WEDISTRICT: POWERING URBAN EDGE DATA CENTERS ON BIOGAS WITH DIRECT HEAT RECOVERY

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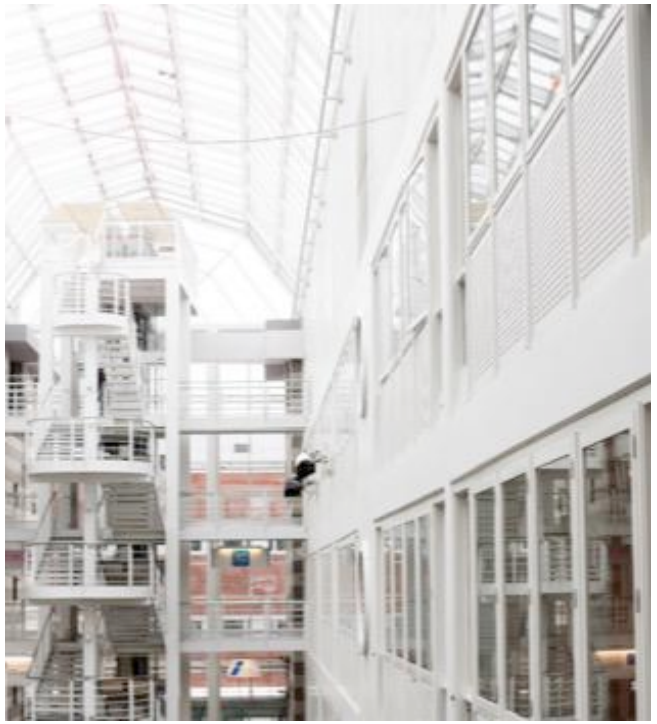
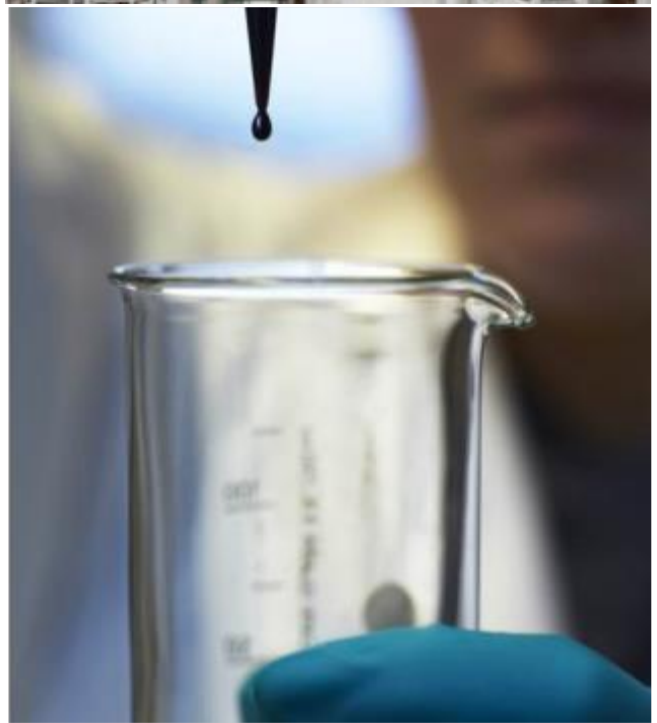
DC FORUM COPENHAGEN, 14th October 2021





AGENDA

- What is the WEDISTRICT project?
- Why data center heat?
- Waste Heat Recovery technology in WEDISTRICT.
- The RISE ICE WEDISTRICT demonstrator status.

SOURCE; Waldrop, M. Mitchell. "The chips are down for Moore's law." *Nature News* 530.7589 (2016): 144.

W.E. DISTRICT

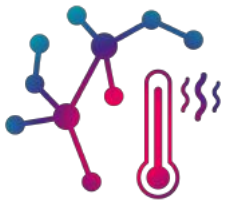
Smart and local reneWable Energy **DISTRICT heating and cooling solutions for sustainable living**

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

WEDISTRICT solutions will integrate

Multiple sources of renewable energy

Data Center excess heat



Advanced thermal storage

To redistribute heat to buildings as needed.

IT technologies

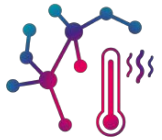
To increase the operational efficiency of the systems

WEDISTRICT **technologies**

Solar
Technologies

Data center waste heat recovery

Biomass
technologies



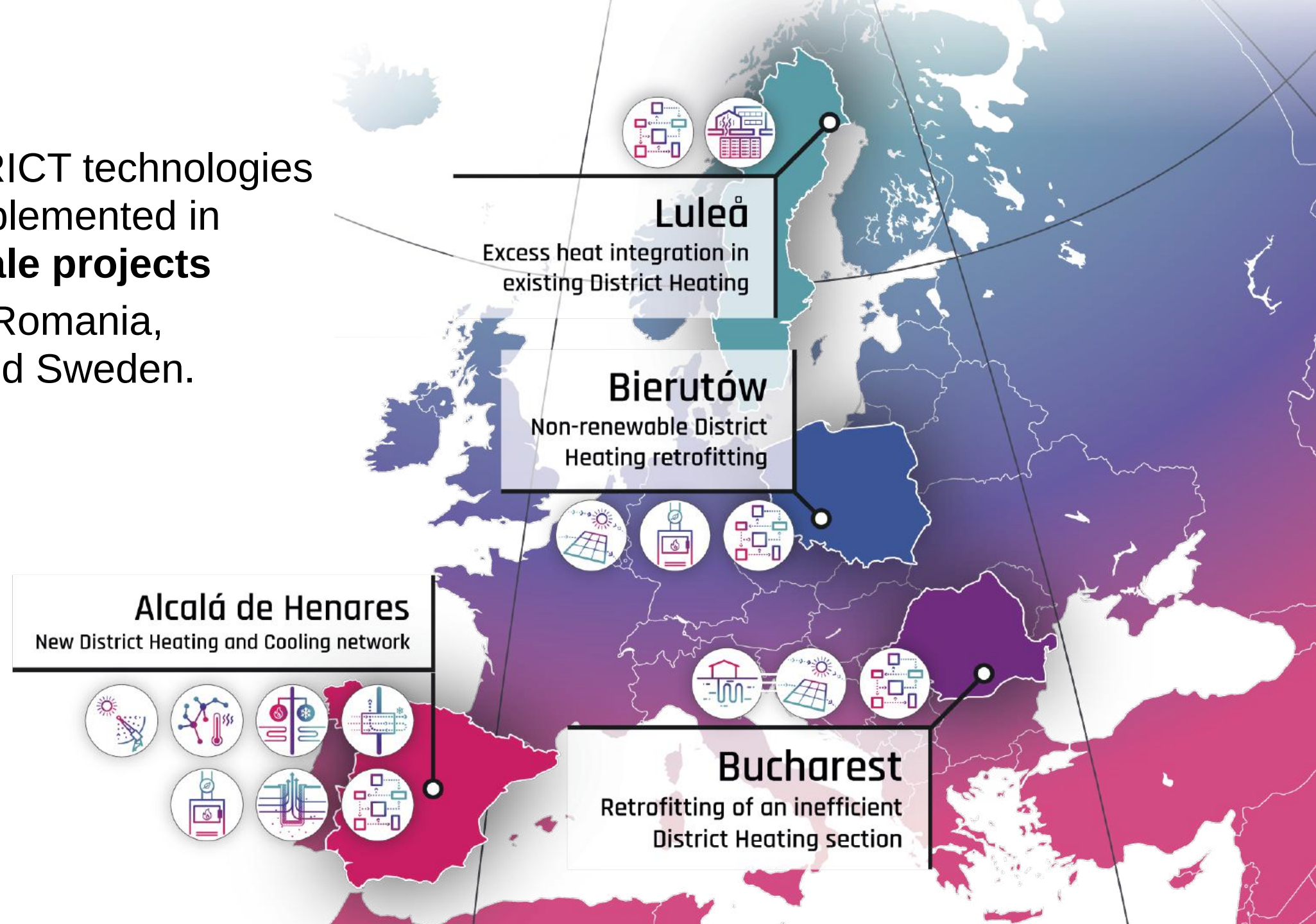
Energy
storage

Hybridation PV-Geothermal Energy

ICT
system

Cooling from renewable energy sources

WEDISTRICT technologies will be implemented in **4 real-scale projects** in Spain, Romania, Poland and Sweden.



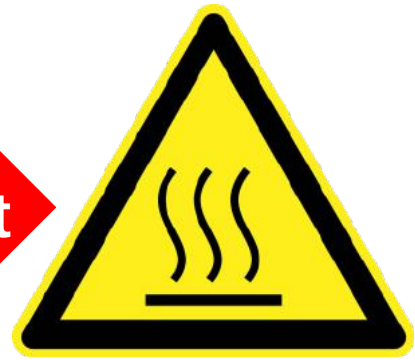
Data center
waste heat recovery
Why?

10110
11100

Today 0.03% of input power is in the data stream.

Electricity

Waste Heat



Today 99.97% of input power is in the thermal stream.

Based on:
Rolf Landauer, “Irreversibility and Heat Generation in the Computing Process,” **IBM J Res. Dev. 5, 183 (1961)**.
http://dx.doi.org/10.1147/rd.53.0183

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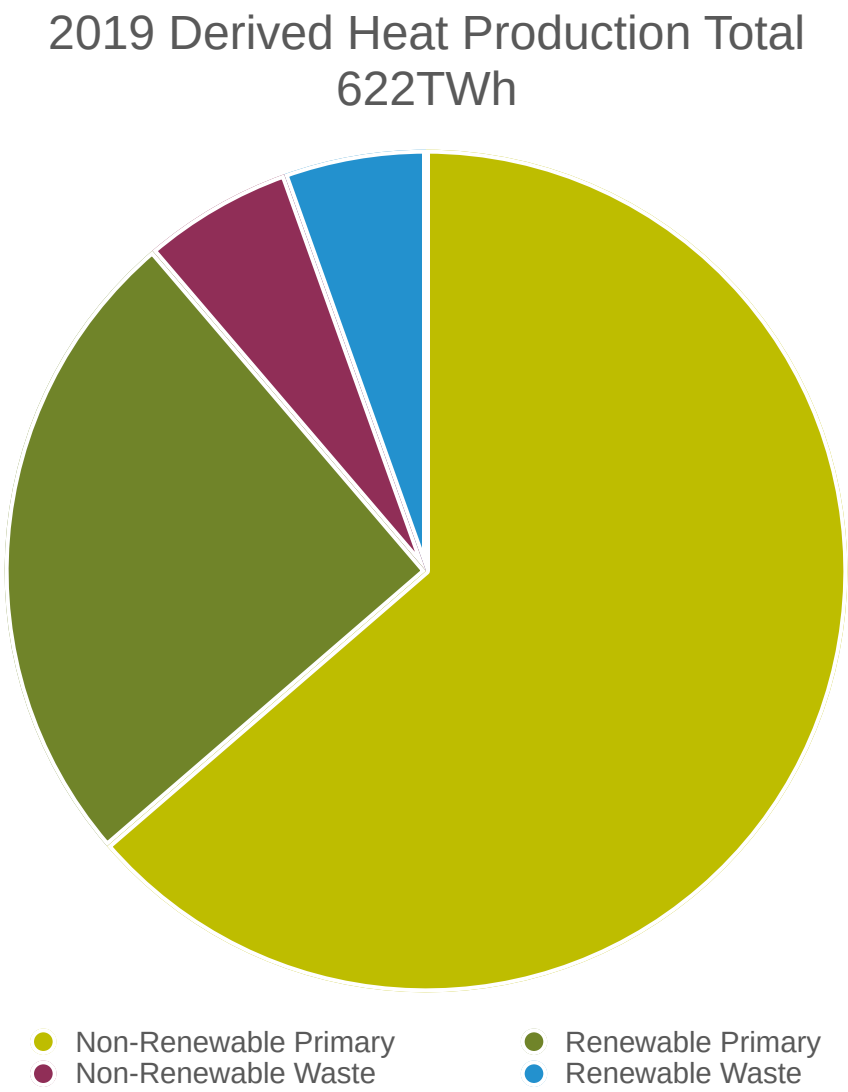
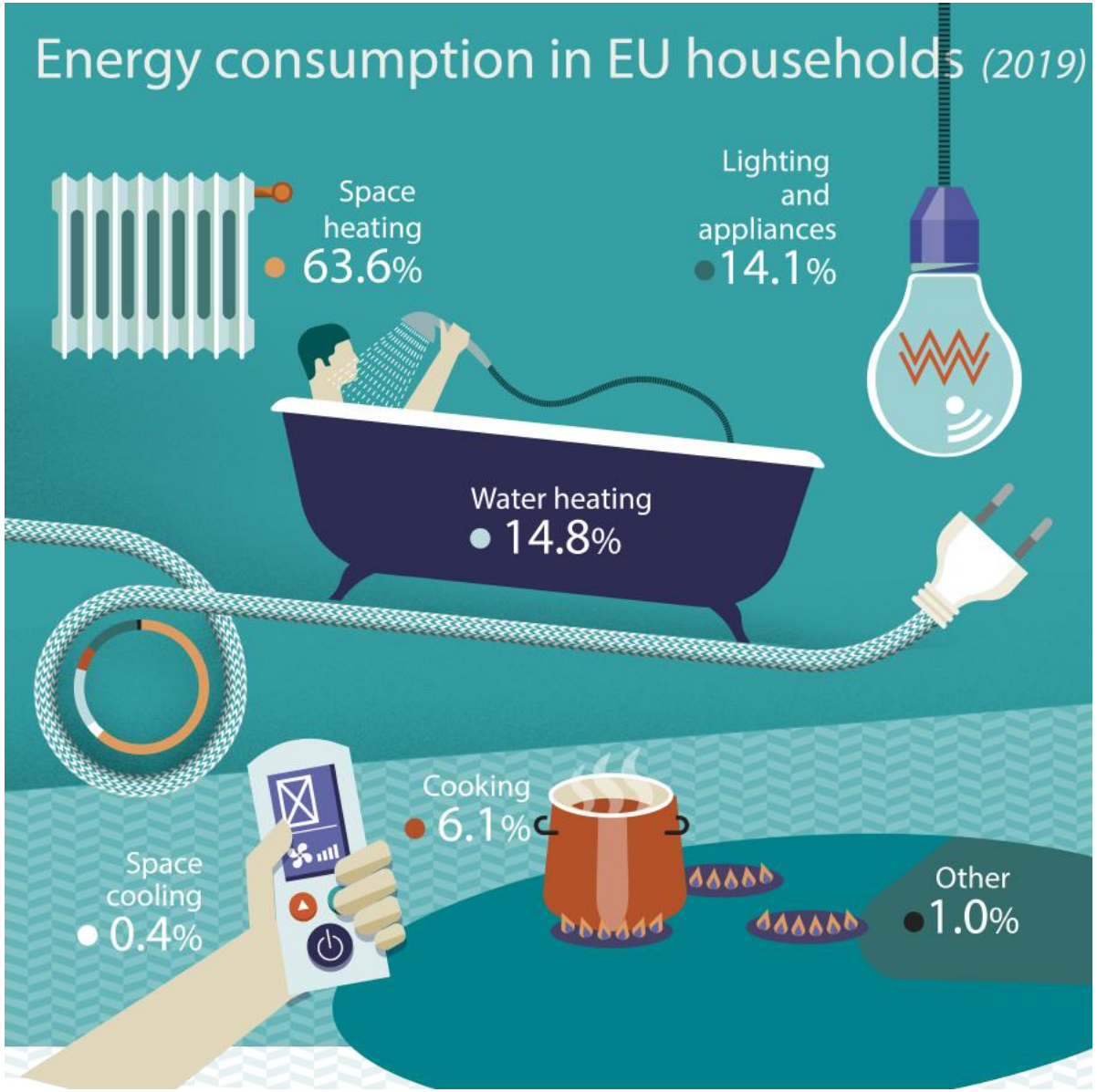
Derived heat production in the EU

- EU Heat derived production has risen by 9.5% since 2000.
- EU population has risen by 4% since 2000.
- EU waste heat accounts for **69 TWh** (11%)
- EU waste production has increased by 154% since 2000.
- Per capita derived heat demand has dropped from 1.6MWh in 2010 to 1.39MWh in 2019.
- Renewable source of waste heat has gone from **13TWh** in 2000 to **33.6TWh** in 2019.
- According to europa.eu data centers consume **80TWh** of energy per year.



Source: Our World In Data, https://ourworldindata.org/
EUROSTATS, https://ec.europa.eu/eurostat/

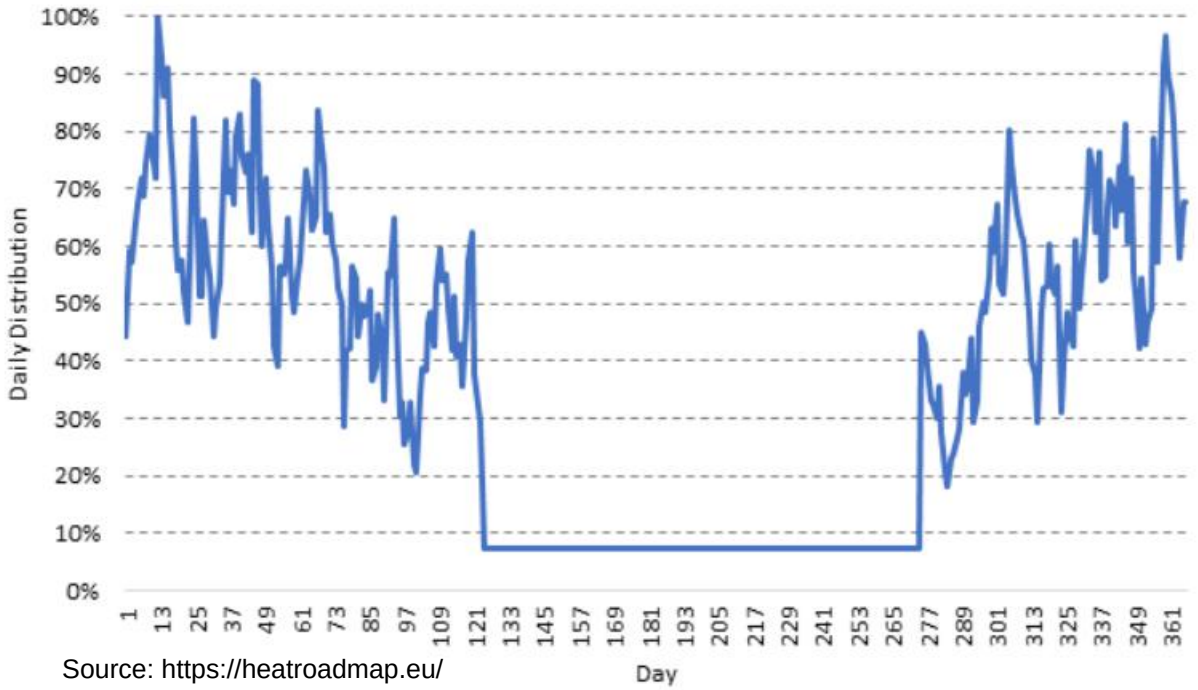
Breakdown of energy consumption



Source: https://ec.europa.eu/eurostat/

Clear demand for space heating at 63.6%
Water heating at 14.8%

But that is averaged over the year. What does heat requirement look like over the year?



Source: https://heatroadmap.eu/

Data center
waste heat recovery
Where?

WHR from Data Centres is not new

Many initiatives in Europe for Waste Heat Recovery from Data Centres:

- Yandex / Nivos Energia Oy, Mäntsälä, Finland
- Facebook / Fjernvarme Fyn, Odense, Denmark
- GleSYS/Falkenberg Energi, Sweden
- Dalkia, Val d'Europe, France
- NorthC data center/Aalsmeer Energy Hub, Aalsmeer, the Netherlands
- Open District Heating, Stockholm, Sweden
- Telia/Fortum, Helsinki, Finland

AND MANY MORE.

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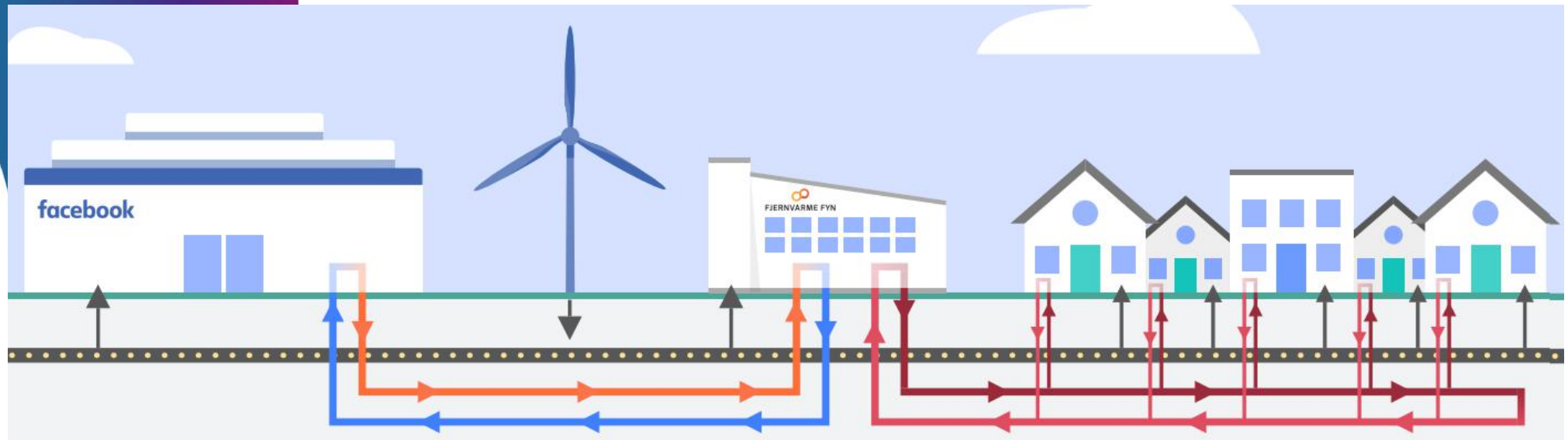
Data center
waste heat recovery
How?

Heat pumps are used to increase temperature of the data centre heat for supply to the district heating network.

Who manages the heat pumps? Data Centres have invested effort to remove the compressor from their estate.

Source:https://sustainability.fb.com/



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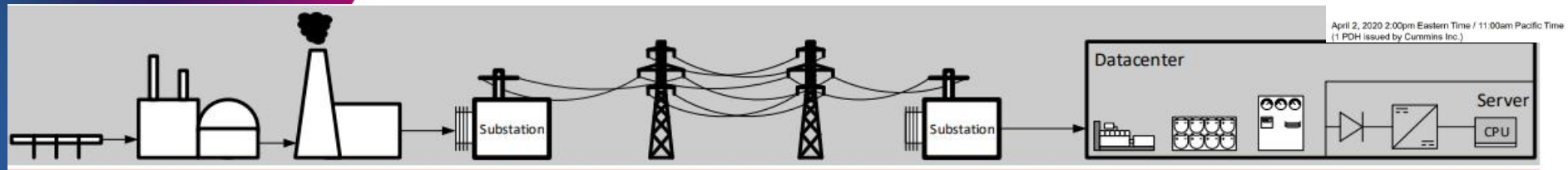
Data centers and fuel cells

Source

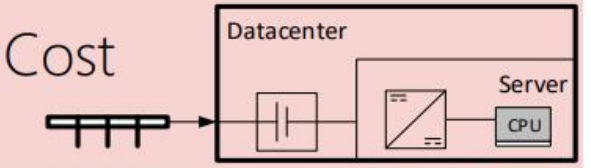
Using Fuel Cells to Address Energy Growth and Sustainability Challenges in Data Centers

PowerHour webinar series for consulting engineers
Experts you trust. Excellence you count on.

April 2, 2020 2:00pm Eastern Time / 11:00am Pacific Time
(1 PDH issued by Cummins Inc.)



Less Infrastructure + Less Complexity = Reduced Cost & Risk



50% decrease in physical infrastructure on-site

5-10% decrease in total DC COGS rate

24-40% efficiency improvement

22-50% CO2 reduction (more w/ RNG)

SIMPLICITY
Streamlined Design
Reduces Risk
Minimal customization
Reduced failure zone

LOWER COST
Elimination of electrical distribution
Less site equipment to maintain
Waste heat reuse
Simple energy supply chain

IMPROVED EFFICIENCY
Dramatic improvement in efficiency
Lower PUE, Reduced losses
Reduced TTM- construction time down 6 months

SUSTAINABILITY
Lower Emissions
Reuse of waste heat

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Data centers and fuel cells

- Equinix installs fuel cells in 12 US data centers
- Apple installs 10MW fuel cell
- CenturyLink installs hydrogen fuel cells at California data center
- Uptime Institute recognizes Fuel Cells as a reliable source of onsite power

FC for reliable prime power, low noise for urban areas. Data centres are investing in FC technology.

Our message is not to replace heat pumps in data centre applications, but to leverage the prime power FC enhanced thermal arrangement to provide thermal energy to the DH.

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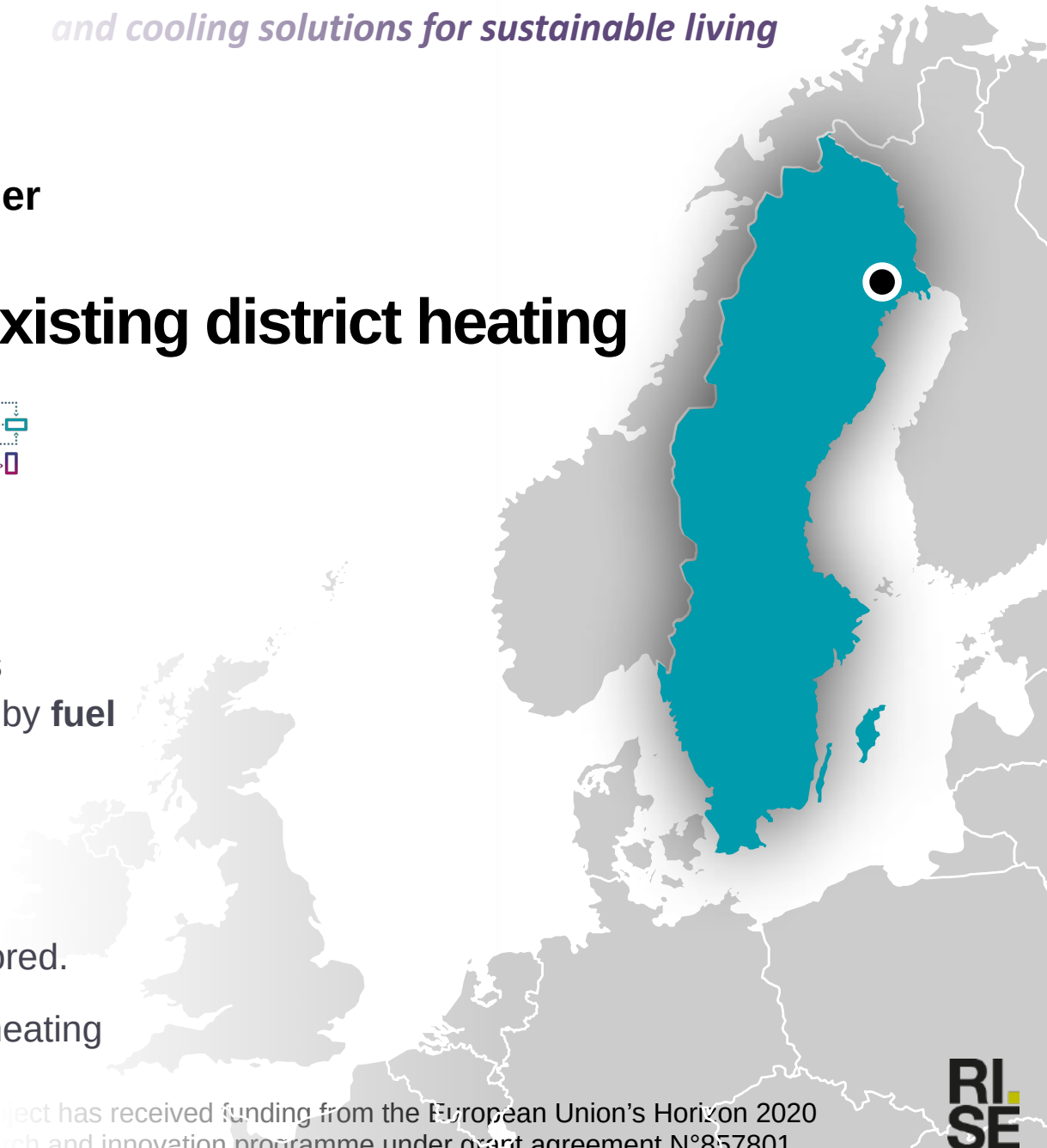
Demonstration site

LULEÅ (Sweden)

Climate zone: Northern European Weather



Excess heat integration in existing district heating

TECHNOLOGIES PLANNED:

- The **excess heat from the data centres** will be 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.

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

Demonstration site
LULEÅ (Sweden)

Orientation, location and setup of demo-site

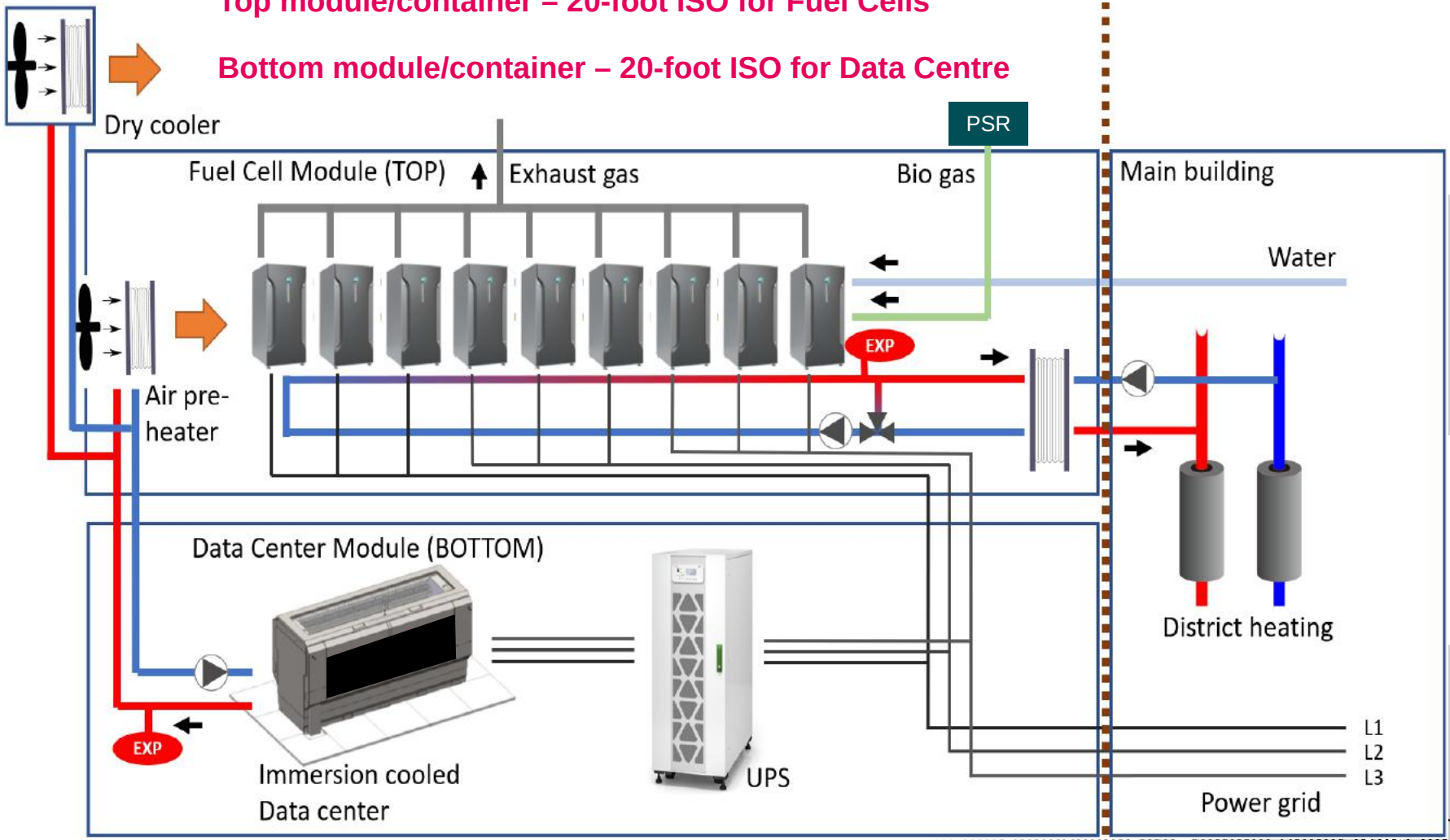
from the European Union's Horizon 2020
and innovation programme under grant agreement N°857801

Demonstration site
LULEÅ (Sweden)

Thermal arrangement of fuel cells and data centre

Top module/container – 20-foot ISO for Fuel Cells

Bottom module/container – 20-foot ISO for Data Centre



Union's Horizon 2020
ch and innovation programme under grant agreement N°857801

DC container, FC container and Biogas container

DC container is 25 tonnes

FC container with 9 fuel cells ~ 8 tonnes

To be stacked on top of the DC container

The biogas container will have 4 tonnes of biogas ~ 5 400 000 litres of gas at 200bar.

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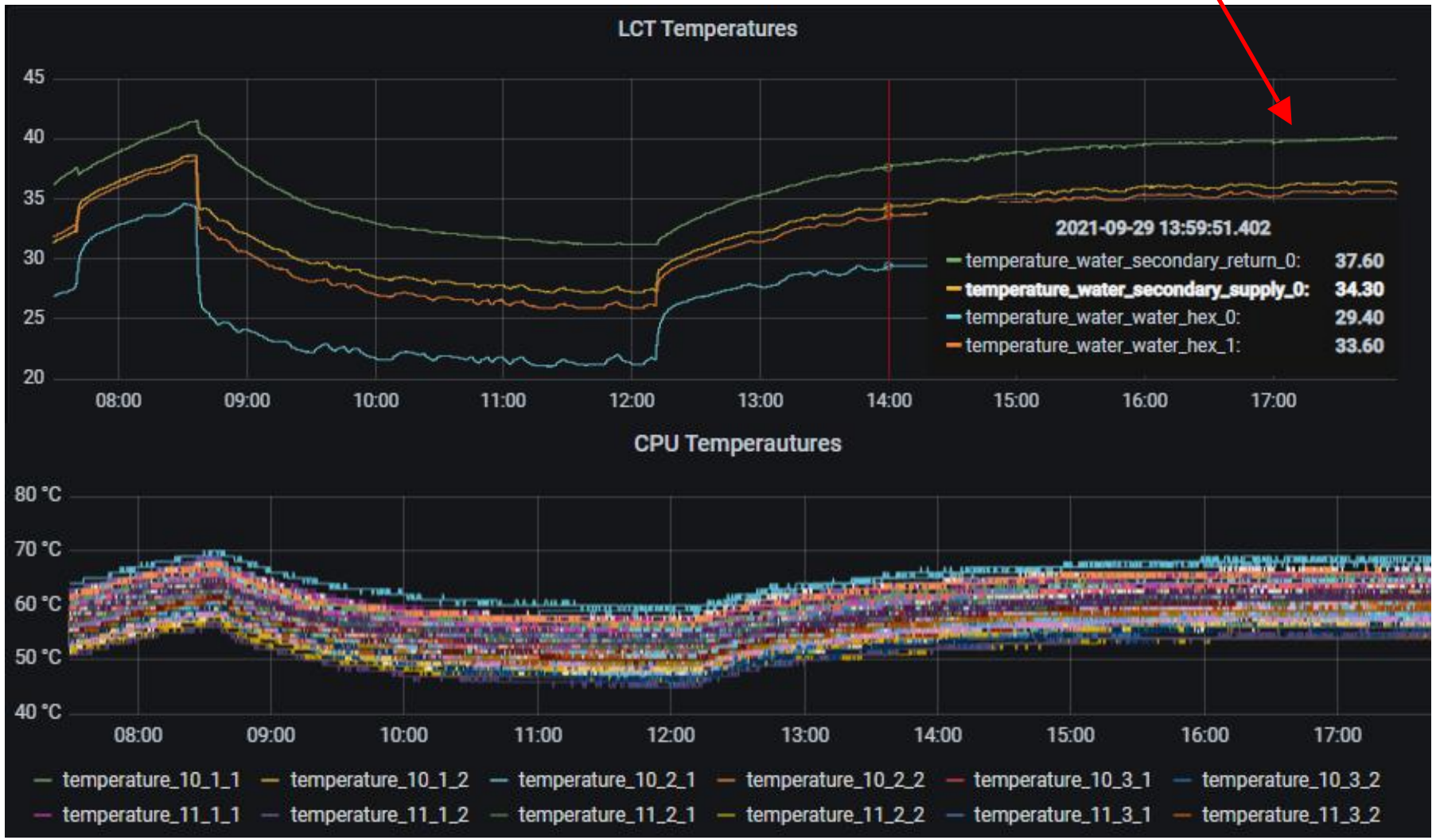
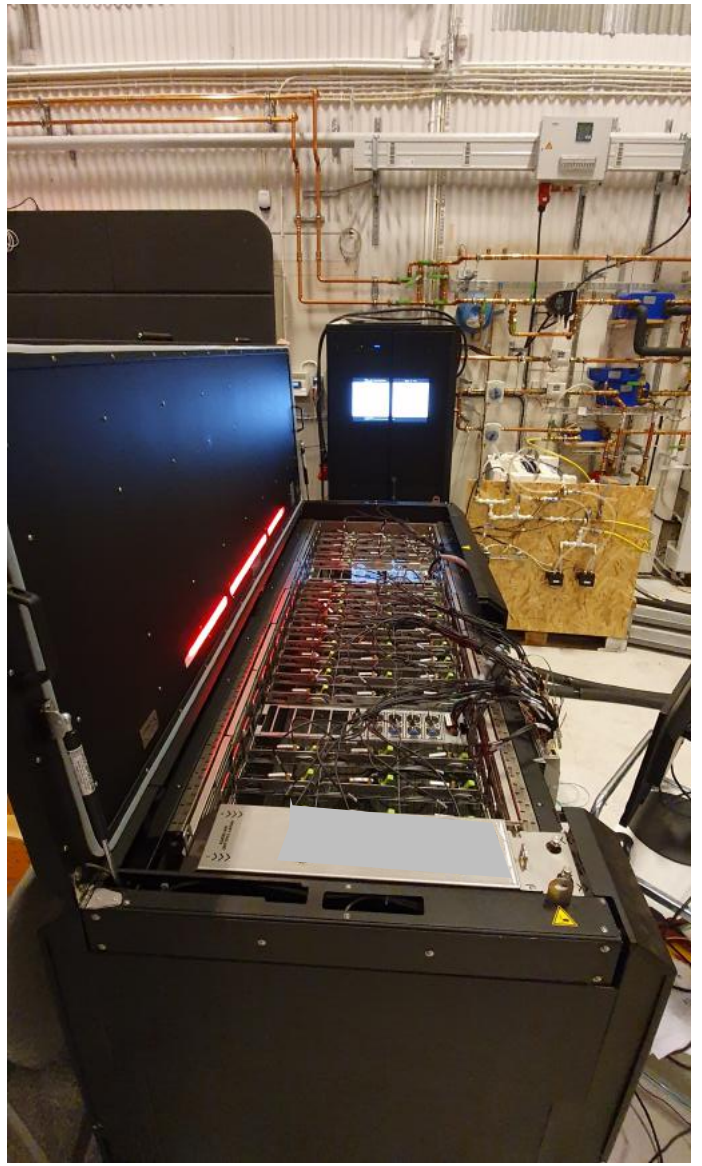
Data centre

waste heat recovery

liquid cooling testbed

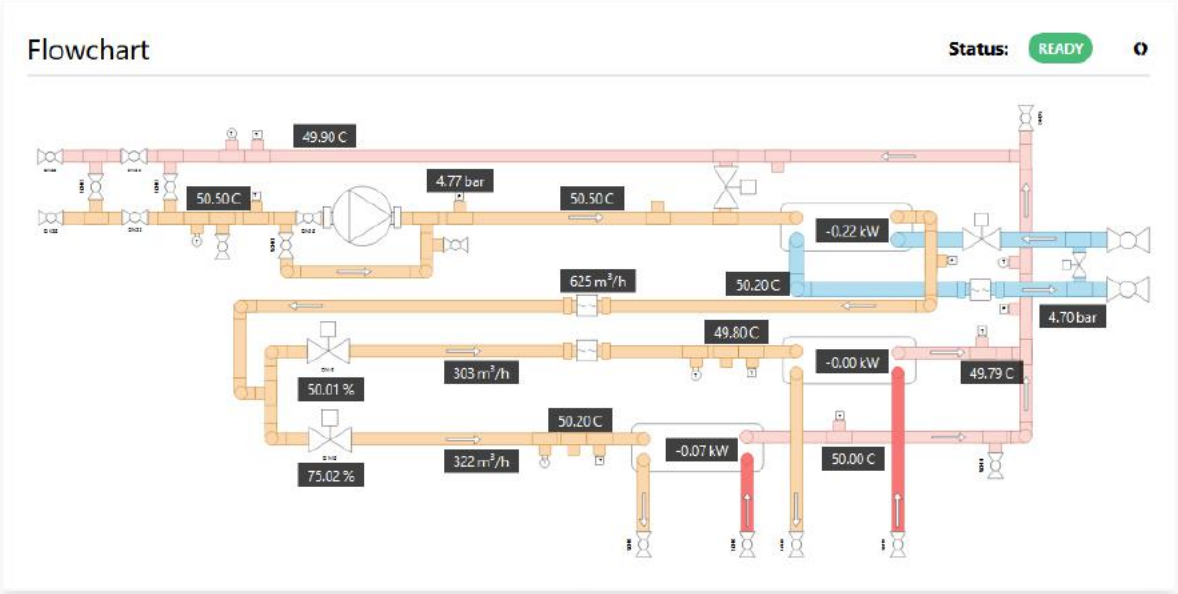
Room for 15°C on CPU and 55°C to hot water loop

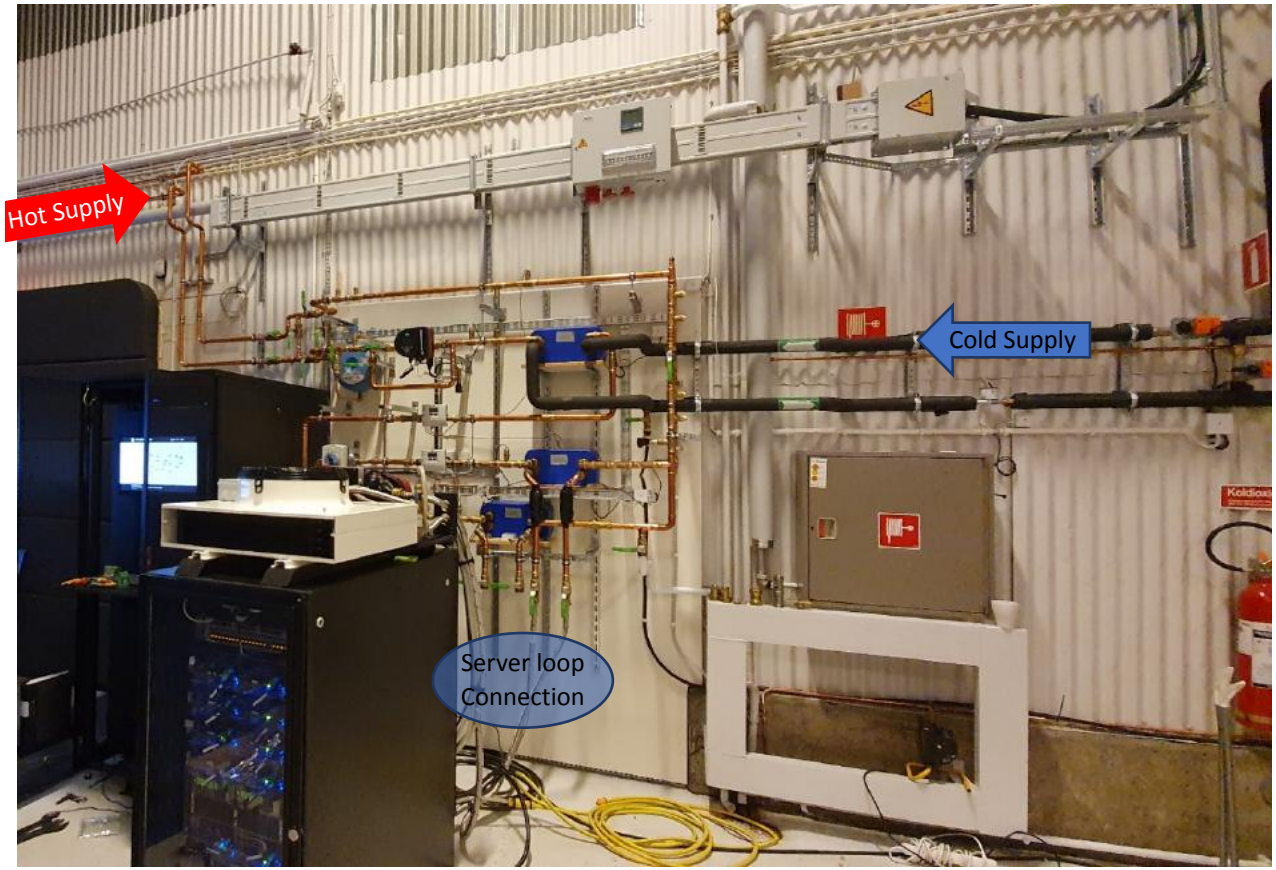




Peak 22kW of OCP servers.

Data center
waste heat recovery
liquid cooling testbed

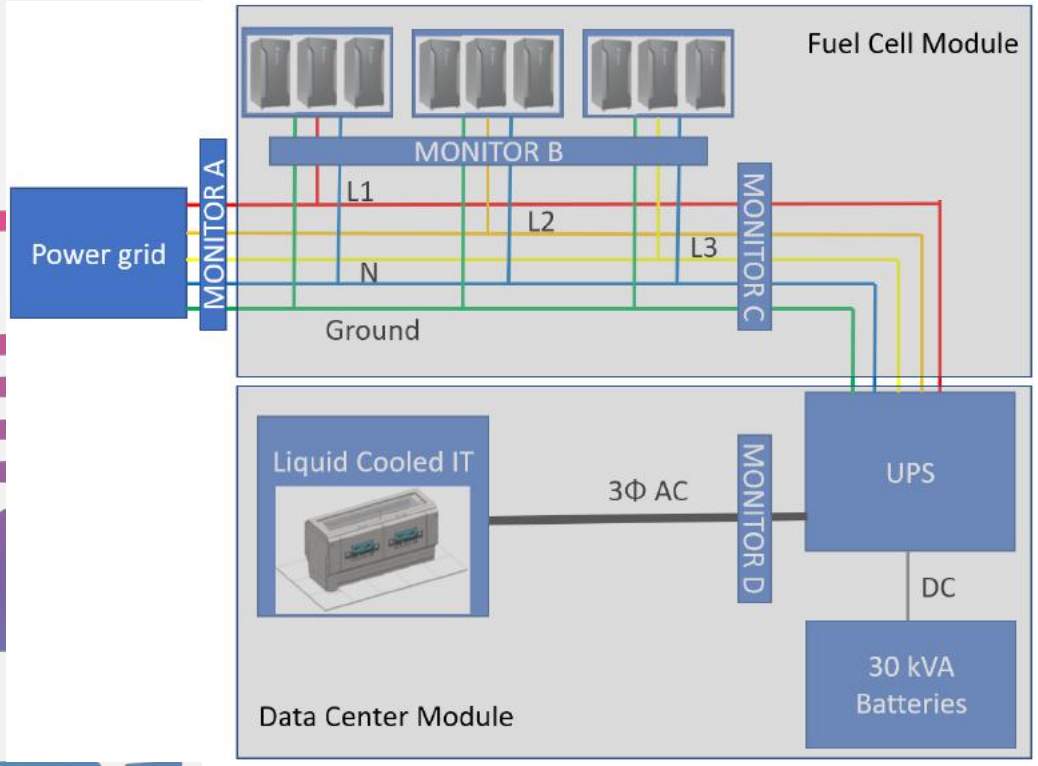


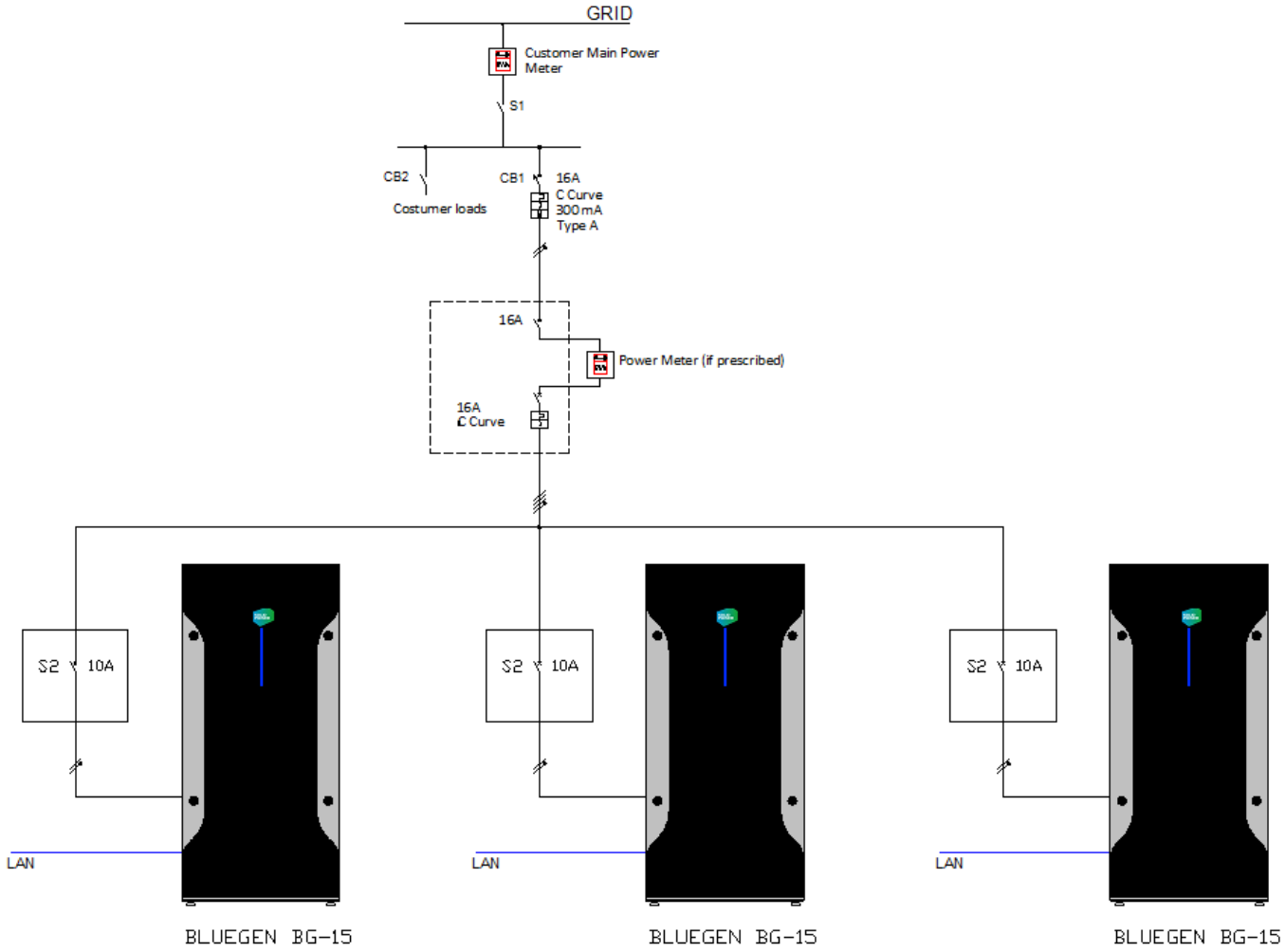


- Dial in a supply temperature to the liquid cooled systems.
- Monitor the return temperature back to the building hot water network.

Demonstration site
LULEÅ (Sweden)

Fuel cell electrical arrangements





Single phase Solid Oxide Fuel Cells.

Phases to be synchronised by the utility.

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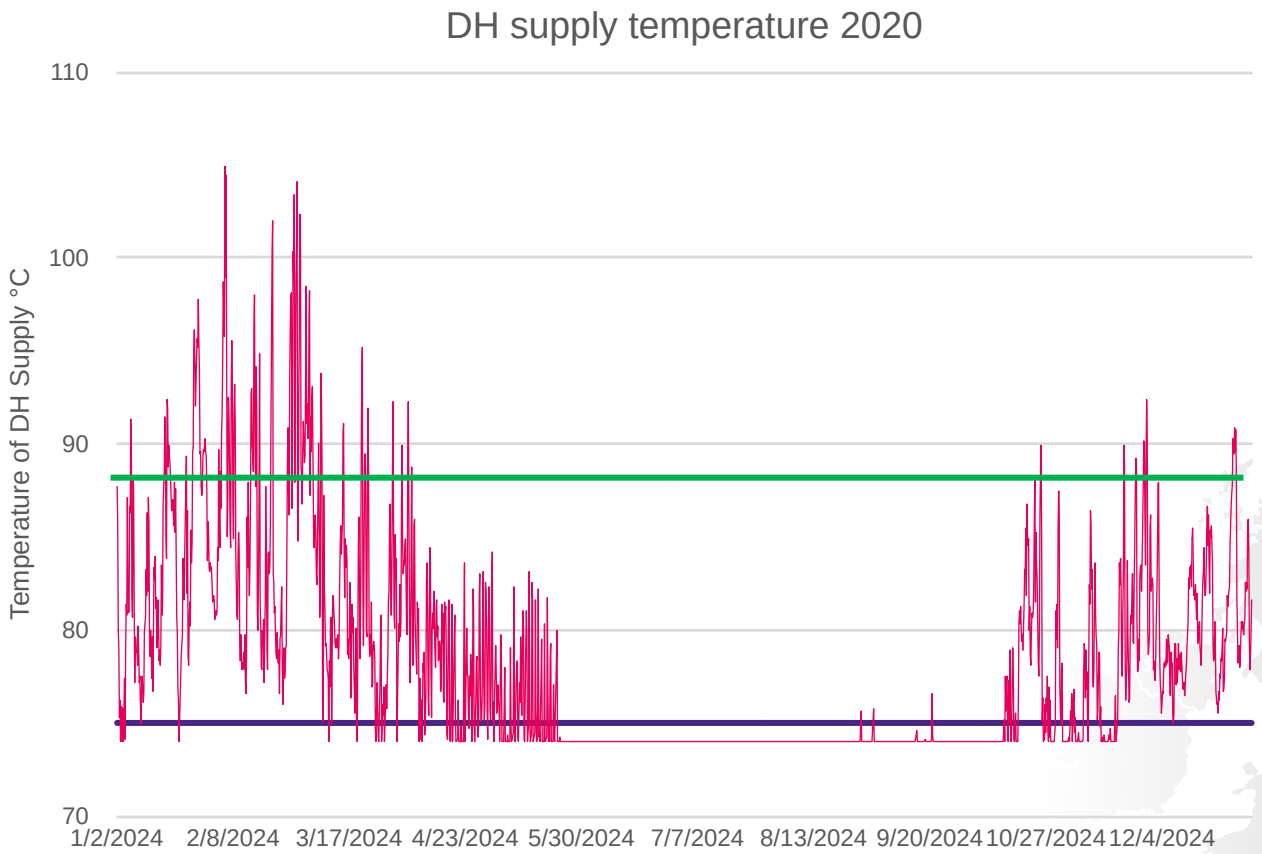
Demonstration site
LULEÅ (Sweden)

Fuel cell BlueGen BG-15 thermal efficiency



87% WHR

50% WHR

% of year meeting DH supply temp.

Fuel cell thermal efficiency drops from around 30% to 10% as the temperature of the water circuit increases from 30°C to 80°C, with an expected maximum of 95°C.

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WEDISTRICT
LULEÅ (Sweden) demonstrator

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

The demonstrator in Lulea plans to go live in late 2021 and will operate for over a year and the data collected will be available via the EU's Open Research Data Pilot initiative.

Operating the data centre between 10 and 60% utilisation, the demonstrator will run on the biogas and the heat is anticipated to be recovered and consumed in the local district heating network for more than 7000 hours per year (DH temperature challenges - 3rd GEN)

The demonstrator should prove to be able to run with WHR all year around on a 4th generation district heating network. Challenges with access to gas – piped gas better.

Data centre applications require a greater density of Solid Oxide fuel cells. SolidPower has on their roadmap raising the 2.7kW/sq.m to nearer 10kW/sq.m. Could become a way to build out Edge infrastructure in urban areas – close to end users, need for heat, access to piped gas, quite operation

Using natural gas, or better still biogas, will be the initial way forward in Europe, but that will quickly become a discussion point (price point today!). SOFC can operate with up to 35% hydrogen in the gas and if it is green hydrogen – carbon intensity will drop.

Start:

Jan. 2022

End:

Dec. 2022

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Demonstrator support

WEDISTRICT Partners

W.E. DISTRICT

Heating & cooling solutions

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THANKS TO MY ICE T&D COLLEAGUES AND WEDISTRICT PARTNERS

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