CITIES
Centre for IT Intelligent Energy Systems

Technical University of Denmark

Control of heat pumps and use of forecasts in future electric energy systems

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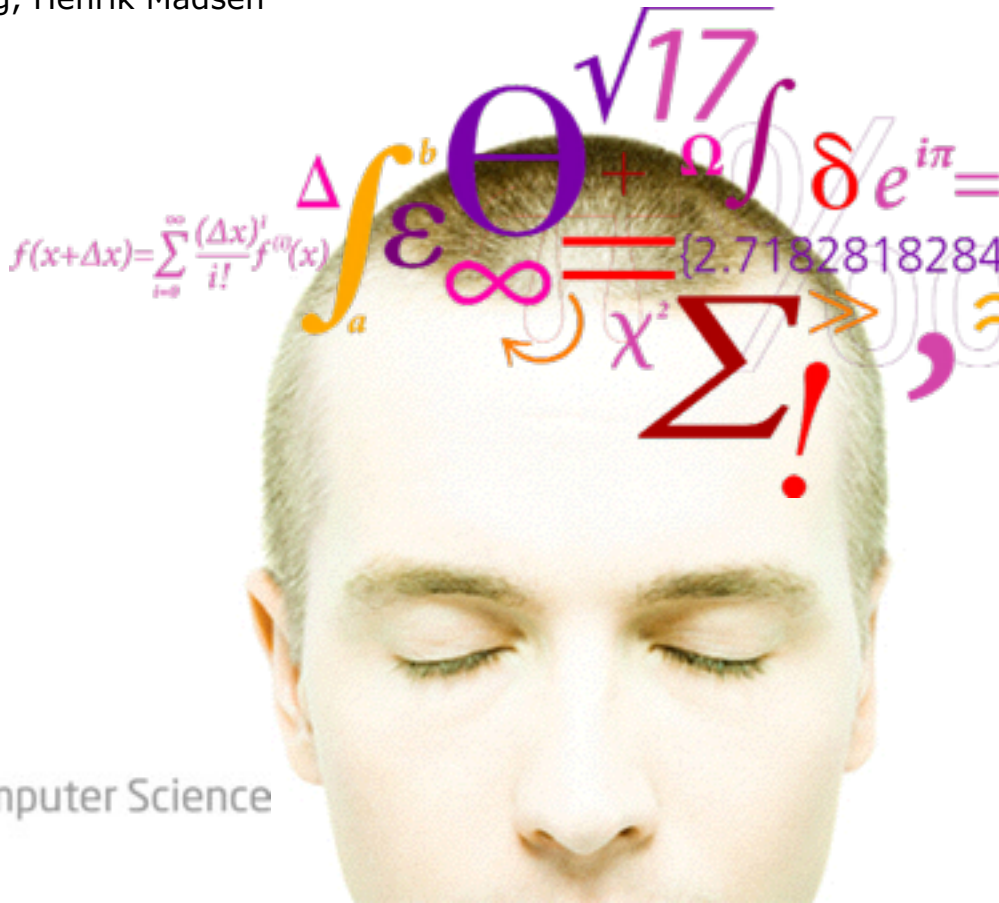
Cities Consortium Meeting
26-05-2014



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ENFOR
Forecasting and Optimization for the Energy Sector

DTU Compute
Department of Applied Mathematics and Computer Science

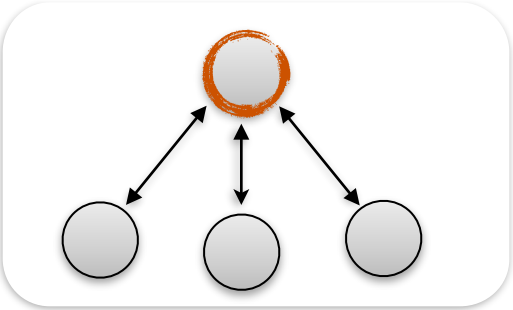
Outline

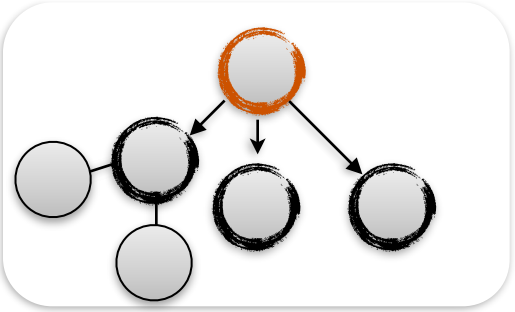
- **Test Facility**
- **System's Architecture**
  - Components
  - Signals
  - Forecasts
  - Controller
- **Conclusions**

Advanced Controller Structure Classification

Direct Control (DC) which controls the power consumption within predefined constraints by directly interrupting or altering the power consumption of the DERs.

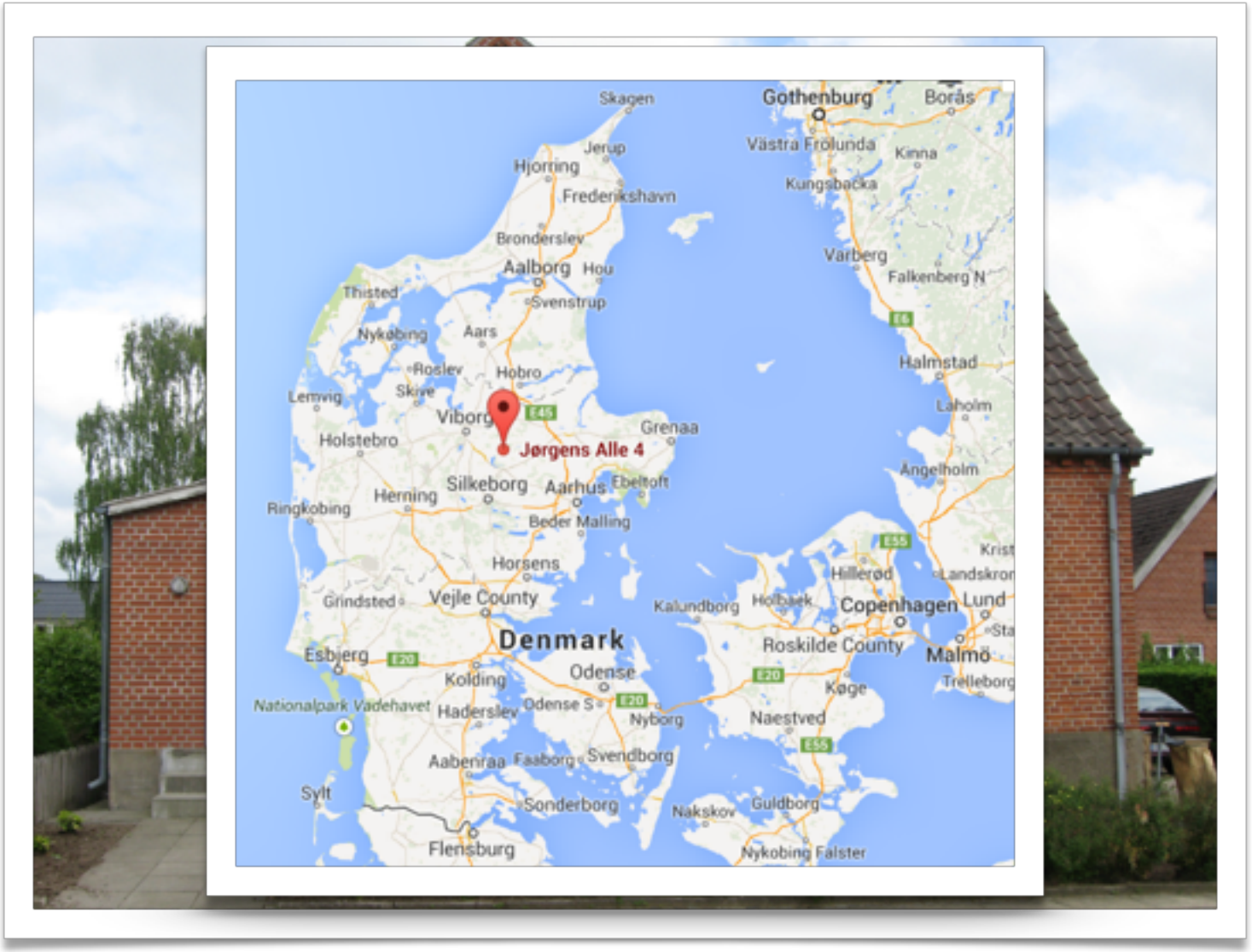
Indirect Control (IC) that consists in setting up a policy, which encourages flexibility of the DERs by changing the cost of electricity.



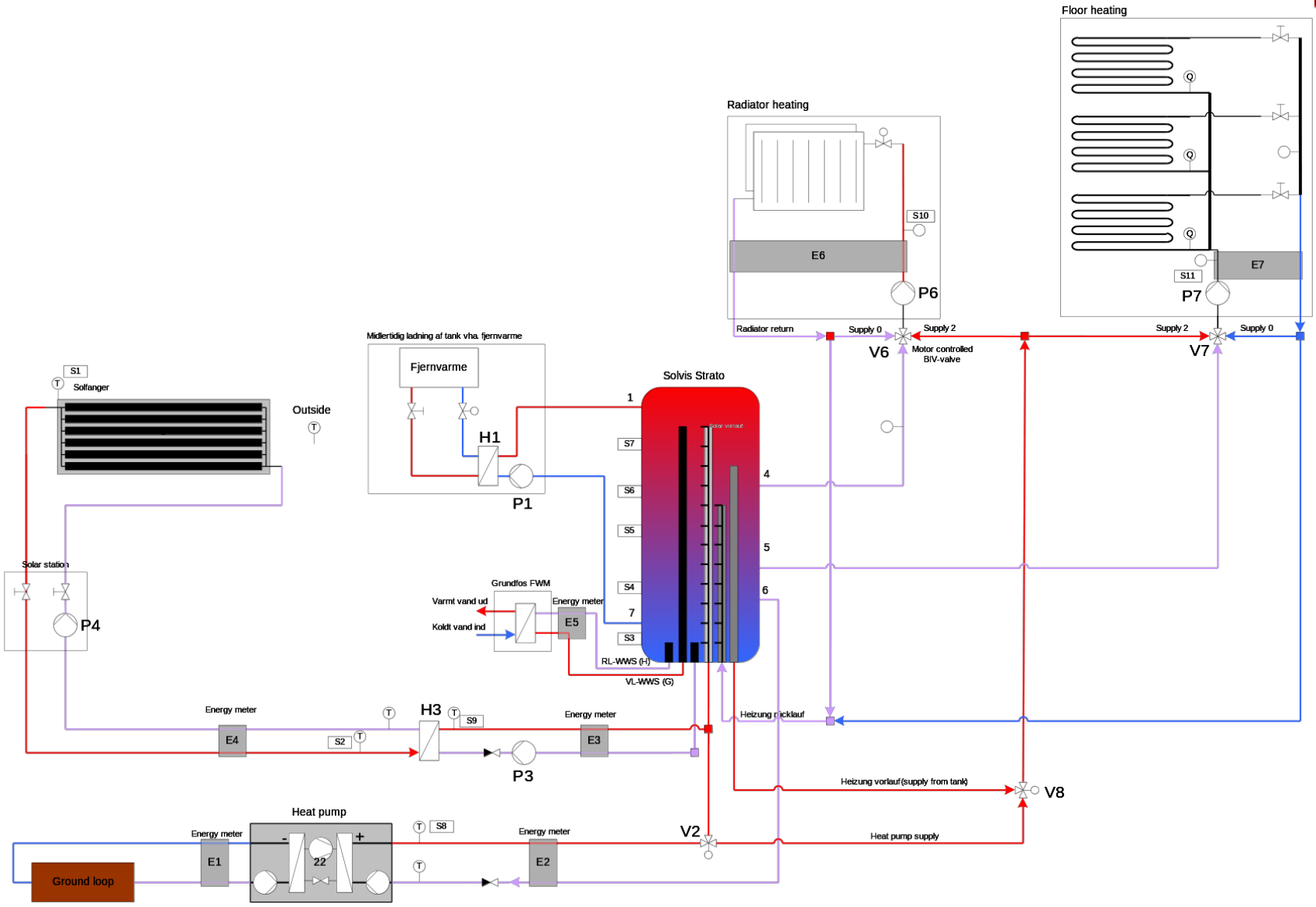


Test Facility

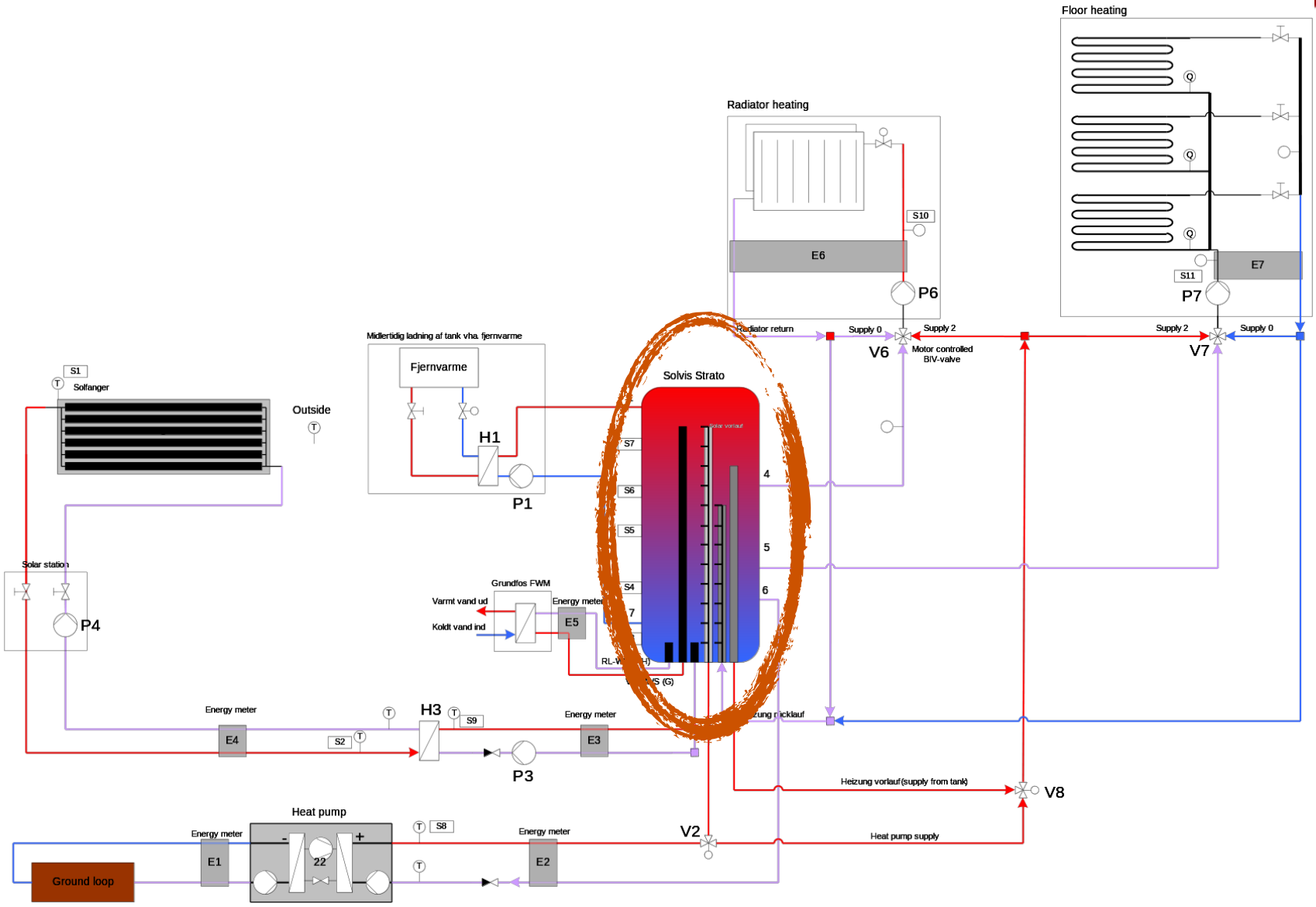
Test Facility



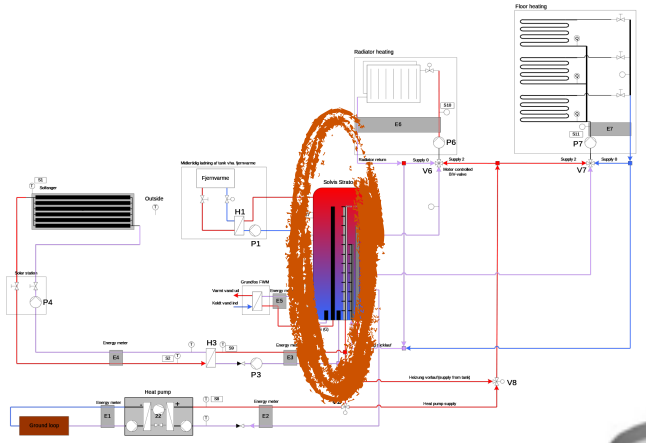
Heating System



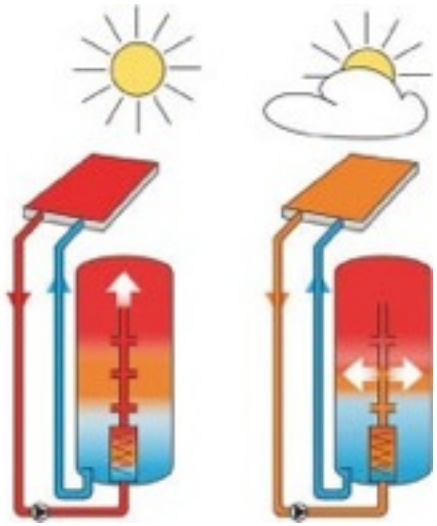
Hot Water Tank



Hot Water Tank

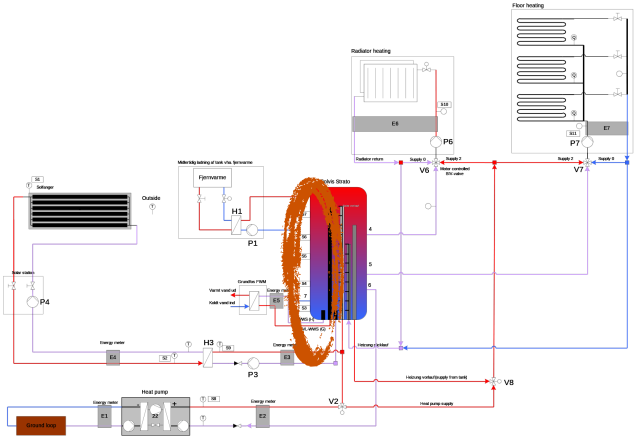


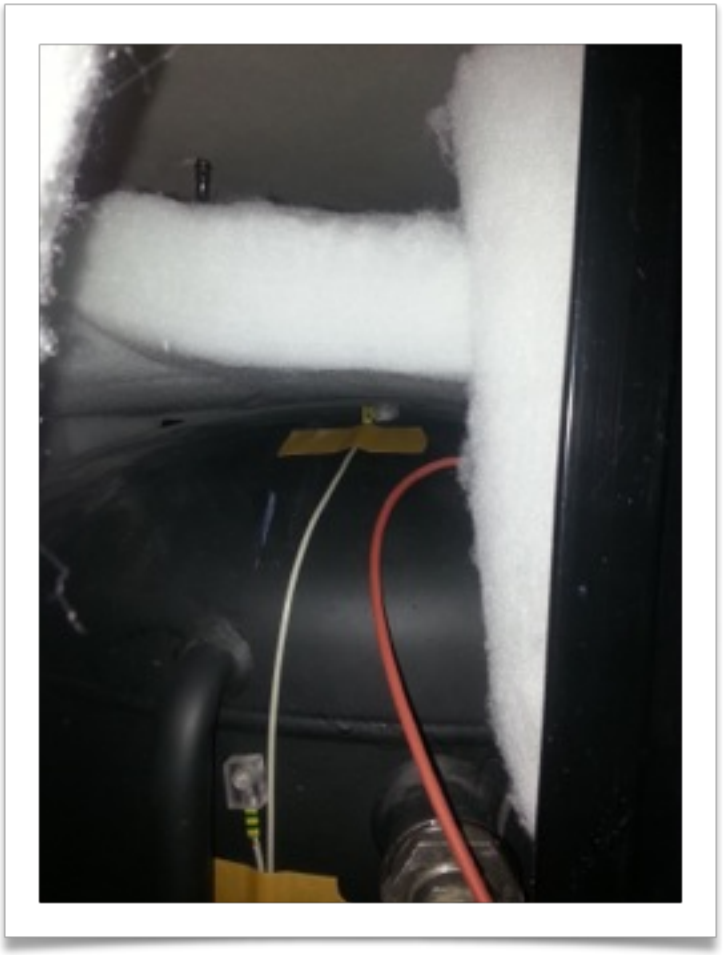
600L Hot Water Tank
- Stratified
- Multiple Connections
- Good with Solar Thermal System

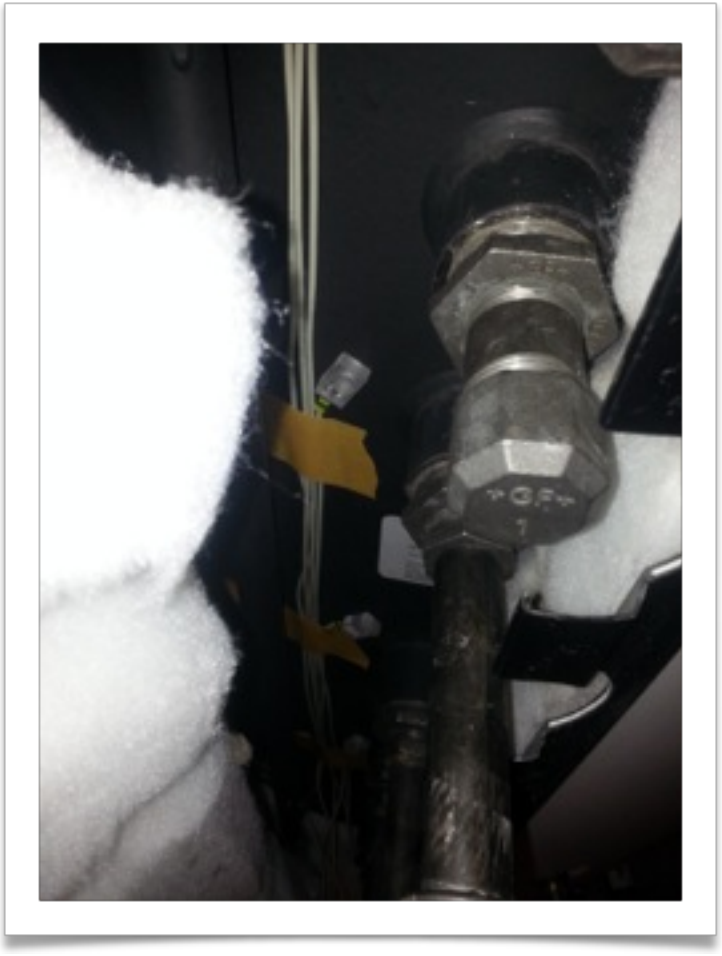


Hot Water Tank - Sensors

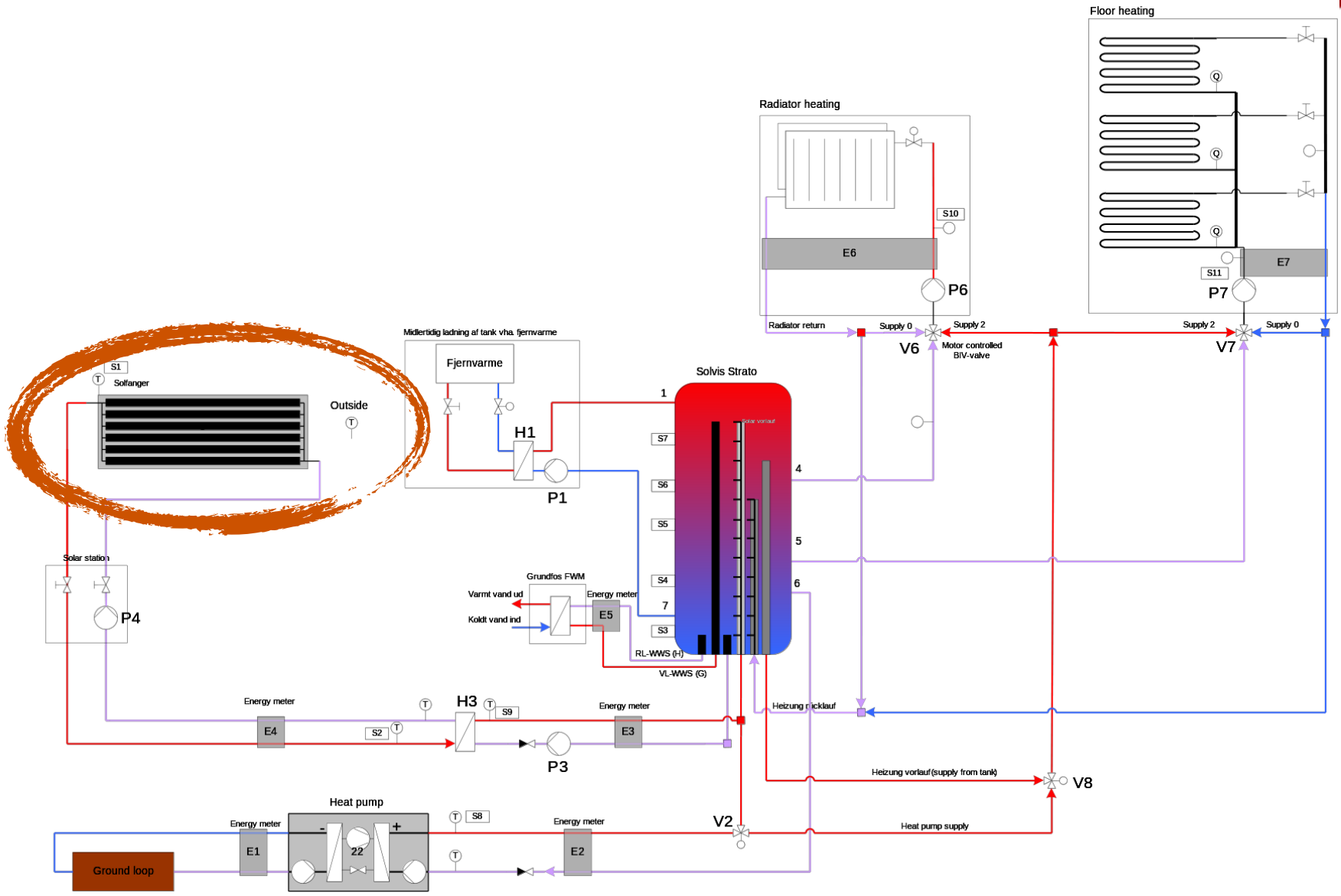
- 8 Temperature Sensors are placed equidistantly from each other on the hot water tank





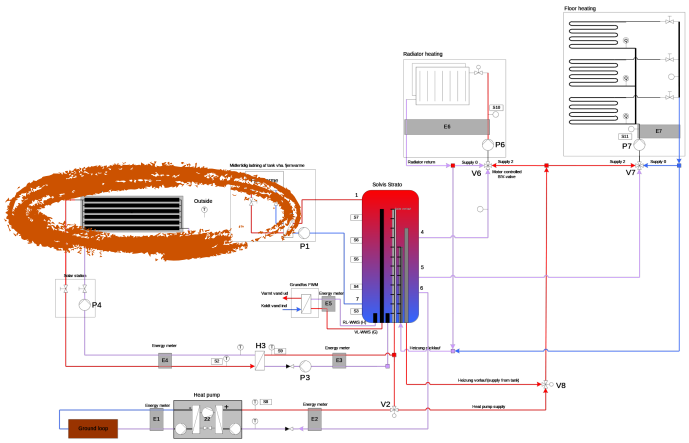


Solar Thermal Collector

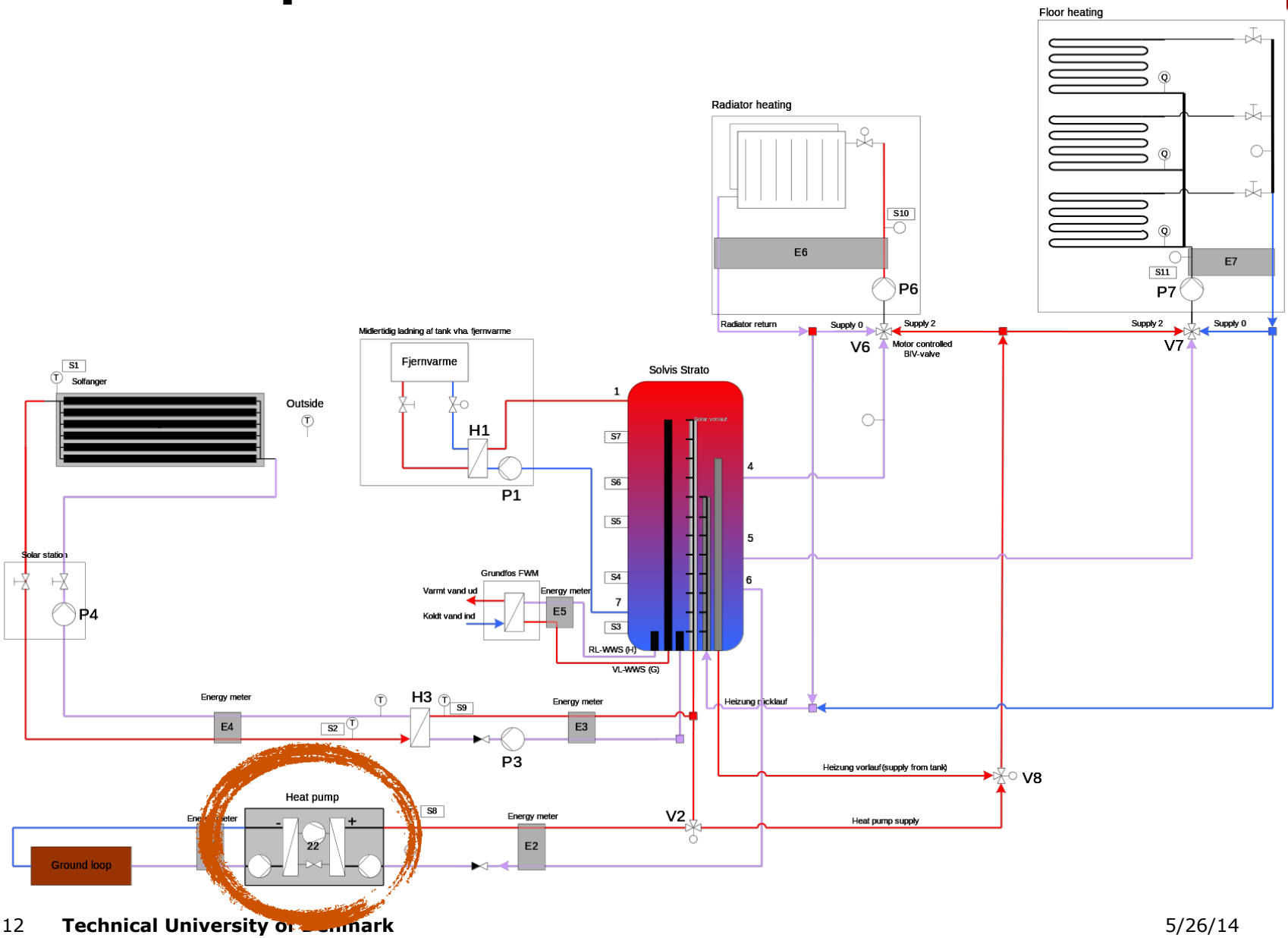


Solar Thermal Collector

- Wall mounted. 7.2 m2
- Approx. 90% effectiveness compared to the optimal tilt

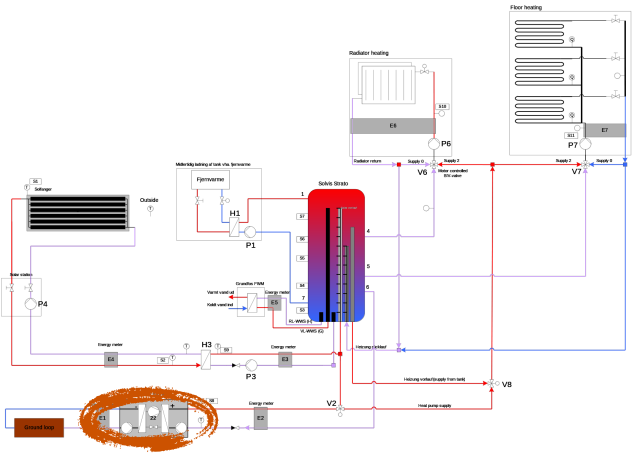


Heat Pump

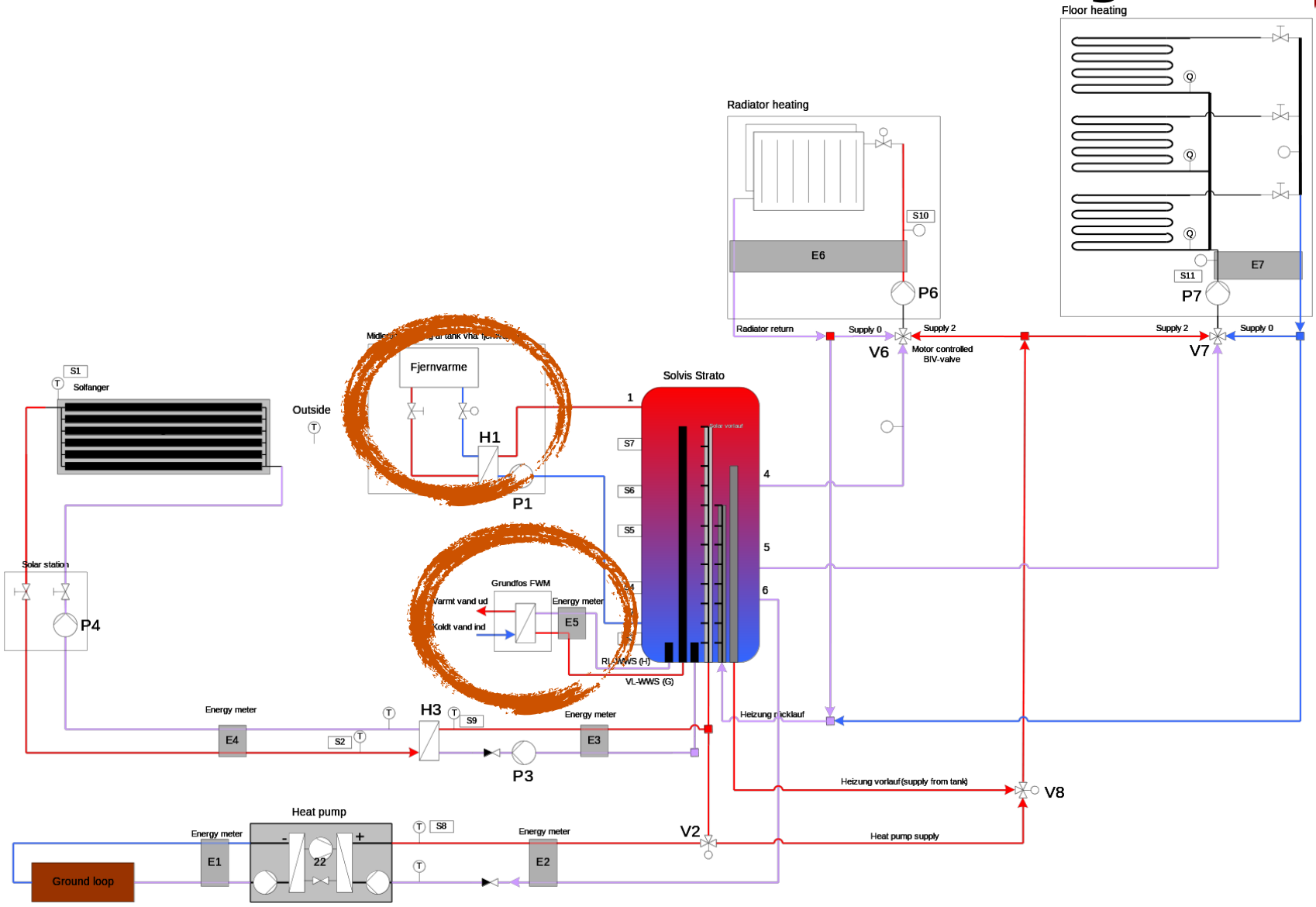

Floor heating
Radiator heating
E6
S10
P6
E7
S11
P7
Radiator return
Supply 0
Supply 2
V6
Motor controlled
BIV-valve
Supply 2
Supply 0
V7
Midlertidig ladning af tank vha. fjernvarme
Fjernvarme
H1
P1
Solvis Strato
S1
Solfanger
Outside
1
S7
S6
S5
S4
7
S3
4
5
6
RL-WWS (H)
VL-WWS (G)
Solar station
P4
Grundfos FWM
Varmt vand ud
Koldt vand ind
Energy meter
E5
Energy meter
E4
S2
H3
S9
Energy meter
E3
P3
Heizung rücklauf
Heizung vorlauf(supply from tank)
V8
Heat pump
S8
Energy meter
E2
V2
Heat pump supply
Ground loop
22

Heat Pump

- Delivers from 1.5 to 7 kW
- Variable speed compressor
- Grundfos pumps
- 300m ground pipe

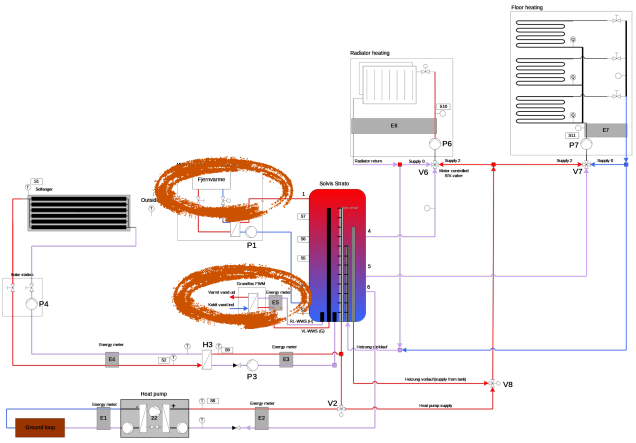


Domestic hot water and district heating

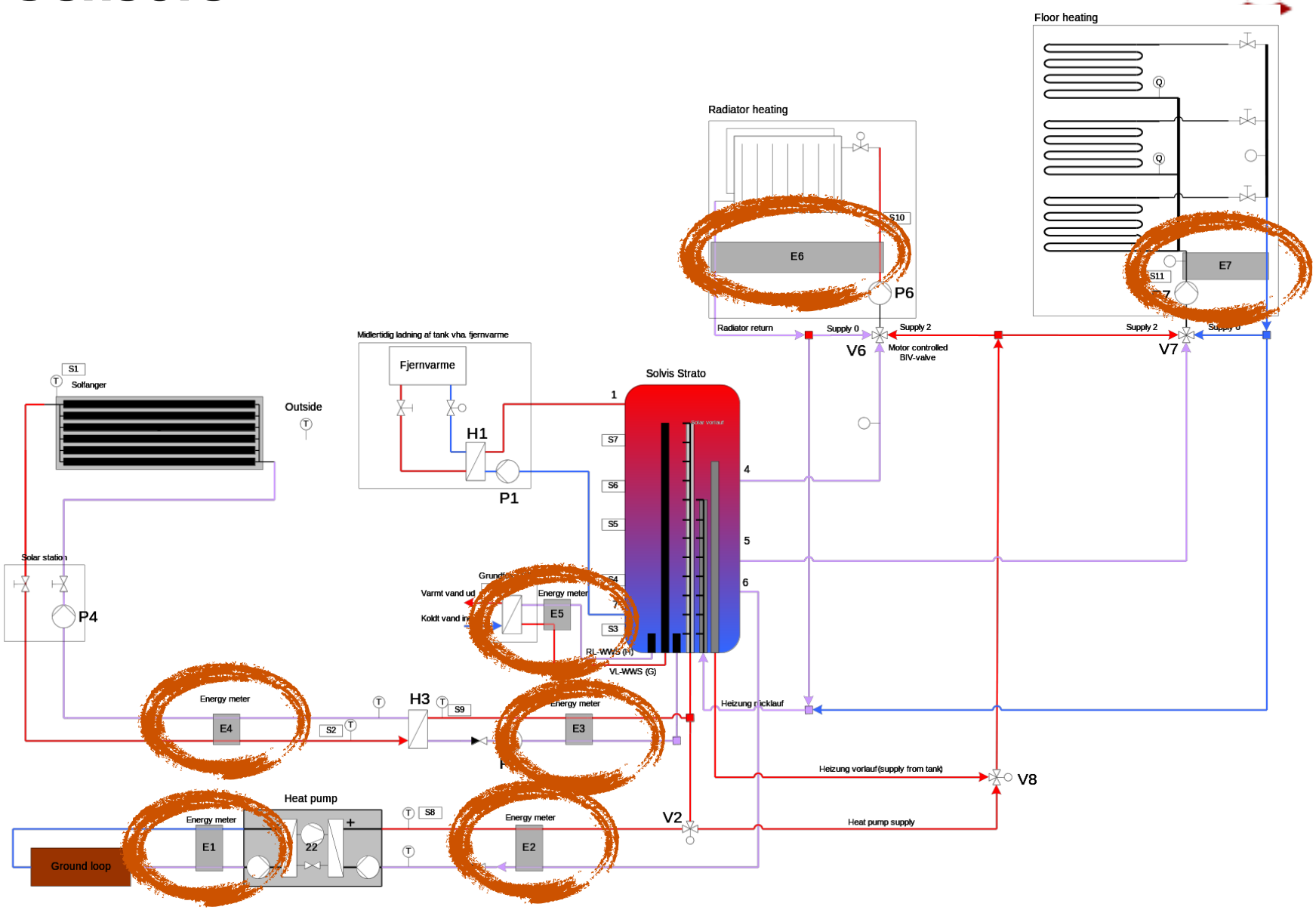


Domestic hot water and district heating

- Sonnenkraft / Grundfos Fresh water module
- District heating connected as backup



Sensors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Outside
Solvis Strato
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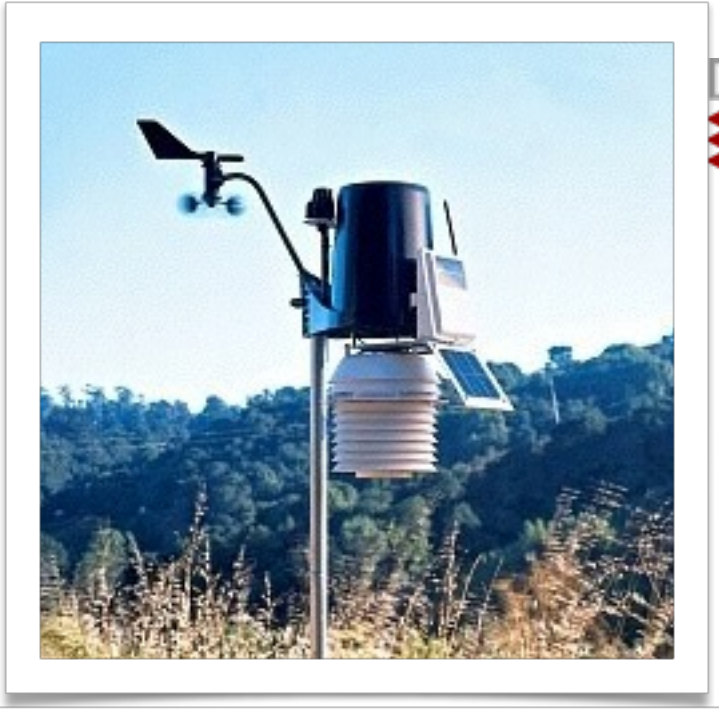
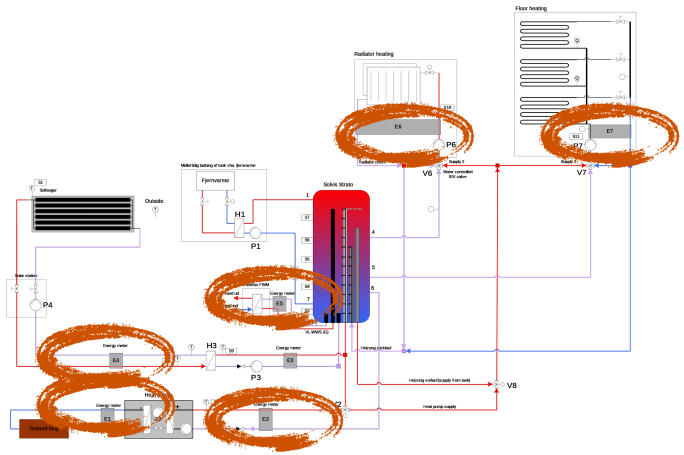
S4
S3
RL-WWS (H)
VL-WWS (G)
Solar station
P4
Varmt vand ud
Koldt vand ind
Energy meter
E5
E4
E3
E2
E1
S2
S9
S8
H3
Heizung ricklauf
Heizung vorlauf(supply from tank)
V8
V2
Heat pump supply
Heat pump
22
Ground loop

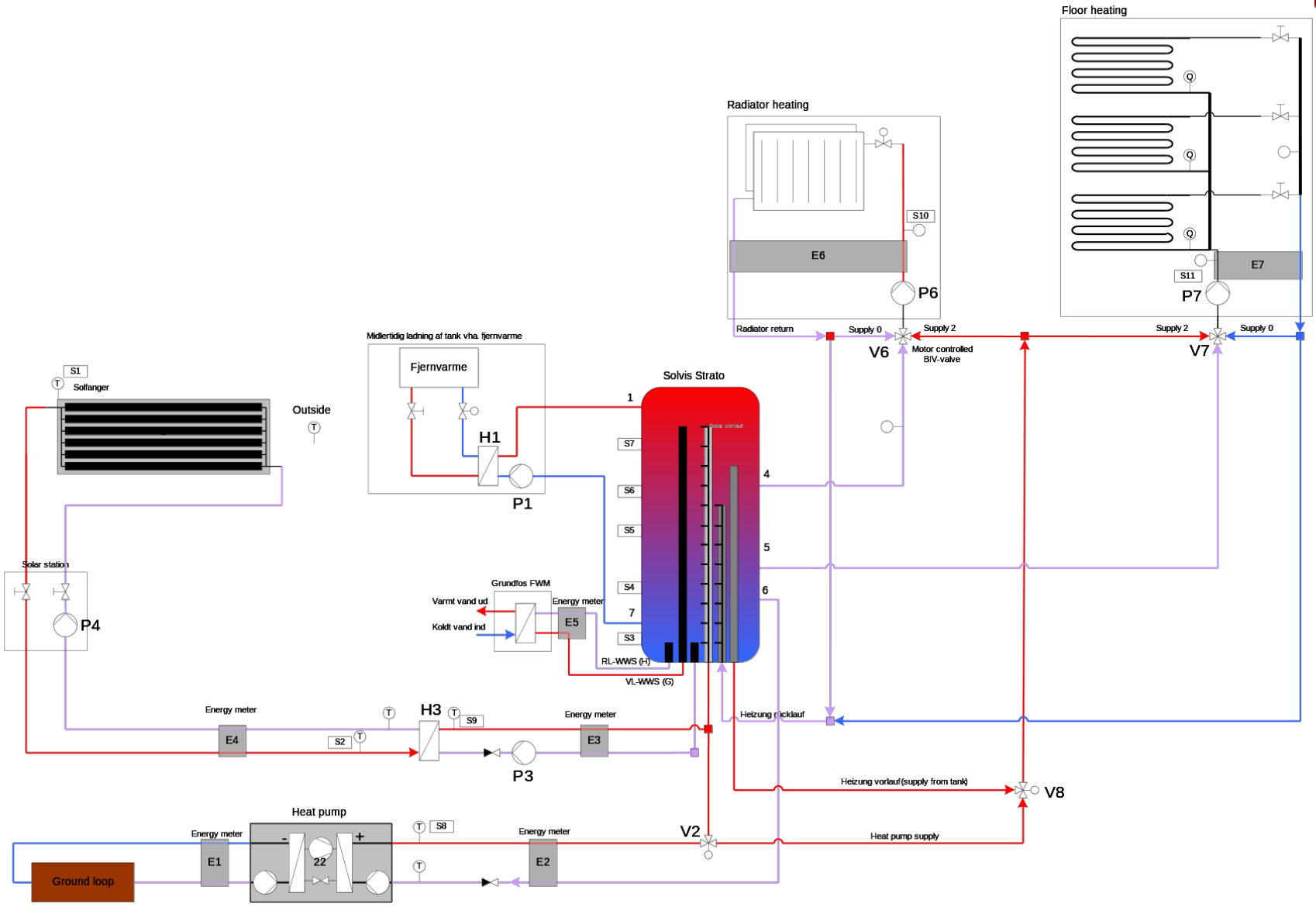
Sensors

- Weather Station
  - Davis Vantage Pro2 Plus
- Heat Meters
  - Kamstrup Multical in water circuits
  - Sontex Multical in brine circuits
- Wireless temp. sensors
  - Room and floor Temps





Heating System - Configuration



Architecture

Low Level Controller

Heat Pump

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Forecasting and Optimization for the Energy Sector

Forecasts Service

Server + Advanced Controller

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Architecture - Forecast Request

Low Level Controller

Heat Pump

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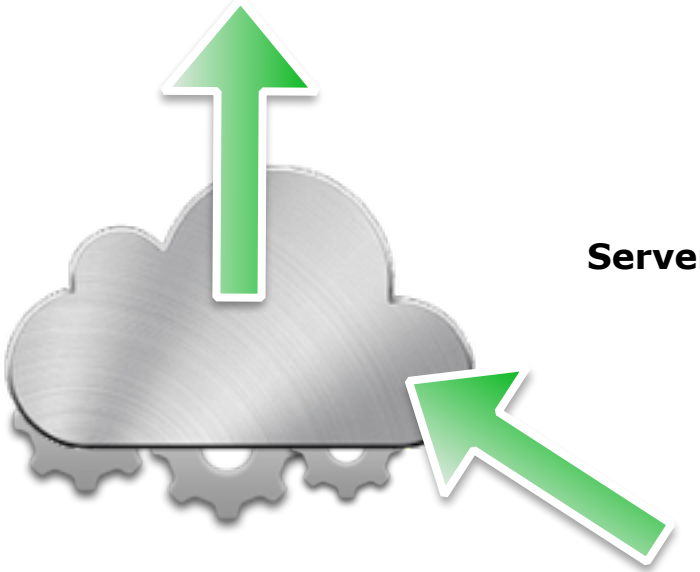
Forecasting and Optimization for the Energy Sector

Forecasts Service



Server + Advanced Controller

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Architecture - Forecast Sent

Low Level Controller

Heat Pump

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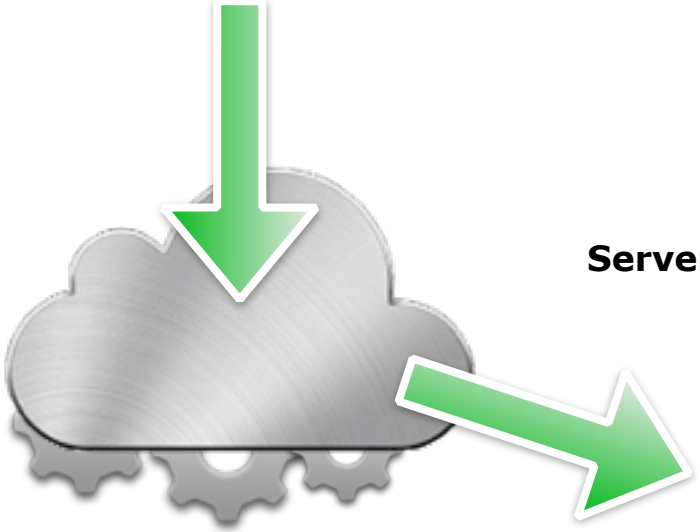
Forecasts Service



Server + Advanced Controller

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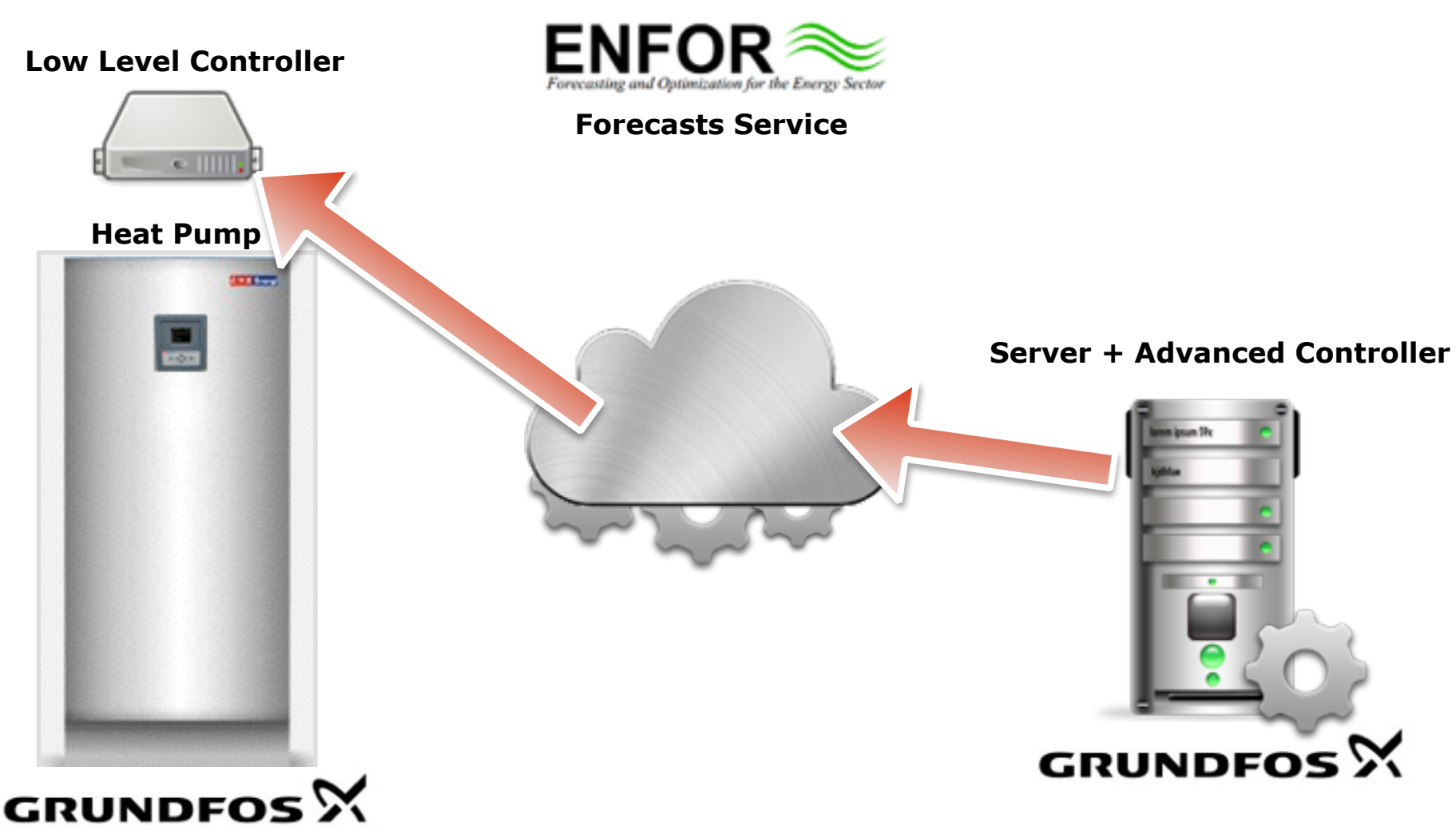
Architecture - Reference Sent



Architecture - Reference Sent

Low Level Controller

Heat Pump

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Forecasts Service

Server + Advanced Controller

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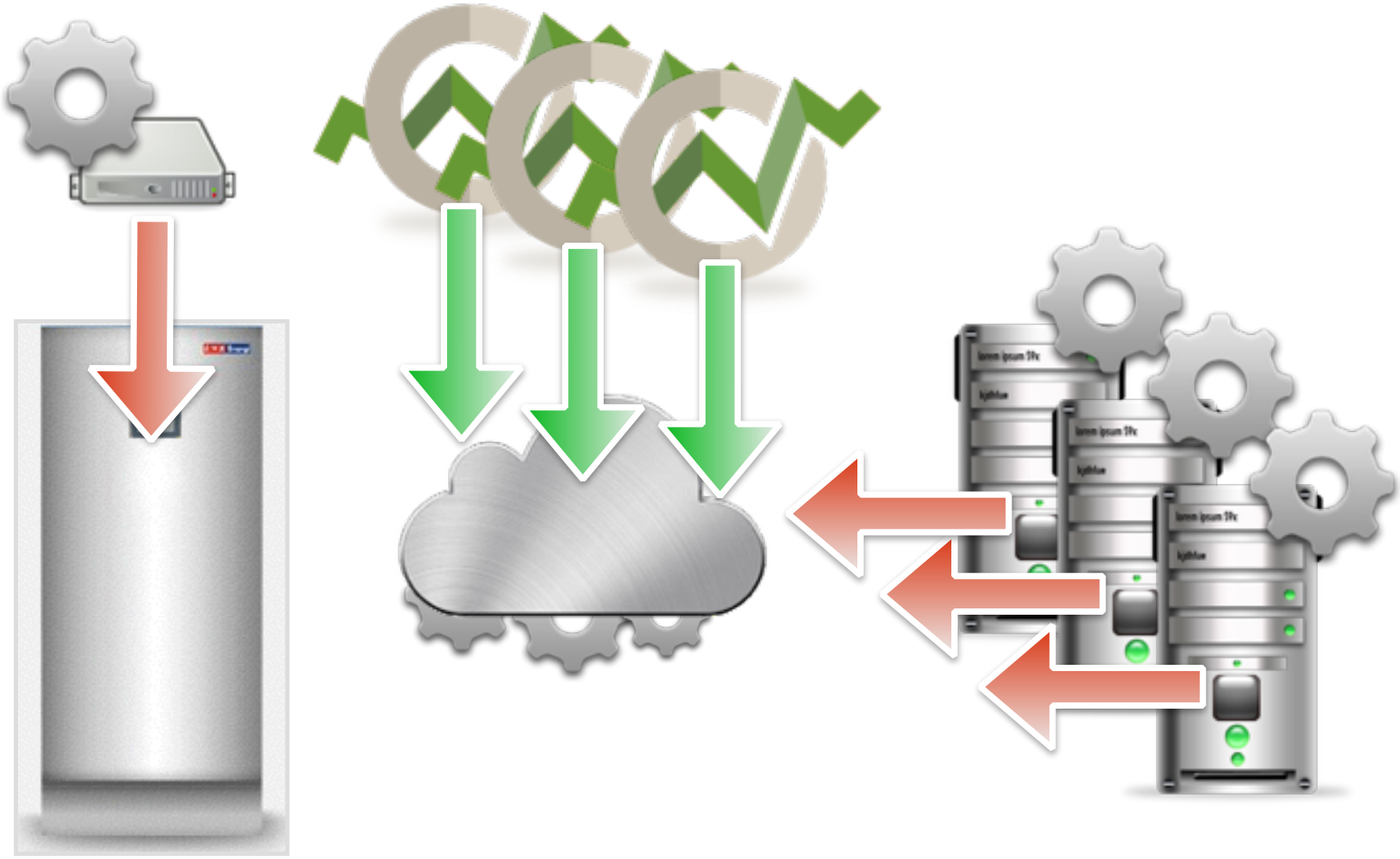
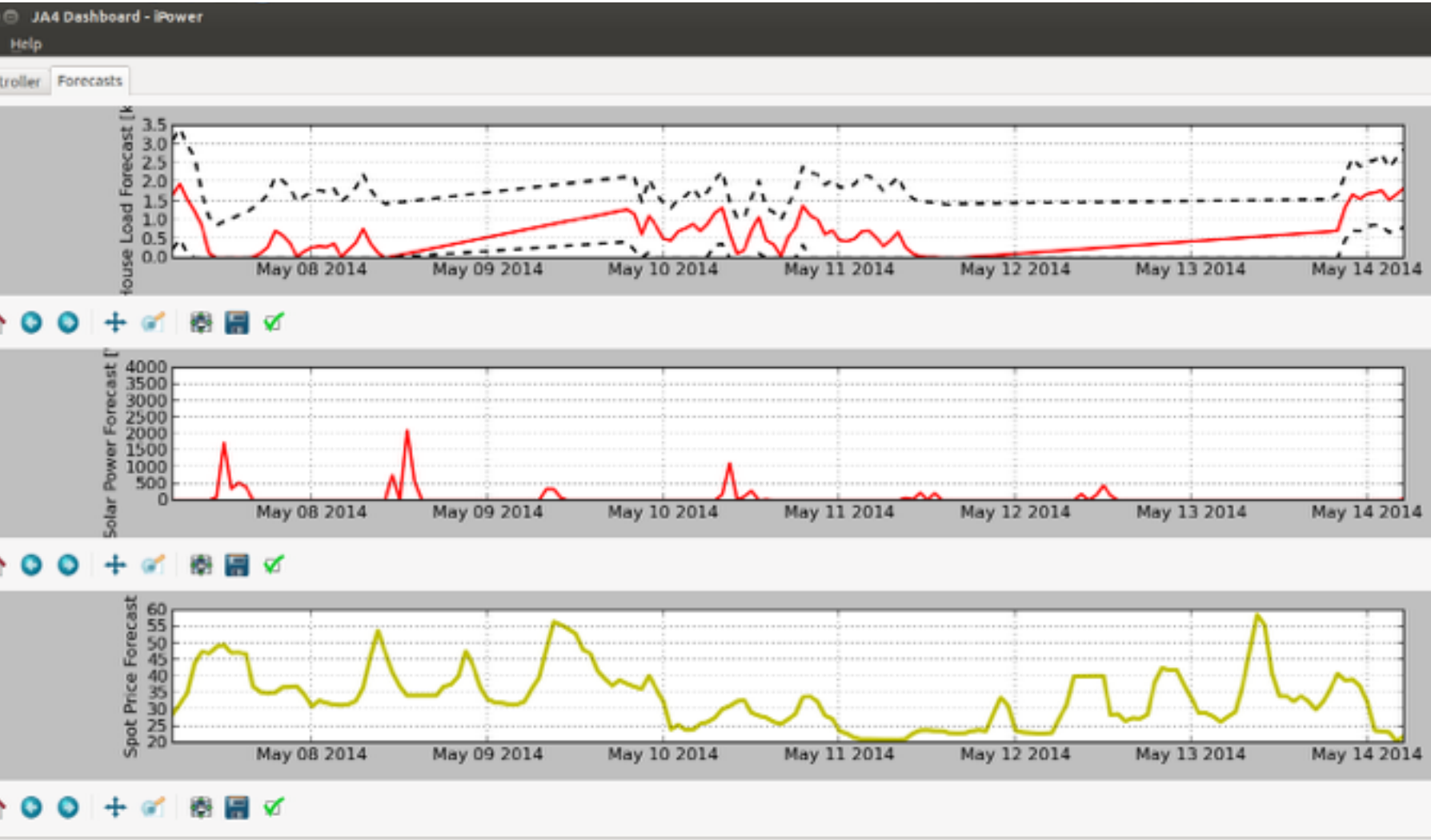
Architecture - Why?



DEMO - Advanced Controller

DEMO - Advanced Controller



Conclusions

- » Controllability
- » Forecast integration
- » Adaptivity
- » Adv./Dis. Installation
- » User Comfort

- » **Future Plans**
  - » Flexibility potentials
  - » Energy Savings
  - » Different Models
  - » Different Configuration
    - » Heat pump -> House

Technical University of Denmark

DTU

Thank you for your attention

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