Luleå Warmer Because of Summers.

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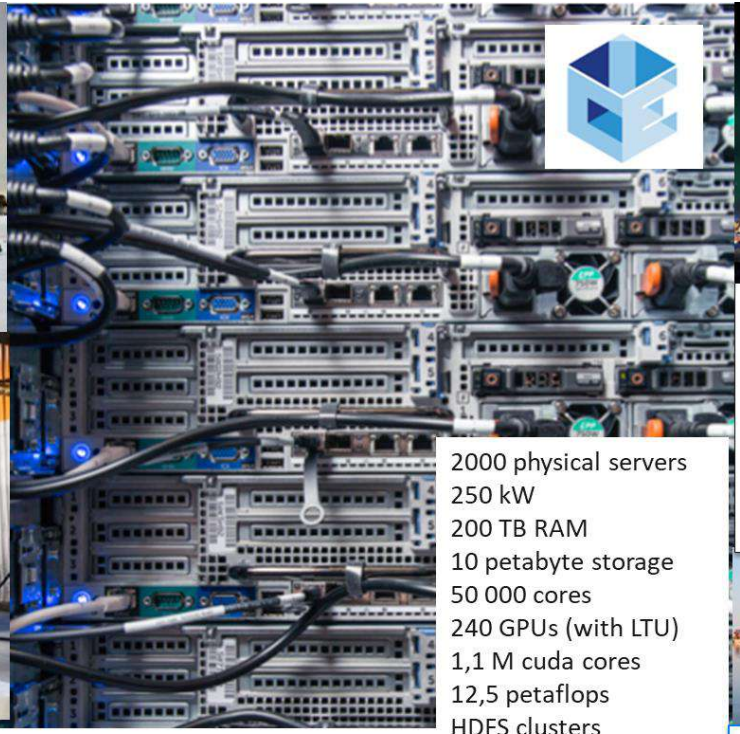
DC Forum OSLO

30th March 2023

RI.SE

RISE ICE datacenter

https://ri.se/ice



- 30 projects, from the ground to the cloud
- 30 employees
- >4 MEUR turnover
- Established 2016

2000 physical servers
250 kW
200 TB RAM
10 petabyte storage
50 000 cores
240 GPUs (with LTU)
1,1 M cuda cores
12,5 petaflops
HDFS clusters
OpenStack ECC
OCP servers

A full-scale research datacenter and test environment with the objective to increase knowledge, strengthen the AI & DC ecosystems and attract researchers.

Stakeholders: Ericsson, ABB, Vattenfall, Facebook, LTU, Region North, Space agency

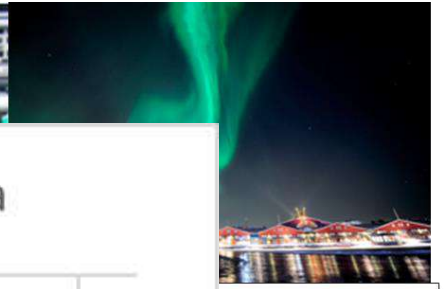
2018, 2019 2020 BDV i-Space GOLD

2016, 2017 BDV i-Space SILVER

DATACLOUD GLOBAL AWARDS 2019

Cluster Management Excellence
STRIVING FOR CLUSTER EXCELLENCE

RISE ICE datacenter



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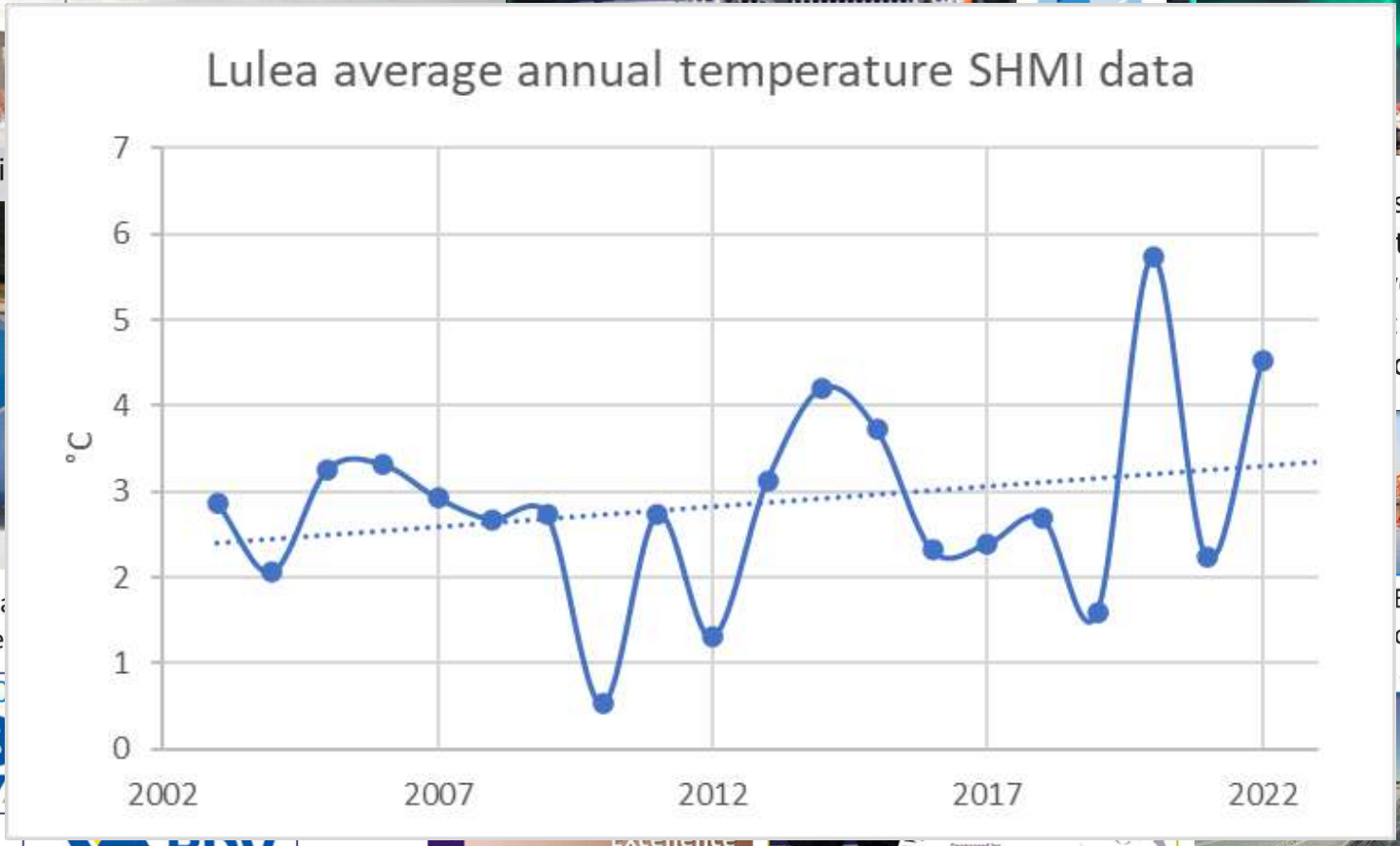

2018, 20
i-Space

BDV
i-Space SILVER

STRIVING FOR CLUSTER EXCELLENCE

DCD >Awards
Sponsored by
DCPRO

AGENDA

- The WEDSTRICT project and the operating demonstrator in Luleå, Sweden.
  Concept was presented in DC Forum Copenhagen in October 2021
- Some quick facts about fuel cells.
- Results from the operating demonstrator in Luleå with its heat recovery setup.
  Operation started with many teething problems in April 2022.

W.E. DISTRICT

Smart and local
reneWable Energy
DISTRICT heating and cooling solutions for sustainable living

https://wedistrict.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°857801.

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Demonstration site

LULEÅ (Sweden)

Climate zone: Northern European Weather

Excess heat integration in existing district heating

TECHNOLOGIES PLANNED:

- The **excess heat from the data center** is recovered by **liquid cooling technology**
- The excess heat will be boosted to temperatures suitable for supplying the Luleå's district heating by **fuel cell technology**.
- Challenge to construct demonstrator in Northern Sweden is two-fold:
  - **No piped gas,** so the gas will need to be stored.
  - **High temperature** of 3rd generation district heating networks.

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Demonstration site

LULEÅ (Sweden)

Smart and local reneWable Energy DISTRICT heating and cooling solutions for sustainable living

2 tonnes of biogas stored at 150 bar.

Covered trench with gas line, power and data.

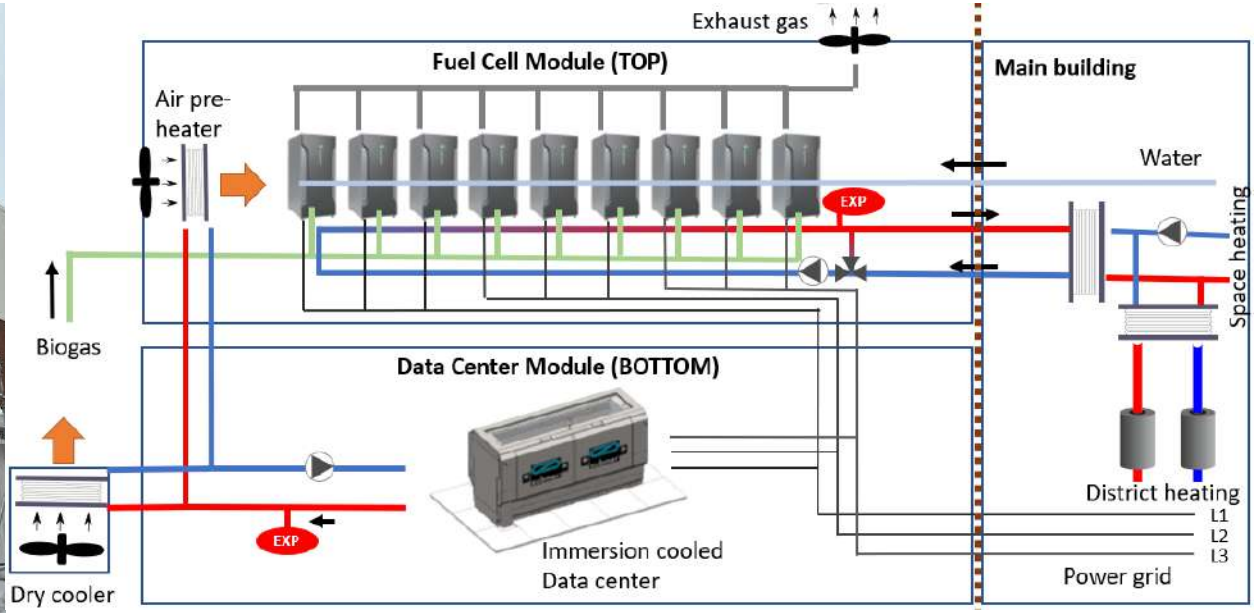
Building with DH network

Fuel cell container with 9 fuel cells

Data centre container

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°857801

Data Center and Fuel Cell container setup



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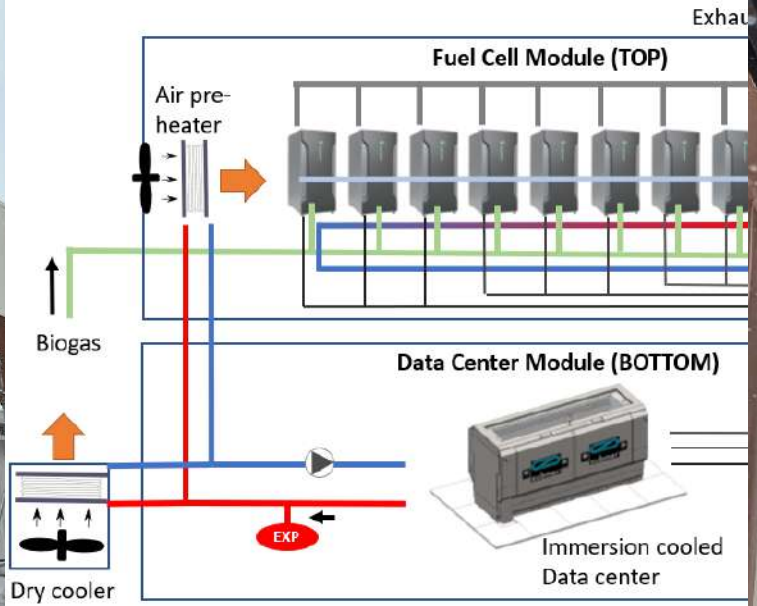
Data Center and Fuel Cell container setup



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Inside the Fuel Cell container

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Immersion cooling setup and tests

Low density OCP Leopard servers with DC bus connection.

- Replace thermal paste with thermal pads
- Removed all labelling from the servers
- Remove the 108 fans from 54 servers
- 2 x Power shelfs with 27kW per shelf connected to a DC bus bar at bottom of tank
- 10.8kW per shelf, so low density.
- Used air cooled heat sinks (not optimal).

Inside the Data Center container




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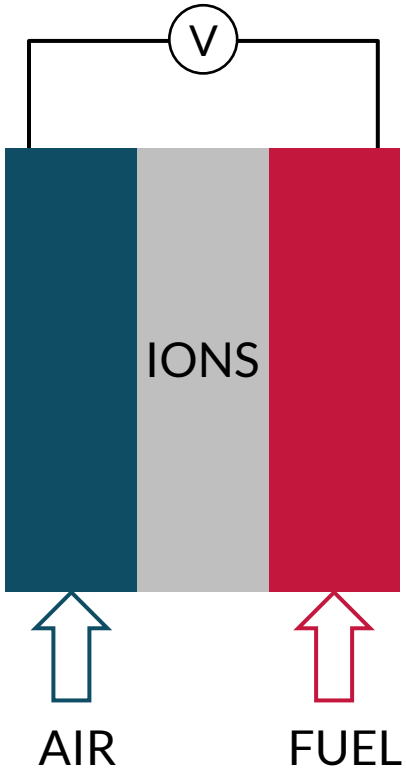
What are fuel cells?

- The first fuel cells were called ”gas batteries”
- It is a box that
  - Generates electricity
  - Sometimes generates usable heat
  - Consumes a fuel and air
- They were initially developed for mobile applications
  - First vehicles were in the 60’s
  - Larger scale roll-out of stationary units started after 2011

How do they work?

- The heart is a layered structure with electrochemical reactions.
- In box there are also
  - Flow regulators
  - Heat exchangers
  - Inverters
  - Etc.

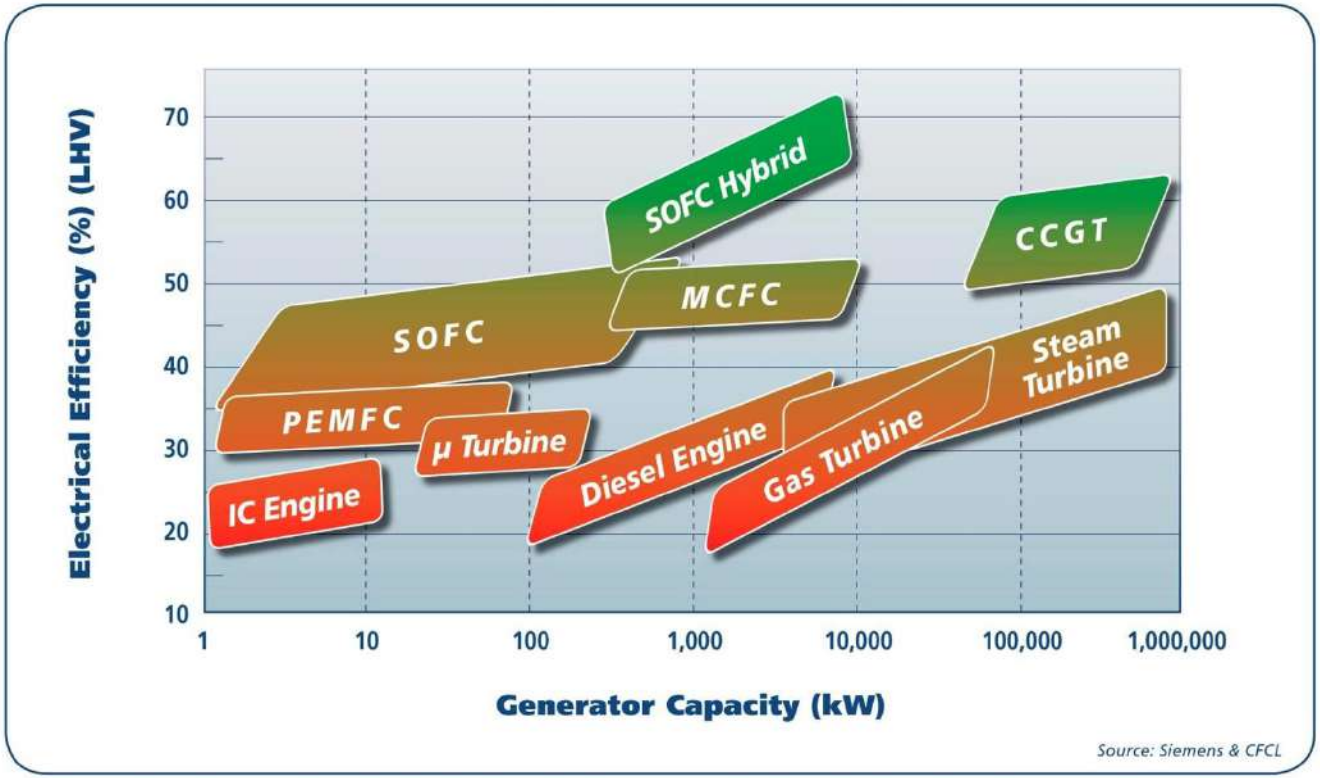
Continuous flow battery



Different types of fuel cells

- 6-7 tested technologies with different chemistry:
  - Alkaline fuel cell (AFC)
  - Phosphoric acid fuel cell (PAFC)
  - Molten carbonate fuel cell (MCFC)
  - **Solid oxide fuel cell (SOFC) [prime power]**
  - **Proton exchange membrane fuel cell (PEMFC) [backup power]**
  - Direct methanol fuel cell (DMFC)
  - Anion exchange membrane fuel cell (AEMFC)

Power generation efficiency



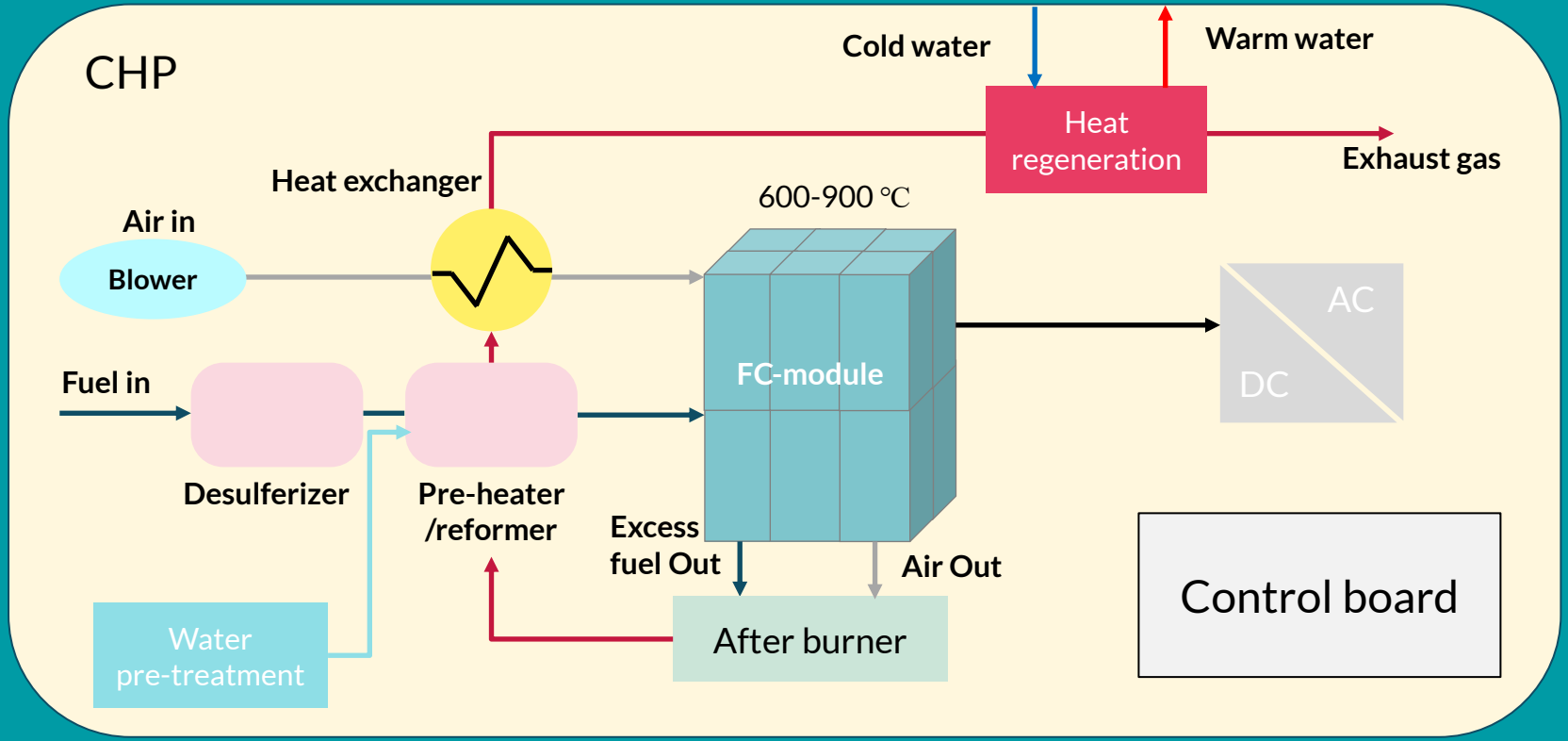
Challenges

- System life today estimate 3 years (~20 000 h)
- Relatively complex to produce
- Most products are **space demanding**
- Limited start/stop cycles
- Slow start-up

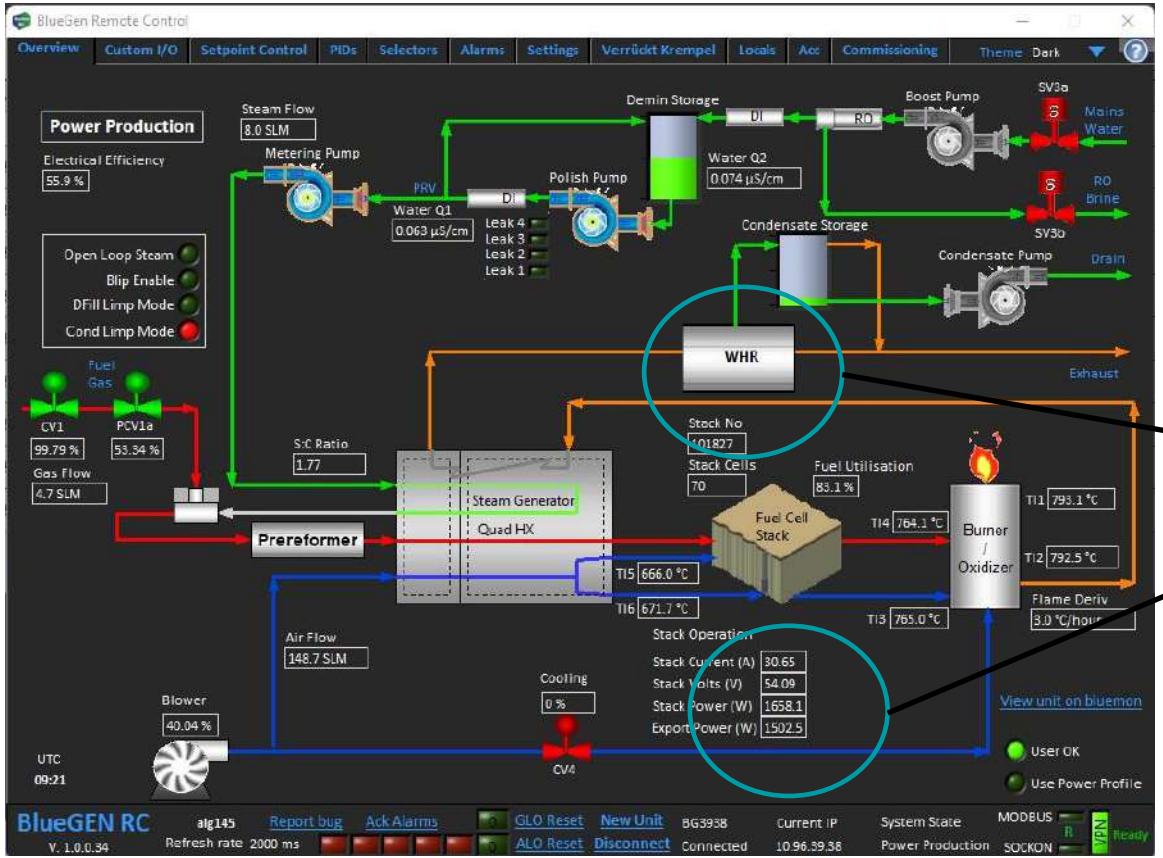
Advantages

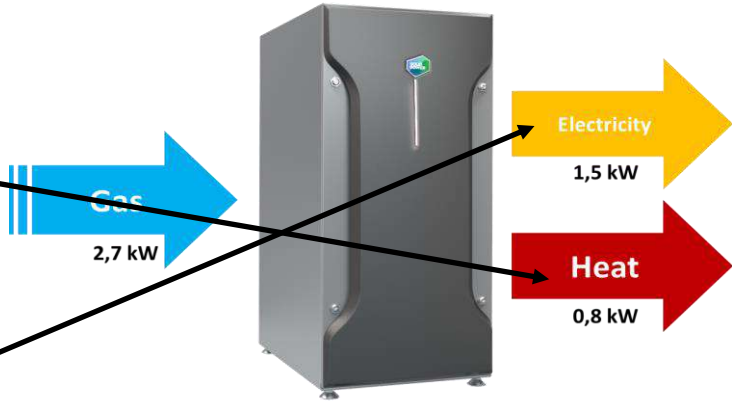
- High efficiency
- Fuel versatile biogas/natural gas/hydrogen
- Possibly reversible
- Only a two phase system, solid and gas.
- Can be combined with both gas turbines and other FC systems for higher efficiency

The FC-system “Box” NG:



Power production (SOFC)





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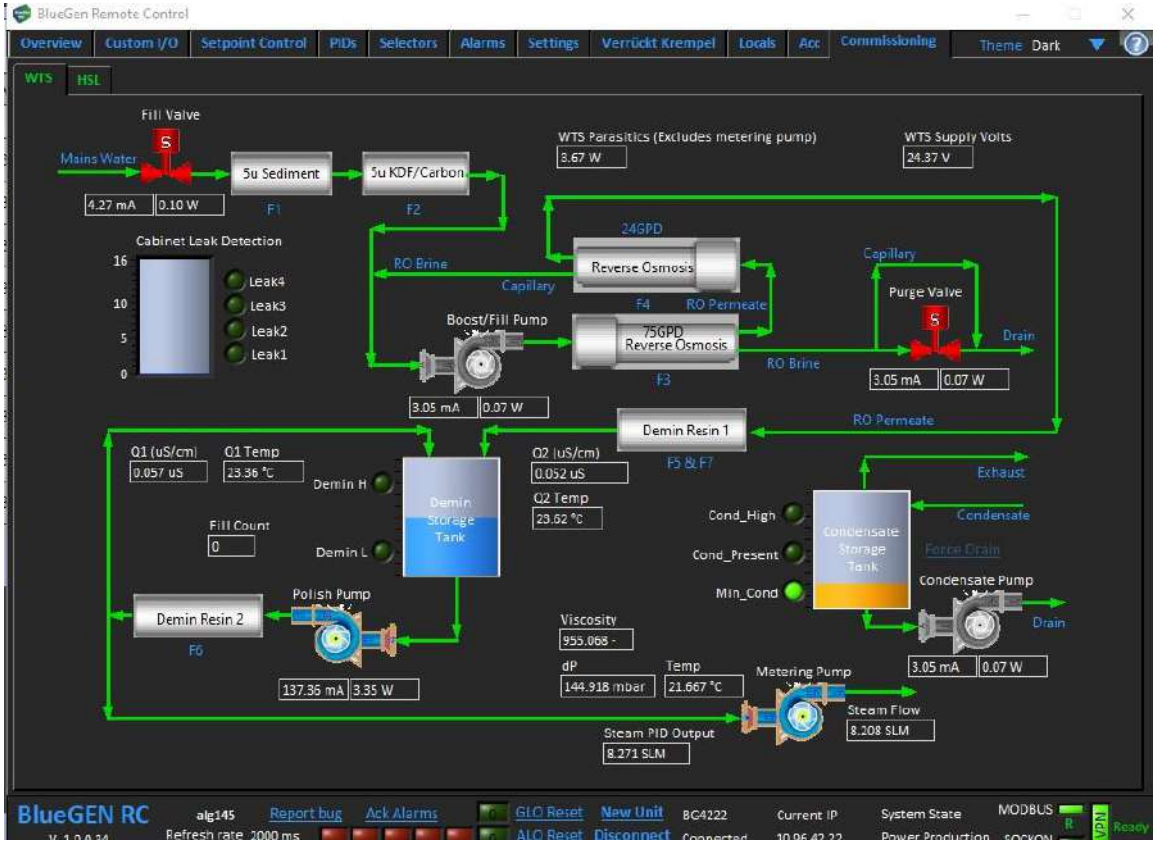
Water treatment (SOFC)



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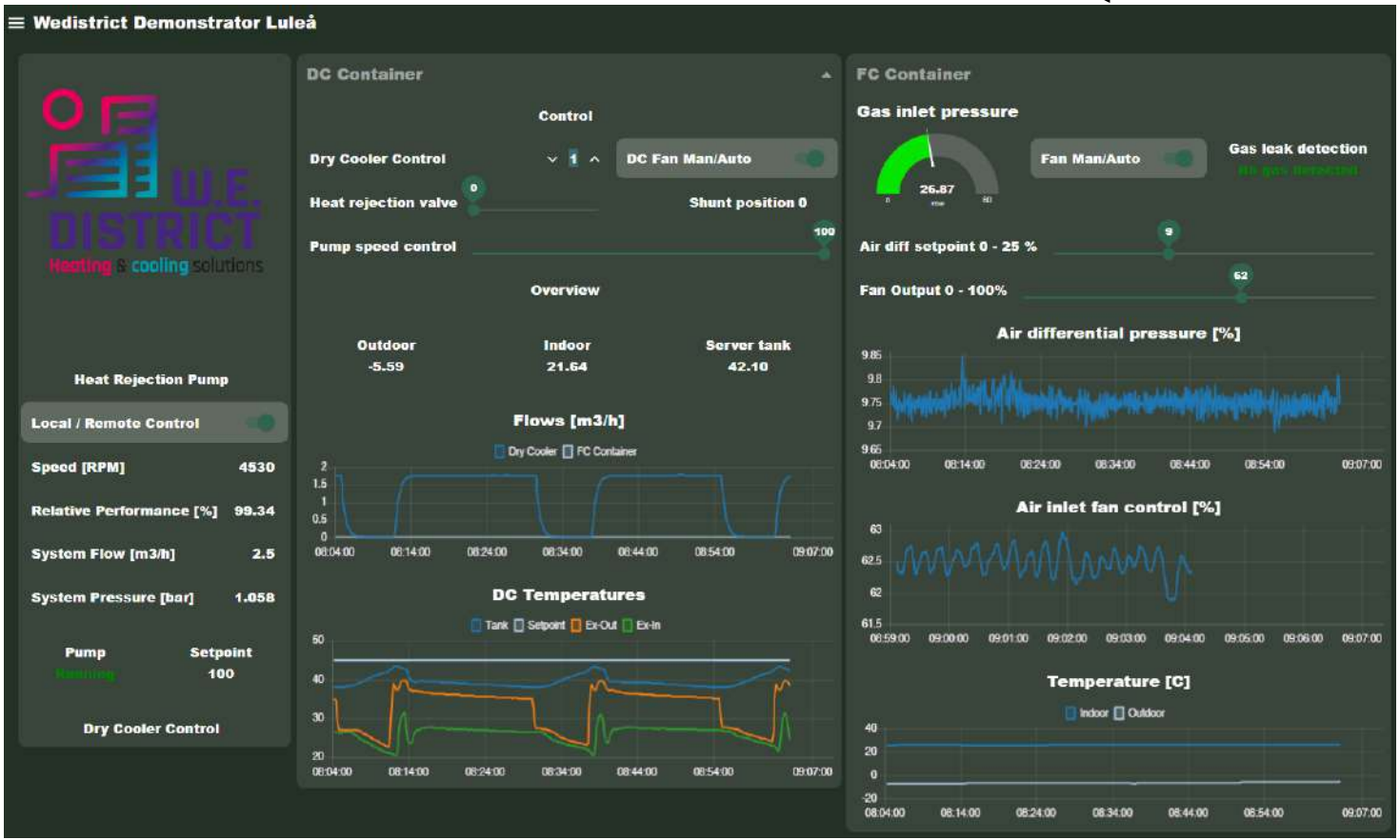
DC and FC container control (node red)



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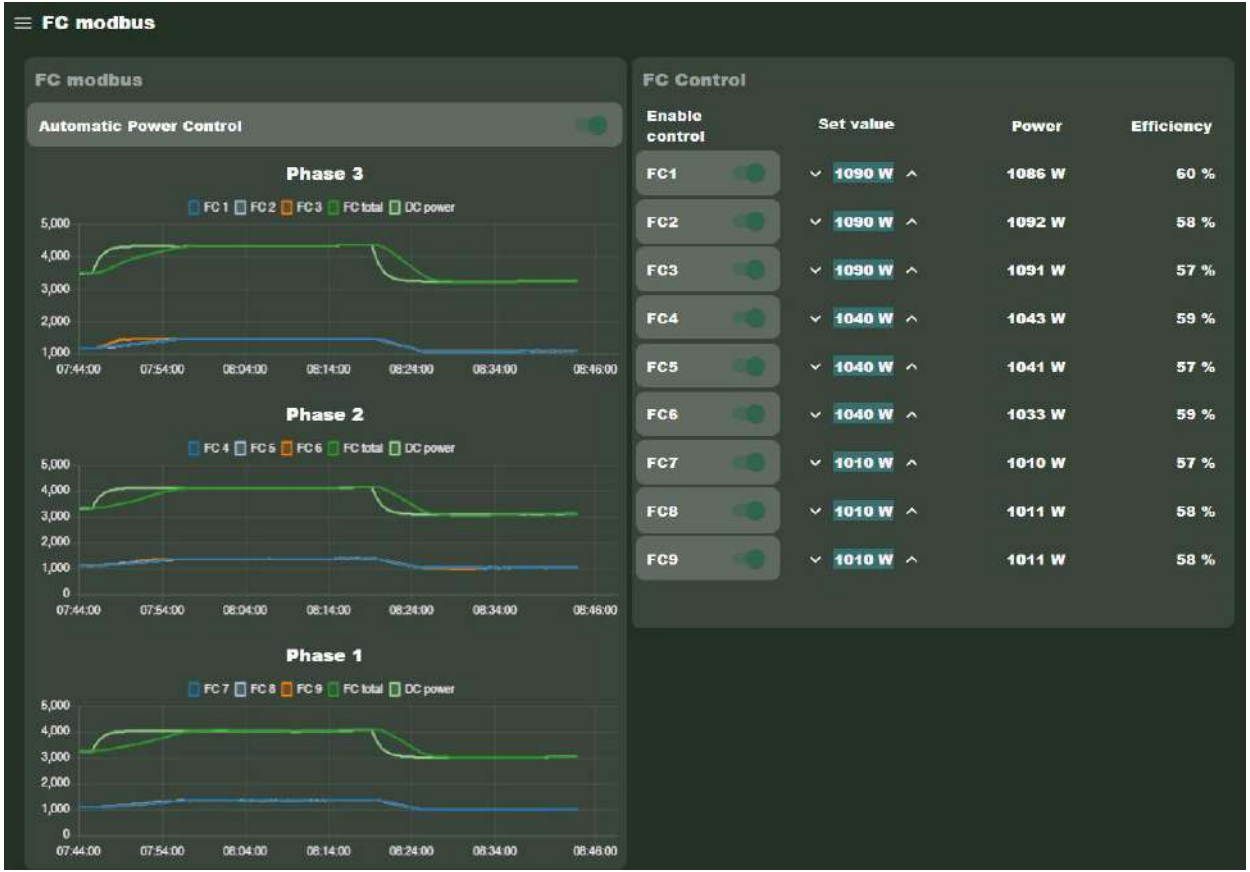
Fuel cell units control (node red)



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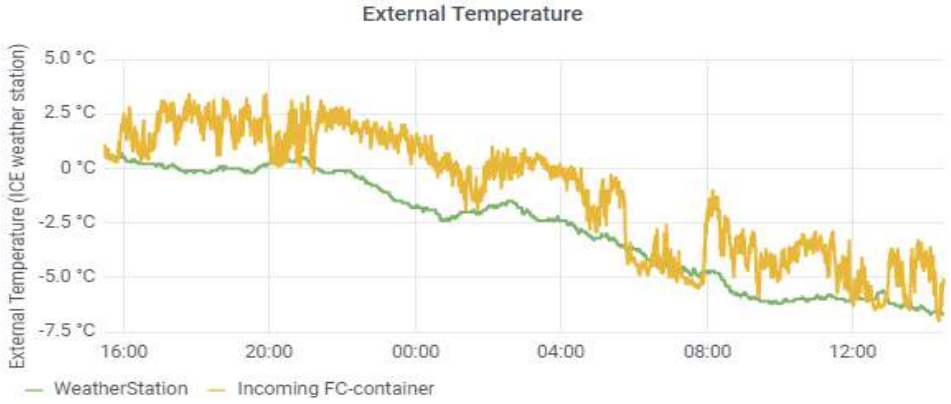
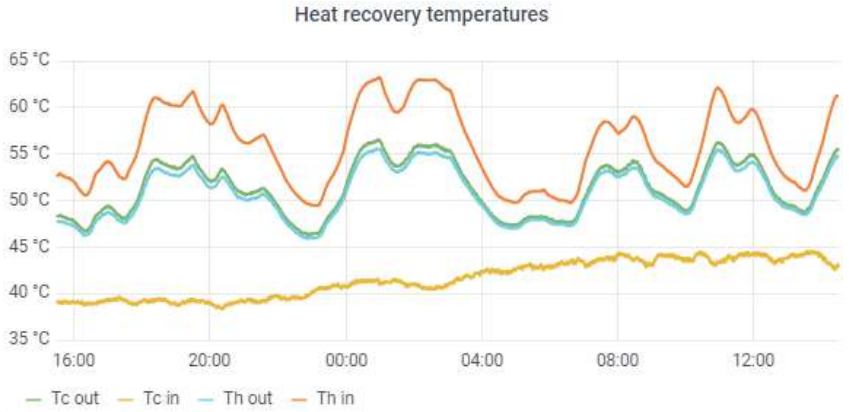
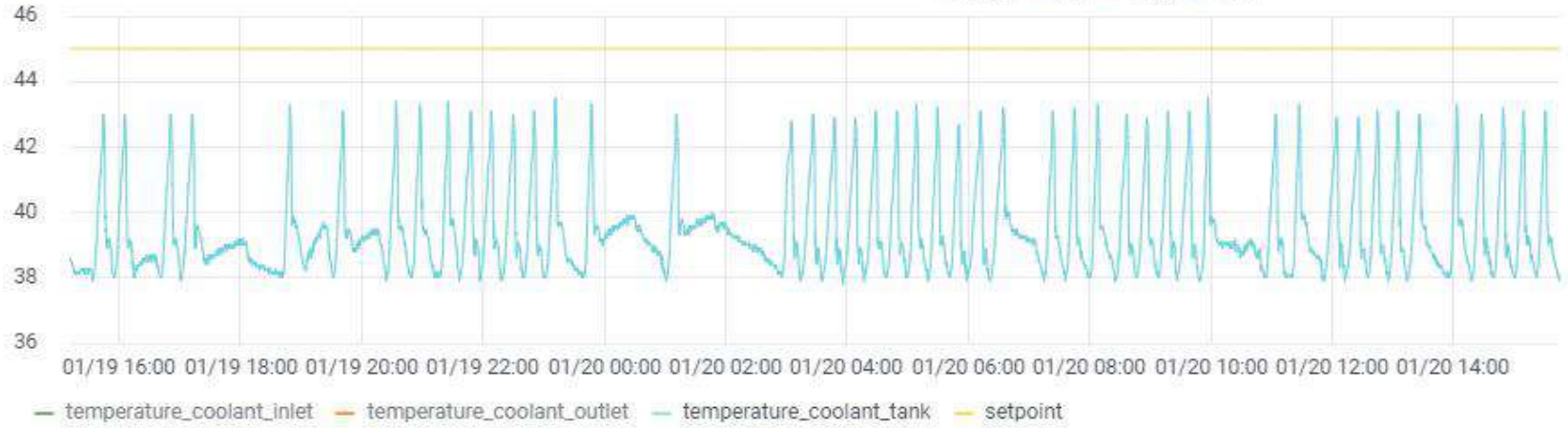
Data center waste heat recovery full system







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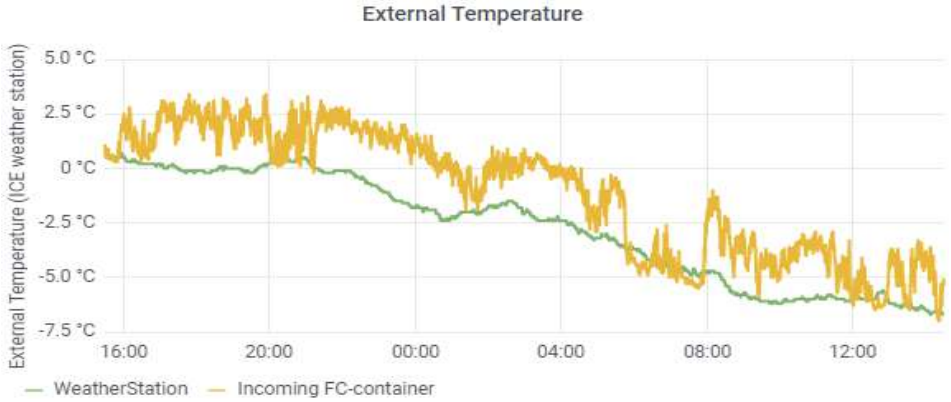

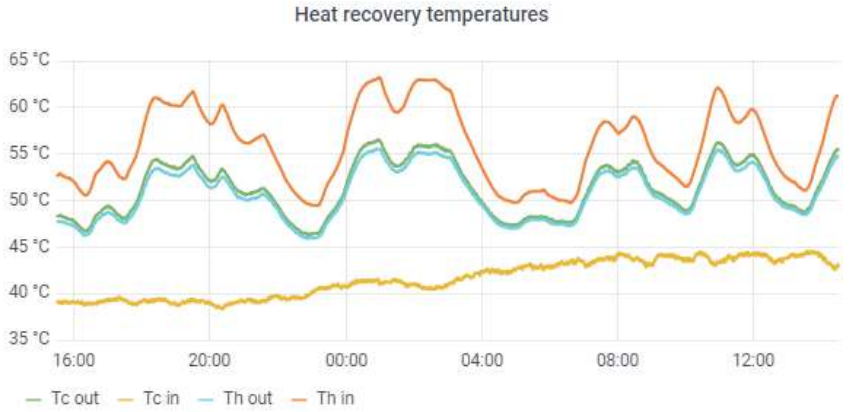

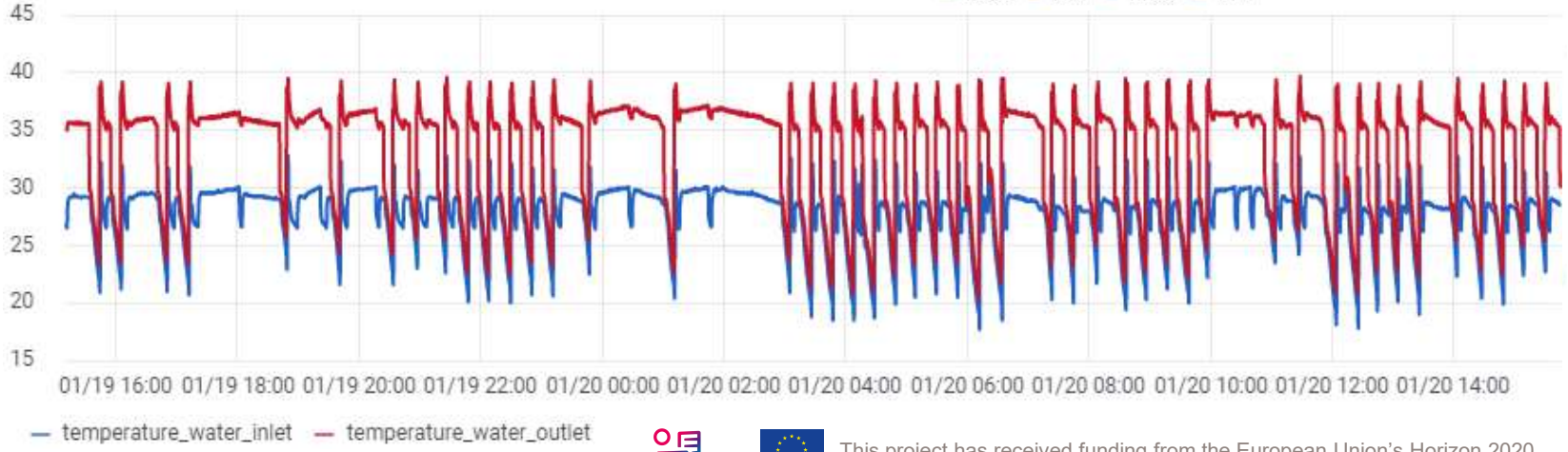

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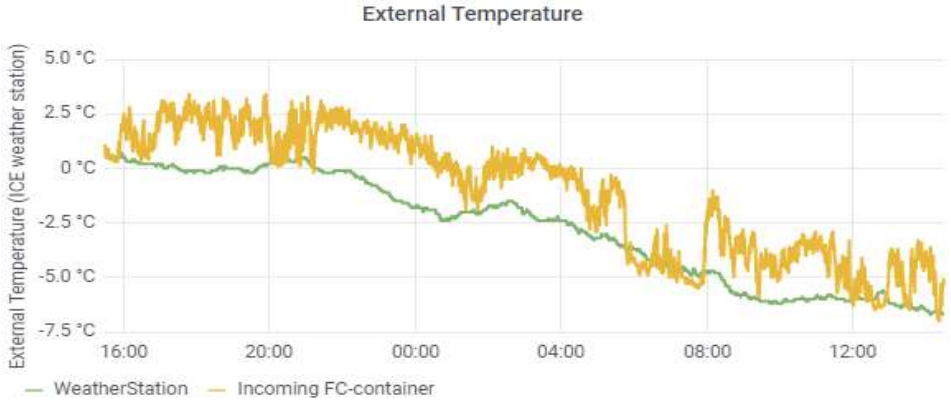

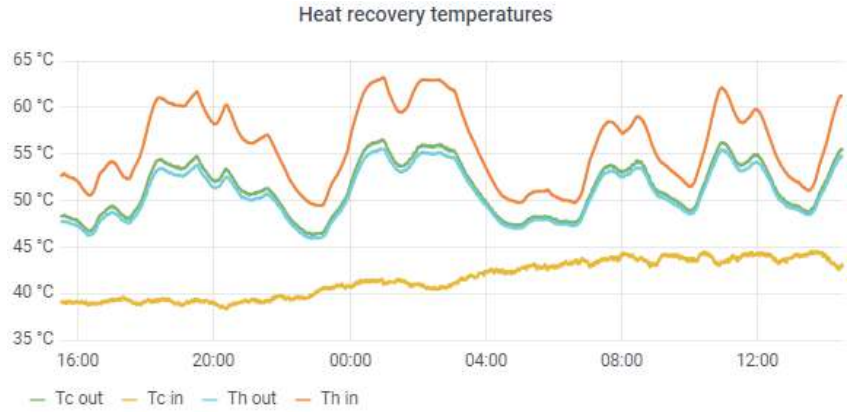

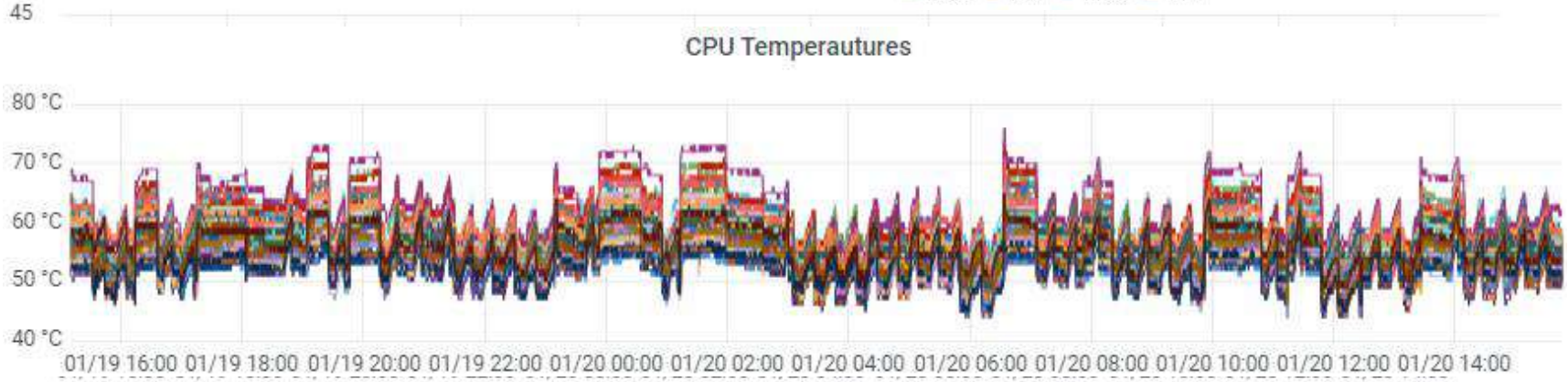

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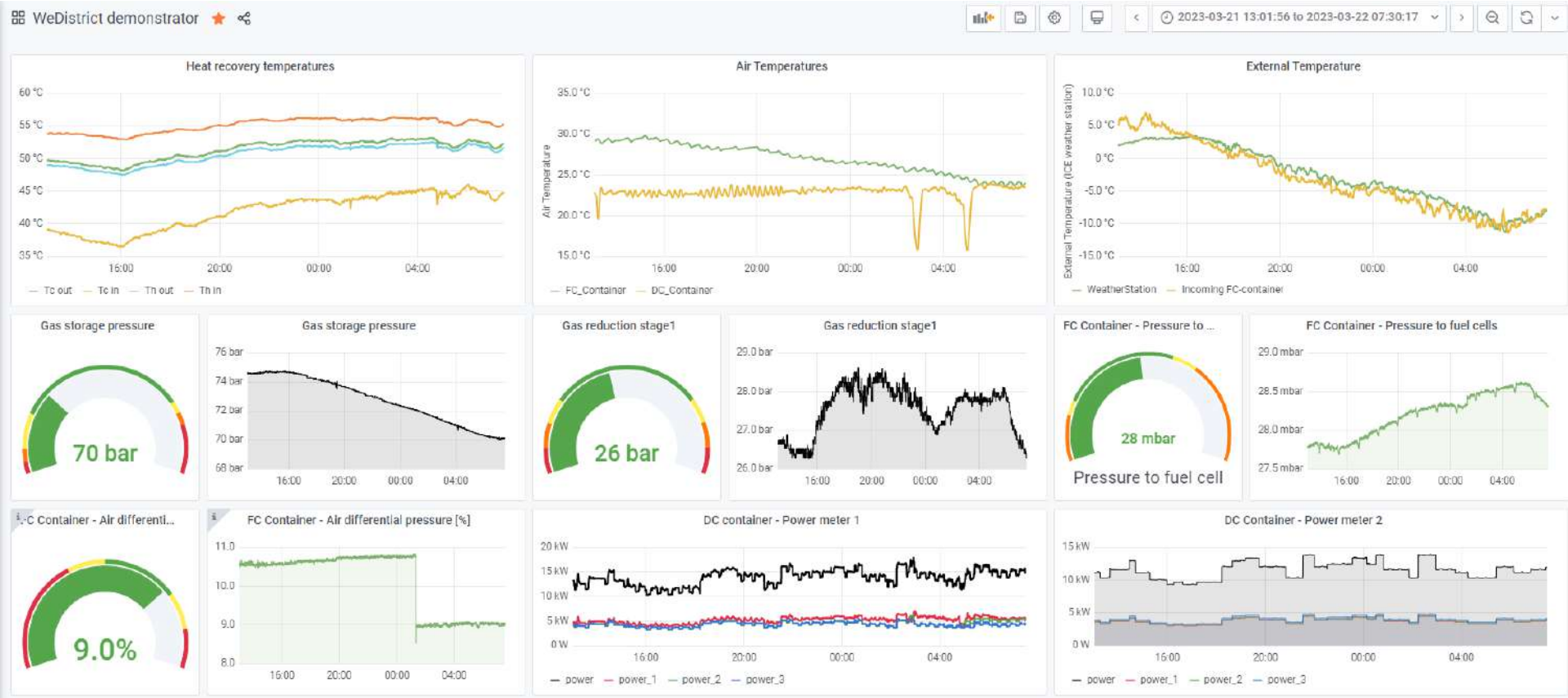
Data center and fuel cells full operation



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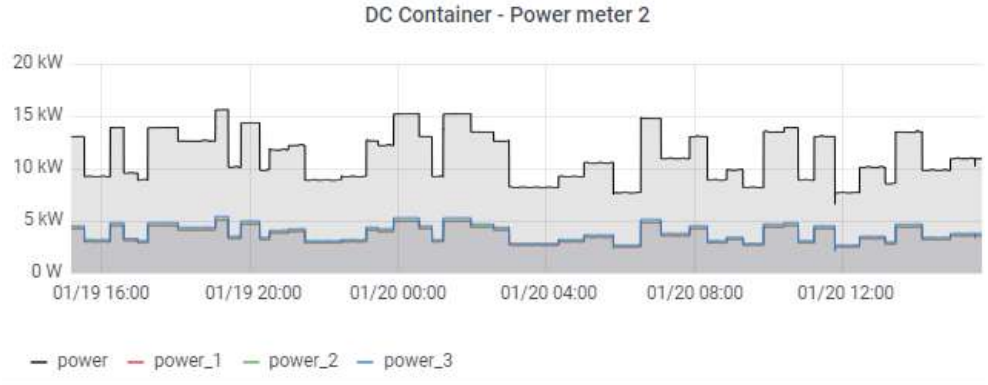
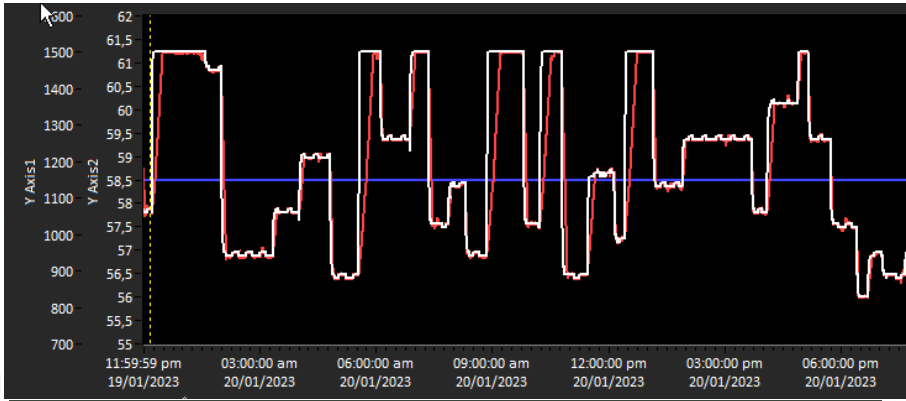
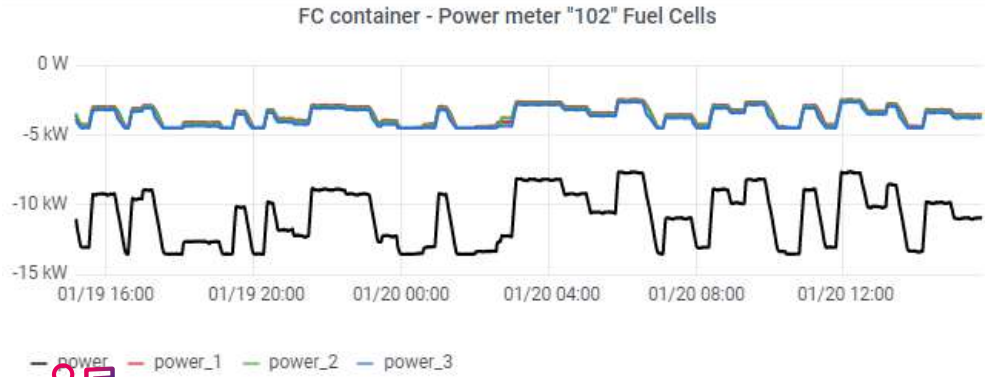
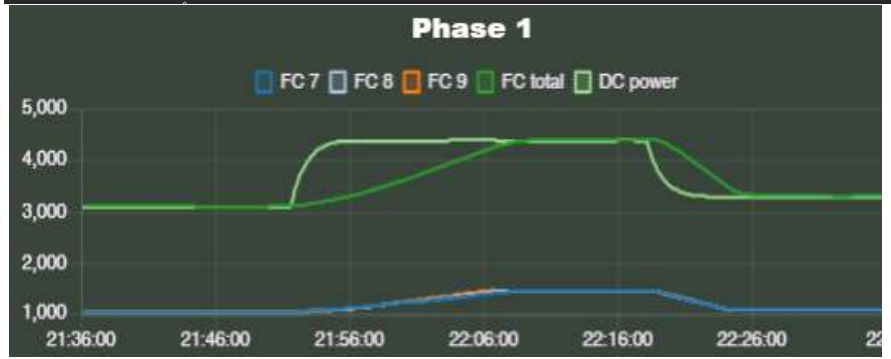
Data center waste heat recovery
power and thermal data









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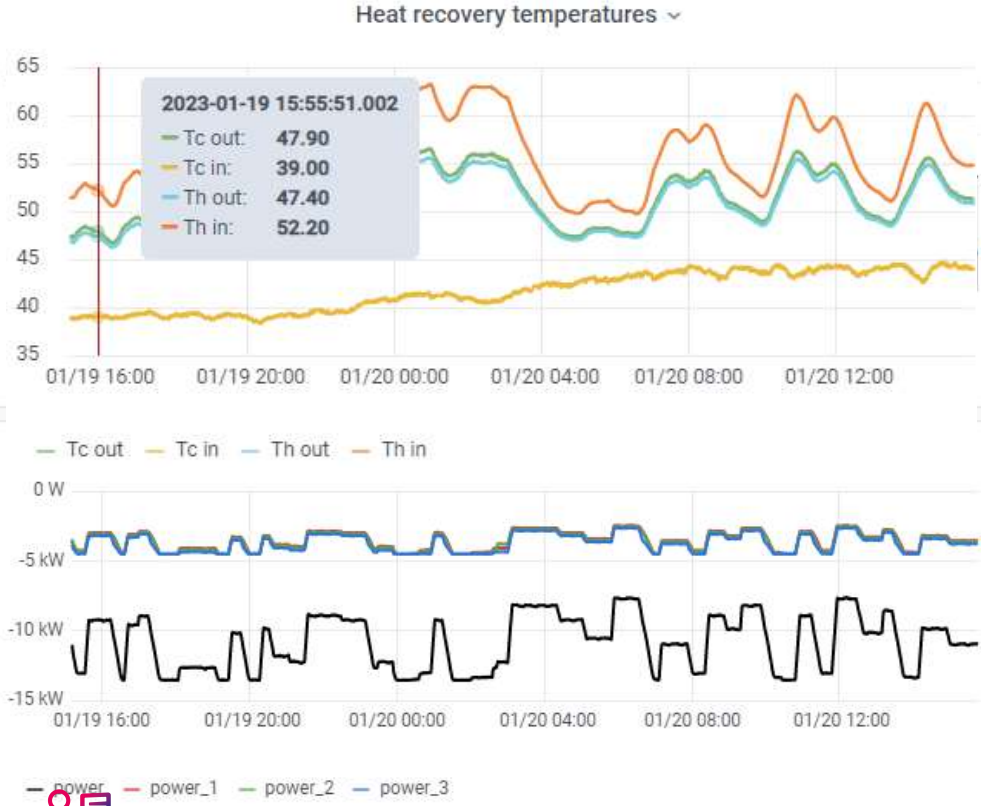
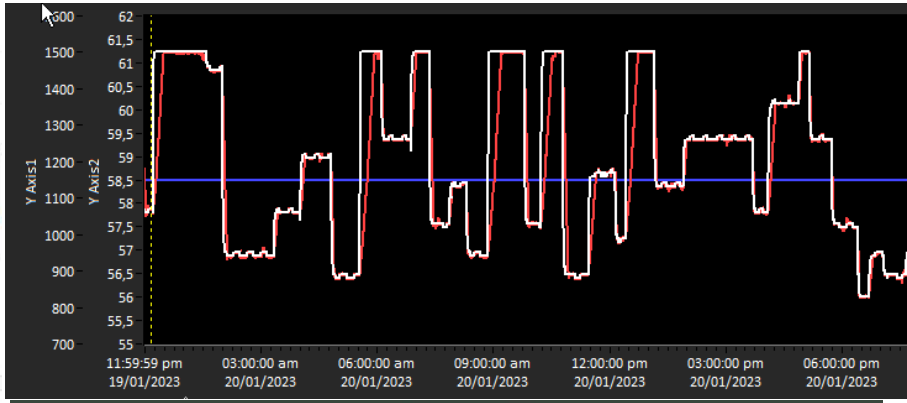
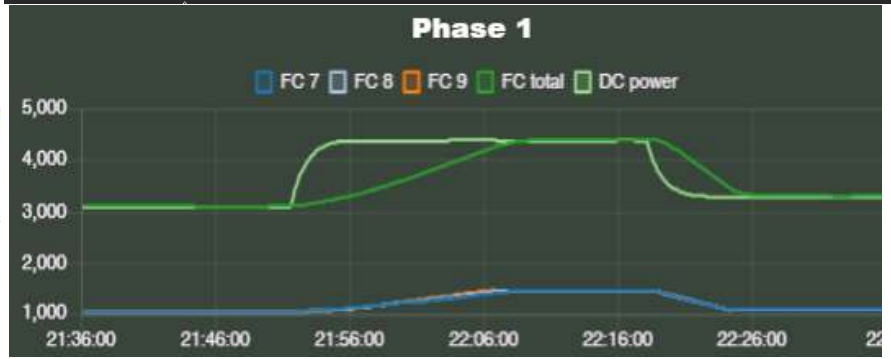
Data center waste heat recovery

power and thermal data







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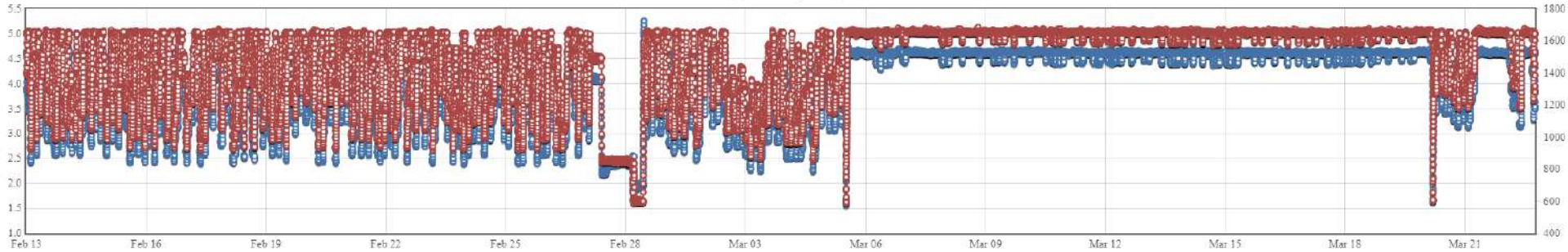
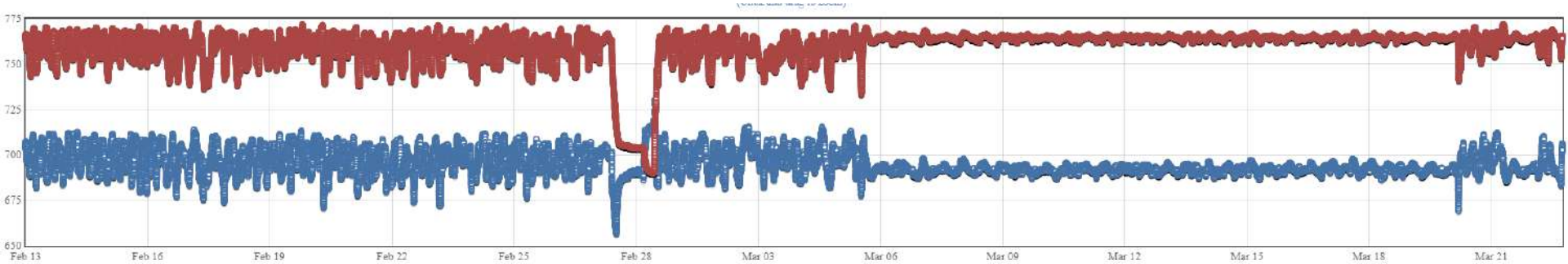
Fuel cell operational data collected

Stack fuel consumption in standard litres per minute / DC power generation



Stack inlet and outlet temperatures



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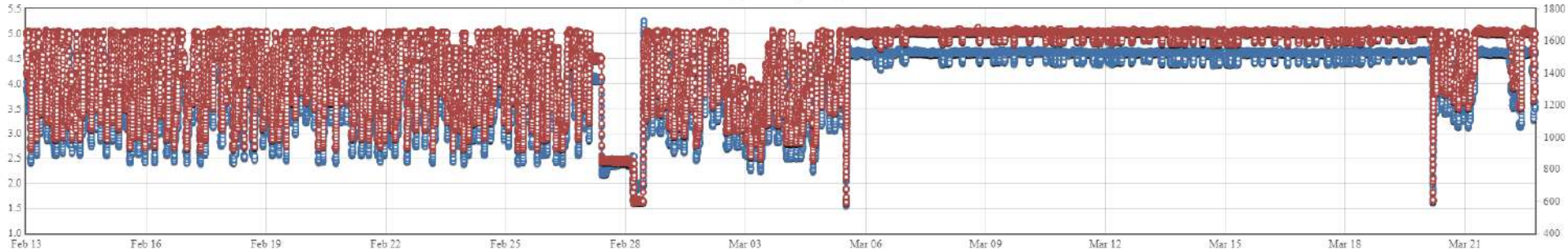
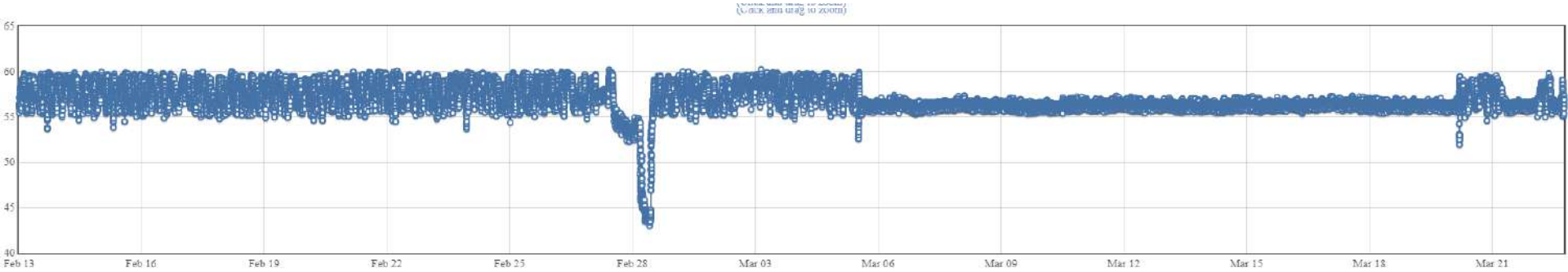


Stack inlet and outlet temperatures

And electrical efficiency.



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Data center waste heat recovery

Some takeaways on Wedistrict.

- Current setup of the demonstrator shows capability of recovering heat up to 65°C with -10 °C outside. Adding further insolation can improve this.

- The fuel cells are operating at >55% electrical efficiency with biogas. Sweet spot of operation around 1200-1300W per FC for nearly 60% efficiency, but heat is recovery reduced, but can still recover heat at over 55 °C.

- The immersion system can reject heat to the FC container at a supply temperature of up to 35°C (after losses) operating immersion with a setpoint of 45°C.

- General discussion points: edge, island mode, partial hydrogen solution, noise levels, urban deployment, reduced load on electrical grid in urban areas.

W.E. DISTRICT

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RI. SE

Thanks to our friendly collaborators who supplied equipment for the demonstrator.

Thanks also to my colleagues at the RISE ICE datacenter and partners on the WEDISTRICT project.

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