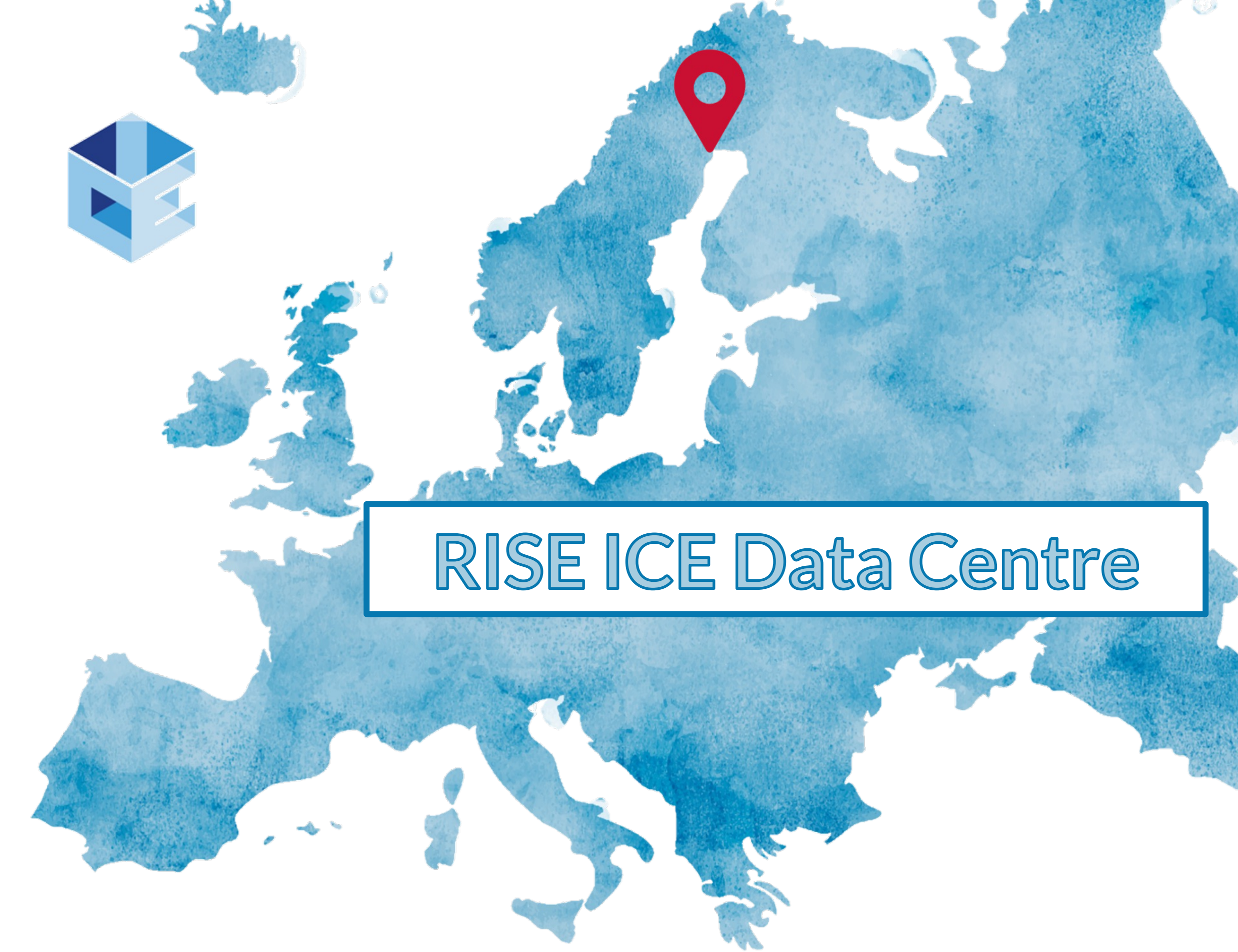
Achieving Sustainable Digitalization: Strategies for Energy Savings in Data Centres

RISE – Research Institutes of Sweden



RISE ICE Data Centre

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

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

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

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

BDV i-Space GOLD

BDV i-Space SILVER

DATACLOUD GLOBAL AWARDS 2019

BRONZE Cluster Management Excellence STRIVING FOR CLUSTER EXCELLENCE

RI. SE
Best Data Center Initiative of the Year
with RISE SICE North Research Data Center
Sponsored by DCPRO

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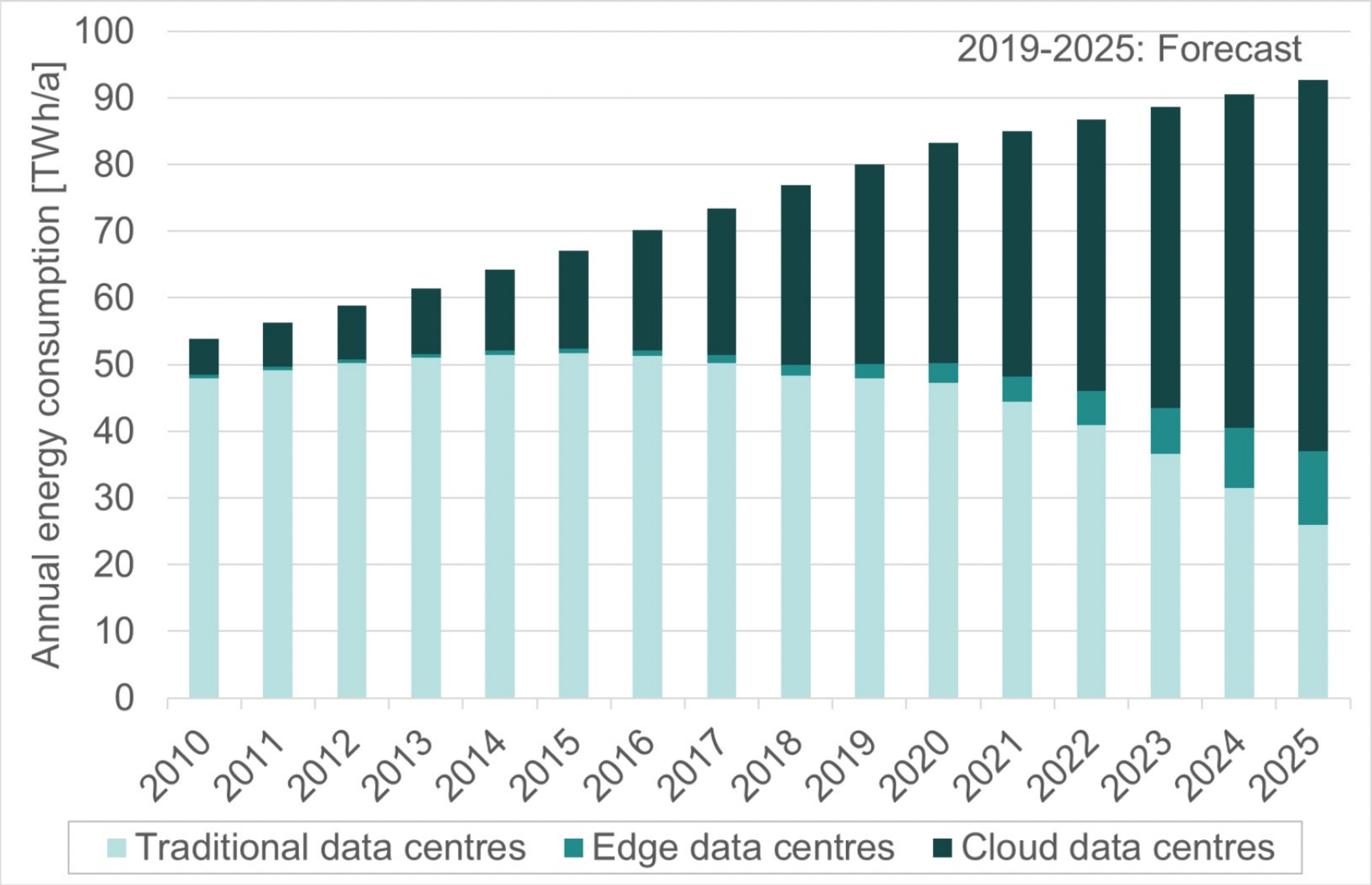

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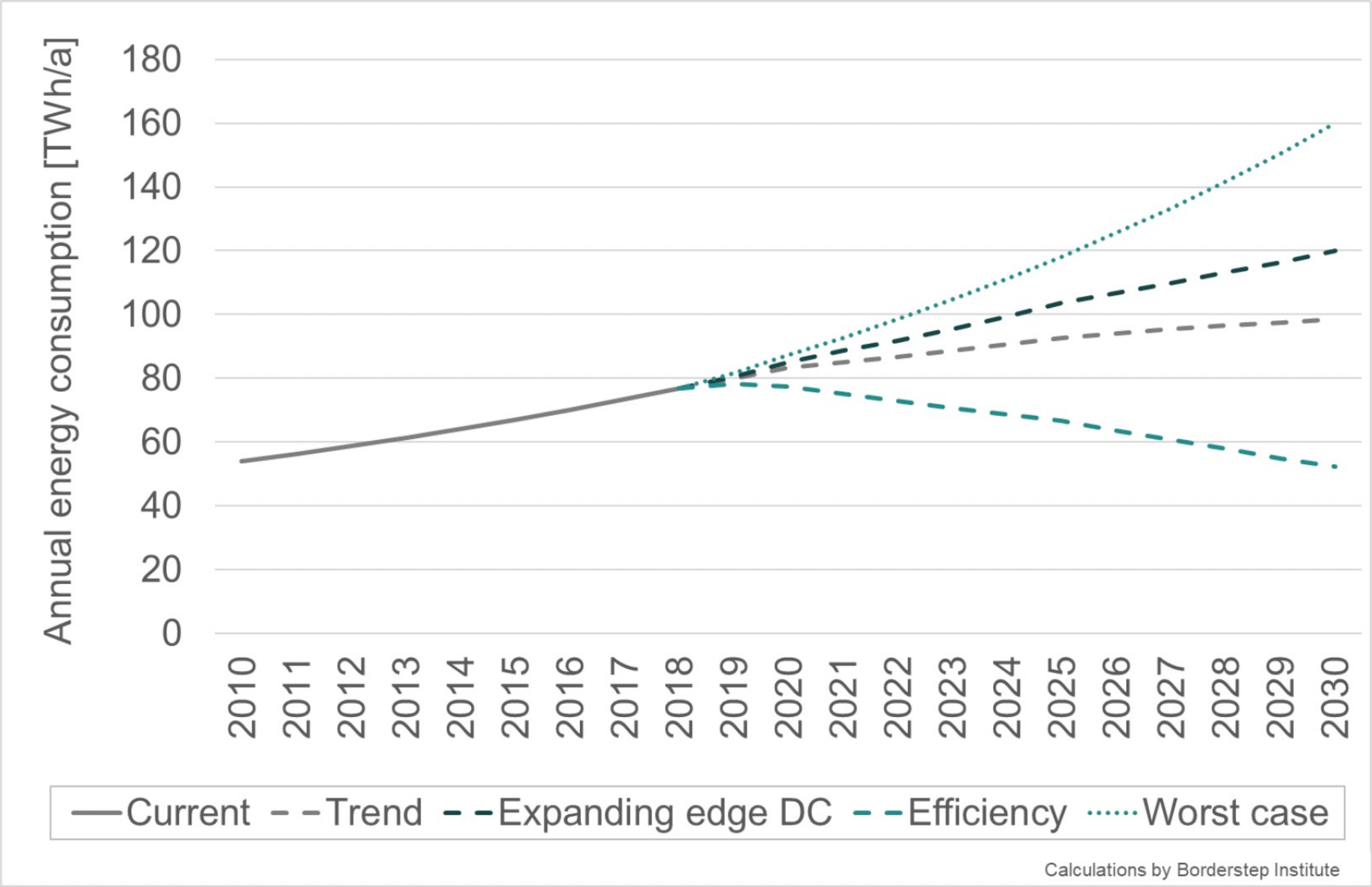
* Energy-efficient Cloud Computing Technologies and Policies for an Eco-friendly Cloud Market (2020)
https://op.europa.eu/en/publication-detail/-/publication/bf276684-32bd-11eb-b27b-01aa75ed71a1



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Council of the
European Union

Brussels, 24 March 2023
(OR. en)

7446/23

LIMITE

ENER 127
ENV 253
TRANS 101
ECOFIN 246
RECH 91
CLIMA 140
IND 112
COMPET 211
CONSOM 84
CODEC 382

Interinstitutional File:
2021/0203(COD)

NOTE

From:	General Secretariat of the Council
To:	Permanent Representatives Committee
No. Cion doc.:	10745/2/21 REV2 + ADD1REV1
Subject:	Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on energy efficiency (recast) - Analysis of the final compromise text with a view to agreement

1.7. **Data centres in new Article 11a and specific provisions on data centres in Article 24**

By 15 May 2024 and annually thereafter, Member States will require owners and operators of data centres with power demand of at least 500kW, to make specific information (set out in Annex VI) publicly available, except information subject to national and EU laws protecting trade and business secrets and confidentiality. The Commission will by 15 May 2025 prepare an assessment and a report, which could be accompanied by a proposal on further measures to improve energy efficiency in data centres. In accordance with Article 24, Member States shall ensure that data centres with a total rated energy input exceeding 1 MW utilise the waste heat or other waste heat recovery applications unless they can show that it is not technically or economically feasible.

The ***collected data should*** be used to measure ***at least some*** basic dimensions of a sustainable data centre, namely how efficiently it uses energy, how much of that energy comes from renewable energy sources, the reuse of any waste heat that it produces***, the effectiveness of cooling, the effectiveness of carbon usage*** and the usage of freshwater. The ***collected data and the*** sustainability indicators should raise awareness amongst**,** data centre owners and operators, manufactures of equipment, developers of software and services, users of data centre services at all levels as well as entities and organisations that deploy, use or procure cloud and data centre services. It should also give confidence about the actual improvements following efforts and measures to increase the sustainability in new or existing data centres. Finally, it should be used as a basis for transparent and evidence-based planning and decision-making. ***The Commission*** should ***assess the efficiency of data centres based on the information communicated by*** Member States.

* https://data.consilium.europa.eu/doc/document/ST-7446-2023-INIT/en/pdf

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D2.2
Green Data Centre Assessment Toolkit

WORKPACKAGE
WP2

DOCUMENT
D2.2

VERSION
0.9.5

PUBLISH DATE
30/08/2018

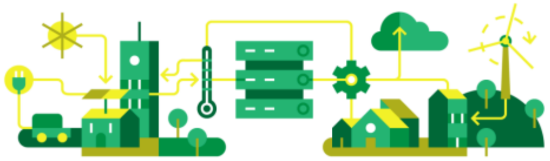
PROGRAMME IDENTIFIER
H2020-EE-2016-2017

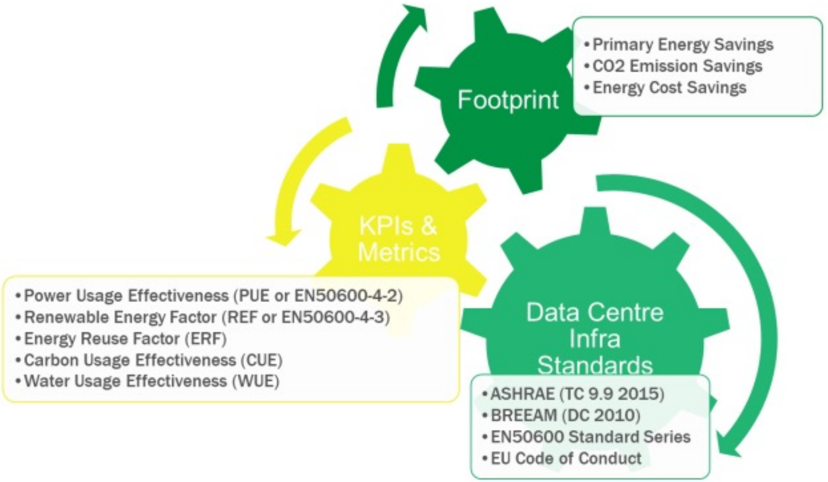
PROJECT NUMBER
768739

START DATE OF THE PROJECT
01/10/2017

DURATION
36 months

DOCUMENT REFERENCE
CATALYST.D2.2.GIT.WP2.v0.9.5





Metric	Description	Formula	Unit / Range	Optimal Value	Source
Power Usage Effectiveness – PUE	% of energy spent powering ancillary equipment	$\frac{Total\ Facility\ Energy}{IT\ Equipment\ Energy}$	N/A 1<PUE	As close to 1 as possible	EN 50600-4-2; ISO/IEC 30134-2
Renewable Energy Factor – REF	% of renewable energy over total DC energy	$\frac{RE\ owned\ \&\ controlled\ by\ DC}{Total\ Facility\ Energy}$	N/A 0≤REF≤ 1	1 = DC powered 100% by RE	EN 50600-4-3; ISO/IEC 30134-3
Energy Reuse Factor – ERF	% of energy exported for reuse outside of DC	$\frac{Reuse\ X\ SourceFactor}{Total\ Facility\ Energy}$	N/A 0≤ERF≤ 1	1 = all energy is being reused	ISO/IEC 30134-6; Cluster
Water Usage effectiveness – WUE	Operational water usage associated with DC	$\frac{Annual\ Water\ Usage}{IT\ Equipment\ Energy}$ [2]	L/kWh 0≤WUE	0 = no water use	The Green Grid; whitepaper #35
Primary Energy Savings – PES	% of savings in terms of primary energy associated with DC operations	$1-\frac{PE_{Current,\Delta t}\ [3]}{PE_{Baseline\_adjusted_{\Delta t}}\ [4]}$	N/A 0≤PES<1	As close to 1 as possible	Cluster
CO2 Savings	% of savings in terms of CO2 emissions associated with DC operations	$1-\frac{CO2_{current_{\Delta t}}\ [5]}{CO2_{baseline\_adjusted_{\Delta t}}\ [6]}$	N/A 0≤CO2 Savings<1	As close to 1 as possible	Cluster

European Commission

JRC TECHNICAL REPORT

2023 Best Practice Guidelines for the EU Code of Conduct on Data Centre Energy Efficiency

Version 14.1.0 (Final version)

Acton, Mark
Bertoldi, Paolo
Booth, John

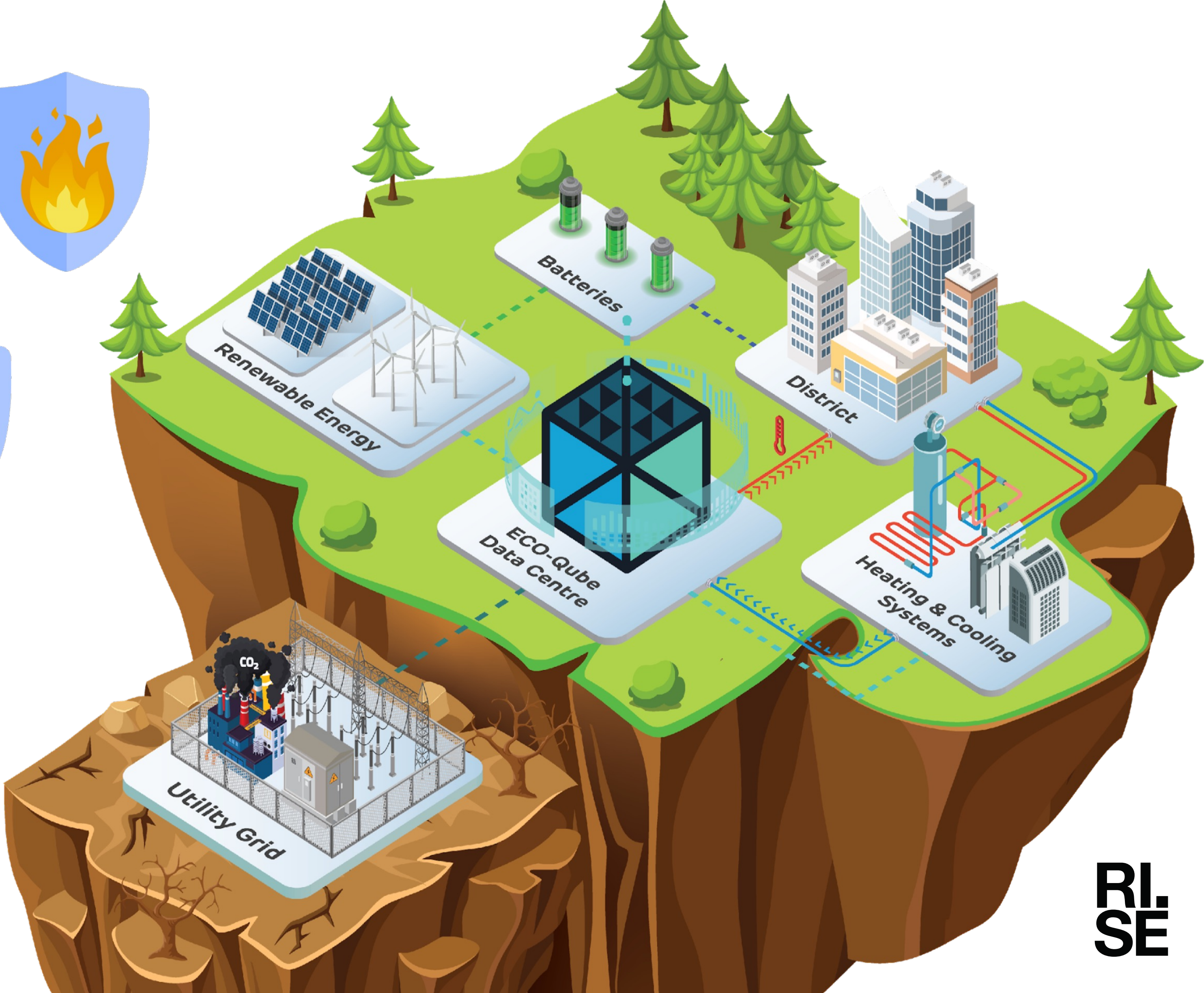
2023

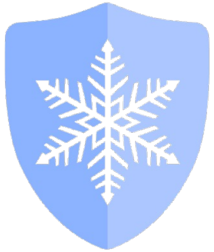
European Commission

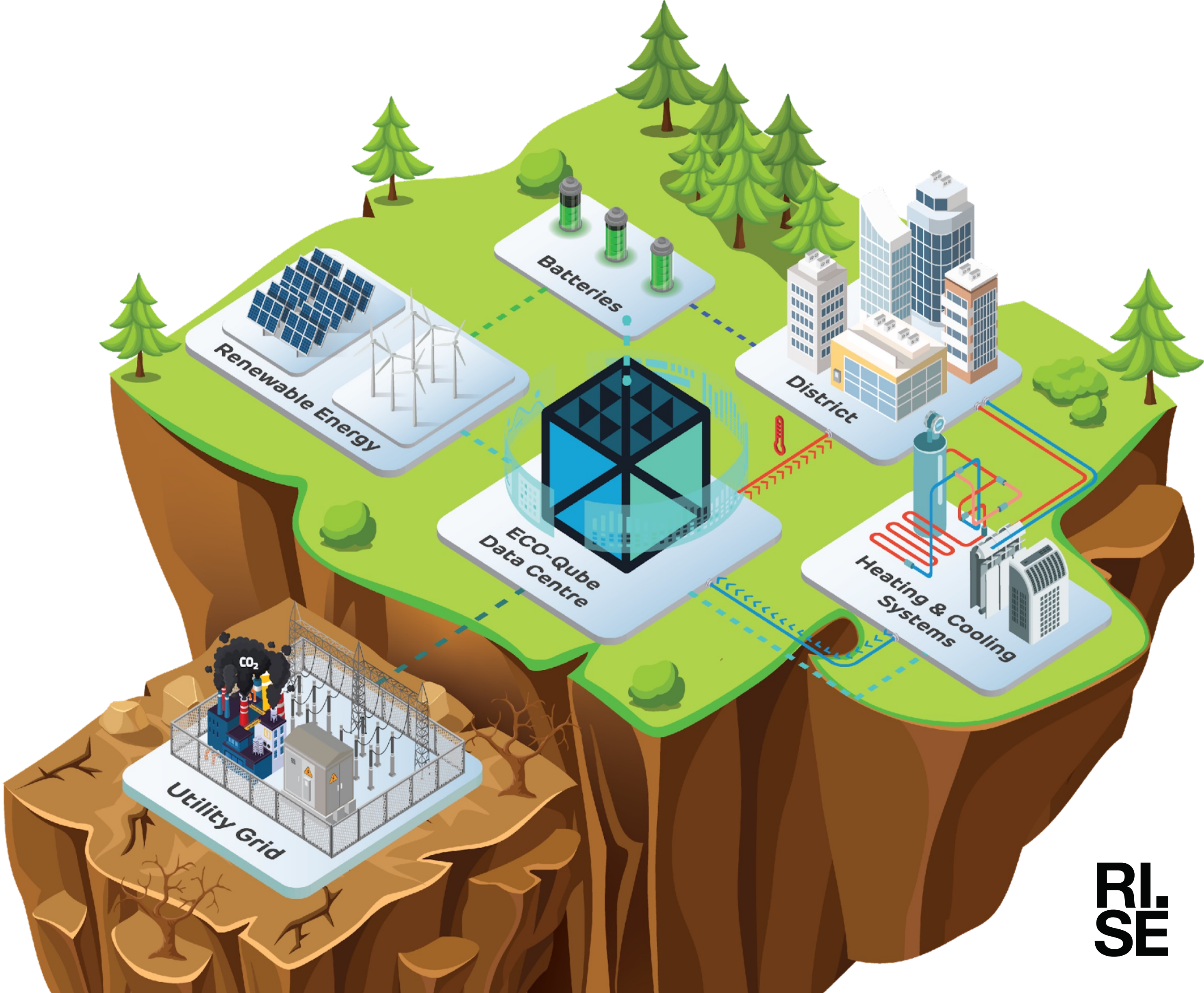
Assessment Framework for Data Centres in the Context of Activity 8.1 in the Taxonomy Climate Delegated Act

2023

CODE OF CONDUCT
DATA CENTRES


Batteries
Renewable Energy
District
ECO-Qube
Data Centre
Heating & Cooling
Systems
CO_2
Utility Grid




Batteries
Renewable Energy
District
ECO-Qube
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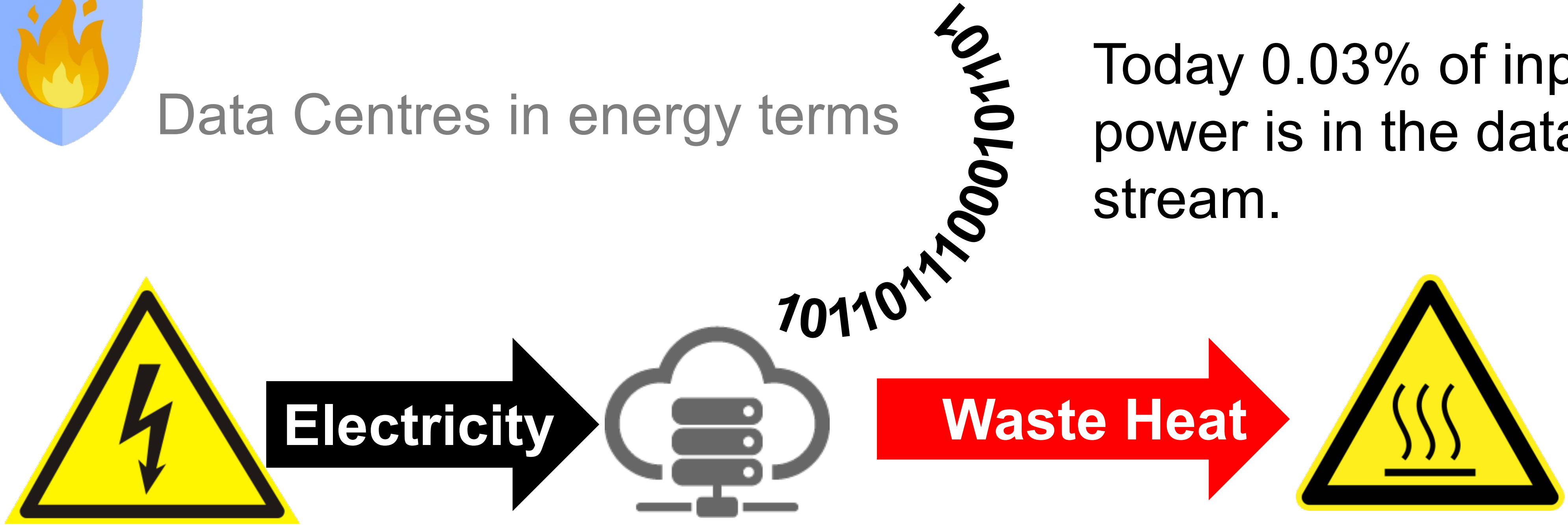
Heating & Cooling
Systems
CO_2
Utility Grid

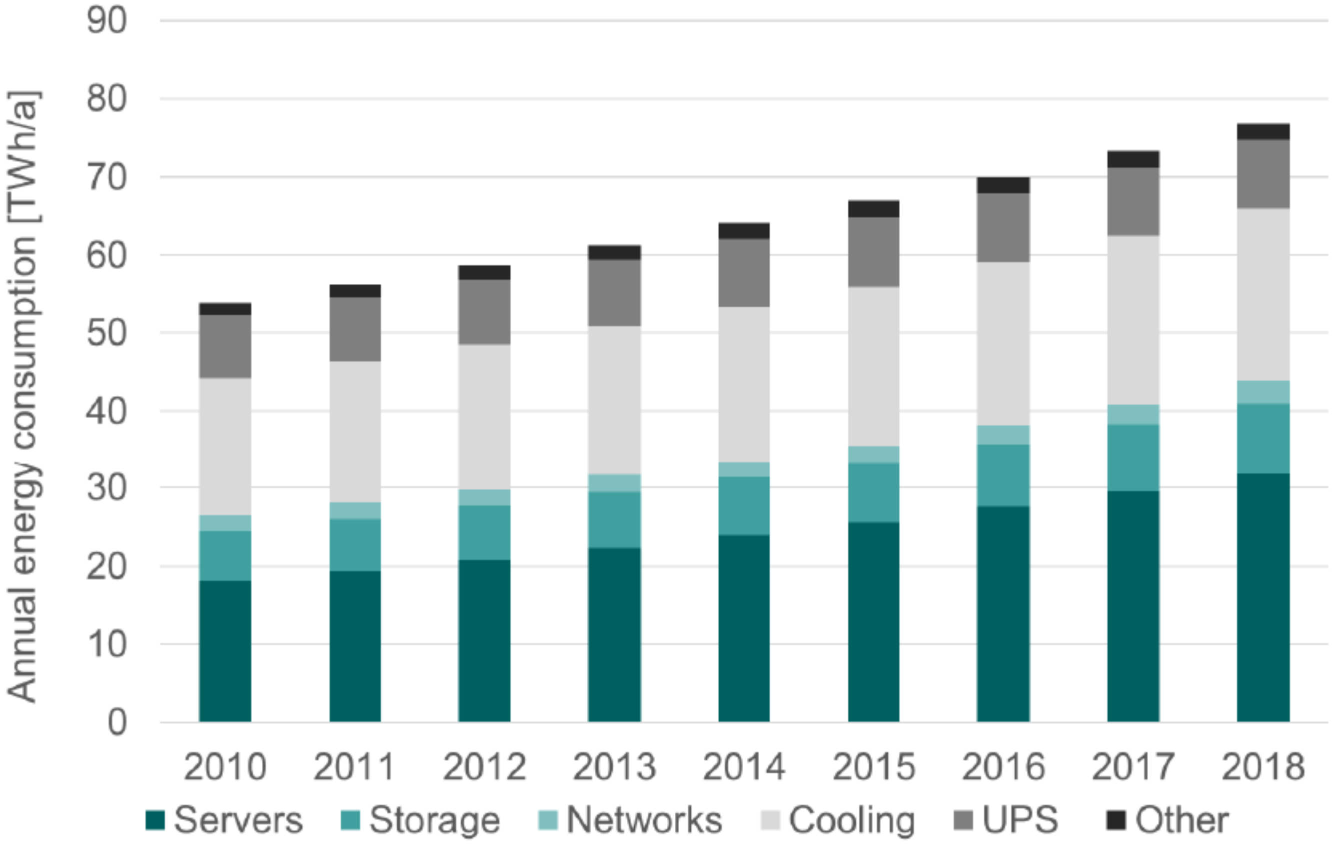
Data Centres in energy terms

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



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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The Boden Type Data Centre

A Horizon 2020 funded project

What knowledge can we apply from building the World's most efficient conventional data centre

The Efficiency of Data Centres - PUE

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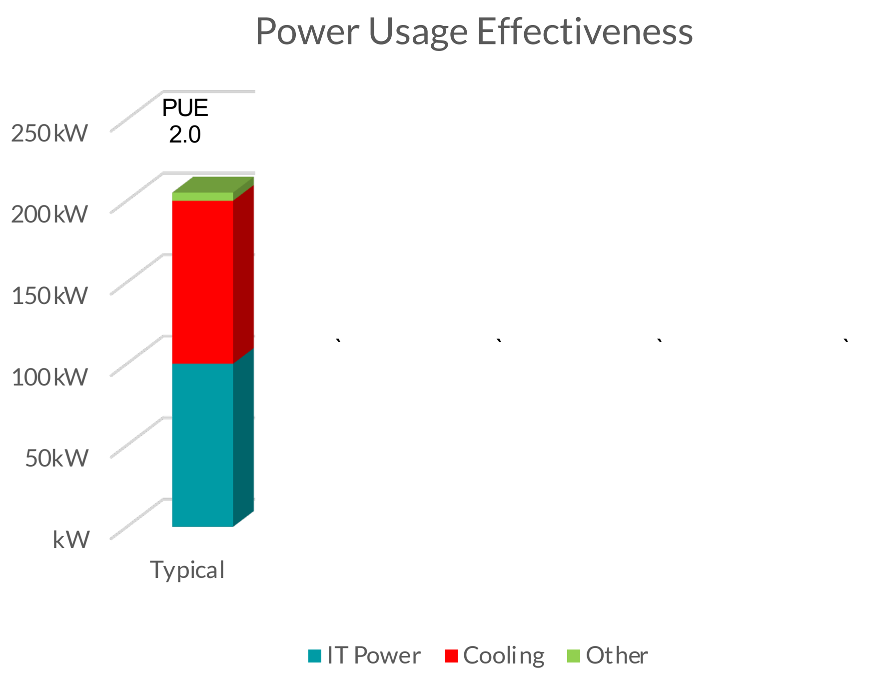

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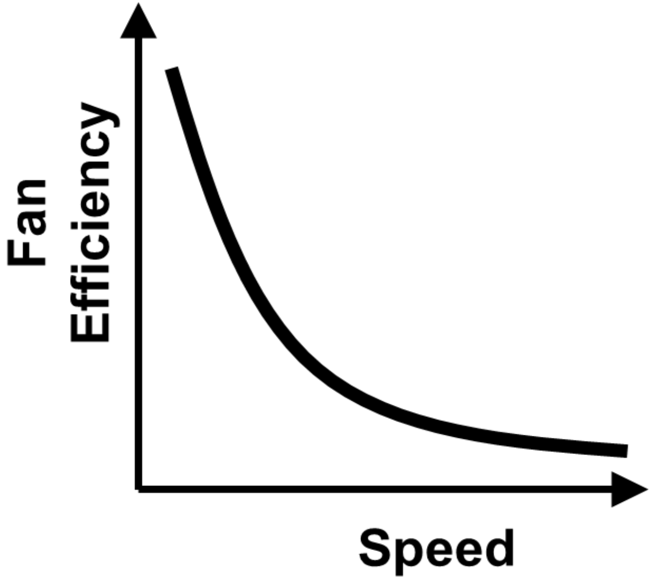
How a PUE of <1.02 was achieved

- Minimise air flow by maintaining the chip temperature by correct control of server fans
- Synchronising the cooling system fans with the server fans



Commission regulation (EU) No 327/2011 of 30 March 2011implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for fans driven by motors with an electric input power between 125 W and 500 kW

Ecodesign

KEY PRINCIPLE 1 – Fan Energy

The energy use of a fan is proportional to the cube of its speed. A 50% reduction in fan speed reduces its energy use by nearly 90%

Holistic cooling control in practice

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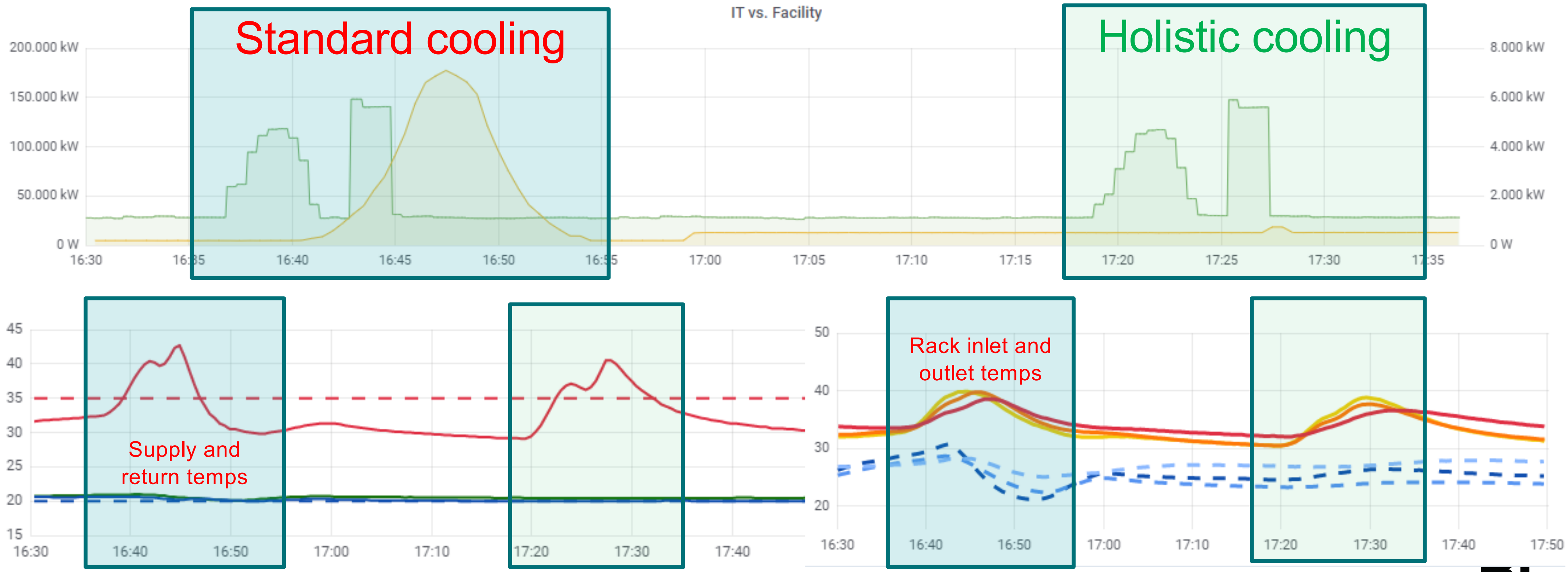
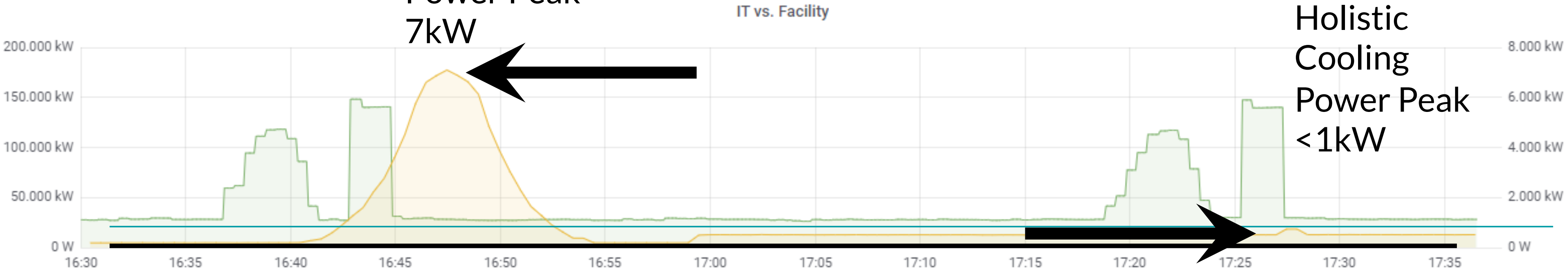
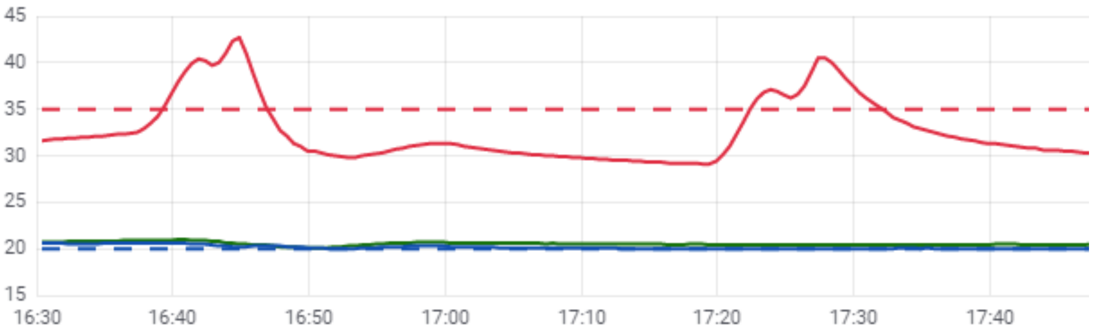


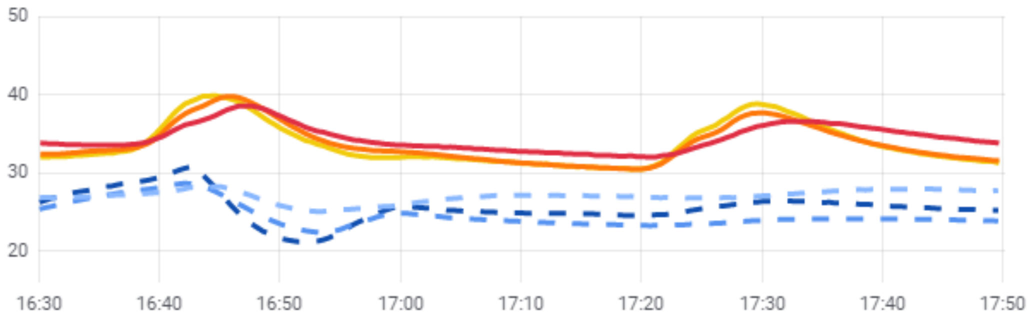
Holistic cooling control in practice

Standard Cooling Power Peak 7kW

Holistic Cooling Power Peak <1kW







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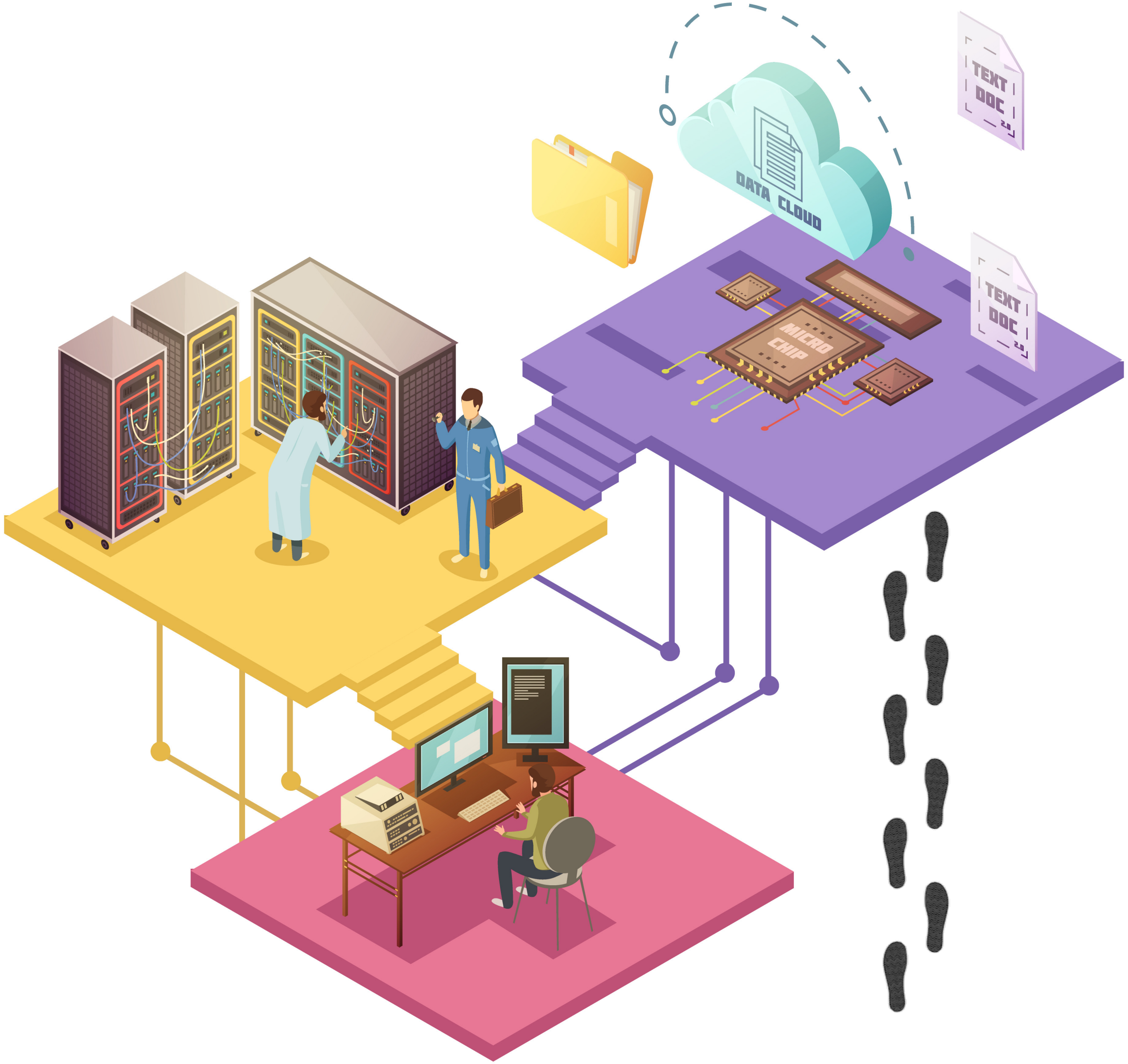
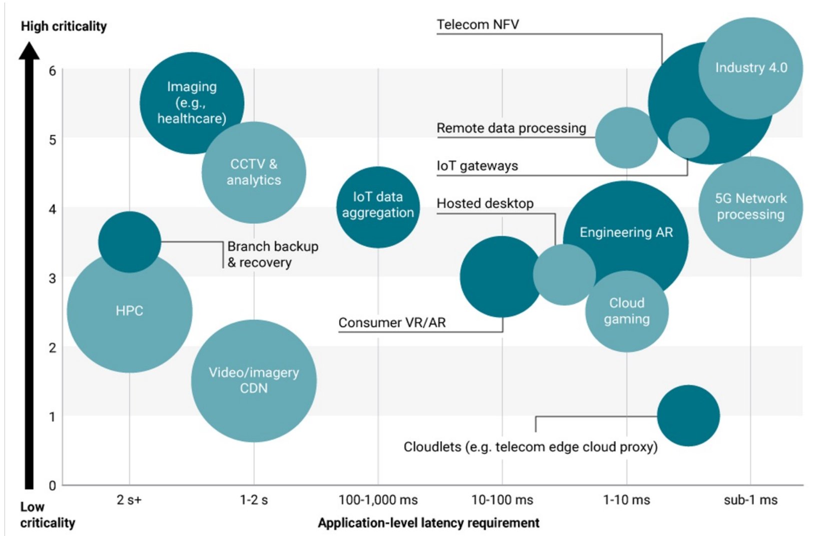
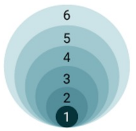
Date	Milestone/Reference
1960s	Personal computers started to emerge, although they were not yet widely used for business management.
1970s	Adoption of personal computers increased, and they began to be utilized for basic business management tasks.
1980s	Personal computers became more powerful and affordable, leading to their widespread use in business management.
1990s	As data volumes grew, personal computers became insufficient for handling business data, and businesses started utilizing dedicated servers in their own server rooms.
Early 2000s	The increasing amount of data and complexity of business operations led to the establishment of larger server rooms and data centers.
Mid-2000s	Virtualization technologies emerged, allowing businesses to consolidate multiple servers into a single physical server, leading to more efficient use of resources in server rooms.
Late 2000s	Cloud computing gained popularity, enabling businesses to store and process data remotely on servers maintained by third-party providers.
2010s	Businesses began gradually shifting their server rooms and data storage to cloud-based platforms due to the scalability, cost-effectiveness, and accessibility offered by the cloud.
2020s	Cloud computing became the dominant infrastructure model for businesses, and the migration from traditional server rooms to the cloud accelerated.





Score value	Volume / day / site	Criticality (availability of data or site)
6	100 TB+ (10 Gbps+)	0 downtime/extreme business risks
5	10-100 TB (1-10 Gbps)	few seconds/ high risks
4	1TB-10 TB (0.1-1Gbps)	few minutes / moderate risks
3	100-1,000 GB (10-100 Mbps)	few hours / low risks
2	10-100 GB (1-10 Mbps)	few days / little risk
1	10 GB (1 Mbps)	irrelevant / no risk

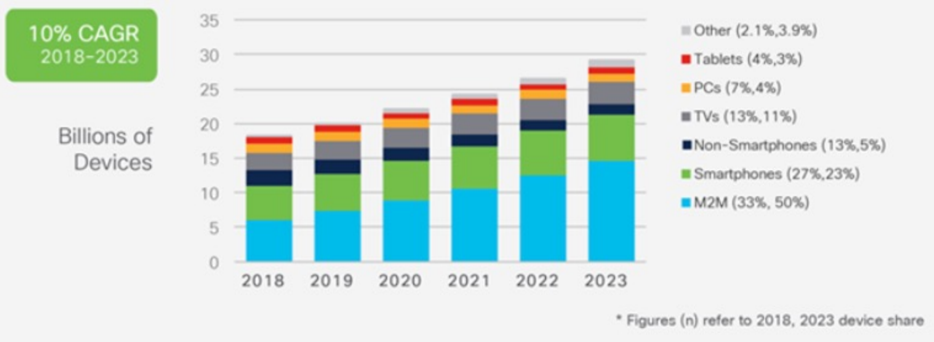
Key for volume/day/site

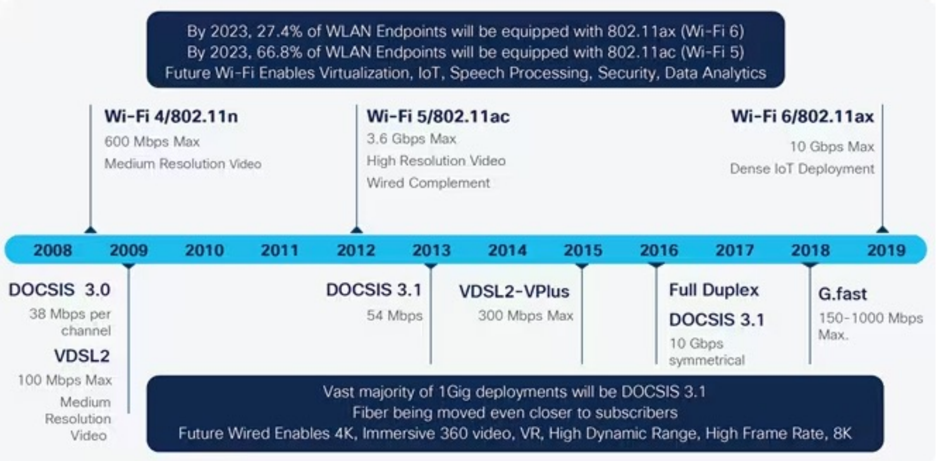


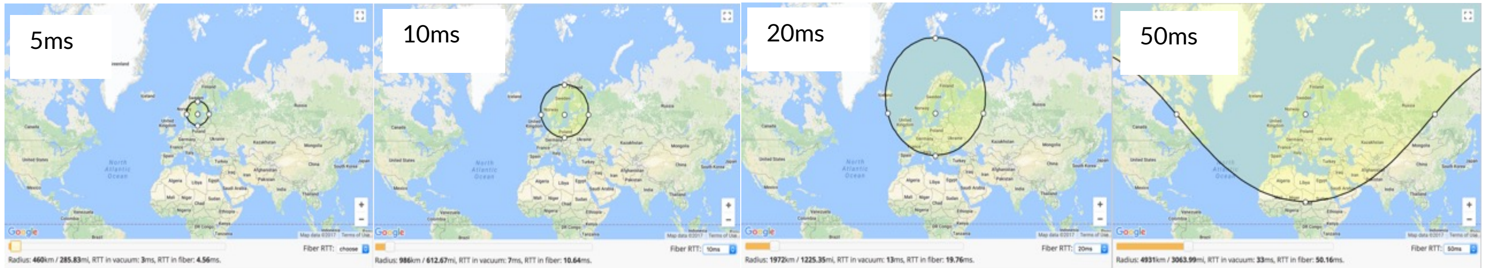
Uptime Institute Intelligence, 2021

UptimeInstitute | INTELLIGENCE

Figure 2 . **Edge workloads by latency, criticality and daily data volume**

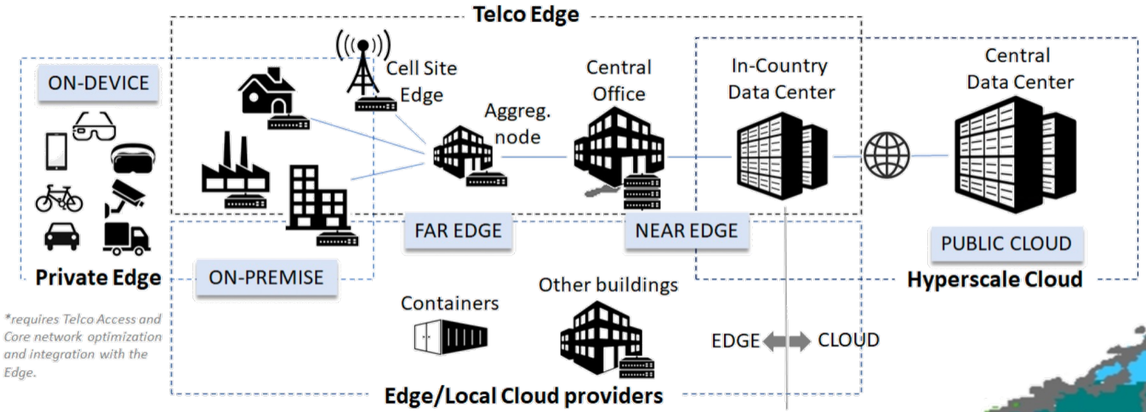


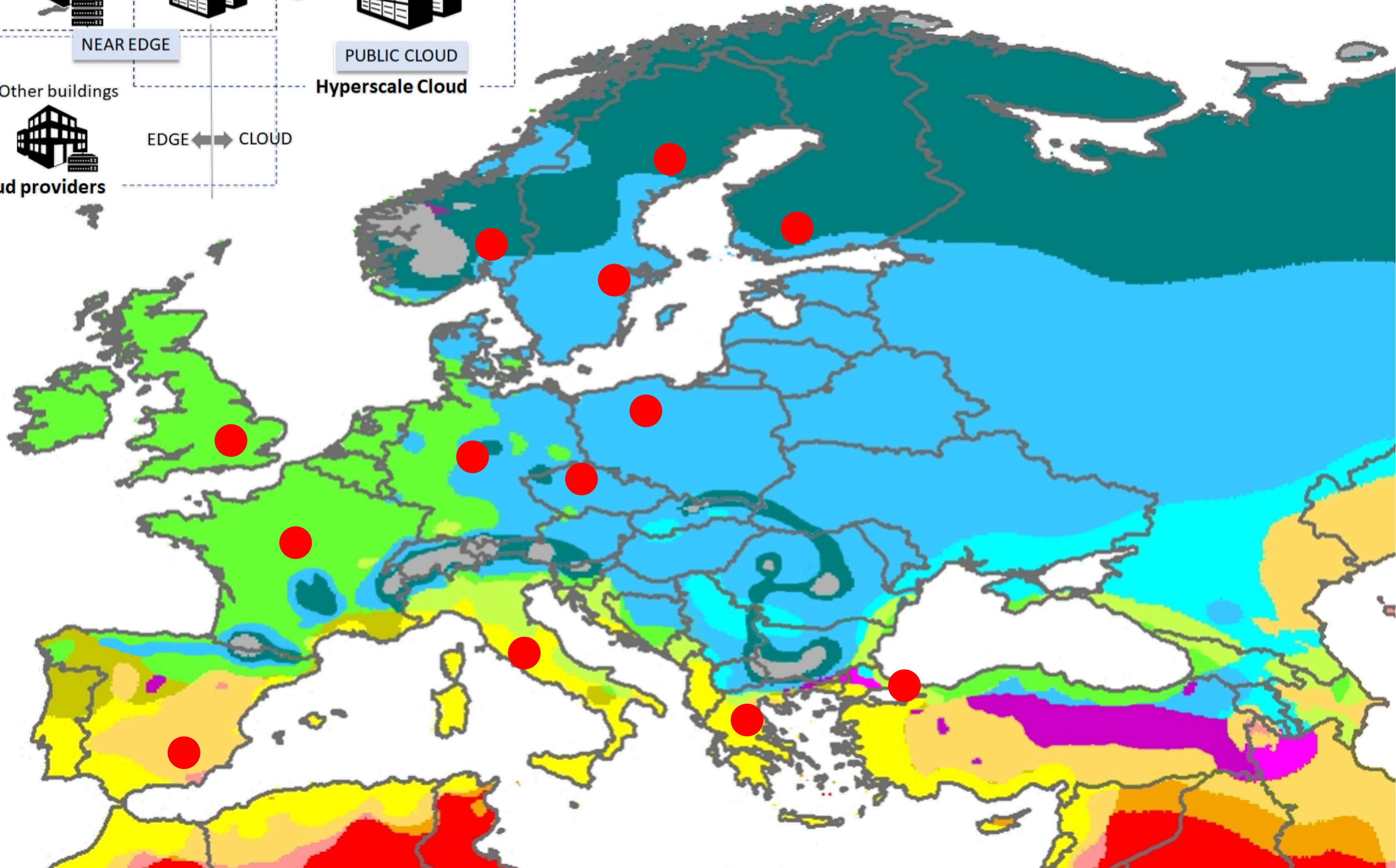




* Uptime Institute UI Intelligence Report 48: Demand and speculation fuel edge buildout

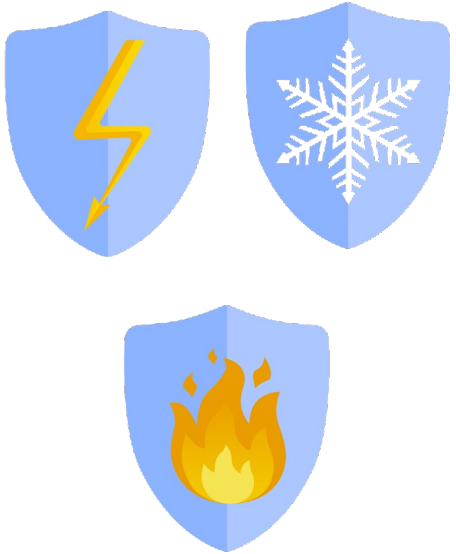
* Cisco Annual Internet Report (2018–2023) White Paper

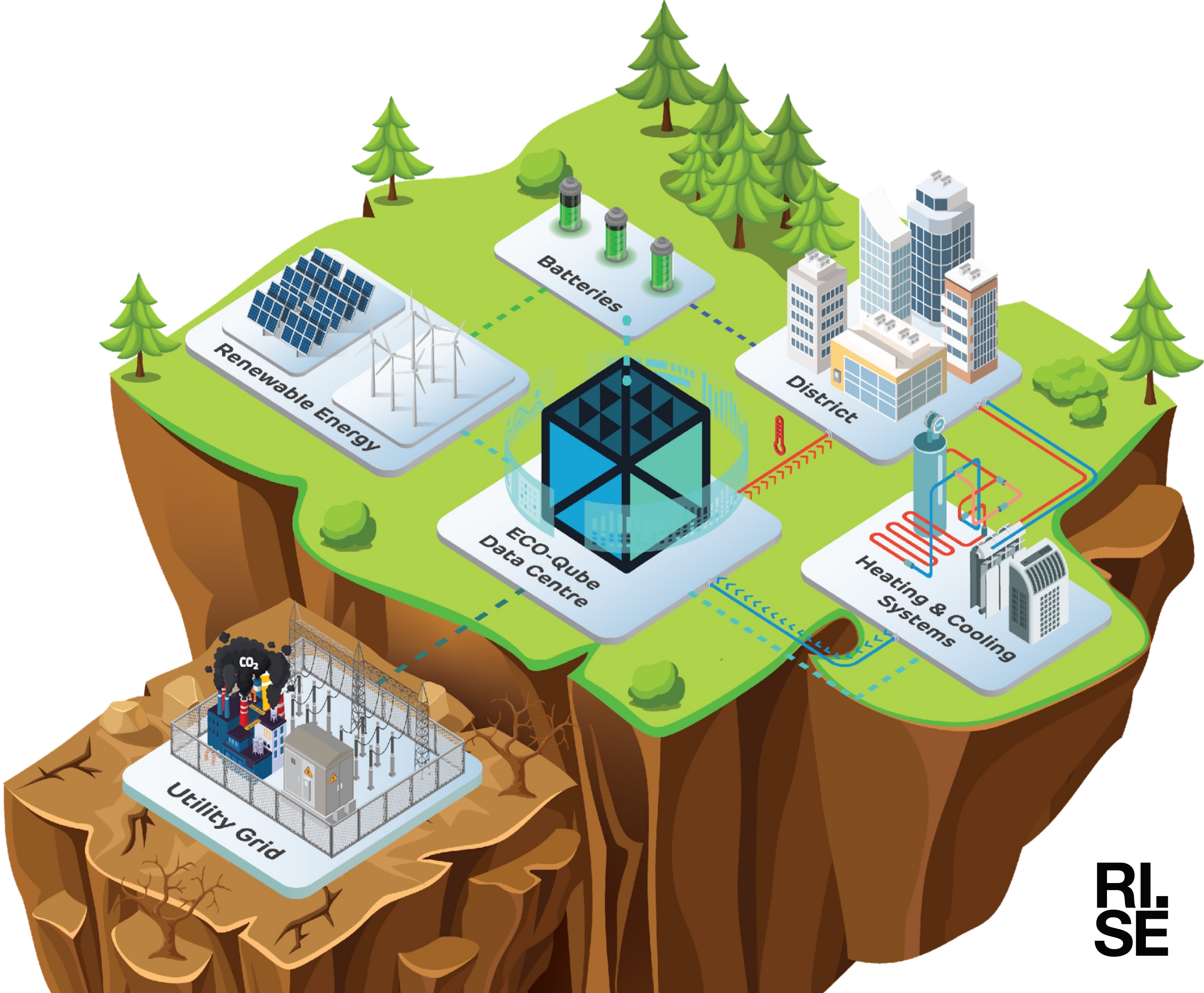




* European Industrial Technology Roadmap
for the Next Generation Cloud-Edge Offering
European Commission

ecoqube





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Empa
Materials Science and Technology

European Commission
Circular Economy Action Plan
The European Green Deal

OPEN Compute Project ®

- Empa’s energy reserach platform ‘NEST’ is the ideal micro-grid
- OCP ORV2 > EDGE (cooling + containment)
- Open source hardware for open science
- Customized refurbished rack compatible with the EU Circular Economy Action Plan

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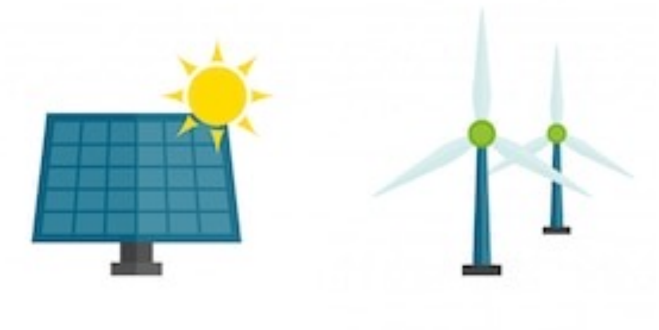

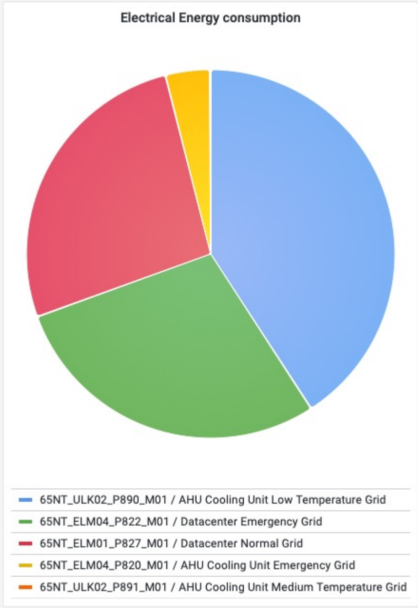

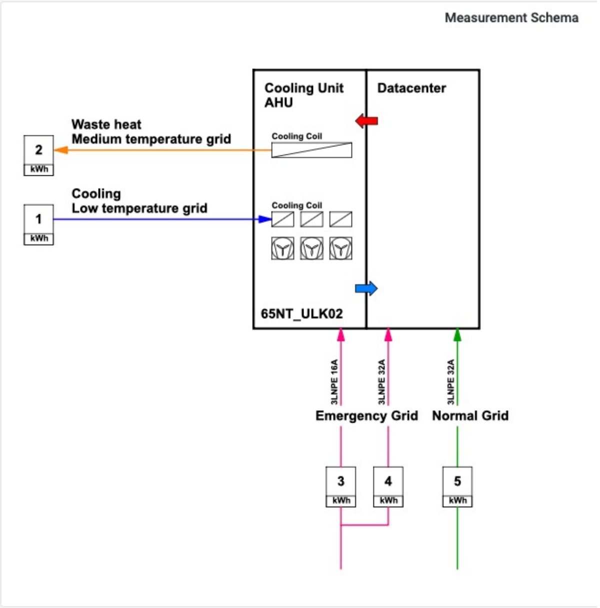

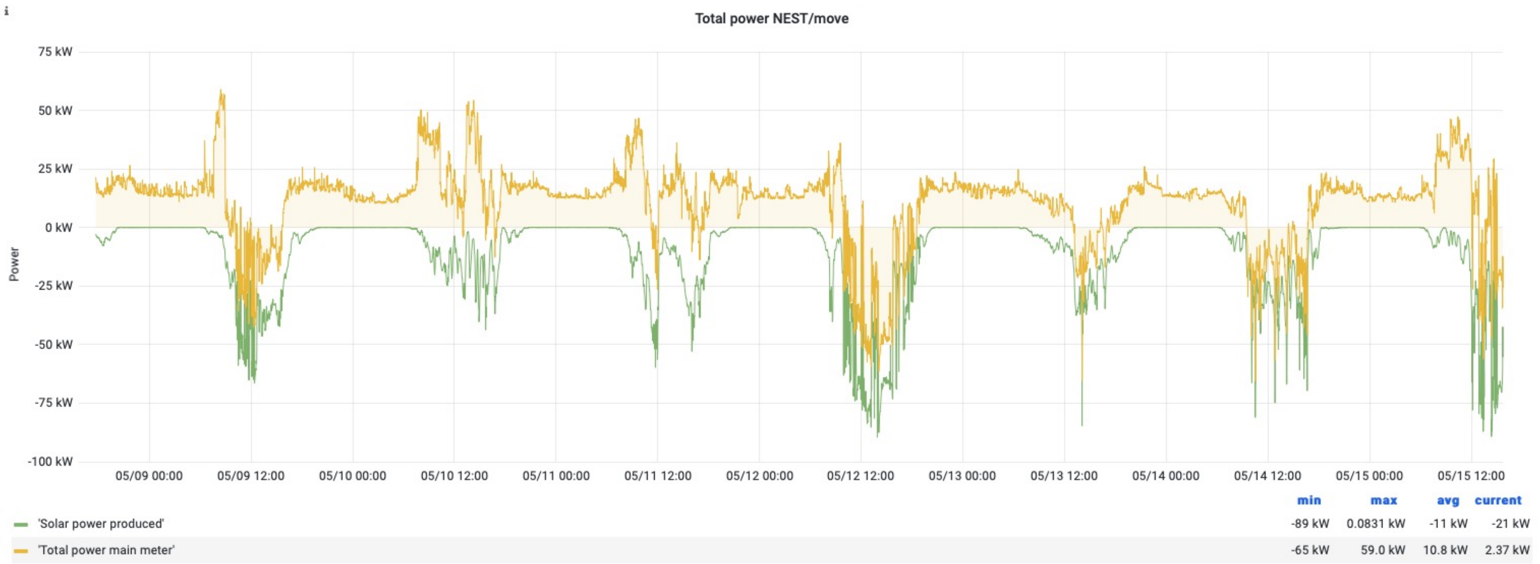

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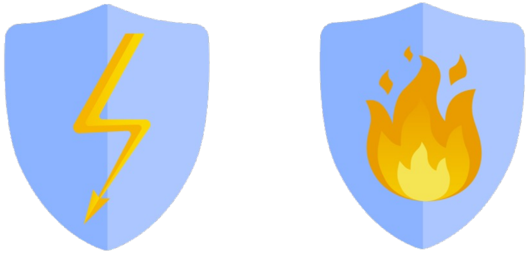

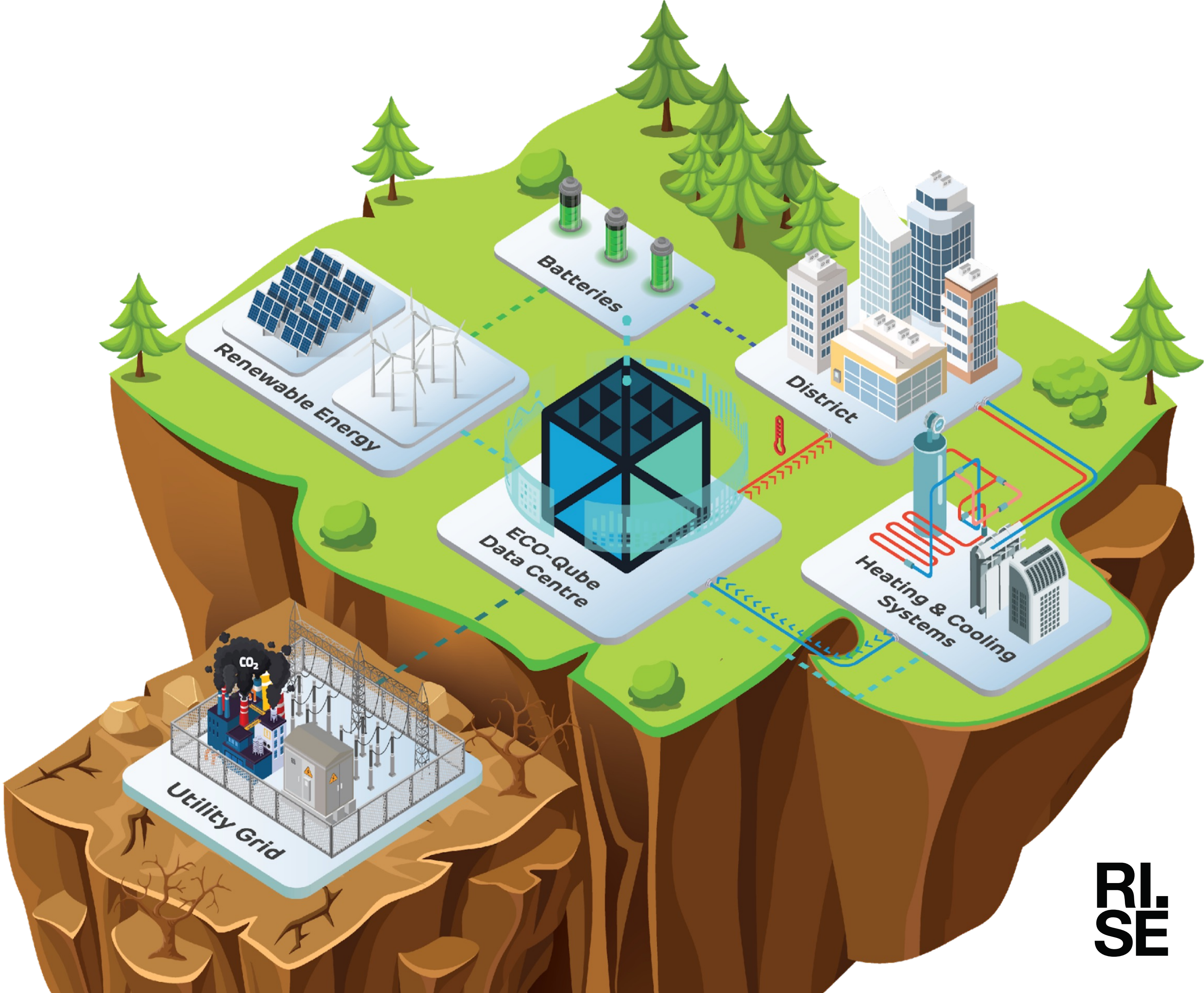
Batteries
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ECO-Qube
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Heating & Cooling
Systems
Utility Grid
CO_2

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.

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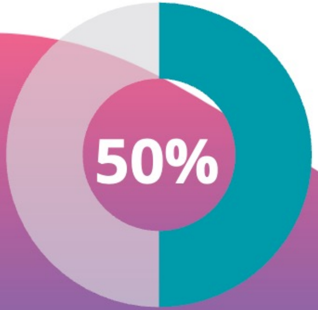
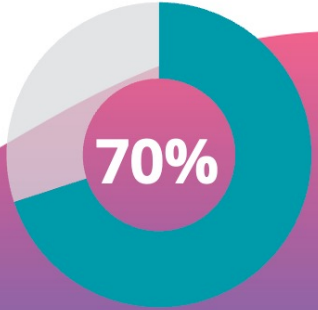
Heating and cooling buildings in EU accounts for



Of total energy consumption in EU



Of this energy is generated from fossil fuels

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Demonstration site

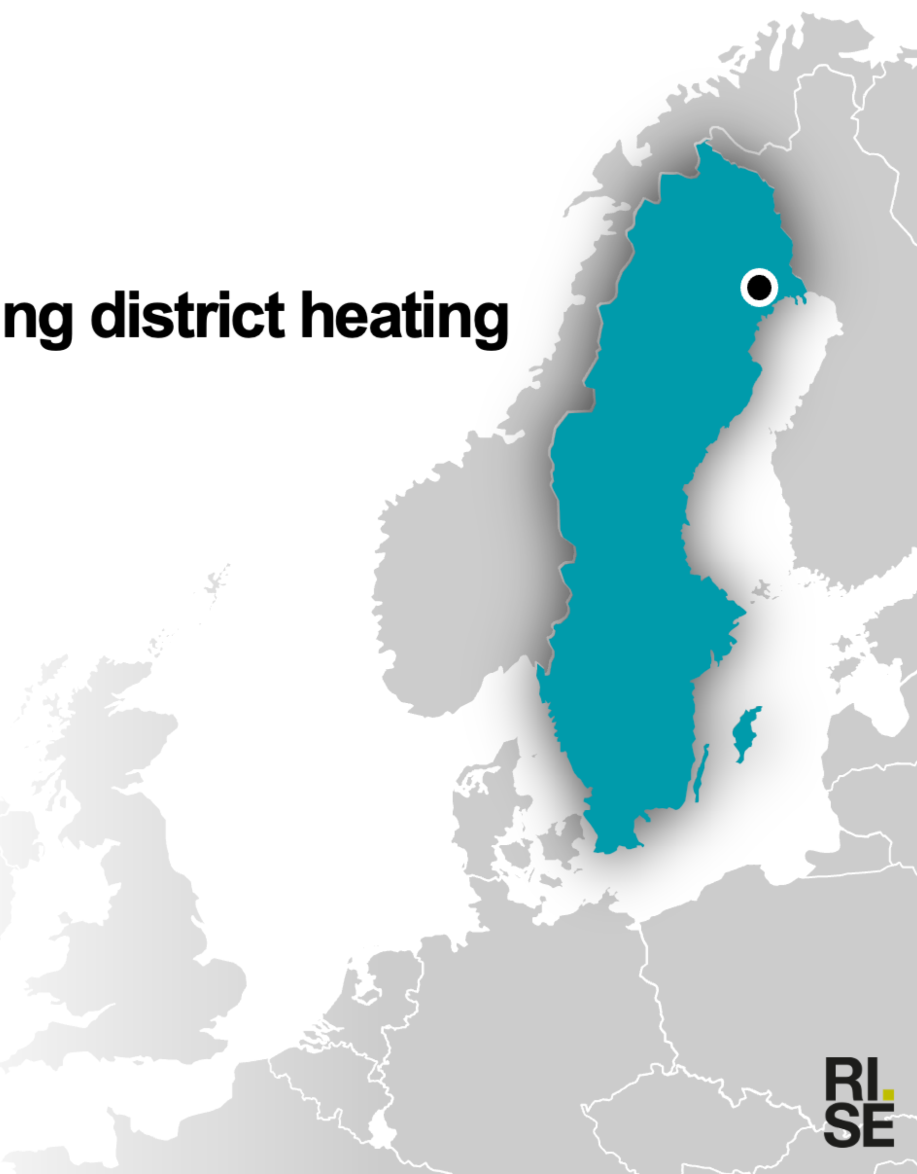
LULEÅ (Sweden)

Climate zone: Northern European Weather

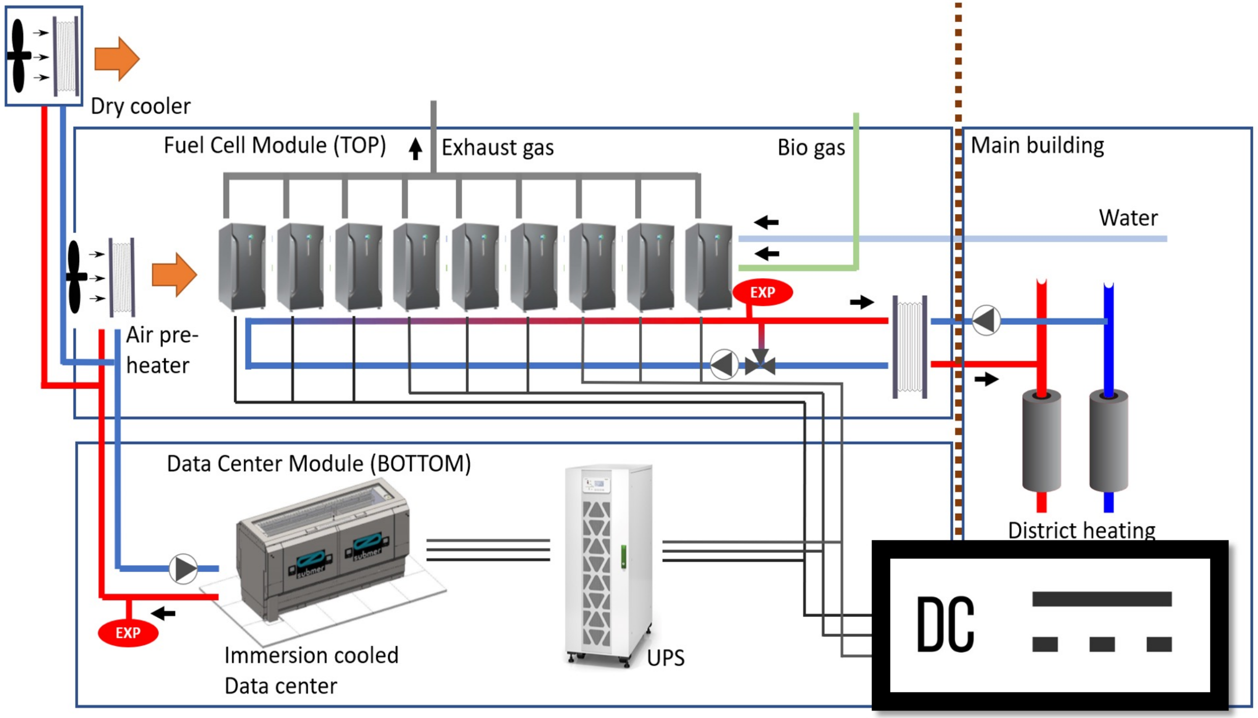
Excess heat integration in existing district heating

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 3rd generation district heating network.



Data centre
heat waste recovery



Data centre
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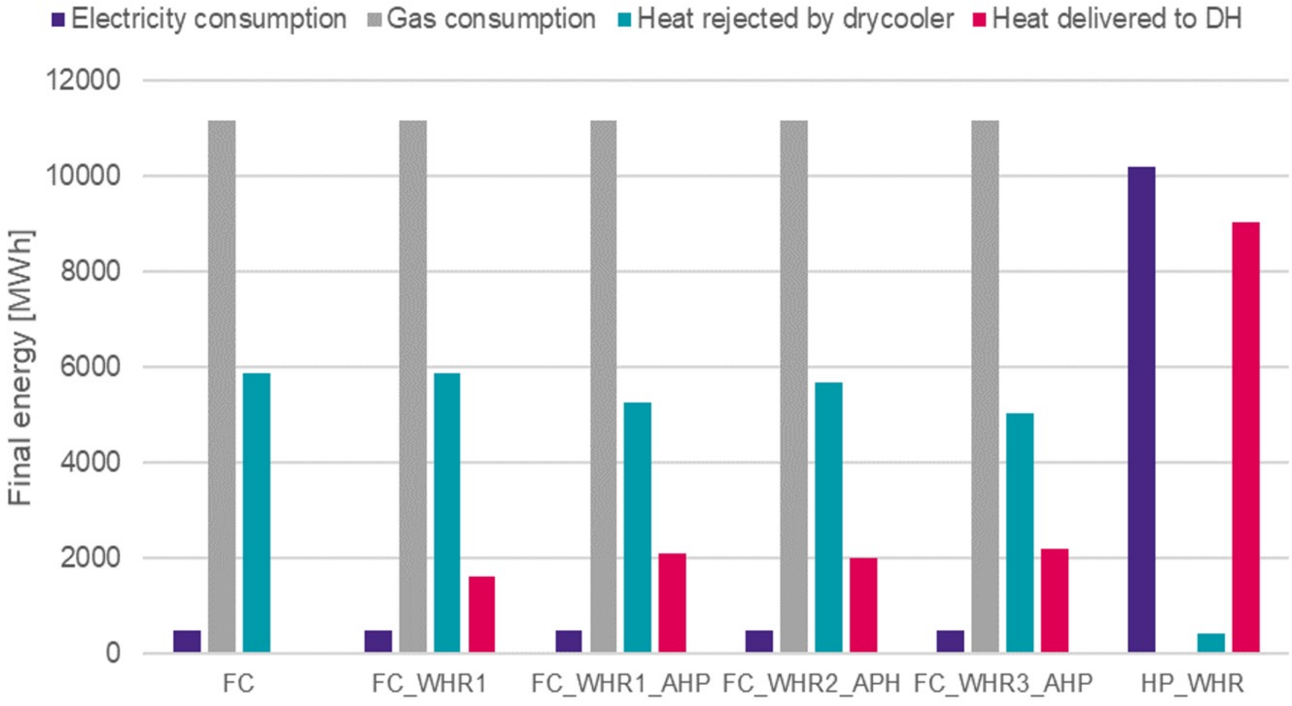

Results of simulations for 1MW of IT equipment in the data centre.

IREC
Institut de Recerca en Energia de Catalunya
Catalonia Institute for Energy Research
RISE

https://www.ri.se/en/ice-datacenter

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