Low Temperature and Cold District Heating & Cooling Systems – Transition, Implementation, Planning, Long-term Evaluation

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Introduction

District heating plays a central role in the Austrian energy supply scheme and already covers 25% of the national heat demand. On a European level district heating was identified as one of the key technologies to transition towards a decarbonized, efficient, sustainable and fossil-free energy system. The historic development of district heating systems shows a decrease in supply temperatures and an increase in the use of renewable energy sources in the system.

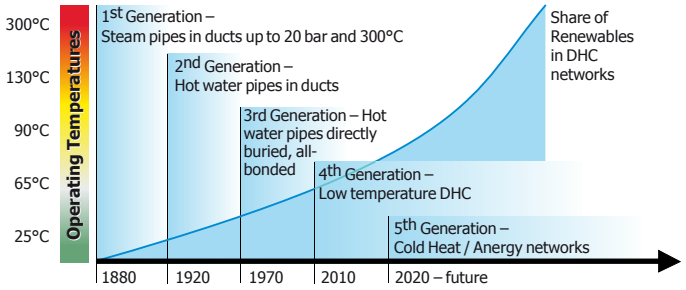


Fig. 1: Development of district heating systems. (in accordance with: Lund, H. et.al.: "The status of 4th generation district heating: Research and results", 2018)

Cold heat is characterized by supply temperatures below 30°C. That makes it particularly suitable for using renewable energy sources and low-temperature heat from other local sources. Another positive side effect is that heat losses in the grid are minimized and novel polymeric materials for piping can be used. The high degree of flexibility allow for expansion and later integration of additional sources, sinks and storages. Compared to conventional district heating networks (2nd and 3rd generation) a high reduction in primary energy consumption is expected.

State of the Art in LTDHC/CDHC & its Limitations

In the field of LTDHC (Low Temperature District Heating & Cooling) and CDHC (Cold District Heating & Cooling) only a few systems are realized yet. The project partner anex Ingenieure AG has been involved in the design and construction of several CDHC-systems in Switzerland and possesses significant expertise in this field of application.

- **Research:** Most research projects focus on the area of low-temperature networks, few on cold heat.
- **Waste heat regeneration:** Heat regeneration from waste water, industrial processes or server facilities
- **Network design:** In CDHC-Systems a special form of the ring-shaped topology, the "anergy"-network layout, is used.
- **Demonstration sites:**
  - Amstetten: heat regeneration from municipal waste water
  - Munich: waste/cooling water from sub-way tunnels to supply municipal utilities
  - Zurich: waste heat from server facilities to feed a anergy network
- **Flexibility:** The current linear topology is insufficient flexible when it comes to extending the network and implementing decentralized energy sources.

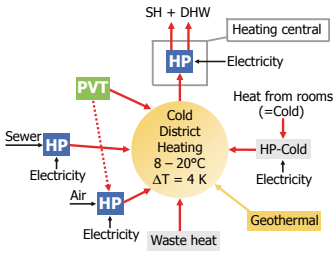
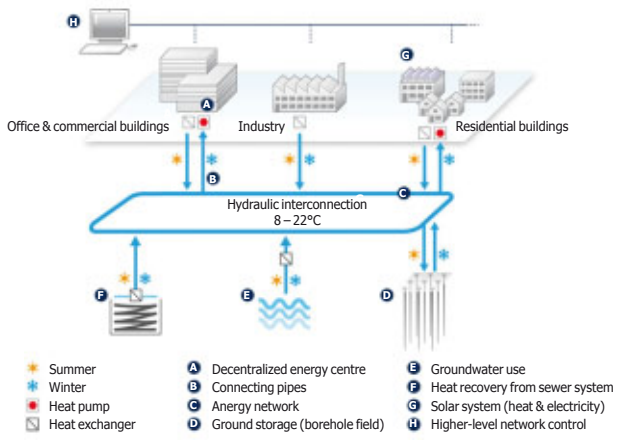


Fig. 2
Left: Potential layout of a cold district heating network, including several producers.

Below: Layout of an anergy network (special form of a cold heat network) as proposed by AMSTEIN&WALTHERT.



Research Project DeStoSimKaFe

Energy Research Programme 2017 / Runtime: 2 years, [09/2018] to [08/2020]

- What's missing?
  - Scientifically sound basic knowledge
  - Methods for the development of holistic system solutions and system optimization
  - Minimum requirements, areas of application and application limits
  - Scientifically sound methods for long-term assessment
  - Basic principles for the evaluation of benefits
  - Business models
- Project goals
  - Enable application and implementation of heating and cooling supply based on cold district heating systems
  - Conception, simulation and optimization of technical system solutions
  - Investigation of low-temperature networks using different grid topologies under undefined flow states
  - Integration of low-exergy sources
  - Development of capabilities for flexible grid expansion and supply of old building stock
  - Long-term evaluation of system solutions using varying framework conditions and stochastic modelling
  - Economic development towards business models and business plans
  - Technical and economic evaluation

Methods

For a detailed evaluation of the various system configurations and for the investigation of the energetic long-term behaviour of the proposed systems the use of simulation tools is indispensable. Using co-simulation one can utilize different tools especially designed for certain applications, allowing for detailed simulations on system, building and network level.

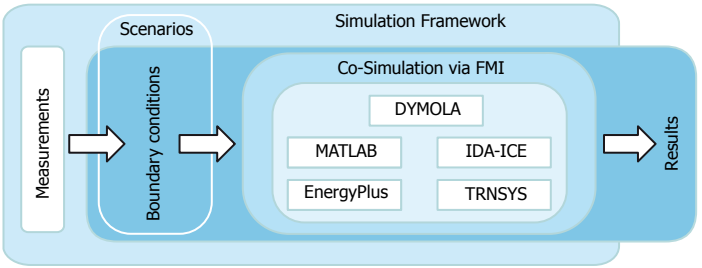


Fig. 3: Framework for the system simulation studies.

For a long-term evaluation of LTDHC/CDHC concepts framework conditions need to be defined to take into account constantly changing system environment parameters. With a long-term simulation, external factors, varying framework conditions and exogenous scenarios can be considered.

Plan of Action

- Development of **possible system concepts**
  - Variants for different system configurations and general conditions
  - Evaluation of possible system solutions for different configurations and boundary conditions
- Development of **simulation models**
  - Deterministic modellling approach for technical evaluation
  - Development of a multi-domain co-simulation framework
  - Evaluation of technical and economic benefits
- Development of a **stochastic optimisation model** concept
  - Parameter model comprising fluctuating external and internal factors
  - Evaluation of optimisation strategies
  - Long-term system evaluation
- Development of **economic evaluation methods** for LTDHC / CDHC
  - Business model prototypes and new services for cold heat
  - Economic evaluation

Dieses Projekt wird aus Mitteln des Klima- und Energiefonds gefördert und im Rahmen des Programms „Energieforschung AS4 2017" durchgeführt.

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