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Technologies to decrease district heating temperature levels – the TEMPO project

Dirk Vanhoudt – EnergyVille/VITO

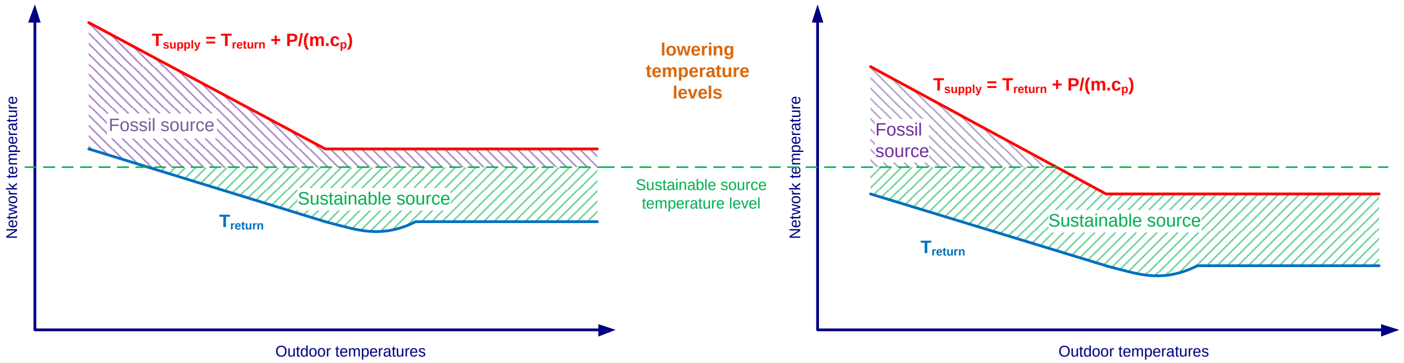
Sustainable District Energy Conference

23-25 October 2019, Reykjavik

Lower network temperatures

Benefits:

- Less heat losses
- Increased share of LT sustainable energy sources
- Increased efficiency of heat production technologies (heat pumps, CHPs, boilers etc.)



Lower network temperatures

By technological innovations:

- Digitalisation
- Network and building infrastructure optimization

By business models rewarding low return temperatures

By consumer commitment

- Awareness creation
- Involvement

Project Partners

TEMPO

Participant No	Participant organisation name	Participant short name	Country
1 (coordinator)	Vlaamse instelling voor technologisch onderzoek	VITO	Belgium
2	NODAIS AB	NODA	Sweden
3	AIT Austrian Institute of technology GmbH	AIT	Austria
4	Thermaflex International Holding bv	THF	The Netherlands
5	Steinbeis innovation GGMBH	Solites	Germany
6	Smet GWT nv	Smet	Belgium
7	Vattenfall Europe Wärme AG	Vattenfall	Germany
8	ENERPIPE GmbH	Enerpipe	Germany
9	A2A Calore & Servizi SLR	A2A	Italy
10	Hogskolan |Halmstad	HU	Sweden
11	Euroheat & Power	EHP	Belgium

Technological innovations

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

A huge amount of building substations return a too high temperature back to the DH network, because of "faults":

- malfunctioning components (sensors, valves, heat exchangers etc.)
- incorrectly designed components
- inappropriate settings in substation controller
- improper dimensioning of substation
- faults in heating supply systems

- In TEMPO:

  build and **demonstrate** and 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.

Technological innovations

2. Visualisation tools for expert and non-expert users

Many utilities and energy companies generate a significant amount of measured data. However, to date, tools are lacking to transfer the amount of data into knowledge. In TEMPO, we will develop and demonstrate visualisation tools for expert and non-expert users:

Expert users

- energy supervisors
- maintenance staff
- hardware installers
- …

Support tools to monitor and analyse network behaviour

Support tools to detect and correct faults in the networks

Non-expert users

- residents
- building owners

Tools to maximise their financial, evironmental and operational gains:

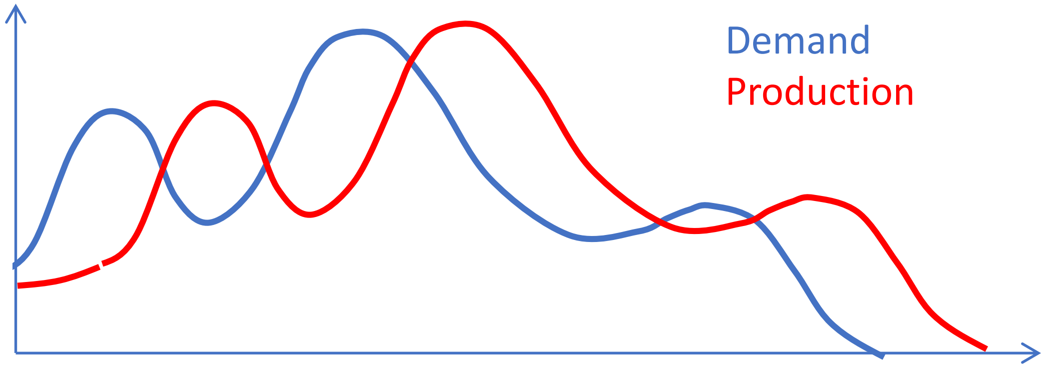
- they give insight in energy use of the consumers building owners
- suggest energy saving possibilities

“natural language generation” for large-scale automatic report generation

Technological innovations

3. Smart DH network controller to balance supply and demand and minimise return temperature (i.e. STORM controller)

STORM controller idea: utilise the intrensic flexibility in the DH network and the buildings to model the heat production to a desired shape.



In **TEMPO**:
development of additional features to minimize the return temperature, rather than balancing power supply and demand

STORM
DISTRICT ENERGY CONTROLLER

Technological innovations

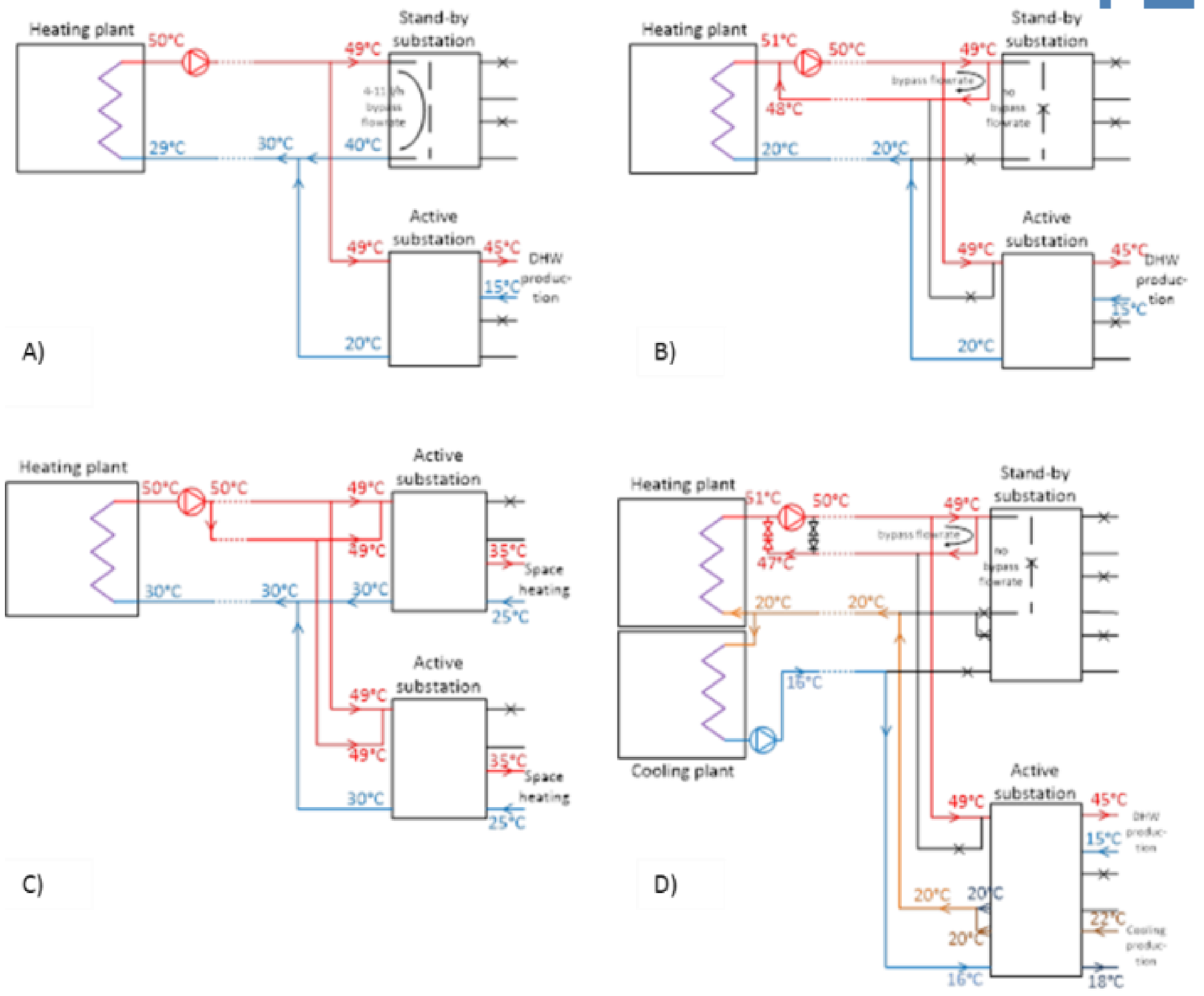
TEMPO

4. Innovative piping system

- The issue: bypasses in substations for comfort reasons (DHW tap time) cause high return temperatures, mainly in summer

In TEMPO:

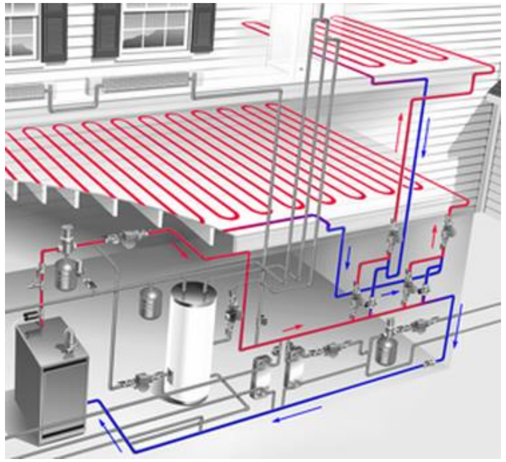
- Elimination of bypass by 3-pipe concept
- Smaller pipe dimensioning by using the recirculation line as booster pipe in winter
- Under investigation: heating and cooling still in 4-pipe system, just like in regular DHC network



Technological innovations

5. Optimisation of the building installation

- The return temperature to the network is determined by the return temperature of the building installation
- Often, in building installations are suboptimally designed or operated



TEMPO:

- Static optimization of the building installation
  - Investigation of typically errors in building installations (e.g. inproper hydraulic balancing, malfunctioning TRVs)
  - Practical guideline describing technical audit procedure
- Dynamic optimization of the building installation
  - Self-learning techniques to substation controllers to increase efficiency

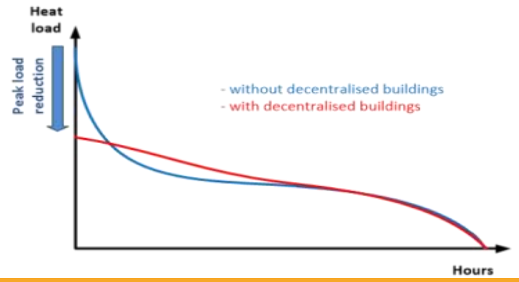
Technological innovations

6. Decentralised buffers at the consumer side

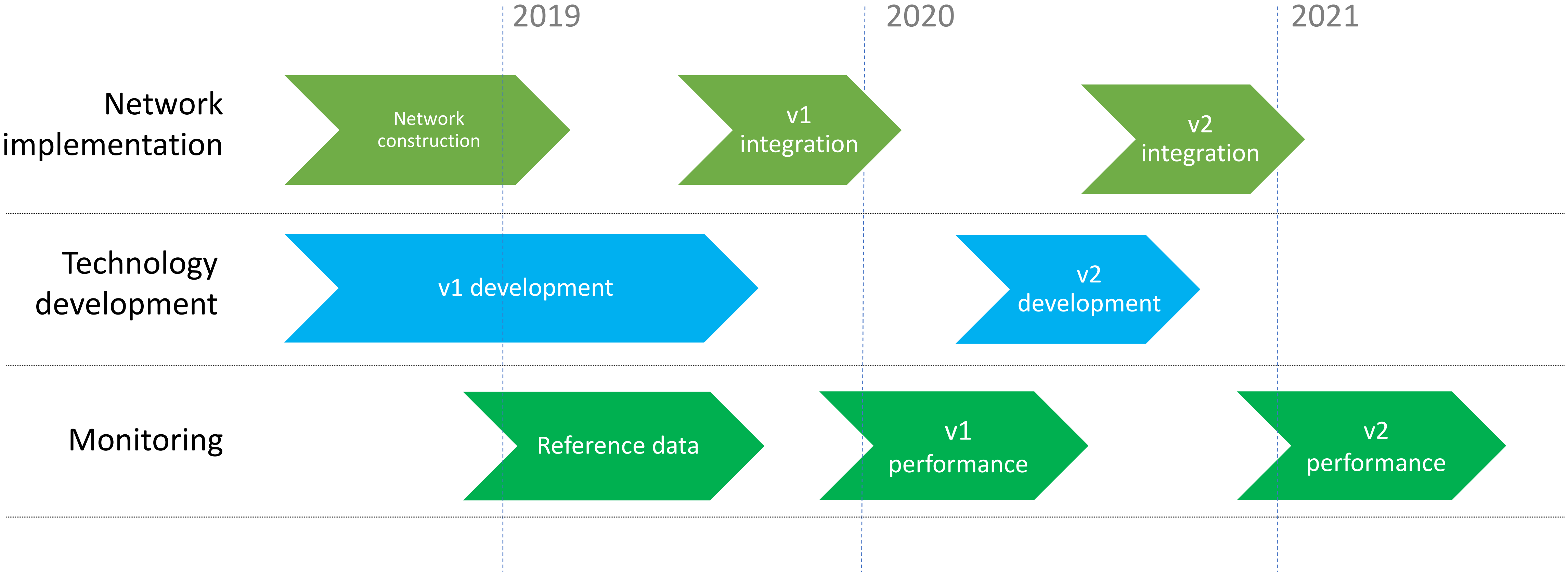
- Especially in rural areas:
  - DH networks are financially burdened by the network investment costs. Therefore, piping dimensions should be minimized to come to a positive business case.
  - Heat losses are relativelly high compared to delivered energy.
- Decentralised buffers, together with an intelligent control concept, can overcome this issue: smaller pipes, no recirculation for comfort reasons.

TEMPO:

Development of new decentralised buffer concept, suited for LT DH (flow: 55-65C, return: 25-30C), inluding smart charging capabilities

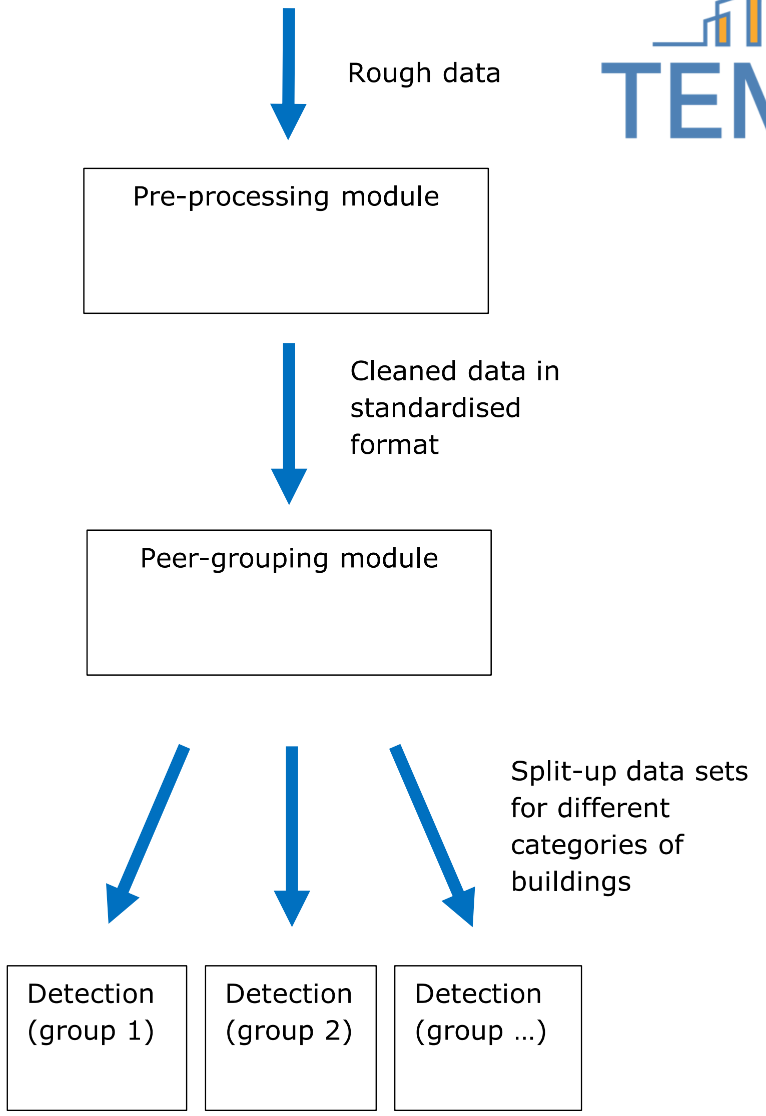


Project timeline



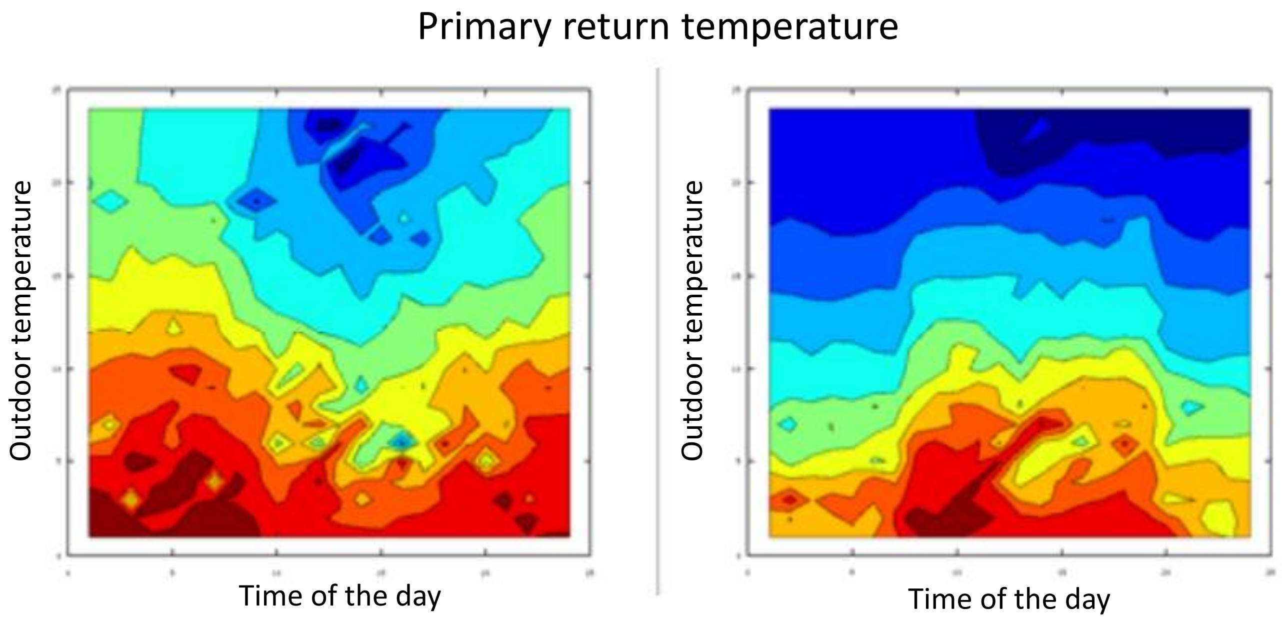
Project status
Technology

1. Fault detection platform
   - V1: Algorithms developed for pre-processing, peer-grouping and fault detection.
   - 'Static' fault detection (i.e. ranking) based on different performance indicators (e.g. overflow, volume per energy…)
   - V2: 'dynamic'



Project status
Technology

2. Visualisation
   - V1: Visualisation tools for experts, mainly showing the results of the fault detection algorithms

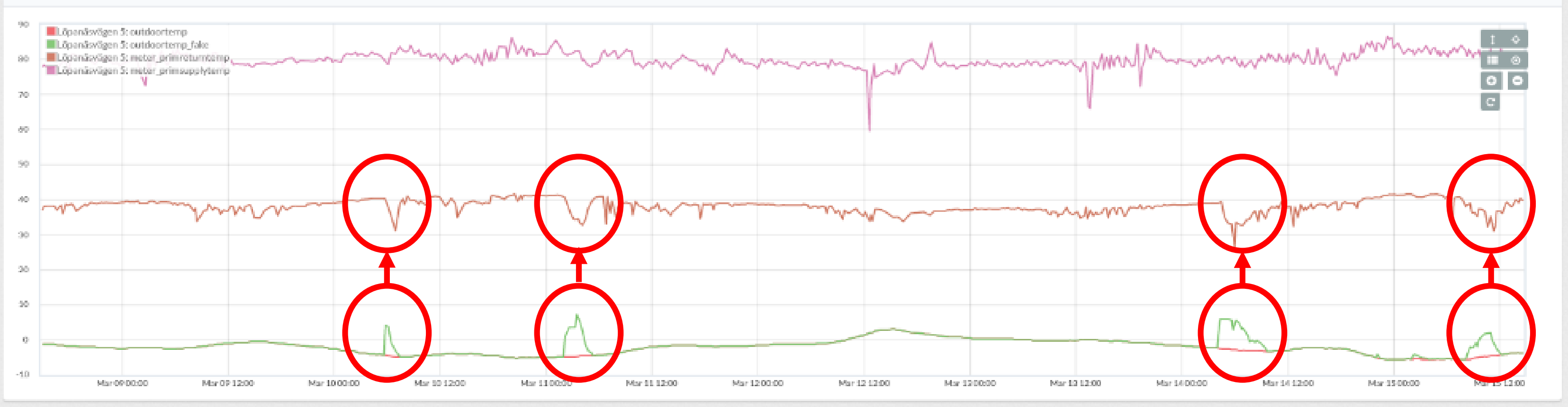


Project status
Technology

TEMPO

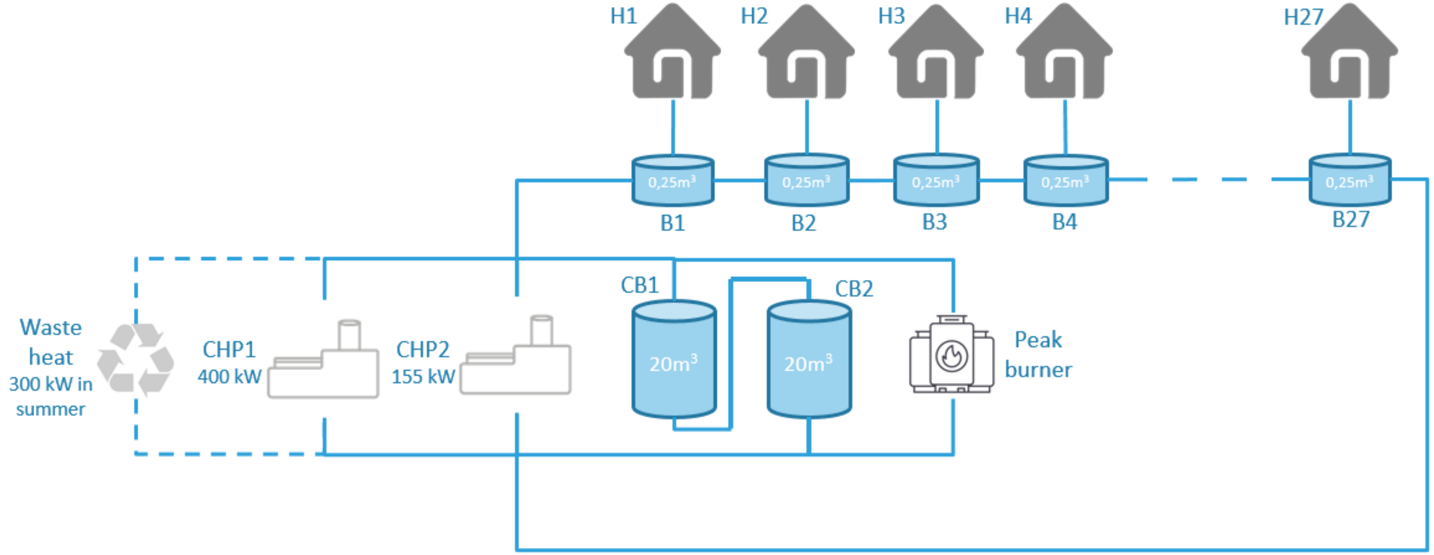
3. Smart control

- V1: Algorithms developed for:
  - Return temperature minimization
    - By sending control signals to the building, 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 return temperature to the heat production source.



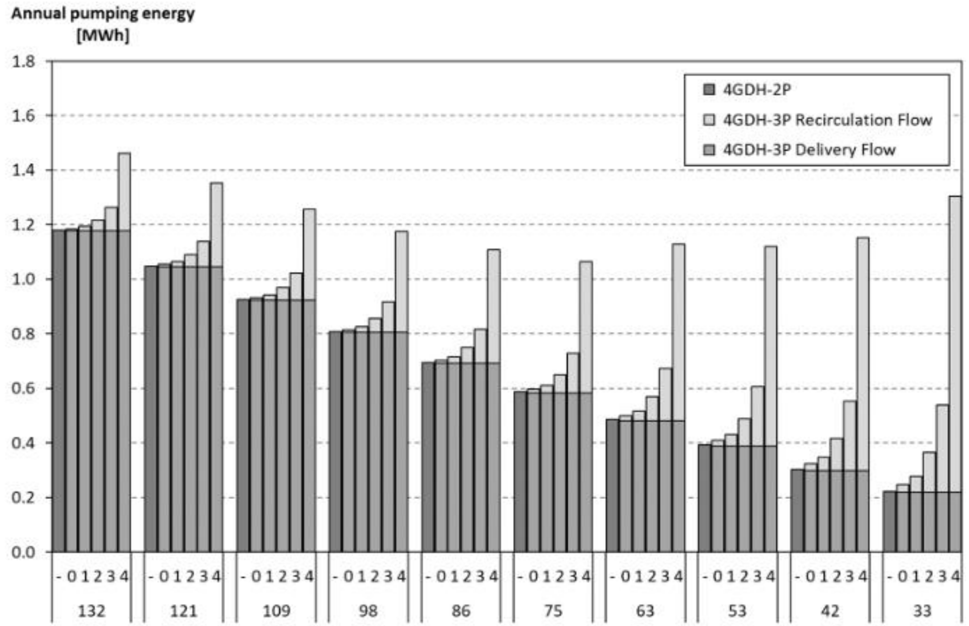
Project status
Technology

3. Smart control
   - V1: Algorithms developed for:
     - Coordinated buffer charging
       - Peak shaving and CHP optimization by controlled charging of the central and decentralized buffers



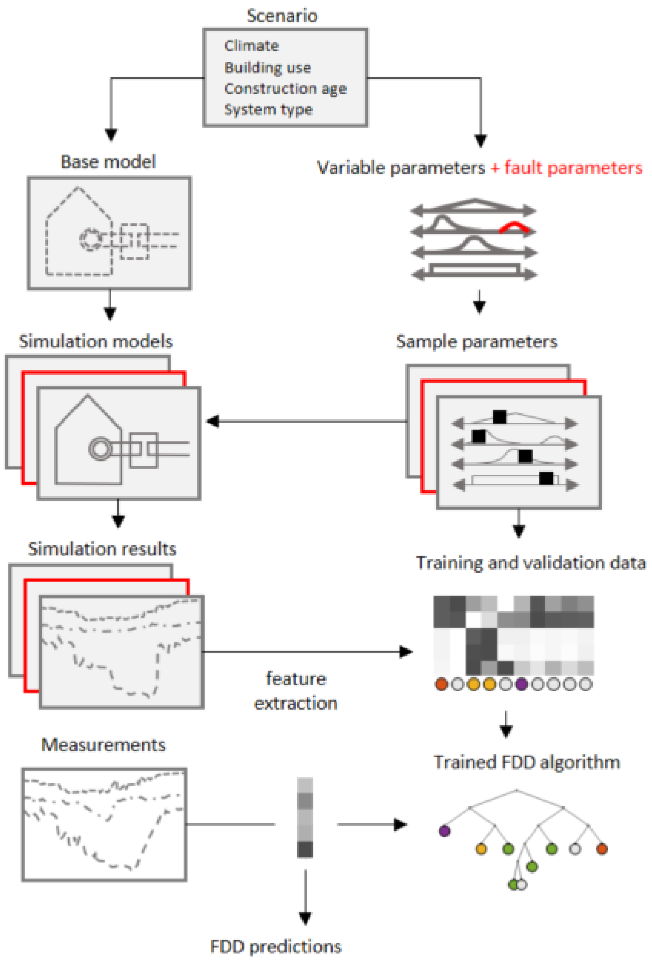
Project status
Technology

4. Innovative piping
   - 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.



Project status
Technology

5. Building installation optimization
   - Proof-of-concept simulation case study: Single-family houses, Northern Germany, 1980
   - 1000 simulations
     - Varying 30+ parameters
     - 4 faults (10% each) + 60% fault-free
   - Classification algorithms
     - Tested classification trees
     - And a few others



Project status

Technology

Classification accuracy

5. Building installation optimization

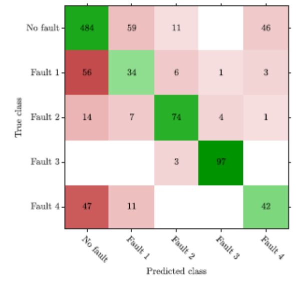
- Case A
  - Primary temperatures and flow rate, outdoor temperature
- Case B
  - As Case A, plus temperatures on the secondary side
- Case C
  - As case B, plus flow rates on the secondary side

➢ Significantly higher accuracy with temperature measurements on secondary side

➢ Expensive flow rate measurements on secondary side dispensable

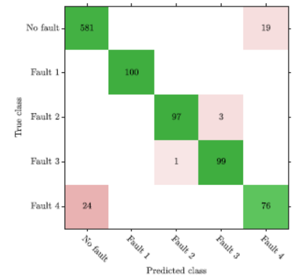
- Practical guide for technical audit of building installation

78%



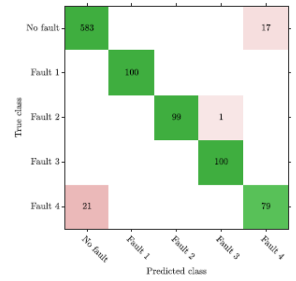
(a) Case A.

96%



(b) Case B.

96%

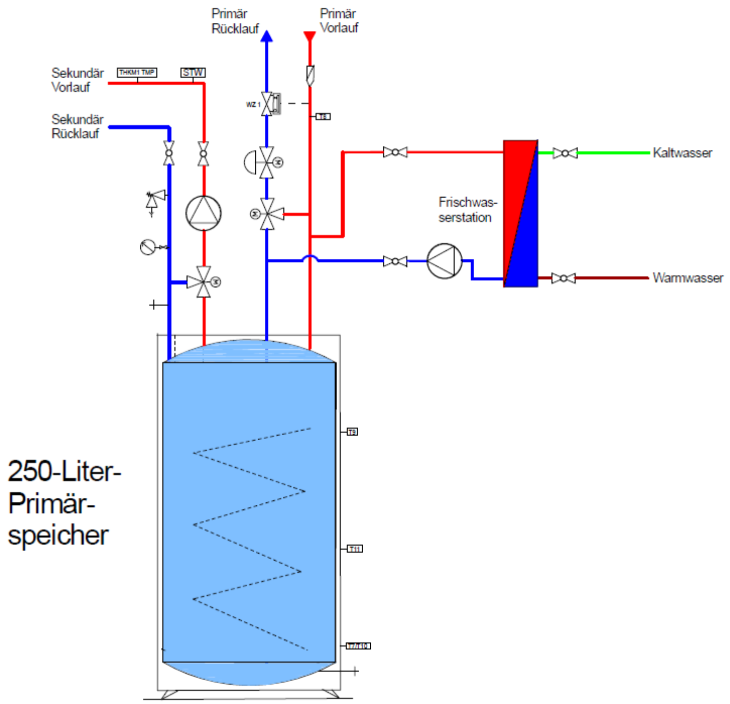


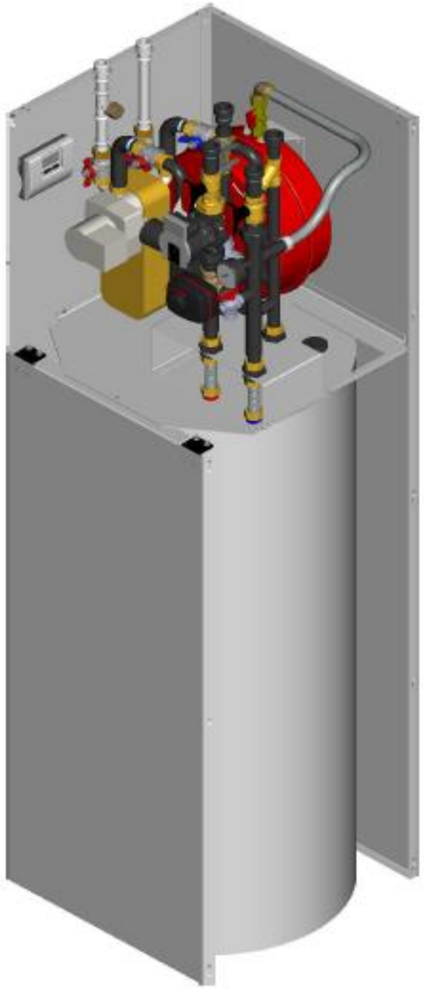
(c) Case C.

Project status
Technology

6. Decentralised buffers

- New design for lower network temperature levels





Project status

Demonstration site Windsbach, Germany

Project status
Demonstration site Windsbach, Germany

Phase 1:

- 58 building sites
  - 31 house connections are planned before the end of 2019
  - 11 houses will not be connected to the DH
  - 15 houses are vacant
  - 1 multi-family house is planned until 2020
- So far 28 buffers delivered:
  - 23 buildings 250 l buffer
  - 4 buildings 600 l buffer
  - 1 building 1000 l buffer

Phase 2:

- Installation of district heating pipes spring 2019

Project status

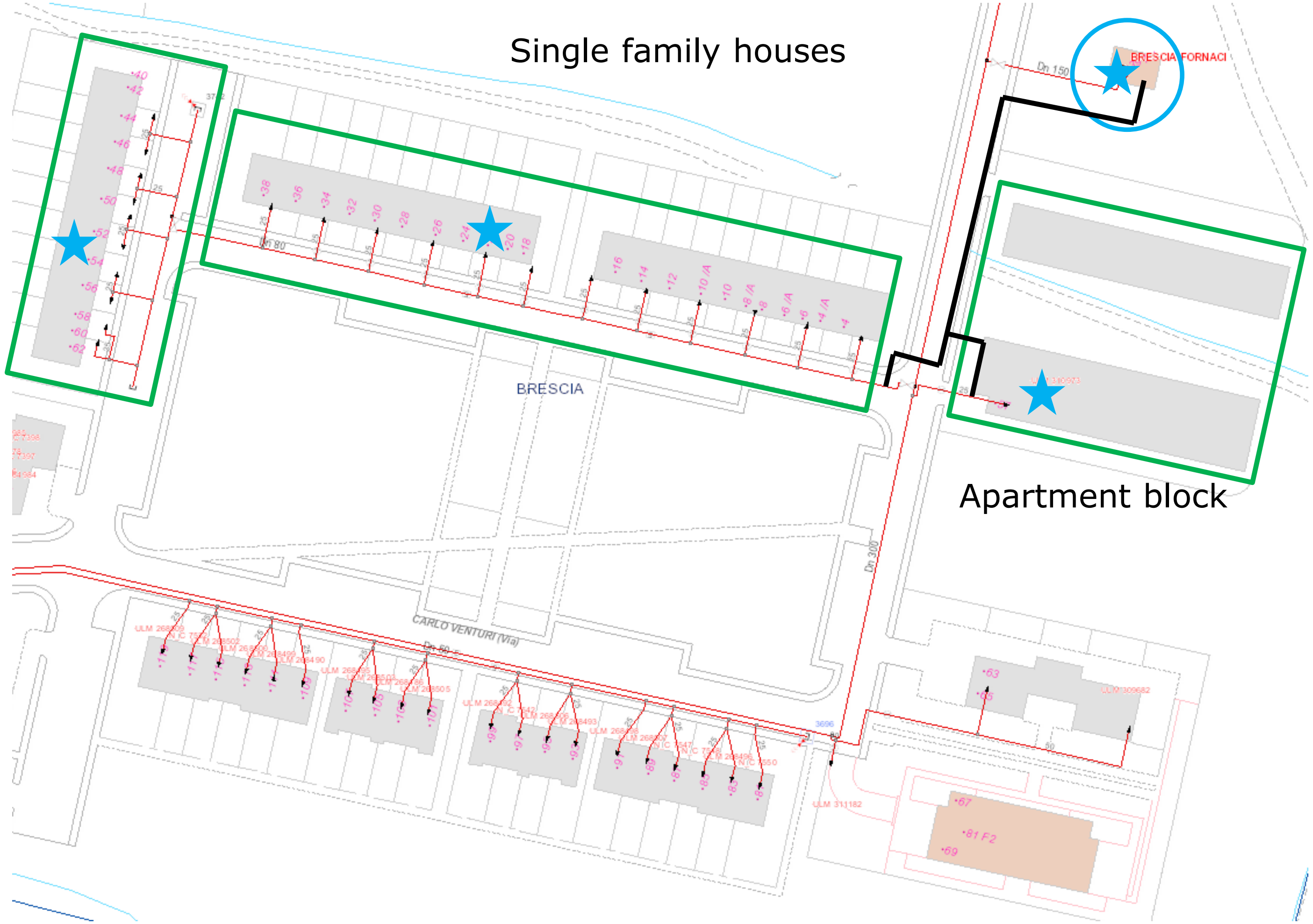
Demonstration site Brescia, Italy

New pipes

Existing pipes

Consumer involved

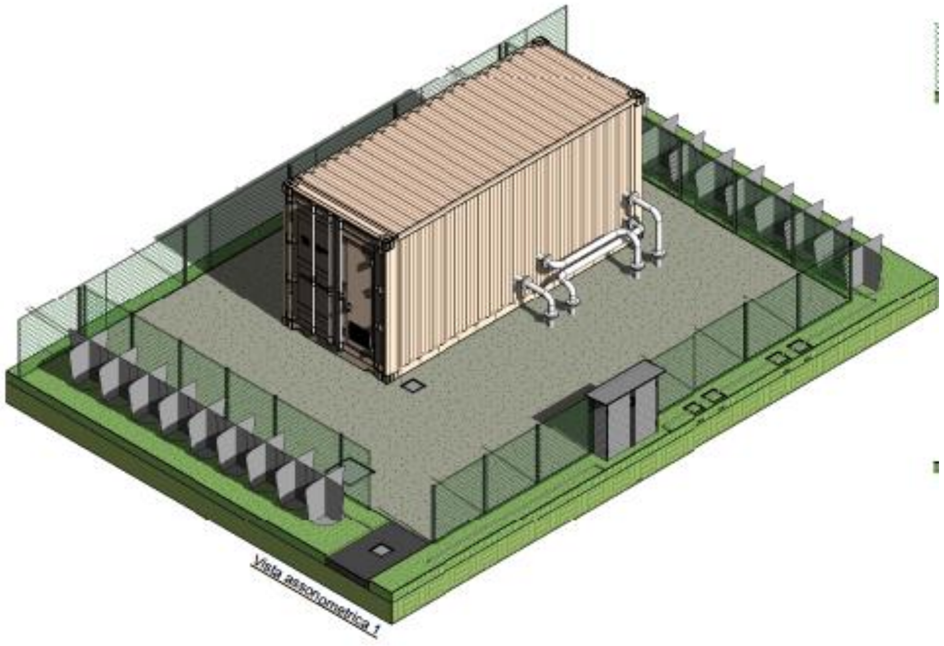
TEMPO innovation tools



Project status

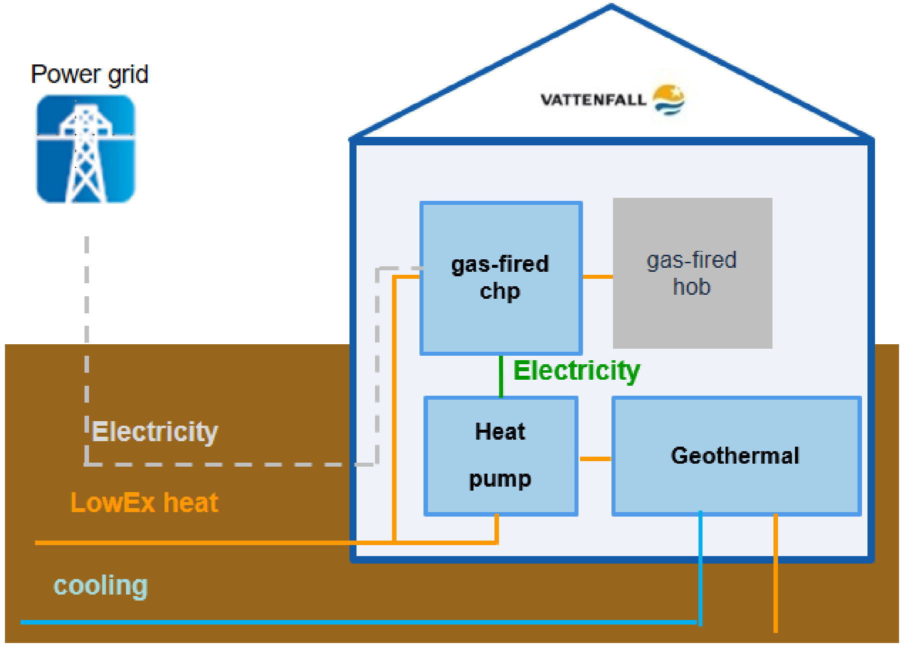
Demonstration site Brescia, Italy

- Mixing station installed and prepared for startup, beginning of November 2019.



Project status

Demonstration site 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
- TEMPO innovations:
  - Supervision ICT platform
  - Visualisation tools
  - Smart DHC controller
  - Innovative pipe system
  - Optimisation of building installation

Unfortunately, this demonstration site will not be implemented due to contractual problems

Business modelling work

See presentation of Janka Vanschoenwinkel, in session B3, tomorrow 10:20h – 12:00h in Hall B.

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TEMPO

Questions?

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