Evaluation of district heating network layout design and operation for district heating systems with multiple energy sources

Master project

In Switzerland around 36% of total energy consumption is used to cover space heating and domestic hot water demands in buildings. District heating networks is one of the prominent solutions, with multi-energy systems and distributed networks for sufficiently provide energy for buildings in a district scale, as opposed to heating systems installed locally at individual building level. It also enables low exergy heat sources, such as waste heat from cooling load, geothermal heat, solar energy, to be integrated and utilized by individual buildings collectively in a more energy efficient and effective way. An example of novel network design is ETH Hönggerberg low temperature networks. The layout is double pipeline with loop network topology, which enables bidirectional energy flow supplying both heating and cooling loads of building, incorporating long-term borehole seasonal storage technologies.

![Figure 1: Traditional Two pipeline Radial Network Topology](image1)

![Figure 2: Two pipeline loop Network Topology](image2)

![Figure 3: Single pipeline loop Network Topology](image3)

The design and simulation of a district heating system requires in-depth knowledge of the system and its components, and an understanding of the different modelling techniques that are suitable for different objectives. Whether to implement a specific type of network layout involves various aspects of concern, including energy sources, operational conditions, consumer types and load profiles, network size, geographical constraints, practical concerns of installation, costs, etc. This project aims at investigating on different network topologies (eg: traditional radial network, loop network, single pipeline, etc), and evaluate their hydraulic, energy and exergy performance. The network model will incorporate detailed information on network layout design, pipe design and corresponding operation strategies.
The ideal candidate has experience with programming and numerical tools (Matlab is required) and knowledge of thermodynamics, hydraulics, energy conversion technologies and urban energy systems. The project is offered at the Chair of Building Physics ETH in collaboration with the Urban Energy Systems Laboratory, EMPA.

**Goals and tasks**

1. Understand traditional and novel network topologies and their applications and technical constraints based on literature review
2. Represent different network topologies addressing their thermal hydraulic characteristics via modelling techniques
3. Identify specific network performance indicators and compare different network layouts
4. Apply the modelling framework on case studies

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