Luleå Warmer Because of Summers.

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AGENDA

- The proof-of-concept solution.
- The WEDSTRICT project and the operating demonstrator in Luleå, Sweden.
- Results from the operating demonstrator in Luleå with its heat recovery setup.

What was the task for RISE ICE datacenter in the WEDistrict project?

- Build a demonstration of liquid cooled edge that is quiet, low impact on the electrical grid and provides heat for direct use in adjacent buildings.
- The WEDistrict project enabled a proof-of-concept to be built in the north of Sweden.
- The concept used three containers:
    1. Storage of locally produced biogas of quality for automotive applications
    2. A network of solid oxide fuel cells to generate electricity and useful heat.
    3. A containerised, immersion system using repurposed Leopard (OCP) 400W servers.
- Challenging climate and location – so if it could be achieved in Luleå it could be done anywhere!

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

LULEÅ (Sweden)

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

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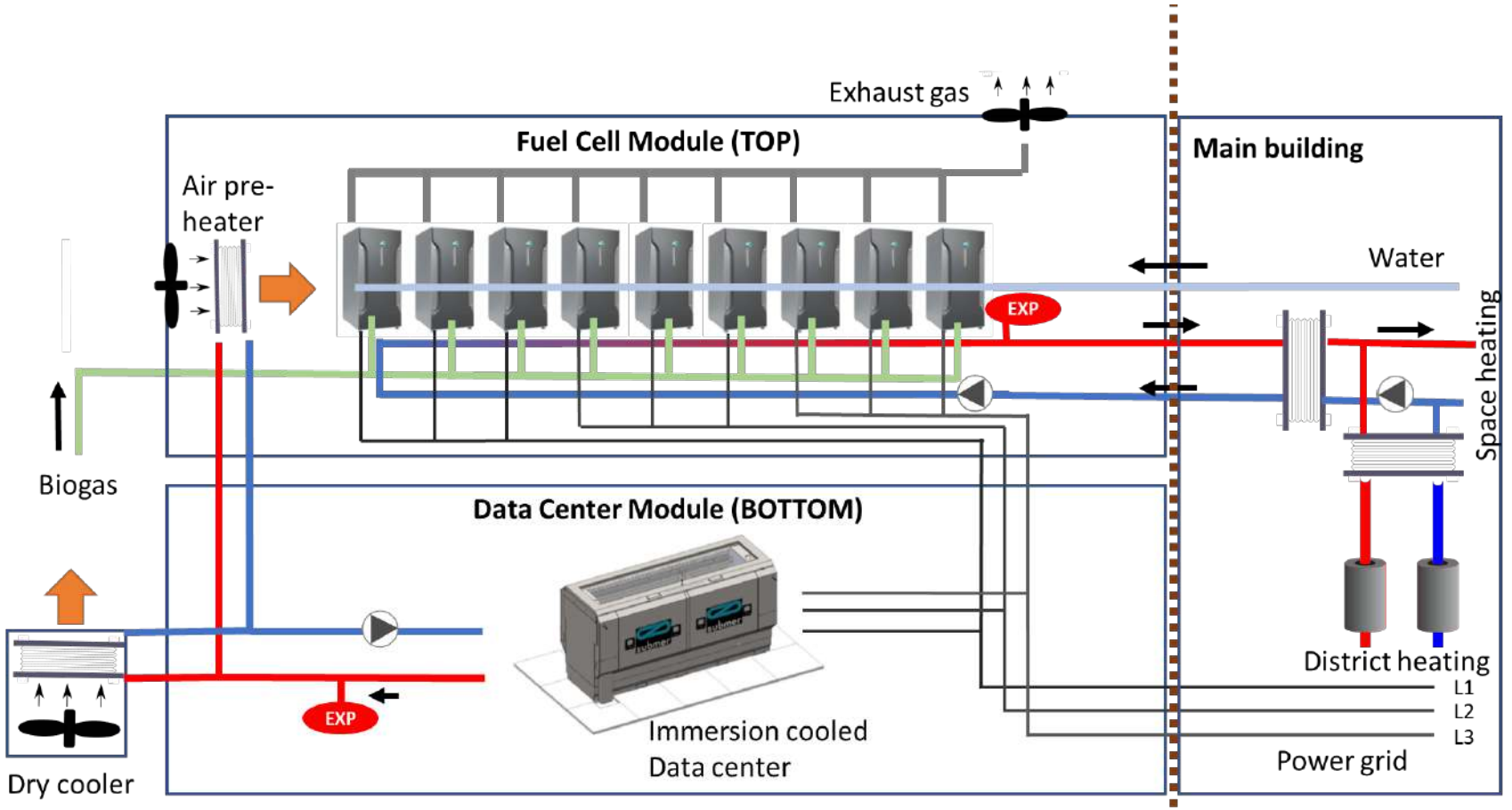
Data Centre and Fuel Cell container setup



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Inside the Fuel Cell container

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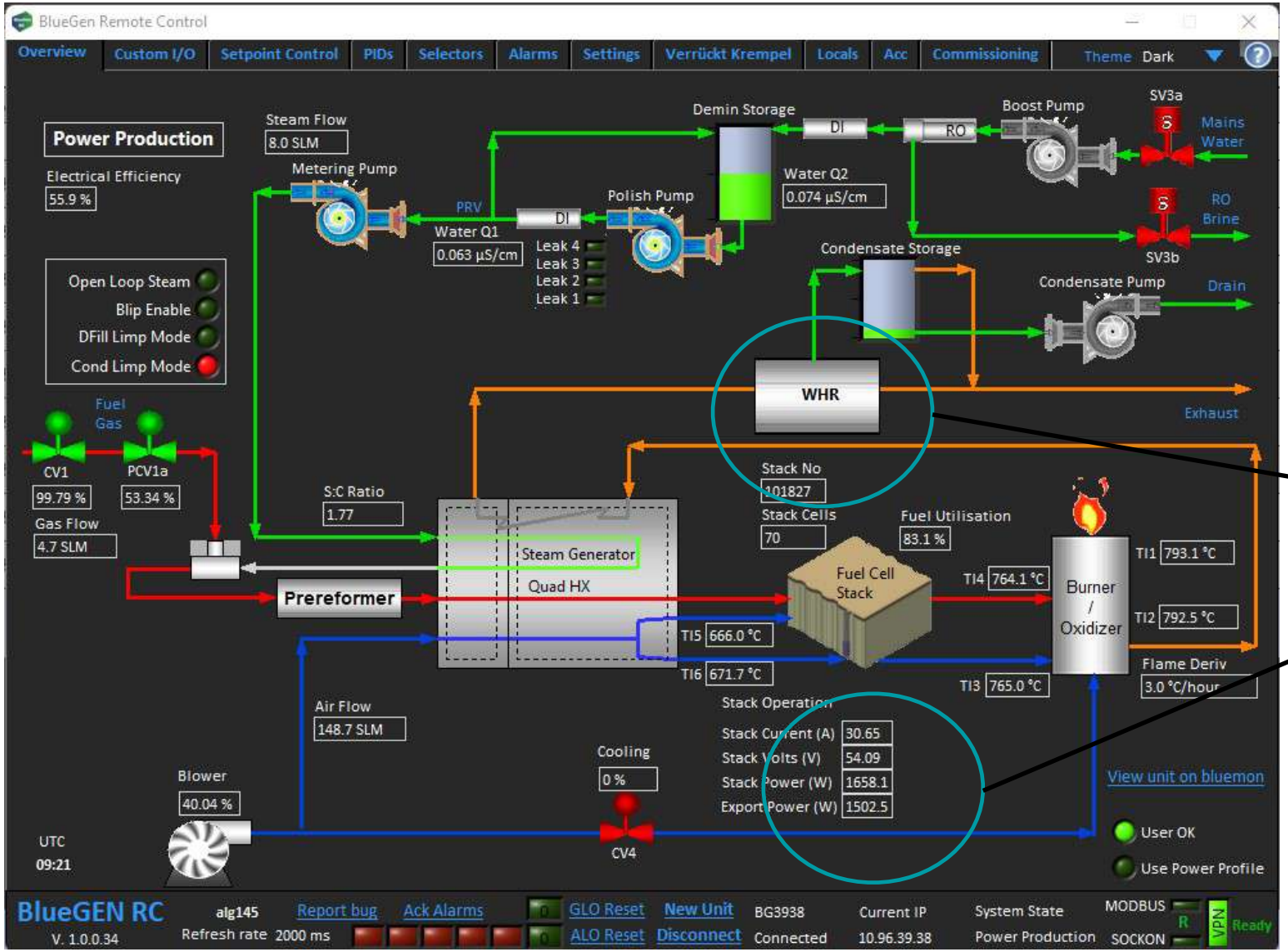
Power production (SOFC)



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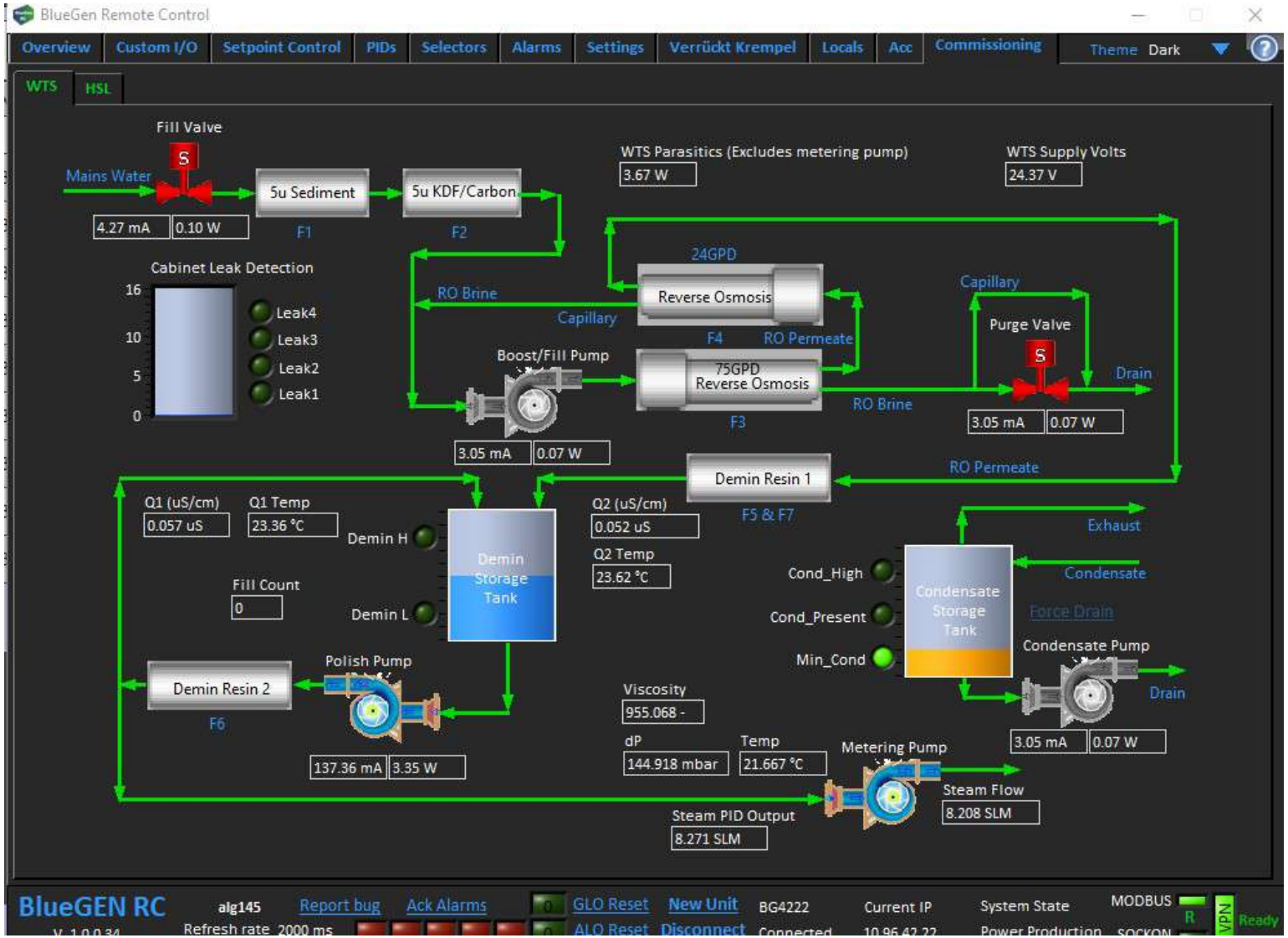
Water treatment (SOFC)



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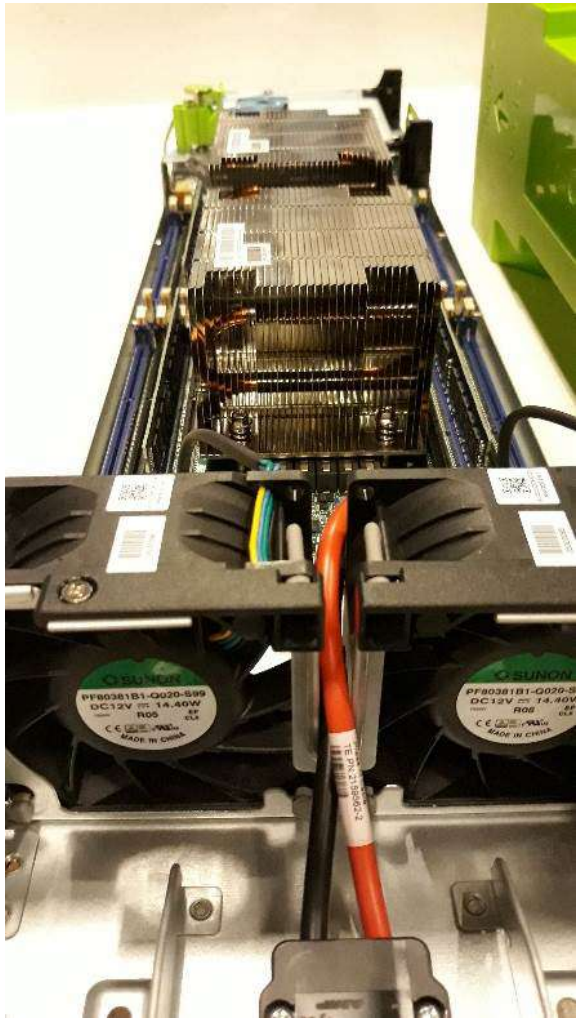
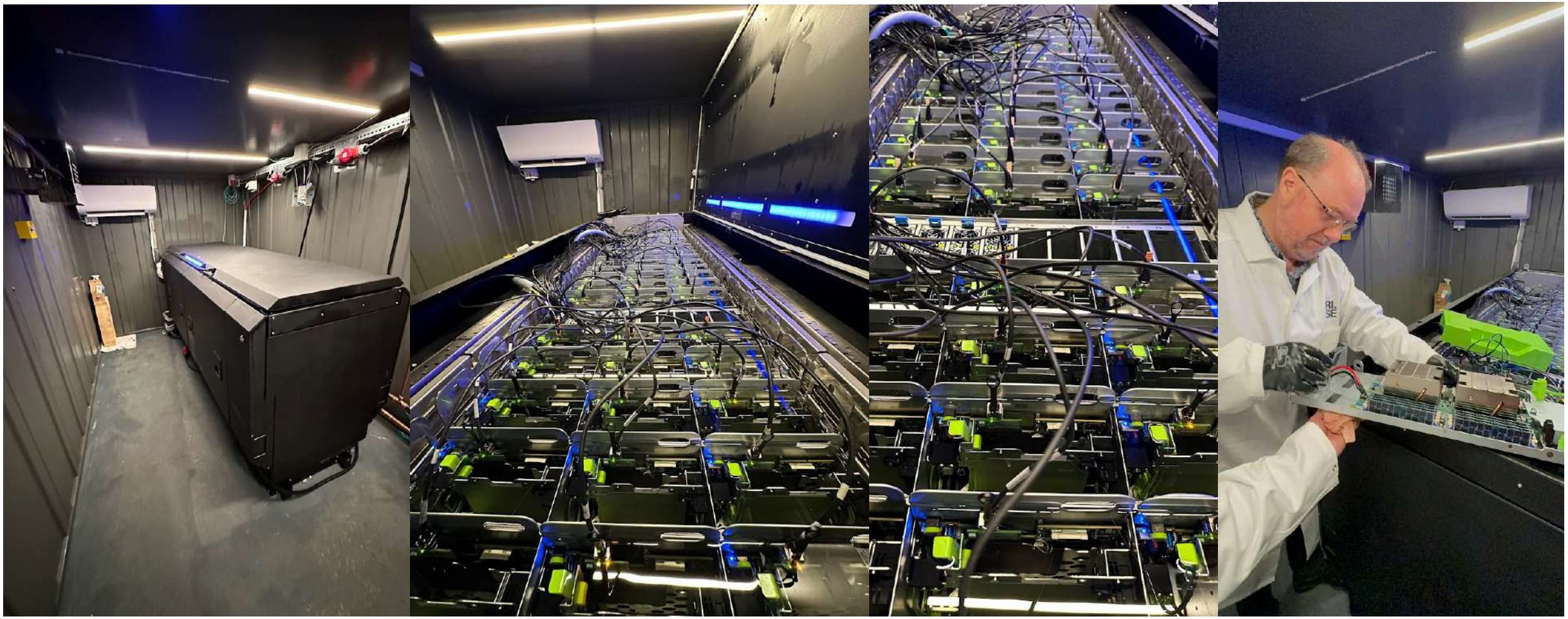
Immersion cooling setup and tests

Low density OCP Leopard servers with
direct current (DC) bus connection.

- Replace thermal paste with thermal pads (indium and graphene testing)
- Removed all labelling from the servers (many sticky labels)
- Remove the 108 fans from 54 servers
- 2 x Power shelfs with 27kW (9 x 3kW PSUs) 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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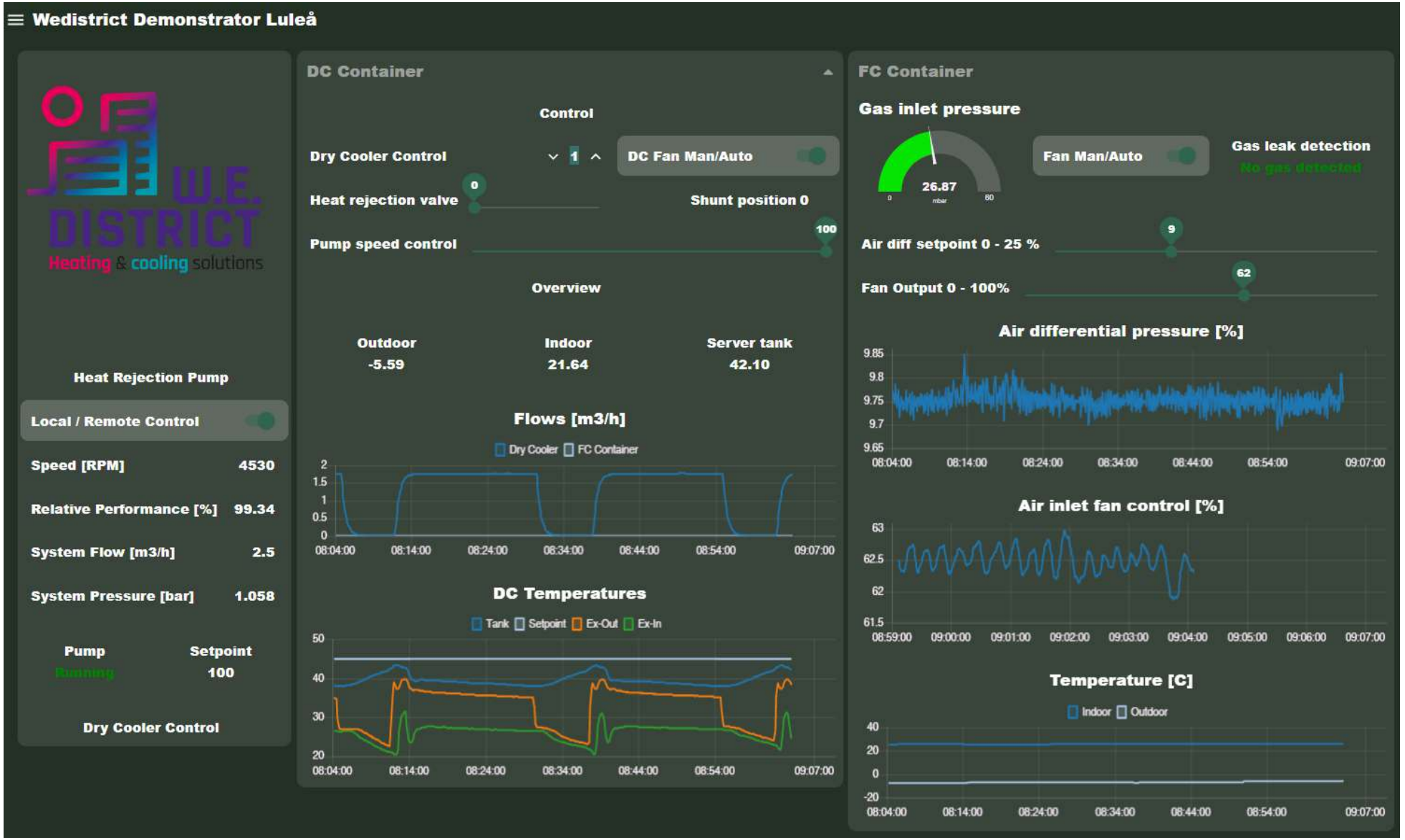
DC and FC container control (node red)



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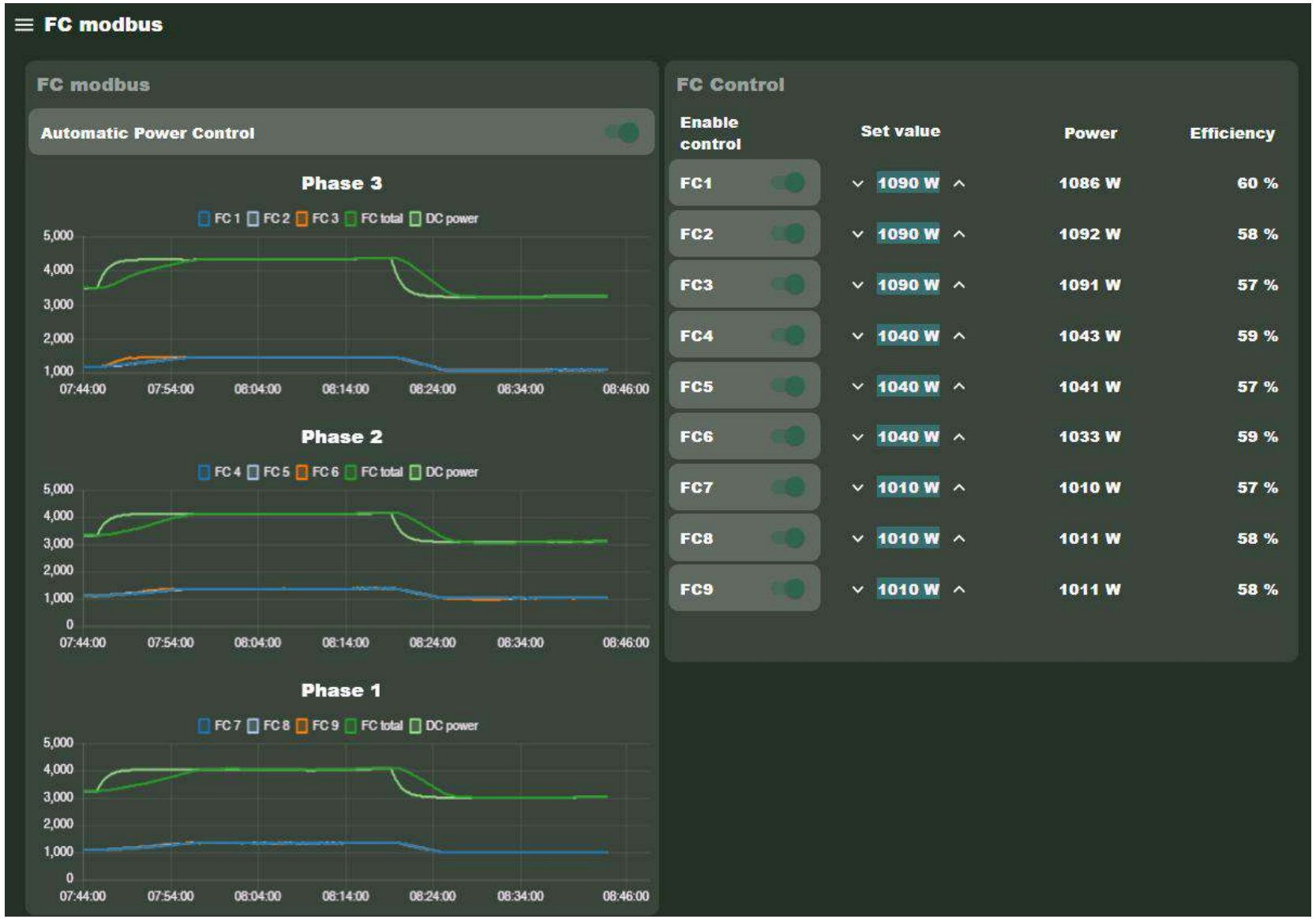
Fuel cell unit control (node red)



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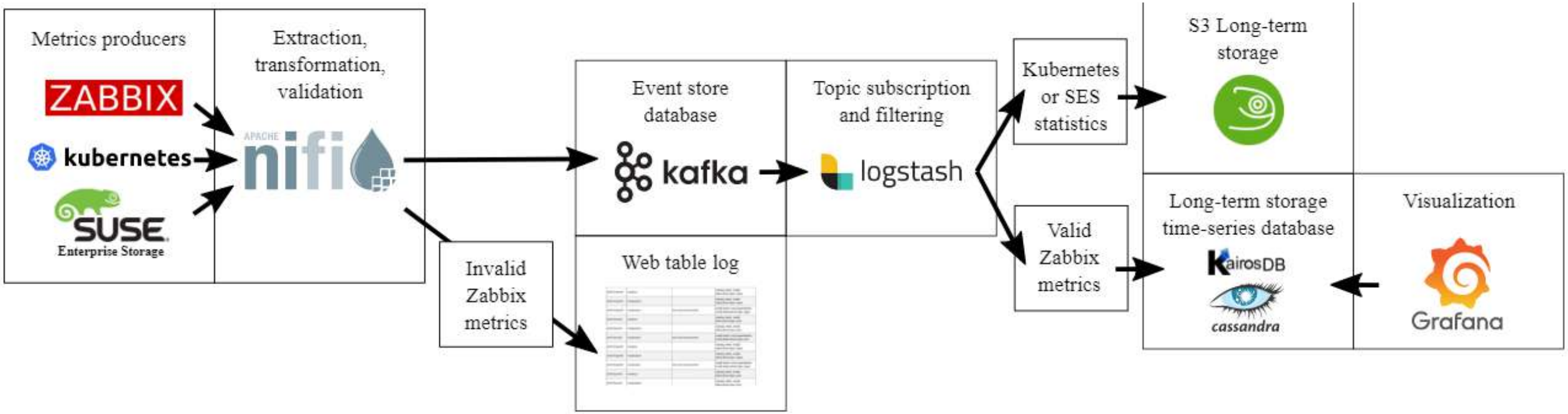
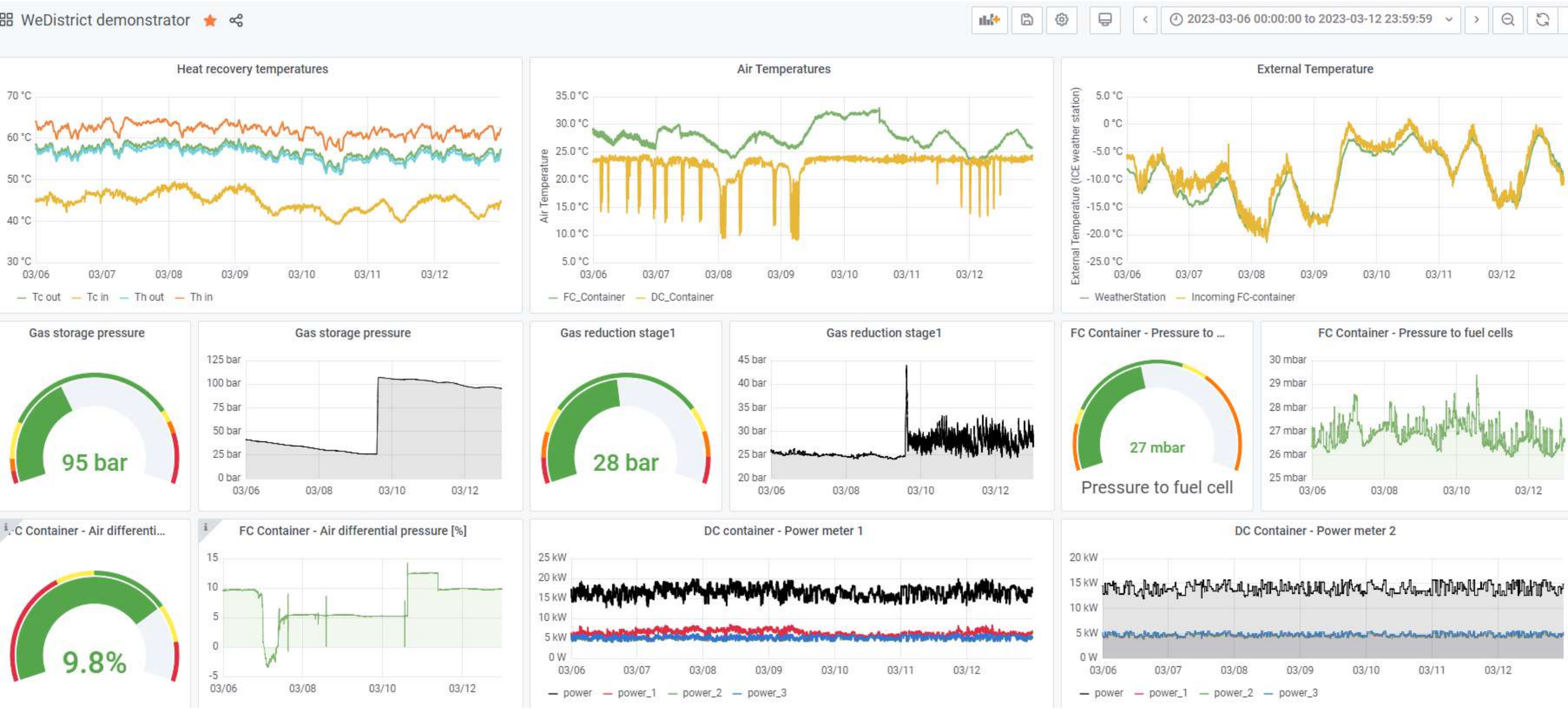
The demonstrator is monitored with long-term data storage in mind.



Data centre and fuel cells full operation



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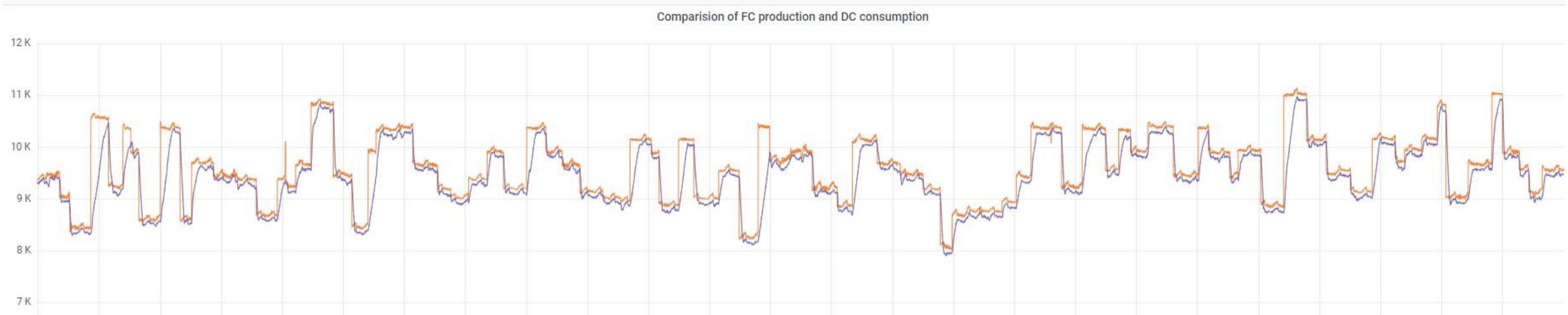
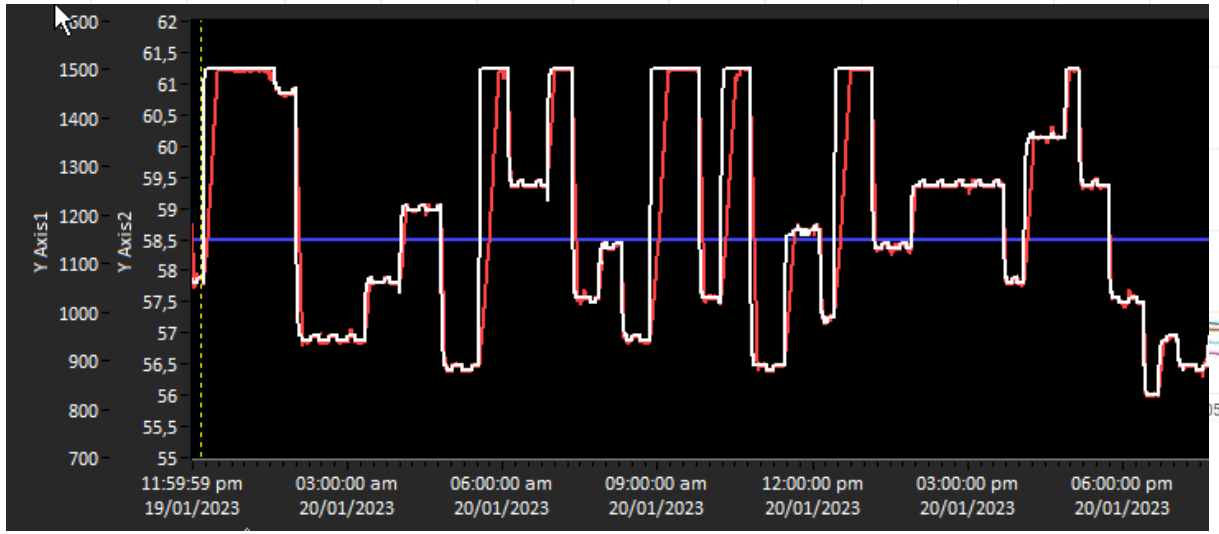
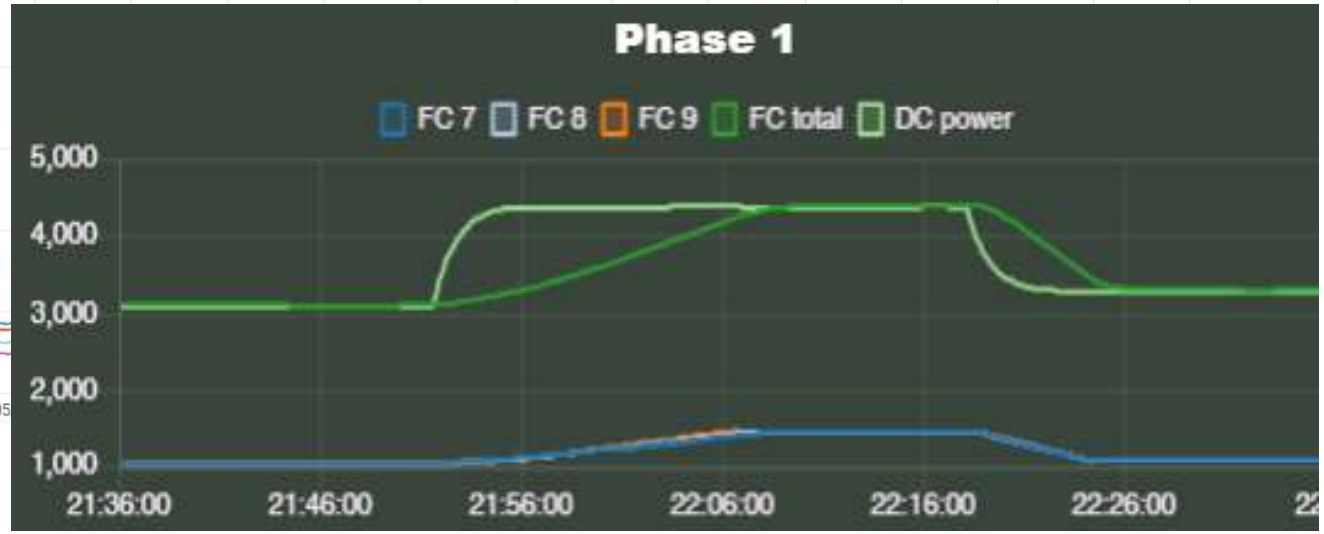
Data centre waste heat recovery
power demand and production







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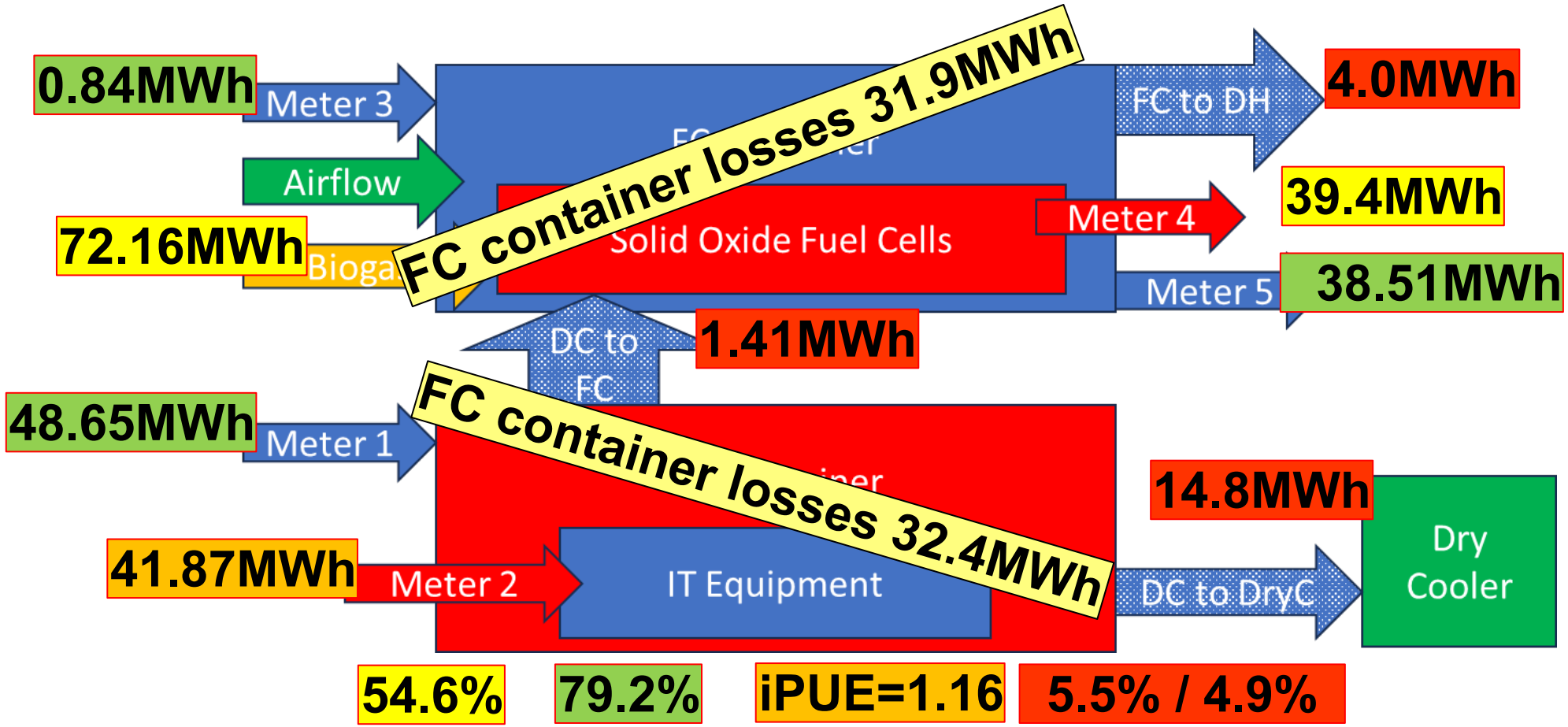
Energy flows during monitored period.

Complete operational datasets from 11/01/2023 to 16/06/2023



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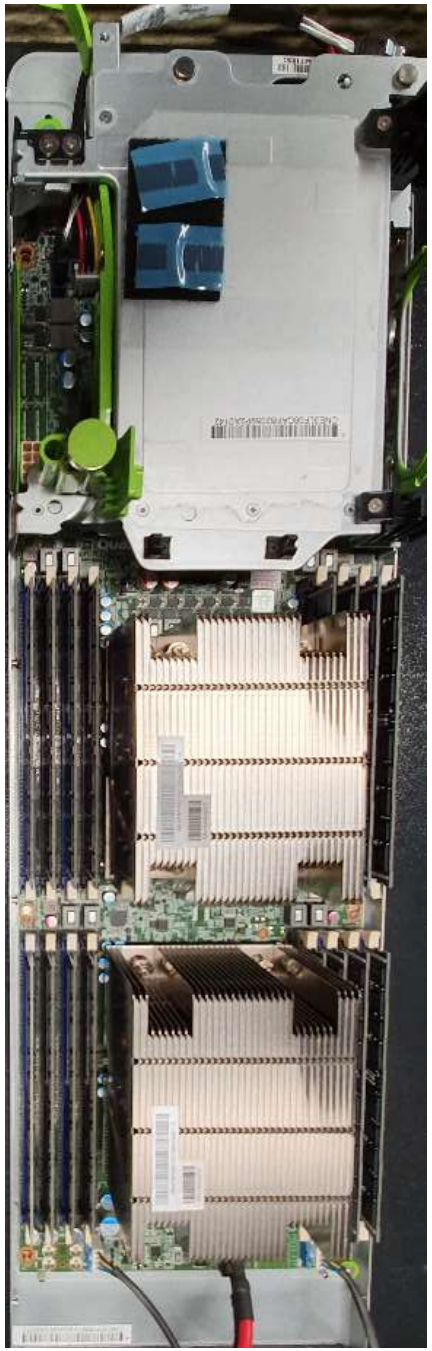
Data from the immersed OCP servers.

- Immersion tank set point used was 45, 50 and 55 degrees centigrade.
- 54 OCP servers with the heat sinks for air cooling (use a lot of tank volume).
- CPU 2 is lower in the immersion tank than CPU 1 (108 x 120W CPUs).
- Statistics on the difference between the CPU and tank temperatures:
- Workloa small:

Tank temp (ºC)	CPU 1 Avg (ºC)	CPU 1 Std (ºC)	CPU 2 Avg (ºC)	CPU 2 Std (ºC)
Setpoint of 45	18.646	1.23991	15.40541	0.99745
Setpoint of 50	19.34378	1.191315	16.03665	0.948931
Setpoint of 55	19.43984	1.3793	15.99343	1.172388

Tank temp (ºC)	CPU 1 Avg (W)	CPU 1 Std (W)	CPU 2 Avg (W)	CPU 2 Std (W)
Setpoint of 45	79.16784	7.470789	77.33415	7.773683
Setpoint of 50	80.79432	7.078337	78.07464	7.284307
Setpoint of 55	80.3909	7.898025	77.94389	8.050226



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Data centre waste heat recovery

Some takeaways from the proof-of-concept.

- Current setup of the demonstrator demonstrated capability of recovering heat at up to 65°C with nearly -20 °C outside. Adding further insolation can improve this.
- The fuel cells are operating at approx. 55% electrical efficiency with the locally produced biogas.
- Immersion system shows a 15 °C to 20 °C difference between coolant and CPU case temperatures with tank operating comfortably at a 45°C setpoint even when using the original air-cooled heat sinks.
- General discussion points: AI workloads at the 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 for listening.

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