SCORES

SELF CONSUMPTION OF RENEWABLE ENERGY BY HYBRID STORAGE SYSTEMS

Training Course on Thermal Energy Storage for Heating, Cooling and DHW for Buildings

Building management system applied to the energy storage system

Hans Hennig, Siemens - NL

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Introduction

Hans Hennig

Hans Hennig

Consultant

Siemens Smart Infrastructure (NL)

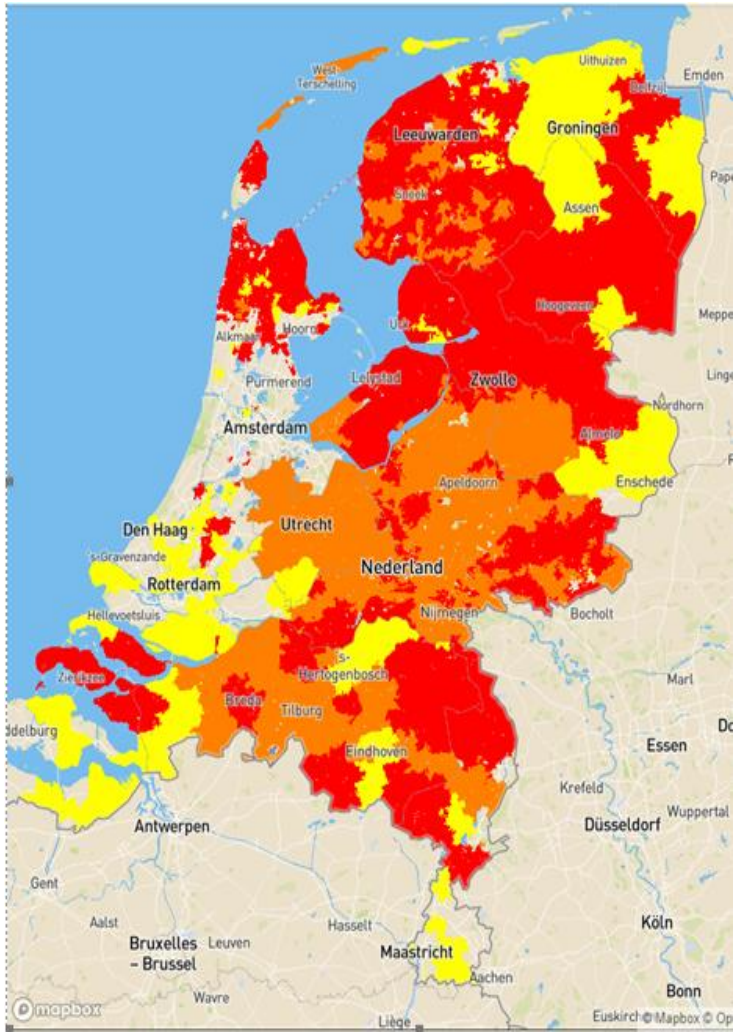
SIEMENS - Smart Infrastructure (SI)

SI is responsible for 25% of total Siemens revenue

Focus:

- Smart grids
- Grid edge
- Smart buildings
- Smart power distribution

Feed-in situation in the Netherlands

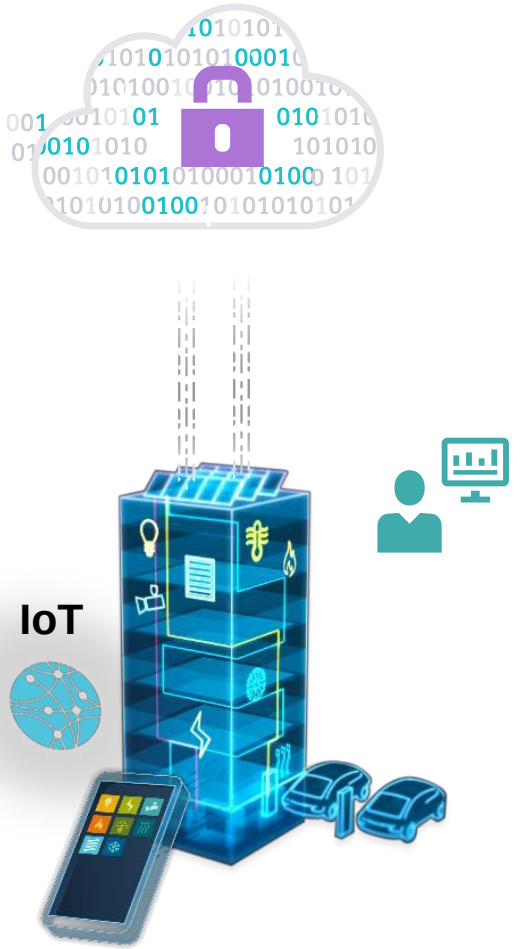


Red = No feed-in allowed
Orange = Nearly full
Yellow = Foreseen problems

Why use a BEMS?

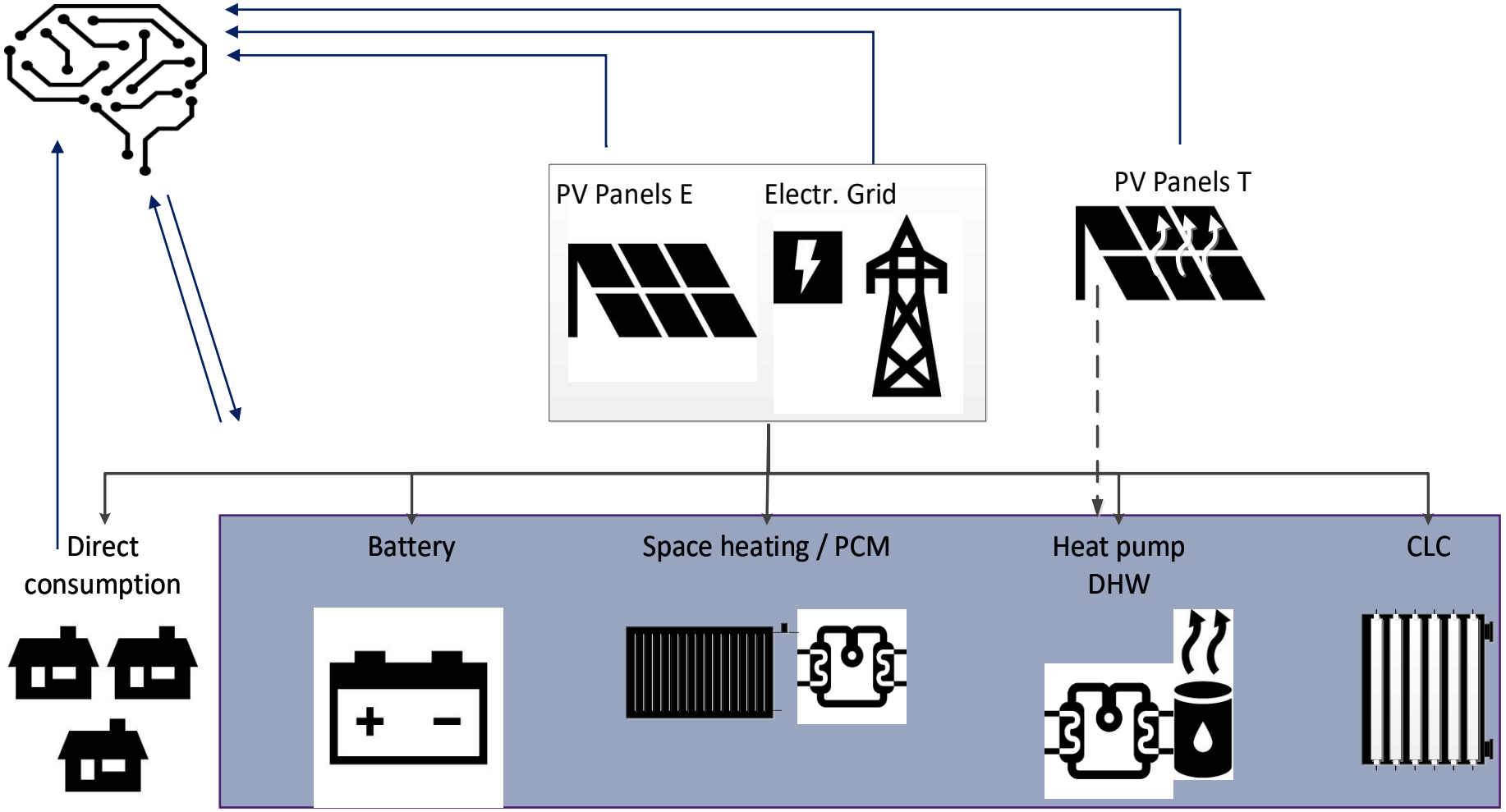
BEMS = ***B***uilding ***E***nergy ***M***anagement ***S***ystems

- Most standard building management systems rely on current measurement (outside temperature / radiation)
- Few systems look ahead (solar load estimations mostly)
- Equipment is thus started when it can/must, not when it is optimal to start it
- There is little storage capacity in modem building (mostly thermal)
- A BEMS system starts the equipment at an optimal point based on available energy or energy cost



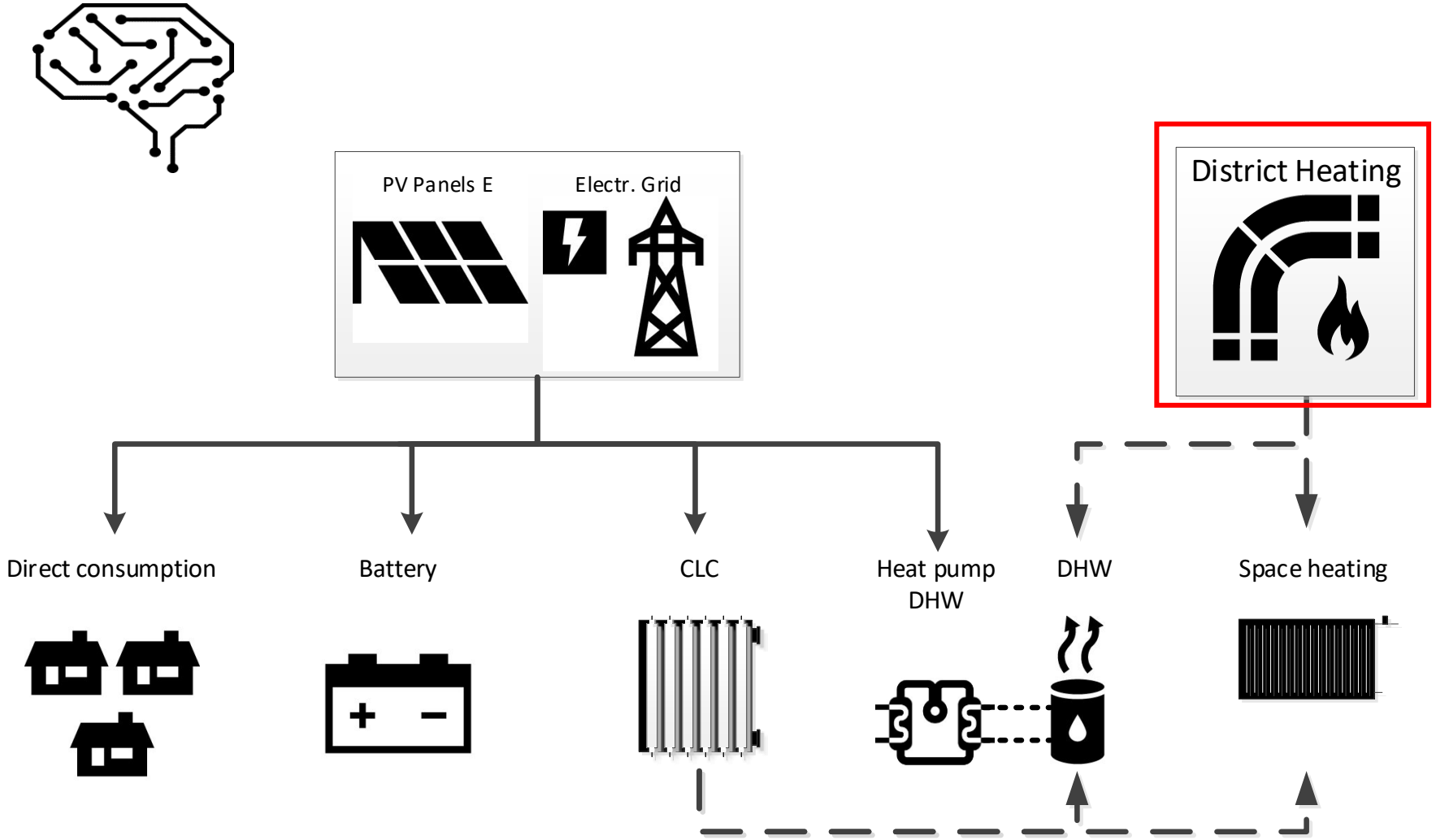
System setup AGEN - France

BEMS (Building energy management system)



System setup Demo A – (Gleisdorf – Austria)

BEMS (Building energy management system)



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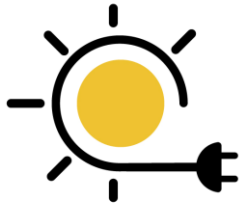
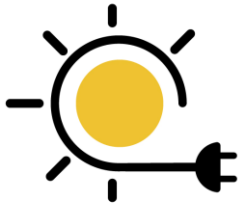
Goals of a BEMS



- To use energy as good as possible given the boundary conditions of the system
- Within SCORES two states of operation:
  - Optimize for self consumption
  - Optimize for cost
    - Electricity prices
    - Capacity incentives
    - Reduced consumption in time-blocks

Algorithm setup

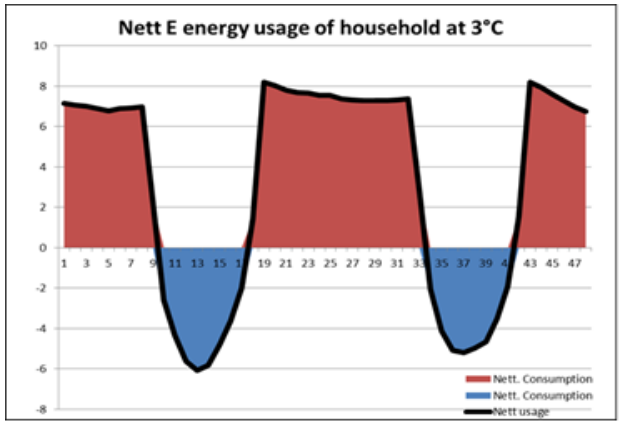


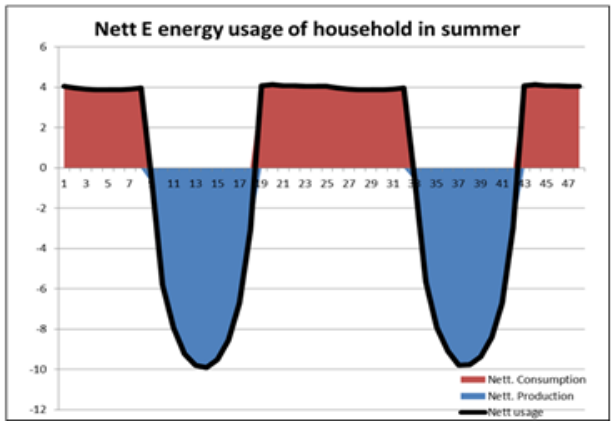
- Two algorithm parts are running at different speeds
  - Prediction algorithm:
  - Decision algorithm:
- Modular approach (all elements have separate modules)
- Programmed in java-script…

BEMS Algorithm – Predicting surplus

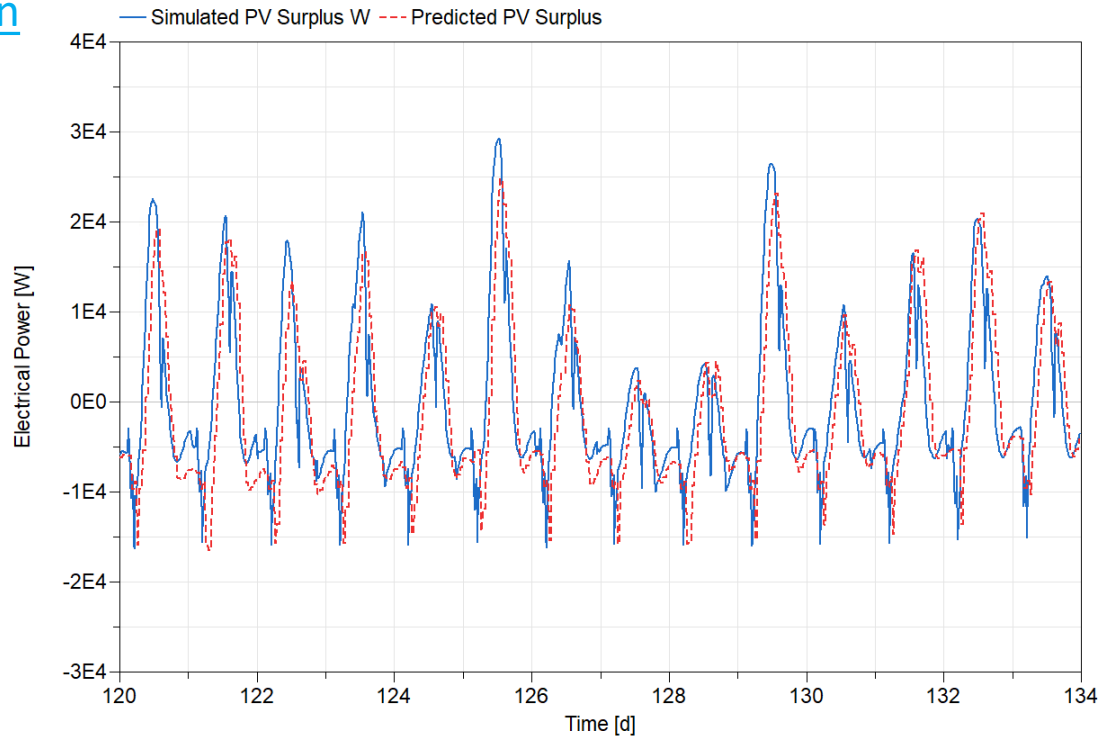
- PV surplus = $P_{PV} - P_{spheat\_elec} - P_{dhw\_elec} - P_{gen\_elec}$

Theory



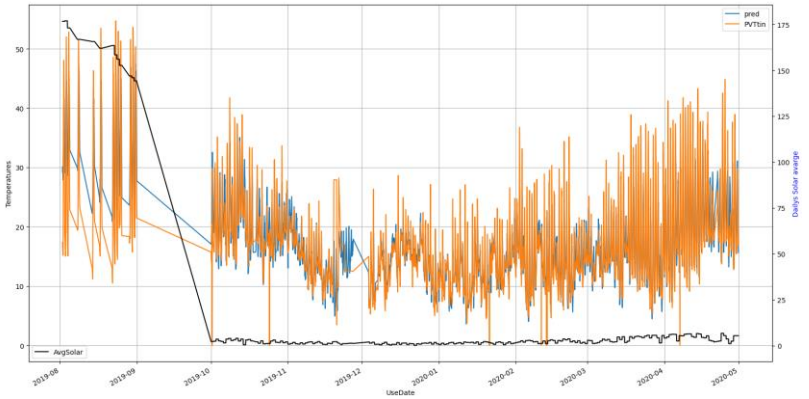


Simulation

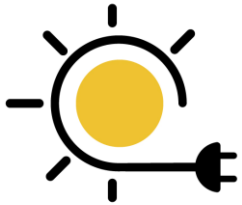


Algorithm setup

- Prediction algorithm:
  - Runs at speed of weather data coming in (1h)
  - predict generation and consumption profiles over a 24 hour prediction horizon (weather, holidays…etc.)
  - Uses physical formulae and regression for the predictions
  - Predicts energy demand and energy surplus based on calculated energy flows (physical models)

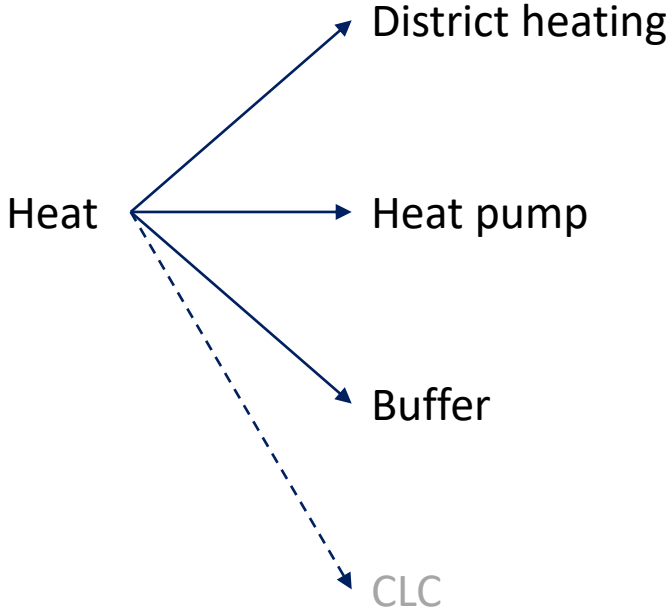


Algorithm setup



- Decision algorithm:
  - Determines how best use energy surplus dependent on boundary conditions and algorithm settings
  - Uses a set of rules to determine optimization
  - Runs every 5 minutes
  - Initiates & controls switching of equipment

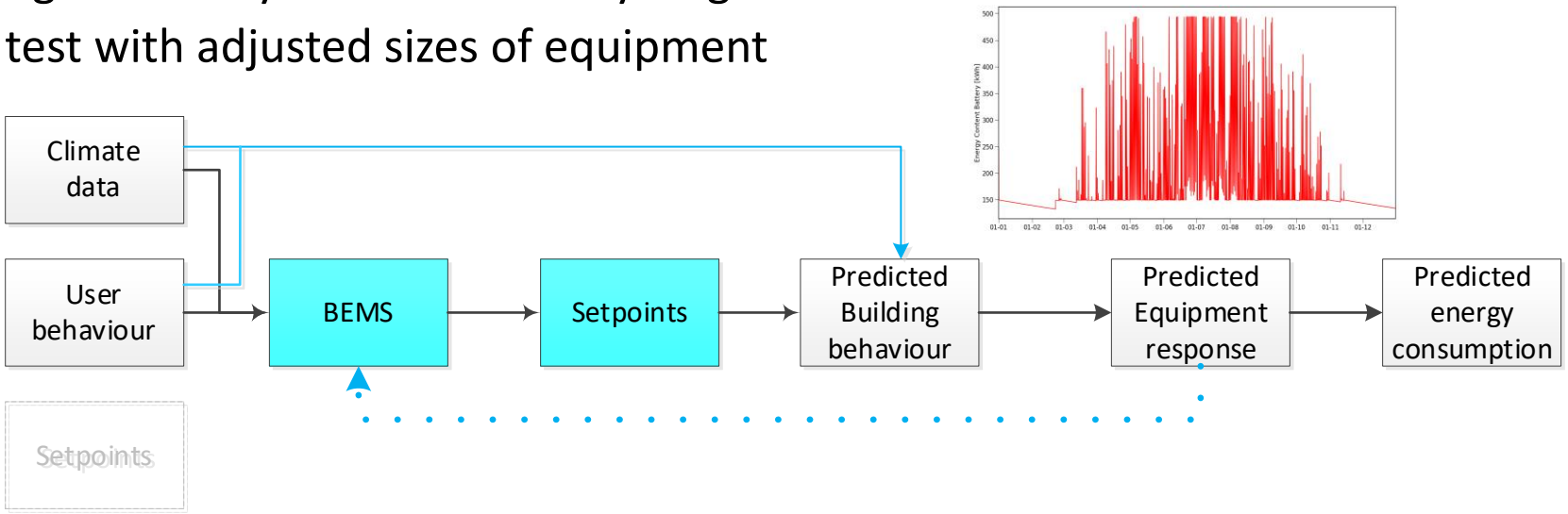
Why is it so complex



Source	considerations
District heating	Temperature in DH grid Refill of buffer required?
Heat pump	Less energy for domestic consumption Energy from battery, PV or grid? Refill of buffer required?
Buffer	Energy available? Refill buffer later from DH, heat pump or CLC Heat loss over longer storage periods
CLC	CLC occupied? Little heat loss over longer storage periods Energy from battery, PV or grid?

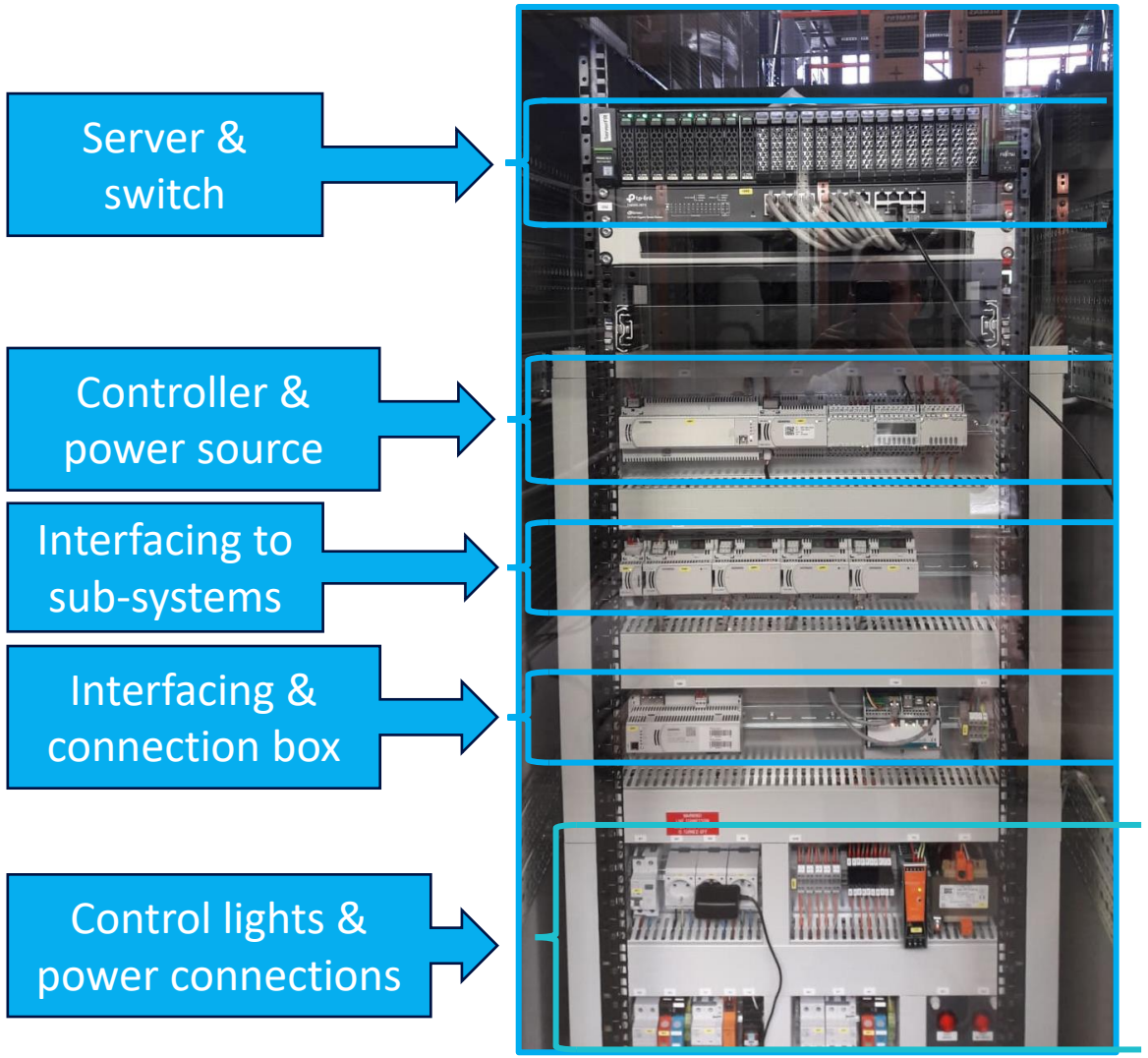
Interactive simulation

- Testing to identify errors in an early stage
- Run test with adjusted sizes of equipment

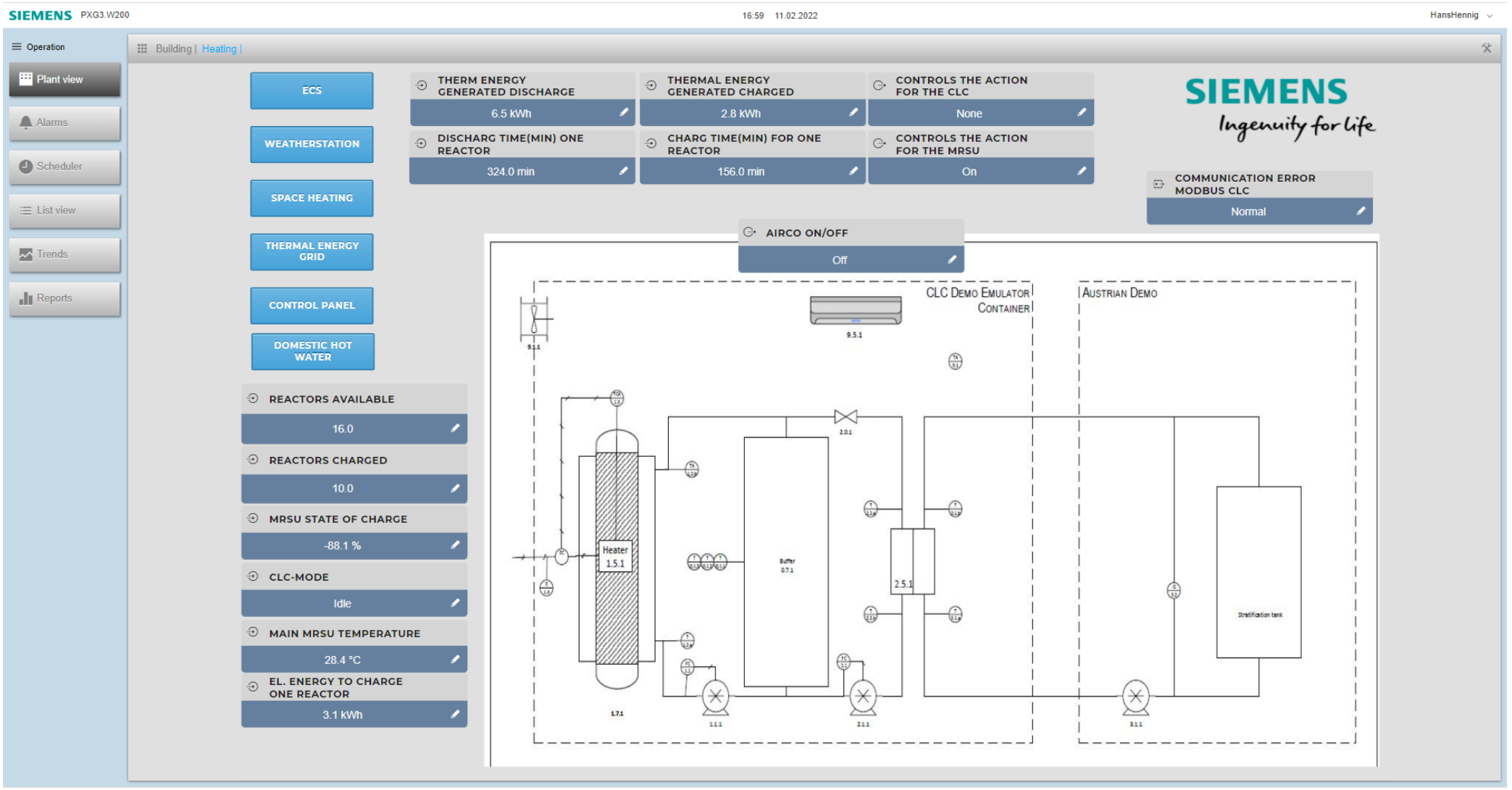


- Steps:
  - Algorithm and simulator (Dymola) will use weather data as input including “forecasted” weather
  - The BEMS will receive the status of the simulated system from Dymola and will determine subsequent actions
  - Dymola will receive subsystem commands from the BEMS and will determine the effect on the simulated system

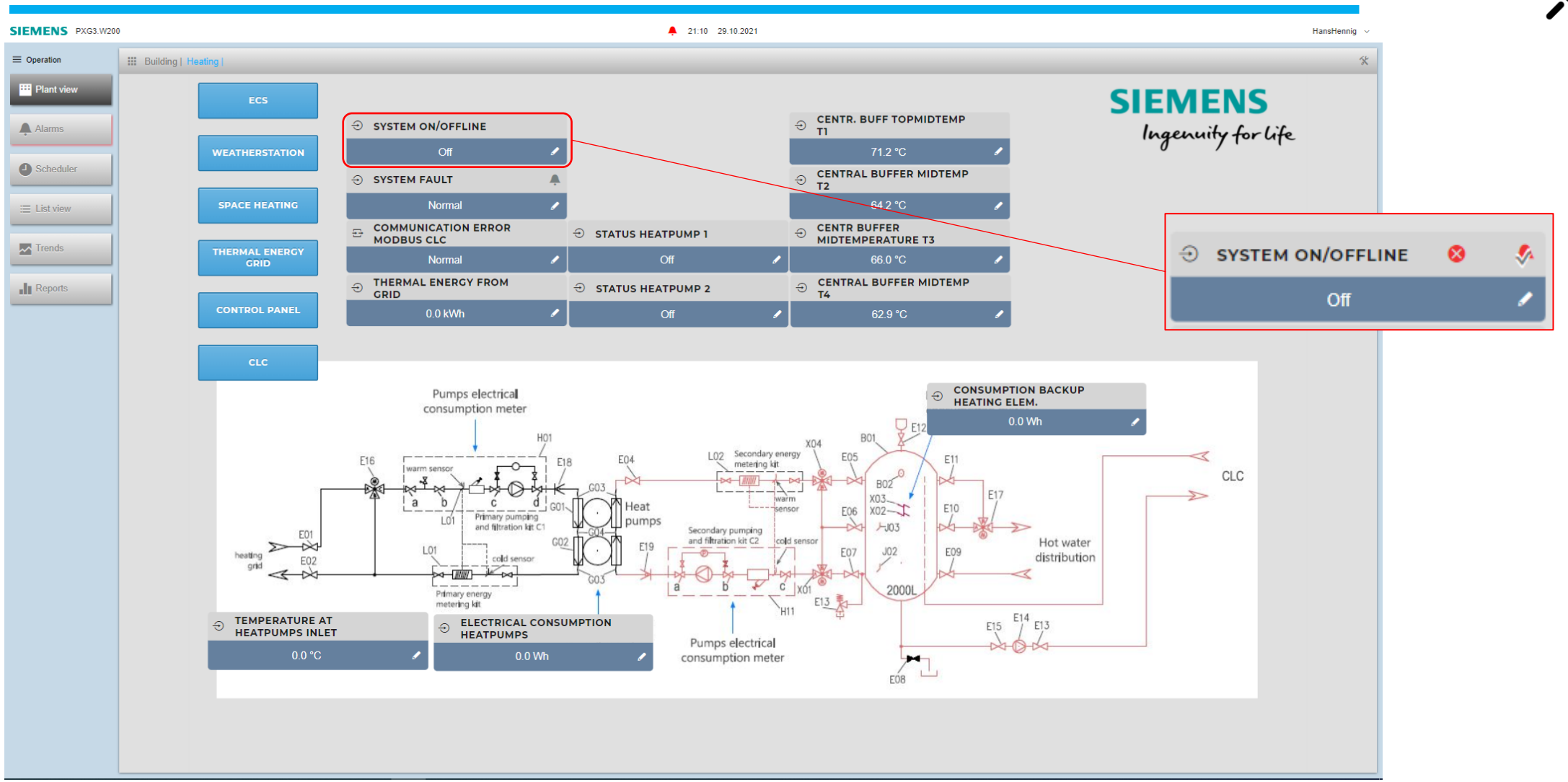
Controlling hardware



BEMS user interface

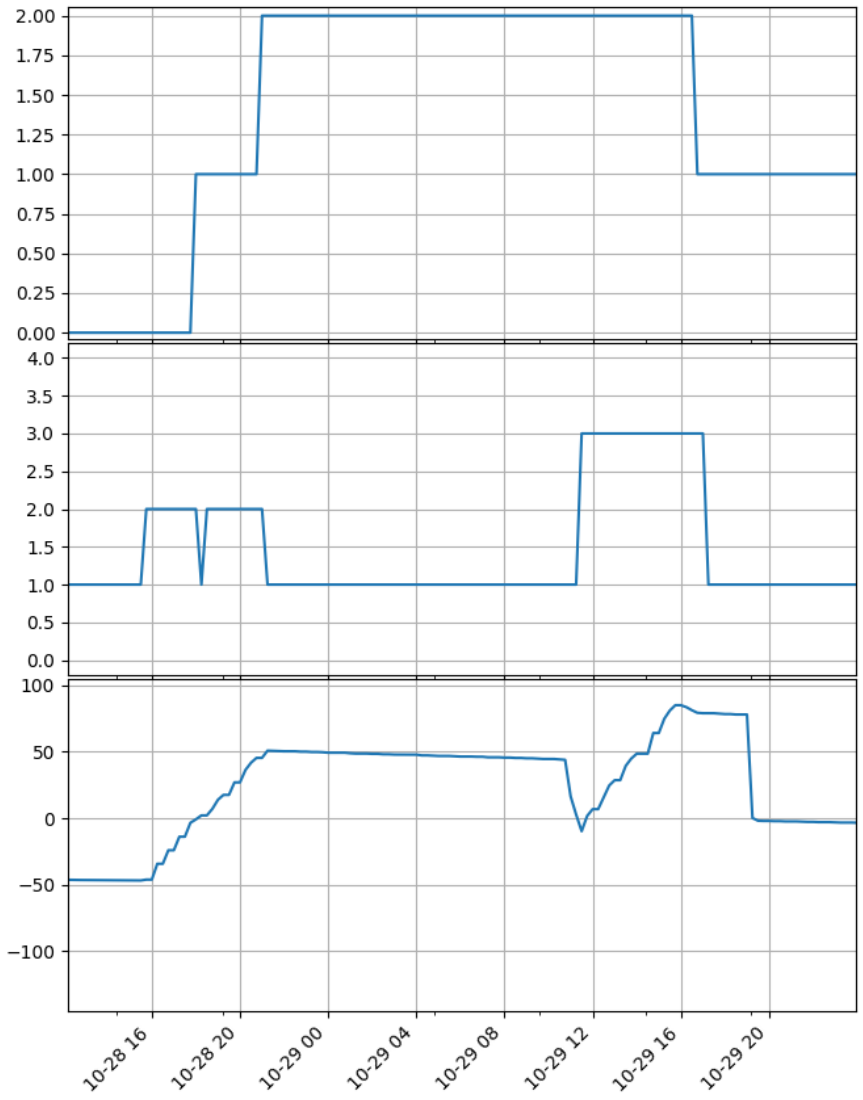


Project Execution: BEMS control panel



BEMS testing: Controlling of CLC

- Robustness test of BEMS Does the system behave as expected with charging and discharging

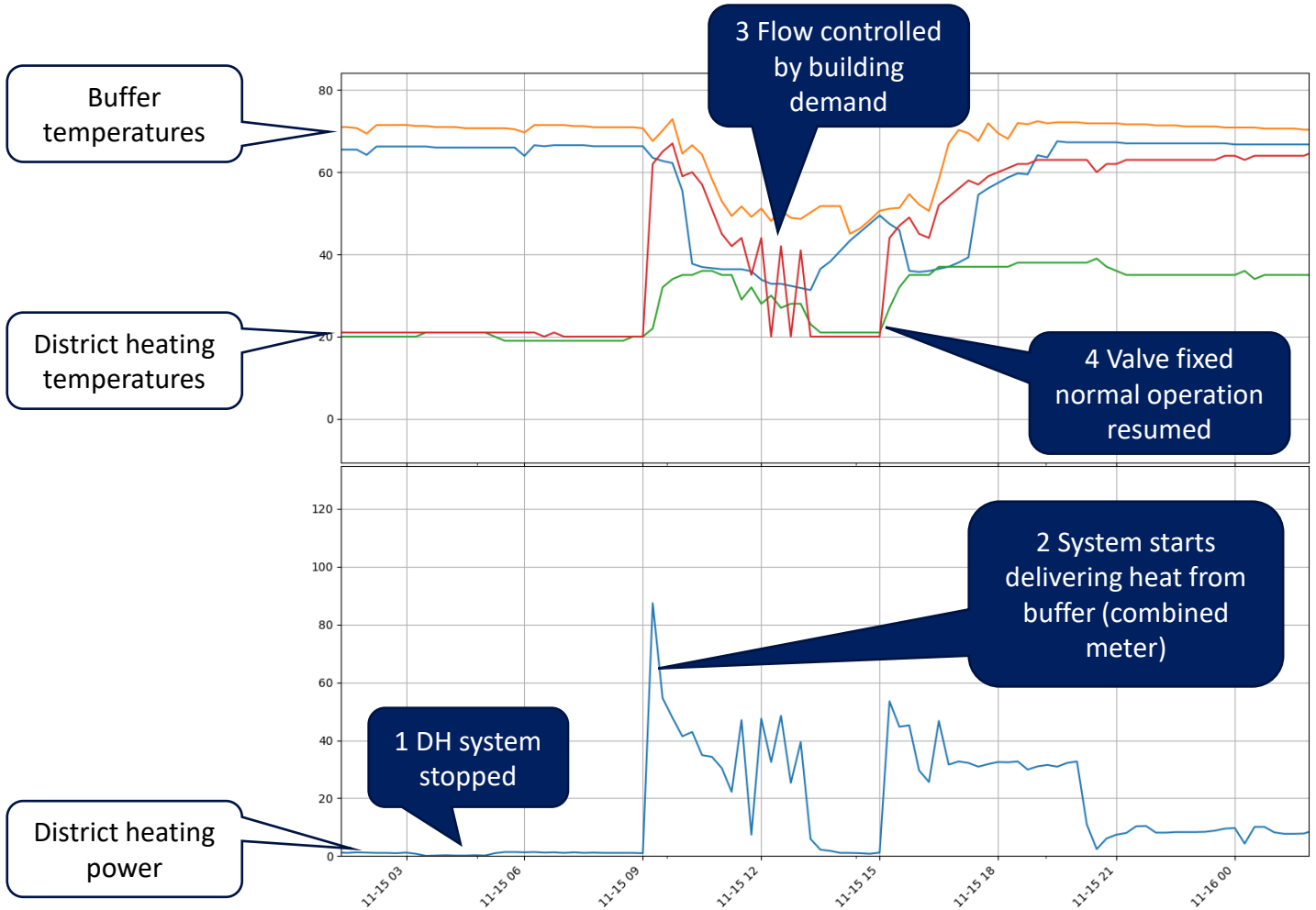


Number of charged reactors

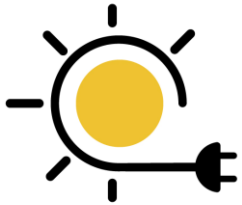
CLC mode
1=idle,
2=charge
3=discharge
4=not-available

State of charge of device buffer (SoC also used as average temperature reading)
-50% ≈ 42°C

Unintended testing



Learnings with testing still in progress



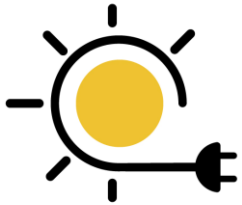
Good:

- An all-round and stable team is required for such projects
- Start with required interfacing signals in a very early stage
- Interactive simulation for testing systems works quite well but takes effort to set op properly
- Remote and secure connections to systems on-site is cost saving

Even better if:

- Work from the desired outcome backwards to the design and the existing products
- More time for modelling of the system in the algorithms
- Use OO languages, solvers or AI for programming (with good debugging facilities!)
- The level of detail for accurate predictions quickly causes complexity
- Set up a plan B & error handling as in research projects not all technologies will perform as expected

Outlook



More renewable energy → BEMS is required

For the BEMS

- Get away from physical models -> use IA & self learning (scale!)
- Standard language(s) for communication with buildings/components
- Keep the modularity

- For the building management system
  - Shift from demand based to supply/price based decisions
  - Change in building equipment & information
  - Standard limited BEMS functionality in all building control systems but increasing

Thank you!

- *Luis Coelho, IPS, PT - luis.coelho@estsetubal.ips.pt*
- *Pavol Bodis, TNO, NL - pavol.bodis@tno.nl*

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