IEA DHC Annex XIV

InteGradeDH – Large-scale integration of low-grade sources into DH networks through geothermal seasonal storage and heat pumps

KEY MESSAGES

1. Unlocking low-grade waste heat for DH decarbonization

Low-grade waste heat (WH) from industrial processes and urban infrastructure represents an important but still underused resource for decarbonizing district heating (DH). Its use is often constrained by two mismatches: many WH streams are below the temperature required by existing DH networks and are largely available in summer, when heat demand is low. InteGradeDH investigated how heat pumps (HPs) and borehole thermal energy storage (BTES) can recover, upgrade, store, and use such heat more effectively in DH systems.

2. Providing a structured framework for combining waste heat, heat pumps, and seasonal storage

InteGradeDH developed a planning-oriented assessment framework for integrating WH into DH networks through HPs and seasonal BTES. The project examined different temperature levels for both WH and DH, as well as different HP-based configurations, operating schemes and performance indicators, supported by a Python-based techno-economic model. BTES was explored with a focus on medium-deep (1 km) systems. Beyond technical and economic performance, the project also addressed implementation aspects such as risk exposure, ownership arrangements, business models, and tariff structures for hybrid WH recovery systems with storage and HPs.

3. Case studies show technical feasibility, but economic viability remains strongly case-dependent

The considered case studies of Göttingen and Bolzano showed that, within the assessed configurations, HPs and BTES can significantly expand the use of otherwise difficult-to-integrate WH. In Göttingen, data center WH at around 30 °C was assessed for a university campus with high DH temperature requirements, showing that temperature matching and drilling cost are decisive for feasibility. In Bolzano, already exploited high-temperature WH from a waste-to-energy plant and low-temperature WH from a dairy facility were evaluated for summer storage, assuming an expansion of the existing urban DH system. The results showed that long-term stable operation is achievable. Economic viability was found to be challenging for the considered cases, but feasibility thresholds were identified by varying source and network temperatures, drilling costs, electricity prices, financing conditions, and suitable contractual arrangements, offering insight to extend the analysis to other boundary conditions.

More details on the project are available on www.iea-dhc.org.