HPC SOLUTIONS - MADE FOR YOU.

Sustainability in High-Performance Computing

2024-02-08 | Axel Auweter | CTO

MEGWARE®

MEGWARE Overview

- Established in 1990
- German private limited company
- Turn-key solution provider for compute, storage and GPGPU/AI/ML clusters
- More than 1700 installed cluster systems in Europe
- 50 Employees
- Financially strong, profitable, growing

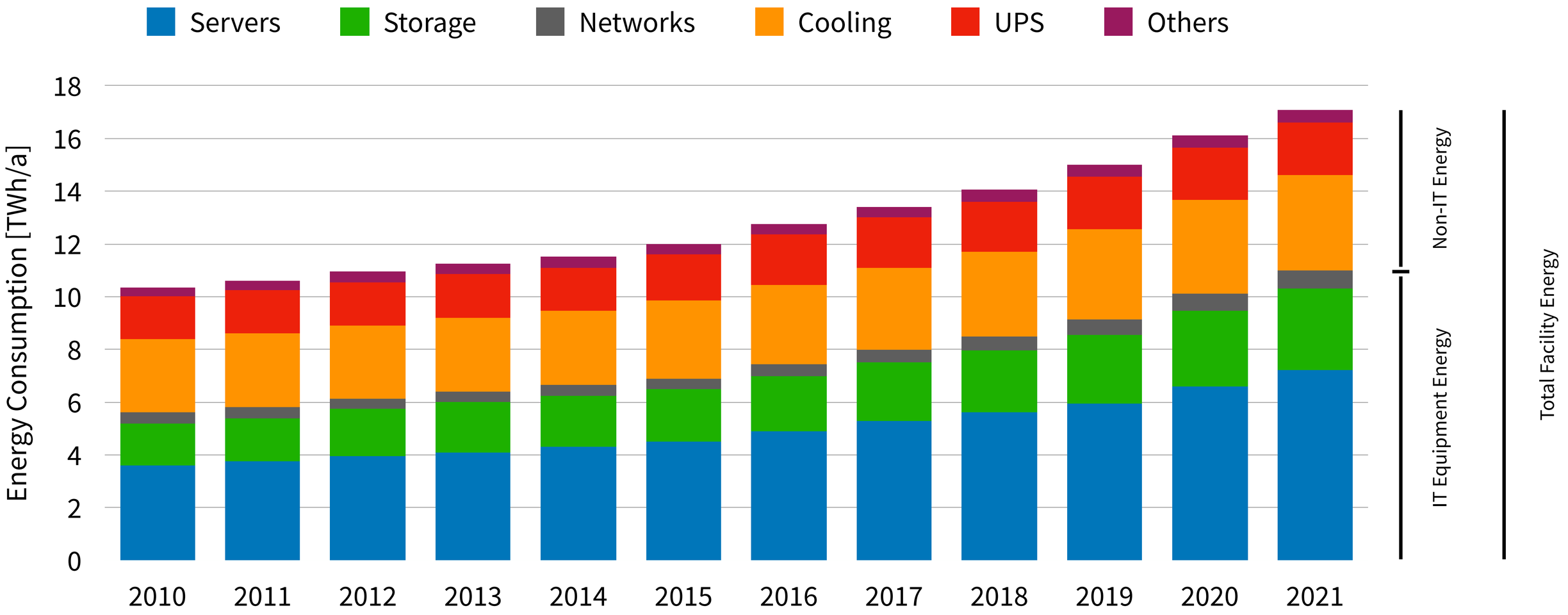
7 Top 500 systems 11’2023

71 Top 500 placements since 2002

ISO 9001 zertifiziert

ISO 14001 zertifiziert

Energy Consumption of Data Centers - in Germany

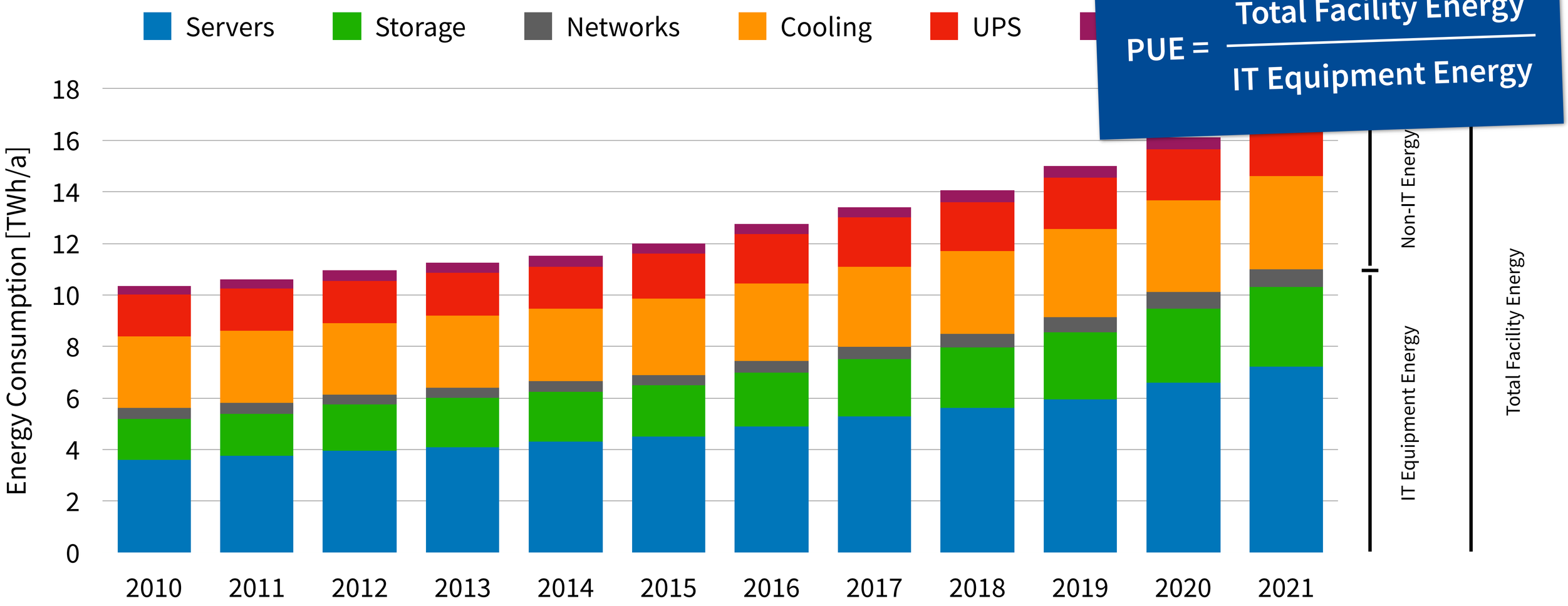


Source: Borderstep Institute & IEA

Energy Consumption of Data Centers - in Germany

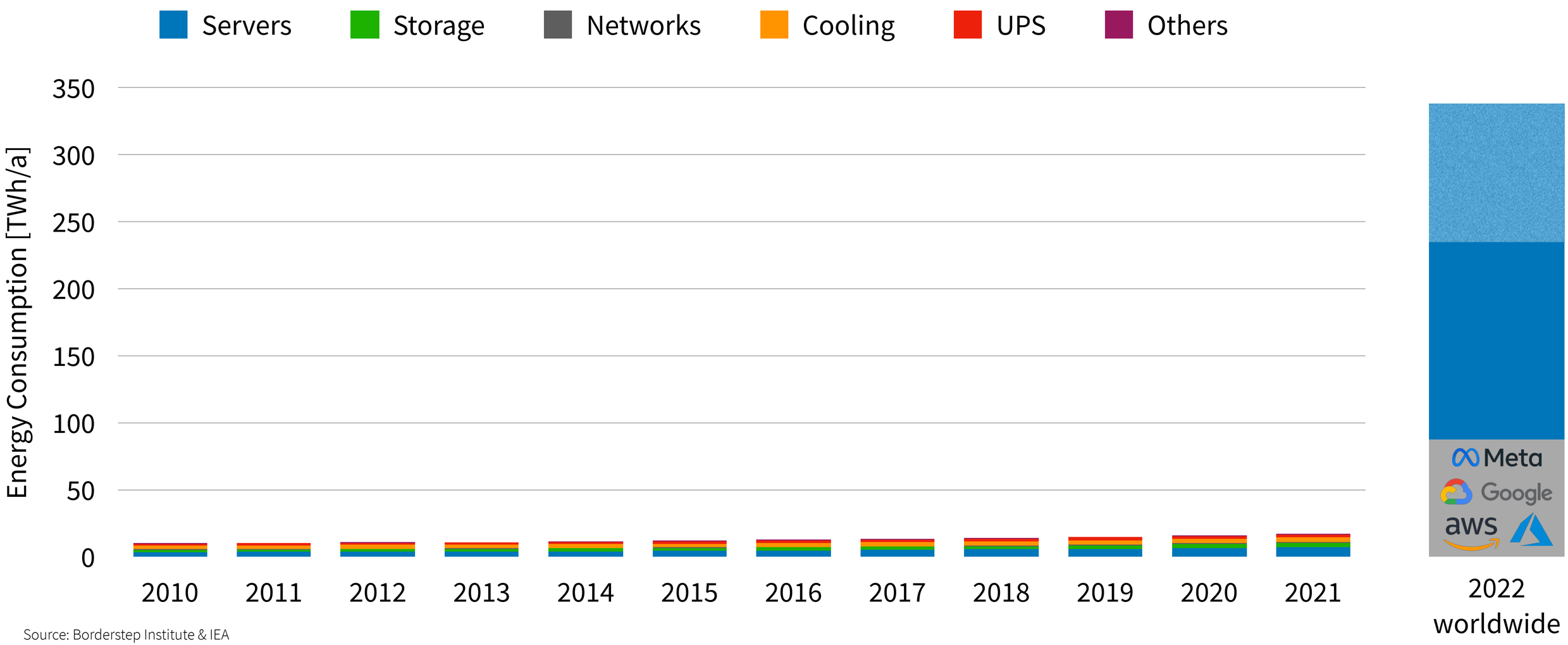
Power Usage Effectiveness

$$PUE = \frac{\text{Total Facility Energy}}{\text{IT Equipment Energy}}$$



Source: Borderstep Institute & IEA

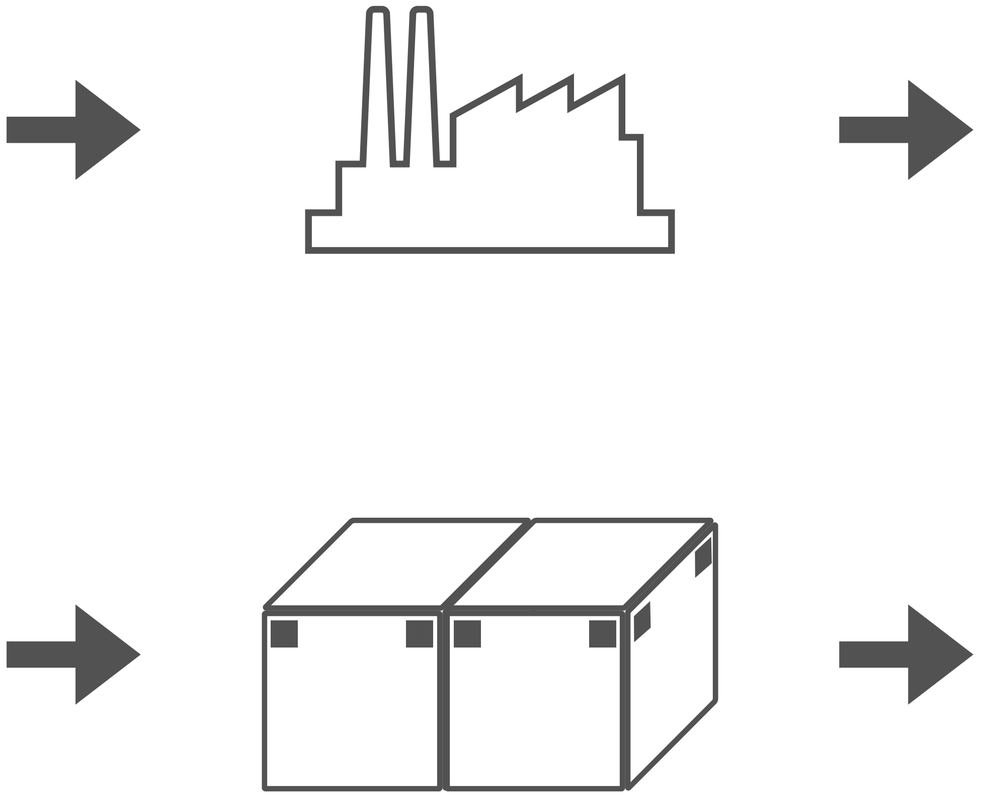
Energy Consumption of Data Centers - Worldwide



Source: Borderstep Institute & IEA

Factory vs. Data Center

Raw materials
Energy

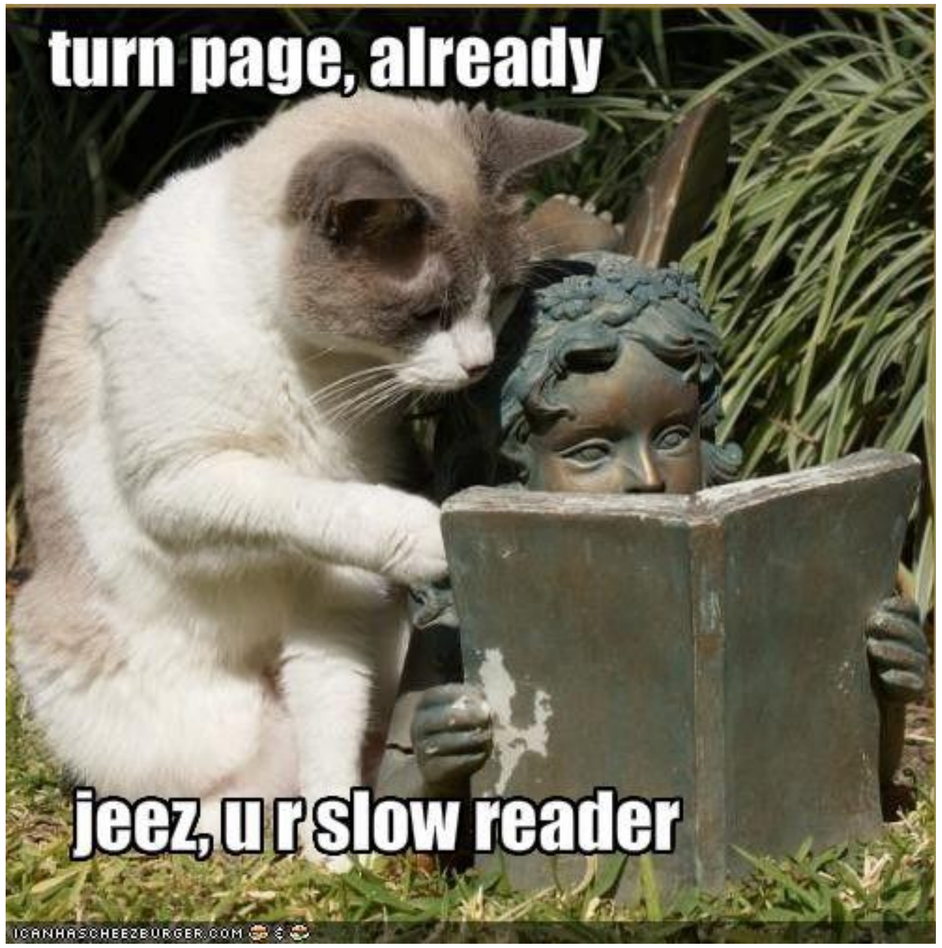


Finished Products
Byproducts / Emissions

Electrical Energy
Water

Heat
Vapor

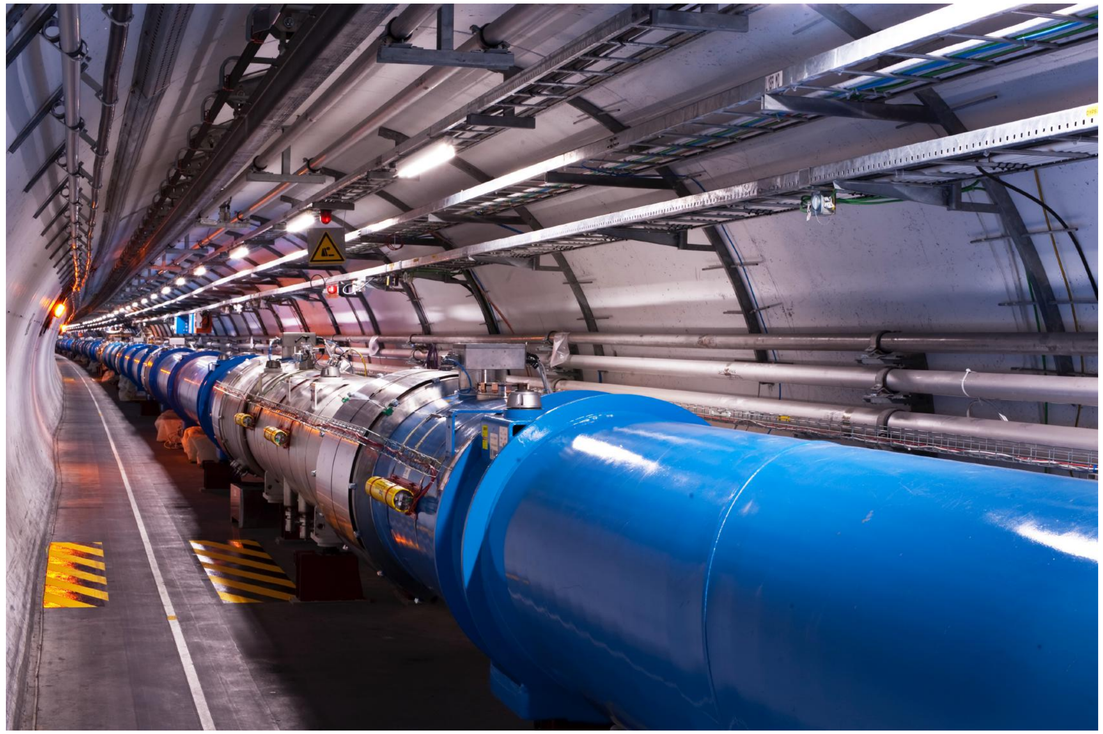
Is it justified…?



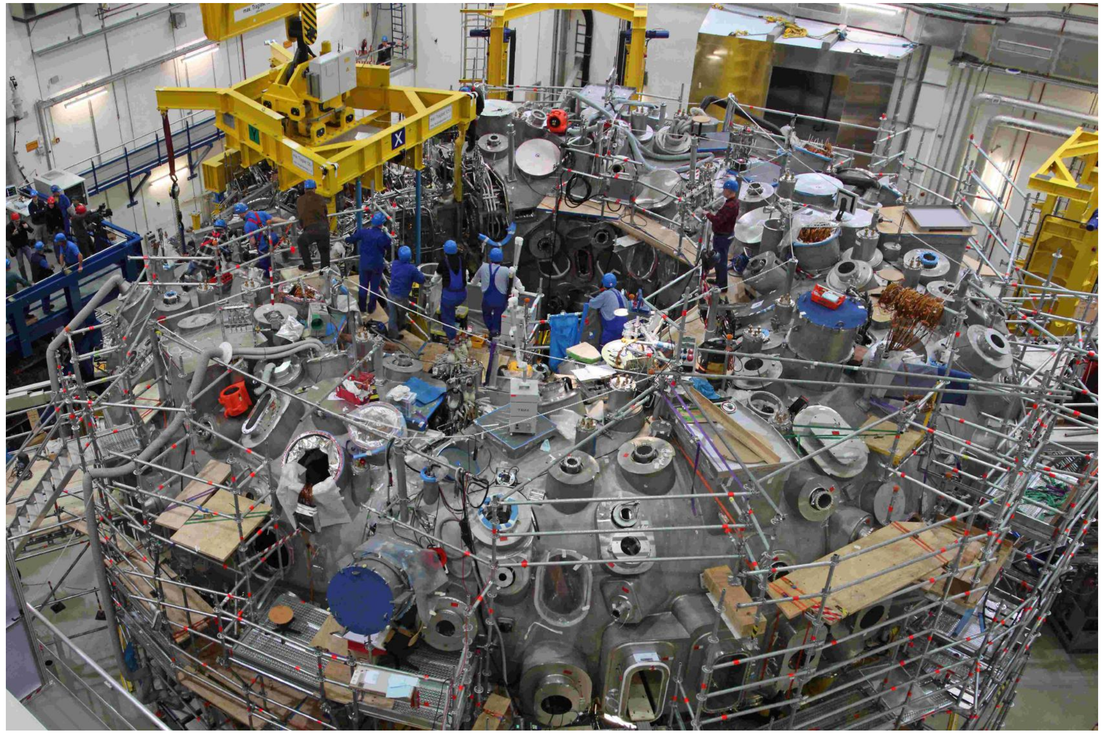
Is it justified…?

vs.

Science needs energy…

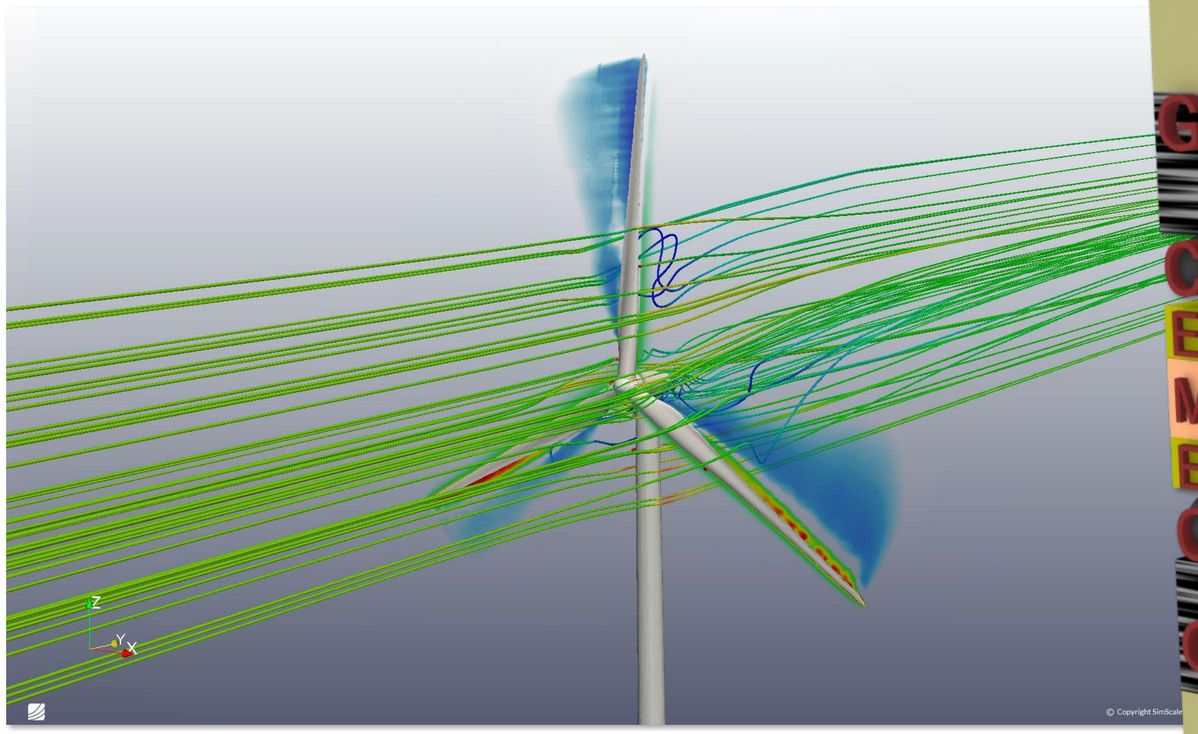


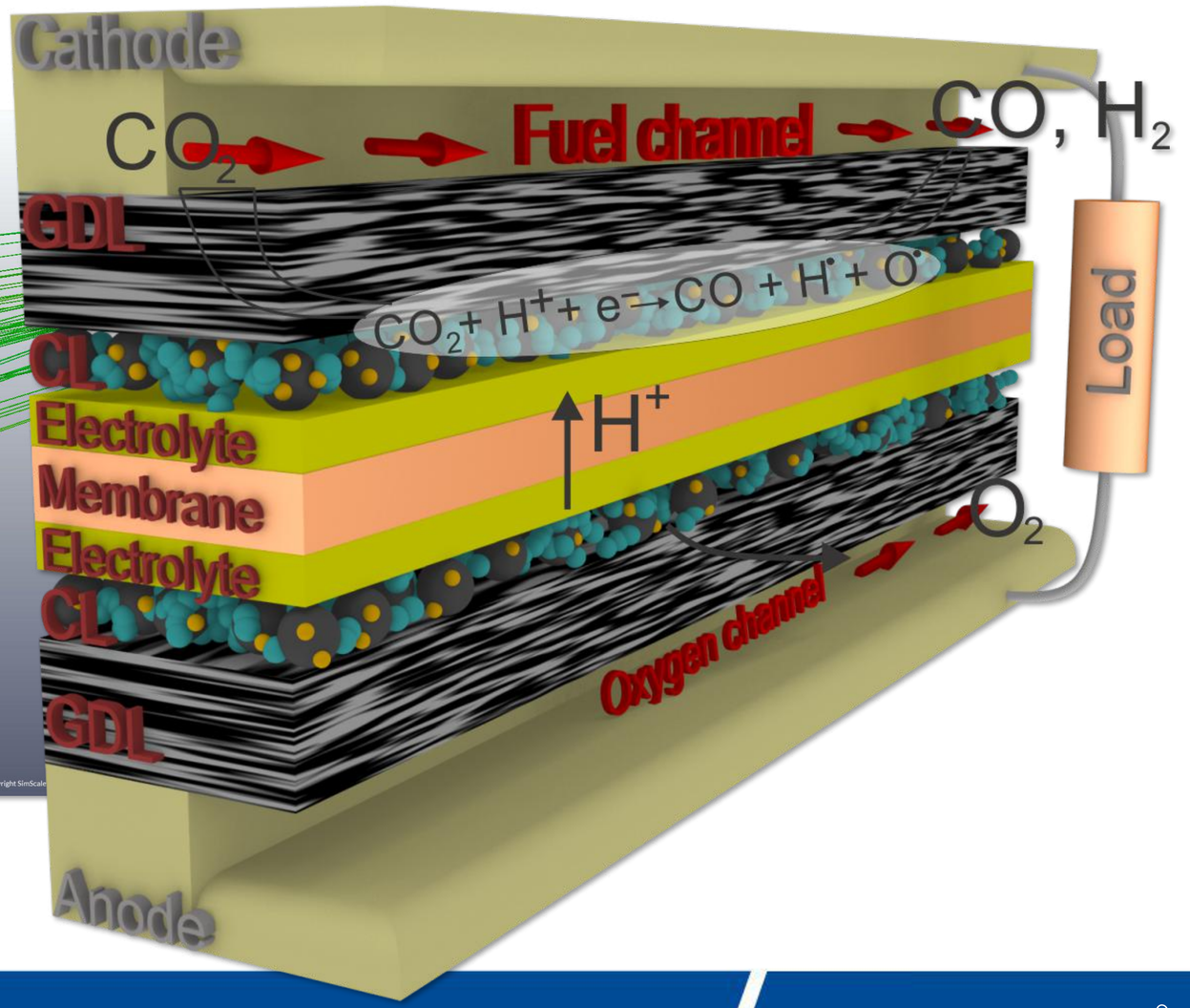
LHC: 120 MW
(CERN total: 180 MW)



Wendelstein-7X: 14 MW

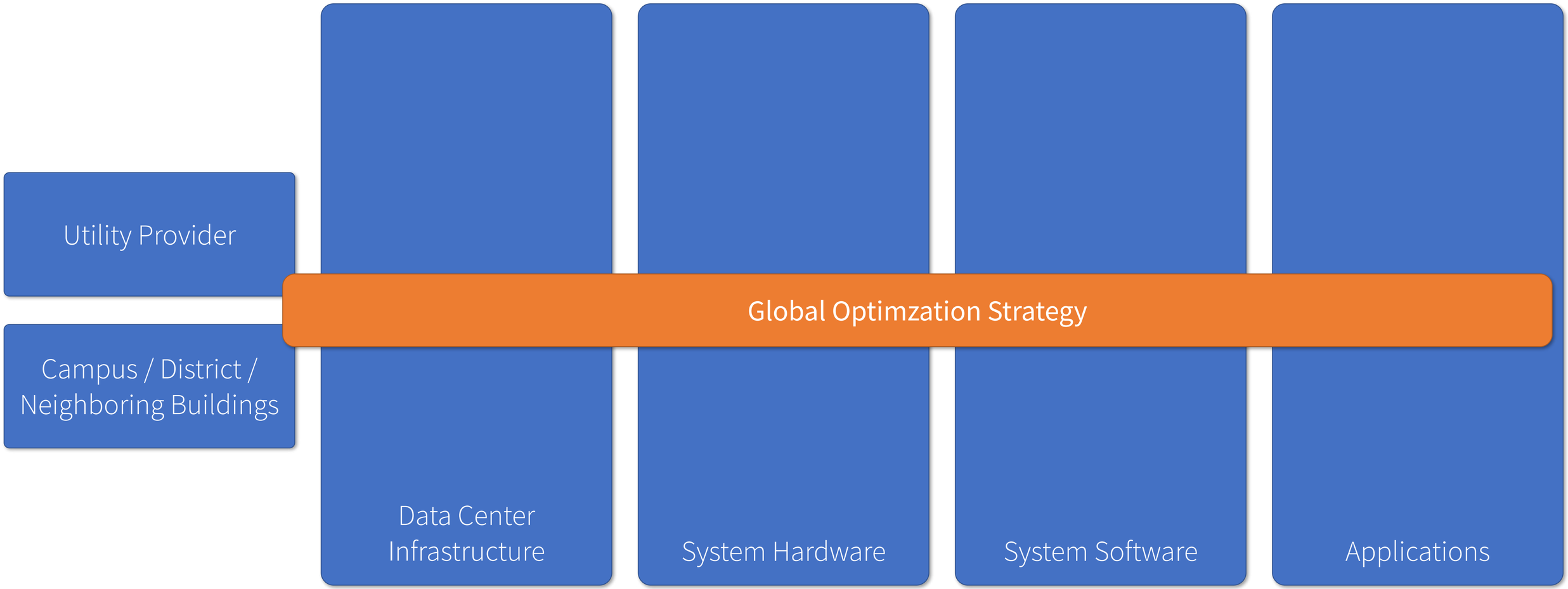
… science (and HPC) helps solving our energy challenges!





The 4 Pillar Framework

for Energy Efficient HPC Datacenters



Torsten Wilde, Axel Auweter, and Hayk Shoukourian. "The 4 Pillar Framework for energy efficient HPC data centers." Computer Science-Research and Development 29.3 (2014): 241-251.

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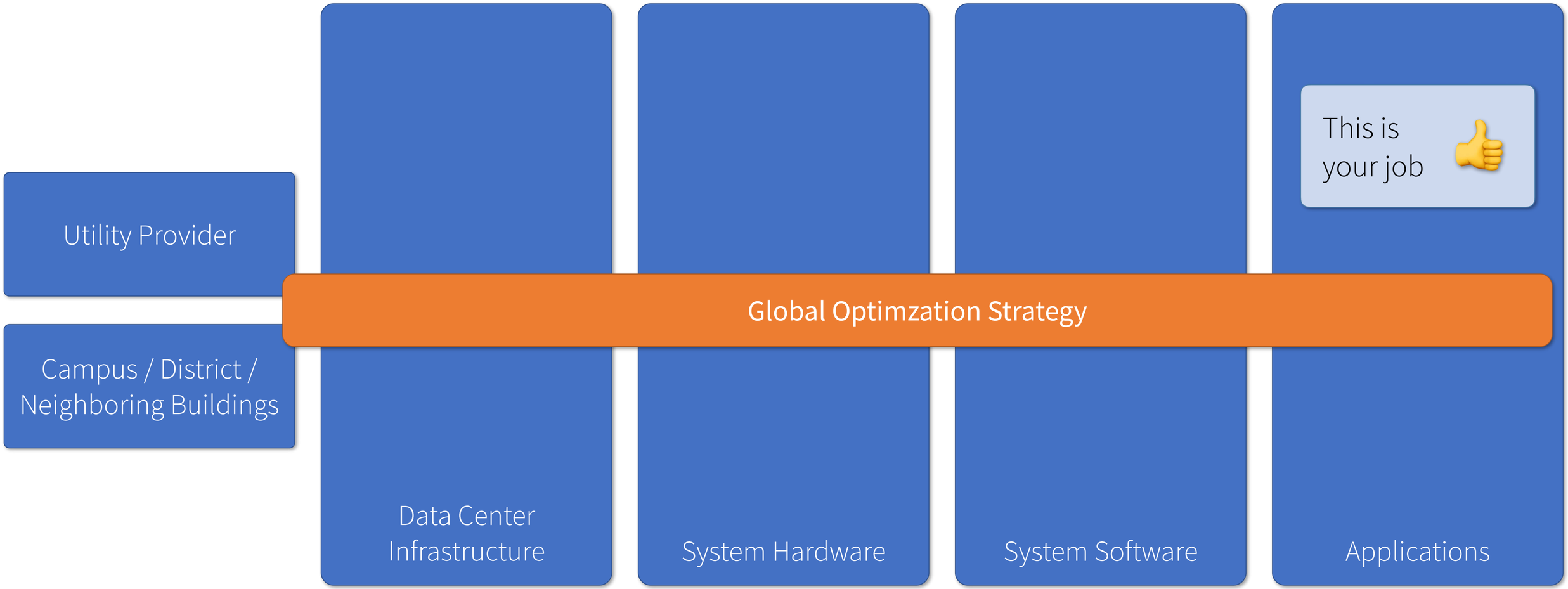

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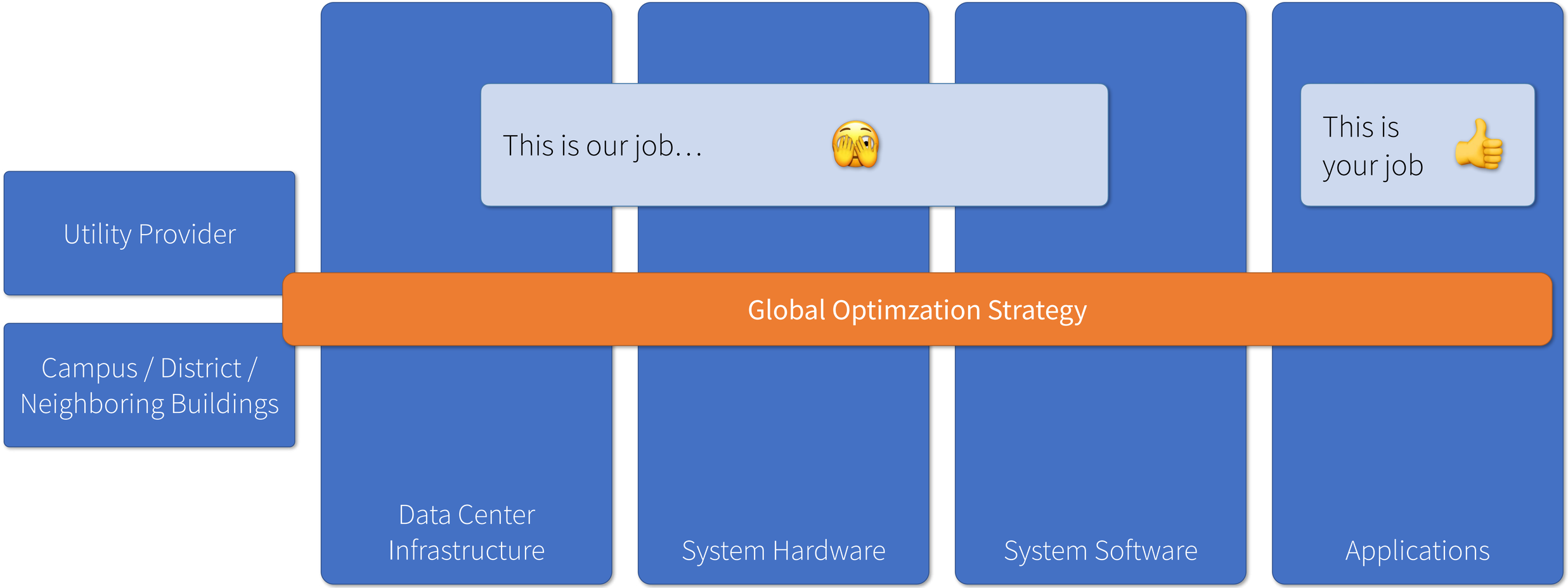

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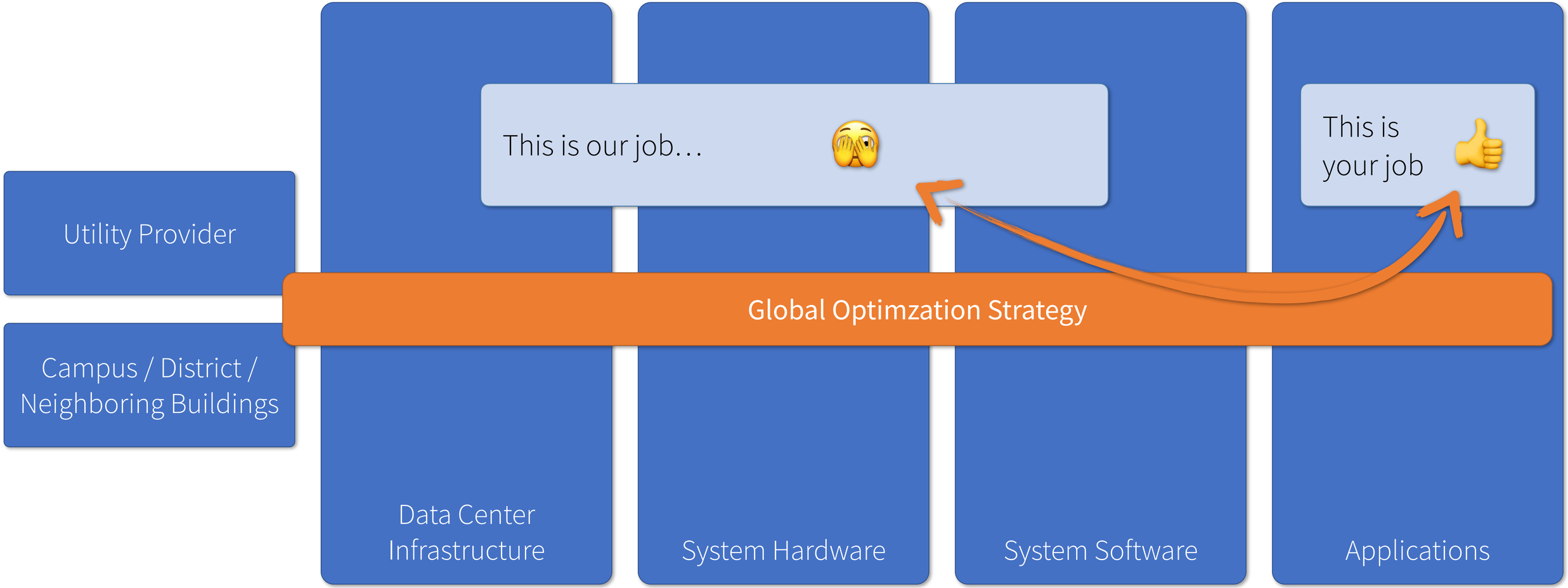

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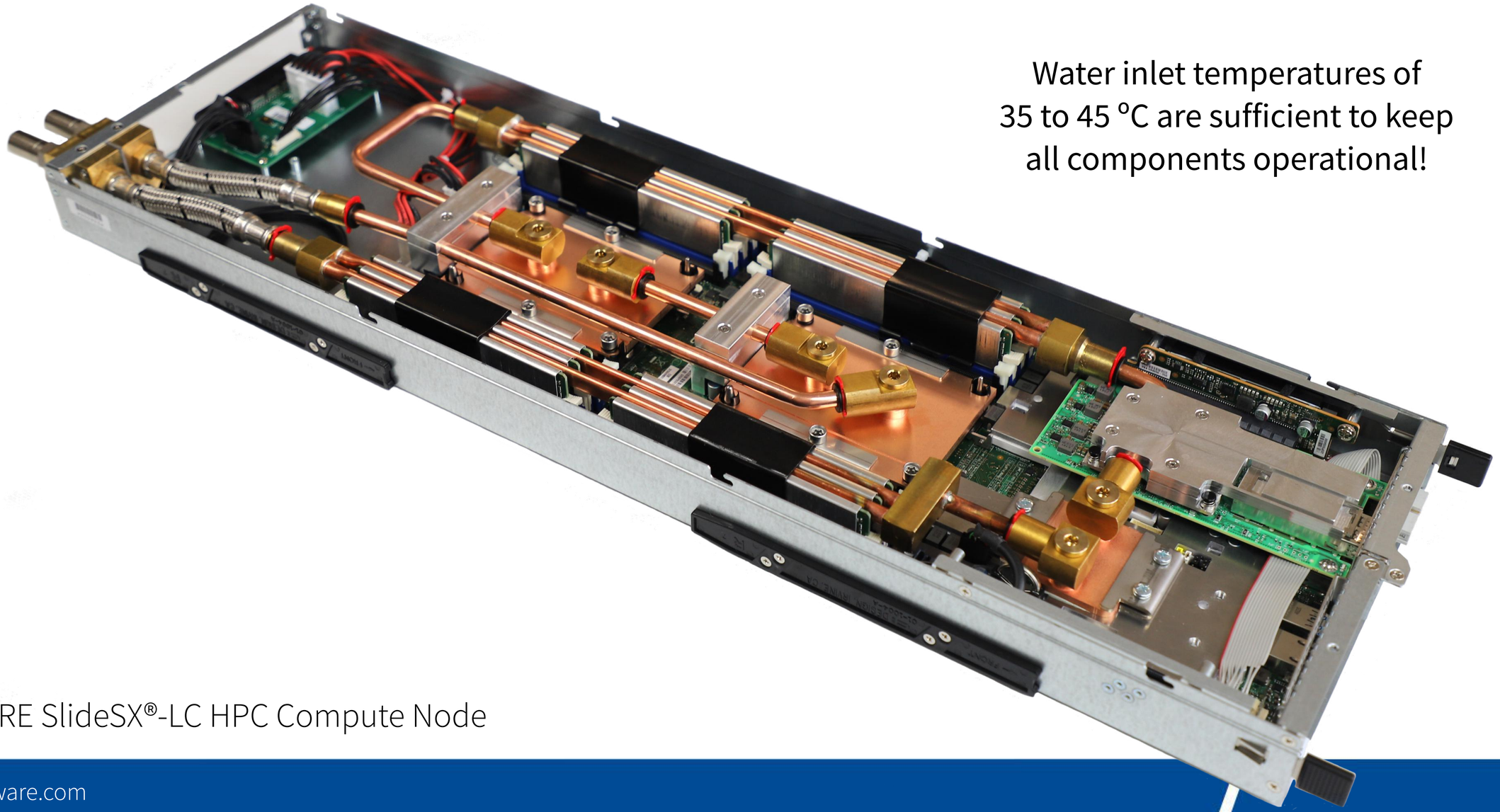
Heat Transfer: Air vs. Water

	Unit	Air	Water	Factor
Thermal Conductivity	$\frac{W}{m * K}$	0.026	0.59	22.7 x
Thermal Capacity	$\frac{J}{g * K}$	1.01	4.18	4.1 x
Volumetric Thermal Capacity	$\frac{kJ}{m^3 * K}$	1.213	4179.6	3445 x
Thermal Inertia	$\frac{J}{m^2 * K * \sqrt{s}}$	5.61	1570.34	280 x

Direct Liquid Cooling in HPC Compute Nodes



Water inlet temperatures of
35 to 45 °C are sufficient to keep
all components operational!

MEGWARE SlideSX®-LC HPC Compute Node

Benefits of Direct Liquid Cooling

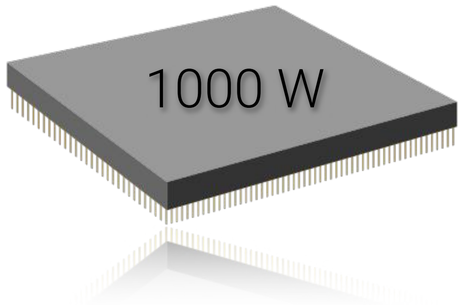
1

Year round, chiller-less (“free”) cooling

Improved PUE
Reduced maintenance
Lower operating costs

2

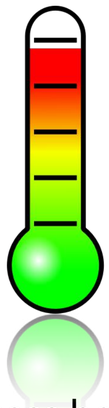
Support for CPUs with high TDPs



Increased performance
Tighter integration
Increased lifetime

3

Improved options for reusing excess heat



Use of excess heat in local facility or supply of district heating systems is possible

The 4 Pillar Framework

for Energy Efficient HPC Datacenters

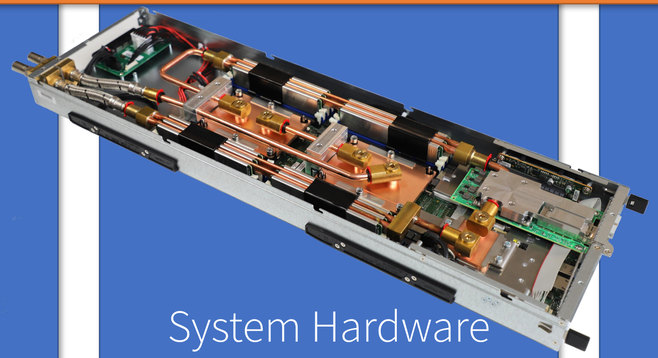
This is our job…

This is your job

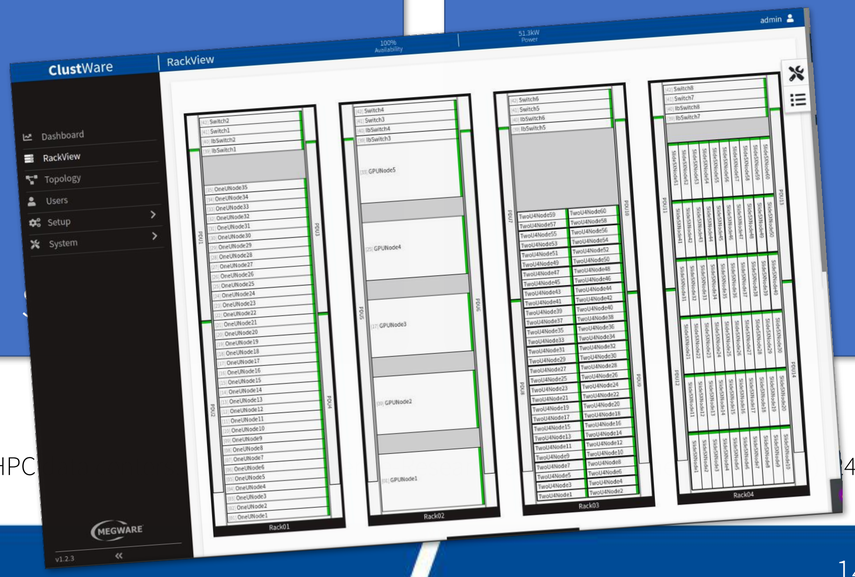
Utility Provider

Campus / District / Neighboring Buildings

Global Optimzation Strategy



System Hardware



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HELMUT SCHMIDT UNIVERSITÄT
Universität der Bundeswehr Hamburg

Helmut Schmidt University
University of the Federal Armed Forces

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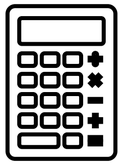
HSU Strategic Goals

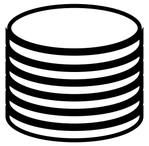
Strengthen the science and engineering in the fields of **computational sciences**, **data sciences** and **machine learning**

HSUper Procurement

single combined procurement of HPC system and container infrastructure



Petascale Class HPC System (CPU only)



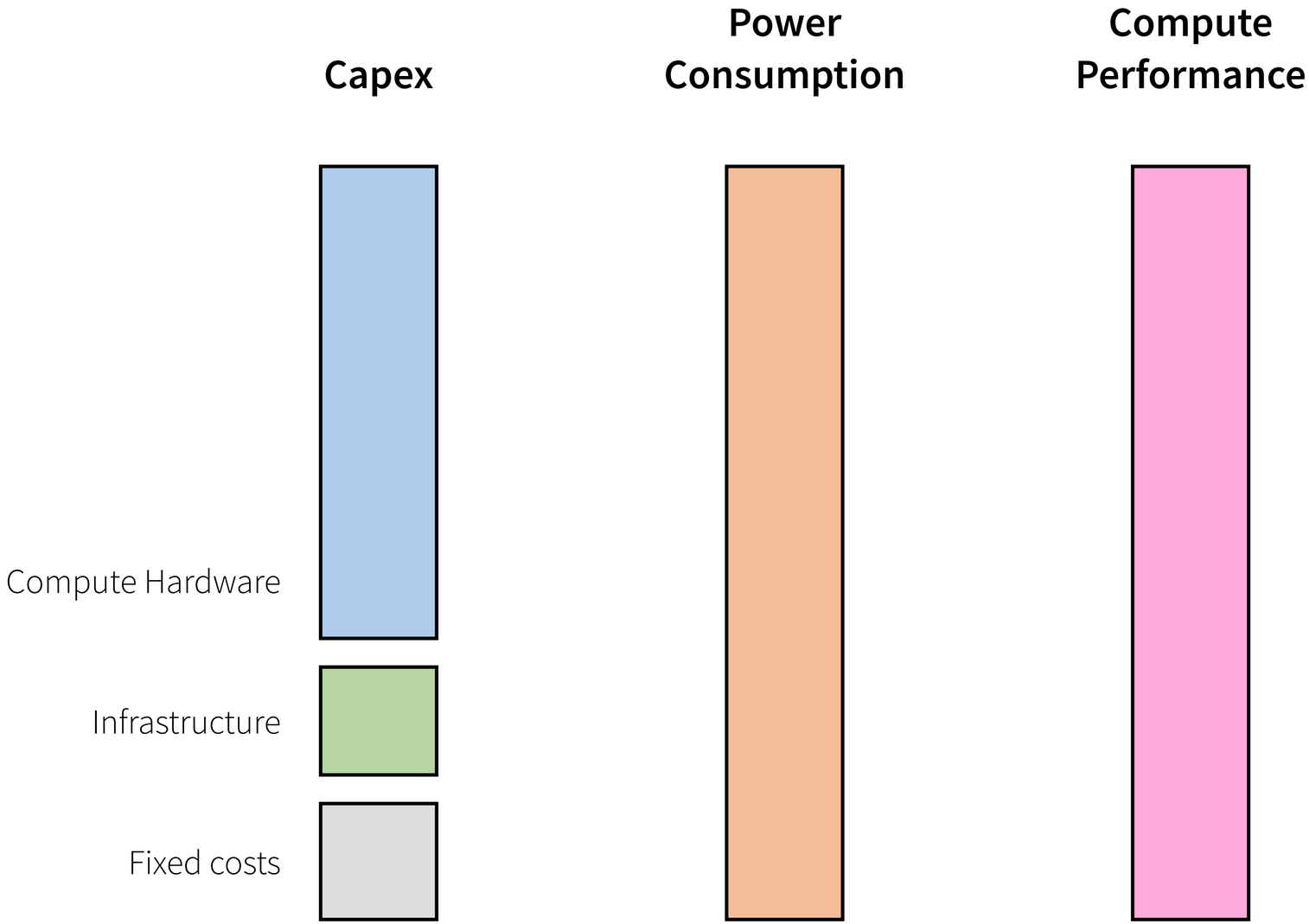
Petabyte Class Storage System

Container based infrastructure

System + Data Center Co-Design

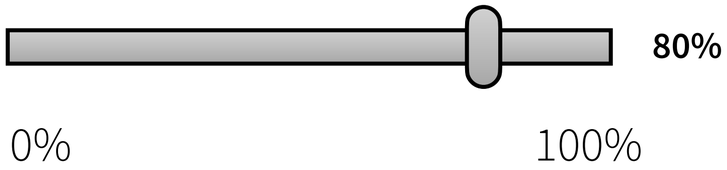
Fraction of High Temperature DLC

0% 100%



System + Data Center Co-Design

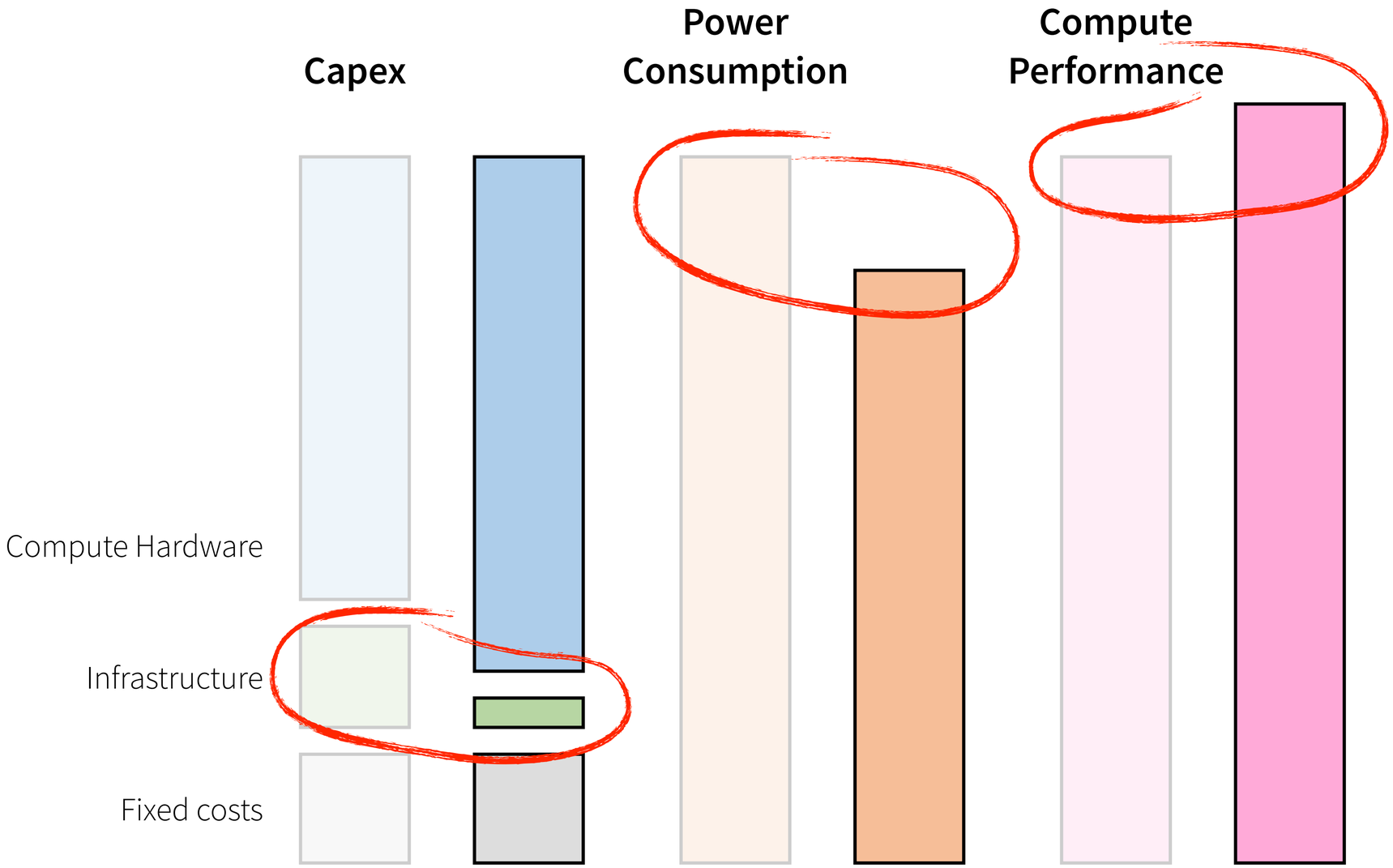
Fraction of High Temperature DLC



Reduced infrastructure cost due to significantly smaller / fewer chillers!

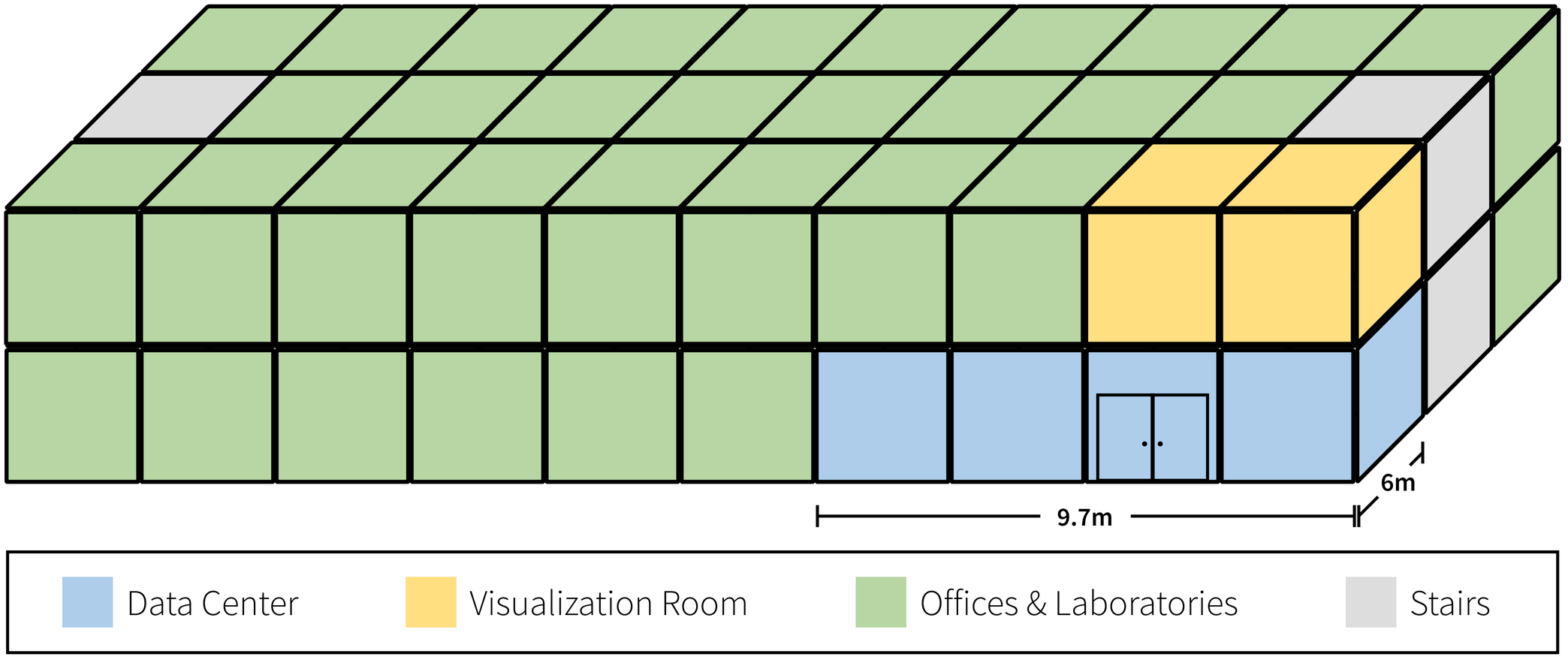
Reduced power consumption!

Increased compute performance due to increased number of compute nodes!



Disclaimer: actual mileage varies based on multiple local factors not shown here - you are not exempt from doing your own math for your own actual use case!

Layout of HSUper Containerized Data Center




KRANDIENST SCHULZ
HAMBURG
040-730 900 0
Der Aufenthalt im Schwenkbereich des Kranes ist verboten
KRANDIENST SCHULZ
HAMBURG
040-730 900 0
DPL 2P98
SCHMITZ
MAC


SCHULZ
KRANDIENST
SCHULZ
HAMBURG
040-730 900 0
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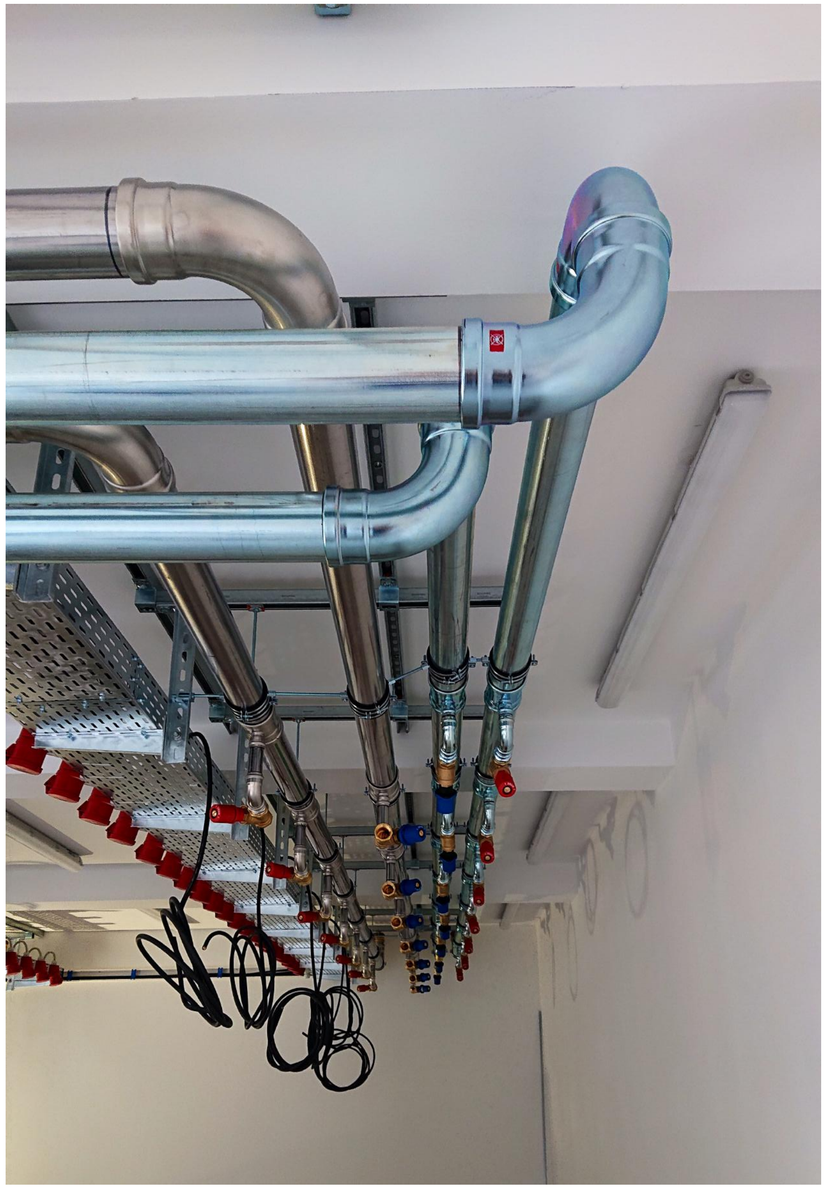


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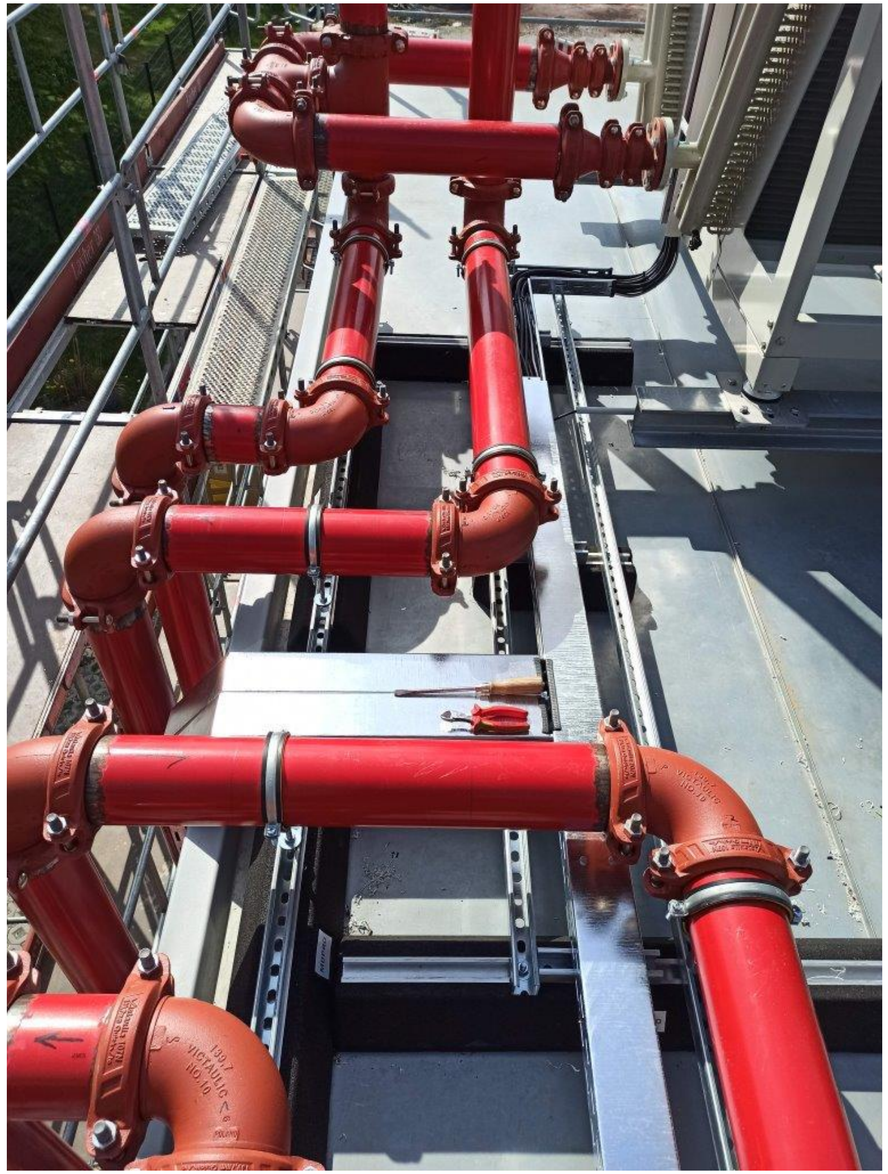
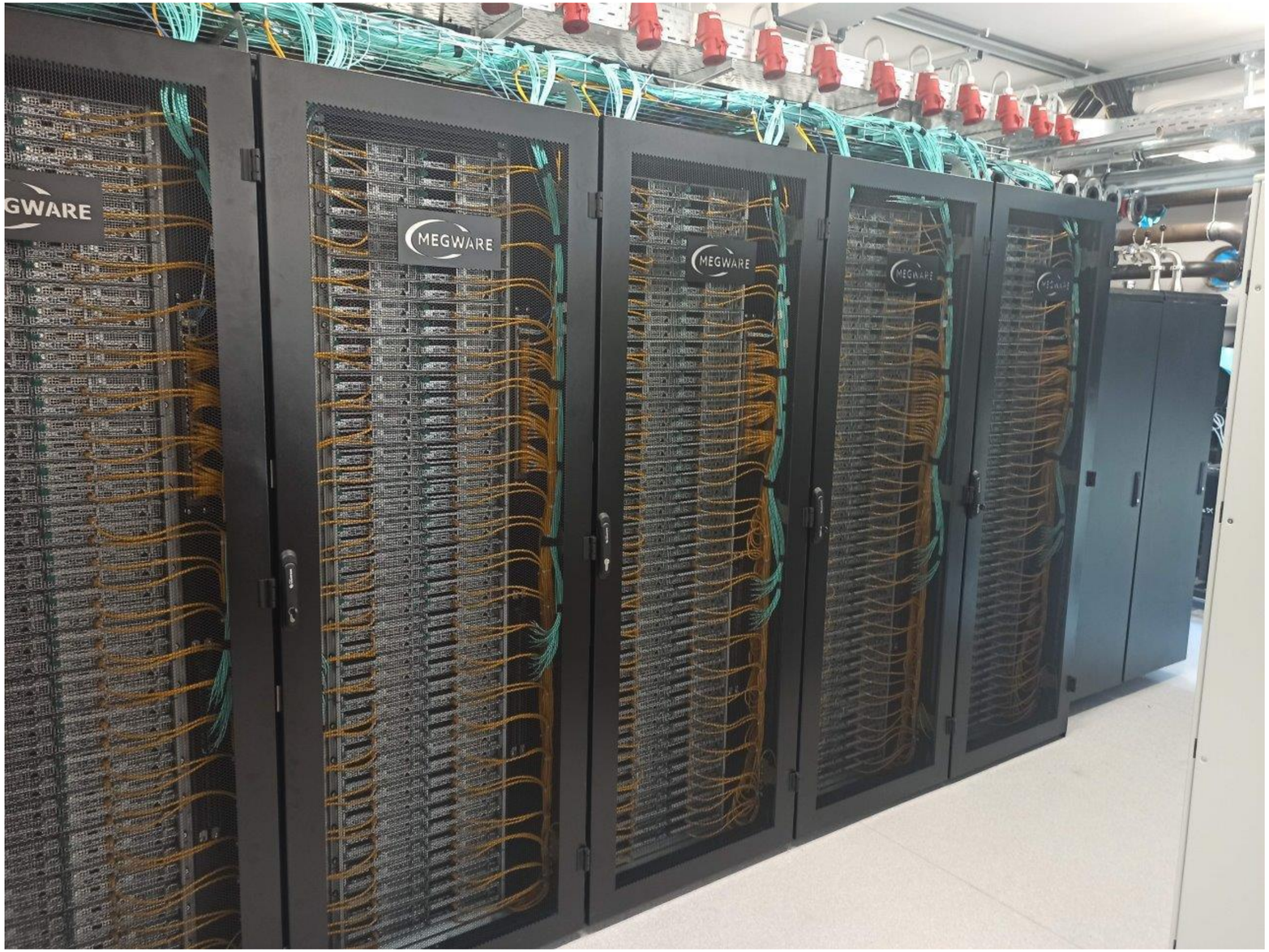
MEGWARE


22J02
22J05




MEGWARE
MEGWARE
MEGWARE

Fast

13 months from contract signature to Top500 run

Energy Efficient

Maximized DLC and chiller-free operation with heat reuse

Sustainability is more than Energy Efficiency…

Hardware Platforms

Supply Chain

Others

Waste Production

Water Usage

Human Rights

Dangerous Goods

Carbon Footprint

Safety

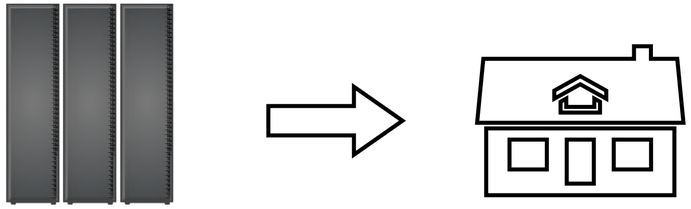
HPC SOLUTIONS - MADE FOR YOU.

Thank you for your Attention!

www.megware.com | info@megware.com

MEGWARE Projects with Data Center Heat Re-Use

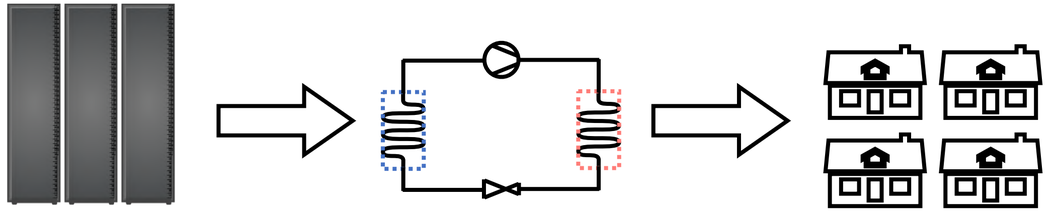
Direct Reuse



DLC → Underfloor Heating

Customer	Year
Leibniz Supercomputing Centre of the Bavarian Academy of Sciences and Humanities	2011, 2017
Universität Greifswald – Wissen lockt. Seit 1456	2015, 2018
TU Wien – Technische Universität Wien, Vienna University of Technology	2022-2023
NHR@Göttingen	2022-2023

District Heating



DLC → Heat Pump → District Heating

Customer	Year
Technische Universität Darmstadt	2019, 2025
Universität Duisburg Essen – Offen im Denken	2023