



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



Alan Beresford: Managing Director, EcoCooling Limited

Dr Jon Summers: Scientific Leader in Data Centres, RISE



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



GA 768875

- The project objectives
- Data centre efficiency metrics
- How the BTDC achieved extraordinary levels of efficiency
- Actions to enable implementation of BTDC techniques

Please ask questions at any time





GA 768875

Why the Boden Type Data Centre?

It is thought that 5% of Europe's electricity is used by data centres

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

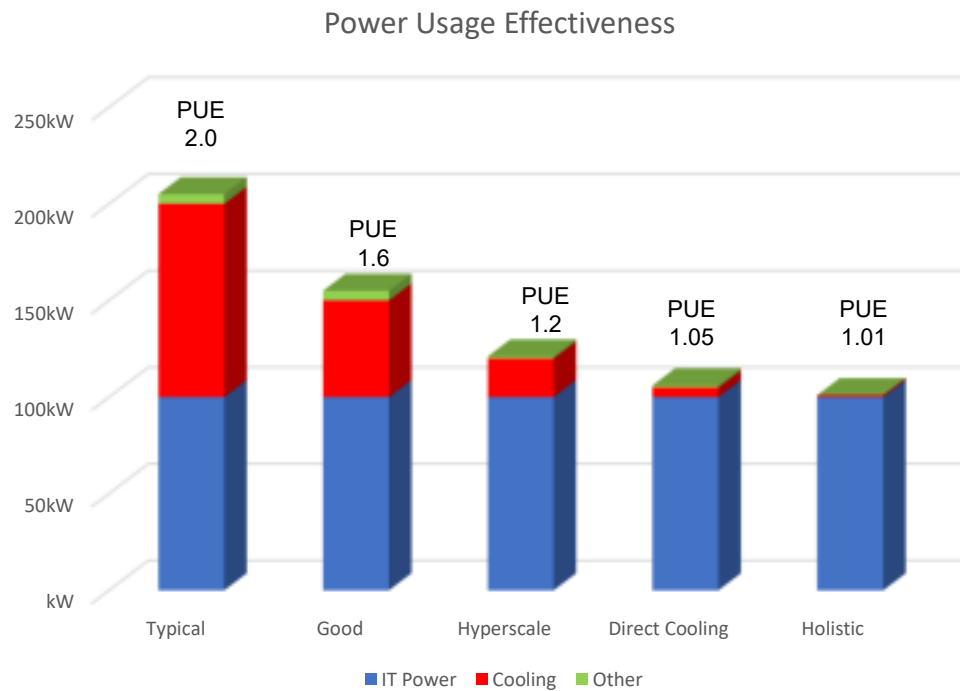
The objective of the 500kW BTDC is to demonstrate at an industrial scale how the **power usage of cooling** can be significantly reduced.





GA 768875

The Efficiency of Data Centres - PUE



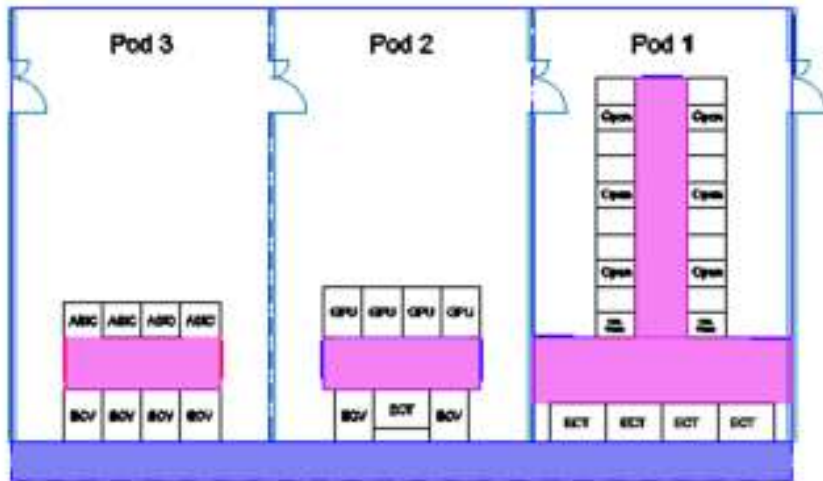
- PUE – Power Usage Effectiveness – the ratio between the total power used and the useful work done
- A PUE of 1 is perfect!
- “Normal” data centres operated between 1.6 and 2.5
- Note the scope of this project is focussed on **facilities efficiency** – NOT the server processing efficiency.





GA 768875

Boden Type Data Centre



The BTDC has achieved a PUE of <math><1.02</math>. Holistic cooling was applied to three different pods each containing different IT equipment:

- Pod 1 – CPU (Open Compute)
- Pod 2 – HPC (GPU)
- Pod3 – HPC (ASIC)

Fresh air cooling systems were used:

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





GA 768875

Boden Type Data Centre

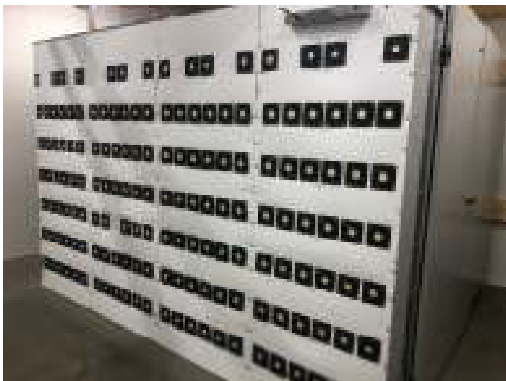
Pod 1 12kW/rack



Pod 2 50kW/rack



Pod 3 75kW/rack



The BTDC has achieved a PUE of <math><1.02</math>. 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


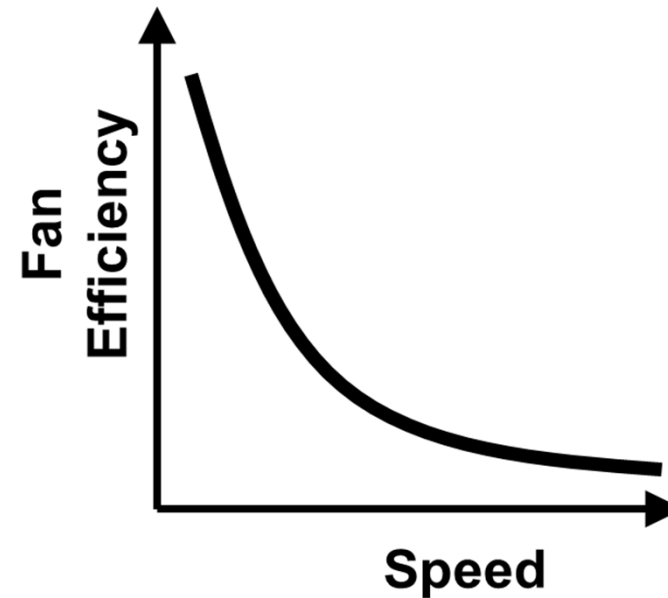




GA 768875

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 2011 implementing 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

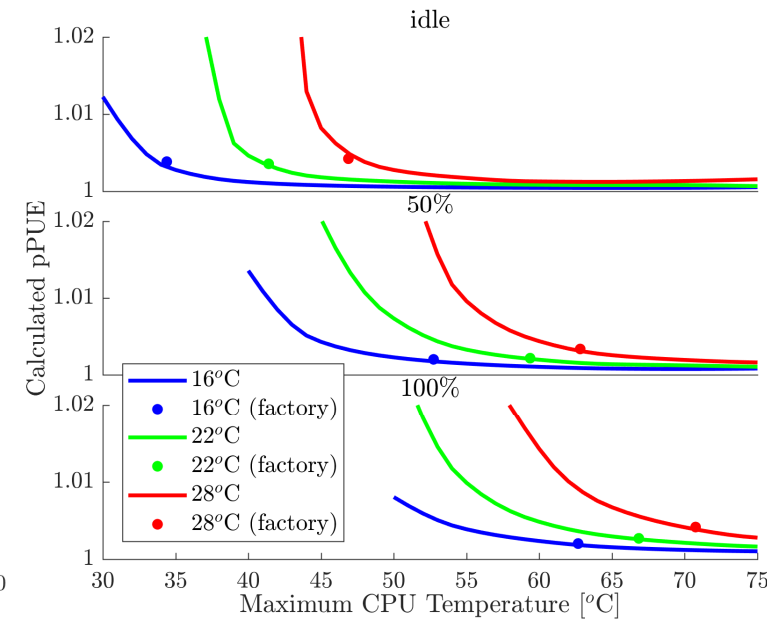
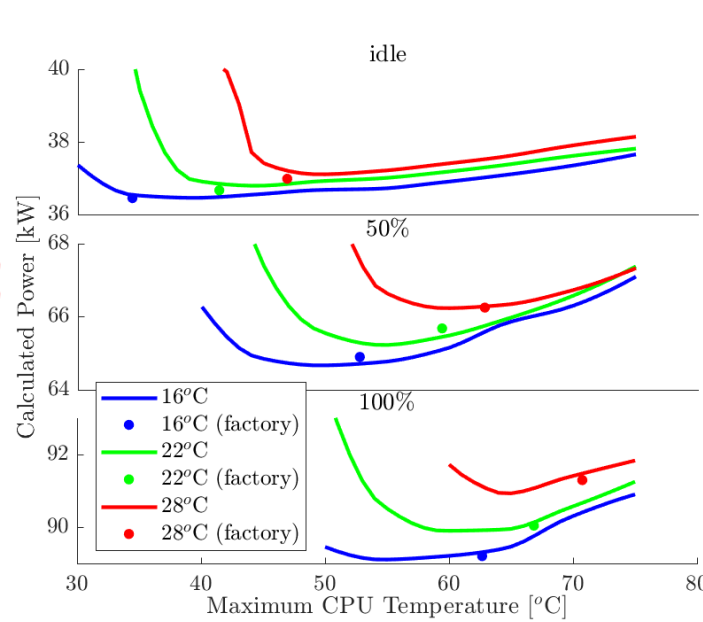
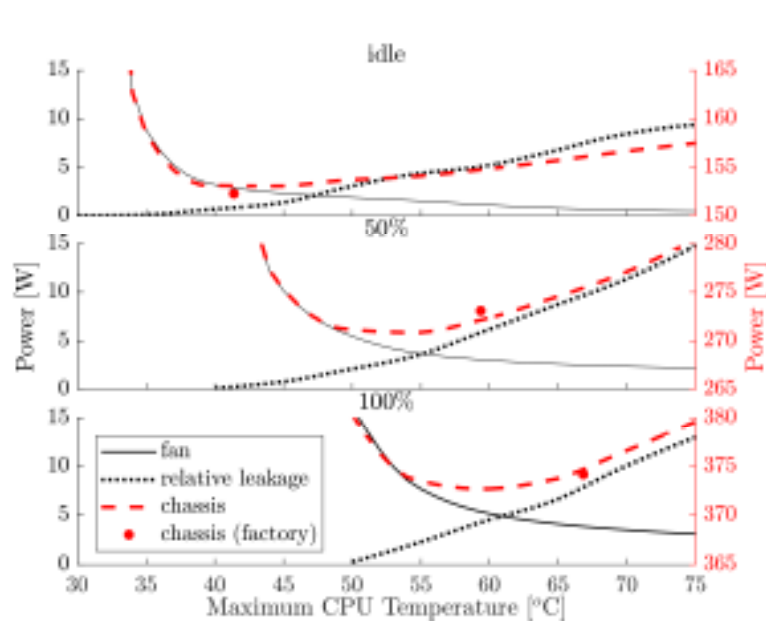
The energy use of a fan is proportional to the cube of its speed. A 50% reduction in fan speed reduces its energy use by nearly 90%



The importance of CPU temperature



GA 768875



Load	ΔP (16/22°C)	ΔP (28/22°C)
idle	- 0.6 %	+ 0.9%
50%	- 1.2 %	+ 0.9%
100%	- 0.9 %	+ 1.4%



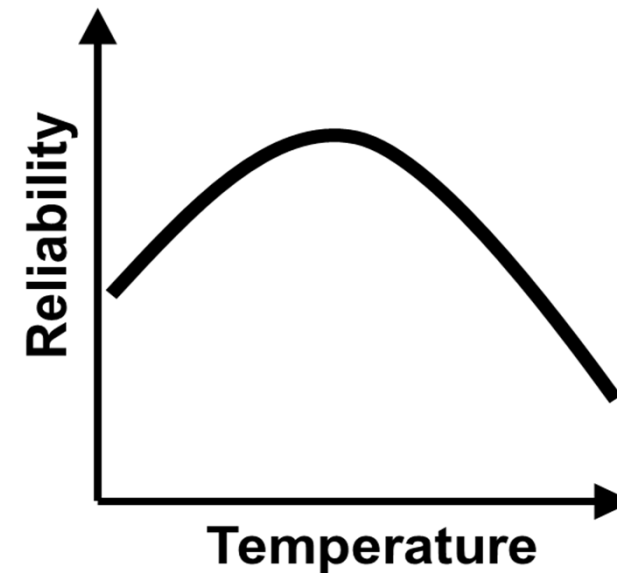
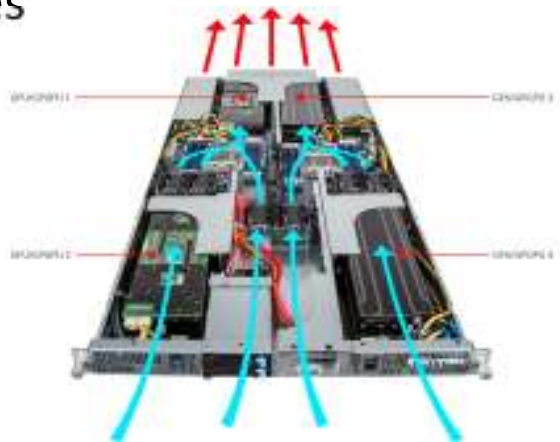


GA 768875

Chip Temperature Control

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.*

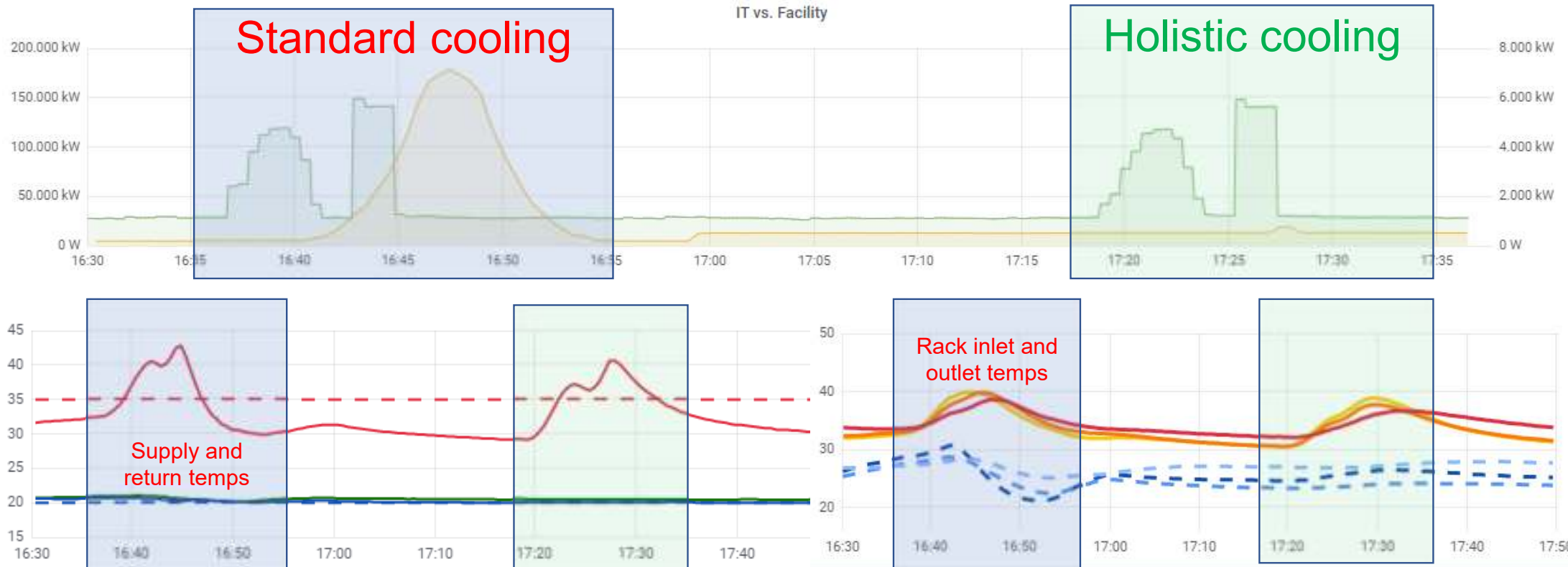
Chip reliability is the prime objective



Holistic cooling control in practice



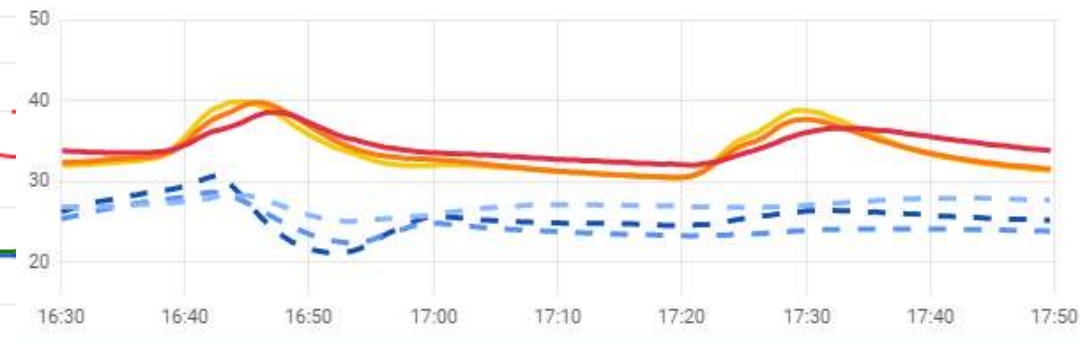
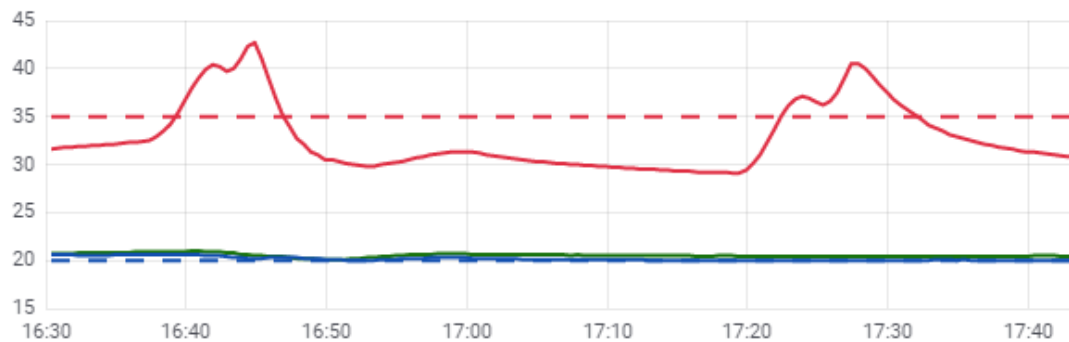
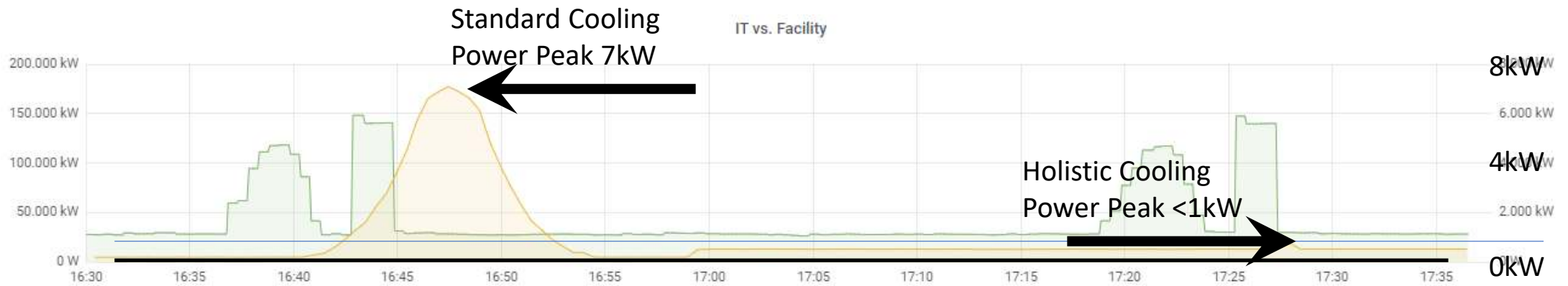
GA 768875



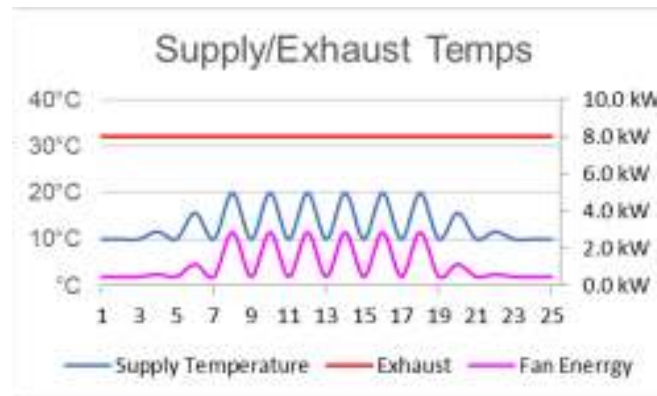
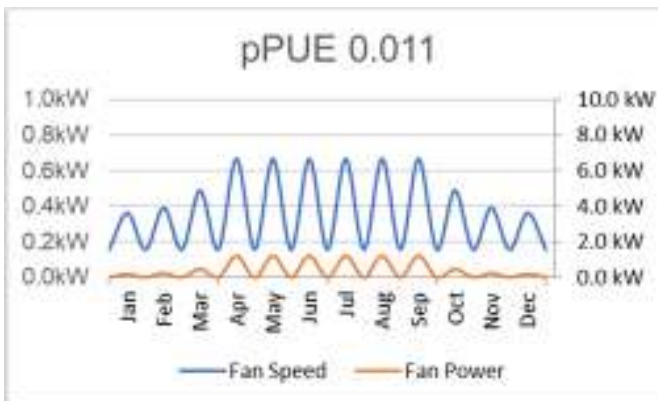
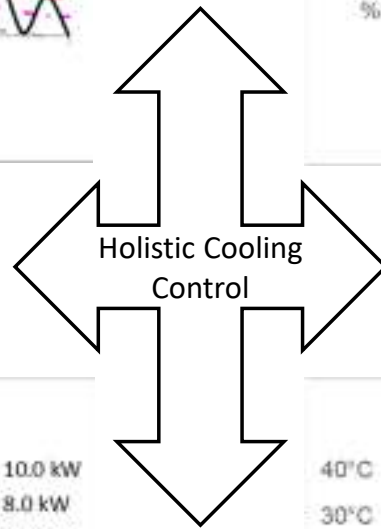
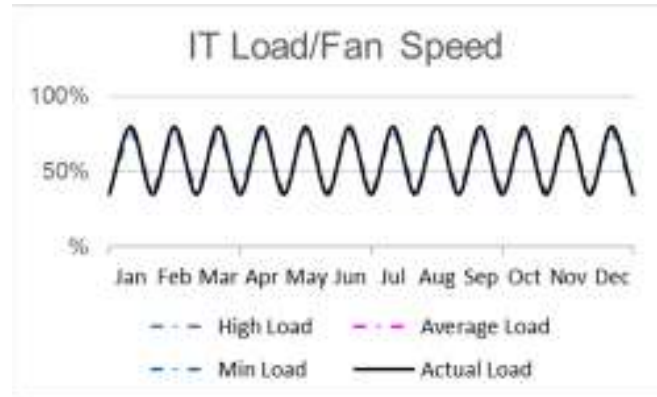
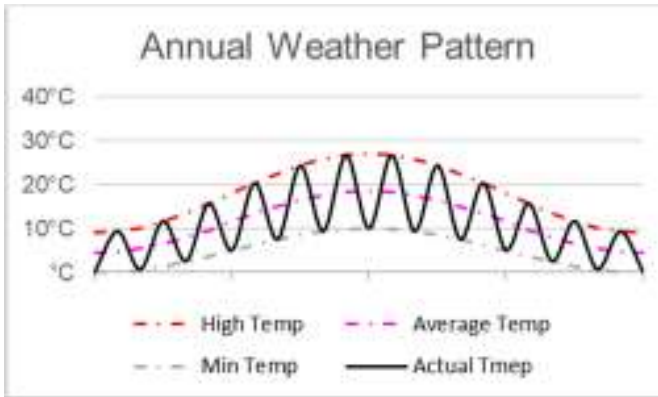
Holistic cooling control in practice



GA 768875



Holistic Cooling Control



Process control requires data!

- Active not reactive control is the better solution
- Simple systems are required using easily read data
- IT and Facility data formats are very different



GA 768875

To build the most efficient data centre in the World...

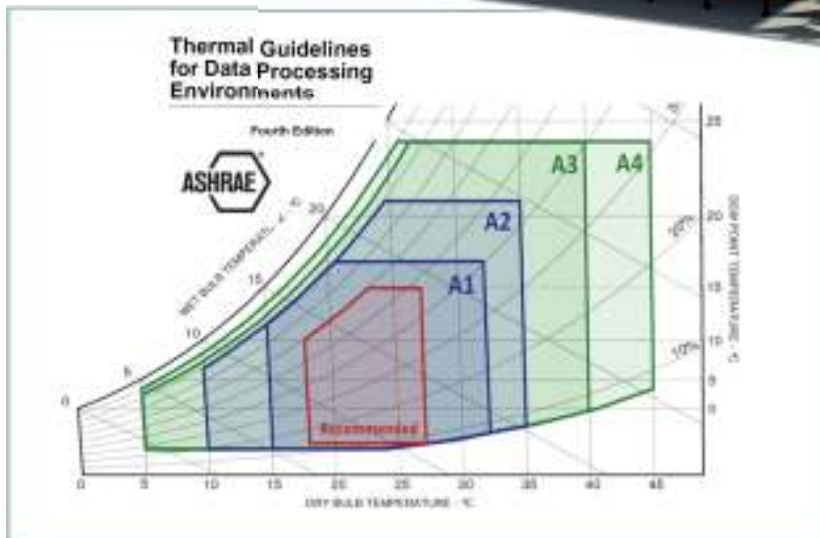
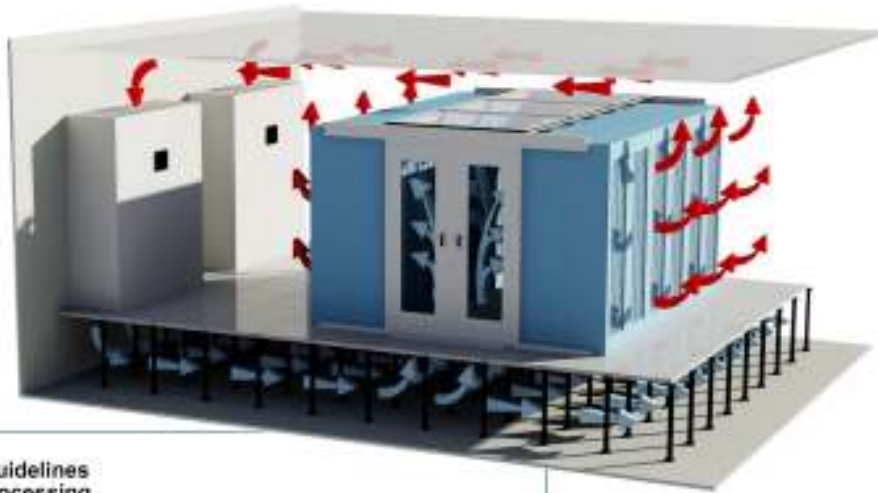
- The project objective was defined by Power Usage Effectiveness
- How was the low PUE achieved?
 - Direct fresh air cooling
 - Using air supply temperatures down to 10⁰C
- How was the extraordinary PUE achieved?
 - The Holistic Cooling Control of server and cooler fans
- **What stops us applying this everywhere?**





GA 768875

What stops us applying holistic cooling?



World Class Standards






GA 768875

The Opportunity

- 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.



Commission Regulation (EU) 2019/424 of 15 March 2019 laying down ecodesign requirements for servers and data storage products pursuant to Directive 2009/125/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 617/2013



The Opportunity for Europe

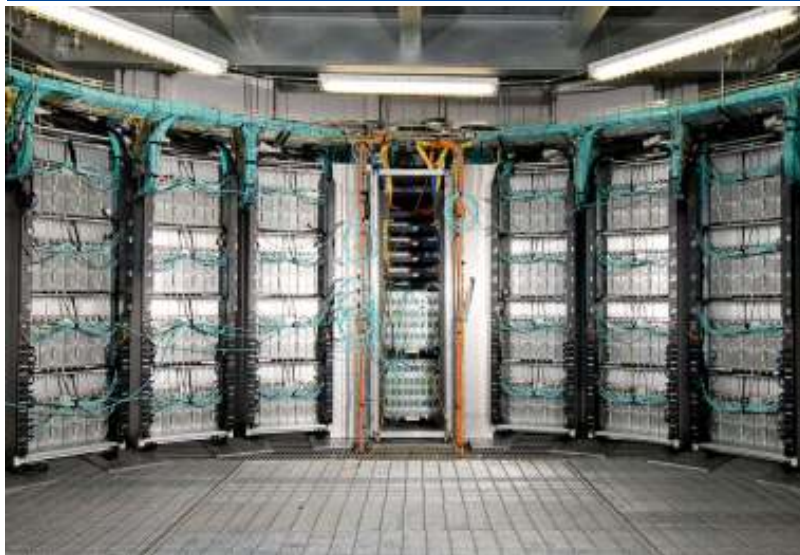


GA 768875

Shaping Europe's digital future

PRESS RELEASE | 21 October 2020

EU steps up investment in world-class supercomputers for researchers and businesses



DIRECTORATE-GENERAL | CONNECT

Communications Networks, Content and Technology

The Directorate-General for Communications Networks, Content and Technology is the Commission department responsible to develop a digital single market to generate smart, sustainable and inclusive growth in Europe.



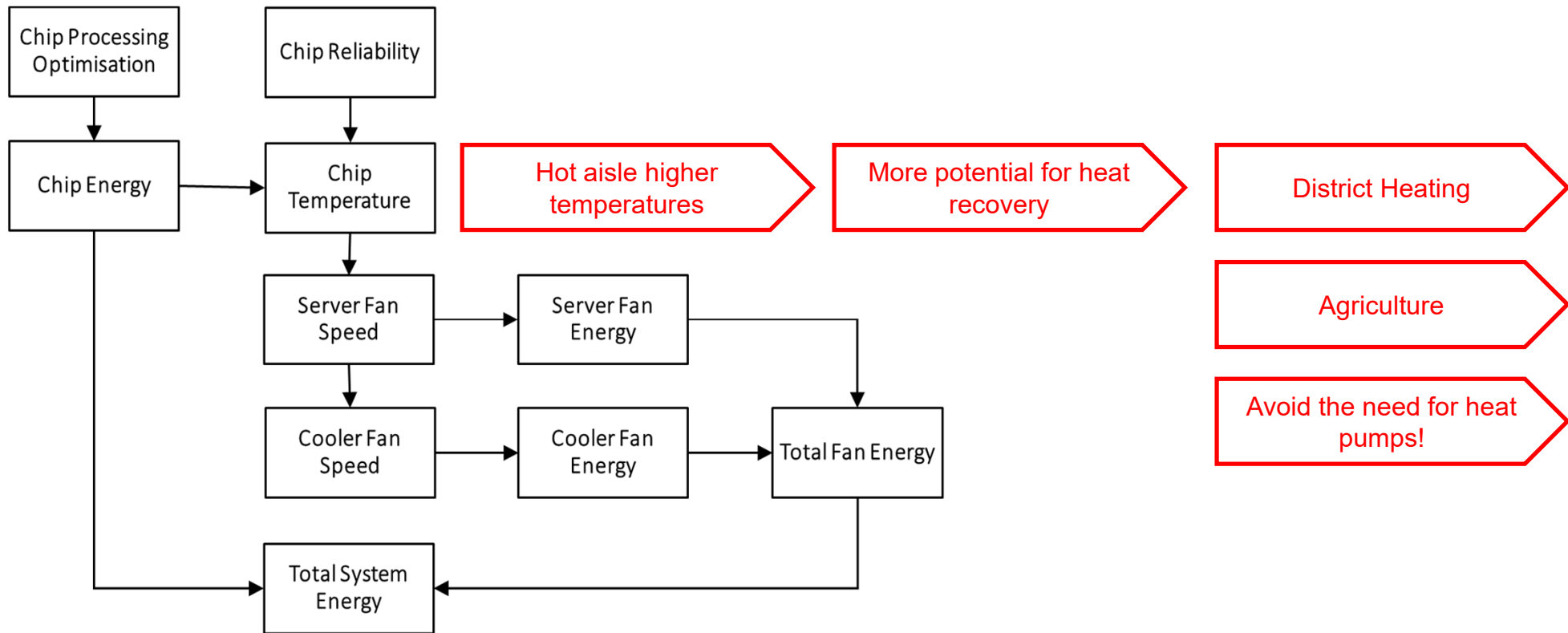
<https://ec.europa.eu/digital-single-market/en/news/eu-steps-investment-world-class-supercomputers-researchers-and-businesses>





GA 768875

Holistic Cooling Control





GA 768875

Demonstration of heat reuse at BTDC

“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



BTDC is a participant and endorser of the EU CoC

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

Demonstration of Adiabatic Humidification

In Pod 1 one of the coolers operated in humidification mode.

By directing a controlled proportion of the hot air from the hot aisle over adiabatic cooling pads virtually 'electricity free' humidification was achieved.



Intellectual Property Office

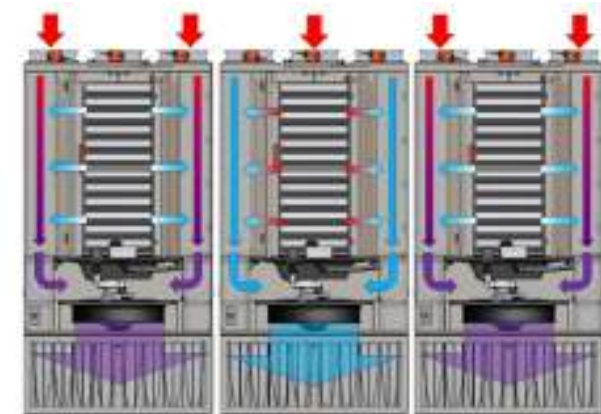
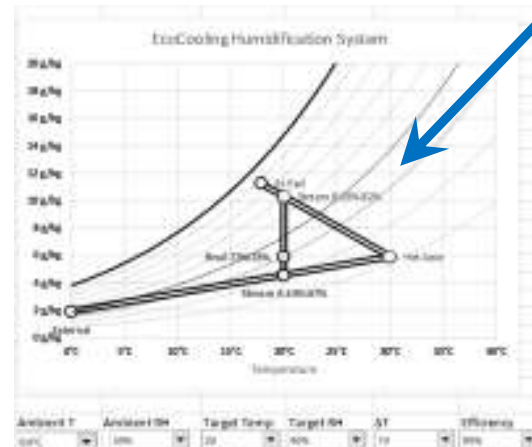
IpsuM - Online Patent Information and Document Inspection Service

NEW BODICE

GB1511731.0 - Evaporative cooler apparatus and method

Case Details

Application Number	GB1511731.0
Status	Pending
Lodged Date	05 July 2015
Application Title	Evaporative cooler apparatus and method
Applicant / Proprietor	GcoCooling Limited



Boden Type Data Centre – The Data



GA 768875

2020 **Tabular Data** <https://fordatis.fraunhofer.de/handle/fordatis/171>
<http://dx.doi.org/10.24406/fordatis/87>

Open Research Data Pilot - BTDC

BodenType Data Center One - Performance Measurements

Herzog, Reinhard (Fraunhofer-Institut für Optronik, Systemtechni...); Summers, Jon (RISE); Batz, Thomas (Fraunhofer-Institut für Optronik, Systemtechni...)

[view all authors](#)

[IOSB Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung](#)

Abstract

The BodenType Data Center One has been operational since January 2019. The data center has 3 PODs which are configured with slight variations in the fresh air-based cooling systems. The datasets that have been collected since operation commenced in PODs 1 and 3 with the operational period from the perspective of data collection using the database system and DCIM system installed and described in D5.1 being from 5th March 2019 to 2nd March 2020 inclusive, so 52 weeks, 364 days and 8,736 hours. The datasets for POD 1 comprehensively include energy, temperature, relative humidity, fan speeds, average server chip temperatures, average server fan... [read more](#)

[Show full item record](#)

This item is licensed under a [Creative Commons License](#)

Files in This Item:

- Data-Collation-version2.xlsx
10.02 MB, Microsoft Excel XML
[Download/Open](#)
- BodenTypeDC_D5.4_RISE_2020-09-25-version2-ORDP.docx
1.41 MB, Microsoft Word XML
[Download/Open](#)

Classification
600 Technik, Technologie

Keywords
Data Center
electricity
efficiency
cooling
PUE
data
center
weather
fan
humidity

Funder
European Commission EC

Fraunhofer Group
IUK-Technologie



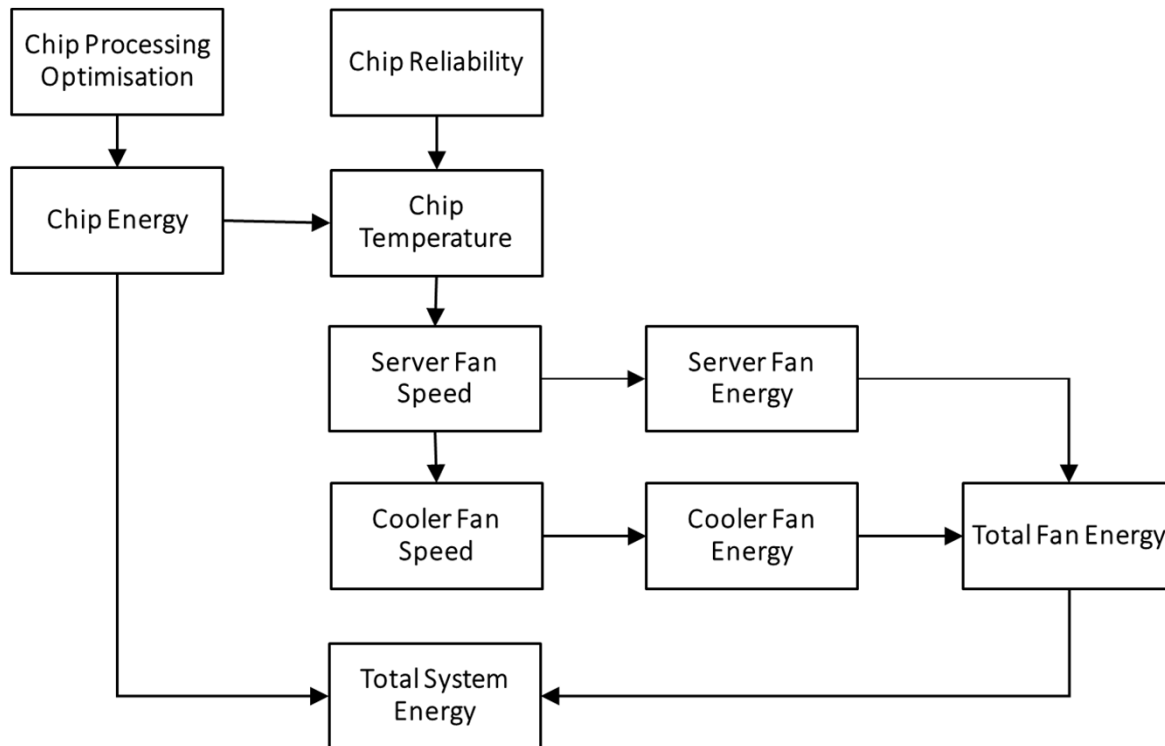
<http://dx.doi.org/10.24406/fordatis/87>

← Document Object Identifier for open research data



GA 768875

The Economic Opportunity



Simple Economics

+ Income from processing

- Cost of energy

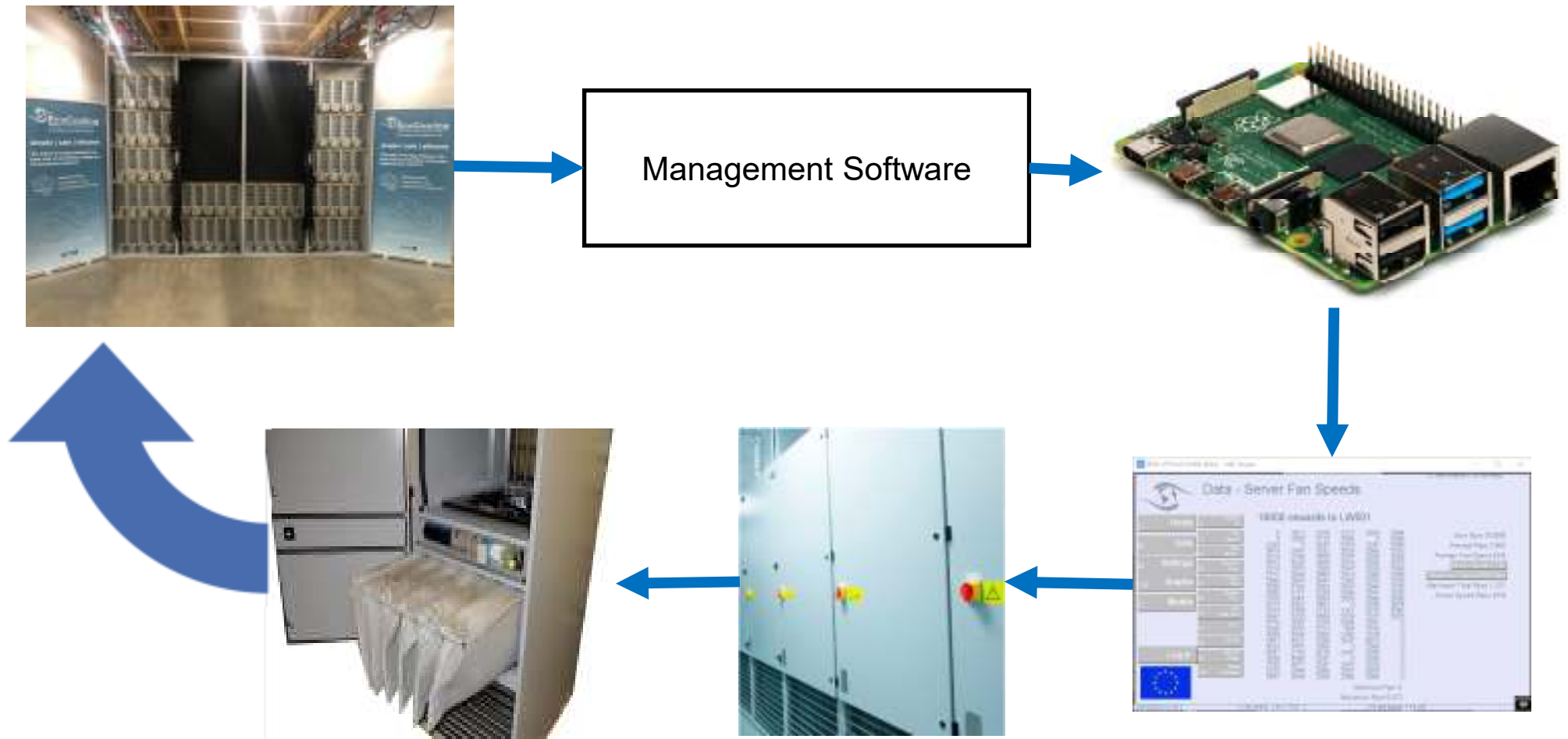
= **Gross Margin**

This is not how the IT sector works!

This could be the future model when processing and storage become a commodity item



Live Demonstration – Pod 2





GA 768875

The Proposed Action

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

