



# LUMI EuroHPC Empowering Sustainable European Research



Non-profit state organization with special tasks



Turn over  
in 2021

**56**M€



Headquarters in  
Espoo,  
datacenters in  
Kajaani



Owned by state **(70%)**  
and all Finnish higher education  
institutions **(30%)**

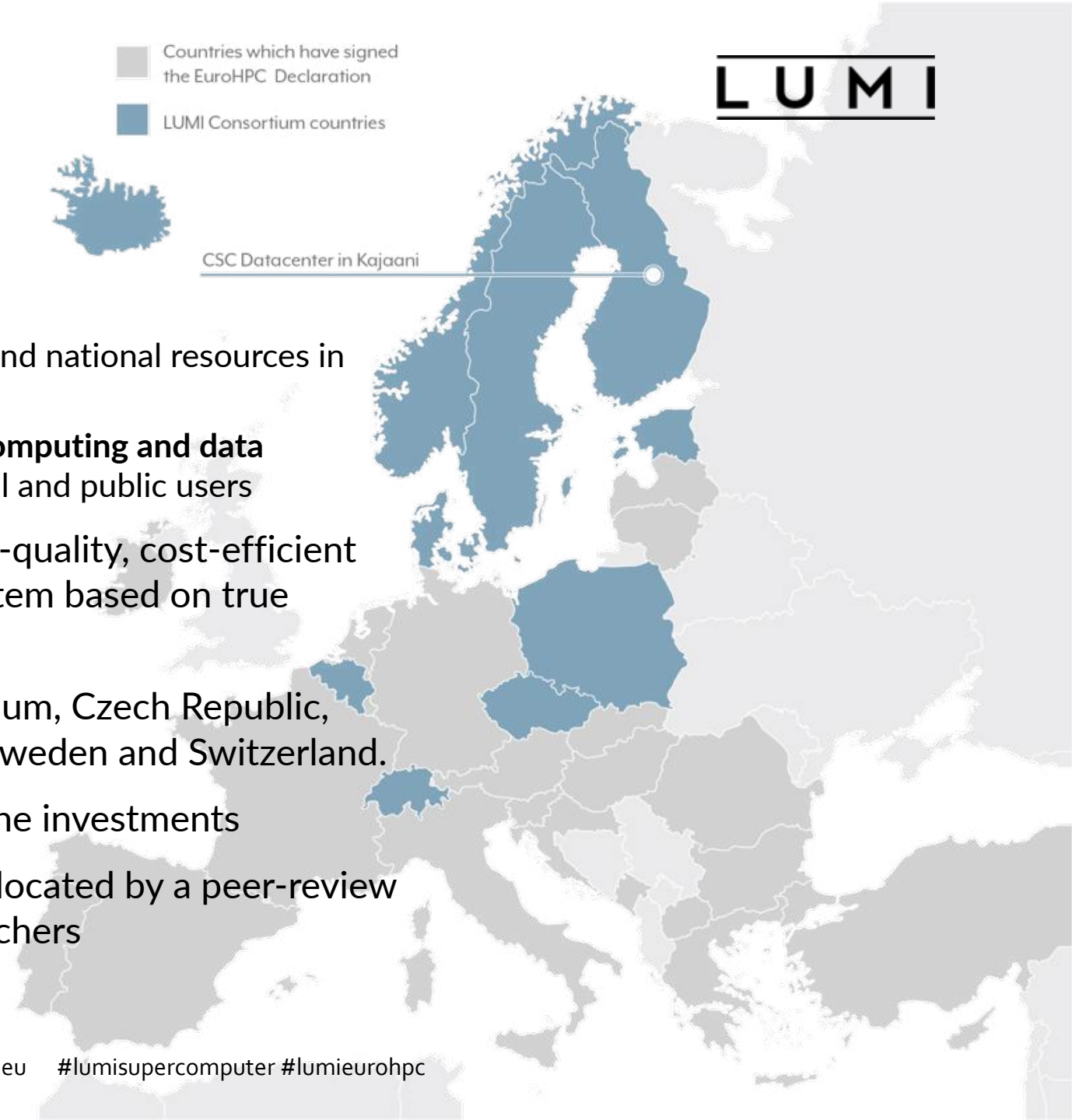


Circa  
**500**  
employees  
in 2021

# EuroHPC & LUMI Consortium

- Countries which have signed the EuroHPC Declaration
- LUMI Consortium countries

LUMI



- **The EuroHPC Joint Undertaking** will pool EU and national resources in high-performance computing (HPC)
  - **acquiring and providing a world-class supercomputing and data infrastructure** for Europe's scientific, industrial and public users
- **LUMI research infrastructure** provides a high-quality, cost-efficient and environmentally sustainable HPC ecosystem based on true European collaboration.
- **LUMI consortium** members are Finland, Belgium, Czech Republic, Denmark, Estonia, Iceland, Norway, Poland, Sweden and Switzerland.
- The resources of LUMI will be allocated per the investments
- The share of the EuroHPC JU (50%) will be allocated by a peer-review process and available for all European researchers

# HPC system's carbon footprint



- **Building phase**
  - **Greenfield vs. Brownfield**
- **Operations**
  - **Design & Efficiency**
  - **Consumed electricity**
  - **Waste Heat utilisation (ERF)**
  - **Hardware "Science per watt"**



# Greenfield vs. Brownfield



# Home of LUMI: Renforsin Ranta Business Park, Kajaani Finland



# Benefits of the brownfield solution



- 80% reduction of CO<sub>2</sub> footprint in LUMI data center construction project
- Saved ~1 000 tonnes of CO<sub>2</sub>eq
- Flexibility to start whenever
- Cost savings

| Materials - building shell<br>5,700 ft <sup>2</sup> (530 m <sup>2</sup> ) office facility | Tonnes<br>of CO <sub>2</sub> | Percentage<br>of total |
|---|------------------------------|------------------------|
| Foundation (concrete)   | 4.7                          | 4%                     |
| Flooring (concrete slab, insulation)  | 39.9                         | 31%                    |
| Ceilings (plaster board)  | 2.3                          | 2%                     |
| Structure (steel beams)   | 15.4                         | 12%                    |
| External walls (brick, insulation)  | 32.1                         | 25%                    |
| Internal walls (wood frame and plasterboard)  | 8.7                          | 7%                     |
| Stairs (concrete)   | 1.1                          | 1%                     |
| Windows (glass and frame)   | 0.59                         | 0.4%                   |
| Internal doors (particle board)*  | -0.4                         | -0.3%                  |
| External doors (plastic)  | 0.6                          | 0.5%                   |
| Roof (wood, concrete, insulation)   | 23.4                         | 18%                    |
| <b>TOTAL</b>  | <b>128.3</b>                 | <b>100%</b>            |

For a 1 MW DC, source: Schneider-Electric white paper 66

# LUMI DESIGN IMPACT

PUE 1.04 & 1.24

Support to Excess Heat Utilisation

Carbon Negative Operations

Use of Local Renewable Energy

20 % of annual need  
40 % impact to  
total cost of energy

 Footprint:  
-12 400 tonnes

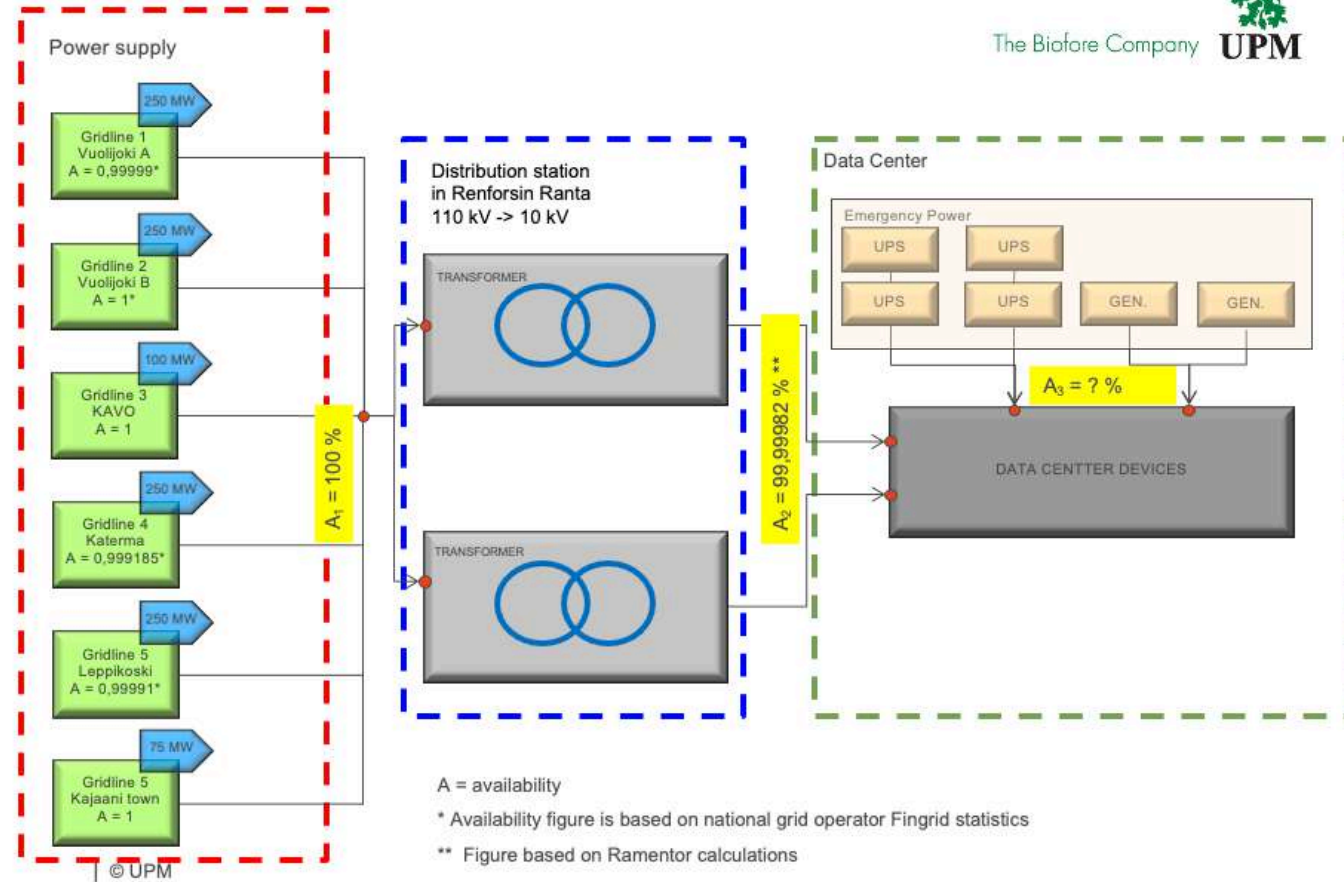


# Electricity & Infrastructure



- Use of power close to production
- Country production profile vs. area production profile
- Utilise existing infrastructure
- UPS & Fast Frequency Reserve (FFR)

### Power supply availability block diagram



# Excess Heat Utilization Process Overview



DRY AIR COOLING  
FOR BACK UP  
~ 10 MW

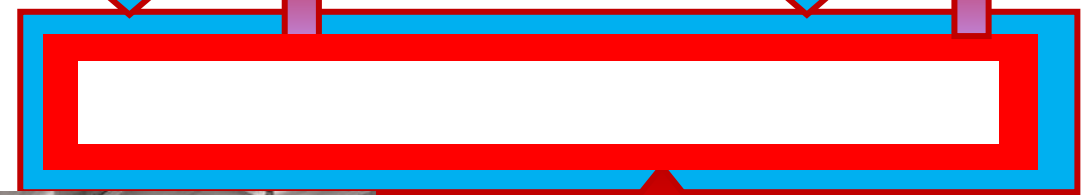
DISTRICT HEATING  
NETWORKS ~ 10 MW  
-Renforsin Ranta Business Park  
-City of Kajaani

HEAT EXCHANGERS



HEAT PUMPS

Service demarcation point  
for the excess heat utilization



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).

# “Science per watt”

**#1 Fugagu Supercomputer:**  
442 PFLOPS / 29,9 MW

**#2 Summit Supercomputer:**  
148,6 PFLOPS / 10 MW

**2016: # Sunway TaihuLight:**  
93 PFLOPS / 15 MW

**LUMI expected figures:**  
552 PFLOPS / 10 MW

# What problems to solve with LUMI & Exascale?

## Climate Science:

“Climate science is a field hungry for flops”

## Genome Science:

“Personalised treatment & medicine”

## Material Science:

Energy storage & Photovoltaics

## Fusion Energy:

4th state of matter

## Brain Simulation:

“Simulation of human brain at neuron level”



# UP TO 20% OF LUMI'S CAPACITY IS RESERVED FOR INDUSTRY AND SMEs



**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



**Kainuun liitto**

# Business use - how to get involved?



- Private - Public engagement
  - Project in cooperation with a research organization and a private sector partner
  - Free of charge if results are published & market price for projects with closed results
- EuroHPC JU Allocation
  - pay-per-use model - market price to be announced
  - Horizon Europe - PRACE SHAPE equiv. programs for SMEs



**EuroHPC**  
Joint Undertaking



**BUSINESS  
FINLAND**

# Contact Information



Kajaani Data Center Program executed by CSC - IT Center for Science Ltd. with the support of Kainuu Regional Council and City of Kajaani.

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**CSC – IT Center for Science Ltd.**



**City of Kajaani**

**Follow us:**

[www.csc.fi](http://www.csc.fi)

[www.aikaecosystem.com](http://www.aikaecosystem.com)

[www.lumi-supercomputer.eu](http://www.lumi-supercomputer.eu)

**LinkedIn:** <https://www.linkedin.com/company/csc---it-center-for-science/>

**YouTube:** <https://www.youtube.com/c/cscfi>

#KajaaniDClocation #lumieurohpc #CSC

# Built-in sustainability for your data center

- CSC data centers in Kajaani are designed and operated to reduce global CO<sub>2</sub> emissions.
- Surplus of local green renewable energy sources available (wind & hydro)
  - **BEING GREEN** instead of **BUYING GREEN**
- Kajaani enables utilization of local cost and environmentally friendly renewable energy
- Excess heat utilization reduces electricity costs and CO<sub>2</sub> emissions equivalent to 6.8 M kilograms of burned coal

Renewable energy

**100 %**

Hydro +100 MW | Wind +400 MW

 footprint

**-12 400T**

Co<sub>2</sub> eq/emissions

LUMI produces

**20 %**

of Kajaani's yearly district heat production



# Secure your time-to-market and future scalability



- Ready existing infrastructure in place to secure fastest time to market
- Multiple brownfield and greenfield options from 10 MW to 200 MW available
- Proven expertise in delivering large and complex data center projects
  - Technical and constructional know-how in place to build your data center in time and on budget
  - Data center operations expertise from local ecosystem
- Built in security processes and no risk of natural hazards

|   |  |   |   |
|---|--|---|---|
| <p>Brownfield</p> <p><b>+50 000 m<sup>2</sup></b></p> <p>3 greenfield options</p> <p><b>+200 ha</b></p> | <p>Existing reference projects</p> <p><b>4</b> data centers <b>with 30 MW</b> allocated</p> <p>on time and on budget</p> | <p>Ready electric infrastructure</p> <p><b>200 MW</b></p> <p>reduced capex and time-to-market</p> | <p><b>ISO 27001</b></p> <p>security certification</p> |
|---|--|---|---|

# Reach the best total cost of ownership for your data center project



- Excess heat sales opportunity reduces total cost of energy
- Significant cost savings offered by the low cost electricity and the existing infrastructure
- Private electricity network in the area owned by the landlord UPM
- Renewable local energy enables low cost operations in the years to come
- Availability for long PPA contracts to secure stable electricity pricing

Data center electricity costs

**<50 €**

MWh

>5 MW data centers

Excess heat utilization ready

**CARBON  
NEGATIVITY**

**+ ASSETS FOR SALE**

PPA contract lowest 25% in 2020

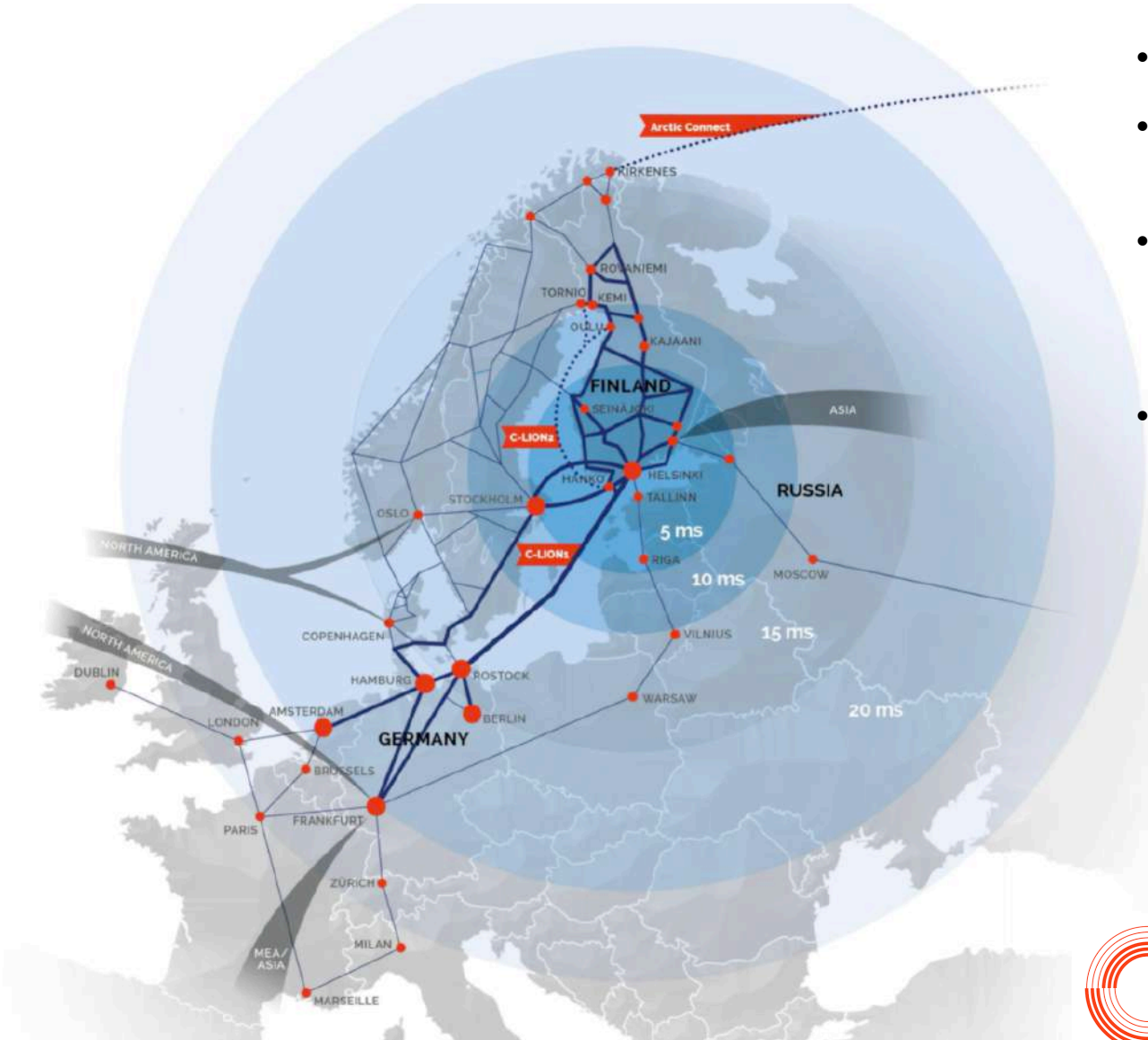
**30 €**

MWh

Waste heat impact to total cost of energy

**~40 %**

# Kajaani Connectivity



- Funet, NORDUnet & GÉANT research networks in place
- Operator neutral business park with multiple physical connectivity routes to the site
- Cinia PoP in place (multiple 100G)
  - Direct C-Lion connectivity
  - Future connectivity to “Far North Fiber”
- All the national operators in place

| CITY      | Kajaan | Helsinki    | Frankfurt   | Hamburg | Amsterdam | London | Berlin      | Stockholm |
|-----------|--------|-------------|-------------|---------|-----------|--------|-------------|-----------|
| Helsinki  | 6,7    |             |             |         |           |        |             |           |
| Frankfurt | 26,4   | <b>19,7</b> | -           | -       | -         | -      | -           | -         |
| Hamburg   | 21,9   | <b>15,2</b> | 5,6         | -       | -         | -      | -           | -         |
| Amsterdam | 26,4   | <b>19,7</b> | 12,1        | 6,5     | -         | -      | -           | -         |
| London    | 32,8   | 26,1        | 16,4        | 10,8    | 6         | -      | -           | -         |
| Berlin    | 22,7   | <b>16</b>   | 11,5        | 5,8     | 12,3      | 16,6   | -           | -         |
| Stockholm | 11,9   | 5,2         | <b>22,4</b> | 12,4    | 19        | 23,2   | <b>17,1</b> | -         |
| Moscow    | 18,4   | 11,7        | 31,4        | 26,9    | 33,4      | 37,7   | 27,7        | 16,9      |
| Tokyo     | 137,5  | 130,8       | 150         | 146     | 152,5     | 156,8  | 146,8       | 136       |
| Hong Kong | 139,5  | 132,8       | 152         | 148     | 154,5     | 158,8  | 148,8       | 138       |

\*Unbolded values are estimates and bolded values are measured



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# Kajaani site & LUMI EuroHPC videos



## Kajaani:

### [Kajaani data center sustainability](https://www.youtube.com/watch?v=GUCVB0Z4B0s)

<https://www.youtube.com/watch?v=GUCVB0Z4B0s>

### [Kajaani Renforsin Ranta Business park](https://www.youtube.com/watch?v=IMC6zXQM4Uo&t=2s)

<https://www.youtube.com/watch?v=IMC6zXQM4Uo&t=2s>

## LUMI:

### [Making of LUMI part-1](https://www.youtube.com/watch?v=covoiGPdAwY)

<https://www.youtube.com/watch?v=covoiGPdAwY>

### [Making of LUMI part-2](https://www.youtube.com/watch?v=N0z0_6skUG8)

[https://www.youtube.com/watch?v=N0z0\\_6skUG8](https://www.youtube.com/watch?v=N0z0_6skUG8)

### [Making of LUMI part-3 & installation](https://www.youtube.com/watch?v=pWxBS_vcofA)

[https://www.youtube.com/watch?v=pWxBS\\_vcofA](https://www.youtube.com/watch?v=pWxBS_vcofA)

### [LUMI 1<sup>st</sup> phase system arrival](https://www.youtube.com/watch?v=g1laWuOZ26A&t=24s)

<https://www.youtube.com/watch?v=g1laWuOZ26A&t=24s>

## LUMI data center

<https://www.youtube.com/watch?v=YJ63BqpHqpw>

### [LUMI world-class supercomputer](https://www.youtube.com/watch?v=gZrw58_Cu4g&t=39s)

[https://www.youtube.com/watch?v=gZrw58\\_Cu4g&t=39s](https://www.youtube.com/watch?v=gZrw58_Cu4g&t=39s)

