3 million
- Board of 8 members

11 teams (49 employees) specializing in:

- Central heating
- Strategic power planning
- Biogas
- Spatial planning of solar power plants and wind turbines
- International research projects (IEA, Horizon, etc.)

INTRODUCTION

Grounds: request by the Economical Department of Korosten Municipality

Aim: assessment of establishing decentral heat pumps at the Public Preschool Education Institution (PPEI) No. 22 in Korosten, Ukraine.

Purpose: to fully cover the heat demand of the PPEI with an individual heat supply and thereby disconnect the institution from the fossil fuel-based central heating supply in the town.

Outcome: comparison of the different alternatives for heat supply to outline most feasible solution for the future heat supply.

BACKGROUND AND PROBLEM DEFINITION

BACKGROUND

- Object – PPEI No. 22 - 2 educational buildings (see images 1,2), centralized heat supply from a gas boiler house (see image 3)
- Communally owned by the Korosten city territorial community, financed from the local budget
- Total number of users of central heating services in the Object - 76 visitors of PPEI No.22
- Heating area: Building #1 – 257.1 m2, Building #2 – 293.2 m2 (each is the one-story building)
- Building #1 has the necessary premises and building #2 needs an extension to be built. Estimated costs - UAH 40 000
- Average internal temp. 20C
- Tariffs for Electricity and Heat consumption are 6.3536 UAH/1 kWh and 3065,52 UAH/Gcal respectively

BACKGROUND AND PROBLEM DEFINITION

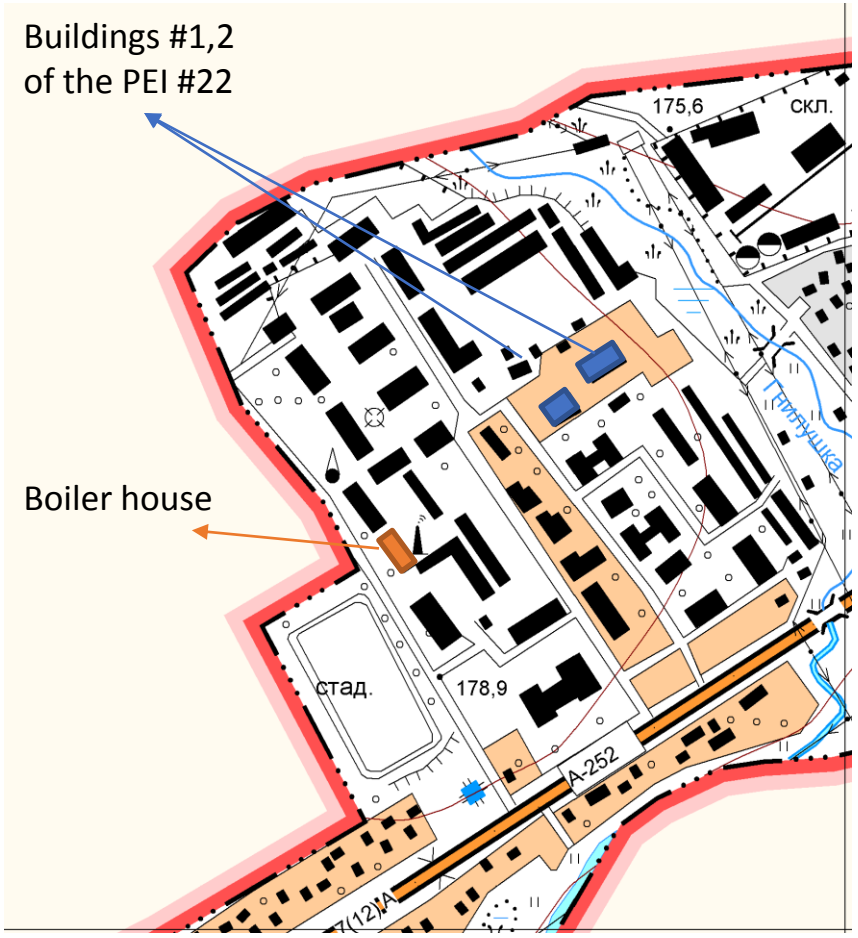
Image 1 Building 1 where an extension needed to be built.

Image 2 Building 2, former boiler house facilities

BACKGROUND AND PROBLEM DEFINITION

Network (boiler house)

- Current network - 1249 m of damaged metal pipes in impassable channels.
- Total number of users served by boiler room - about 400 people
- Operated by 4 operators and 1 fitter
- Huge thermal energy losses and constantly increasing q-ty of emergency situations
- Unprofitable and is scheduled to be closed



BACKGROUND AND PROBLEM DEFINITION

Problem definition

- Imbalance of the system, large heat energy losses
- Consumers are constantly being disconnected from the central heating network
- The increased volatility of natural gas prices, dependence on the Ukrainian energy system, instable central heat supply system make the centralized heating supply in Korosten vulnerable and its stable operation cannot be guaranteed

AIM AND TACTICS

- **The project definition**: Autonomous heat supply system for PEI#22 in Korosten, Ua
- It is suggested to use renewable energy sources, namely, the installation of two heat pumps (air-water) – one for each building of the institution.
- The following scenarios are calculated and compared, and sensitivity analysis was made for Scenario 1:

1. **Reference:** Operation with the current centralized heat supply, based on natural gas
2. **Scenario 1:** Establishment of decentralized heat supply with heat pumps and electric boilers

- The project is supported by Department of Education of the Central Committee

AIM AND TACTICS

Also, the possibility of transitioning the entire heat supply system to individual heat supply using alternative sources of heat (e.g., waste heat or heat pumps depending on availability of sources of waste heat) should be considered.

Such solution could significantly reduce costs of heat production in the future, making the whole system more efficient and sustainable.

RESULTS

A business-economic calculation for all scenarios is carried out. The calculation of the economic consequences is made by comparing the annual costs for heat production in the reference and the alternative scenario.

The end-result is a comparison of the calculations, outlining the implications that the alternative has from economic and technical standpoint, in comparison to the reference.

First, an economic assessment of the current situation is made.
Operation expenses for centralized heat supply to PEI 22 are calculated considering the energy system as it is. This is followed by an assessment of the changes in the operation expenses caused by the establishment of decentralized heat supply with heat pumps in combination with electric boilers.

Operation expenses for each scenario are calculated in the energy system modelling tool energyPRO [1].

The electricity costs for operating the heat pumps and electric boilers as well as gas consumption are calculated based on data provided by the partner (See tables 1,2).

[1] https://www.emd-international.com/energypro/

RESULTS

Table 1. Overview of heat and electricity costs

Consumption of thermal energy	**3065,52**	UAH/Gcal
Electricity consumption	**6,3536**	UAH/1 kWt

Table 2. Historic heat consumption for PEI #22

PEI #22 (buildings 1,2)			**PEI #22**
Year	Total consumption by object		Released heat from boiler room
	Gcal	**MW**	**MW**
2019	73,6	85,59	110,45
2020	66,08	76,85	99,16
2021	72,71	84,56	109,11

RESULTS

As shown in Figure 4, in the reference scenario the heat supply is solely provided by natural gas-based central heating.
In the project scenario the consumption of natural gas is completely replaced by heating provided by individual heat pumps together with electric boilers

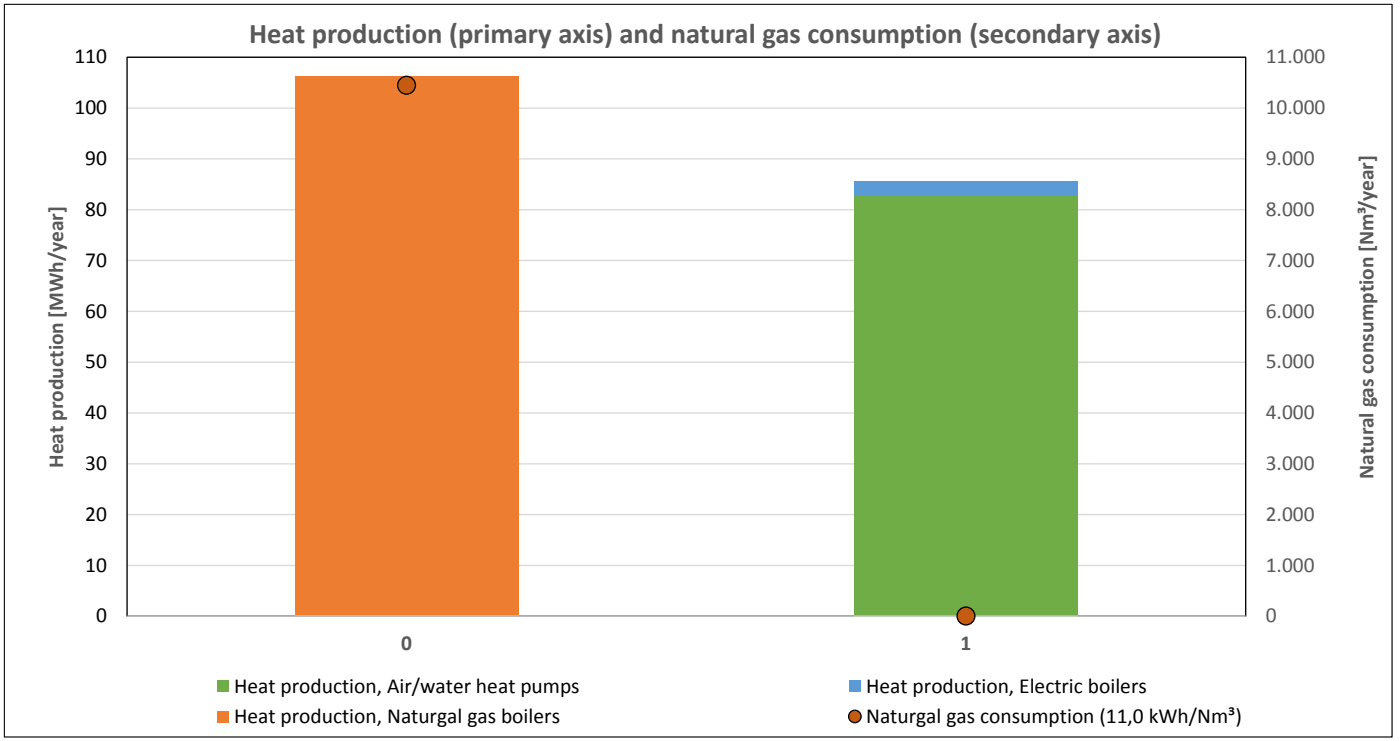


Figure 4: Heat production and natural gas consumption for the two scenarios.

RESULTS

Table 3 shows the overall investments necessary in the project scenario, including costs of purchasing and installing the equipment, facility extension, additional costs such as consultancy fees, etc.
The production units in the project are dimensioned so that they meet the energy needs at PEI 22.

		1 Korosten Heat pump + El. boiler
Estimated investment, Air/water heat pumps	**Capacity**	**24 kW**
Heat pumps incl. Circulation pumps, compensation tanks and electric boilers	UAH	1.530.000
Samlet investering, Luft/vand varmepumpe	**UAH**	**1.530.000**
Additional investments		
Project planning, supervision and regulatory procedures	UAH	260.000
Expansion of current building	UAH	40.000
Heat storage tank, 600 m^3	UAH	
Contingencies, 10%	UAH	180.000
I alt	**UAH**	**2.010.000**

Table 3: Overview of the investment costs.

RESULTS

As seen in Table 4, it is not economically feasible to establish decentralized heat supply at PEI 22 without receiving a grant or other type of public financing. This is due to the fact that the overall capital costs in the project scenario are larger than the operation savings compared to the reference scenario, resulting in a cost increase of ca. 14.000 UAH/year compared to the reference.

Thereby, alternatives for financing the project need to be investigated, to ensure that it is economically feasible.

Economy **Electricity price 6.353 UAH/MWh$_{el}$** **Natural gas price 2.637 UAH/Nm³**		**0** **Korosten** **Reference**	**1** **Korosten** **Heat pump + El. boiler**
Investment, Air/water heat pumps*	UAH	0	1.530.000
Investment, El. boilers*	UAH *	0	0
Additional investments*	UAH	0	480.000
Total investment costs	**UAH**	**0**	**2.010.000**
Grant received	**%**	**0%**	**0%**
Total capital costs	**UAH/year**	**0**	**101.284**
Operation expenses	UAH/year	280.117	192.718
Operation savings	UAH/year	0	87.399
Net savings (Operation savings - capital costs)	**UAH/year**		**-13.885**
Simple payback period	year	-	23,0
Heat production price incl. capital costs	UAH/MWh	2.638	3.435
Reduction in the heat production price	UAH/MWh	-	-797,0
**) The loan is calculated as a 25 year annuity loan*			

Table 4: Business economy for the main calculation.

RESULTS

Sensitivity analysis

An alternative economic assessment of the feasibility of the project scenario is made, where it is assumed that a public grant equal to 100% of the overall investment costs (approx. 2 mil. UAH) is obtained.
The results are shown in Table 5.

Economy - alternative calculation **Electricity price 6.353 UAH/MWh$_{el}$** **Natural gas price 2.637 UAH/Nm³**		**0** **Korosten** **Reference**	**1** **Korosten** **Heat pump + El. boiler**
Investment, Air/water heat pumps*	UAH	0	1.530.000
Investment, El. boilers*	UAH	0	0
Additional investments*	UAH	0	480.000
Total investment costs	**UAH**	**0**	**2.010.000**
Grant received	**%**	**0%**	**100%**
Total capital costs	**UAH/year**	**0**	**0**
Operation expenses	UAH/year	280.117	192.718
Operation savings	UAH/year	0	87.399
Net savings (Operation savings - capital costs)	**UAH/year**		**87.399**
Simple payback period	year	-	23,0
Heat production price incl. capital costs	UAH/MWh	2.638	2.251
Reduction in the heat production price	UAH/MWh	-	386,3

Table 5: Business economy for the alternative calculation.

CONCLUSION

The calculations presented in Table 4 and Table 5 clearly show that the establishment of decentralized heat supply with heat pumps and electric boilers at the institution would **not be feasible** from a business-economic perspective.

On one hand, in the present economic and political situation, considering instability, high rate of inflation and other factors, taking long term loans is unlikely both due to banks pausing the issue of long-term loans and the lack of economic feasibility in case of taking a long-term loan without a grant.

This means that there would be a necessity for financial support from the state for the project to become attractive for a possible investor.

It can be concluded that obtaining a grant payment on the investment is of paramount importance for the realization of the project.

All-in-all, the results from this report cannot be directly used for initiating the project, since as mentioned throughout the report, there are still uncertainties to be clarified. The results from this report are to be used as an indication of the limitations and possibilities of the current system in Korosten. Following further investigation and clarifications, a more detailed and exact assessment should be made.

DISCUSSION?

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