

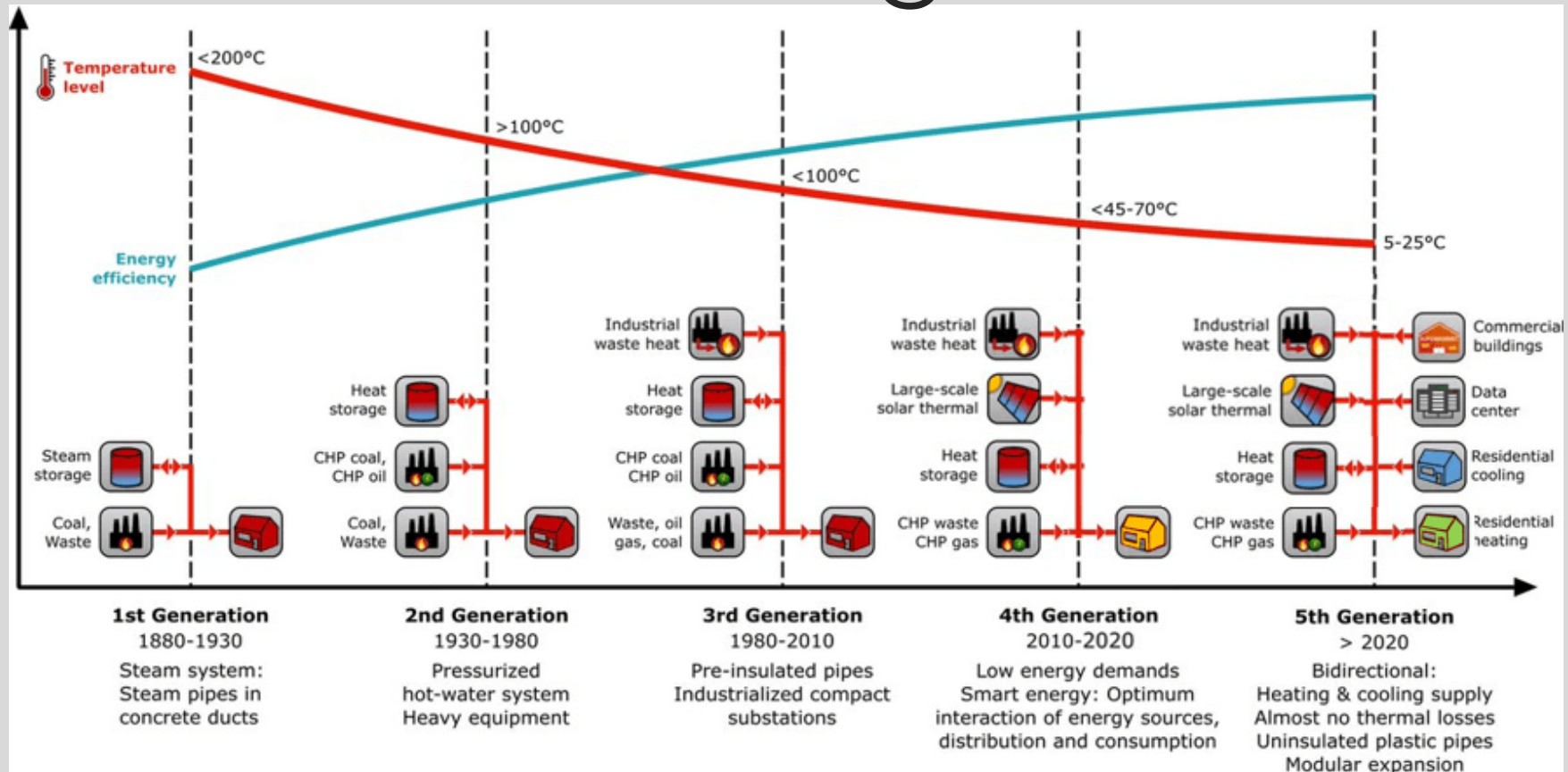
ON THE DESIGN OF 5GDHC CONTROL SYSTEMS

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Overview

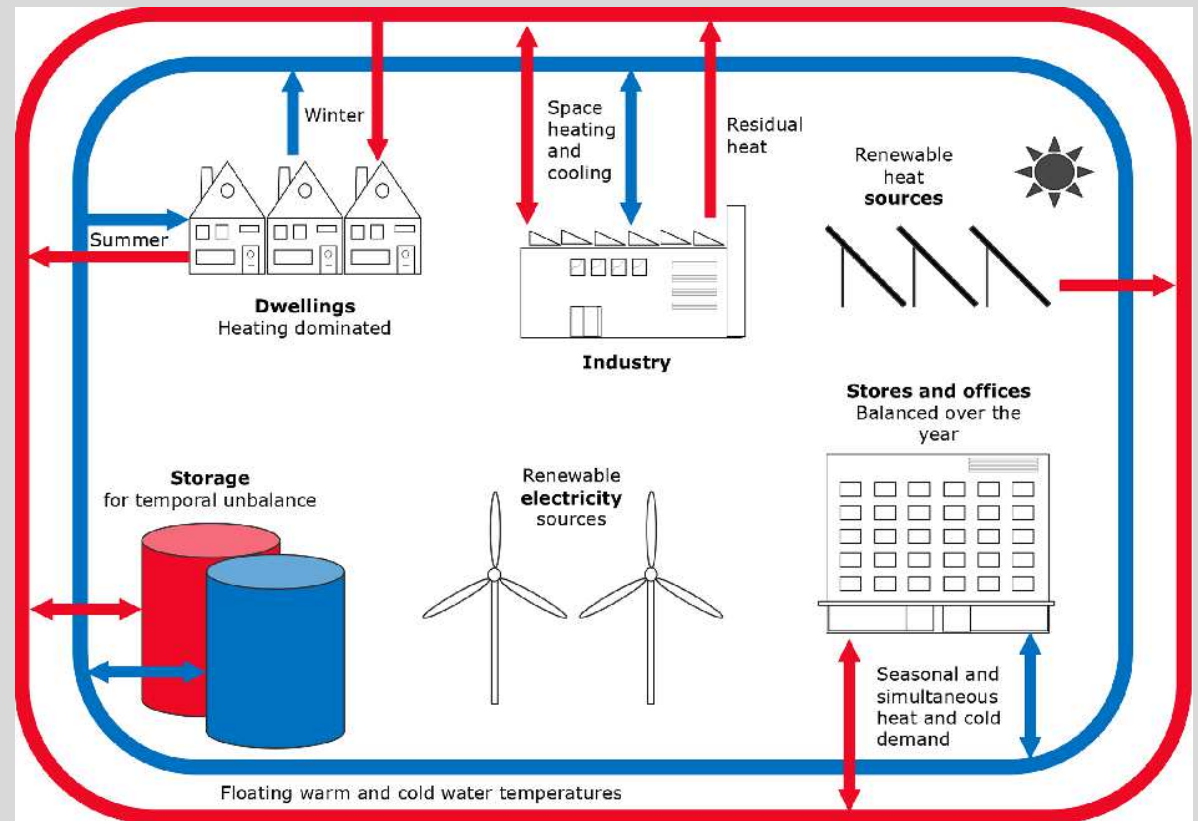
- What is 5GDHC?
- Stepwise approach to control 5GDHC
- Case study
- Future work

District heating Evolution

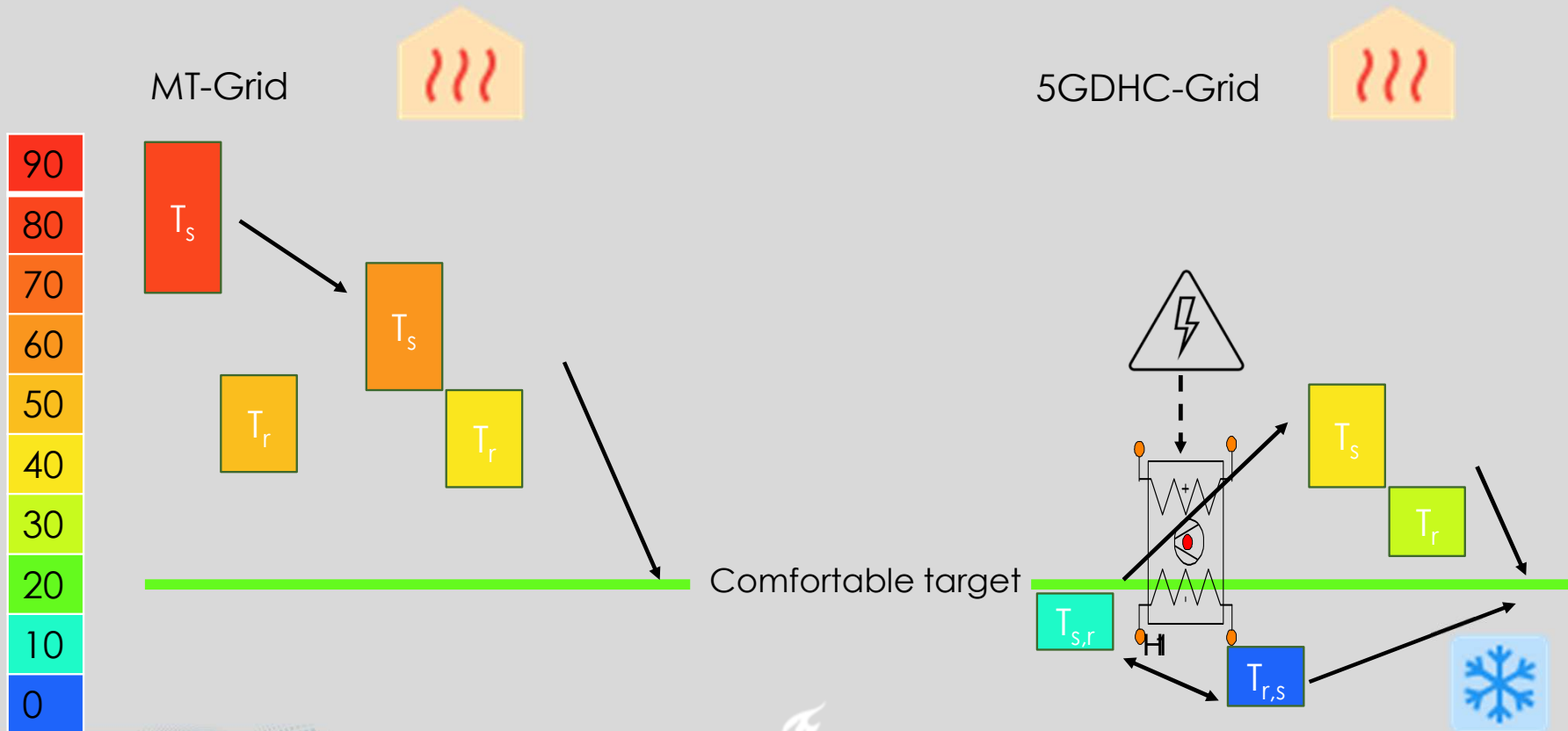


What is 5GDHC?

- Distributed sources at ultra-low temperatures (PVT, surface water, datacentre)
- Seasonal warm and cold storage
- Buildings use heat pumps
- Simultaneous supply of heating and cooling.
- Bidirectional flows
- Small temperature differences of 5 to 10 C in warm and cold lines
- Strict requirements on return temperature



Complexity MT vs 5GDHC grids



Robust approach to control 5GDHC

1. Hydraulics. The hydraulic design must be completed, including design of expansion vessels and a pressure transient analysis for emergency scenarios.
2. Active components. Identification of all active components that enable the control of the substation.
3. States. Define the possible substation “states”, which are characterized by a unique combination of active component settings: discrete setting (ON/OFF) or a setting to control a certain continuous variable (a temperature difference/pressure).
4. Control transitions. Define all feasible transitions between the possible states, which is conveniently summarised in a state-transition diagram or table.
5. Verification stability. The stability within each state should be verified using control theory or simulation studies.
6. Verification transitions. The most critical state transitions should be verified.

Comparison of 5GDHC technology with

conventional heating systems:

traditional high-temperature DH:

Decarbonisation target can be achieved by utilities or municipalities by developing this kind of infrastructure.

Bi-directionality

New energy concept at a district level permit to achieve high primary energy savings target by means of a light renovation of buildings.

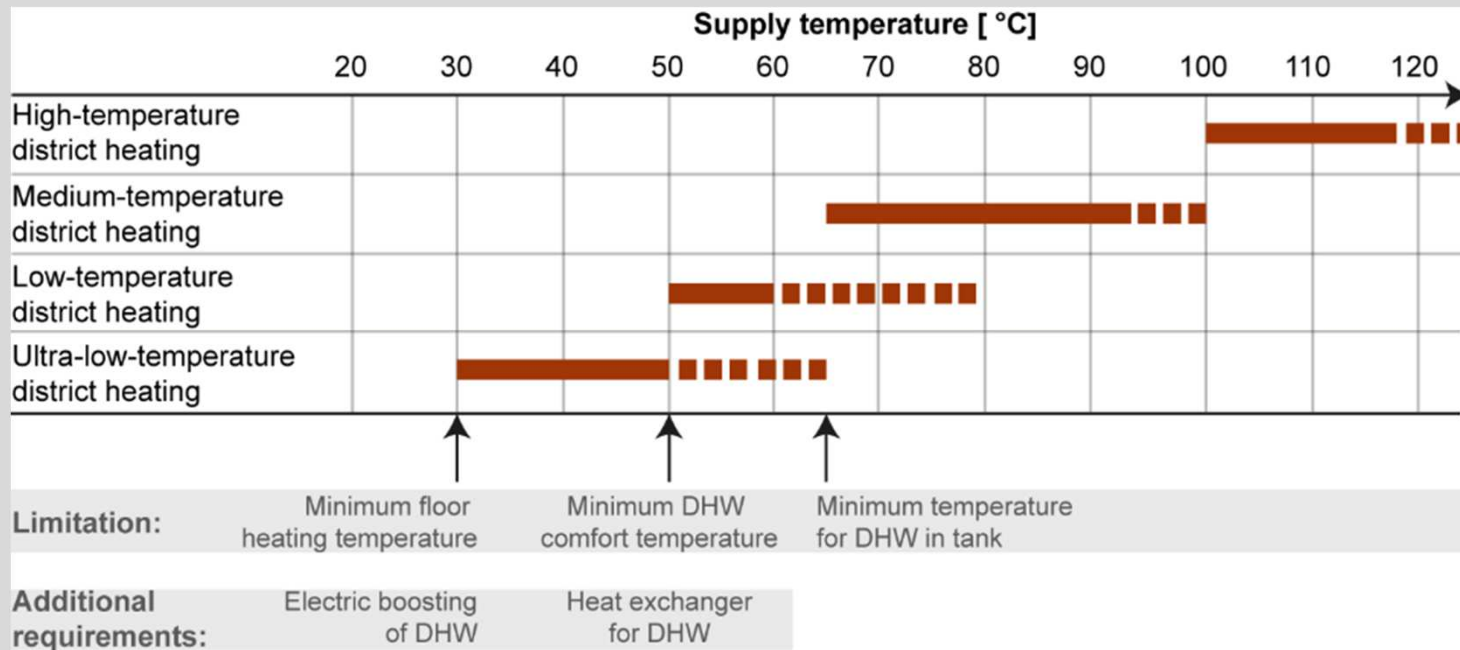
Negligible thermal losses

Higher interaction with the electric sector (possible usage of HPs for Demand Side Management)

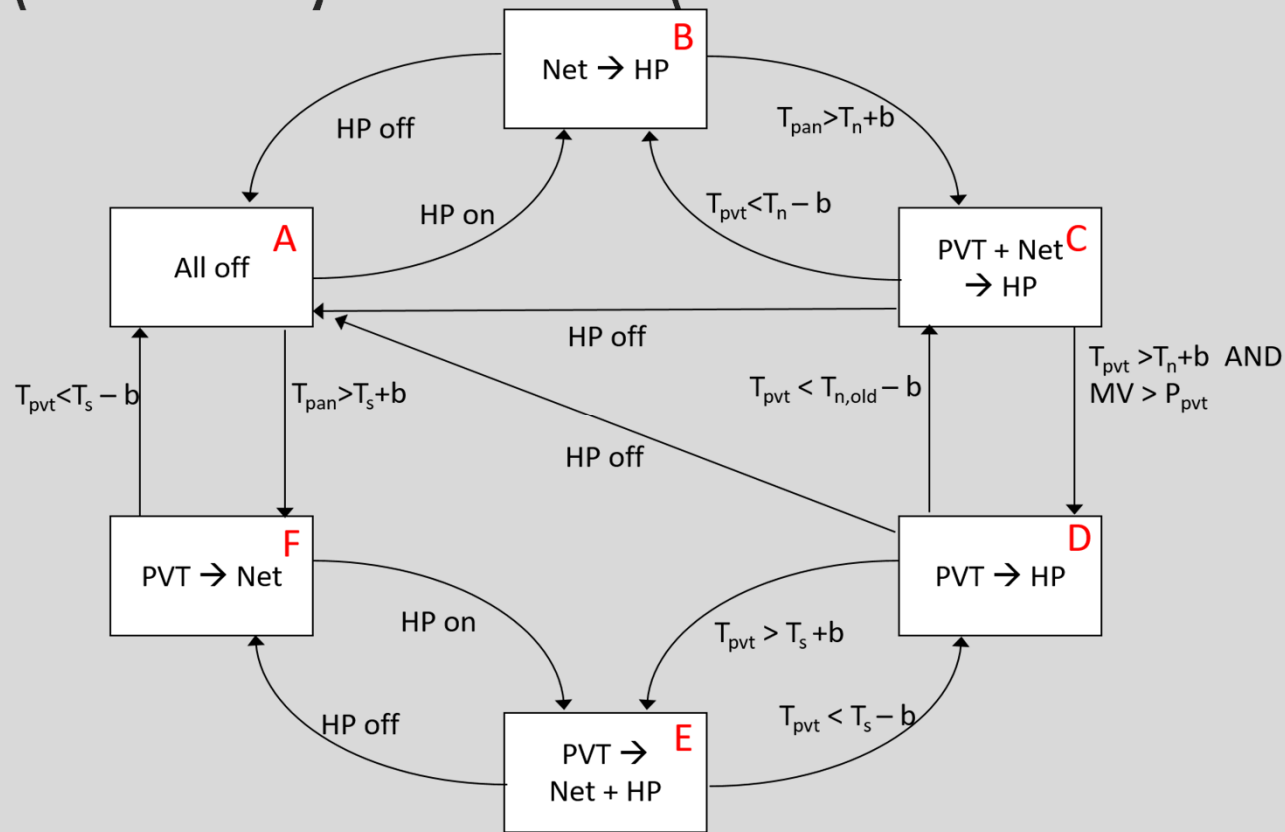
The ground and the network can be used as thermal storage.

Allow recovering low-temperature excess heat and include low enthalpy RES.

Definition of four different types of district heating where temperatures are limited by the technical requirements of the buildings



Step 3 (States) and 4 (Control transitions)



State-transition diagram of the novel PVT-based 5GDHC substation

Step 6 (Verification transitions)

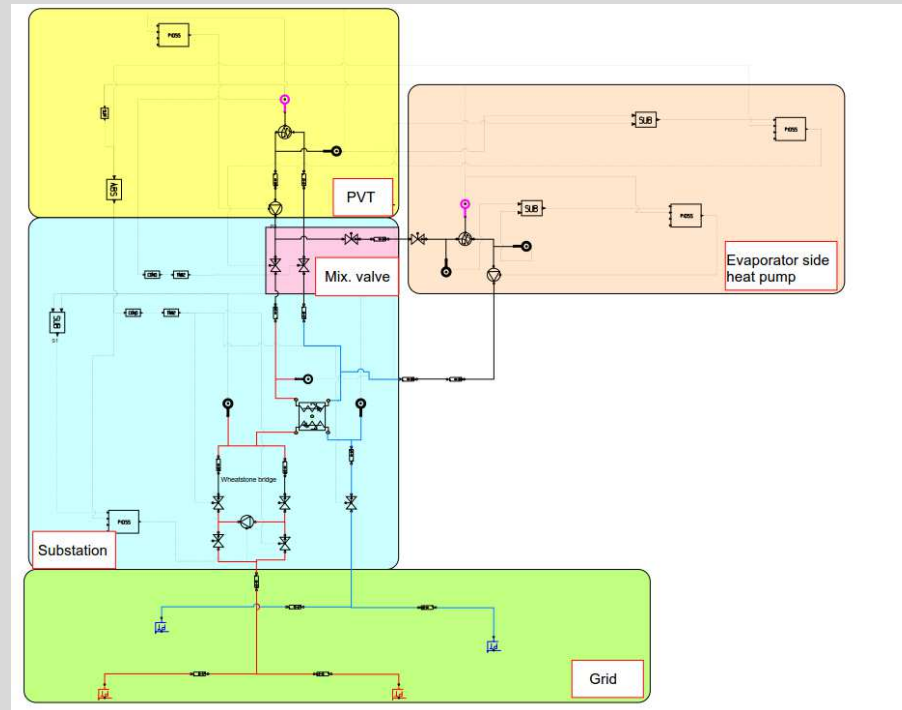
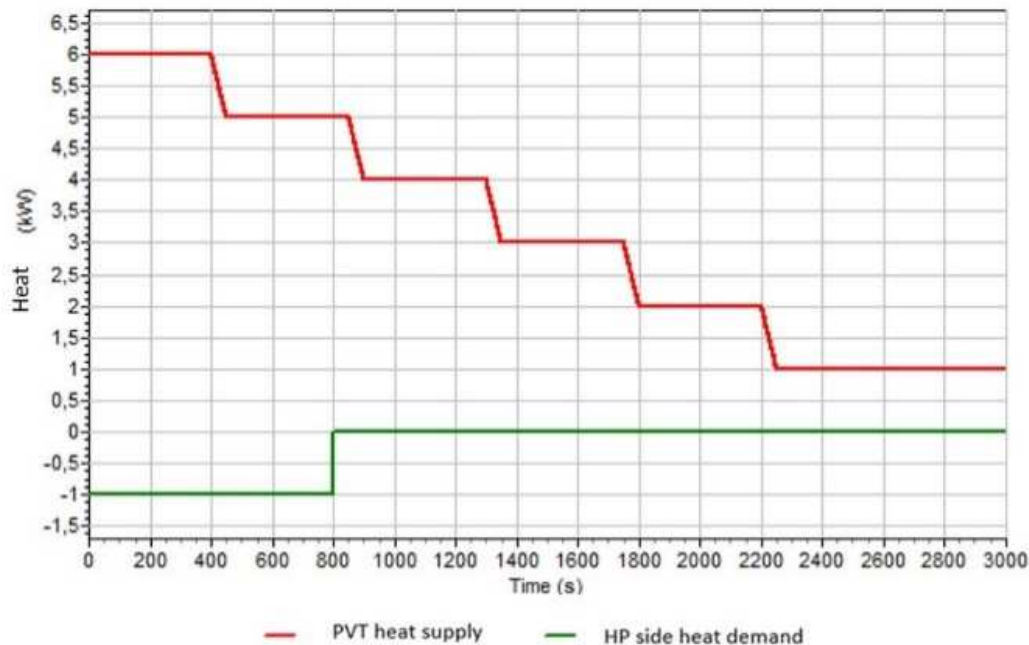


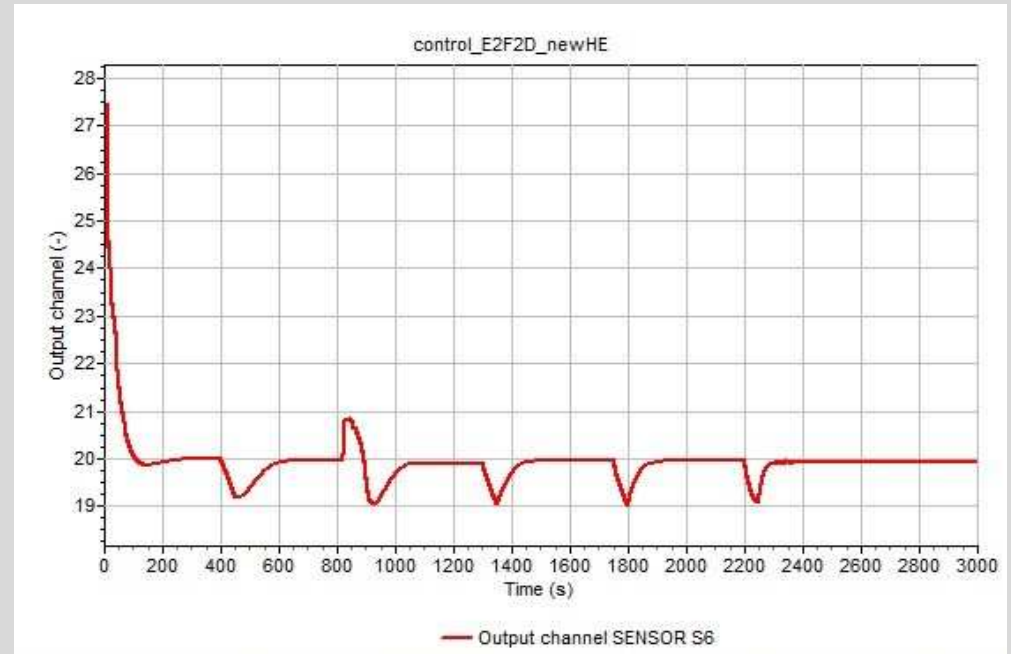
Fig. 3: Substation hydraulic and control model (Wanda)

Step 6 (Verification transitions)

- TRANSITIONS WITH HEAT PRODUCTION EXCESS (E → F)



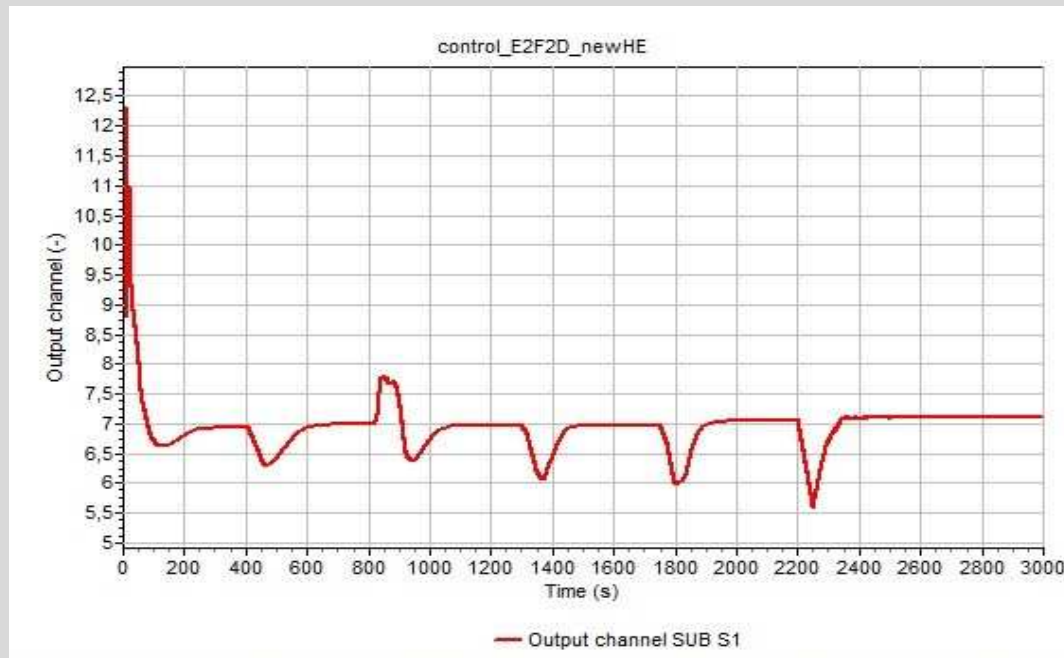
Heat pump shuts off (800 s) while PVT production reduces



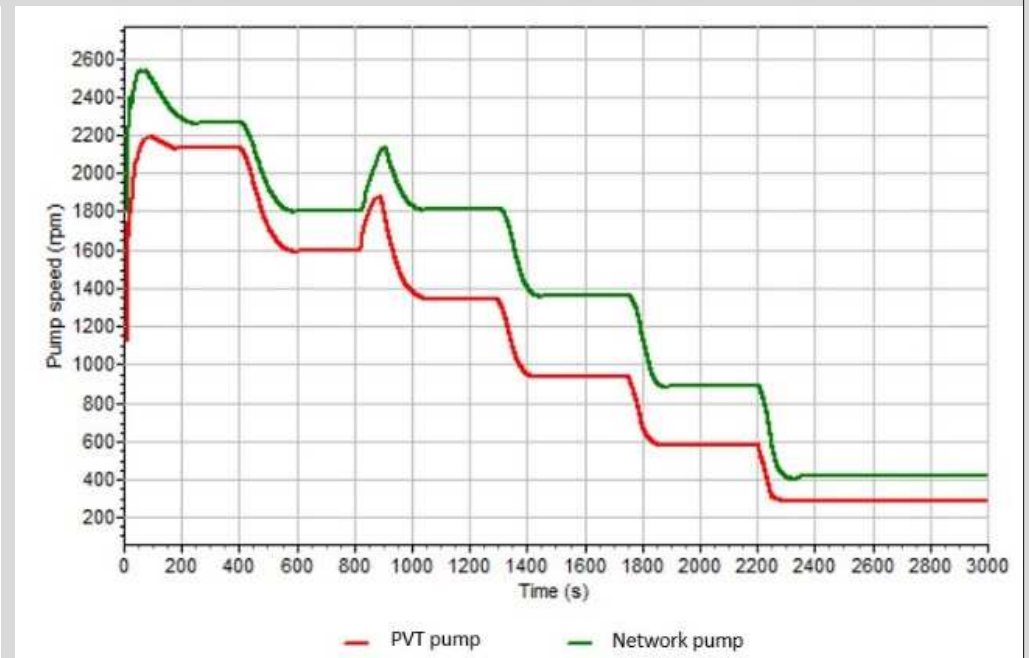
PVT production temperature during transition

Step 6 (Verification transitions)

- TRANSITIONS WITH HEAT PRODUCTION EXCESS (E → F)

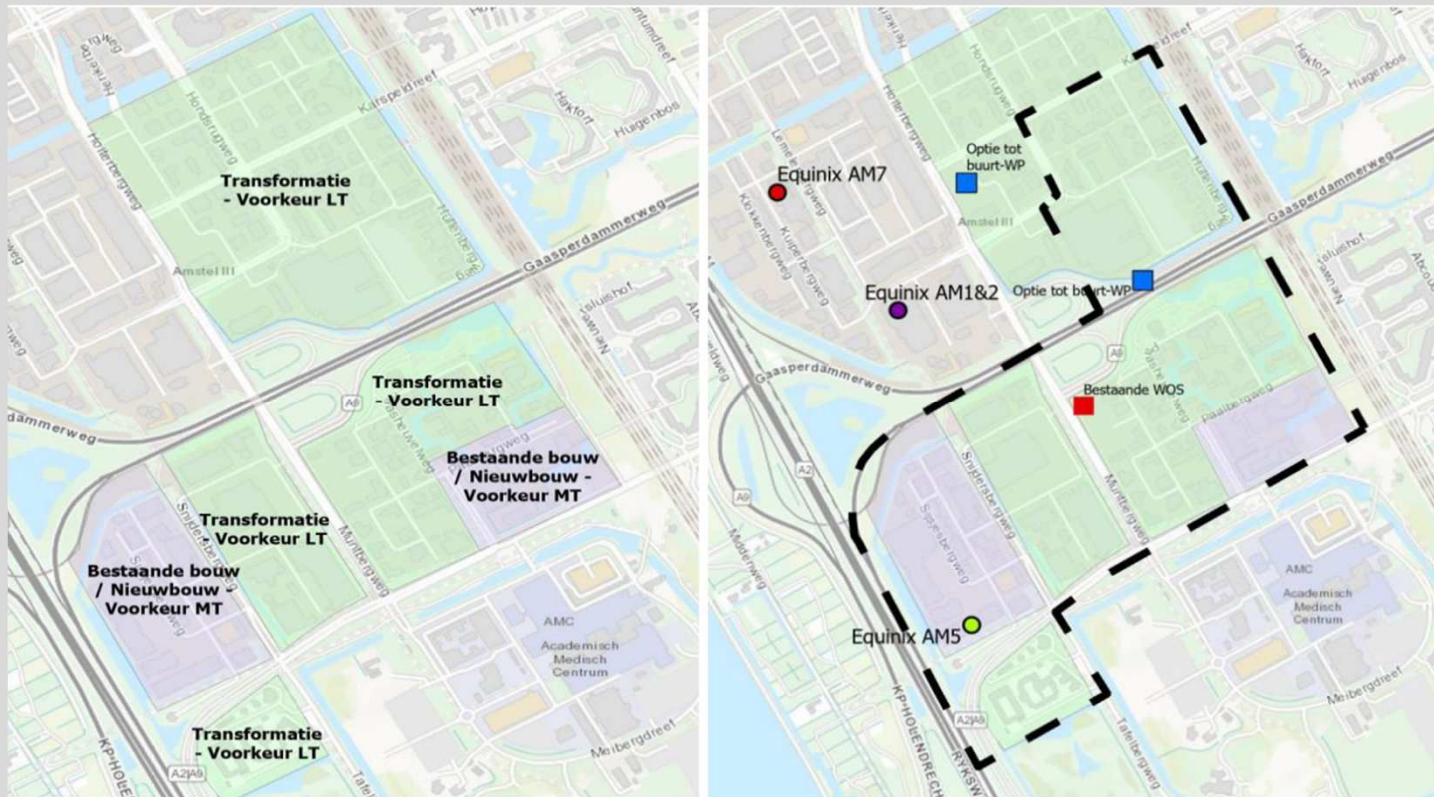


Temperature difference at the two network sides.
Setpoint adjusted at $\Delta T = 7\text{ }^{\circ}\text{C}$



Pump rotational speeds

Future work



Preferred systems per area & location of data centers (Overview maps for study heat plan, Amsterdam)

Project partners

Firan

 **TU Delft** Delft University of Technology

Deltares


AMSTERDAM INSTITUTE FOR
ADVANCED METROPOLITAN SOLUTIONS

✘ **Gemeente**
✘ **Amsterdam**
✘



Q&A



Thank you!

Contact us!

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