**Power-to-Heat concepts with heat storage for district heating system**

Energieerzeugung/-infrastruktur und Netze

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Motivation

Heating, the largest final energy consumption, remains highly dependent on fossil fuels globally. In Germany, fossil fuels continue to dominate source of heating even in district heating systems (DHS) [1]. Sometimes in systems that use renewable energy sources such as biomass, gas boilers are still a standby technology during system overload or maintenance. Therefore, replacing gas boilers with more environment-friendly heating technologies is essential to achieve CO2 reduction targets and to ensure energy security in Europe. The goal of this study is to improve energy efficiency and renewable energy ratio of district heating system by combining P2H technology with various of heat storage technologies.

Methodology

Power-to-Heat (P2H) technology improves the efficiency and security of the energy supply network by converting excess electricity generated from renewable energy sources into thermal energy. However, there are still many difficulties in the specific implementation and diffusion of P2H technology. As basis for the concept development, this paper first dealt with the basics of the applied technology and analyzed the status quo of the heat supply in the target district heating network. By creating a heat demand profile, the required heat demand was analyzed to determine the energy saving potential in the system. Then, two scenarios were designed to achieve the goal of reducing the operation of gas boilers as backup technology in the district heating system. In the first scenario, a system was designed to replace the gas boiler by combining a heat storage tank with an electrode boiler to cover the peak load. In the second scenario, the possibility of using high-efficiency heat pumps and heating pipes as energy storage systems was investigated to avoid the use of gas boilers during the maintenance of biomass cogeneration plants. Furthermore, the potential of using photovoltaic and solar thermal technologies in residential buildings to reduce district heating loads was also discussed.

Results

To cover peak loads, scenario 1 provides for a daily heat storage tank in combination with an electrode boiler. The heat storage tank is charged during nights and releases heat during peak loads, The electrode boiler converts the electricity generated by the biomass cogeneration plant into thermal energy. In this case, the economic viability of the systems is still verified at current natural gas prices, although the electricity feed-in is lower. The system also reduces CO2 emissions by about 10 %, which improves the sustainability rating of the system.

In scenario 2 a centralized large-scale heat pump converts green electricity to heat to cover the use of gas boilers during the maintenance of biomass cogeneration plants. Downtime for maintenance and repairs was shifted to the summer months for the lowest heat loads. In summary, the combination of heat storage tanks and large heat pumps, in order to avoid the use of gas boilers, provides only an ecological advantage but not financial benefits. This combination leads to approximately 30% reduction in CO² emissions from district heating networks.

In addition, increasing the temperature difference between flow and return in the district heating pipeline by 10% can result in significant savings in gas consumption.

Literatur

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