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From HT-DHS to MT-DHS using MPC

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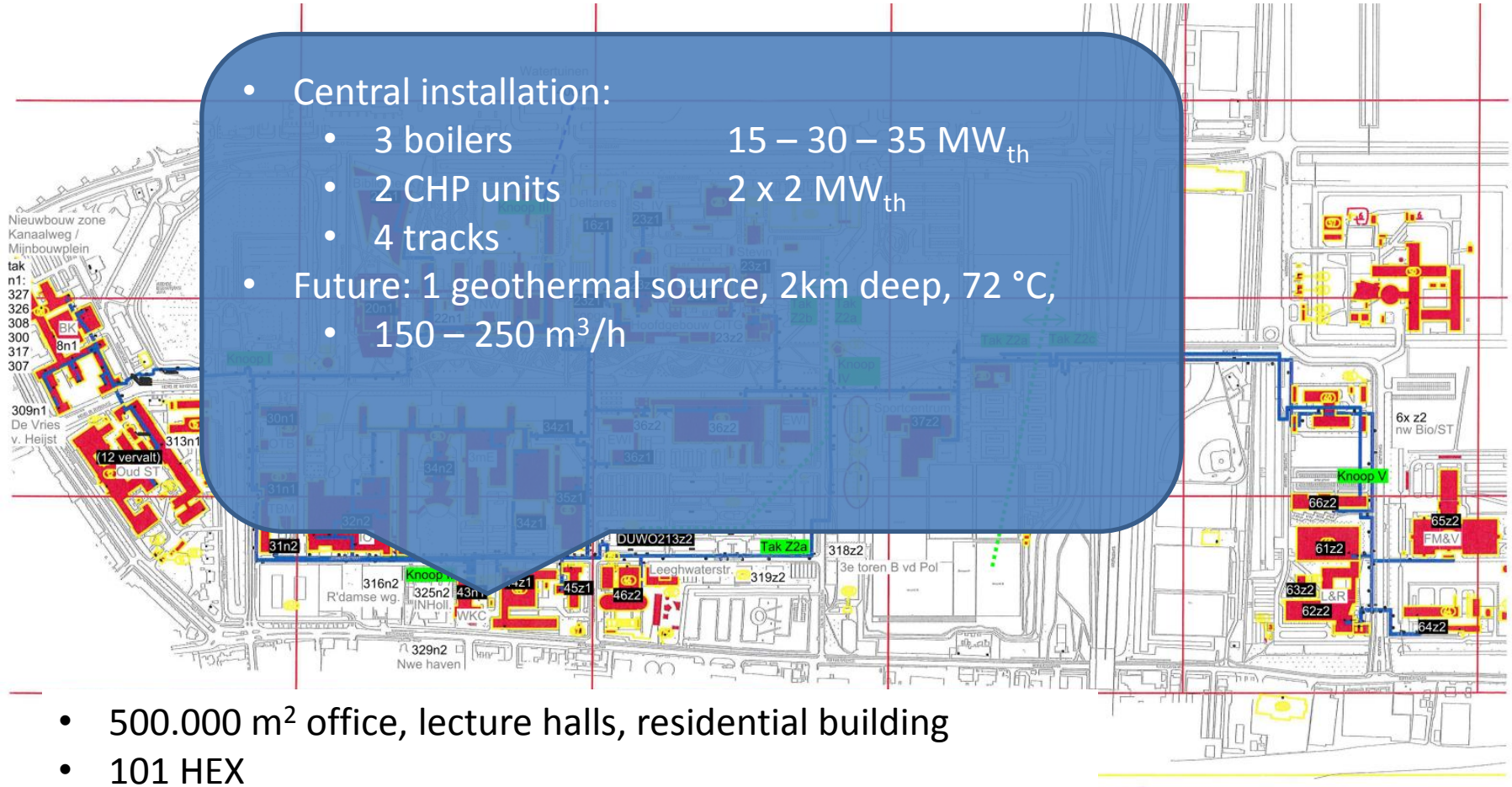
4DH
4th Generation District Heating Technologies and Systems

DHS Campus
Delft University of Technology

- Central installation:
  - 3 boilers 15 – 30 – 35 MW_{th}
  - 2 CHP units 2 x 2 MW_{th}
  - 4 tracks
- Future: 1 geothermal source, 2km deep, 72 °C,
  - 150 – 250 m^3/h



- 500.000 m^2 office, lecture halls, residential building
- 101 HEX
- Heat demand ~ 125.000 GJ

The challenge

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- **Transform conventional DHS (120 – 80°C) to novel MT DHS (dyn. °C)**
- **Consortium**
  - **Deerns – building physics, LEA**
  - **Deltares – DH-network + control**
  - **Kuijpers – installation contractor**
  - **Priva – Hardware supplier**

Kuijpers

Deerns

Deltares
Enabling Delta Life

PRIVA

Deltares

- **Independent institute for applied research in the field of water, subsurface and infrastructure**
- **Motto: Enabling Delta Life, dare-to-share**
- **800 employees, 28 nationalities**
- **110 M€**
- **Expertise in this project**
  - **Hydraulics and control DH network, WANDA**
  - **RTC-Tools**

RTC-Tools

- Toolbox for Model-predictive control
- Designed for real-time applications
  - Robust, fast algorithms
- Open software

- Application (examples)
  - BPA (USA) 22 GW Hydropower production optimisation
  - CEMIG (Br) 30 GW hydropower optimisation + flood control
  - Waterboard NL: Optimal operation WWTP Garmerwolde
  - Waterboard NL: Optimal operation polder pumping stations

WANDA

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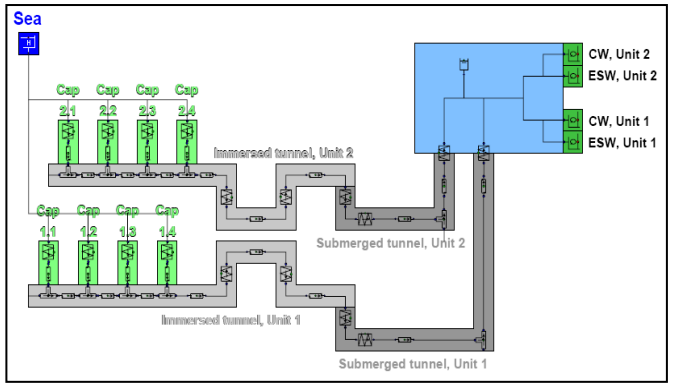
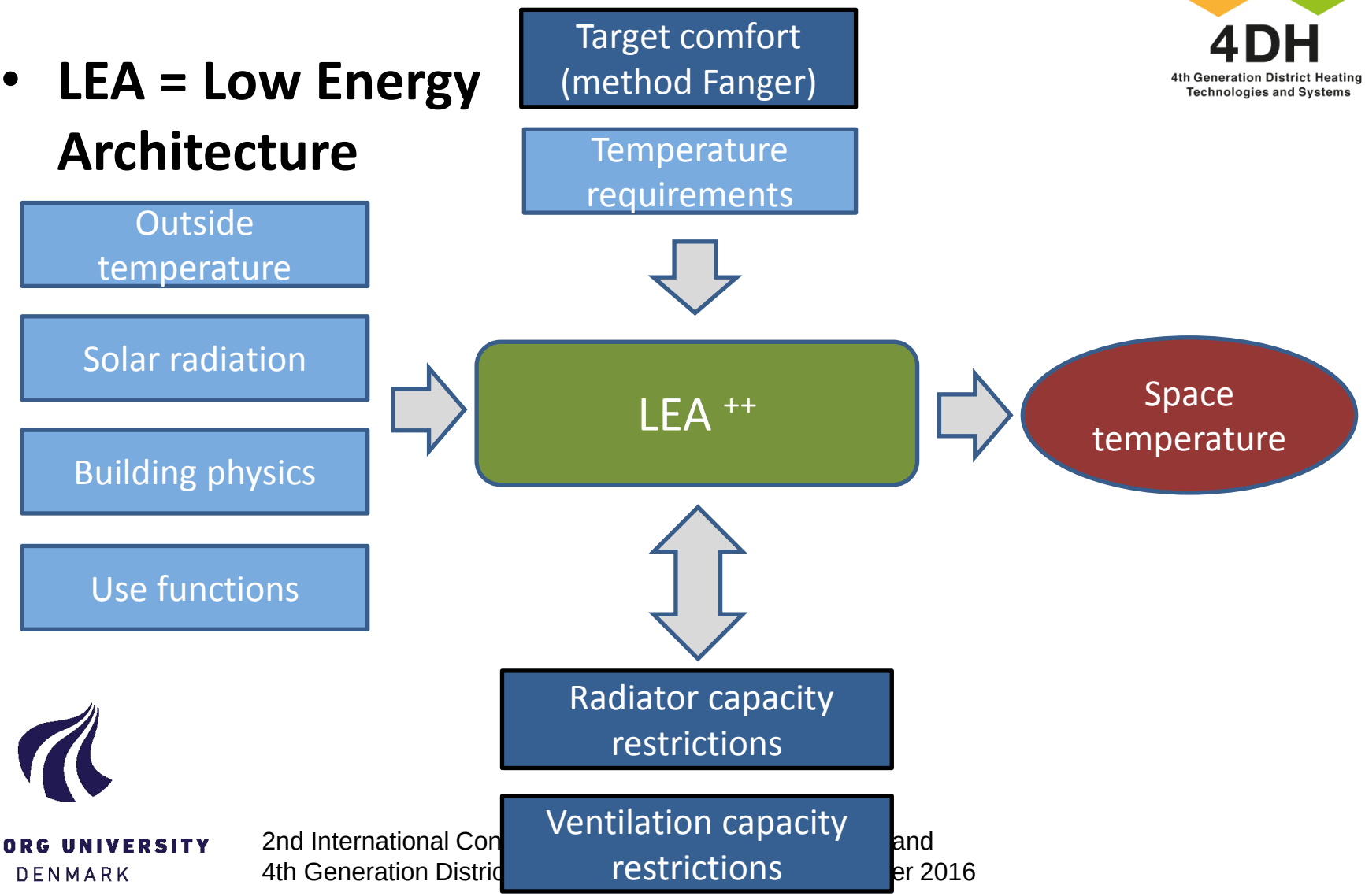
- **Validated simulation platform for pipe hydraulics and control**
- **Design, commissioning, real-time performance monitoring**
- **Used as real-time verification**

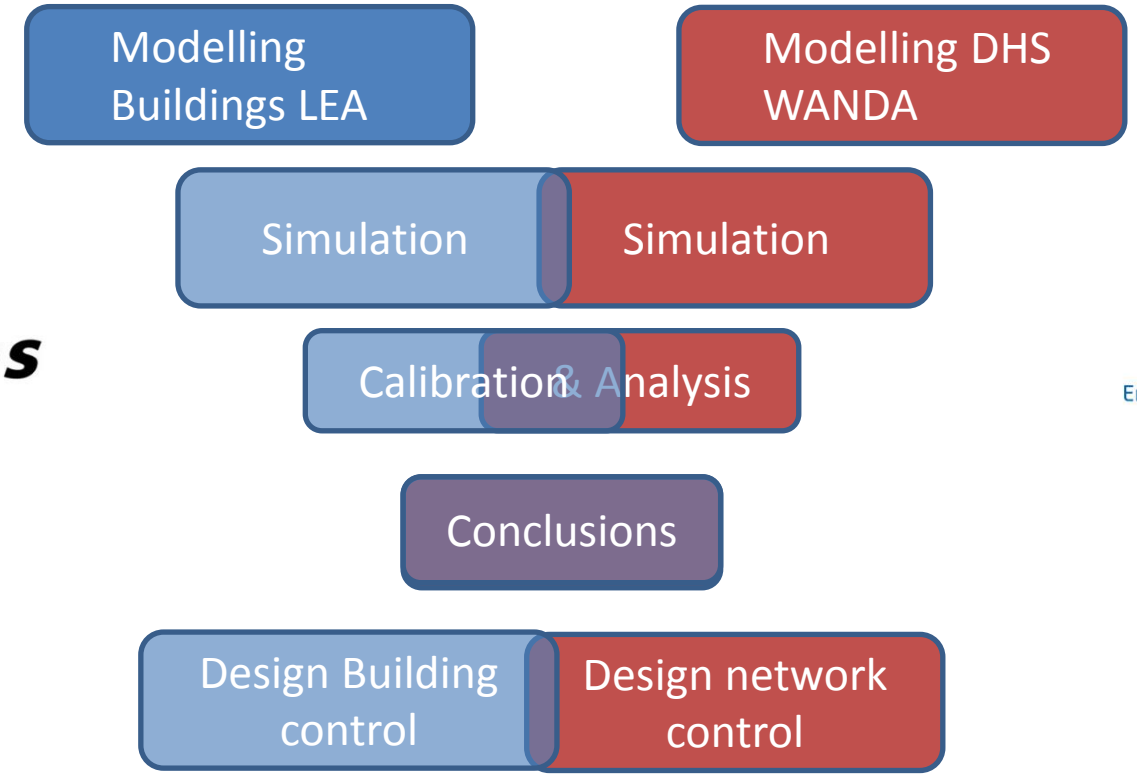


LEA

- **LEA = Low Energy Architecture**



Design approach



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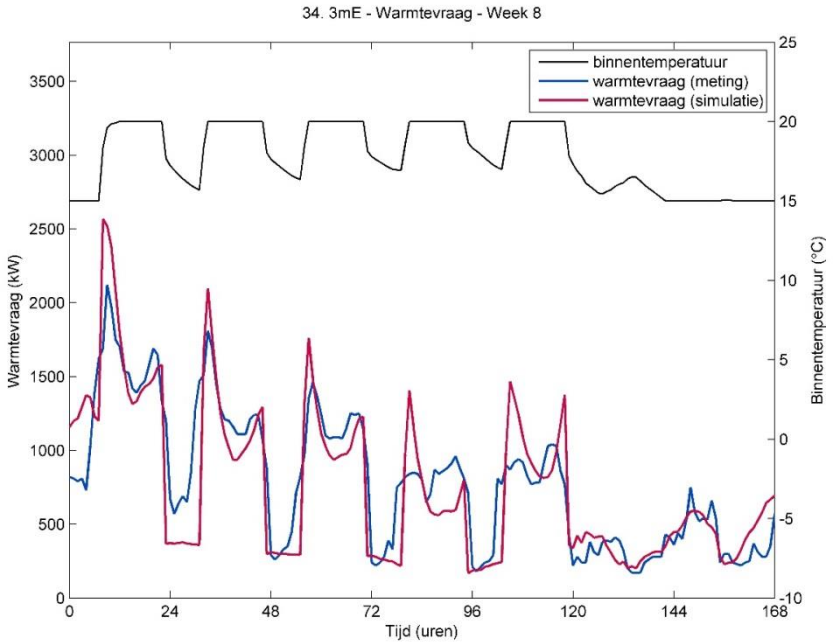
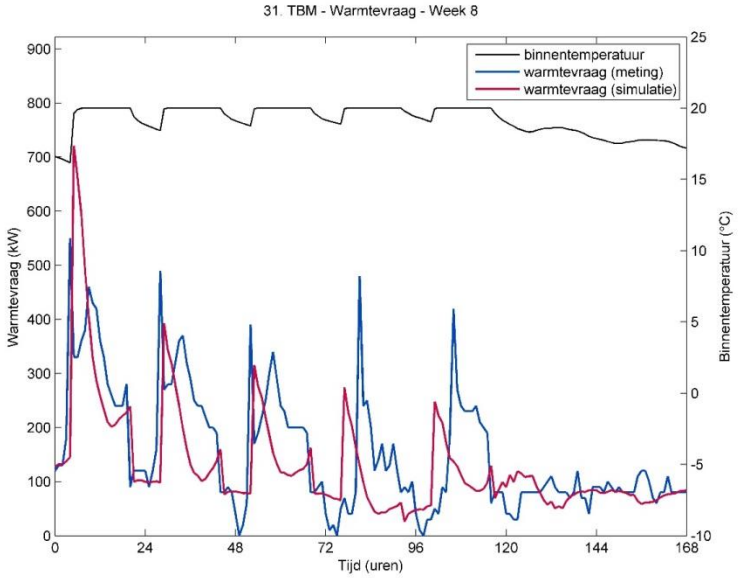
Design scenarios

1. Current situation: HT firing curve DH. Reference for comfort.
2. MT firing curve DH. No optimisation ; comfort < reference.
3. MT firing curve DH. Optimisation to meet comfort by raising temperature.
4. MT firing curve DH. Optimisation to meet comfort by extending start-up period (pre-heating) and if necessary, raising temperature.
5. LT firing curve DH. Optimisation to meet comfort by extending start-up period (pre-heating) and raising temperature

Calibration LEA models





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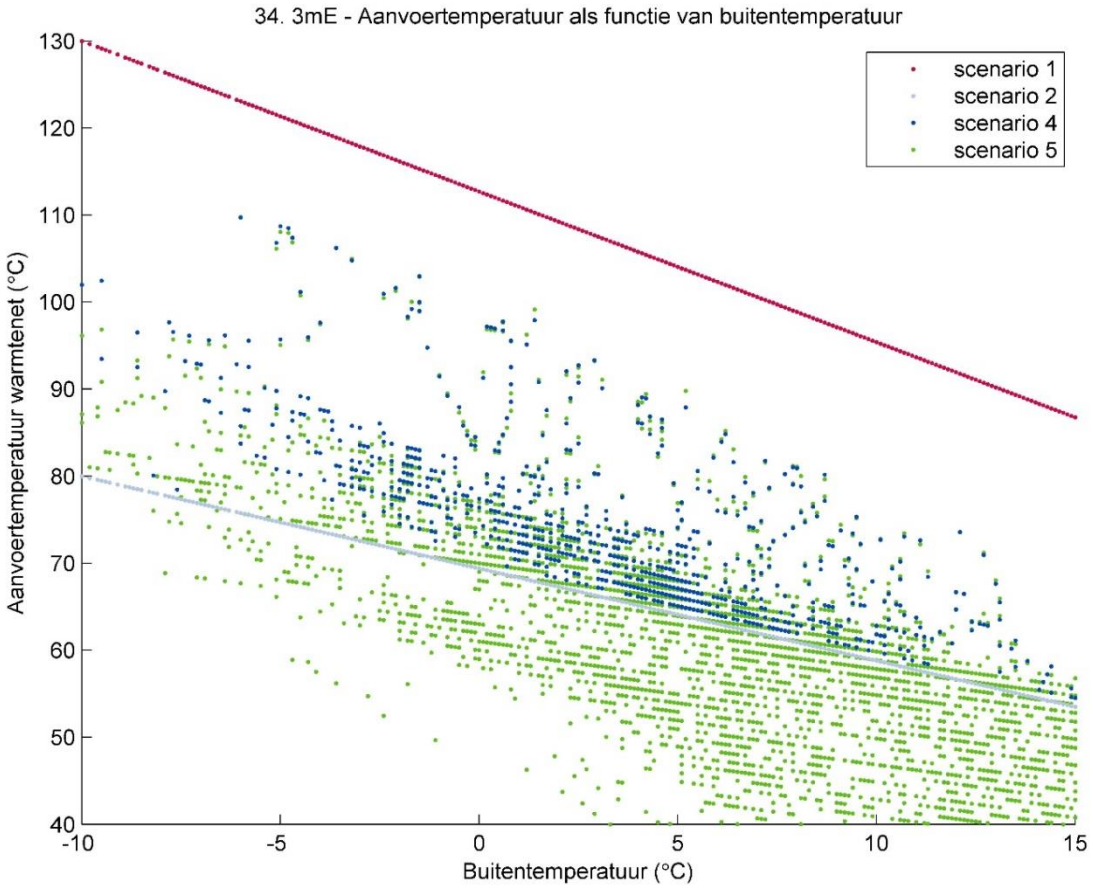
Results



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Results

Without geothermal source

Scenario	CHP1 (hr)	CHP2 (hr)	Boiler 15 MW(hr)
Current	1725	1644	1850
Scenario 4	5536	3598	1093

With geothermal source

Scenario	CHP1 (hr)	CHP2 (hr)	Geothermal 5MW (hr)	Boiler 15 MW(hr)
Scenario 4	5536	3598	n/a	1093
Scen 4 + geo	3290	2035	1185	606

Modifications

- **Central installation**
  - **Allow different temps/track**
- **DH primary network**
  - **All by-passes closed, HEX control → return temp**
- **Model-predictive controller**
  - **Installed 1 track, with 3 buildings**
  - **Sets optimised hourly supply temperatures (1 day ahead)**

In operation since April 2016

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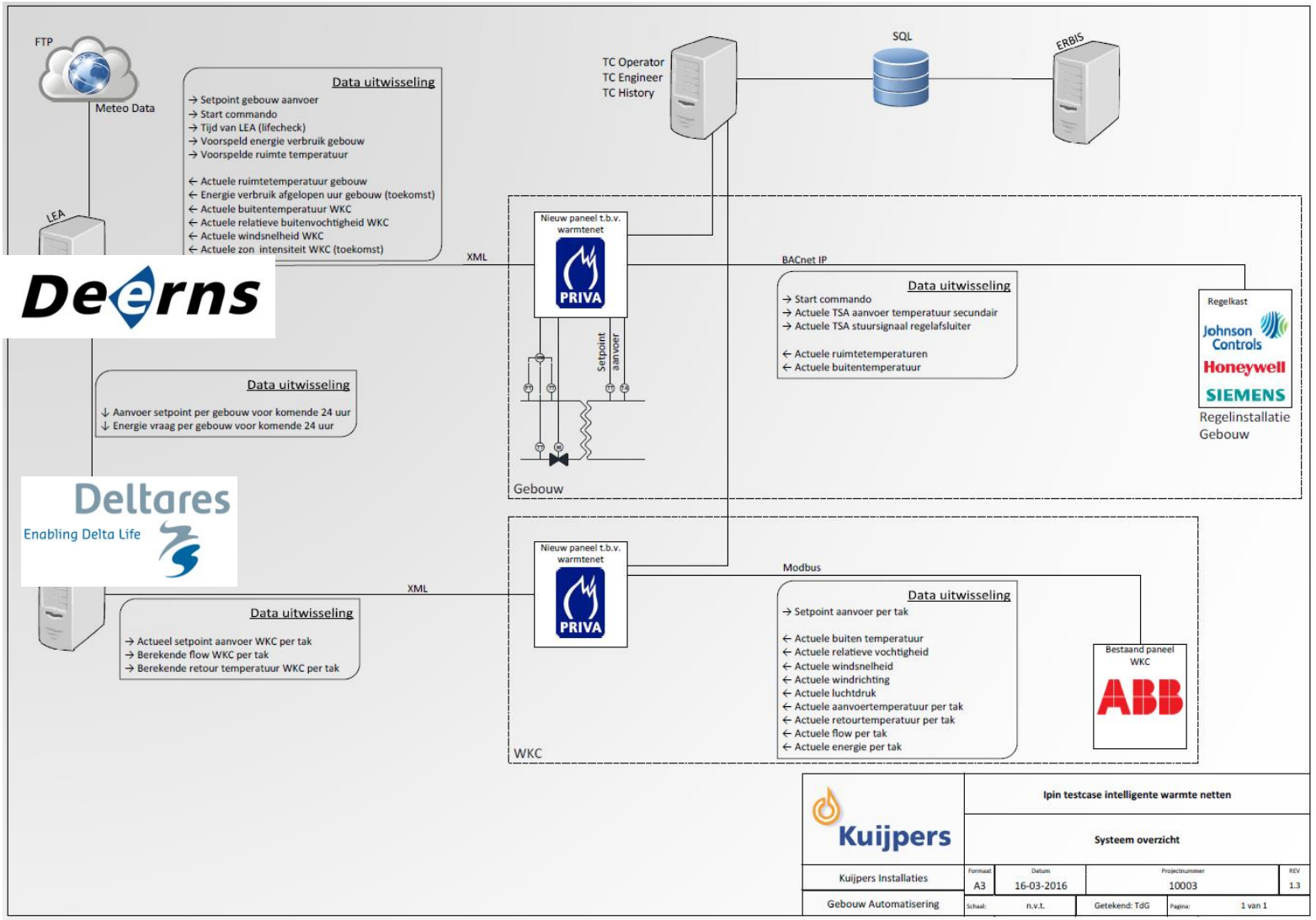

Future work

- **Drill geothermal source**
- **Expand MPC to 4 tracks**
  - **System wide peak shaving**
  - **Integrate building optimiser into MPC**