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RETROFITTING AND OPTIMIZATION STRATEGIES FOR DECARBONIZING DISTRICT HEATING SYSTEMS

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This paper investigates retrofit strategies for decarbonizing a district heating system through the integration of low-carbon technologies and optimized operation. The study focuses on the implementation of large-scale heat pumps utilizing various heat sources, including industrial waste heat, wastewater streams, and heat recovery from boiler flue gases. Thermodynamic performance of selected working fluids is evaluated using Aspen HYSYS, while system-level dispatch is analyzed using a model developed in Excel.

Realistic operating conditions are considered, including part-load behavior, electricity price driven operation, thermal storage, and hot standby modes. A condensing flue gas heat recovery system coupled with a heat pump is also assessed as an additional retrofit option. The performance of individual configurations is evaluated in terms of efficiency and contribution to heat supply.

A multi-criteria decision analysis (MCDA) framework is applied to compare the alternatives based on economic, environmental, safety and utilization criteria. Environmental evaluation includes both avoided CO_2 emissions and the impact of refrigerants, while utilization criteria reflect thermodynamic performance and annual heat supply potential. The results provide a comprehensive comparison of retrofit pathways and identify promising solutions for the transition toward low-carbon district heating systems.

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