Case Studies

https://heatpumpingtechnologies.org/annex57/

ANNEX 57

Flexibility by implementation of heat pumps in multi-vector energy systems and thermal networks

Heat Booster Substation, EnergyLab Nordhavn, Denmark

Boosting the temperature from ultra-low temperature district heating at building level

Demonstration of the operation and the load shift potential of a heat booster substation and a circulation heat pump to provide domestic hot water in multifamily buildings supplied by ultra-low temperature district.

KEY FACTS

RD&D Status:
Demonstration project

Type of heat pump:
Decentralized heat pump (HP)

Building description:
Havnehuset, a newly-built multifamily building with 22 individual flats

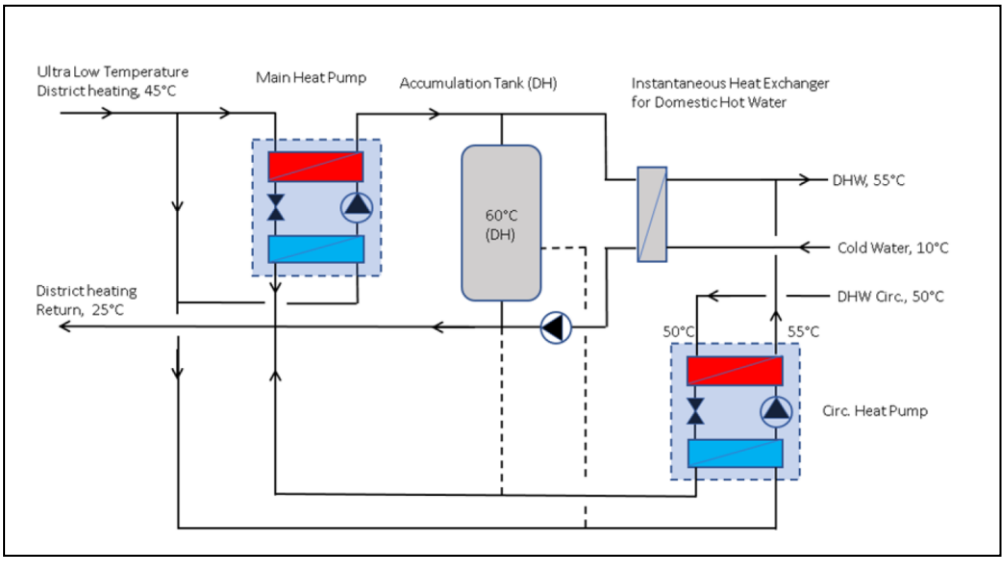
System:
Ultra-low temperature district heating

Energy Storage:
Domestic hot water storage (2x750 liter)

Control for the flexible heat pump operation:
On/Off operation, possibility of load shift

General description:
14 kW one-stage booster heat pump using R134a as refrigerant + 3 kW one-stage circulation heat pump

Source:
Ultra-low temperature district heating



Summary of the project:

The demonstration of the heat booster substation in Havnehuset, Copenhagen was part of the EnergyLab Nordhavn project.

The heat booster substation is a heat pump integrated at building level that boosts the temperature of the ultra-low temperature district heating (at forward temperatures of 35 °C to 40 °C) to temperatures high enough to provide domestic hot water. To do so the district heating stream is split. One part is used as heat source, while the other part is heated up to provide domestic hot water in a heat exchanger. The domestic hot water is produced at 55 °C and distributed to the apartments in the buildings. A buffer tank of two times 750 liter is included in the system, which ensures a high comfort level and provides flexibility regarding when to operate the heat pump. Thereby, the load on the district heating grid and on the electricity grid may be shifted to off-peak periods.

A second heat pump was included in the system to reheat the circulated domestic hot water from 50 °C to 55 °C. The demonstration project aimed at demonstrating the operation of the Heat Booster Substation as an enabling technology for ultra-low temperature district heating. Further, the potential to shift the load and thereby utilize the flexibility in the domestic hot water system to minimize operational cost was demonstrated.

IEA Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP)

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Demonstration

The Heat booster substation was installed, tested and operated during 12 months when the results were reported. During this period the average amount of domestic hot water produced was 1700 liters per day.

Results:

For district heating forward temperatures of 45 °C, the return temperature from the heat booster substation was 30 °C. In average, 14 % of the energy provided to the domestic hot water is related to the electricity consumption of the two heat pumps, while 86 % stem from the ultra-low temperature district heating.

Due to the installed storage, the consumption of district heating and electricity may be moved to off-peak hours. The tank could e.g. be filled before the morning peak. This would correspond to a load reduction of 3 kW electric power and 30 kW district heating.

The daily average load shifting potential was found to be 75 kWh/day for the entire building, hereof 7 kWh per day are electricity and 68 kWh per day are district heating. This was found to be similar to the load shifting potential of the space heating system in the building.

Several studies have shown the economic feasibility of ultra-low temperature district heating system with heat booster substation is limited compared to low temperature district heating.

FACTS ABOUT THE PROJECT

Place:
Nordhavn, Copenhagen, Denmark

Time Frame:
2018-2019

Project owner/leader:
Danfoss

Project participants:
DTU Mechanical Engineering
DTU Civil Engineering
(involved in FlexHeat demo site, for all project partners, see https://www.energylabnordhavn.com)

Published articles:

EnergyLab Nordhavn – Deliverable no.: D10.1c Heat Booster Substation for Domestic Hot Water and Circulation Booster for Domestic Hot Water
http://www.energylabnordhavn.com/deliverables.html

Thorsen, J. E., & Ommen, T. (2018). Field experience with ULTDH substation for multifamily building. Energy Procedia, 149, 197–205. https://doi.org/10.1016/j.egypro.2018.08.184

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