Pipe Systems

Installation methods & pipe varieties in District Heating

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LowTEMP training package - OVERVIEW

Introduction

- Intro Climate Protection Policy and Goals
- Intro Energy Supply Systems and LTDH
- Energy Supply Systems in Baltic Sea Region

Energy Strategies and Pilot Projects

- Methodology of Development of Energy Strategies
- Pilot Energy Strategies – Aims and Conditions
- Pilot Energy Strategy – Examples
- Pilot Testing Measures
- CO_2 emission calculation
- LCA calculation

Financial Aspects

- Life cycle costs of LTDH projects
- Economic efficiency and funding gaps
- Contracting and payment models
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Technical Aspects

- Pipe Systems
- Combined heat and power (CHP)
- Large Scale Solar Thermal
- Waste & Surplus Heat
- Large Scale Heat Pumps
- Power-2-Heat and Power-2-X
- Thermal, Solar Ice and PCM Storages
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Best Practice

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Content

- **Introduction to this module**
- **General overview of Pipe systems & DH-infrastructure**
  - Functional classification of DH-pipe systems
  - Classification of DH-systems by grid levels
- **Installation methods & pipe designs**
- **Heat transport medium**
- **Simplified EXAMPLE of Network planning & heat estimation**

Introduction to this module

Basic facts about DH pipe systems

- **water temperatures** of DH-systems range usually from 80°C to 120 °C of supply and 30 to 70 °C of return water
  (temperature levels depend on the used system and other conditions like weather, etc.)
- **LowTEMP-network temperature levels range up to 80 °C supply temperature**
- **Heat losses** of pipe systems range from approx. 5 to 10 % in proportion to the produced heat
- **Type of pipes** that are mostly used in DH- networks: plastic jacket pipes (PJP); Steel jacket pipes (SJP); FLEX-pipes

Source: pixabay

European wide DH-customers can be estimated on approx. 60 million citizens with an increasing number in future! (Quote: EuroHeat & Power)

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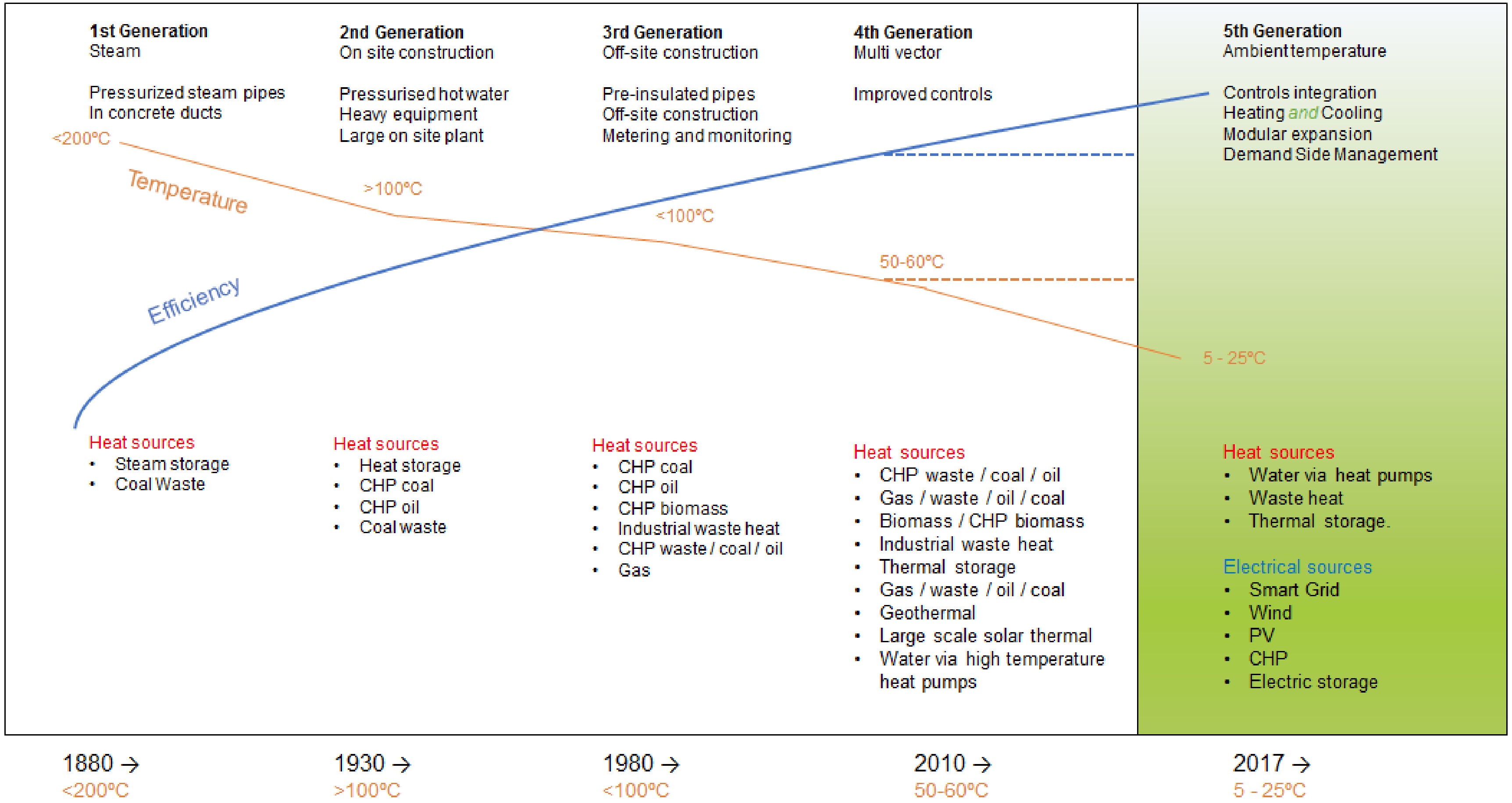
Introduction to this module



Heat network trends to lower distribution temperatures and higher efficiency   Source: ICAX [1]

Introduction to this module

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Heat generating technologies within DH-systems

- DH-systems are able to integrate different heat sources within one heat network
- DH-systems could therefore help to integrate more and more renewables within the heating sector
- **Possible heat sources:**
  - Heating plants
  - Thermal power stations
  - Combined heat and power units (CHP)
  - Waste heat integration from industrial processes
  - Heat utilization from waste incineration
  - Solid & liquid biomass
  - Large heat pumps
  - Geothermal heating units
  - Solar thermal systems, etc.

Source: pixabay

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General overview of pipe systems & DH-infrastructure

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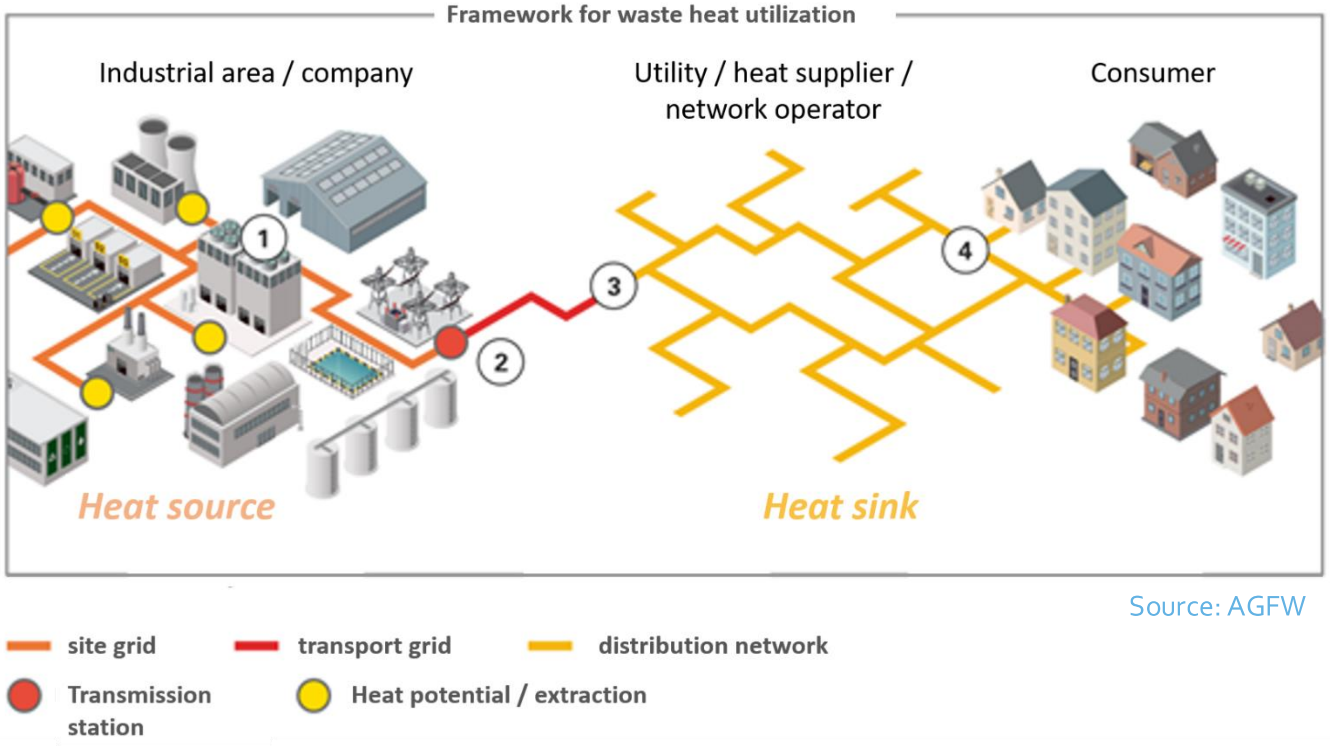
Functional classification of DH-pipe systems

- Piping systems of DH-networks can be roughly classified in following categories/terms:
  - Transport pipes
  - Distribution pipes
  - Connecting pipes (to consumer substation)
- **EXAMPLE:** waste heat utilization with a DH-system & network structure

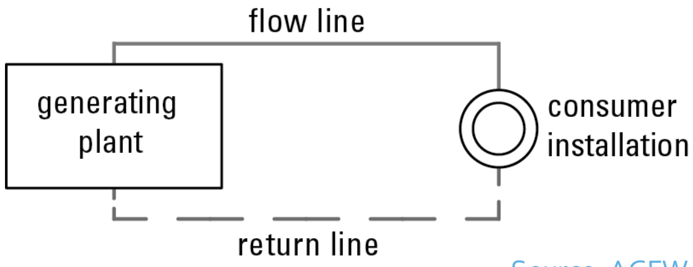


Source: AGFW

General overview of pipe systems & DH-infrastructure

Classification of DH-pipe systems by grid levels:

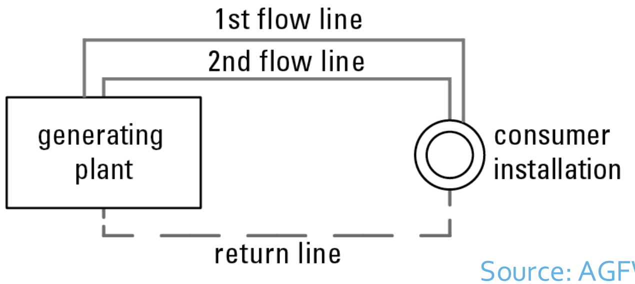
Dual-pipe system



Source: AGFW

- closed district heating grid

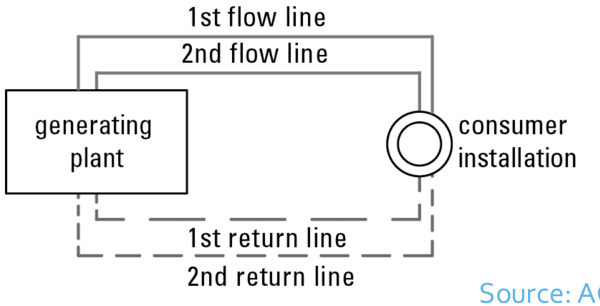
3-pipe system



Source: AGFW

- **1st flow line** used for heating purposes
- **2nd flow line** (**ϑ** = const.) used for water and air heating
- High installation costs
- More complex operation

4-pipe system



Source: AGFW

- Two overlapping dual-pipe systems
- management of specific heat demands and supply
- High installation costs
- Usage in special cases only

General overview of pipe systems & DH-infrastructure

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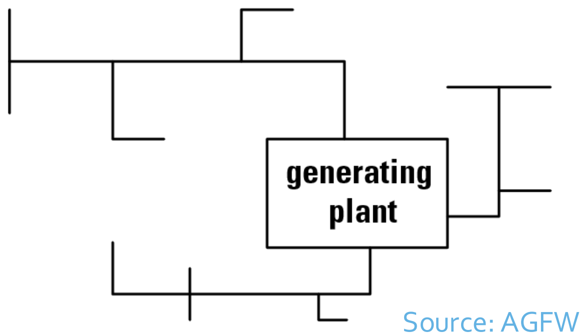
DH-network structure/design:

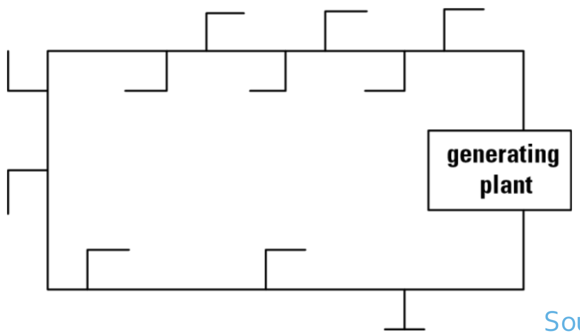
Radial network



Source: AGFW

- Flow and return line are dimensioned symmetrically
- shortest length in comparison to other network designs
- usually used in small heat networks with one central heat source

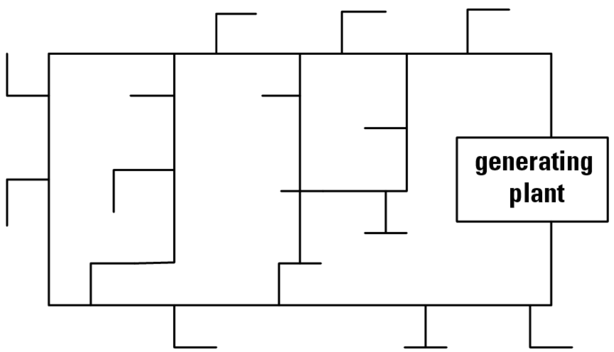
Ring network



Source: AGFW

- circular connected main distribution pipes
- facilitates the integration of other heat sources
- During maintenance, it is possible to ensure partial supply
- Combinations of radial and ring networks are possible

Mesh network



Source: AGFW

- Common version of the ring network
- distribution pipes and heating units are linked together in operation
- Ring with cross connections

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General overview about Pipe systems & DH-infrastructure

The size of the system can be characterized by the following parameters:

- Length of the piping system (trench length) [m, km]
- Number of substations
- Number of connected consumers
- Amount of investment costs [M€]
- Complexity (e.g. number of heat generators, connection points, grid levels)
- Distributed energy (sold heat) [MWh, GWh, TWh]
- Installed heat generation capacity [MW, GW]
- Spatial coverage of the district [km^2]

(Source: Upgrade-DH, 2019 [2])

Installation methods & pipe designs

Aboveground lines

Underground lines

Source: all AGFW

Installation methods & pipe designs

Installation methods

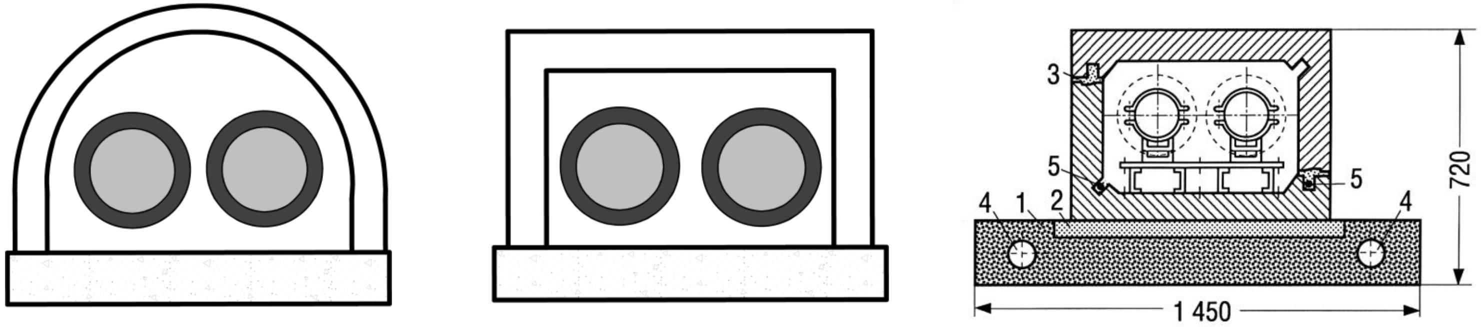
- biggest part of DH-piping systems is usually installed underground
- sometimes huge aboveground transport lines can be found next to train tracks, bridges and very seldom also overland
- For underground lines two main installation methods are used:
  - **Channel or in-duct laying methods**
  - **Trench laying methods**

Examples of **in-duct laying methods** & **trench laying methods** (Source: AGFW)

Installation methods & pipe designs

Channel or in-duct laying methods

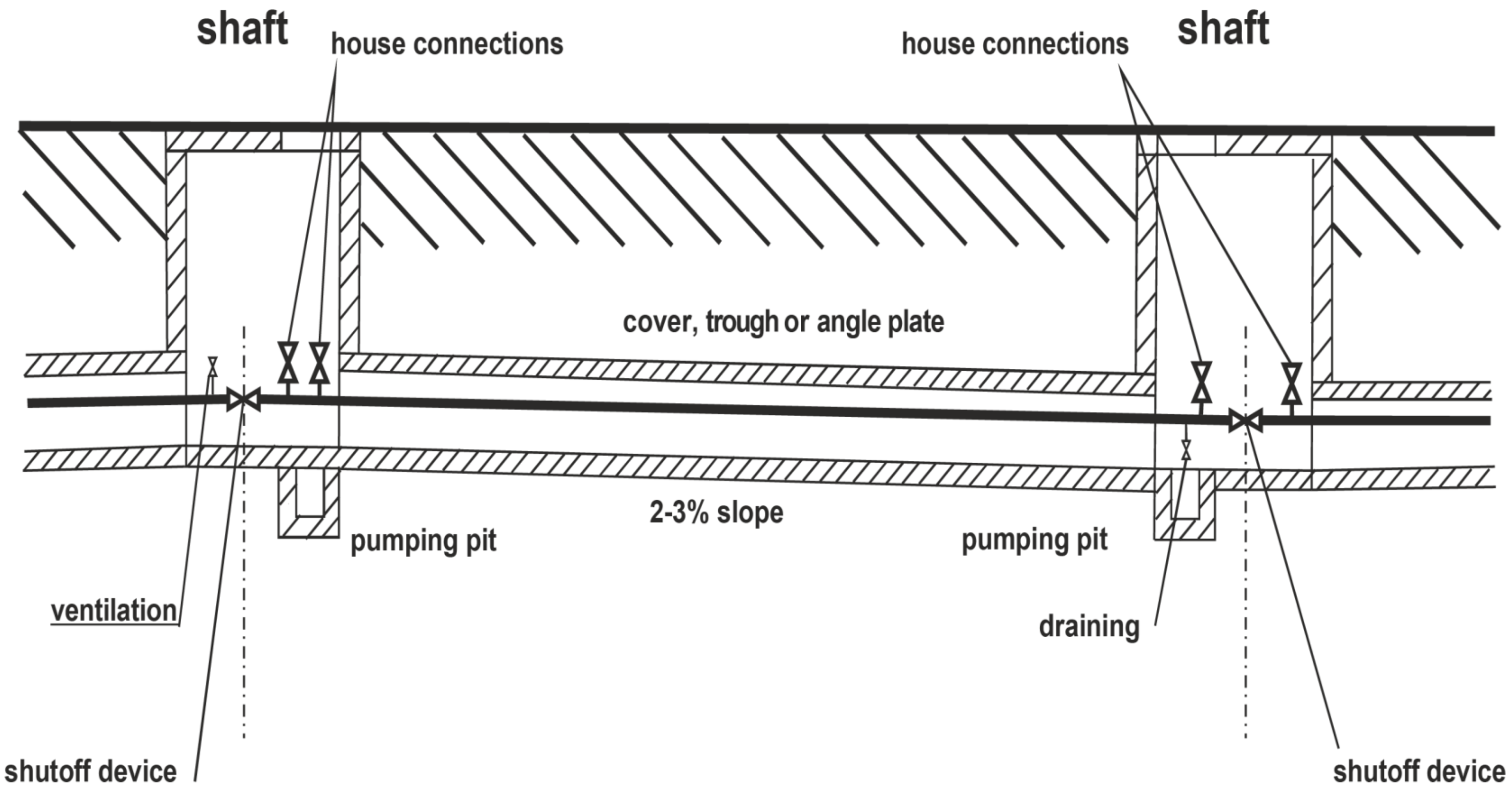
- reliable protection against mechanical damages
- support against unwanted moisture
- **but** very cost intensive
- method is only being applied in very special cases nowadays
- shape of the channel can vary



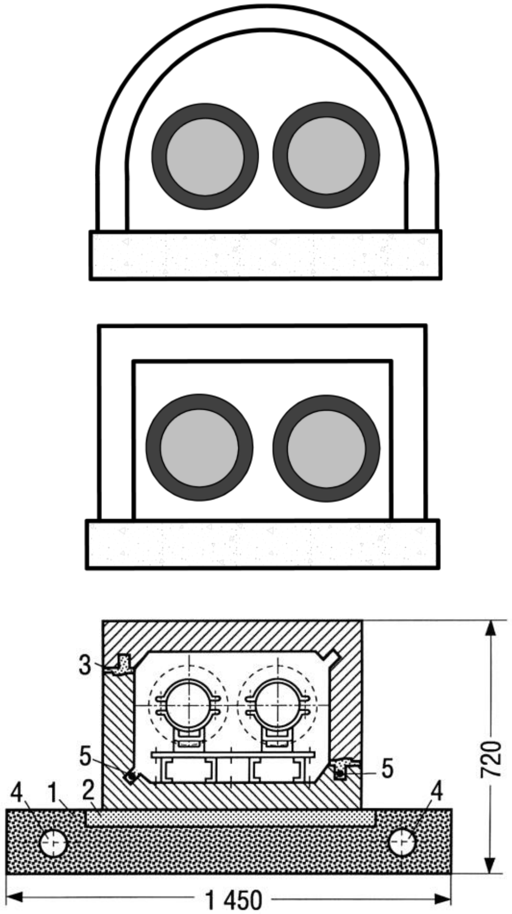
Semi-circular hooded channel, rectangular hooded channel and **double angle channel** are most common systems for in-duct laid pipelines (Source: AGFW)

Installation methods & pipe designs

Cross section of a hooded DH-channel



Source: AGFW



Source: AGFW

Installation methods & pipe designs

Summary of channel or in-duct laying methods

Advantages	Disadvantages
• Sturdiness and safety against external influences (e.g. mechanical, ground and surface water)	• Expensive installation
• High service life expectancy (70 years)	• Time-consuming construction
• Shafts allow inspection	• lot of space is needed for construction
• Point of damage can be localized sufficiently enough	• Water-resistance against (ground and surface) water is difficult
• Good ventilation from shaft to shaft	

Source: AGFW

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Installation methods & pipe designs

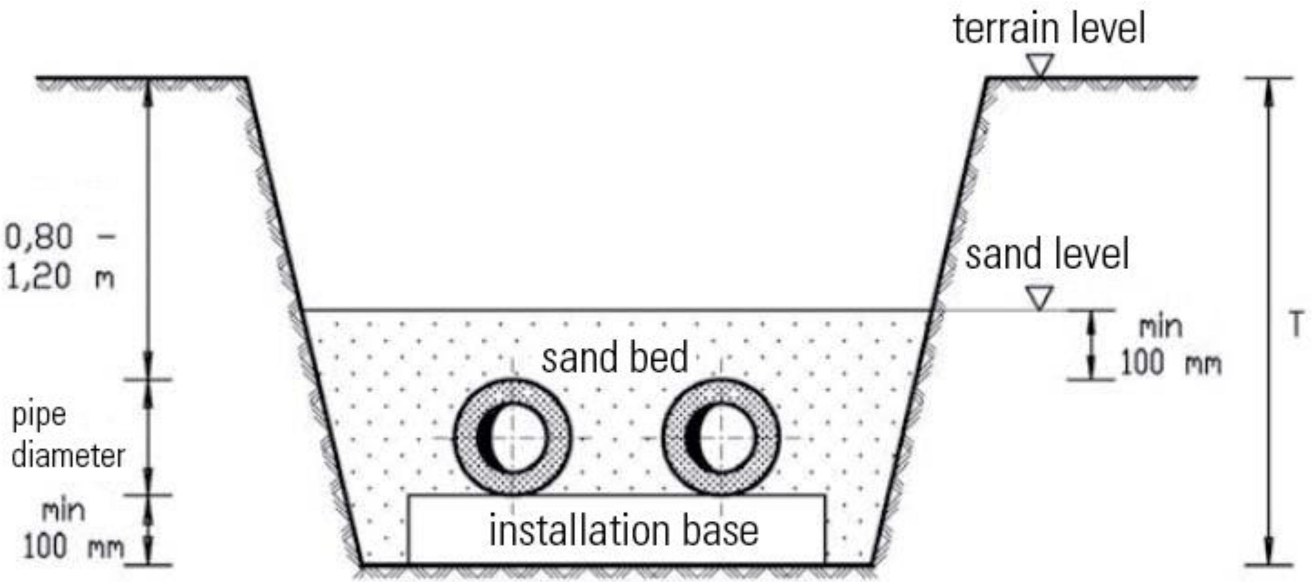
The trench laying method

- trench laying methods are much more common than the construction of hooded-systems
- important that the pipes are implemented in frost-free depths
- approximately below one meter trench depth for Central Europe
- risk of frost damaging the pipes is normally very low due to heat losses
- installation base or bedding layers are necessary to avoid pipe damages
- drainage of the trench must be ensured
- top laying sand bed is also called **the friction layer that must provide sufficient and stable resistance to axial pipe movement** (implementation of adhesion zones necessary)

Installation of plastic-jacket pipes with the trench laying method (Source: AdobeStock Image)

Installation methods & pipe designs

The trench laying method



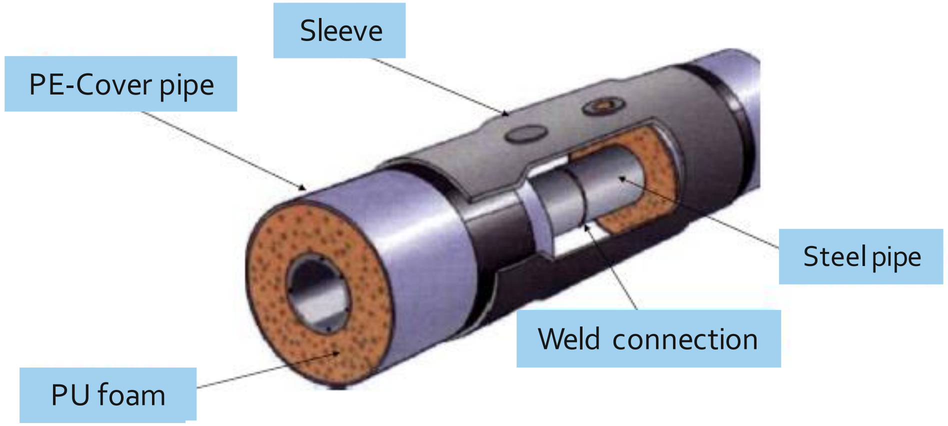
Cross-section through a DH-trench laying system (Source: AGFW)

Installation of plastic-jacket pipes with the trench laying method (Source: AdobeStock Image)

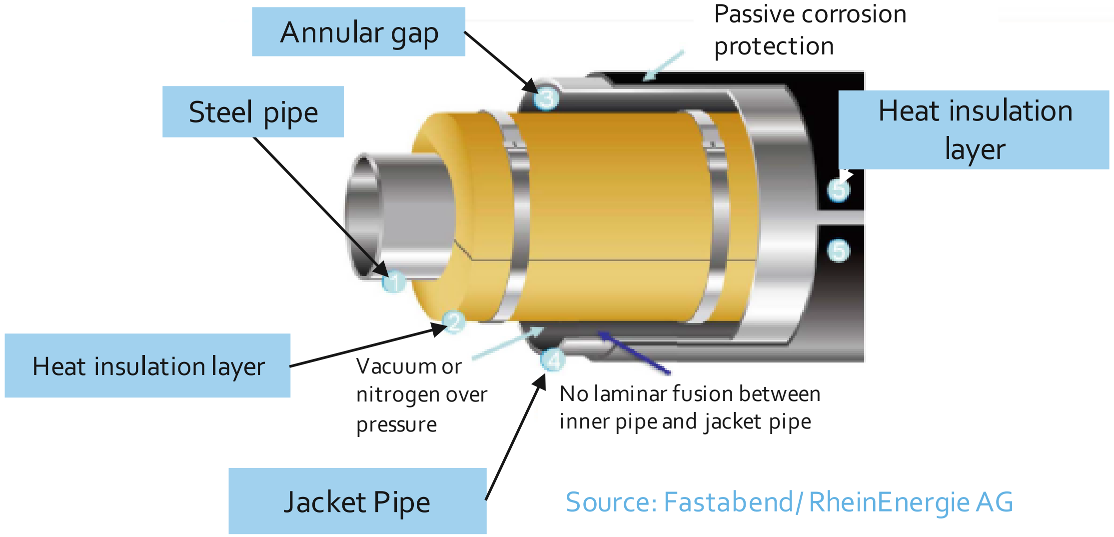
Installation methods & pipe designs

Pipe designs

- **Steel jacket pipe-systems**
  - Reliable protection against external stresses – versatile applications
  - Thermal insulation per fiber insulation material and/or vacuum
  - Medium temperatures up to 400°C



- **Plastic jacket pipe-systems**
  - Minimum lifetime > 30 years
  - Water- and damage-proof against external stresses
  - Good thermal insulation
  - Constant operation temp. ≤ 120°C



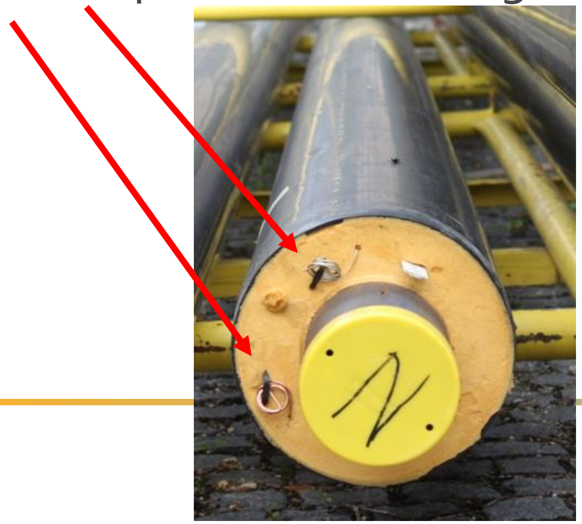
Source: Fastabend/ RheinEnergie AG

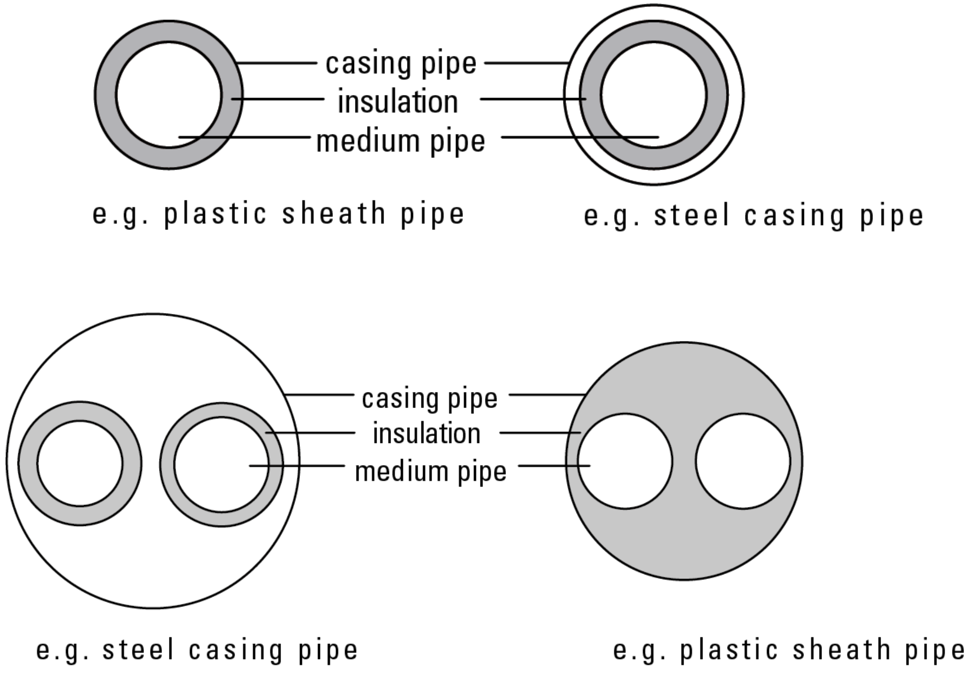
- **Both operate with steel and plastic medium pipes**

Installation methods & pipe designs

Pipe designs

- basic structure of commonly used piping technologies - two concentrically placed pipes that are separated by an insulating layer
- outside casing from plastic or steel functions as protection against moisture and corrosion of the inner medium pipe
- usually are equipped with additional wires inside the insulation, which could help to detect leakages





One-pipe layout and two-pipe layout (Source: AGFW)

Source: D. Rutz [3]

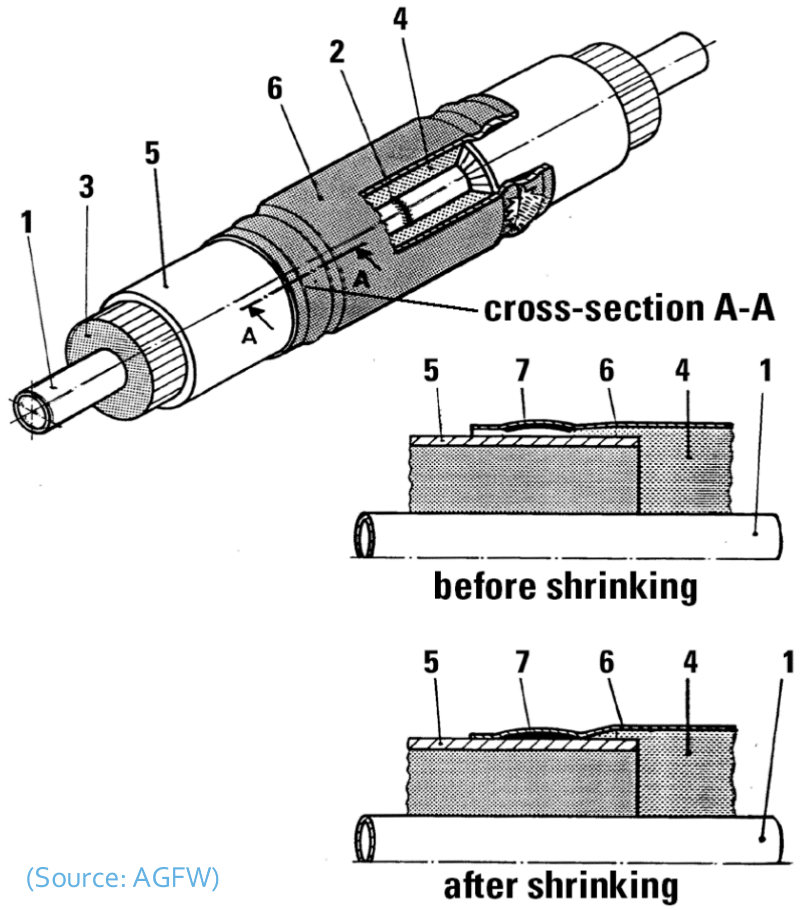
Installation methods & pipe designs

Overview of different PJPs

PJP pipe with a steel medium pipe
(Source: D. Rutz) [3]

Varieties of flexible PJPs – so called PEX-pipes - with a plastic medium pipe
(Source: Logstor / Uponor)

One example of sleeve connections



(Source: AGFW)

1 Medium pipe

2 Weld connection

3 Factory produced PU foam

4 On-site produced PU foam

5 PE-jacket pipe

6 PE-X-shrink sleeve

7 Shrink tape with hot melt glue

Heat transport medium

- DH piping system is also influenced by the quality of the **heat transport medium** which is described in AGFW FW 510 (2018)
- impact on the operation lifetime of the piping network
- influences the rate of corrosion for the steel made medium pipe
- Bad quality could cause deposits in the pipelines or valves

For the application of water in DH two operating modes can be classified:

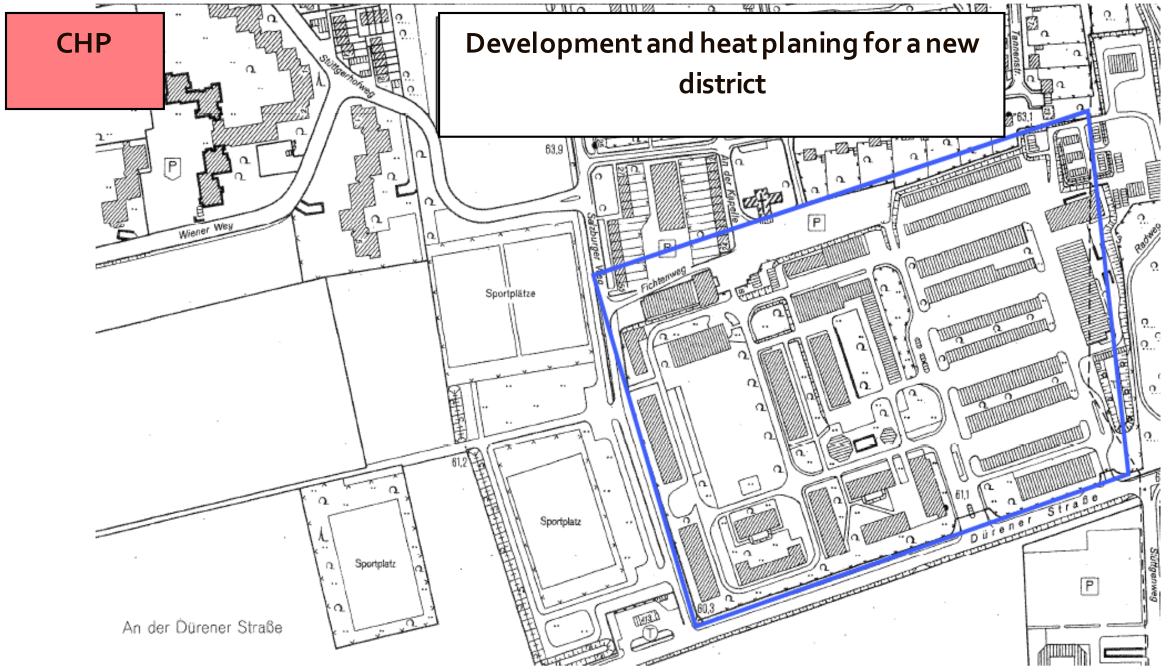
saline circulation water and low-salt circulation water

The criteria for the assessment of DH water are:

- Electrical conductivity at 25°C
- Appearance
- pH value at 25°C
- Oxygen
- Sum of alkane earth (hardness)
- Iron
- Copper
- Sulphide
- Sulphate

EXAMPLE: simplified case of network planning

- **Example:** A city plans to build a new residential area and the nearby cogeneration plant has free capacities to supply the new district. A network for district heating has to be planned between the cogeneration plant and the residential area (blue).



Source: Dipl.-Ing. Fastabend - RheinEnergie

EXAMPLE: simplified case of network planning

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1st Step: Determine heat demand (following DIN EN 12831)

- Usually the city or the investor have information about the heat demand
- Gross floor area (GFA) allows a good estimation of the heat demand

Experienced heat demand values

Single-family house

- Terrace house 8-10 kW (without hot water supply)
  15-18 kW (with hot water supply)
- Freestanding 15-20 kW (without hot water supply)
  18-25 kW (with hot water supply)

Specific heat demand

- House development 40-60 W/m² GFA
- Office use 60-80 W/m² GFA
- Commercial area 60-80 W/m² GFA
- Special use ≤ 100 W/m² GFA

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EXAMPLE: simplified case of network planning

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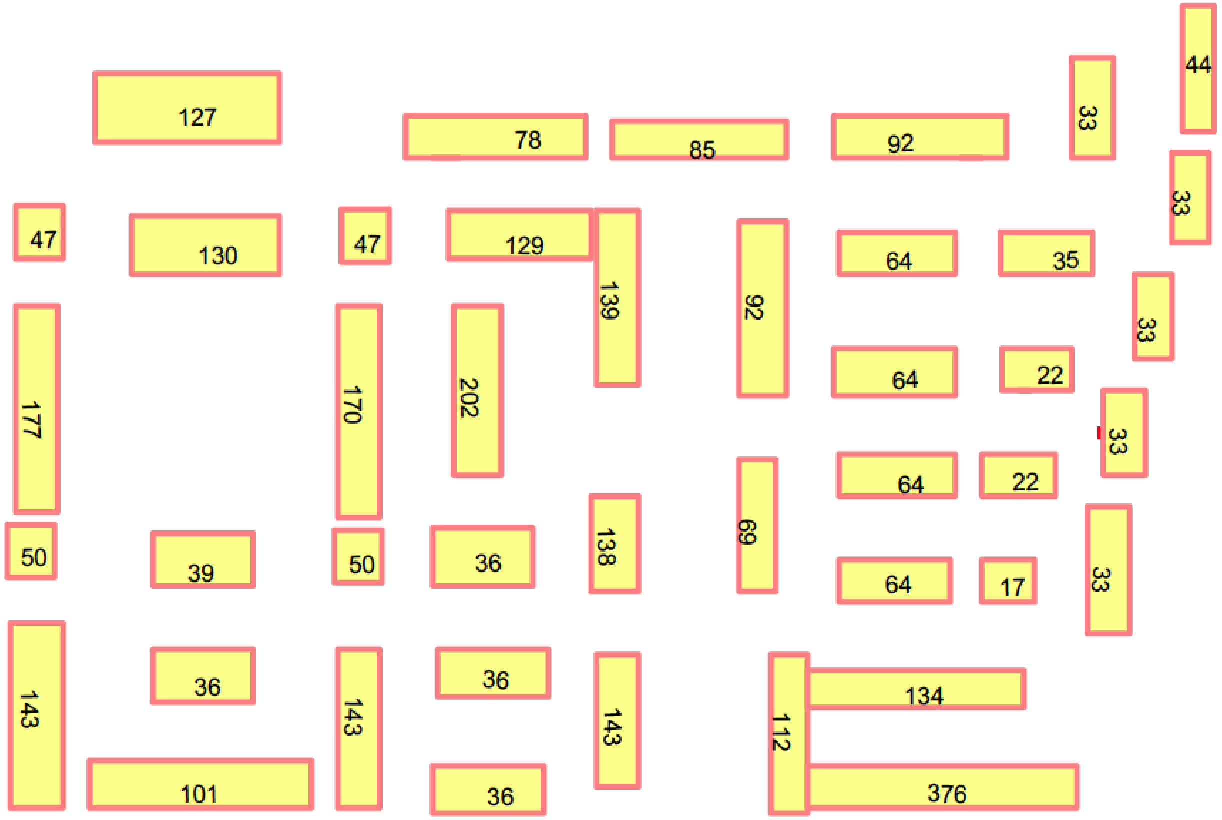
- Calculation of heat demand: 3.720 kW

2nd Step: Determine further parameters

- Network operation
- Pressure loss

3rd Step: Define first lines

4th Step: Dimension pipes



Source: Dipl.-Ing. Fastabend - RheinEnergie

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- [1] ICAX. https://www.icax.co.uk/Fifth_Generation_District_Heating_Networks.html
- [2] Upgrade-DH, 2019. Upgrading the performance of district heating networks. Technical and non-technical approaches. A Handbook.
- [3]D. Rutz 2019. picture taken from: Upgrading the performance of district heating networks. Technical and non-technical approaches. A Handbook.
- [all others] AGFW 2013: Technical Handbook

References & Contact

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