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DEVELOPMENT OF A HYBRID BIDIRECTIONAL HEAT TRANSFER STATION FOR DECENTRALIZED FEEDING OF SOLAR ENERGY INTO DISTRICT HEATING NETWORKS

Fabian Stefan ACHILLES¹, Alois RESCH^{2*}

^{1,2} *University of Applied Sciences Upper Austria, School of Engineering, Stelzhamerstrasse 23, A-4600 Wels, Austria*

* *Corresponding author. Email address: alois.resch@fh-ooe.at*

Abstract – As a result of the continuous expansion of district heating networks (DHNs) in Austria and their growing importance for centralized heat supply, there is an increasing demand for innovative solutions to decarbonize these systems, particularly under partial- and low-load operating conditions. Moreover, the rising complexity and extension of DHNs lead to hydraulic and thermal limitations in certain network sections, which in some cases prevent the connection of additional consumers. One potential solution to address both challenges is the decentralized integration of so-called prosumers equipped with their own solar thermal systems (ST) or photovoltaic (PV) installations including power-to-heat components. This integration would enable surplus solar energy to be fed into DHNs, thereby increasing overall system utilization and reducing system payback periods for both solar systems, ST and PV. Especially, it provides an alternative to feeding PV electricity into the electrical grid, which becomes technically and economically more challenging. However, there is a lack of technical solutions to connect a potential prosumer to a DHN in a way that heat can be transferred in both directions. Therefore, the research work presented by this paper aims to contribute to overcome this shortage of bidirectional heat transfer stations (HTS). Based on the current state-of-the-art, a new concept for a hybrid bidirectional HTS was developed, which is capable of feeding excess solar energy from decentralized ST or PV systems into a DHN. Various hydraulic concepts were designed and evaluated, followed by engineering tasks and material selection. A prototype of the novel hybrid bidirectional HTS was constructed by modifying an existing unidirectional HTS, and performance measurements were conducted in the laboratory. Both the supply operation at 20 kWth and feed-in operation at 10 kWth were successfully tested. The measurement data confirmed that the target temperatures of 80 °C in the flow and 55 °C in the return of the emulated DHN as well as 70 °C in the flow and 50 °C in the return of the building side were achieved. The feed-in operation could almost be kept constant at 10 kWth, even during a sudden load change. Based on the results and experience gained during the construction and following testing phases, valuable insights were obtained for the further development of a market-ready system for commercial applications in the long-term perspective.

Keywords – *Bidirectional heat transfer station; decentralized feed-in; district heating network; integration of excess solar energy; surplus energy applications*

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