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Opportunities and challenges of future district heating portfolios

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Overview

The district heating sector is currently in transition and challenged in many ways: (1) Energy and climate policy objectives set new frameworks, (2) Heat demand is reduced due to thermal building renovation, (3) Sector coupling and digitization present new opportunities and challenges, (4) The revised Renewable Energy Directive 2018/2001 for the first time also sets concrete targets for the annual increase of the share of renewables in the heating sector in general and particularly in district heating until 2030. Against the background of all these challenges, in this paper we want to assess the opportunities and risks of different concrete portfolio options of an Austrian district heating supplier.

Method

To analyse the opportunities of different concrete portfolio options following steps were performed for this work: (1) Analysis of status quo of the district heating system: In this step the current demand for district heating and the technical parameters of the district heating supply portfolio were analysed. (2) Analysis of current and possible future economic framework conditions: In this step a consistent set of framework conditions were generated built on the EU reference scenario. This included current energy prices and current taxes and fees for the different technologies plus three future scenarios of energy and carbon prices and scenarios of expansion of renewable electricity generation. The defined framework conditions were used to calculate hourly electricity prices using a simple electricity market model. (3) Definition of future portfolio options: In this step 4 concrete portfolio options were developed together with the district heating utility to enhance the current supply portfolio. These portfolio options have different technical focuses and in particular a heat pump portfolio, an excess heat portfolio, a biomass portfolio and a renewable portfolio were developed. (4) Modelling: In this step the status quo and the future portfolios together with the respective framework conditions were implemented in a linear dispatch optimization model. Each modelled supply unit is described by its (nominal) thermal power and its (nominal) thermal and electrical efficiency. Using linear equations, the required (fuel) input and the eventually combined generated electricity can be calculated for each operation point for every hour. (5) Perform techno-economic analysis: In this last step the dispatch optimisation was performed for each portfolio and for the different possible future framework conditions and sensitivities of the most important factors. For all units the generated heat and the full load hours are calculated and indicators like total CO2 emissions, total share of renewable heat and resulting levelized cost of heat are compared for the different portfolios.

Results

The assessment shows that the expected increased renewable power generation capacity is likely to increase volatility in future electricity prices with hours of both very low and very high electricity prices. This higher volatility of electricity prices results in higher flexibility requirements for the generation plants per se (fast and frequent start-up and shut-down, less continuous operation). Therefore there is also a need for heat generation portfolios to respond to both high and low electricity prices. From the analysis it can be seen that heat pumps are well suited to use periods of low electricity prices and CHP plants for periods of high electricity prices. It is therefore recommended to combine different portfolio options. Under the made assumptions, the construction of large heat pumps in combination with efficient CHP systems seems to be an effective strategy to hedge against different price developments. Therefore a complete withdrawal from gas fired fossil CHP is not recommended from the model results until 2030 as otherwise periods of high electricity prices and thus potential gains from the electricity market could not be used. Nevertheless, the assessment also showed that by combining heat pumps, integrating waste heat and generating heat from biomass, an almost CO2-free district heating supply of the assessed district heating network seems to be possible at reasonable costs in the medium to long term. However, the future requirements for renewable heat generation are still associated with uncertainties, in particular with regard to combined production of heat and power from fossil fuels and the role of conventional electricity generation.