The most energy and cost-efficient data centre in the world ‘Boden Type DC One’

Head of Lab
Tor Björn Minde
RISE ICE datacenter research

RISE ICE data centre research

RISE ICE data centre

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

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

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

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

2018, 2019 2020 BDV i-Space GOLD

2016, 20 BDV i-Space SILVER

DATACLOUD GLOBAL AWARDS 2019

Cluster Management Excellence
STRIVING FOR CLUSTER EXCELLENCE

RISE 2017, 2019
Best Data Center Initiative of the Year
with RISE SICE North Research Data Center
Sponsored by DCPRO
DCD > Awards

The Boden Type Data Centre

GA 768875

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

BODEN BUSINESS AGENCY

EcoCooling

Fraunhofer

H1 SYSTEMS

RI. SE

What is Boden Type Data Centre?

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Goal: Build a 500 kW demonstration site of the **most energy and cost efficient data centre in the world** in Boden

- 3 years – October 2017 – December 2020
- €2.5M funding by EU H2020

Why the Boden Type Data Centre?

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In a normal data centre ~40% of the electricity is consumed by cooling systems.

The objective of the 500kW BTDC is to demonstrate at an industrial scale how the **power usage of cooling** can be significantly reduced.

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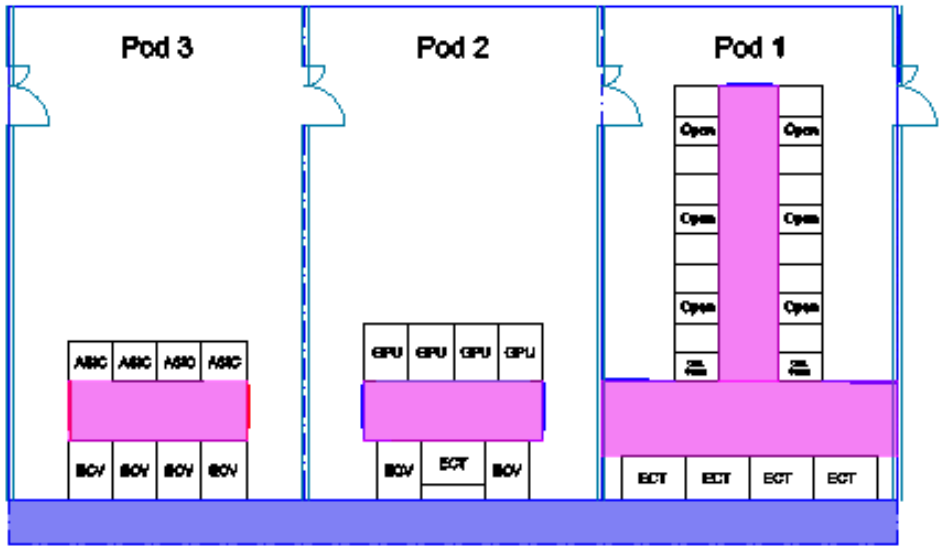

Holistic cooling was applied to three different pods each containing different IT equipment:

- Pod 1 – CPU (Open Compute)
- Pod 2 – HPC (GPU)
- Pod 3 – HPC (ASIC)

Fresh air cooling systems were used:

- Pod 1 – Fresh air plus adiabatic plus humidification
- Pod 2 – Fresh air
- Pod 3 – Fresh air

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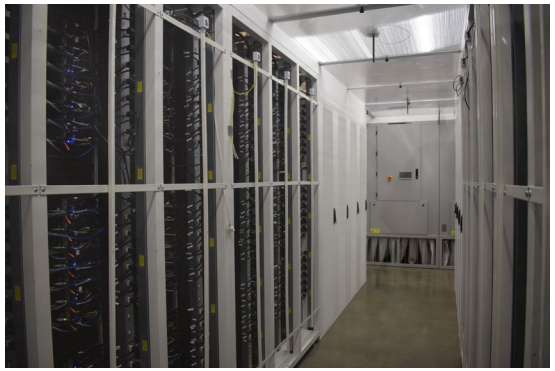
Pod 1 12kW/rack



Pod 2 50kW/rack

Pod 3 75kW/rack

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Improved effectiveness

Data centre power usage effectiveness have flattened out according to Uptime Institute

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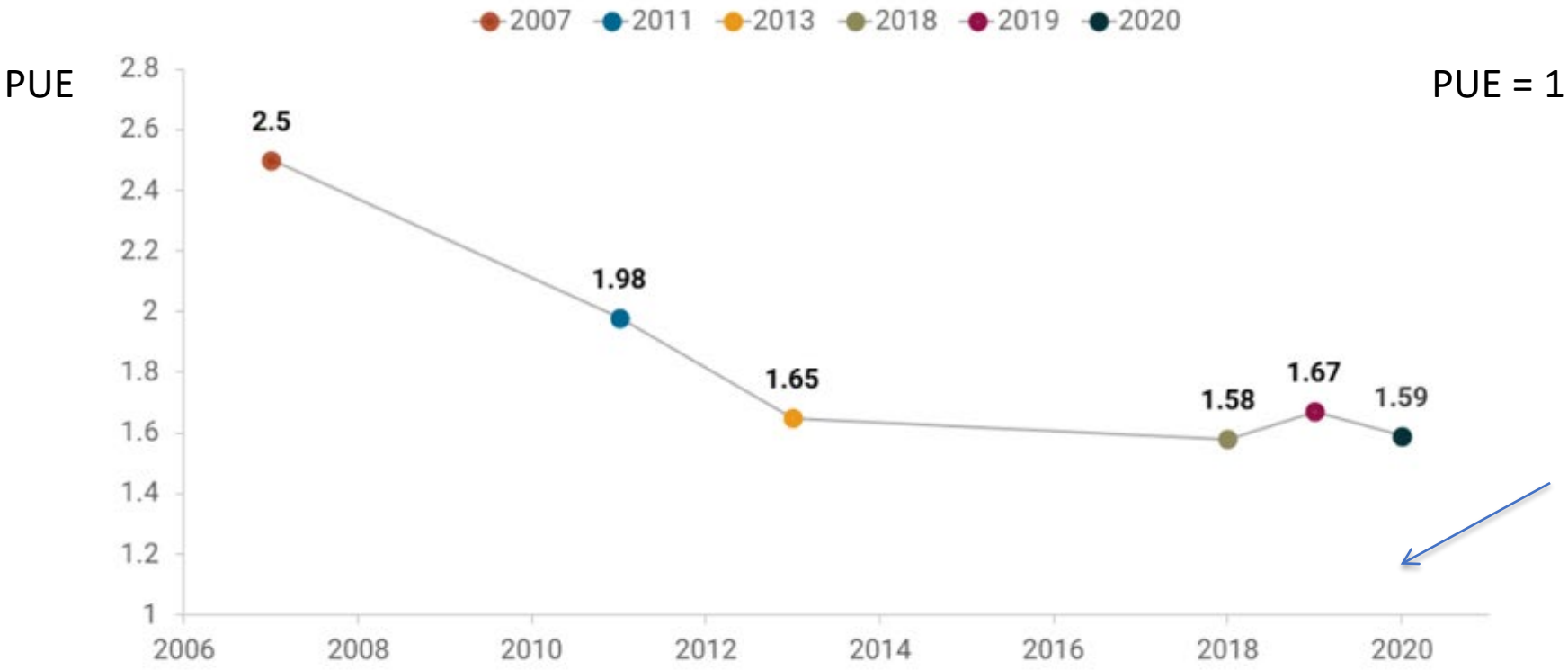

PUE = 1 + Overhead

Many hyperscale datacenters operates at PUE = 1,1

Source: Reported data center PUE figures in global Uptime Institute surveys from 2007 to 2020

Uptime Institute | INTELLIGENCE

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How a PUE of <1.02 was achieved

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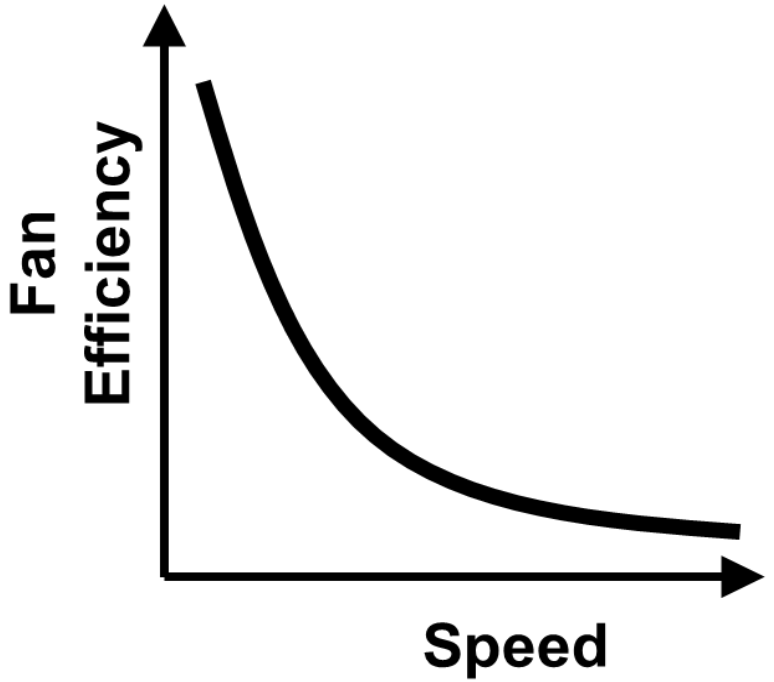
- Minimise air flow by maintaining the chip temperature by correct control of server fans
- Synchronising the cooling system fans with the server fans



Ecodesign

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

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%

The importance of CPU temperature

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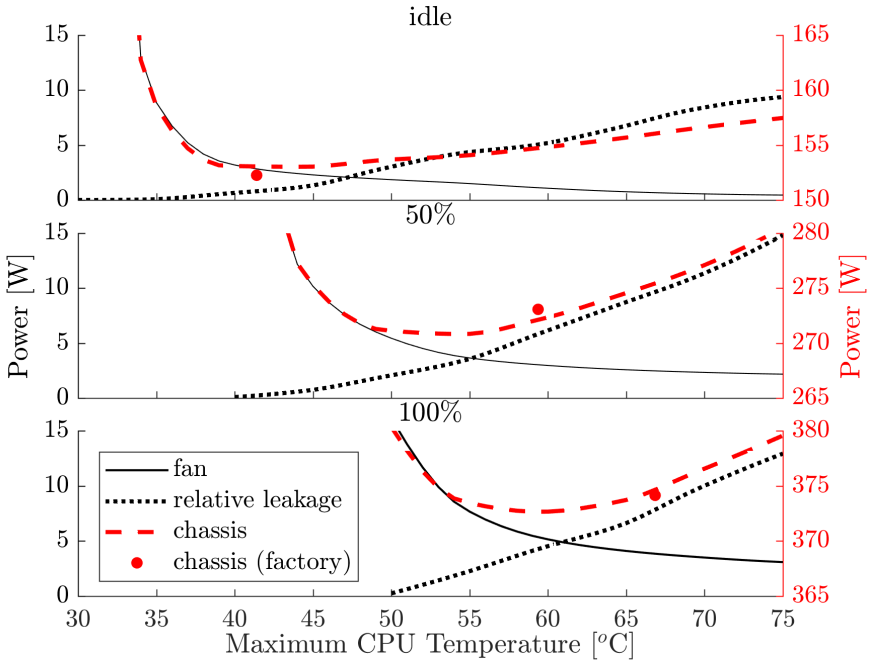

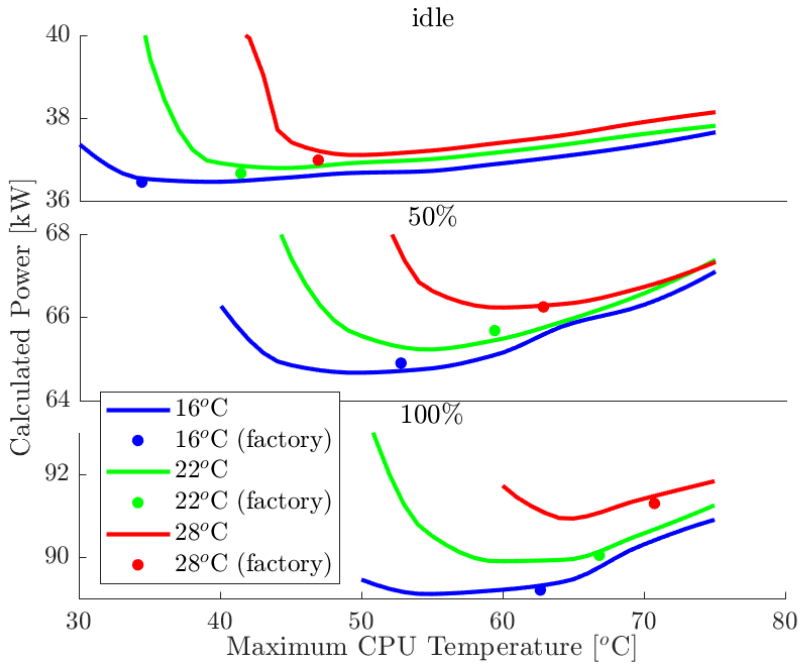

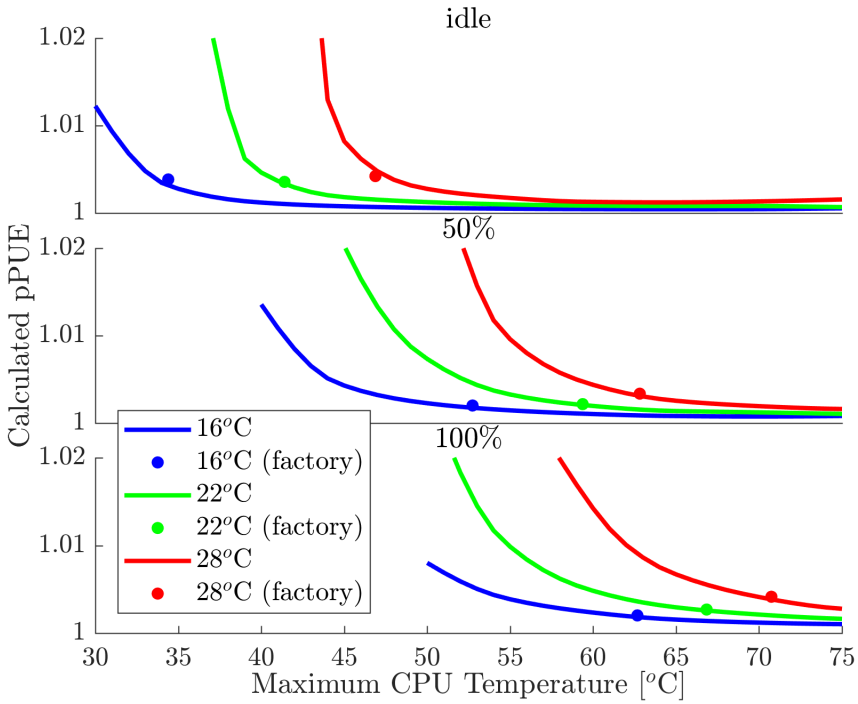

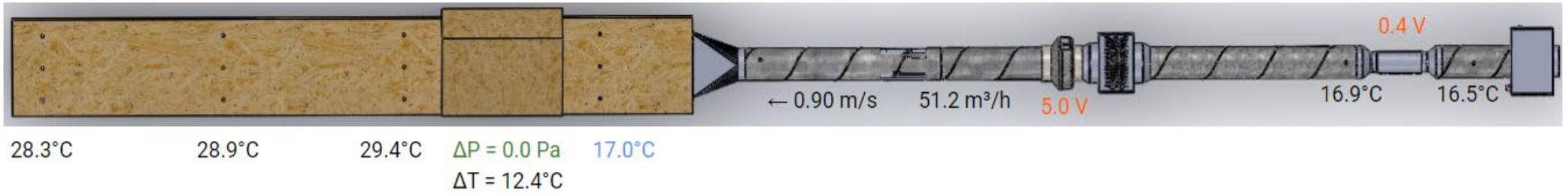

Chip temperature control

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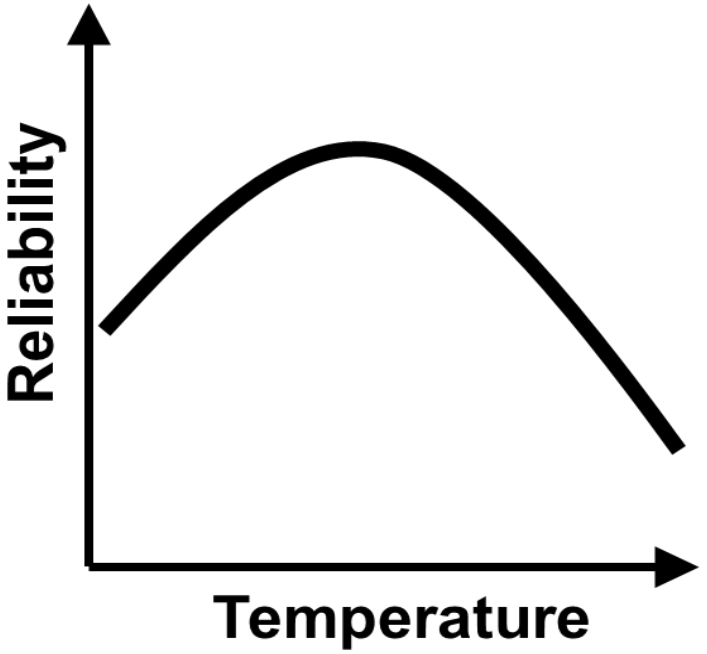
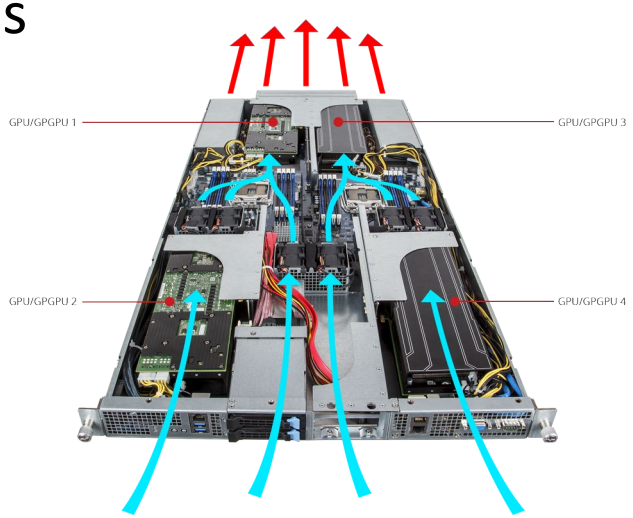
Chip temperatures shall be:

- Not too hot
- Not too cold
- Stable
  - Avoid temperature cycling or rapid changes





KEY PRINCIPLE 2 – Chip and Server Reliability

Very low temperatures damage components – particularly power supplies.
Very high temperatures cause many server component to fail.

Chip reliability is the prime objective

Two test campaigns – same workload.

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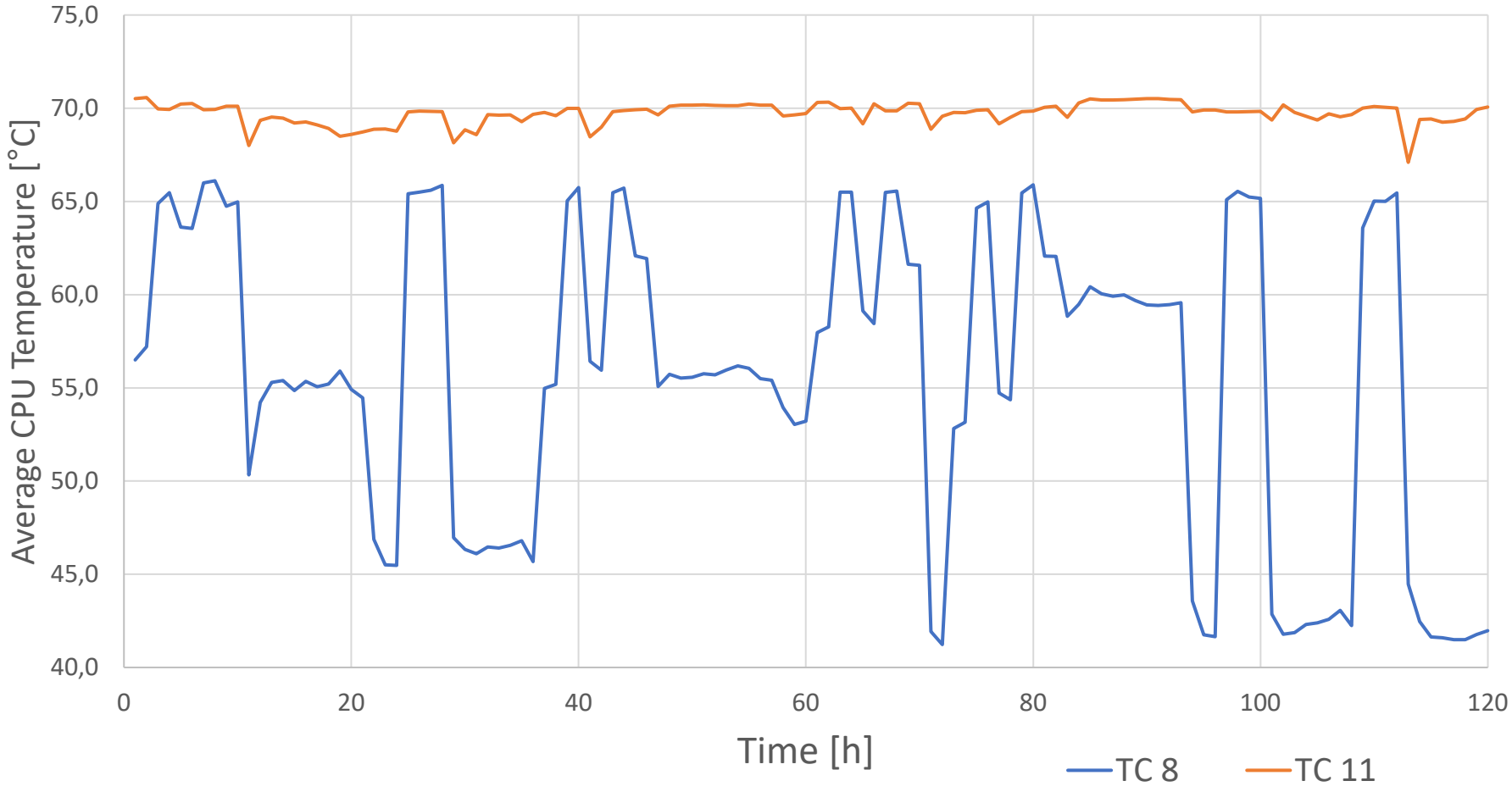

Holistic cooling

Holistic cooling control in practice

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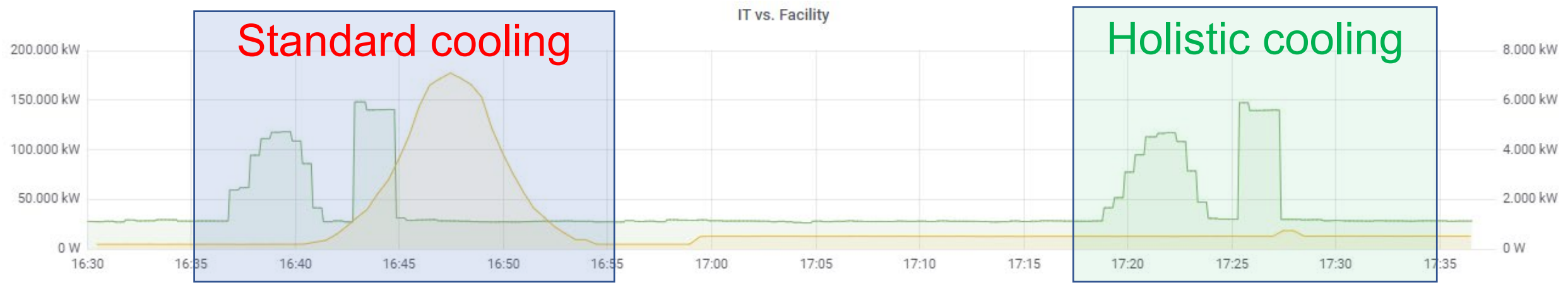

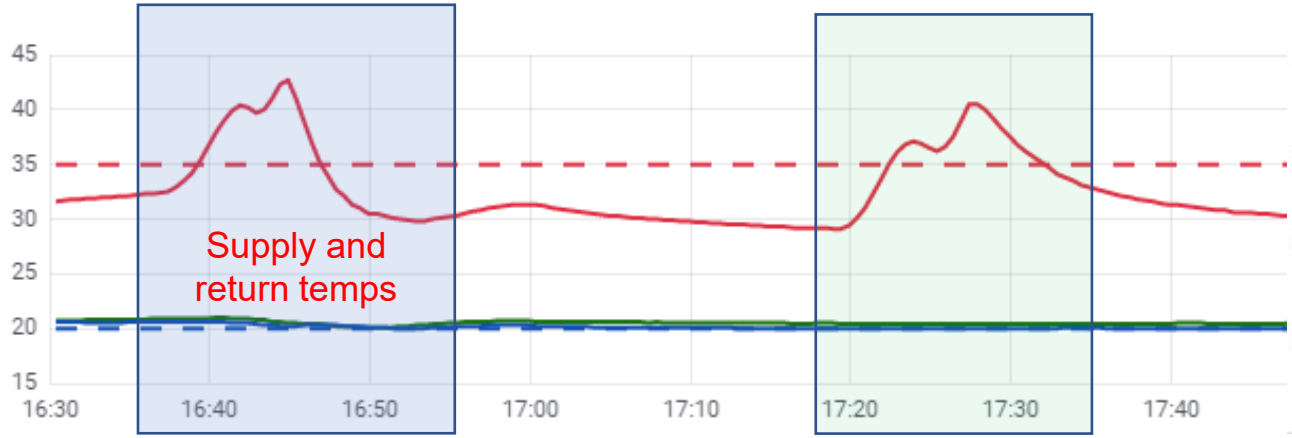

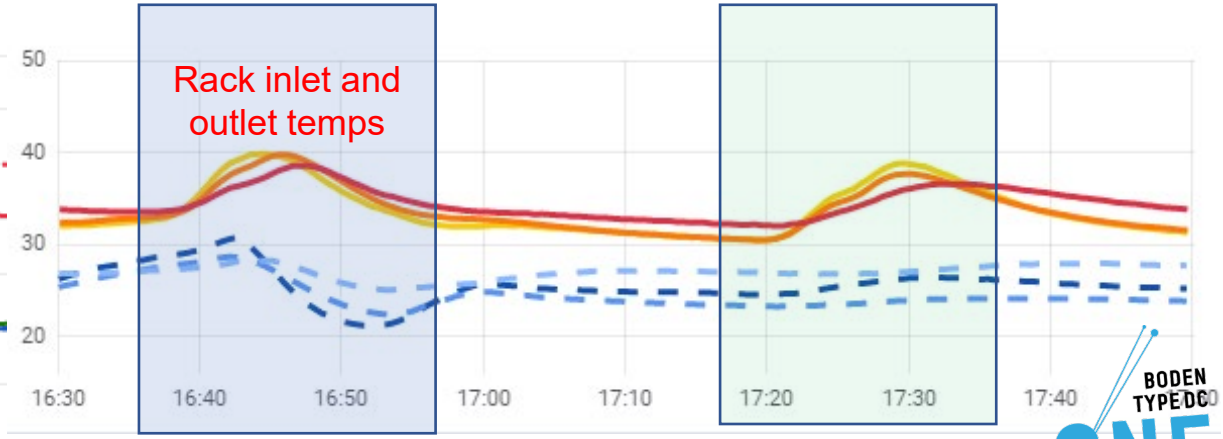

To build the most efficient data centre in the World…

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- The project objective was defined by Power Usage Effectiveness
- How was the low PUE achieved?
  - Direct fresh air cooling
  - Using air supply temperatures down to 10^0C
- How was the extraordinary PUE achieved?
  - The Holistic Cooling Control of server and cooler fans
- **What stops us applying this everywhere?**

What stops us applying holistic cooling?

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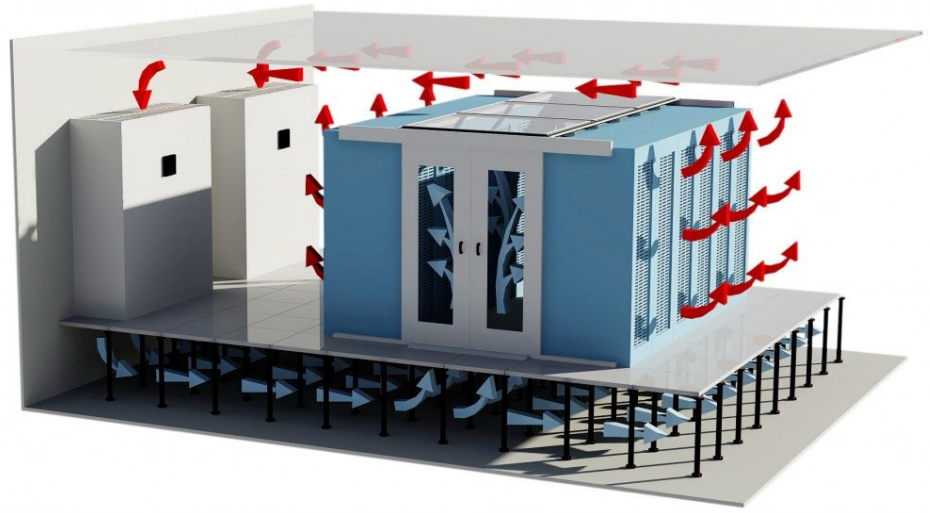

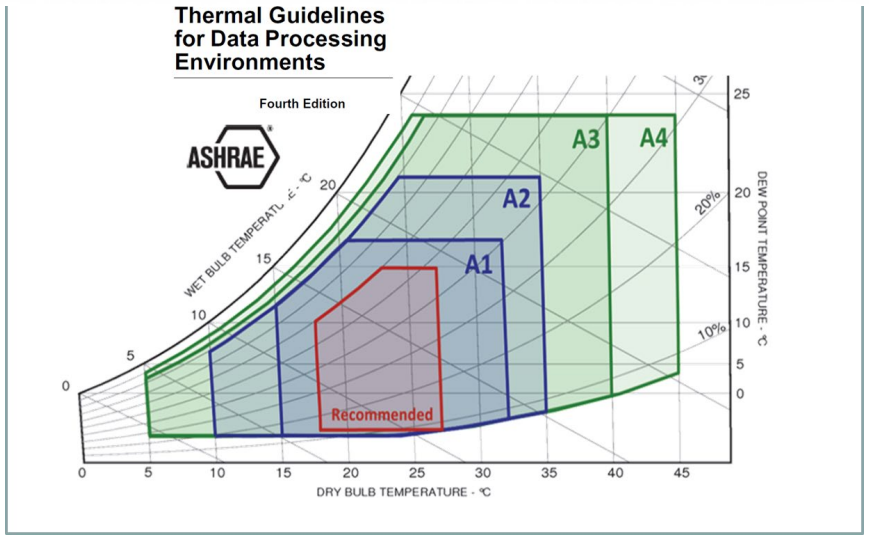

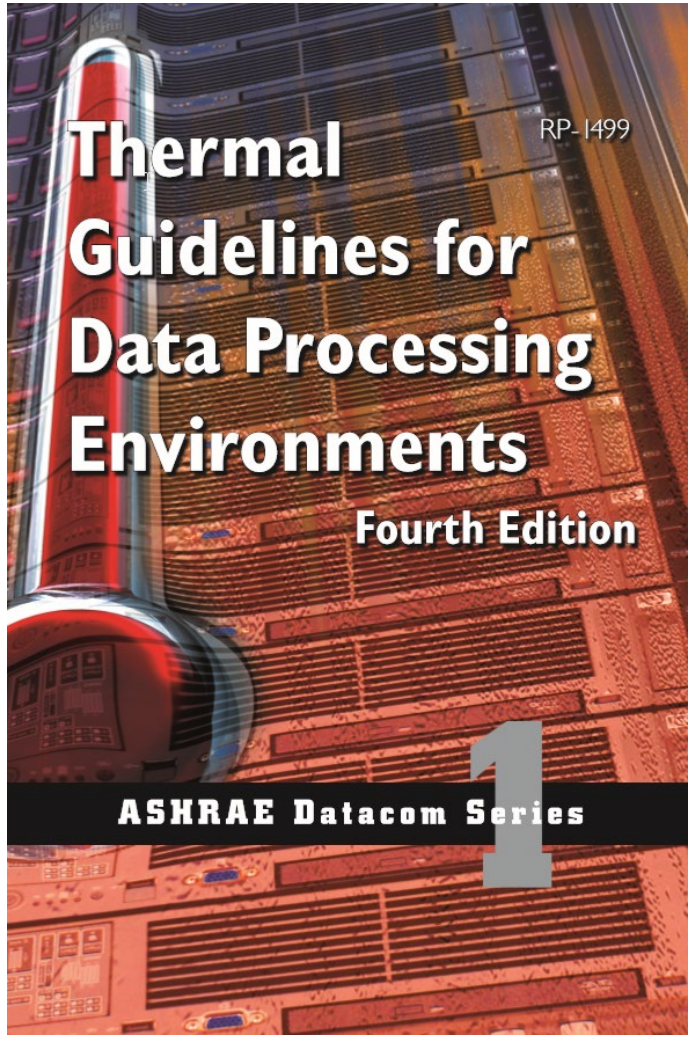

The opportunity

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- Holistic cooling control can be implemented with only software changes:
  - Servers give open data regarding air flow or fan speed so the cooling system can be synchronised
  - Servers should give the option of low temperature operation so the server fans slow down automatically when lower temperature air is supplied
- Holistic cooling control can be applied to all forms of cooling – not just direct fresh air systems
- Holistic cooling control can be applied in all climates – This is not restricted to Arctic data centres!
- Europe has the opportunity to take a lead from ASHRAE in implementing new standards which reflect European environmental standards and economic demands.

The proposed action

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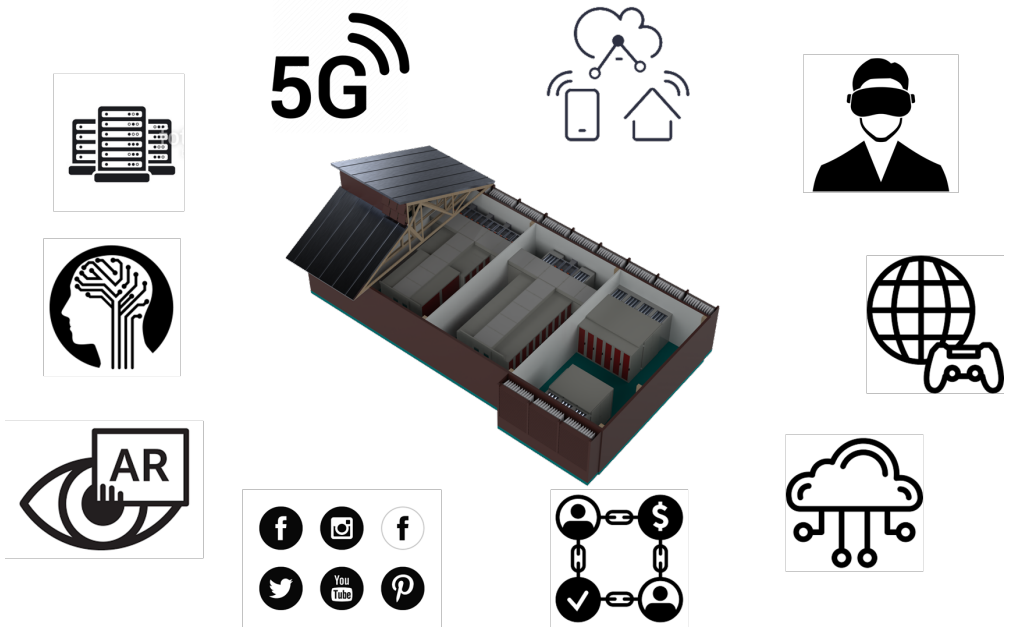
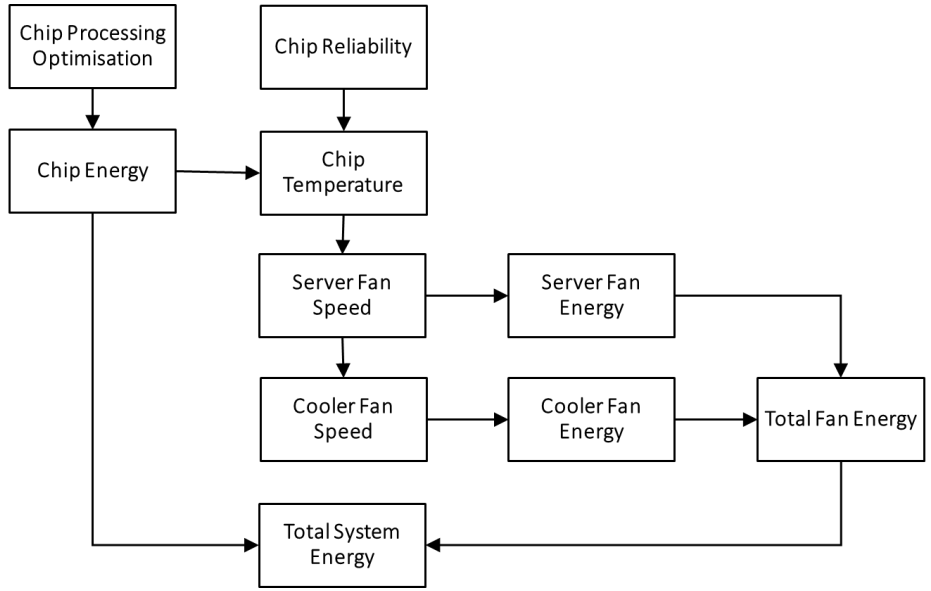
To implement a new EU standard for IT equipment sold in Europe

- Air flow data shall be made available in a readable form from the servers
- All servers should have a low temperature BIOS configuration option





Other aspects

Data centre efficiency

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Engineering definition of efficiency:

What we want/What we have to pay for

= Digital services/ kWh

How to measure the digital services?

Demonstration of heat reuse at BTDC

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“our energy sector can become more “circular” and make full use of the energy efficiency first principle. This is not only about reducing our consumption, but also about the overall efficiency of our energy system”

Boden Type Data Centre – EU CoC

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RE: EUCOC Application for Boden One DC, EU Research Project

P

Paolo.Bertoldi@ec.europa.eu
To Jon Summers; john.booth@carbon3it.com

You forwarded this message on 25/06/2020 10:17.

Dear Jon,

Thank you again for your application.

Your DC is approved as Participant (our ref is Dc 384)

Best Regards

Paolo Bertoldi

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BTDC is a participant and endorser of the EU CoC

Official energy figures submitted indicate an official annualised **PUE** of **1.0148**

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Boden Type Data Centre – The data

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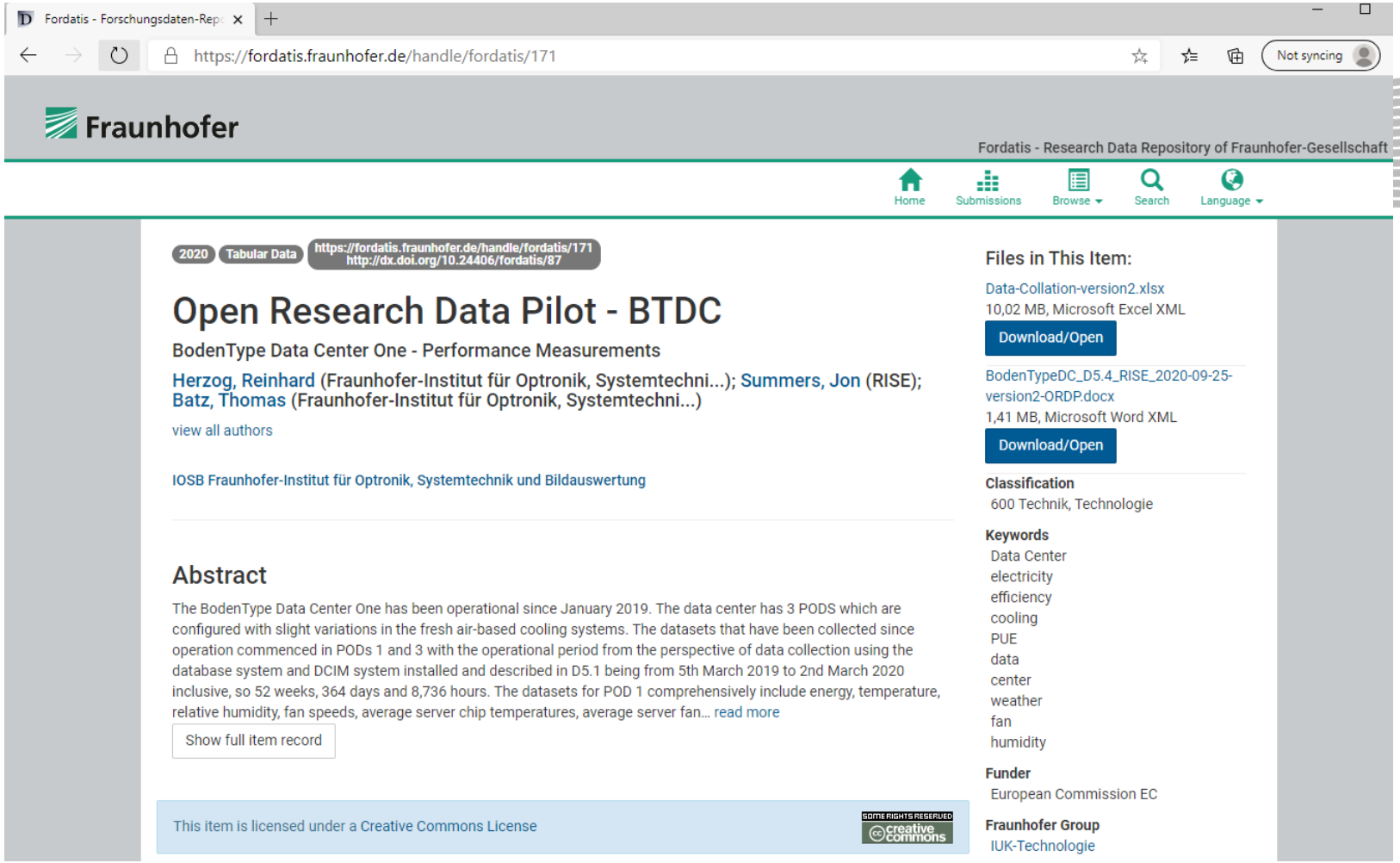

European Commission

http://dx.doi.org/10.24406/fordatis/87

Document Object Identifier for open research data

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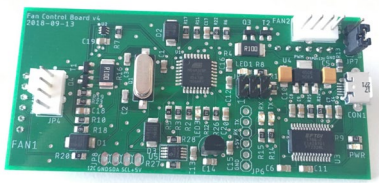

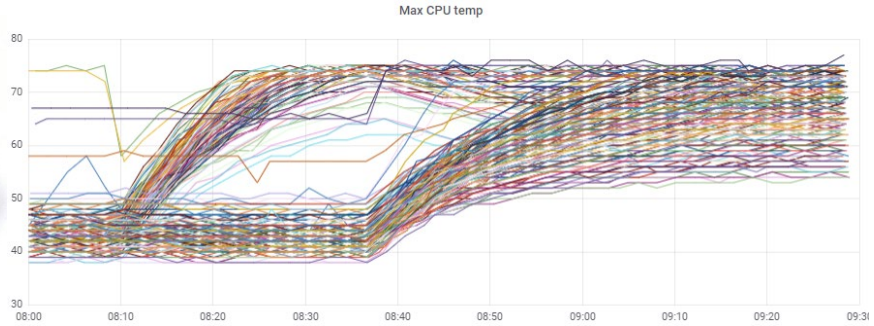

Highlights

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- March 2019 – March 2020
  - Testing phase
- September 2020
  - 480 custom server fan controllers deployed
  - Novel holistic cooling approach implemented
- Self proclaimed world record ISO PUE
  - 1.015
- DCD Award winner 2019

Thank you!

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