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Renewable Power-to-Heat in Hajnówka

Feasibility study for the changeover of the heating network from coal to renewable energies in the City of Hajnówka, Poland

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Overview

This study investigated whether the coal-based district heating system in the Polish city of Hajnówka could be converted to large-scale heat pumps powered by electricity from renewable sources. The result shows that such a heat supply is technically possible, economically viable in the long term and ecologically sensible.

Two large heat pump cascades (eight heat pumps in total) can be installed in two existing boiler houses of Hajnowka Public Utility. The geological data to date suggests that there is sufficient groundwater for this to act as a heat source.

The heat pumps provide about 90 per cent of the annual heating work. The remaining demand can be covered by a new gas boiler. Seven heat pumps use groundwater as a heat source. One uses sewage.

The feasibility study is not a substitute for detailed implementation planning, but it provides a good basis for decision-making.

Investment costs

The cost of the heat pump systems is estimated at just under PLN 50 million, or EUR 11 million. In addition, the investment costs for the wind and photovoltaic plants amount to PLN 62 million and EUR 14 million, respectively. In total, investment costs in the order of PLN 112 million and EUR 25 million, respectively, can be expected. However, the consumption costs are decisive for the economic evaluation since the investment costs correspond to only about a quarter of the total costs. Heat cost calculation with CO2 price.

To investigate the economic viability, effects of different CO2 prices (45, 100 and 200 Euro/ton CO2[1]) on four heating scenarios were considered. Two fossil scenarios with different coal prices (676 PLN/150 Euro/t and 1,221 PLN /272 Euro/t[2]) were considered with two scenarios with renewables (once without and once with an additional heat storage).

Already at the CO_2 price of PLN 203/EUR 45/t, the heat pump systems have the same price level as the existing heating system at the lower coal price. The heat pump system with storage tank is even lower. In the case of the higher coal price, the differences are significant at PLN 68/EUR 15 and PLN 126/EUR 28, respectively.

[1] Based on the European CO2 price for heat coming in 2027 in the amount of 45€.
[2] The coal price before and after the start of the war of aggression on Ukraine was taken.

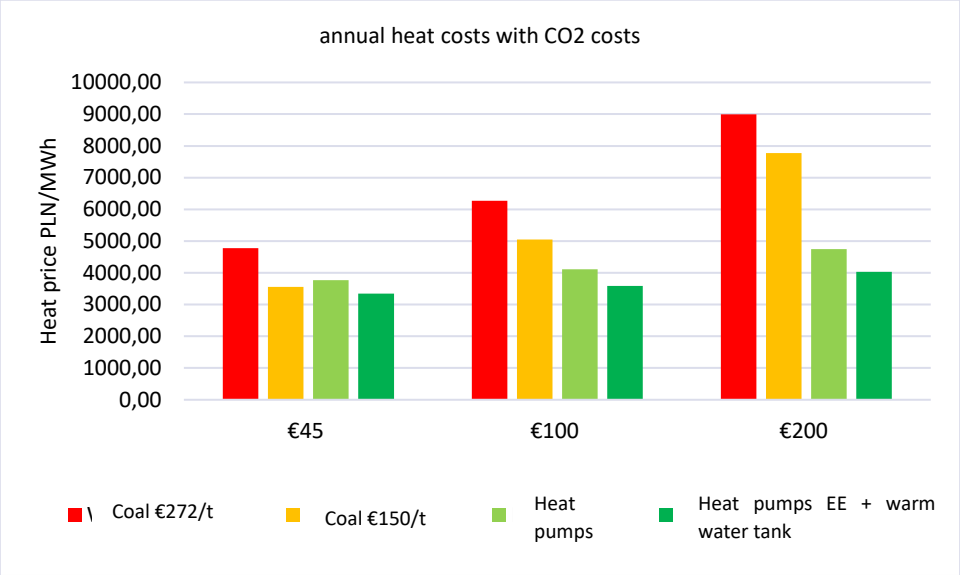

Diagram 1: Illustration of heat costs (€/MWh) of the four scenarios (coal scenario 1 + 2, heat pumps and heat pumps + storage depending on CO_2 certificate prices (EUR 45, 100, and 200/t). Own illustration.

With rising CO_2 prices, the heating costs for the heat pump systems also rise (due to the remaining fossil-fuel covered residual heat demand of 10 per cent), but this only moderately. In comparison, heating costs would nearly double with the existing system. The increase in both price scenarios is over PLN 360 and EUR 80/MWh, respectively. If a biomass boiler were used, the heat costs of the heat pump scenarios would not be affected by the CO2 price.

This makes two things clear: on the one hand, it shows how sensitively heating costs react to changes in fuel costs. On the other hand, it shows the high-cost stability that a conversion to an own power supply with renewable energies brings with it and contributes to the security of supply of the region.

CO_2 reduction

Switching the heat supply to heat pumps would reduce CO_2 emissions by 54 per cent at the current electricity mix. As the share of renewables in the Polish electricity mix increases, emissions will be further reduced in the future. If, as proposed in this study, 60 per cent of the energy supply for the heat pumps is provided by renewable energies and the share of self-generated electricity is increased by an additional heat storage system, CO_2 emissions are reduced by 84 per cent[3].

Air quality modelling in the Podlaskie Voivodeship report[4] shows that in 2021 in Hajnówka the concentration of benzo(a)pyrene in PM10 particulate matter exceeds the values of the "target value for the average annual concentration for the protection of health" and ranges from 1.5ng/m^3 to about 5ng/m^3. The maximum PM10 concentration from the daily average concentrations indicates elevated values of this indicator, which ranged from 35.5µg/m^3 to 45µg/m^3.

An end to coal burning in Hajnówka's heating system will significantly improve air quality and thus the health of the city's residents.

[3] 4,775 tonnes of CO_2 instead of 29,323 tonnes of CO_2.
[4] Główny Inspektorat Ochrony Środowiska. 2021: Roczna ocena jakości powietrza w województwie podlaskim. Raport wojewódzki za rok 2020. Bialystok. https://powietrze.gios.gov.pl/pjp/rwms/publications/card/1427. Last visited on 03/05/2023.

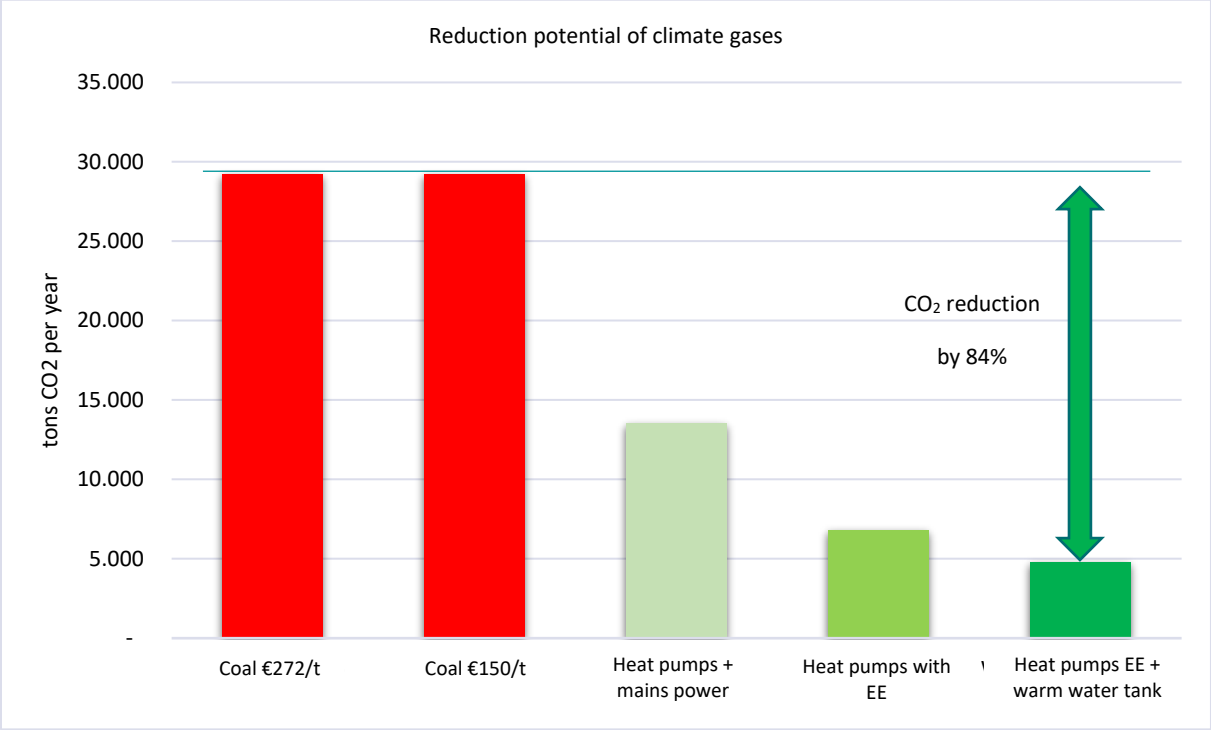

Diagram 2: Compilation of the reduction in emissions when switching the heat network to heat pumps.

Notes on possible detailed and execution planning

Even if some data are estimated, it shows that a switch to large heat pumps would be technically possible, economically, and ecologically sensible.

The level of detail of the feasibility study provides sufficient basis for further political debate and decision-making in the city and region of Hajnówka.

Should the political decision-makers decide to implement the concept, some of the assumptions still need to be checked and details verified or clarified in a detailed implementation plan. For further and detailed information please refer to the feasibility study.

Further and detailed information can be found in the feasibility study, which can be downloaded from www.100-prozent-erneuerbar.de/publikationen in German, English and Polish.

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