AGFW

Existing District Heating Networks in Context of German Climate Goals: Potentials for “UrbanTurn”

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AGFW | Energy efficiency association for heating, cooling and CHP
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Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag

Who we are…

» **AGFW** is an independent, impartial German association promoting energy efficiency, (district) heating, cooling and CHP – Combined Heat and Power – at national and international levels

» **AGFW** comprises more than 550 regional und municipal energy suppliers, consultants, experts manufacturing companies including component and system manufacturers, assembling companies and testing institutes within Germany and Europe

» **AGFW** represents approx. 95% of the heat load connected to German district heating systems – the largest scale in Western Europe

» **AGFW** with over five decades of expertise in the district heating sector covers the entire process chain of efficient district heating, district cooling and CHP

The national funded Research Project

» **Title:** „UrbanTurn: Transformation of the urban district heating supply“

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» **Project partners:**

Fraunhofer IEE

BRUGG Pipes A BRUGG GROUP COMPANY

GEF Ingenieur AG

hcu HafenCity Universität Hamburg

Danfoss

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Existing district heating systems in Germany

…based on the AGFW main report [1]:

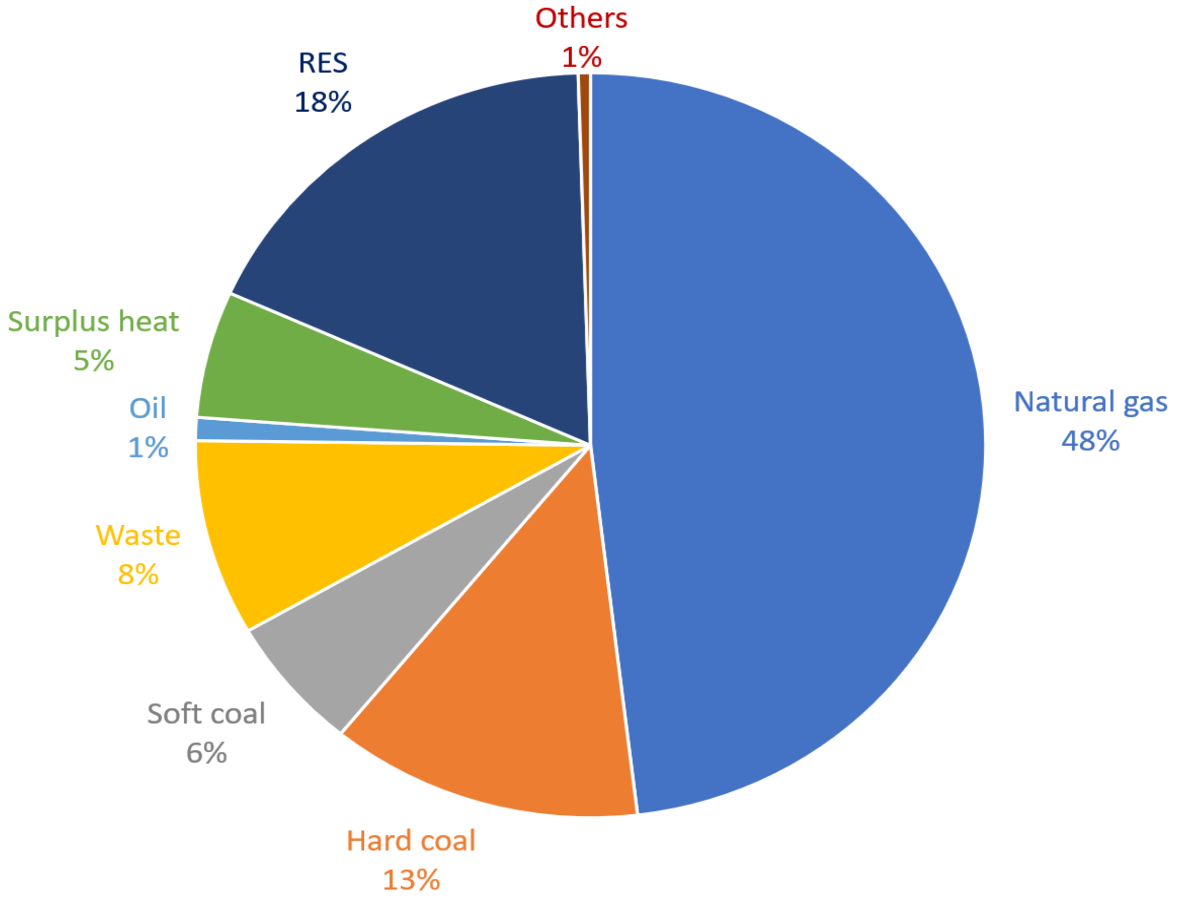
- » Ø 3 heat generation plants (1 CHP, 2 heating plants) per DH system
- » Total amount of 377.305 substations
- » Total length trace of 21.482 kilometers
- » Hot water networks (20.938 km)
  with design temperatures above 110 °C
- » Steam networks (544 km)

Research section in Chemnitz, Source: AGFW

Existing district heating systems in Germany

…further information

- **Market share of DH in Germany is about 14 % [2]**
- **The final energy demand for space heating and hot water preparation in total: 698 TWh (2018) [3]**
- **Share of about 18 % renewable heat sources was determined 2020 [4]**
- **Digital recording of the operating parameters (temperature, pressure and volume flow) at heat generation plants, defined points in the DH network (e.g. pressure increase stations) and for special customers [5]**



In Total: 126 billion kWh, Source: BDEW 2021 [4]

German climate goals & reviewed political studies

German climate goals:

- Federal climate change act (2019) → reduce greenhouse gas emissions by 55 % until 2030 and greenhouse gas neutrality is to be achieved by 2050 [6].
- The coal phase-out law it was legally stipulated to stop burning coal in power plants by 2038 at the latest [7].
- Amendment in 2021: Greenhouse gas emissions must be reduced by 65 % by 2030 and greenhouse gas neutrality is to be achieved by 2045 [8].

Reviewed studies:

Reference	2030			
	Final energy demand [TWh]	share of DH [%]	RES in DH [%]	Modernisation rate [% p. a.]
Gerbert 2018 [3]	582	15.6	46	1.9
Wünsch 2020 [9]	486	30	45	-
Prognos 2020 [10]	610	16	45	No rate, but goals for 2050

German climate goals & reviewed political studies

Expected measures to achieve the climate goals until 2030 [9]:

- Increase the share of DH from 14 % today up to 30 % in 2030
- Increase the share of Renewable Energies Sources (RES) in the DH production up to 45 %
- Increase the total length of DH grids from 21.000 km length trace today to 45.000 km in 2030

Objectives for existing DH systems in Germany

- Substitution of fossil heat generation plants with RES
- Adjustment of the supply temperatures and an increase in the decentralisation of DH generation
- Increase in DH customer connections and new customer installations
- New variations in the operational modes of temperature and pressure in relation to new network hydraulics
- Modification within the buried infrastructure (e.g. changes in nominal pipe diameters).

The impact of the climate goals on DH grids

The design of DH grids

- Overall goal of the design: secure heat supply, considering local conditions and technical operating parameters
- Fulfil the heat output requirement of customers
- For more detailed information on the design of DH grids check standards, recommendations and codes of practice!

Focus on temperature flexibility according to EN 13941 important design parameters are [11,12]:

- The difference between the installation temperature and the maximum operating temperature (ΔT_{ref})
- The rate of temperature change
- The equivalent temperature full load cycles resulting from temperature variations are.
- Temperature change of the heating water should not exceed 10 K/h during operation [12]

Operation modes and operating parameters

$$\dot{Q}_{feed\ in} = \dot{Q}_{demand} + \dot{Q}_{heat\ losses} = \dot{m} \times c_p \times \Delta T$$

the mass flow ($\dot{m}$)
of the heat transfer medium

$\Delta T = T_{supply} - T_{return}$

Potentials for „UrbanTurn“

DH network	Network E	Network G	Network I
$T_{supply,max}$ [°C]	130	140	130
ØT_{supply} [°C]	94,9	112,8	91,1
Equivalent full load cycles	0,4	0,13	0,01
Data set	8782	8759	8759
Measuring frequency	1 hour	1 hour	1 hour
Number of temperature change categorized in rates of temperature changes			
< 5 K/h	8626	8559	8746
< 10 K/h	118	171	11
< 15 K/h	28	22	0
>15K/h	10	7	0

- **Long technical service life of the pipelines (> minimum service life according [11] and [13]) can be expected due to the compliance with the limit temperatures, the low full load cycles, and the low rates of temperature change**
- **To date, it has not been sufficiently investigated how a more flexible temperature operation with higher rates of temperature change affects the technical service life[14].**
- **Studies assume that lowering the flow temperature in the heating network has a prolonging effect on the technical service life of the pipelines [15].**

Potentials for „UrbanTurn“

Trends for future DH networks based on the analysis of German demo case for RES in DH

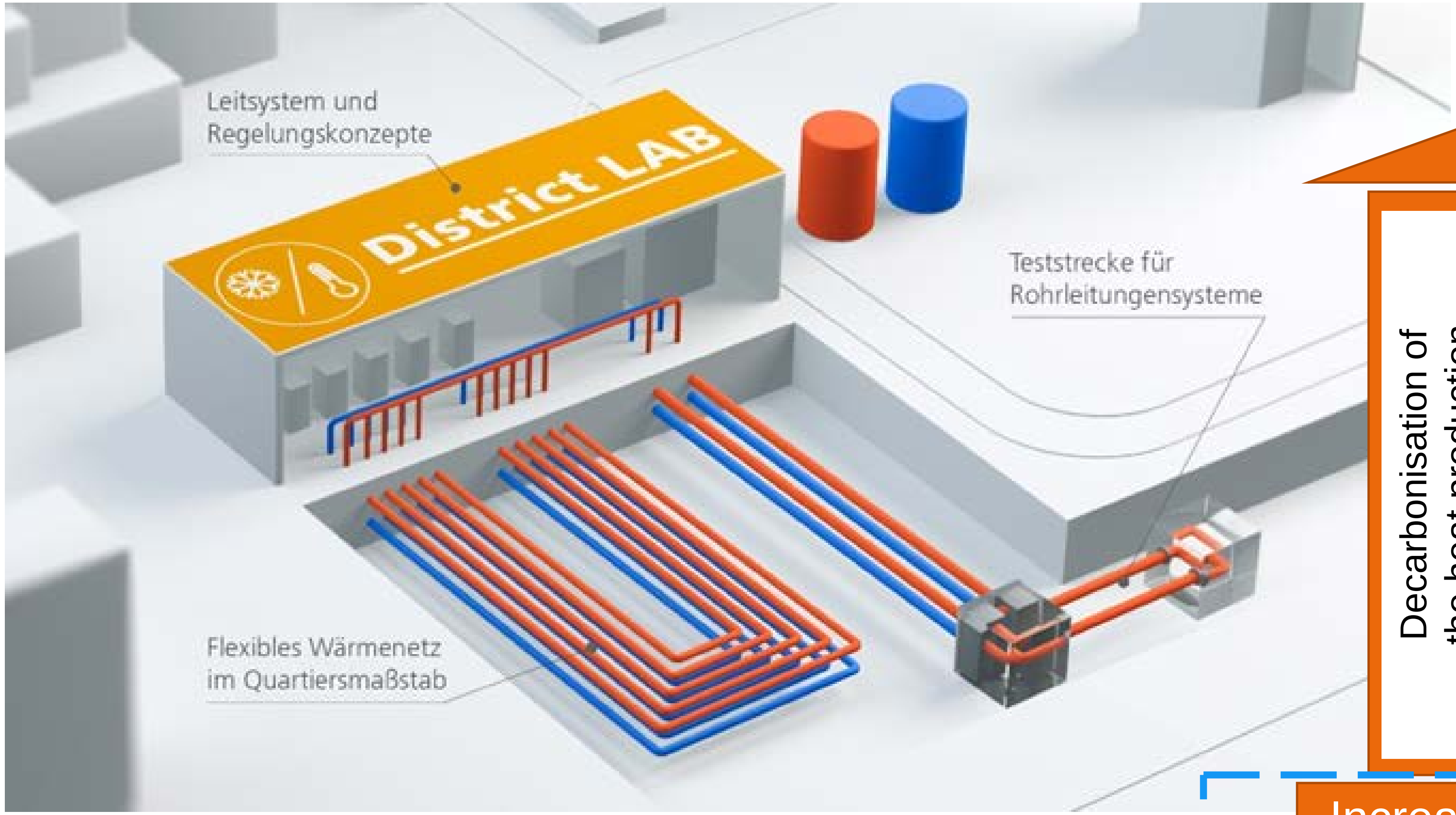
- **Reduction of supply temperature: Depending on the size of the network, temperatures of <100°C can be expected for large networks and <80°C for smaller networks. In very small networks with newer buildings, temperatures <60°C or even lower temperatures are possible.**

- **Due to an increase in decentralised feed-ins, higher thermo-hydraulic dynamics are to be expected in the DH networks for example [16]:**
  - **Pressure changes due to the local transport function of the integration pumps**
  - **and bottlenecks in the transport capacity due to existing nominal pipe sizes**

→ Research results on the effects of fluctuating supply temperatures, dynamic operating pressures, the effects of temperature reduction in the DH network and data-based operational optimisation must be developed.

→ To migrate these results into existing standards, both theoretical and practical investigations must be carried out.

Conclusions



Source: Fraunhofer IEE

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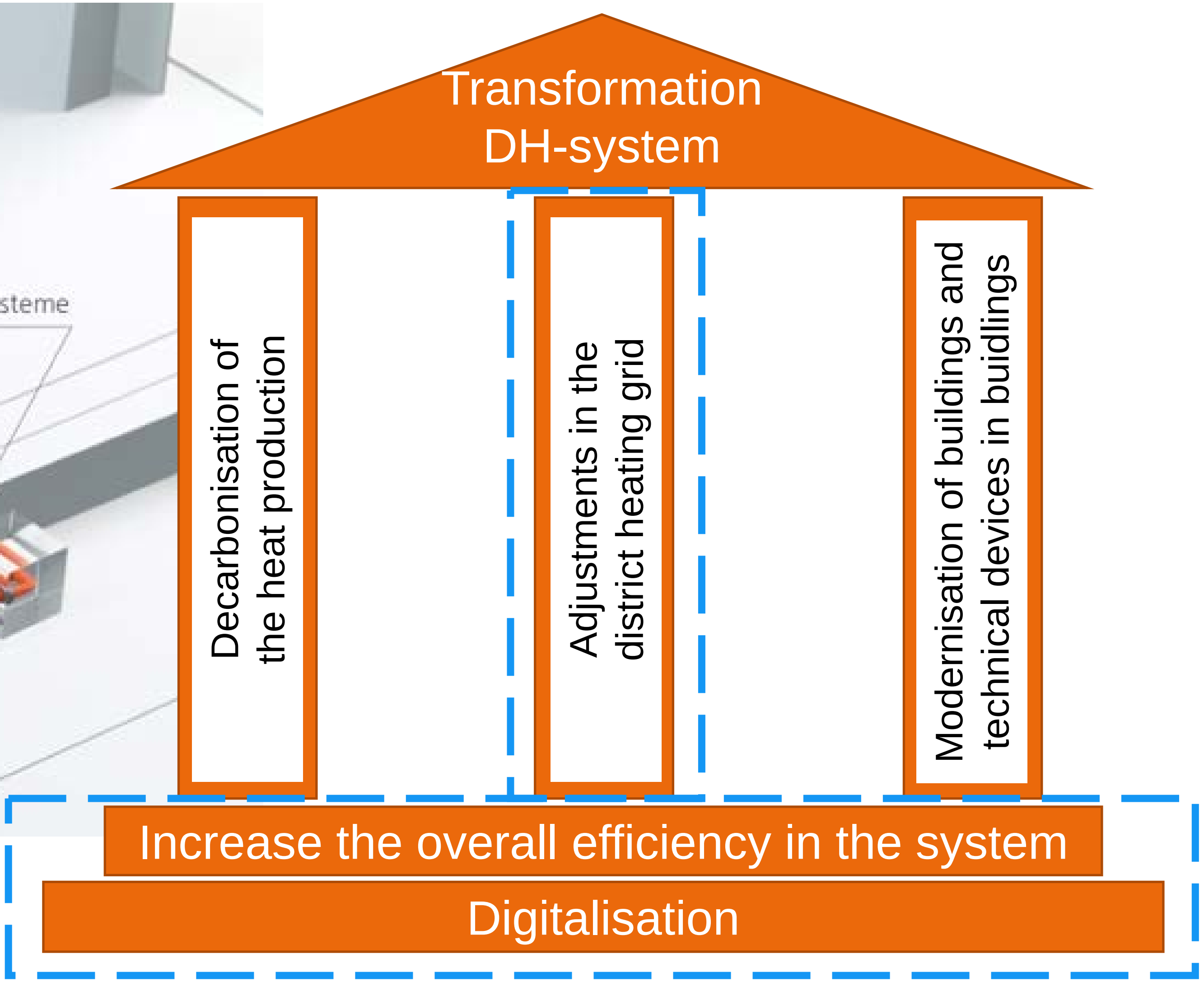

Any more questions?

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