

World-Class Sustainability with Heat Re-Use in LUMI EuroHPC Data Centre



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CSC develops, integrates, and provides high-quality ICT services for research, education, culture, and public administration



Turn over
in 2022

64M€



Headquarters in
Espoo,
datacenter in
Kajaani



Non-profit state enterprise with special
tasks owned by the state of Finland **70 %**
and
Finnish higher education institutions
30 %



+650

Employees
in 2023

LUMI is an HPE Cray EX Supercomputer

LUMI




**Hewlett Packard
Enterprise**

Its powerful processors can perform millions of calculations simultaneously, so it can operate millions of times faster than conventional computers and help us solve highly complex problems.

LUMI EuroHPC

Fastest Supercomputer in Europe



EuroHPC
Joint Undertaking

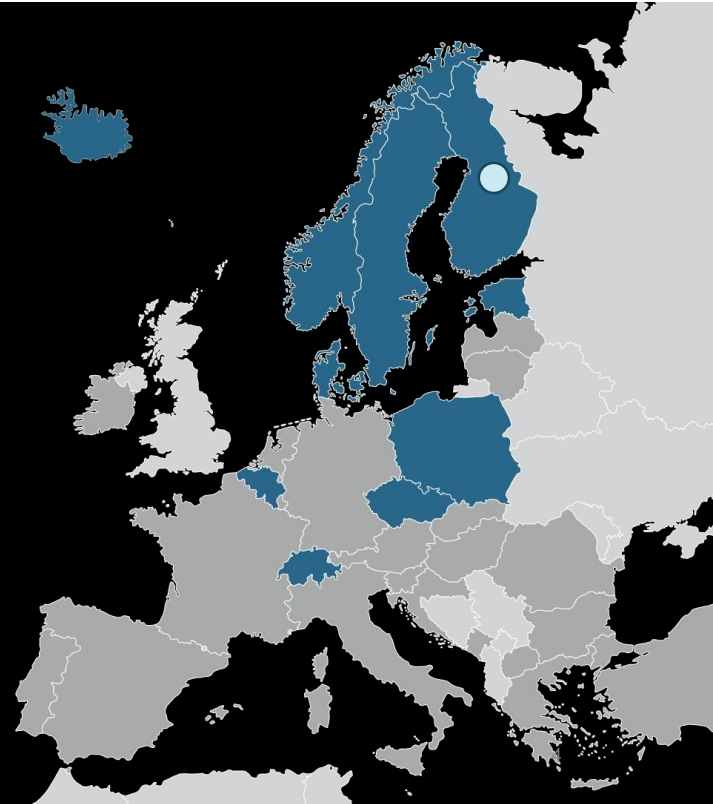
L U M I

LUMI is a co-investment of ten LUMI consortium countries (FI, BE, CH, CZ, DK, EE, IS, NO, PL, SE) and the EU to build and operate a world-class supercomputer.

The EuroHPC Joint Undertaking pools EU and national resources in high-performance computing.

The total budget of LUMI in CSC's data center in Kajaani, Finland, is over 202 Meur (half from the EU, half from the consortium countries).

The resources of LUMI are allocated per the investments. The share of the EuroHPC JU (50%) is allocated by a peer-review process and available for all European researchers.



LUMI EuroHPC

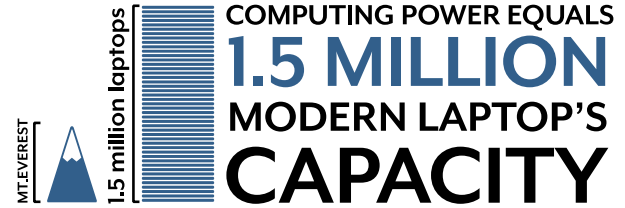
Operating 2022-2026

LUMI

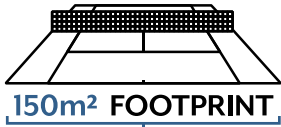
SUSTAINED PERFORMANCE

375 PETAFL0P/S

= performs 375×10^{15} calculations per second



2 x



Massively
parallel
simulations

AI

Data
analytics

Some Basics of DC Business



Electricity consumption:

- **Datacenter capacity (and size)** is primarily measured by electricity consumption in kilowatts (kW) or megawatts (MW)
- **Main cost in datacenter operations**

Power Usage Effectiveness (PUE):

- PUE measures the total energy use of the data center compared to the energy used by IT equipment.

$$\text{PUE} = \frac{\text{Total Facility Energy (Cooling+Power+Lightning+IT)}}{\text{IT Equipment Energy (IT)}}$$

Energy Reuse Factor (ERF):

- The ERF of a data center reflects how much energy is exported for reuse outside of data center operations.

$$\text{ERF} = \frac{\text{Energy Reuse}}{\text{Total Facility Energy}}$$

Energy Reuse Effectiveness (ERE):

- The ERE is a metric for measuring the benefit of reuse energy from a data center

$$\text{ERE} = \frac{\text{Total Facility Energy} - \text{Energy Reuse}}{\text{IT Equipment Energy (IT)}}$$

Home of LUMI

Renforsin Ranta Business Park, Kajaani Finland


Greenfield (200 ha)


National grid substation (1000 MW)

Excess heat utilisation to district heat network

3 hydropower plants
In Kajaani river

3 x  →

230 MW existing transformer capacity



LUMI Euro HPC



CSC's national supercomputers



LUMI: Excess Heat Utilization Process Overview

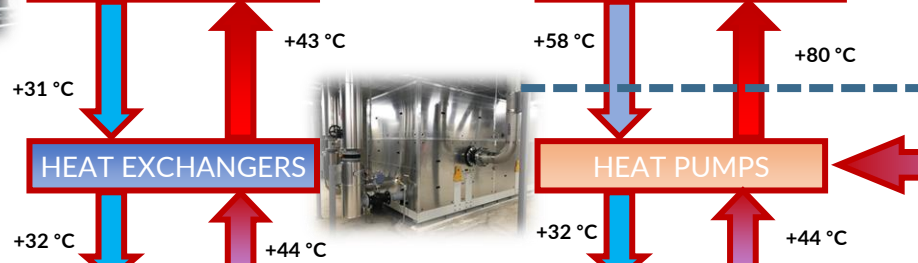


Annual CO₂ savings around 6.000 tonnes



DRY AIR COOLING
FOR BACK UP
~ 10 MW

DISTRICT HEATING
NETWORKS ~ 10 MW
-Renforsin Ranta Business Park
-CITY of Kajaani



Service demarcation point for the excess heat utilization

Heat pumps use renewable energy



HPC load

In addition of Direct Liquid Cooling there is approximately 1 MW of capacity for the air-cooled servers (e.g. storage and management servers).

District heating specifications



- District heating to power plant
 - Two 4000kW heat exchangers
 - Controlled based on LUMI IT-load and district heating network demand
- District heating to business park area
 - One 2500kW heat exchanger
 - Controlled based on return temperature of area district heating network.
- District heating water loop to customer heat exchangers
 - Temperatures: Inlet to heat pumps 58°C, Outlet 80°C
 - Connection pipes between CSC data center and customers heat exchanger ~200 meters

LUMI data center sustainability and metrics



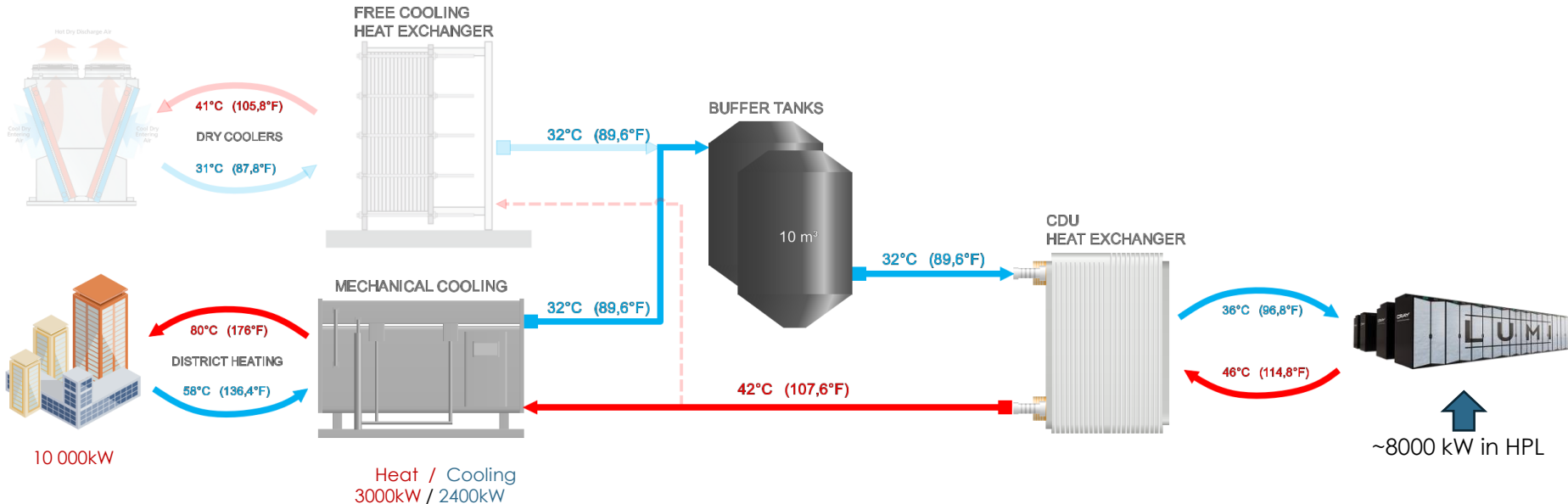
- Waste heat is re-used for district heating ~9 months / year. Dependent on district heating network demand because power plant has minimum operating power.
- Average temperature in Kajaani in 2022 was 3.6°C and highest measured temperature 2023 was 26.2°C. Free cooling available around a year.
- We assume having reduced the CO2 footprint of LUMI data center construction by over 80% when comparing the brownfield solution vs. constructing an all-new building for LUMI. Approximately 1000 tons.

LUMI cooling and heat reuse

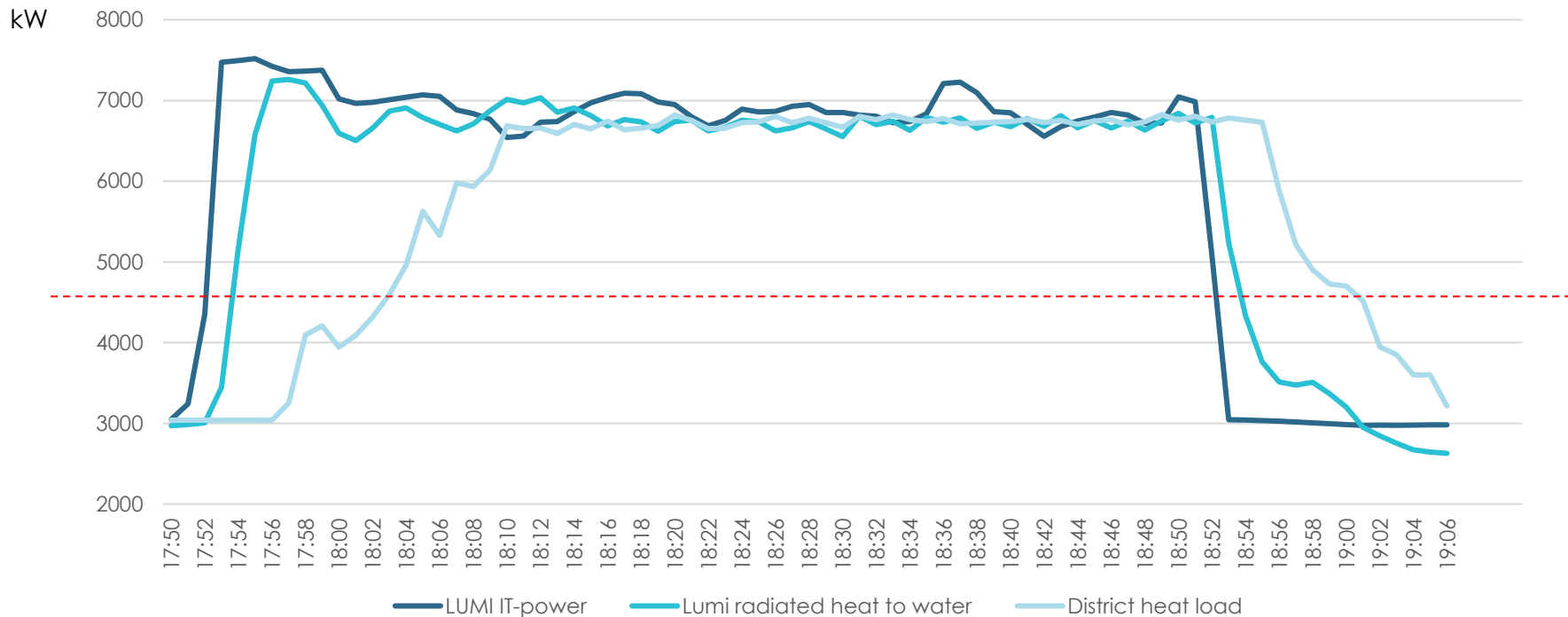


Three individually controlled cooling modules started in 2000kW steps based on LUMI IT power

- **Mechanical cooling** and heat reuse for district heating with three heat pumps.
 - 2400kW cooling and 3000 kW of heating capacity/heat pump.



Example of power usage and heat rejection delay



Drivers to implement heat re-use in Finland



- Changes in Finnish energy taxation for data centers on 2022
- Energy taxation classes for data centers drives more energy efficient data centers with lower Opex.
 - Energy taxation Class 1, 22,53 €/MWh
 - Energy taxation Class 2, 6,3 €/MWh
- Data centers whose IT-power exceeds 0,5MW and who are full filling energy efficiency requirements are eligible to apply energy taxation class 2.
- From technical economic reasons data center cannot utilize waste heat PUE requirements needs to be met.
- ERE or PUE requirement must be achieved
 - **ERE**
 - Data center with 0.5...5 MW IT-power calendar year average, ERE < 0.90
 - Data center with 5...10 MW IT-power calendar year average, ERE < 1.00
 - Data center over 10 MW IT-power calendar year average, ERE requirement does not apply
 - **PUE**
 - Data center calendar year average PUE < 1.25
 - From 2026 calendar year average PUE < 1.20

LUMI data center statistics for 2023



Metric	LUMI (values from 2023)
Free cooling PuE	<1.05
PuE with heat re-use	1.31
Heat re-use COP	4
ERE	0.52
ERF	0.57
Annual heat production	26,7 GWh
Reduced co2 emissions	~ 6.000 CO2 tonnes *
Source of electricity	100% hydro power

* LUMI reduced CO2 emissions based on district heating production plant average CO2 emissions / year (2022: 161kg/MWh). No real-time data available



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EuroHPC
Joint Undertaking



The acquisition and operation of the EuroHPC supercomputer is funded jointly by the EuroHPC Joint Undertaking, through the European Union's Connecting Europe Facility and the Horizon 2020 research and innovation programme, as well as the of Participating States FI, BE, CH, CZ, DK, EE, IS, NO, PL, SE.

**Leverage from
the EU
2014–2020**



European Union
European Regional
Development Fund



EURO