

Demonstration

- Implementation of Low Temperature District Heating Systems

Dietrich Schmidt

Fraunhofer Institute for Energy Economics and Energy System Technology / Germany



Solutions for urban districts

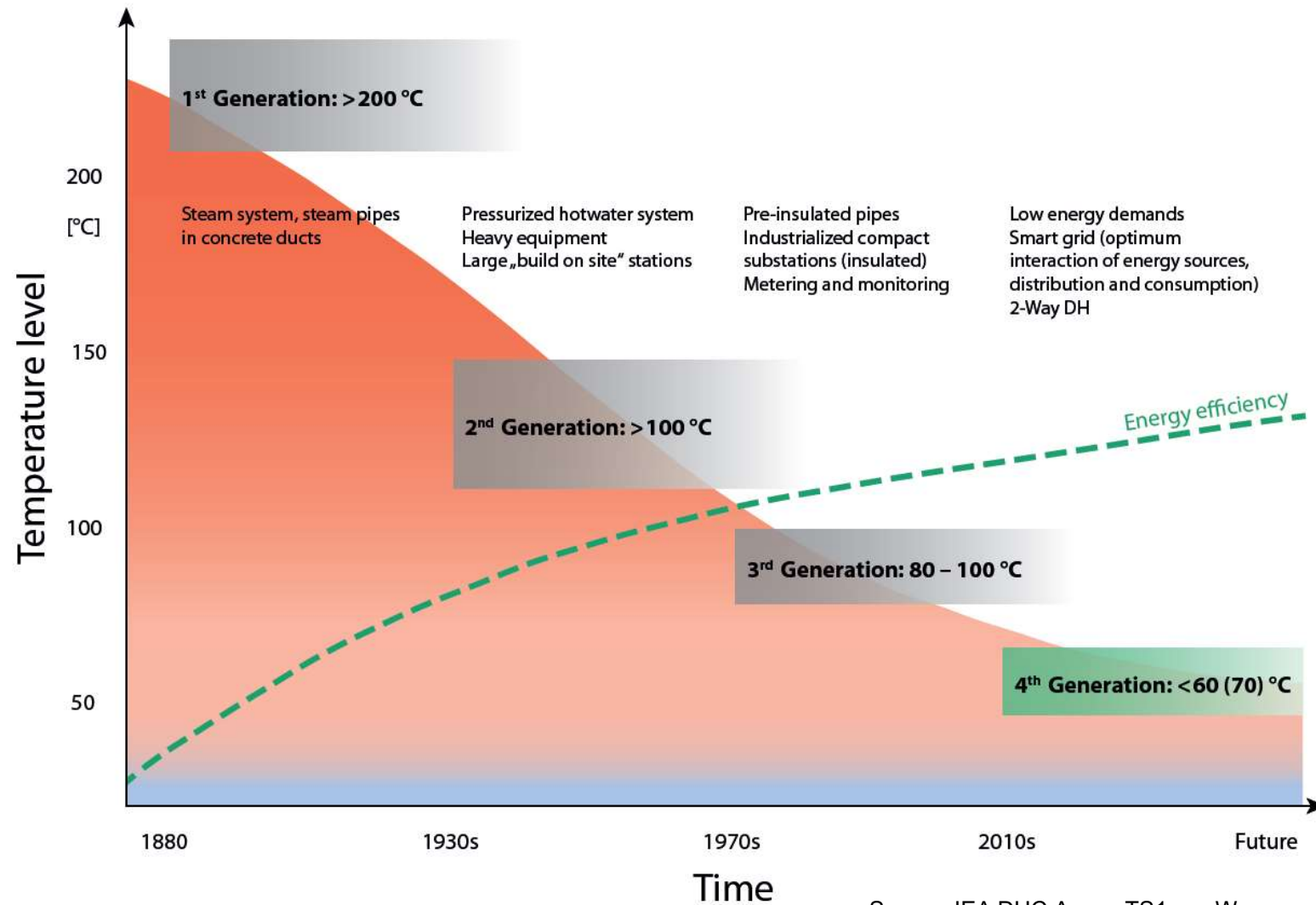
Innovative heat supply on a community level

„Low temperature district heating is a key technology for an efficient integration of renewable energy sources and waste heat in our energy systems.“

IEA DHC Annex TS1



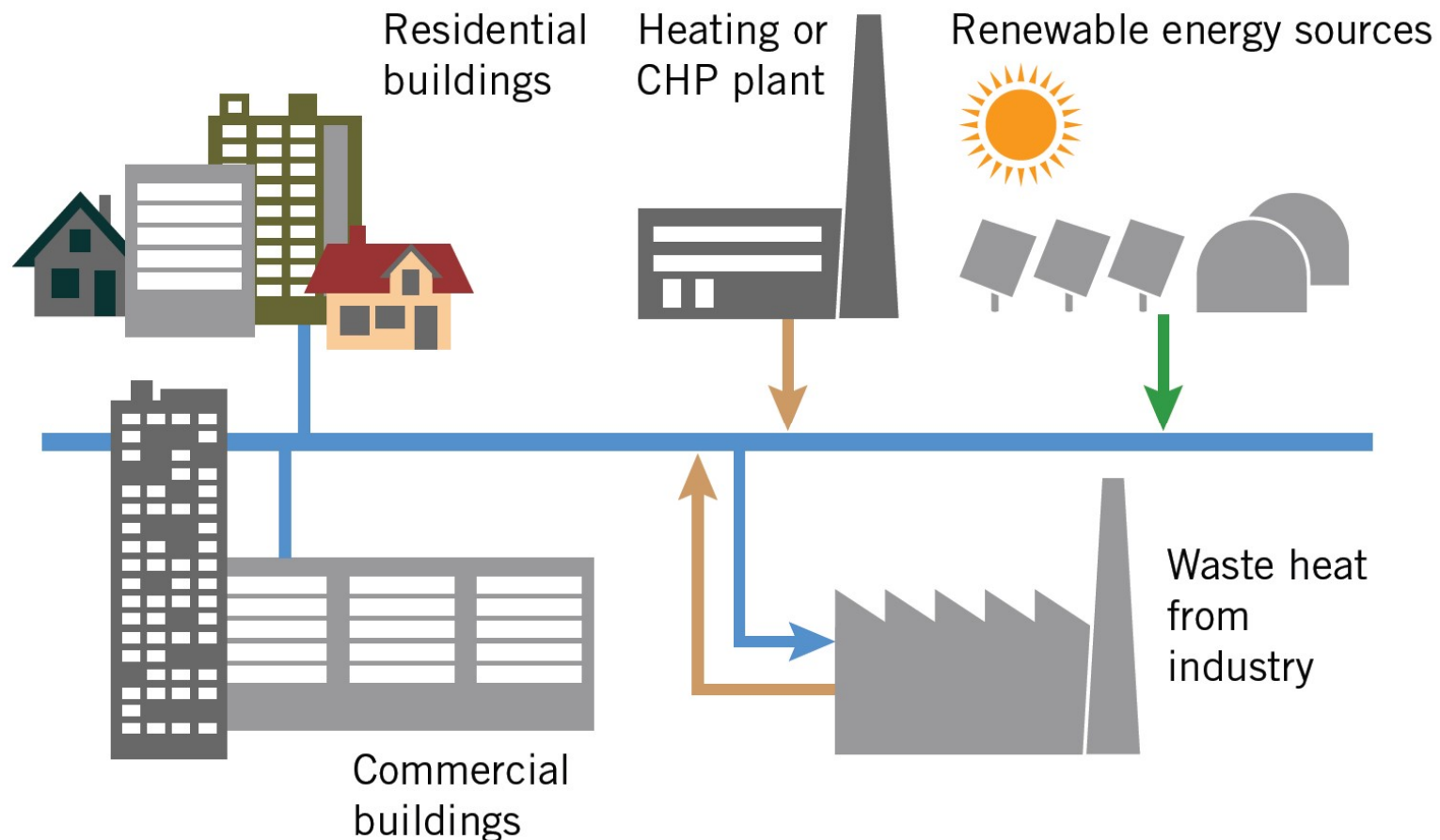
Low Temperature District Heating



Source: IEA DHC Annex TS1 acc Werner and Fredirksen 2014

Low Temperature District Heating Systems

- integration of decentral and renewable heat sources



Source: IEA DHC Annex TS1 acc Werner and Fredirksen 2014

Demonstration projects on various scales

- Demonstration of realized projects: New construction
- Demonstration of realized projects: Conversion and existing projects
- Demonstration of realized projects: Building scale
- Demonstration of simulation and design studies
- Demonstrators on lab scale

In total 33 demonstrators from 9 countries reported so far...

Hyvinkää (FI)

⇒ Realised new construction



Building fair with passive houses

- Improving the competitiveness of district heating in small houses (LCC)
- Design criteria for new small houses according to 2012- and 2021 regulations
- Solutions for new 2012- and 2021 small house districts
- New business and pricing models

Source: VTT/Espoo

Woergl (AT)

⇒ Realised new construction



Low temperature secondary network for 20 affordable row houses (60/40)

- Innovative pre-fabricated piping systems
- Heat supply from industrial biomass plant and from 3 heat pumps
- Direct connection of the heating system

Source: Thermaflex

Sigtuna (SE)

⇒ **Realised new construction**

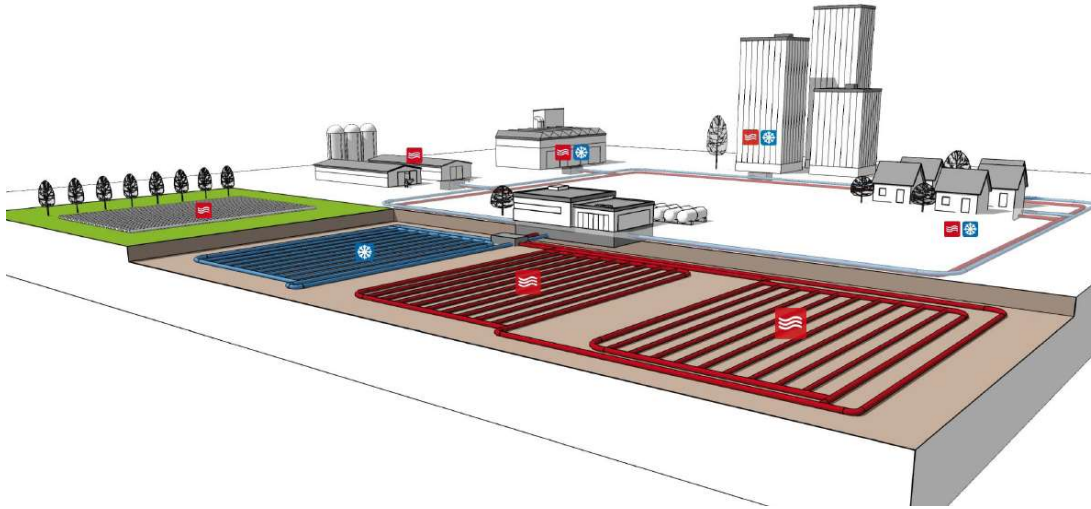


Low temperature neighbourhood (60°C supply)

- Solar heating parking (1000m² collector)
- Electric heat pumps with geothermal source

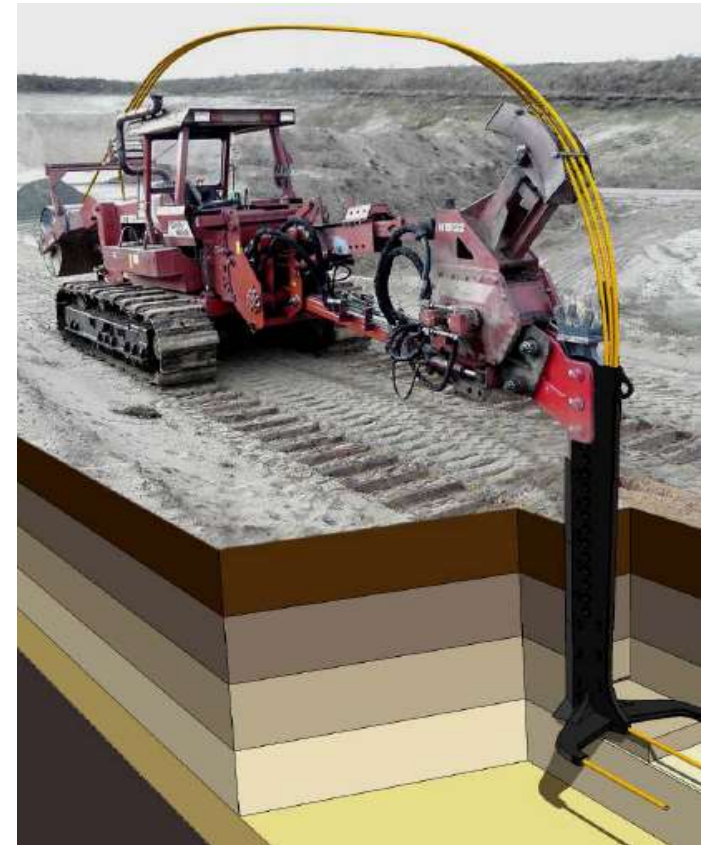
Wüstenrot (GER)

⇒ Realised new construction



Agrothermal low temperature district heating

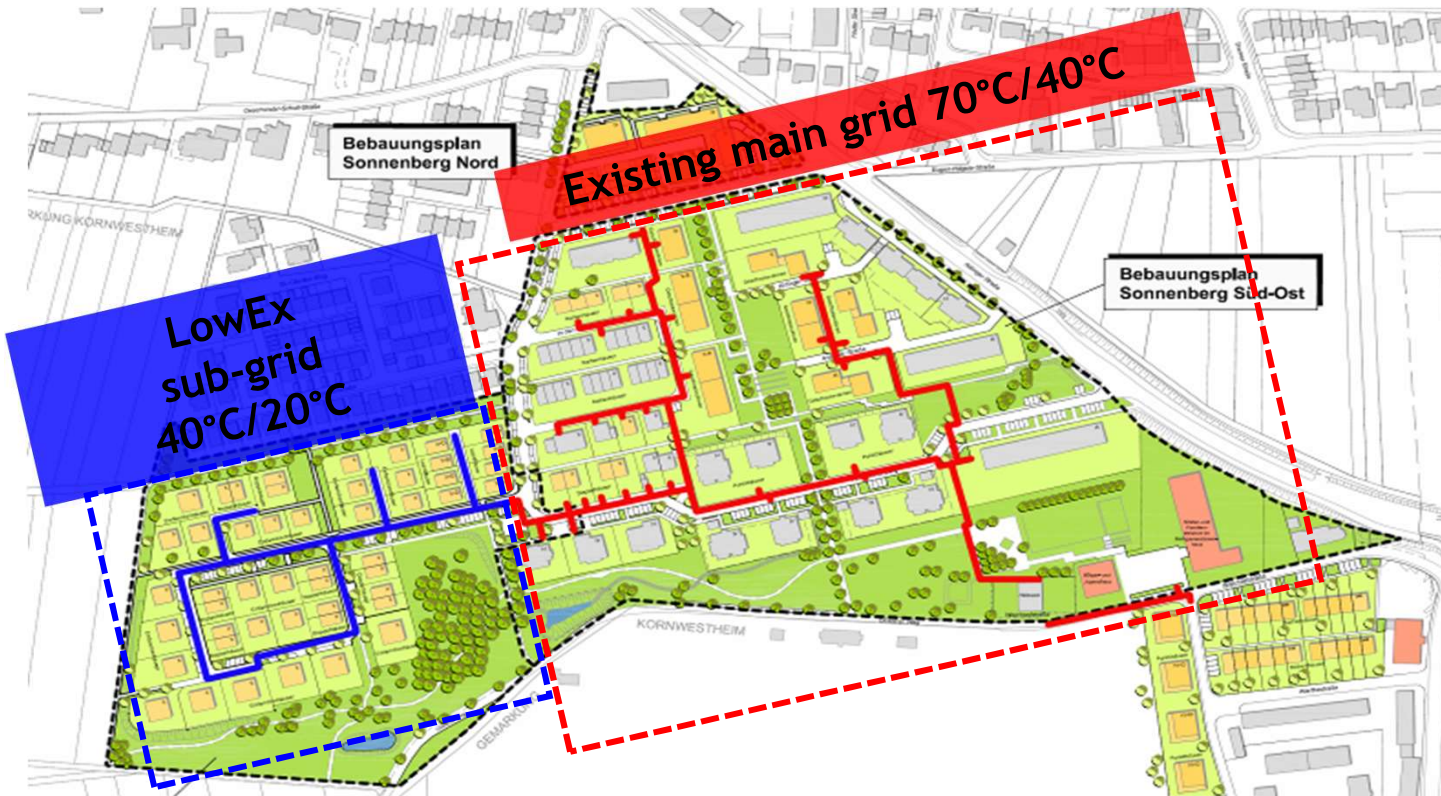
- Heat demand supplied via heat pumps combined with agrothermal collectors
- Integration of different users
- Decentral DHW-preparation



Source: HfT Stuttgart

Ludwigsburg (GER)

⇒ **New construction and existing buildings**



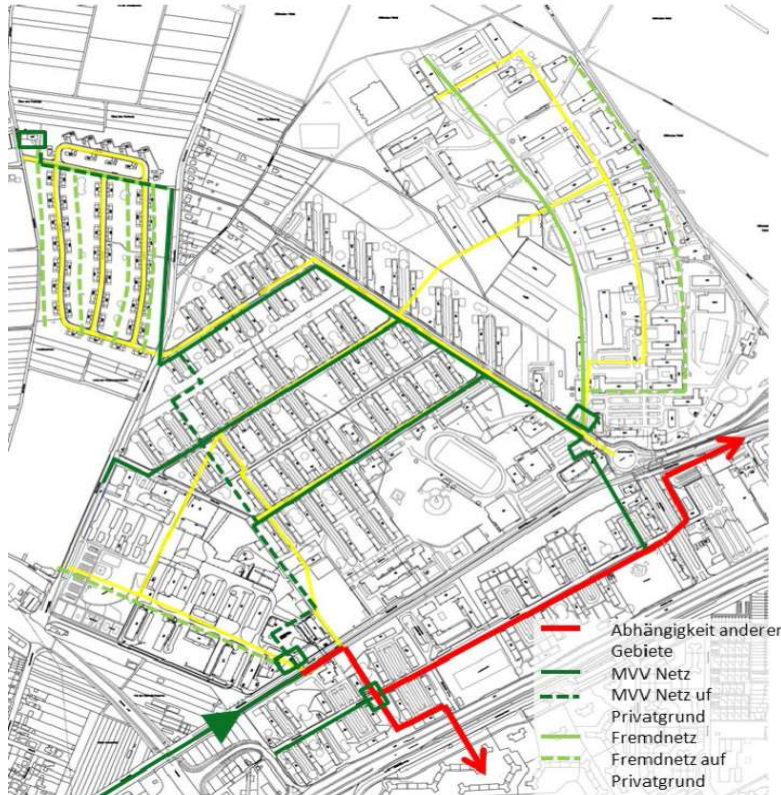
LowEx grid extension with passive houses

- Grid extension as low temperature DH
- Decentralised heat storages inside the buildings
- New buildings in Passive House standard

Source: HfT Stuttgart

Benjamin Franklin in Mannheim (GER)

⇒ New construction and existing buildings



Smart thermal subgrid

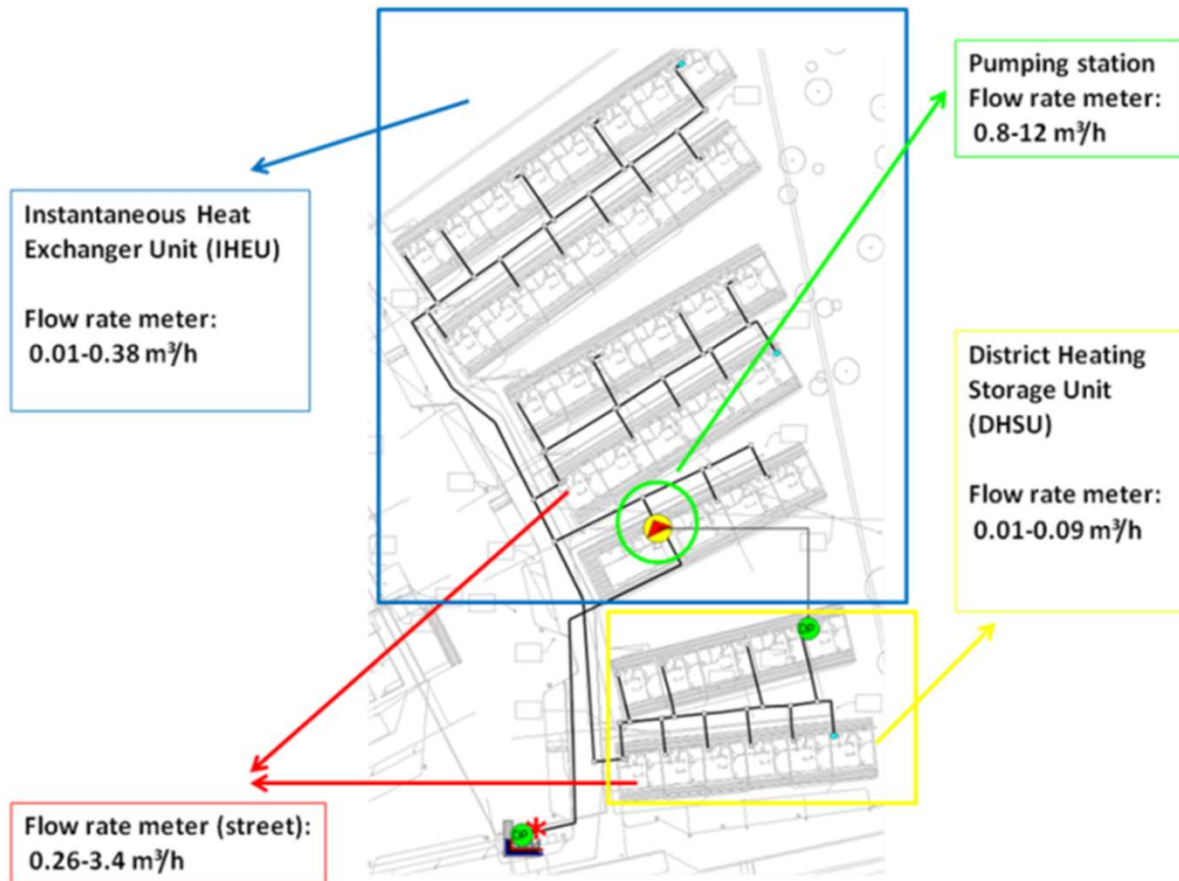
- Integration of renewable heat (ca. 20%) from heat pumps / PV systems (ca. 25.000 m²) in addition to the classic district heating supply
- Heat pumps are operated with 100% PV power
- Utilization of surplus electricity in summer time for the operation of cooling machines
- Smart control of subgrids
- Modular expansion

Source: MVV Netze



Lystrup (DK)

⇒ Existing buildings



Lowering of the grid temperatures for existing buildings

- Hydraulic and thermal simulations
- Realisation and monitoring
- Low energy houses with low temperature radiators

Source: DTU Lyngby / COWI

Copenhagen Fredriksberg (DK)

⇒ **Building scale**

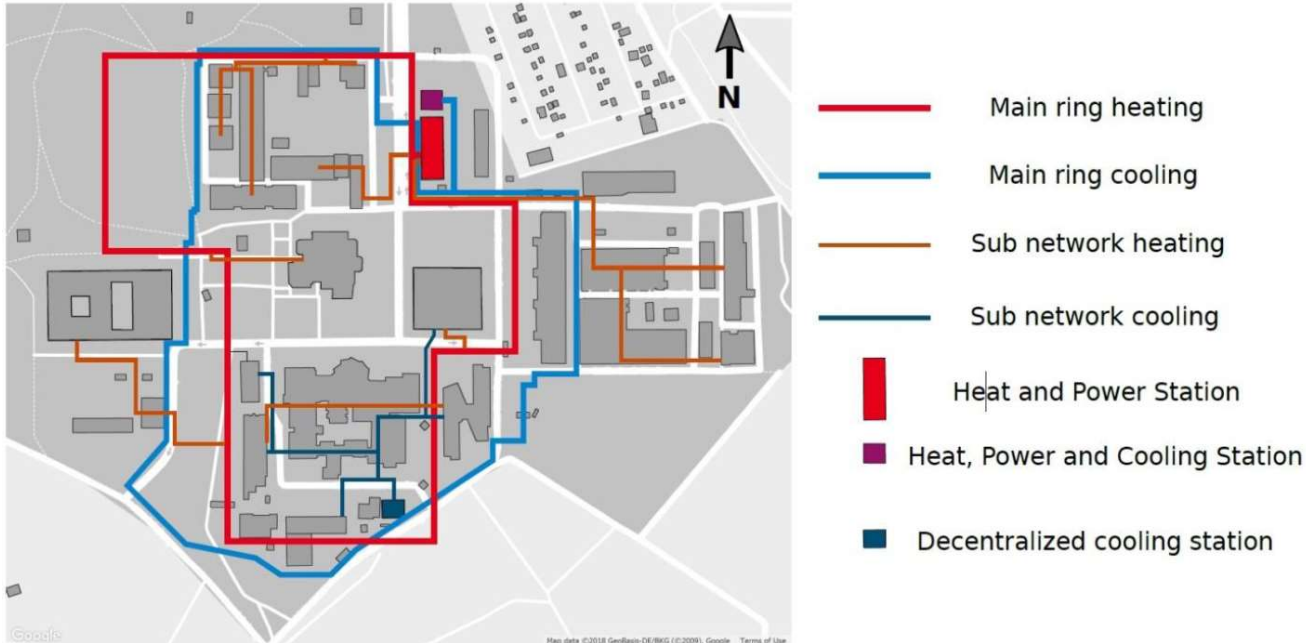


Return temperature optimization in cities

- Central substation including weather compensation
- Online control of substation
- Radiators are equipped with smart electronic thermostats and return pipe temperature sensor
- Optimisation of operation and monitoring

Darmstadt „Lichtwiese“ (GER)

⇒ Simulation study



Source: TU Darmstadt

Energy efficient campus Lichtwiese

- Heating and cooling network
- Based on monitoring a virtual model / digital twin has been up
- Strategy developed to reduce network temperatures
- Waste heat utilisation from high performance computer centre

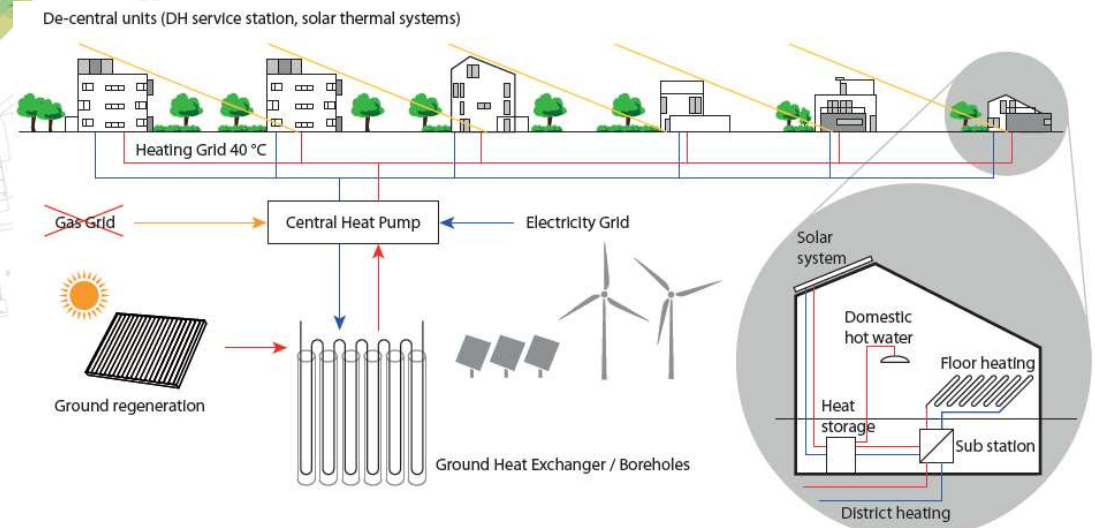
Kassel „Zum Feldlager“ (GER)

⇒ Simulation study



Geo-solar district heating

- Low temperature DH with ground coupled HP and solar collectors
- Decentral DHW-preparation
- Solution for new housing areas
- New business and pricing models

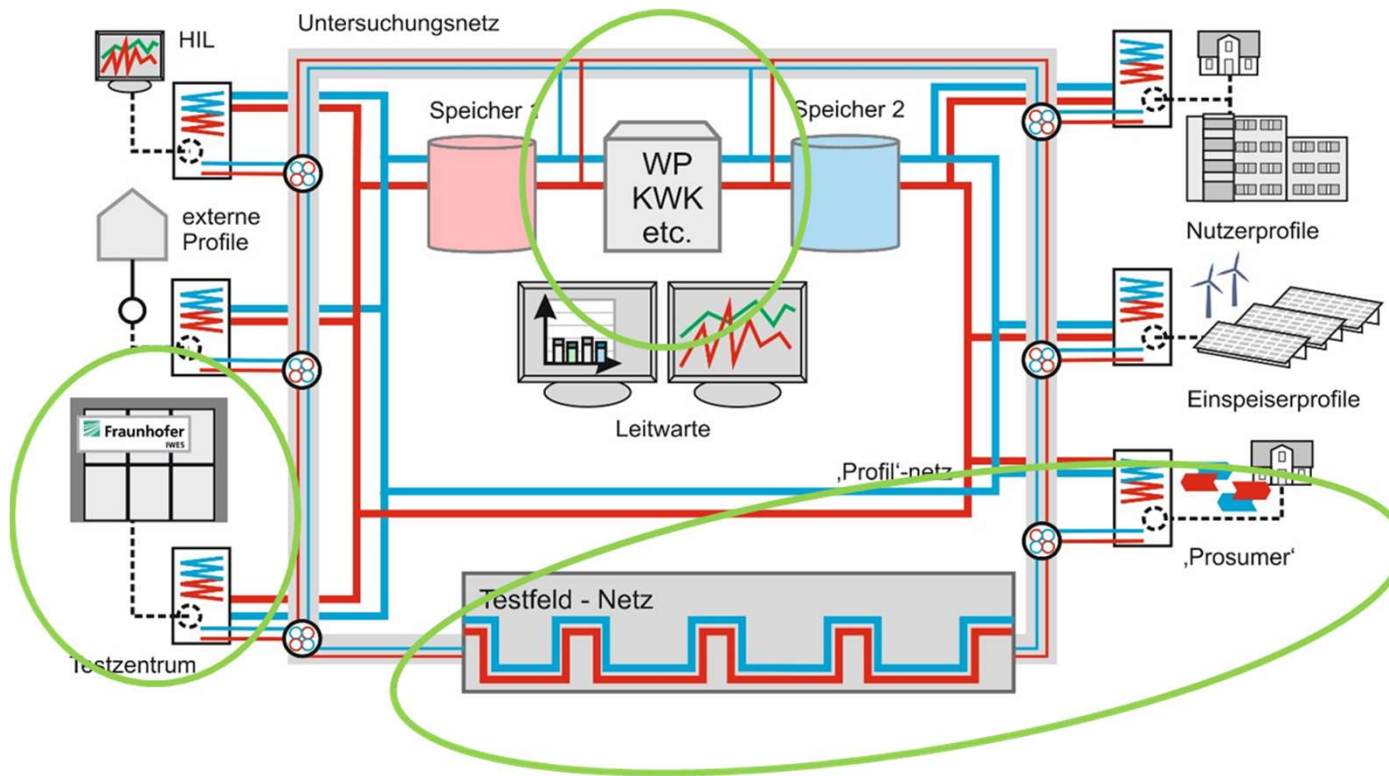


Source: IBP/IEE, UniK, SWKs & City of Kassel

District LAB in Kassel (GER)

⇒ Lab scale

Experimental facility for innovative district heating systems on a community scale



4 Focus areas :

1. Innovative district heating grid with decentralized feed in
2. Mechanical tests – piping systems
3. Central heat supply – big heat pump
4. Smart Energy Utilization/Test building

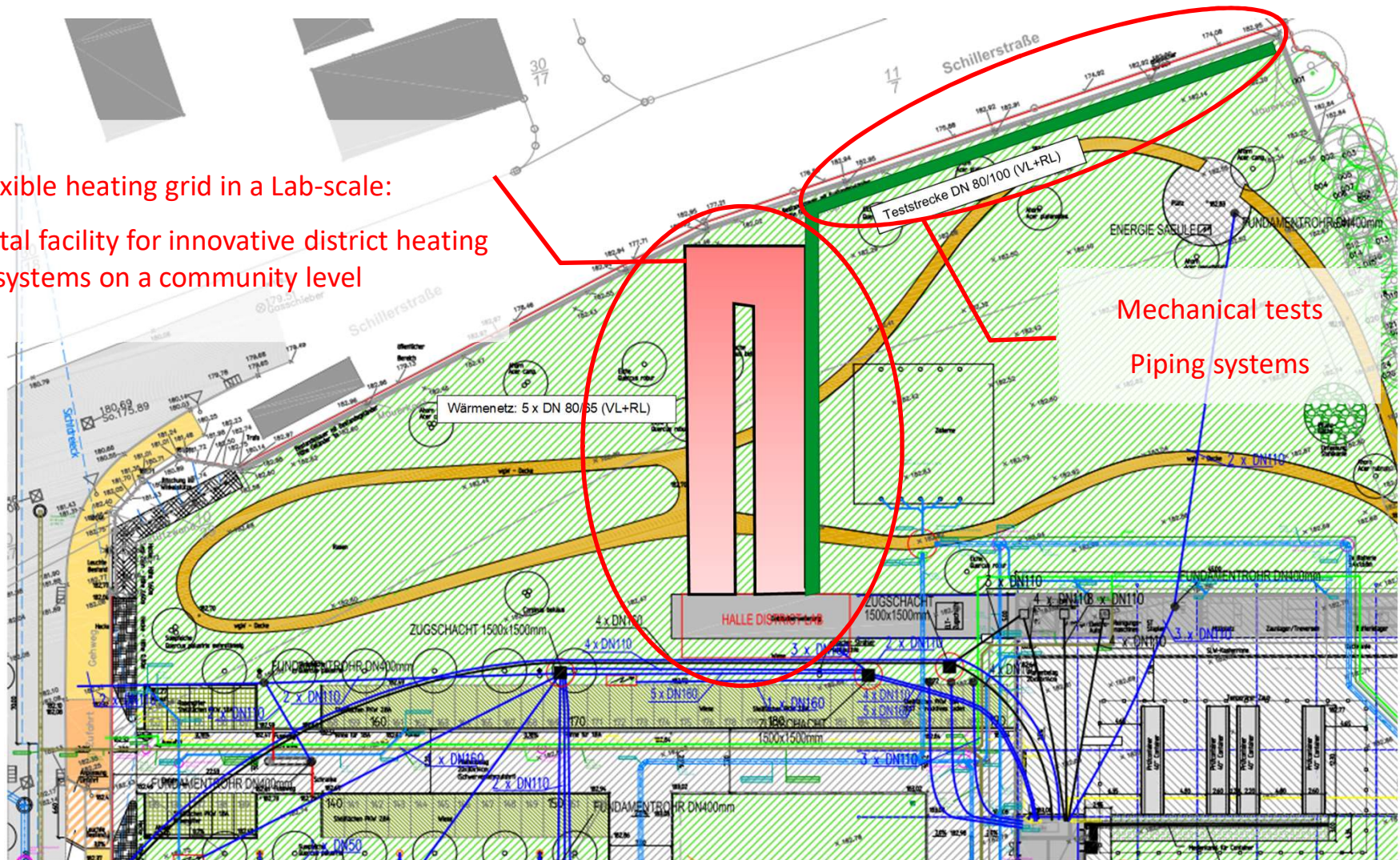
Location at the new Fraunhofer IEE office building in Kassel



District LAB - concept

Flexible heating grid in a Lab-scale:

Experimental facility for innovative district heating systems on a community level



First project ideas

1. District heating grids and new operational strategies

- Dynamic and changing boundaries for feed-in and utilization
- Grid operation with new temperature regimes
- Dynamic pressure- and temperature variations

2. Tests of components

- Piping systems
- Heat exchanger / sub-stations
- Pumps
- Control elements


3. Development of simulation tools and validation

- Static hydraulic simulations incl. heat losses
- Dynamic simulations of control sequences and pressure surges

Brochure of Case Studies (from IEA DHC Annex TS1)

International Energy Agency
Implementing Agreement of District Heating and Cooling,
including the integration of CHP

Annex TS1 | Low Temperature District Heating for Future Energy Systems



SUCCESSFUL IMPLEMENTATION OF INNOVATIVE ENERGY SYSTEMS IN COMMUNITIES
- WITH LOW TEMPERATURE DISTRICT HEATING AND RENEWABLE ENERGY SOURCES

LOW TEMPERATURE DISTRICT HEATING IN EXISTING BUILDINGS - DENMARK - SØNDERBY, DENMARK



LOW-TEMPERATURE DISTRICT HEATING SUPPLY TO EXISTING BUILDINGS

The large-scale implementation of low-temperature district heating results in reduced heating in existing buildings. The full-scale demonstration project at Sønderby aims to operate the heating in an economic manner to supply low-temperature district heating to existing buildings.

The low-temperature supply includes 15 single-family houses, which were built from 1957-1958. The buildings are supplied with the heating. The previous district heating was based on oil-fired boilers and district heating pipes. In the project, the old pipes are replaced by district heating pipes.

The average supply temperature of consumer is 52 °C with 20 °C cooling at consumer.

The average network heat loss is reduced from 4.5 % to 1.3-1.8 %. The significant heat loss reduction is mainly due to the reduced network temperatures, improved pipe insulation and reduced diameter of pipes. By using high network pressure, during operation, it was found that network water temperature is close to 45 °C. This high water temperature is due to large return flow rates in connection with control valves. Another reason is due to consumers who forget to close valves for the heating system during summer. The network water for the heating system.

PASSIVE HOUSE BUILDING FAIR - HYVINKÄÄ, FINLAND



HYVINKÄÄ HOUSING FAIR AREA CONSISTS OF LOW ENERGY SMALL HOUSES CONNECTED TO DISTRICT HEATING

The project of the housing fair area Hyvinkää is based on the connection of very low energy buildings and so-called passive houses to a district heating system.

The particular goal for this project is to estimate the long-term performance of innovative district heating systems. On the long-term goal extends to the year 2020. The aim is also to explore if Finnish climate, the housing conditions and opportunities for the district heating system to be called "passive energy house".

Based on the length of a series of new low energy and passive houses are of interest, low energy and long-term addition and power supply in district heating connection will be examined to optimize the entire energy system. For this last point the proper using of on-chip energy production (e.g. solar collector) will be examined to the houses as a reference.

The housing fair area in Hyvinkää opened in 2013 and is a place for demonstration. This location also offers larger long-term opportunities. It includes the use of district heat to supply domestic hot water for heating, bathing and cleaning in place of electricity. Finally, a contribution to the development of national building code is in focus, since the energy consumption demands are actually not accounted for in the code. Thus, the project is demonstrating compliance with the regulation.

SUCCESSFUL IMPLEMENTATION OF INNOVATIVE ENERGY SYSTEMS IN COMMUNITIES



LOW TEMPERATURE DISTRICT HEATING OFFERS A FAIRLY EASY AND COST EFFECTIVE WAY TO REALIZE A FOSSIL-FREE HEATING SYSTEM COMPARED TO SOLUTIONS BASED ON RENEWABLE ENERGY PRODUCTION ON EACH BUILDING

What is low temperature district heating?

Low temperature district heating is a heat supply technology to efficient, convenient, flexible and cost-effective community supply. Traditionally district heating grids are operated at temperature levels up to 120 °C. In comparison with conventional district heating, in low temperature district heating the network supply temperature is reduced down to required temperature levels of about 50 °C or even less. Consequently low temperature district heating, coupling with reduced network temperatures and well-designed district heating network can reduce heat losses of the grid by up to 15 % compared to the current system design. To achieve maximum efficiency, the district heating network, energy conversion process and the end user demand need to be optimized to utilize lower network supply temperatures. When the heating system and district heating supply network are integrated into a holistic system, synergies and economies of scale can be optimized in a community scale.

A sustainable and flexible approach to the energy supply of communities

Low temperature district heating offers a sustainable and flexible approach to the energy supply of communities. On the long-term scale a number of issues of meeting the demand need to be addressed in developing advanced low temperature heating and energy systems. On community scale synergies are maximized, if buildings and building systems are regarded as integrated components of an energy supply solution. That is why implementation of solutions based on large shares of renewable energies require an adaptation of technical and building infrastructure. In contrast to the current district network design, the low temperature district heating concept permits a different approach: starting from end-user thermal comfort, as well as a quality match between energy supply and the energy utilization, the identification of the most efficient and economical way to supply the heat demand is through efficient distribution networks. Furthermore, low temperature district heating systems open up for a 200+ scenarios for supply systems based on waste heat and renewable energy only.

An economically efficient low temperature heating energy supply

The utilization of low network temperatures is a flexible approach to the heating energy supply of communities and results in economically competitive solutions. Because of the early integration of cheap renewable energy, heating energy into the supply system, from an economical point of view, relatively high price volatility can be expected due to the use of locally available, renewable or surplus heat energy sources. An additional advantage of this is a lower dependency on fossil fuel supplies. The high overall system performance can be achieved by using innovative low temperature district heating technologies and leads to reduced resource consumption as well as lower costs for facilities.

For this reason, low temperature district heating is seen as an emerging innovative system technology with high potential to

Conclusions

- Low temperature is a proven heat supply technology
- Many cases show the advantages and cost efficiencies
- “Right” business models are important

„Low temperature district heating is a key technology for an efficient integration of renewable energy sources and waste heat in our energy systems“

Contact



Tekn. Dr. Dietrich Schmidt

Head of Department Heat and Power Systems

Fraunhofer Institute for Energy Economics and Energy System Technology IEE

Mail: dietrich.schmidt@iee.fraunhofer.de

Phone: +49 561 804-1871

<http://www.iee.fraunhofer.de>