Parallel session

4th and 5th generation DHC

What does it change in terms op operations and technologies

September 15th 2020

Final Conference Heatnet-NWE

Speakers

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Welcome

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What will we discuss in this panel discussion

- Key aspects of the transformation from a 3GDH to a 4GDH, experiences TEMPO (Horizon 2020)
- Key aspects of a 4th and 5th GDHC, experiences HEATNET-NWE (Interreg)

Heatnet-NWE

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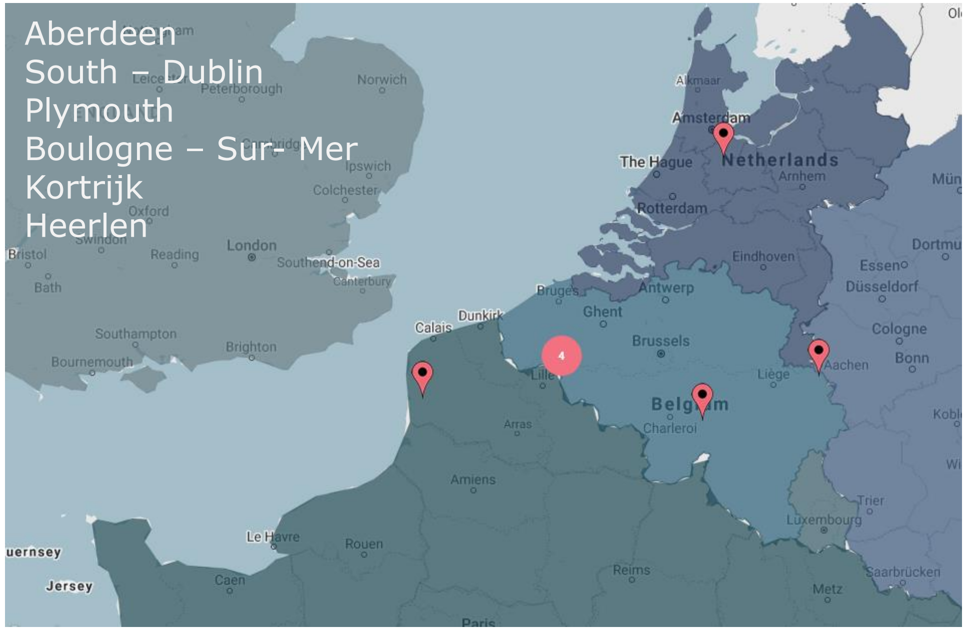
Challenge of **reducing CO_2 emissions**, by creating an integrated approach to the supply of renewable and low carbon heat (incl. waste heat) to residential and commercial buildings.

- The overall objective is to **introduce and demonstrate** the 4th generation DHC (4DHC)
- The concept requires the **development of new institutional and organizational frameworks**
- The project will result in **15,000 t CO_2e saved** per annum at its end.

The main outputs are:

- A transferrable HeatNet model for the implementation of 4DHC schemes in NWE;
- Six living labs develop, test and demonstrate through investments the HeatNet model to make it robust;
- Transition Roadmaps plan,
- Promotion and fostering of the HeatNet model in NWE
- Able energy sources, and supplies multiple low energy building



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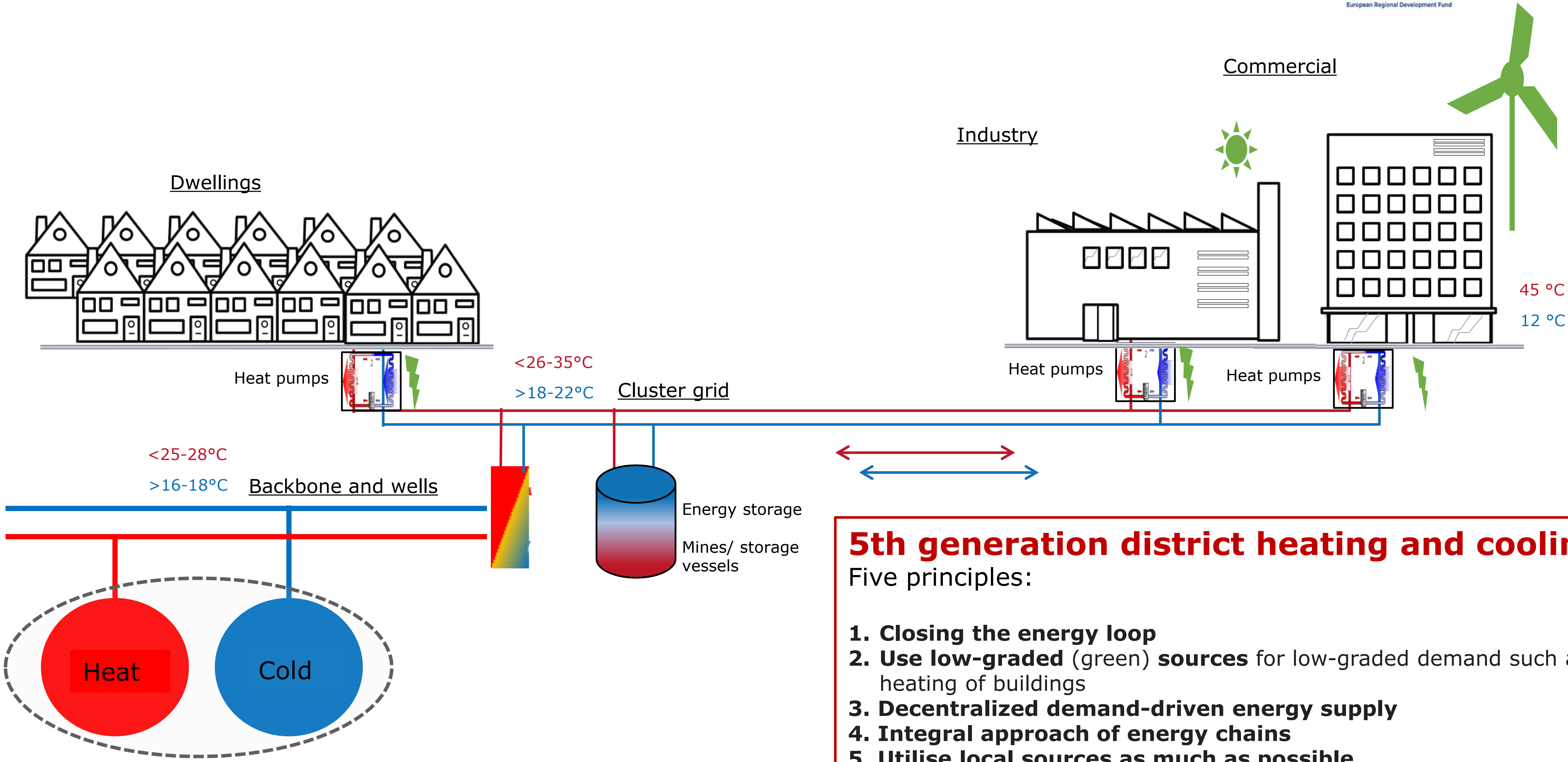
5th generation district heating and cooling



5th generation district heating and cooling

Five principles:

1. **Closing the energy loop**
2. **Use low-graded** (green) **sources** for low-graded demand such as heating of buildings
3. **Decentralized demand-driven energy supply**
4. **Integral approach of energy chains**
5. **Utilise local sources as much as possible**

Welcome
A2A Calore e Servizi

ACS is the main DH company in Northern Italy, it manages the DH networks of Brescia, Milan and Bergamo.

Brescia DH network:

- It started functioning in 1972;
- It is 672 km long (trench length);
- Heat supplied to more than 21.300 connections.

Milan DH networks:

- >10 networks;
- > 300 km long (trench length)
- Heat supplied to around 3.500 connections.

Bergamo DH networks:

- 2 networks;
- > 50 km long (trench length)
- Heat supplied to around 700 connections.

ACS performs several activities: designing, coordinating intervention, maintenance and participates to several founded projects.

TEMPO Project
Project description

TEMPerature Optimisation for Low Temperature District Heating Across Europe (TEMPO), it started the 01/10/2017 and it finishes the 30/09/2021.

Main objectives:

- Develop **technological innovations** for LT DH networks
- Quantify the **benefits of the TEMPO solution packages** for LT DH networks through demonstration in 2 representative demonstration sites (Windsbach, De and Brescia, It)
- Empower of **end users** in LT DH network
- Develop innovative **business models** and demonstrate their **replication potential** for the roll-out of sustainable and economically viable DH networks across the EU.
- Guarantee EU-wide **market uptake** of TEMPO solutions packages by developing an **exploitation** and **replication plan**

Demo sites were chosen:
- New urban area
- Nurnberg area (new rural area), Germany
- Brescia area (existing urban area), Italy.

Nurnberg region: New rural district heating network

A new network in the Nurnberg region (Germany) will supply heat to a less dense area of new buildings, heated by residual heat of a biogas plant and biogas CHPs. Solution package 2 will be demonstrated at this demo site to reduce temperatures and so open up the possibility to integrate a renewable energy source at a later stage.

▷ READ MORE

Brescia: Existing high temperature district heating network

The A2A pilot project involves part of the Brescia district heating network in a low building density area consisting mainly of terraced houses and some apartment blocks. The existing network is heated by a waste-to-energy plant (~50% coverage), residual heat from industry and CHP, and peak-load gas boilers. The A2A network in Brescia started operating in the '70s, and currently operates at temperature levels of 120/60°C.

▷ READ MORE

TEMPO website: https://www.tempo-dhc.eu/

TEMPO Project
Technological innovations

1. A supervision ICT platform for detection and diagnosis of faults in DH substations

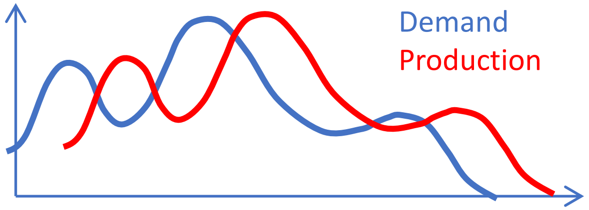
Build and **demonstrate** an on-line supervision **ICT platform**, able to **detect** and **diagnose** system faults ranging from slight operational deviations to actual malfunctioning system behaviour at the substation level.

2. Visualisation tools for expert and non-expert users

Develop and demonstrate visualisation tools for expert and non-expert users: support tools to monitor and analyse network behaviour, to detect and correct faults in the networks, maximise their financial, evironmental and operational gains.

3. Smart DH network controller to balance supply and demand and minimise return temperature

Additional features to minimize the Tr, rather than balancing power supply and demand. By sending control signals to buildings, it is possible to influence the power consumption and the return temperature. By doing this in a coordinated way, it is possible to minimize the overall Tr to the heat production source.



4. Innovative piping system

Elimination of bypass by 3-pipe concept; smaller pipe dimensioning by using the recirculation line as booster pipe in winter.
Simulation studies on the effect of pipe sizing on heat losses and pressure drops were performed.

All information: *Averfalk, H., Ottermo, F., & Werner, S. (2019). Pipe Sizing for Novel Heat Distribution Technology. Energies, 12(7), 1276.*

TEMPO Project
Technological innovations

5. Optimisation of the building installation
Implementation of a static optimization of building installations by investigating typically errors in building installations and by creating a practical guideline describing technical audit procedure. After that, TEMPO will study a dynamic optimization of the building installation to increase efficiency by self-learning techniques to substation controllers.

6. Decentralised buffers at the consumer side
Development of new decentralised buffer concept, suited for LT DH (flow: 55-65C, return: 25-30C), including smart charging capabilities.

Application area per package solution	Included technological innovations
Solution Package 1 New LT networks in urban areas	- Supervision ICT platform - Visualisation tools - Smart DHC controller - Innovative pipe system - Optimisation of building installation
Solution Package 2 New LT networks in rural areas	- Supervision ICT platform - Visualisation tools - Smart DHC controller - Decentralised buffers - Optimisation of building installation
Solution Package 3 Existing (HT) networks	- Supervision ICT platform - Visualisation tools - Smart DHC controller - Optimisation of building installation

Preparation work on business models for low temperatures network
- Mainly research on available business models to promote lower return temperatures.

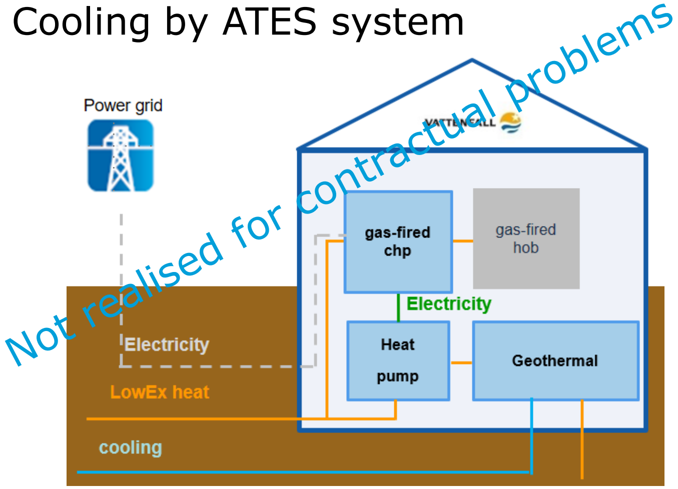
Study on "Crowdfunding as a novel financial tool for district heating projects
- Publicly available on the TEMPO website
- Direct link: https://www.tempo-dhc.eu/crowdfunding-as-a-novel-financial-tool-for-district-heating-projects/

TEMPO Project

Demo sites

New LT network in urban areas, Lübeck, Germany

- DHC network, temperature level 50°C-22°C (heating) and 14°C-22°C (cooling), innovative pipe system;
- individual apartment substations;
- Heat pump coupled to an aquifer thermal energy system (ATES), covering 50% of the peak load, >90% of the heat demand
- Small gas fired CHP to provide the electricity for the heat pump
- Peak load provided by natural gas boiler
- Cooling by ATES system



New LT network in rural areas, Nürnberg, Germany

- Source: residual heat of a biogas plant and biogas CHP;
- Estimated demand: 1.000 MWh (800 kW peak load);
- 58 building sites:
  31 houses connections (end of 2019)
  11 houses not connected to the DH
  15 houses are vacant
  1 multi-family house is planned (end of 2020).
- 28 buffers delivered:
  23 buildings 250 l buffer
  4 buildings 600 l buffer
  1 building 1000 l buffer

Existing (HT) networks, Brescia, Italy

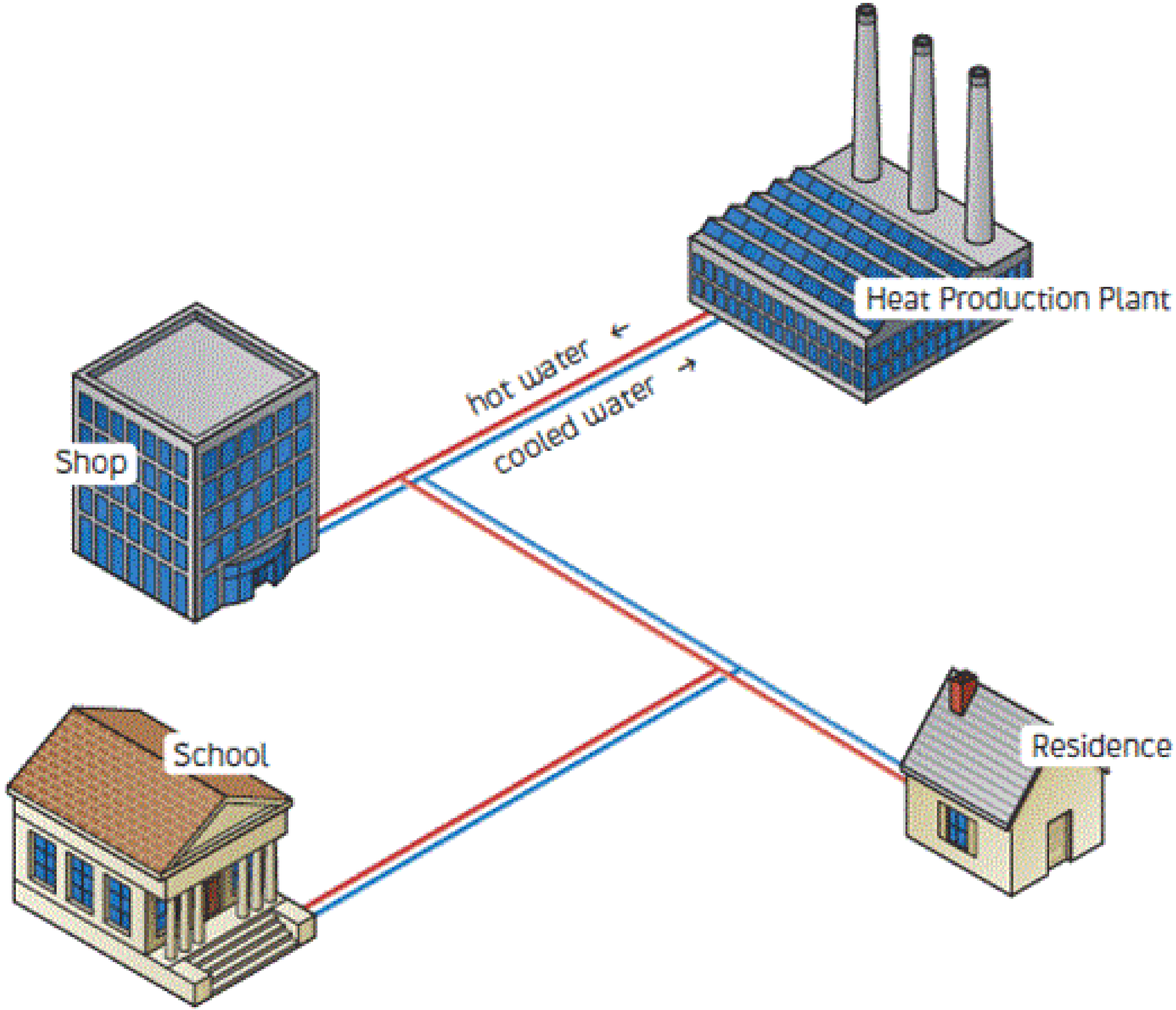
- Subnetwork hydraulically divided by the main DH system;
- 34 single family houses and a block of apartments (43 flats);
- Installation of a mixing station to supply heat at 85°C – 90°C;

More details in the second part...

4th generation district heating and cooling

District heating and cooling systems consist of **pipe networks** between the **buildings of a city** and one or more **centralized heating/cooling plants to supply heat/cold efficiently**. They provide the **flexibility** to improve/change the heat/cold source easily. They allow the use of **combined heat and power (CHP) plants,** waste-to-energy plants and other industrial surplus heat/cold as well as several renewable energy sources to supply heat/cold to the grid.

Source: Heatnet-NWE technology guide



4th generation district heating and cooling

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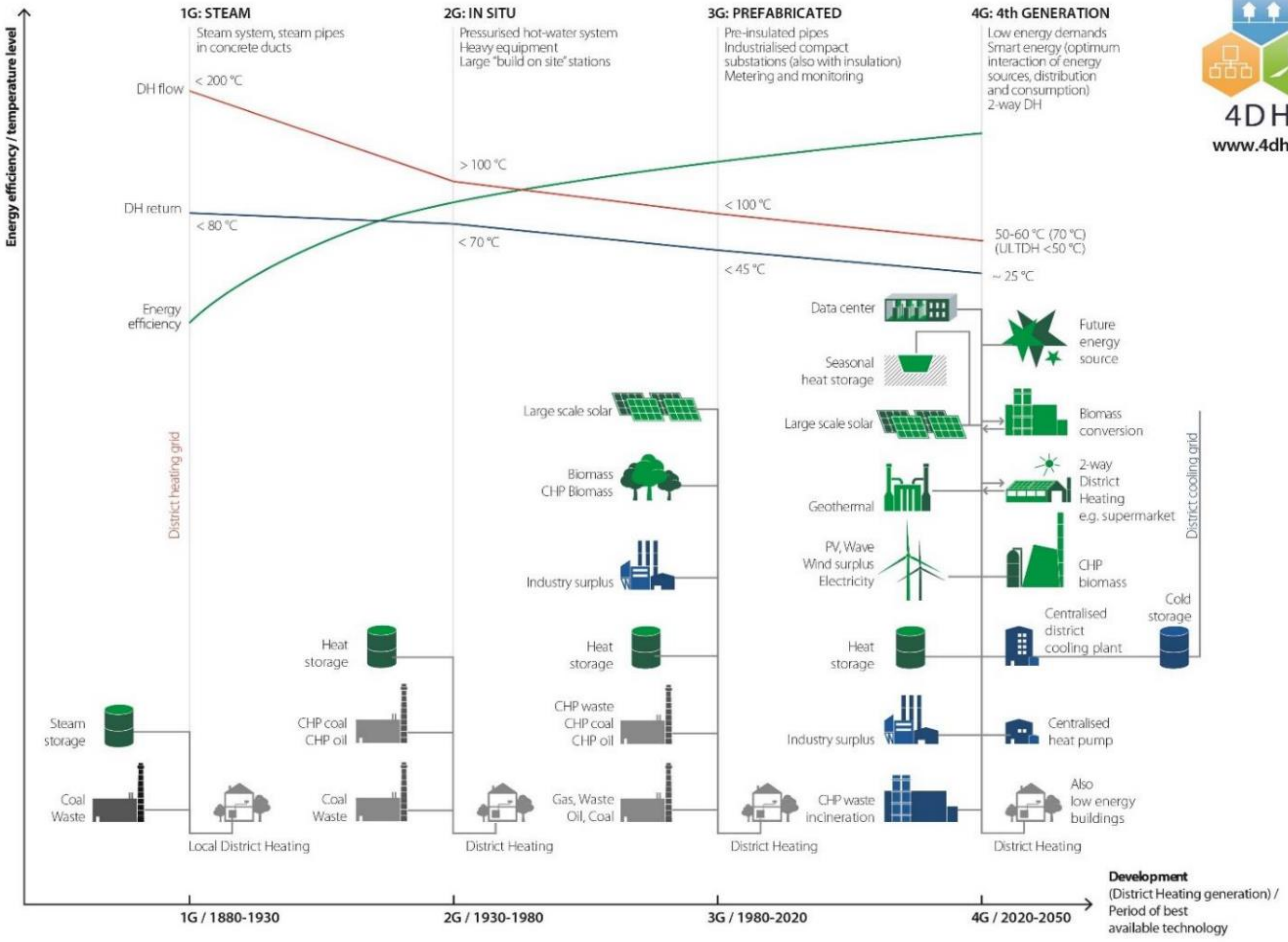
Lund et al., 2014 defined the concept of 4th Generation District Heating (4DH), including the relations to district cooling and the concept of smart energy and smart thermal grids. They aim to **decrease grid losses**, **exploit synergies** and thereby **increase the efficiency of low-temperature** production units in the system. The key aspects of 4DHC system include:

- Ability to supply low-temperature heat for space heating and domestic hot water to both existing and new buildings
- Ability to distribute heat in networks with low grid losses
- Ability to recycle heat from low temperature waste heat and integrate renewable heat sources such as solar and geothermal heat
- Ability to be an integrated energy system (synergy with other grids)
- Ability to ensure sustainable planning, cost and motivational structure in relation to operation as well as to investments

Source: Heatnet-NWE technology guide



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Brescia DH system

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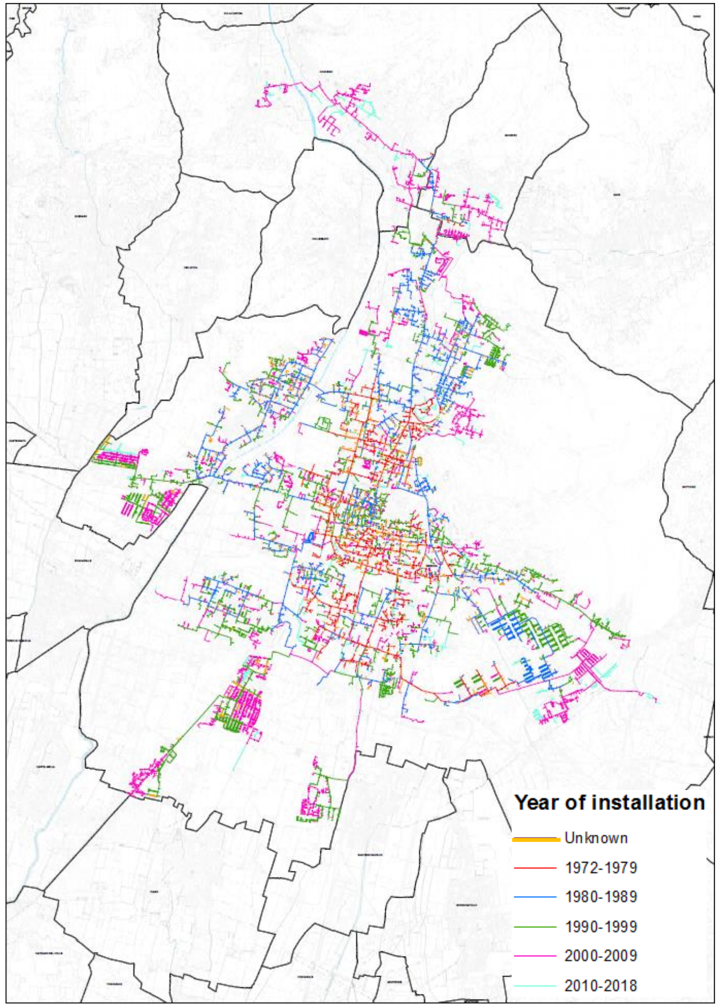
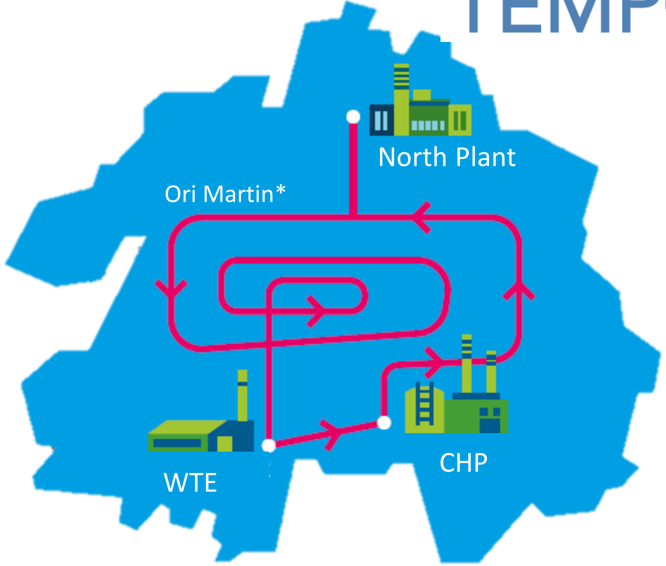


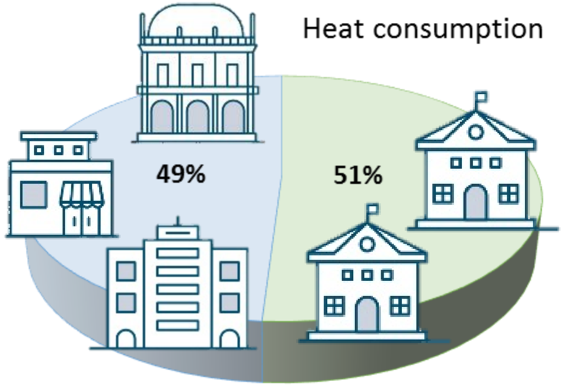


*Ori Martin is a steel plant.
A2A recovers its waste heat 10 MW, at peaks.

Heat storages:

- **North Plant**:
2 tanks of 2200 mc each; heat storage capacity = 190 MWh.
In service: end 2020.

- **Lamarmora Plant**:
1 tank of 5200 mc; heat storage capacity = 224 MWh.
In service: end 2019.



DH system supplies heat to more than 130.000 customers, equal to 42 MLN mc

contractual flow ≤3 mc/h   contractual flow >3 mc/h

TEMPO Project
Brescia demo site

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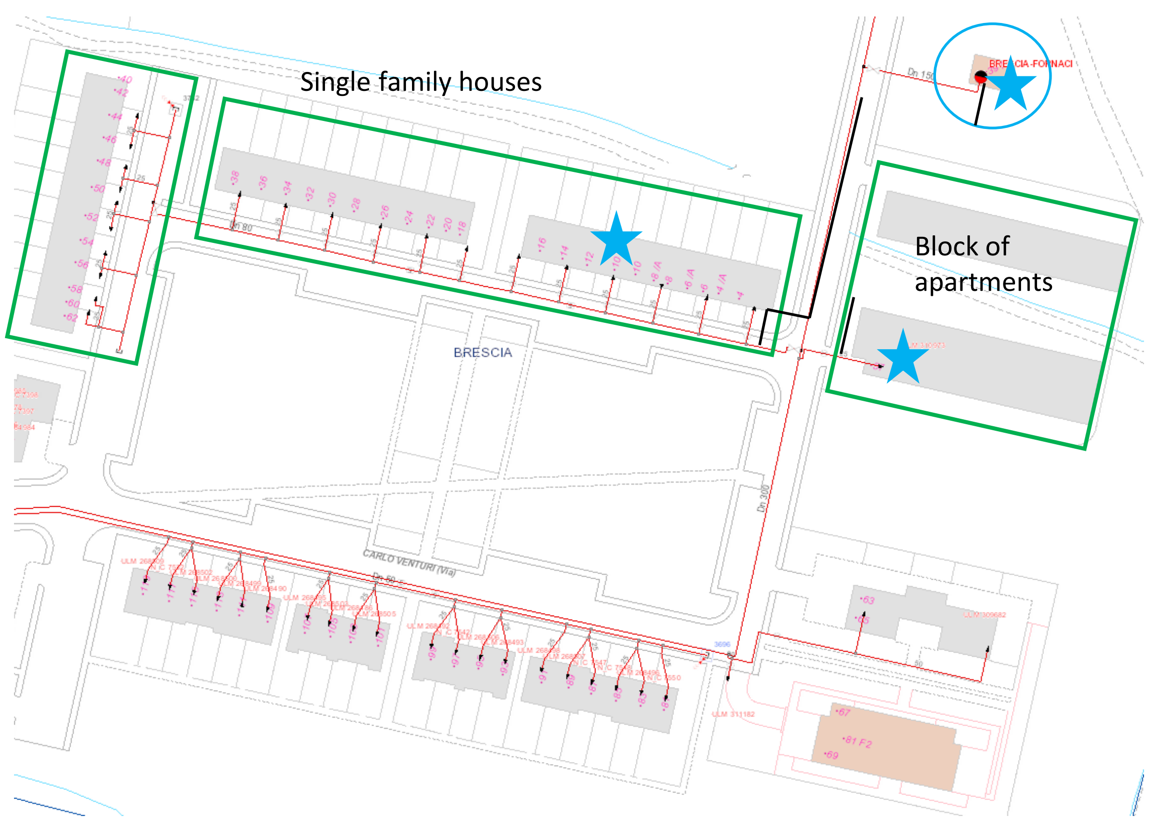
Peripheral area of Brescia DH system



New pipes
Existing pipes
Consumer involved
Mixing station location

- Block of apartments (43 flats) and more than 30 single family houses in a small area;
- Installation of around 100 m of new pipes to create a subnetwork;
- Nearby available area where to install the mixing station;
- Previous to TEMPO, in this area characterised: 2 heat boilers not in used owned by ACS authorised in 1997 by Brescia City Council;
- The former authorisation facilitated the authorisation process for the mixing station.

- Close to the area: a wastewater treatment plant that, <u>in future</u>, could be used as heat source.

TEMPO innovations_installation of:
- 9 indoor temp sensor in different flats in MFH;
- 1 indoor temp sensor in 1 SFH;
- 2 ICT smart controllers (NODA box) to monitor and control temperatures: 1 in the mixing station and 1 in the MFH;
- 1 ICT smart controller (NODAbox) to monitor in 1 SFH.

Project phases:
- Monitoring of the system at high temperature;
- Monitoring of the system at low temperature;
- Optimisation of the performances and their monitoring

TEMPO Project

Brescia demo site_Mixing station

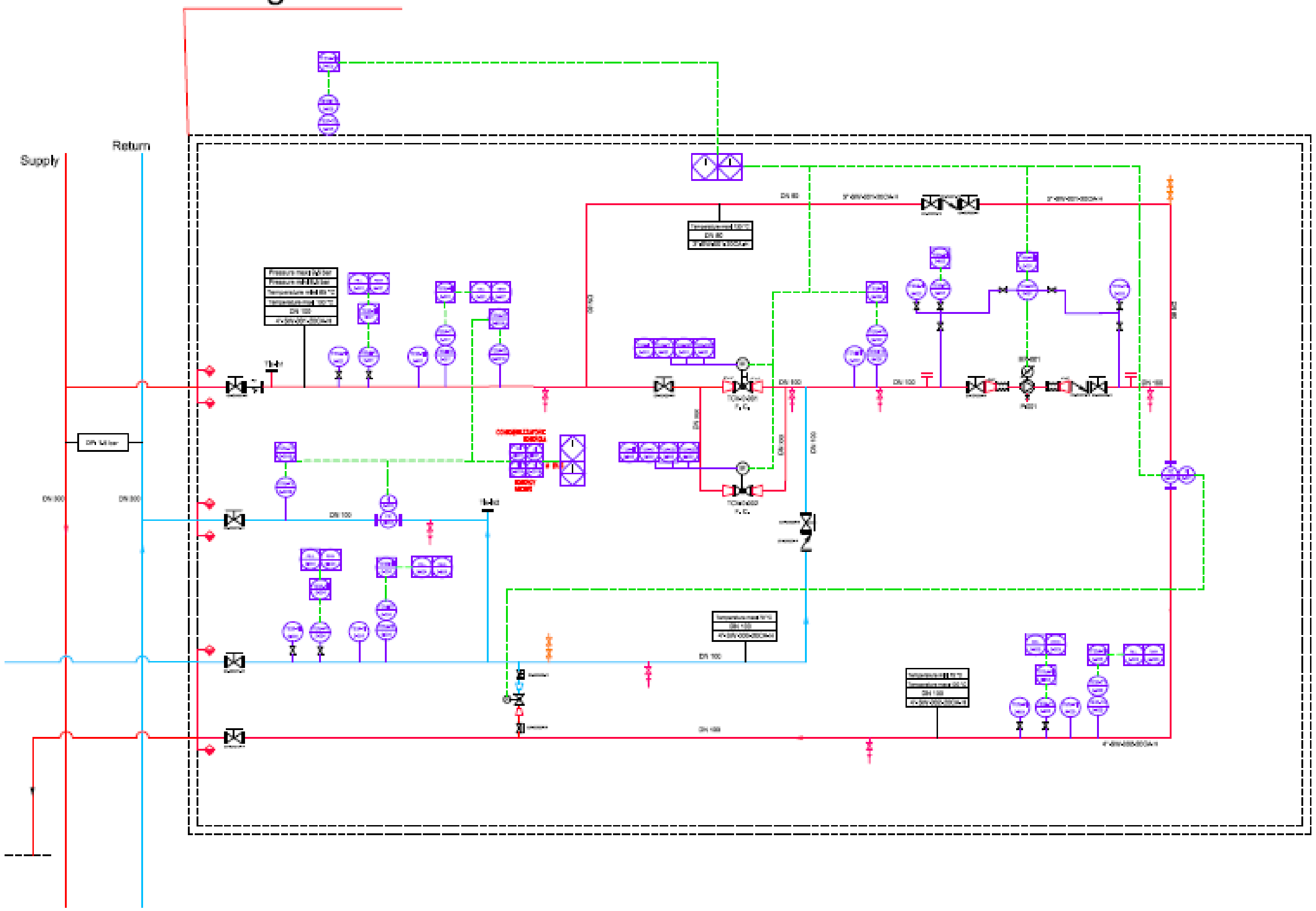
Main DH systems (HT) during winter season:
Ts 120°C, Tr 60°C.
Mixing HT supply water to return water:
Supply low temp: 85°C – 90°C.
No changes on customers installations nor on secondary sides.

<u>Monitoring activities:</u>

Winter season 2019 – 2020:
Tests to verify the correct functioning, lowering temperatures manually with two different approaches.
Ready to start with remote lowering and control: COVID-19 spread → interruption of activities on site.
Low temp (85°C – 90°C) kept, no issues registered.

Winter season 2020 – 2021:
Remote control and optimisation of the system

Mixing Station

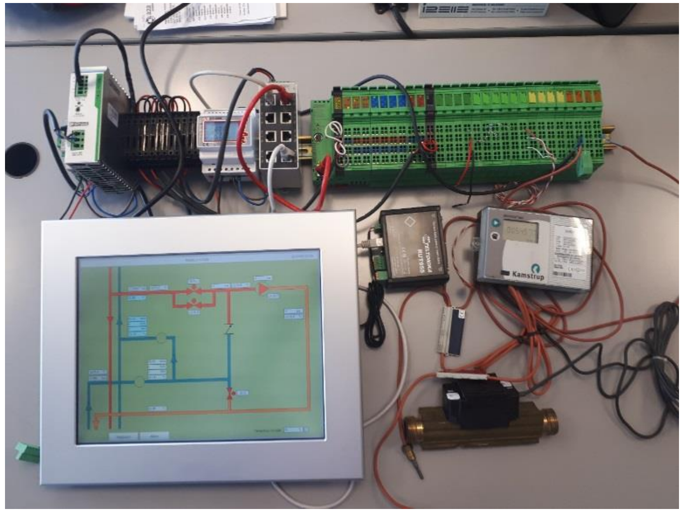


TEMPO Project

Installation works Pictures

TEMPO Project

Installation works - Pictures



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Brescia demo site - Customer involvement

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Visualisation tool for non-expert users

- residents
- building owners

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Tool to maximise their financial, evironmental and operational gains:

- they give insight in energy use of the consumers building owners
- suggest energy saving possibilities

NODA Intelligent Systems

Mijnwater – 5GDHC

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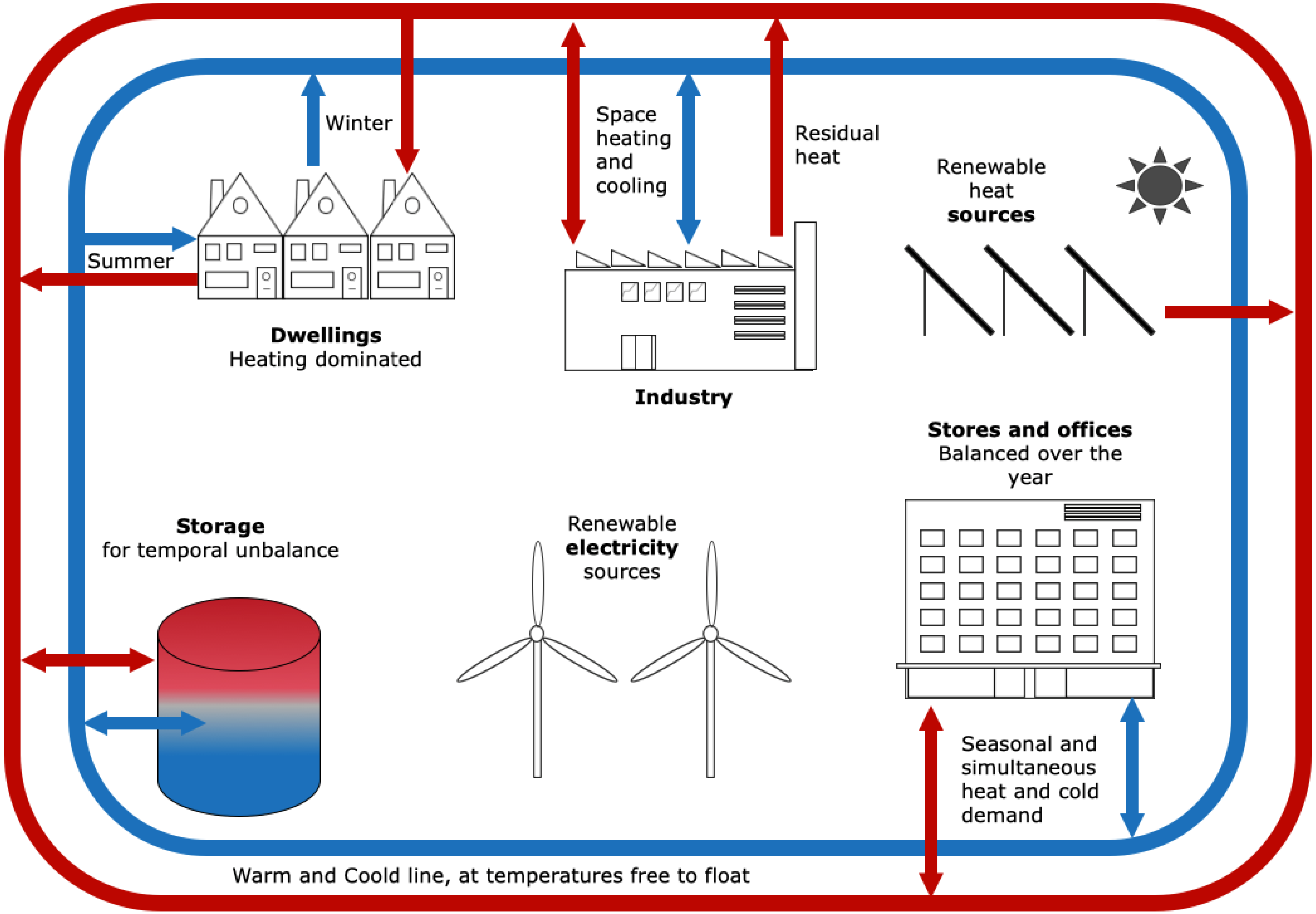

Source: Boesten, S. et al. (2019)

5th generation district heating and cooling
Five principles:

1. **Closing the energy loop**; exchange of energy between end users

2. **Use low-graded** (green) **sources** for low-graded demand such as heating of buildings; low graded waste energy can cover three times the need of buildings

3. **Decentralized demand-driven energy supply**; generate (sustainable) energy only when there is a demand, making use of smart control and data mining

4. **Integral approach of energy chains**; electricity and heat must reinforce each other and more in general also other environmental aims must be served

5. **Utilise local sources as much as possible**; first apply all avilable local energy to feed the regional demand and only if not available employ more distant sources

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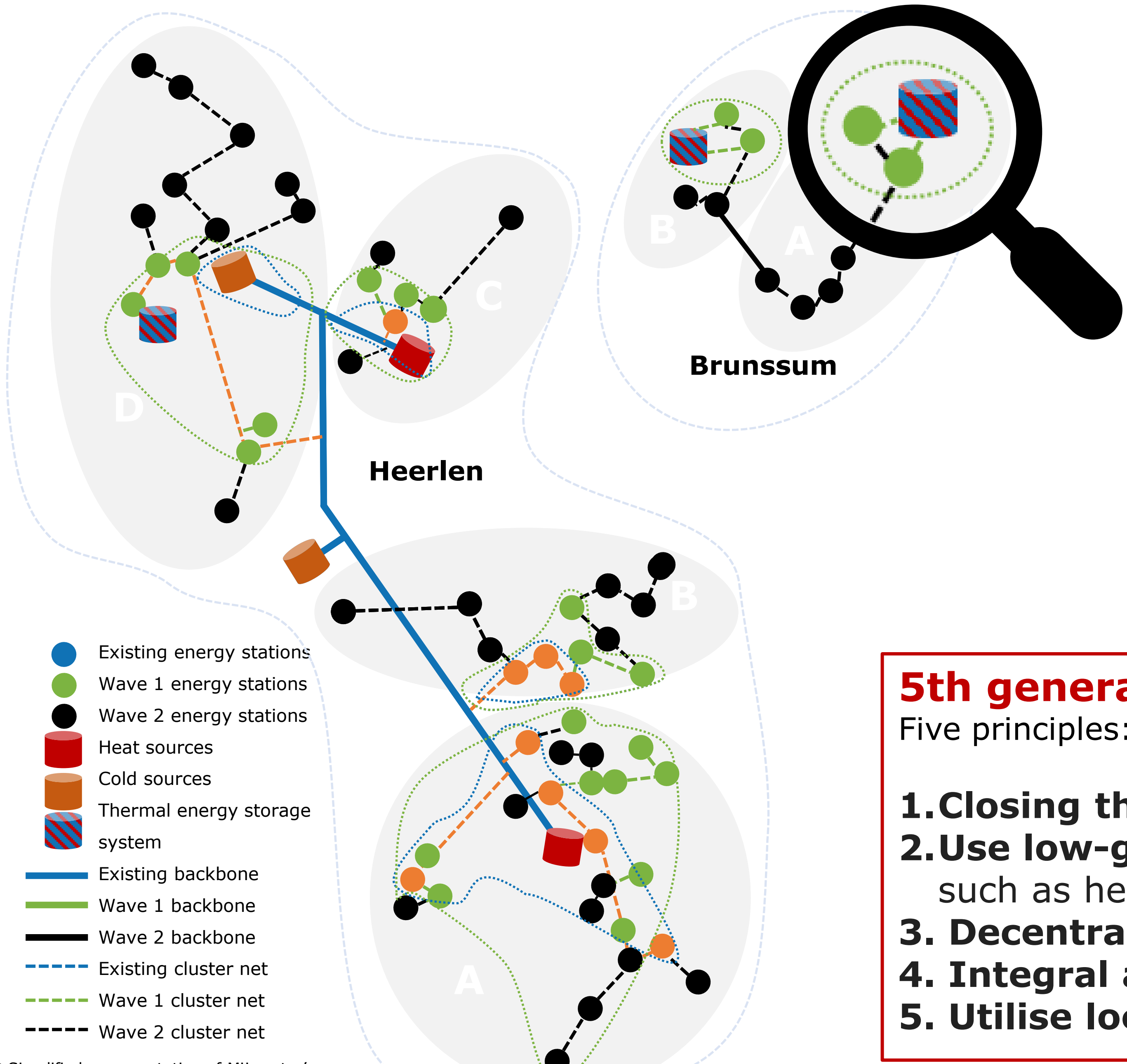

* Simplified representation of Mijnwater's expansion

5th generation district heating and cooling

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4th generation district heating

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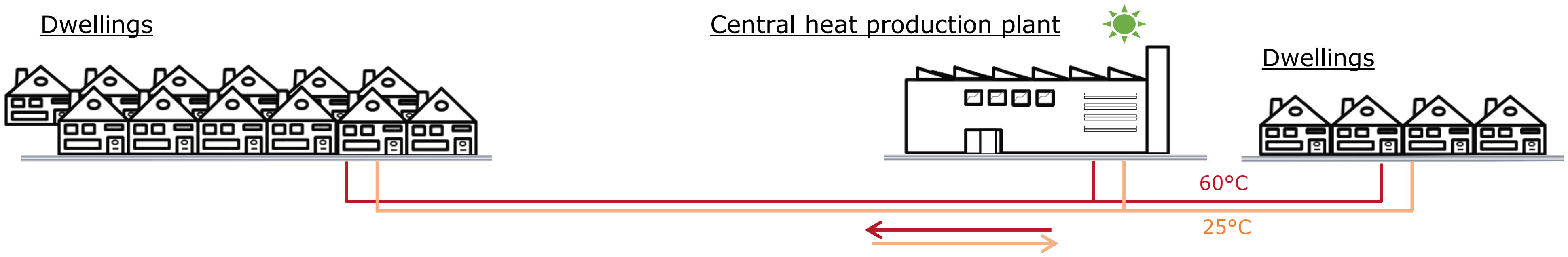
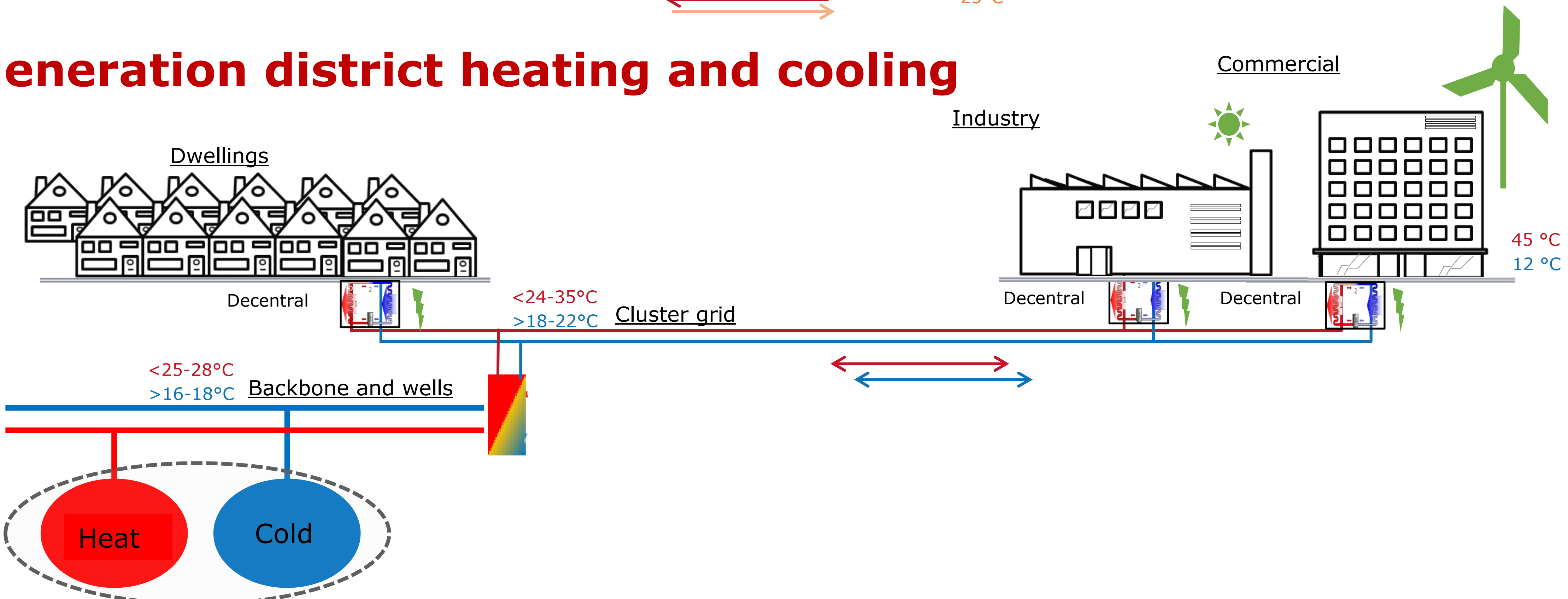
SMART SUSTAINABLE ENERGY GRID



5th generation district heating and cooling



5th generation district heating and cooling

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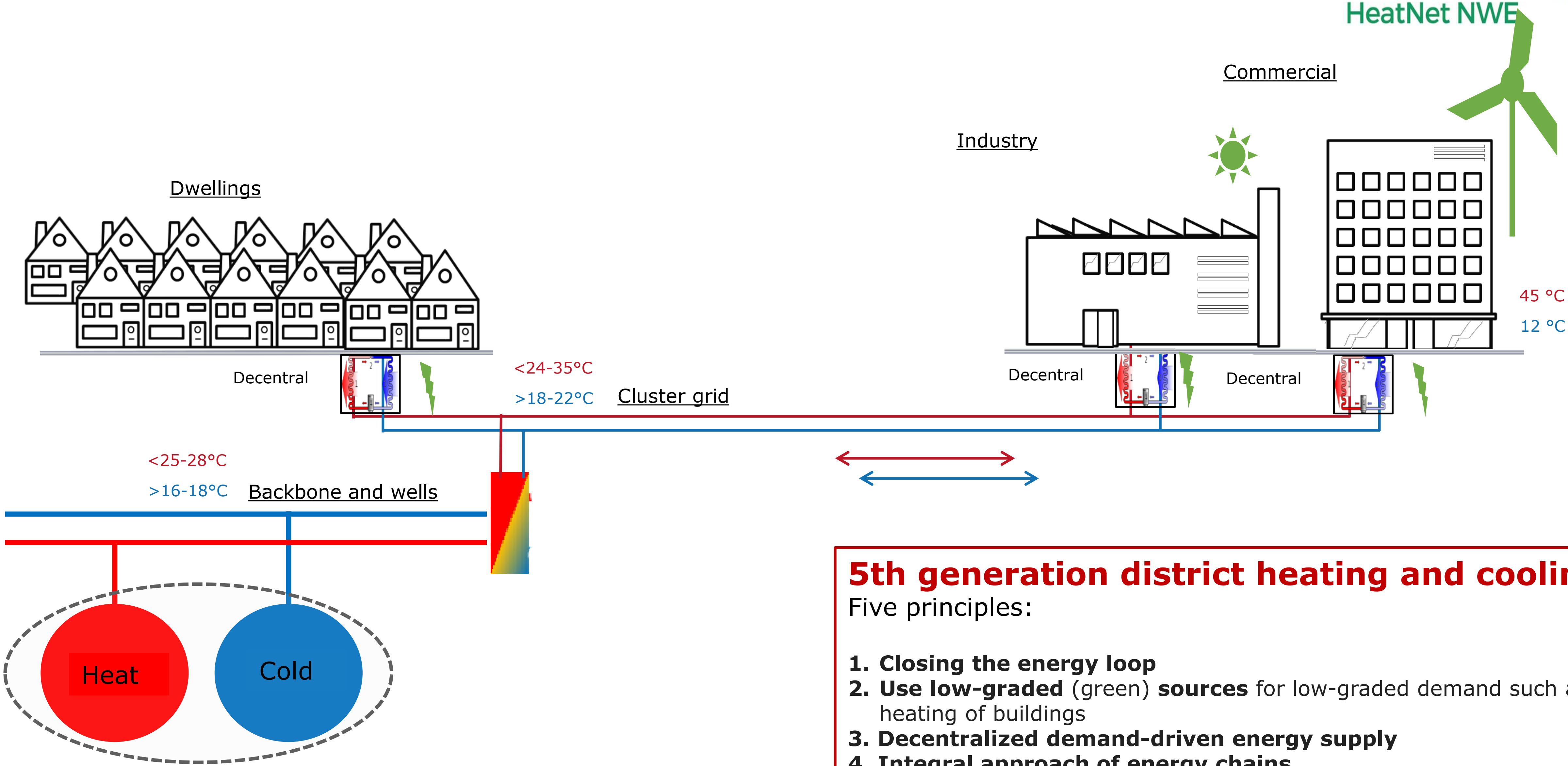

5th generation district heating and cooling

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Conclusion

Main benefits of installing LT networks:

- Less heat losses;
- Possibility to add cooling;
- Increased share of LT sustainable energy sources;
- Increased efficiency of heat production technologies (heat pumps, CHPs, boilers,..);
- Integration of more LT heat sources at local level, even waste heat

Main issues regarding replicability:

- Technical characteristics and optimization activities on systems and buildings of each (individual) system
  - Primary (heating network)
  - Secondary (customer)
- Legal characteristics of contracts
- Customer demands and whished regarding to the contract or technical issues
- Stakeholders involvement regarding to authorization processes, policies and funding
- Standardisation of activities – modularity of the components of the system

Contact information

If you have any questions, please contact

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- *Ilaria Marini (A2A Calore e Servizi):* *ilaria.marini@a2a.eu*

- *More information about the TEMPO Horizon 2020:* https://www.tempo-dhc.eu/

- *More information about the Interreg NWE project Heatnet-NWE:* https://www.nweurope.eu/projects/project-search/heatnet-transition-strategies-for-delivering-low-carbon-district-heat/

- *More information about the Interreg NWE project D2grids:* https://www.nweurope.eu/projects/project-search/d2grids-increasing-the-share-of-renewable-energy-by-accelerating-the-roll-out-of-demand-driven-smart-grids-delivering-low-temperature-heating-and-cooling-to-nwe-cities/

Invitation
Digital Workshop MIJNWATER
October 9th 2020

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Thank you for your attention!

Behaaglijk warm
Aangenaam koel
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Interreg North-West Europe HeatNet NWE

Interreg North-West Europe D2Grids

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