Why are we in the age of Bragawatts?

Why do we see this AI datacenter growth? What are the implications? What is RISE doing about it?

Tor Björn Minde
RISE – Research Institutes of Sweden

Intelec, February 4, 2026

A full-scale research datacenter and test environment with the objective to increase knowledge and strengthen the global AI & Data Center ecosystems

- 40+ projects, from the ground to the cloud
- 30+ employees
- 4+ MEUR turnover
- Established 2016
- 100+ project partners

Partners: Ericsson, ABB, Vattenfall, Meta, LTU, Region North, Vertiv, BP Castrol, Alfa Laval, Grundfos, Google, Intel, Telia, Submer

Current Official Partners in the Partner Program

Premium partners:

ERICSSON VATTENFALL Meta ABB VERTIV

Castrol ALFA LAVAL GRUNDFOS Google

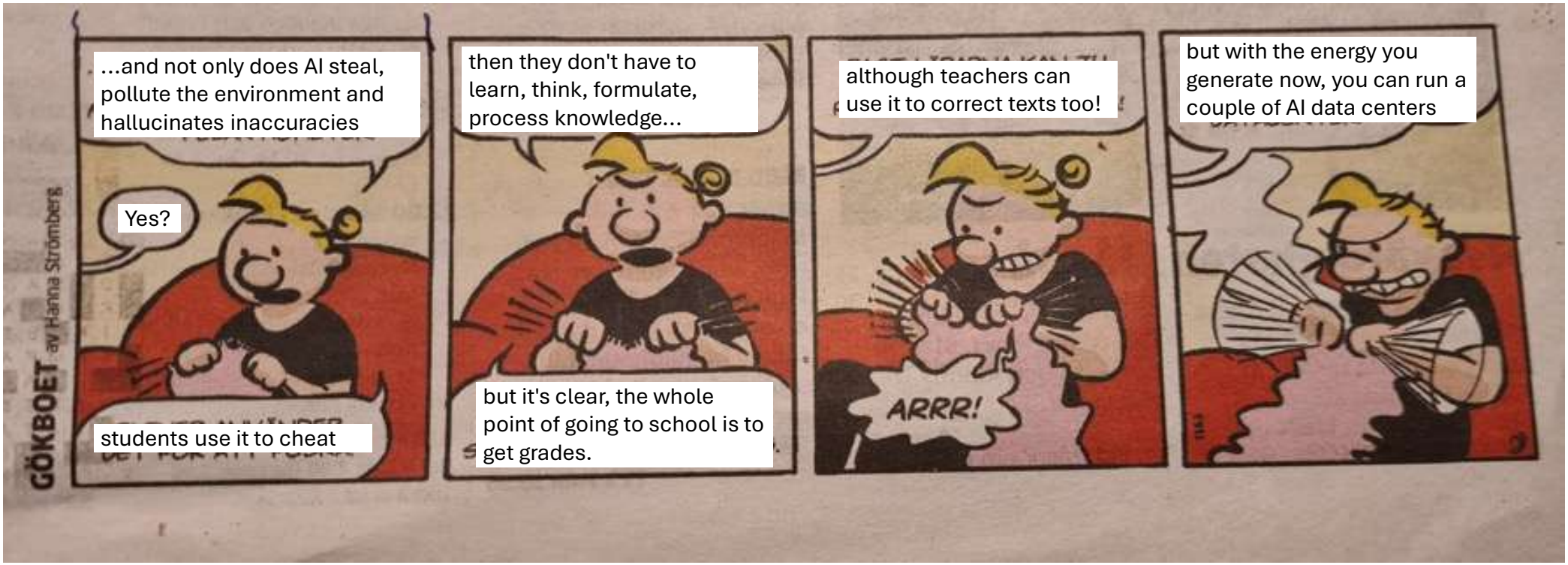
Collaborators:

intel Telia submer Datacenters that make sense

Academic:

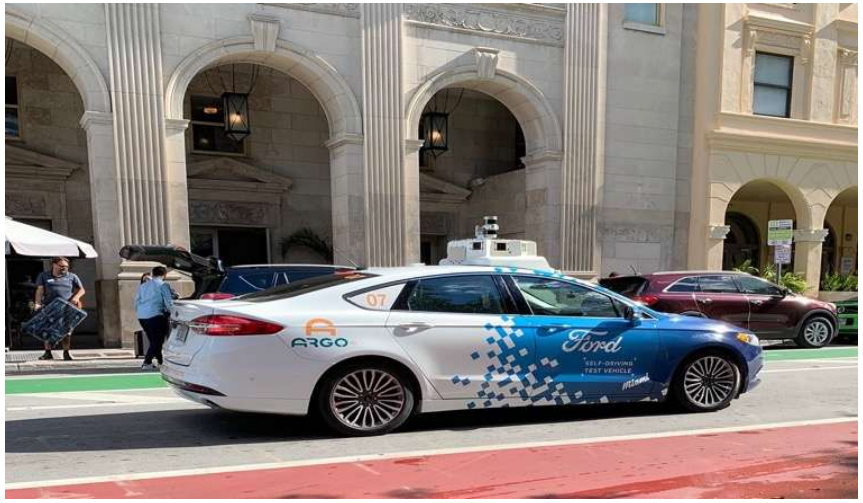
LULEÅ TEKNISKA UNIVERSITET Åbo Akademi ktl NUS National University of Singapore

Comic strip about energy & AI data centers



Sources: RISE 2025

Applications for the era of Bragawatts



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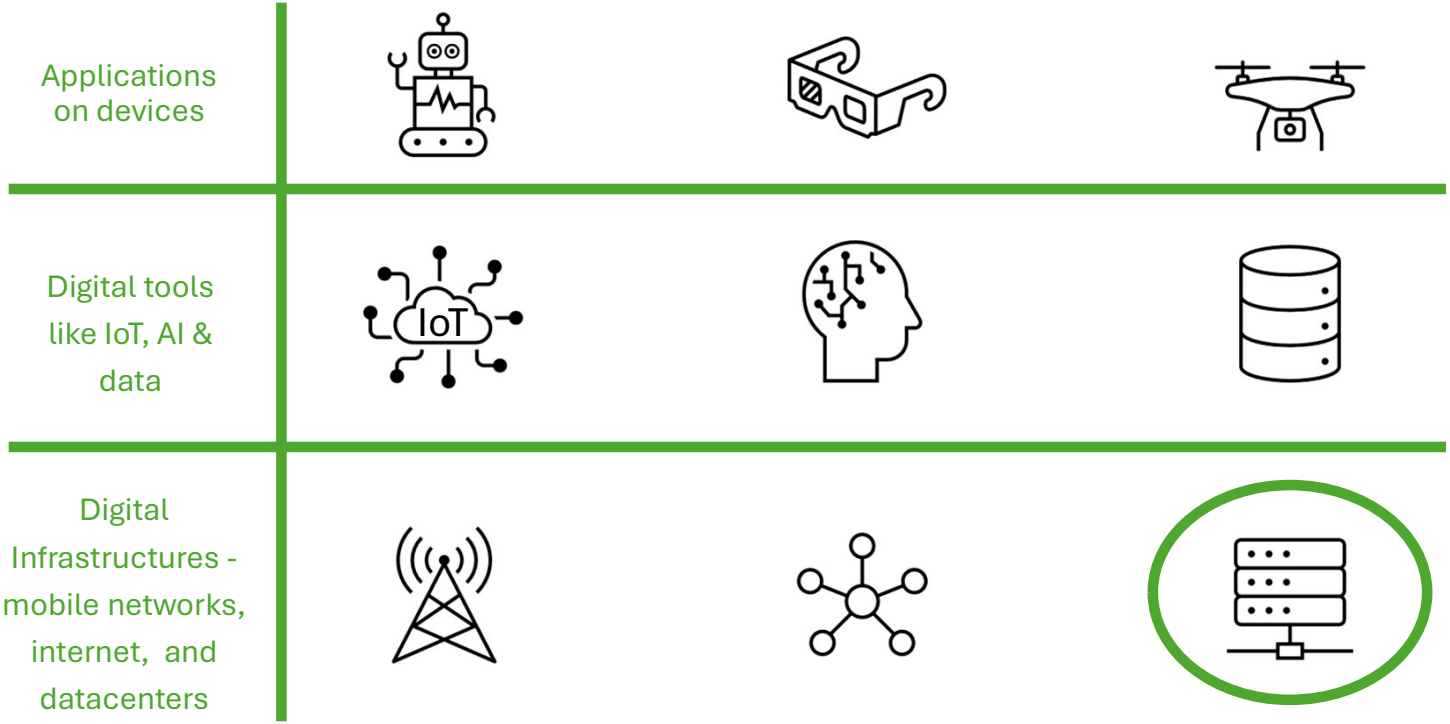
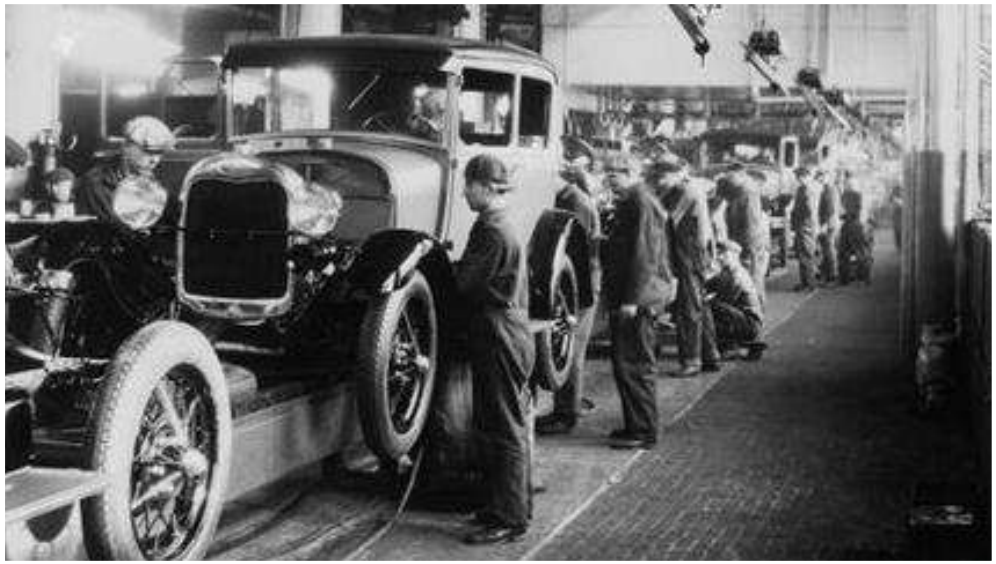
Digital infrastructure – including data centers – is the foundation for AI



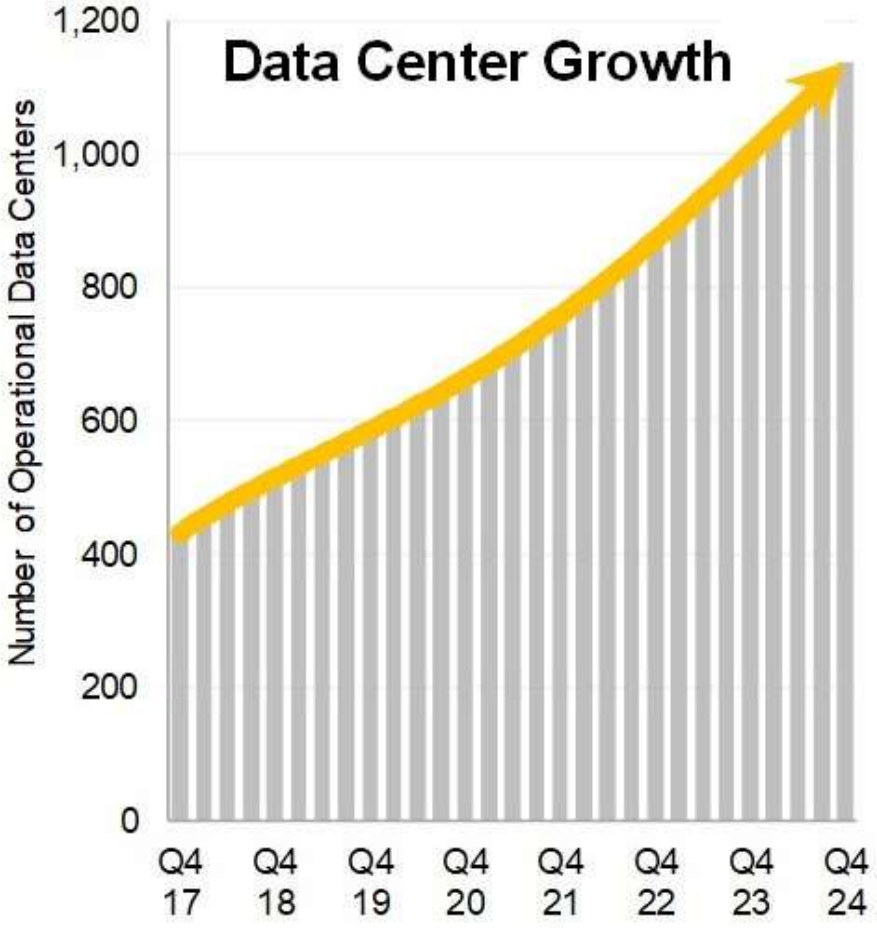
Sources: RISE 2025

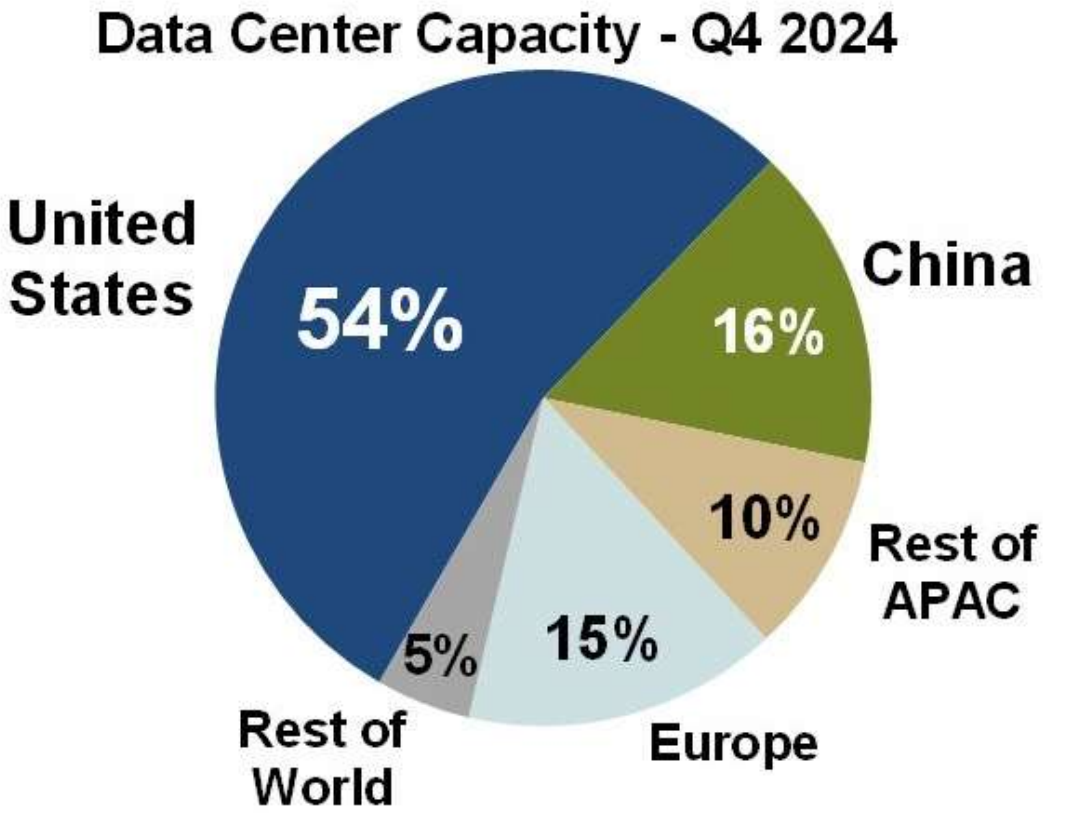
Industrialization – Innovation based on power



New-Industrialization – Innovation based on power

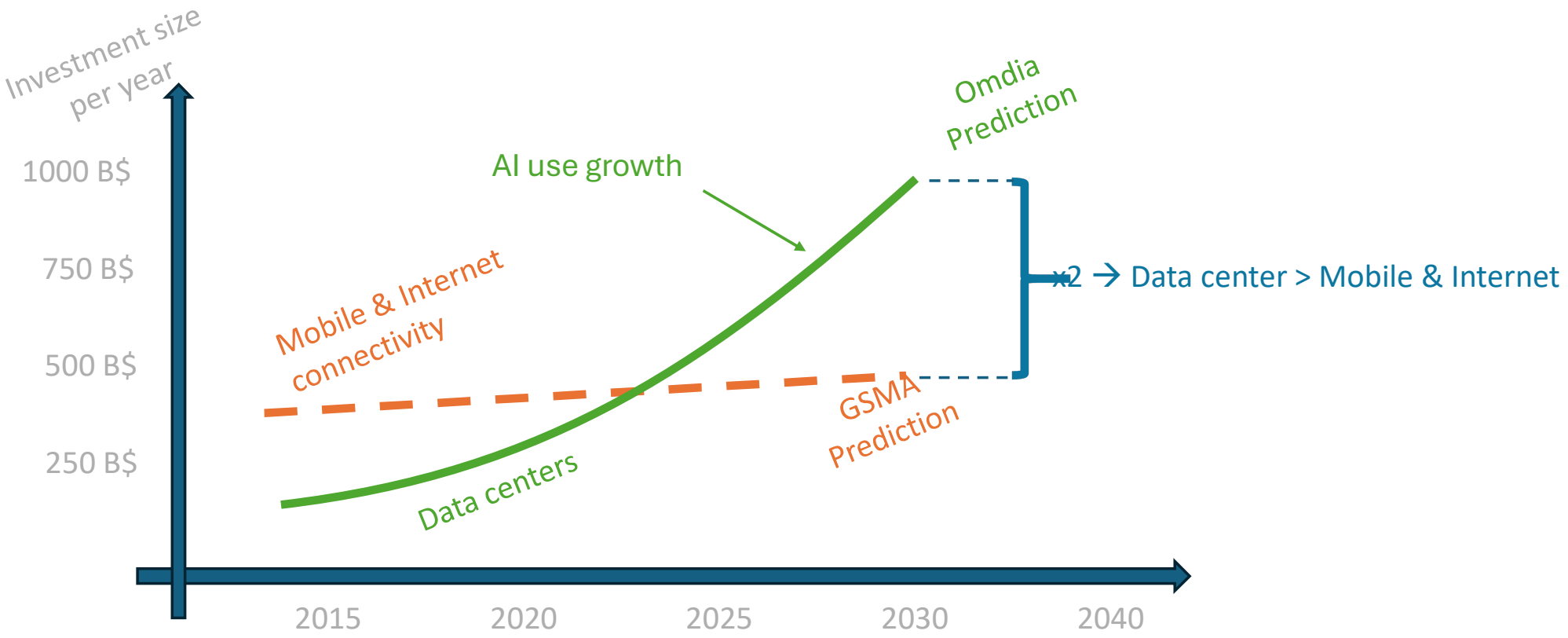
Hyperscale data centers





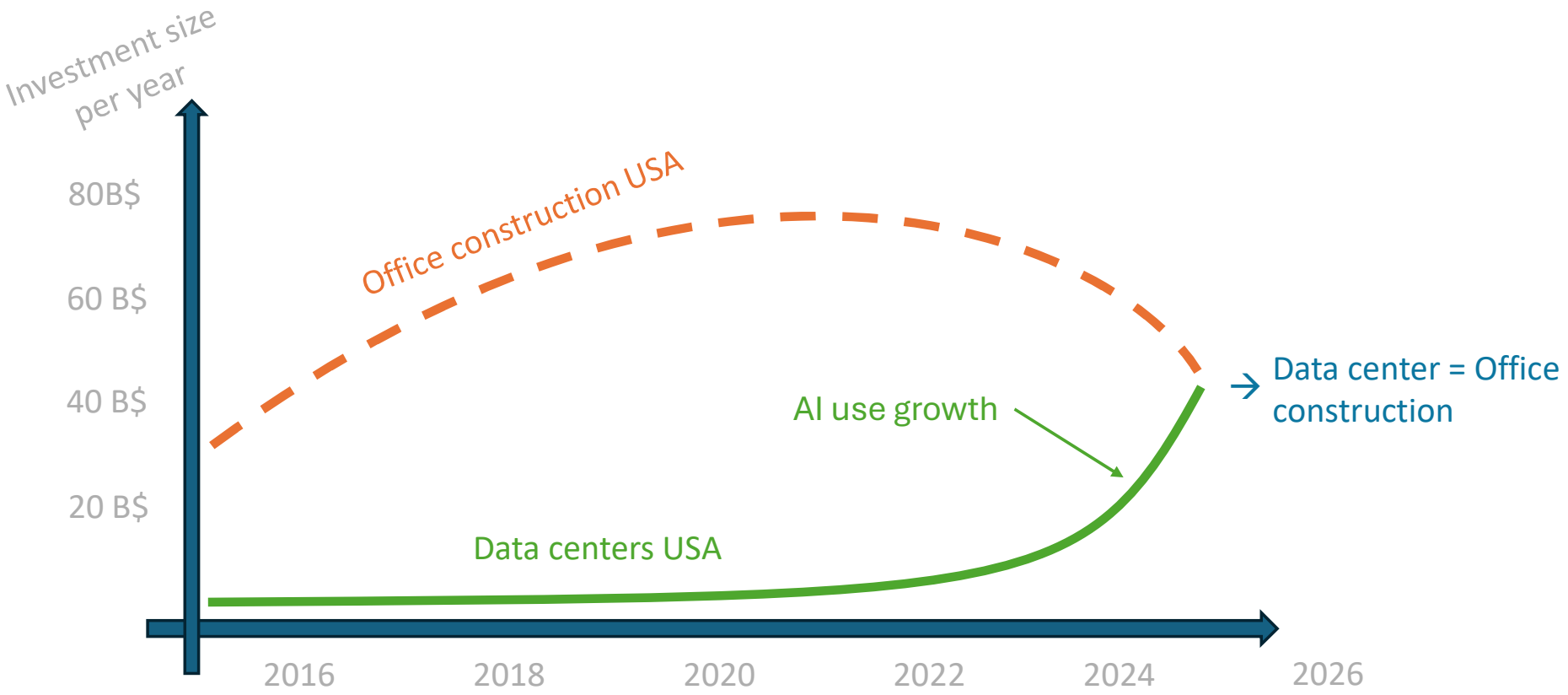
Source: Synergy Research Group

Data centers vs connectivity investment sizes



Source: Omdia Analyst Summit 2025 and Mobile Infrastructure Investment Landscape, GSMA, 2025

Data centers vs Office construction investment sizes

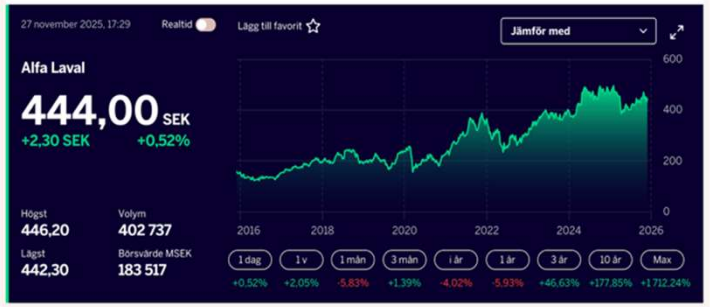


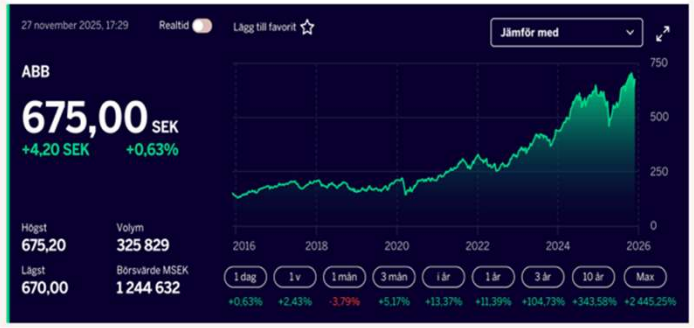
Source: US Census Bureau, 2025

Digital infrastructure vendors stock development

Mobile industry

Data center Sweden





Data center International

Swedish data center industry association

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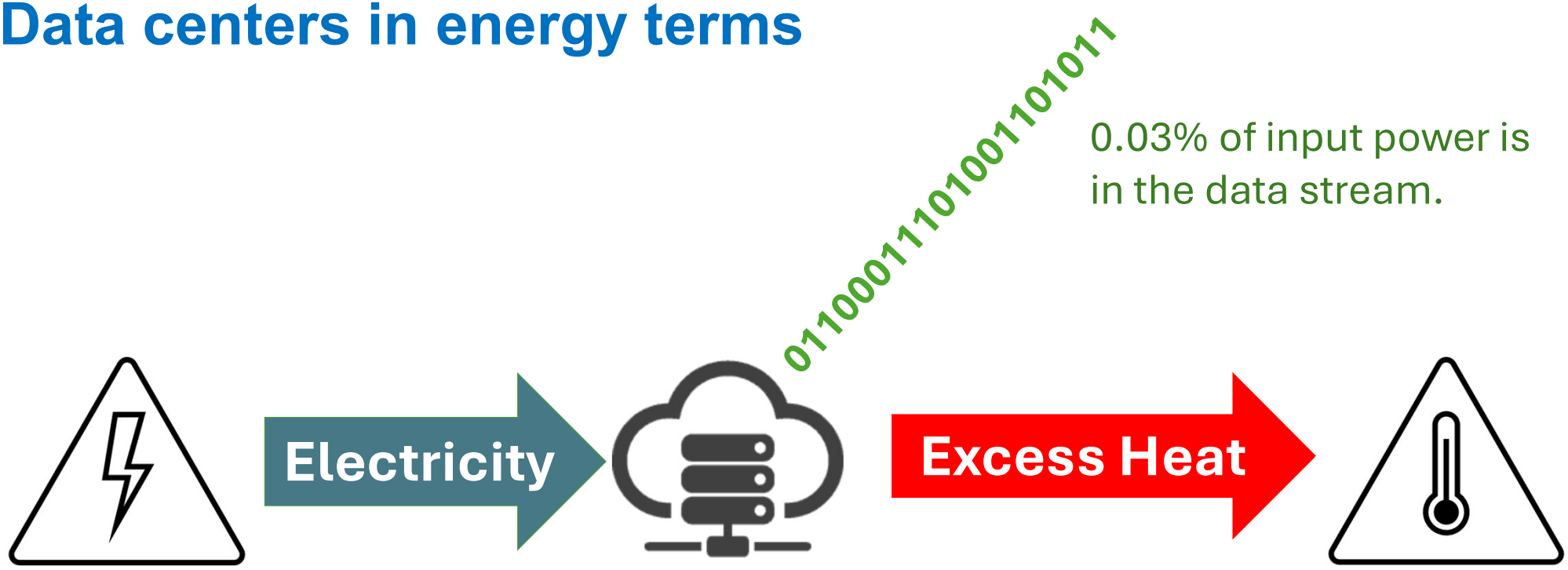
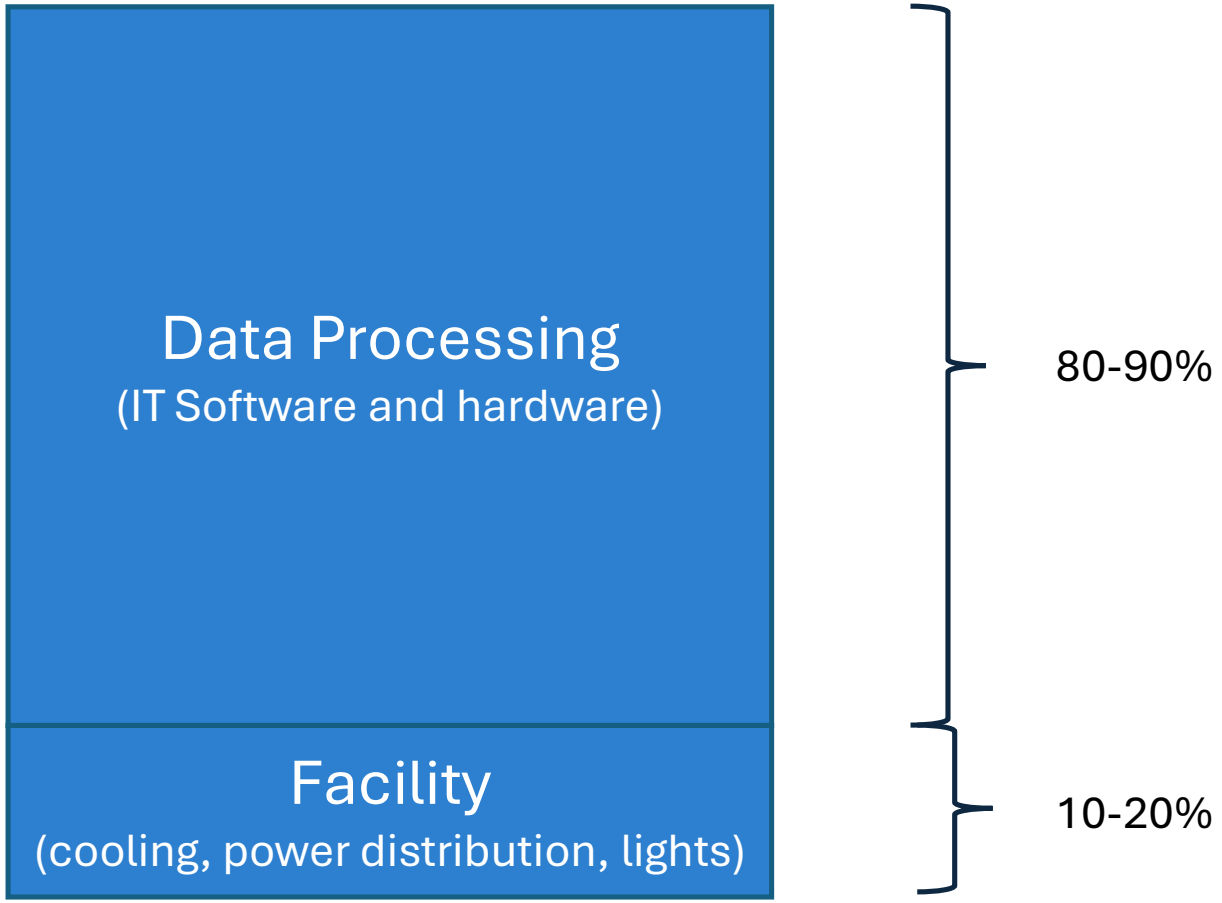
Data centers in energy terms



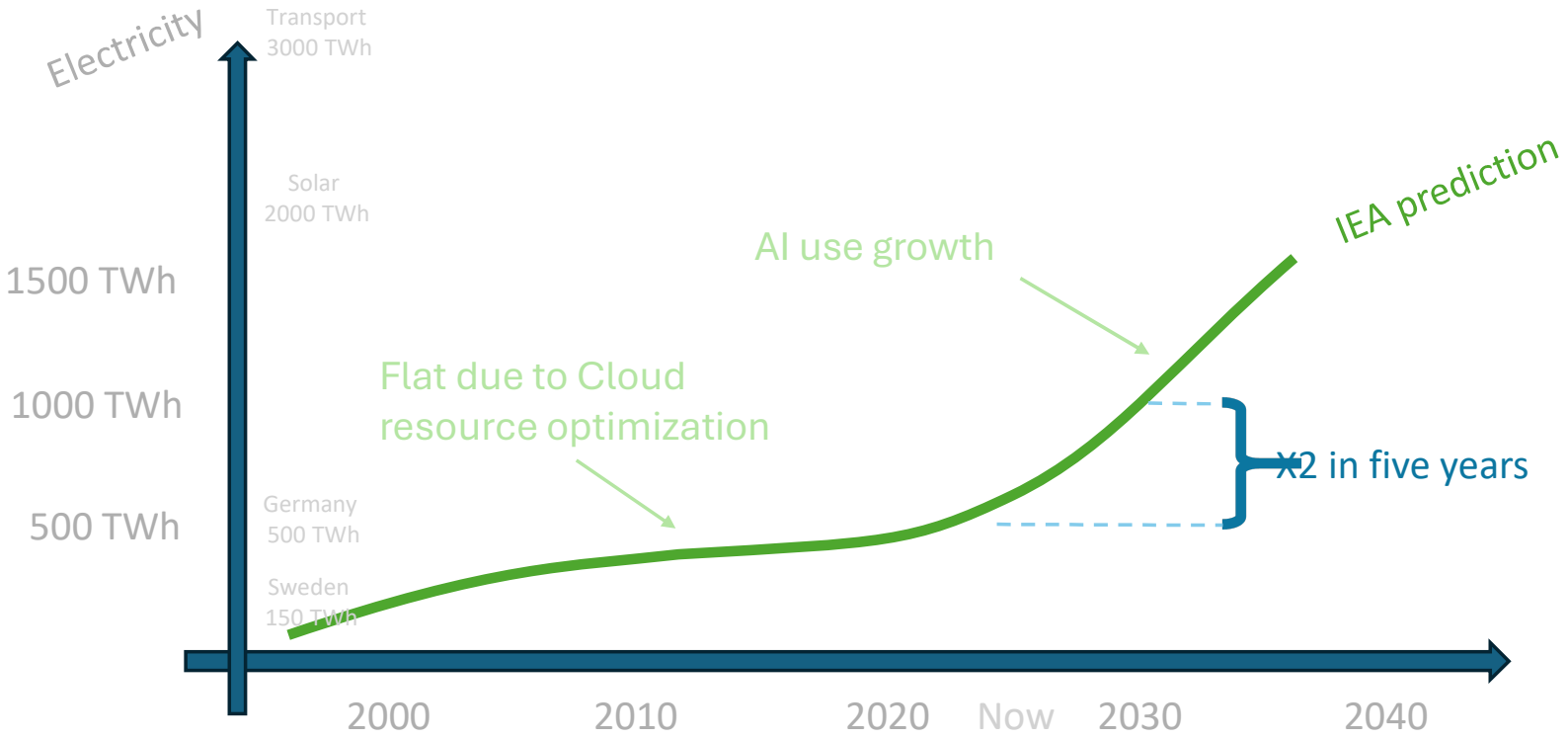
Based on: Rolf Landauer, “Irreversibility and Heat Generation in the Computing Process,” IBM J Res. Dev. 5, 183 (1961).

Where do the energy go? 99,97% becomes heat
(illustration)



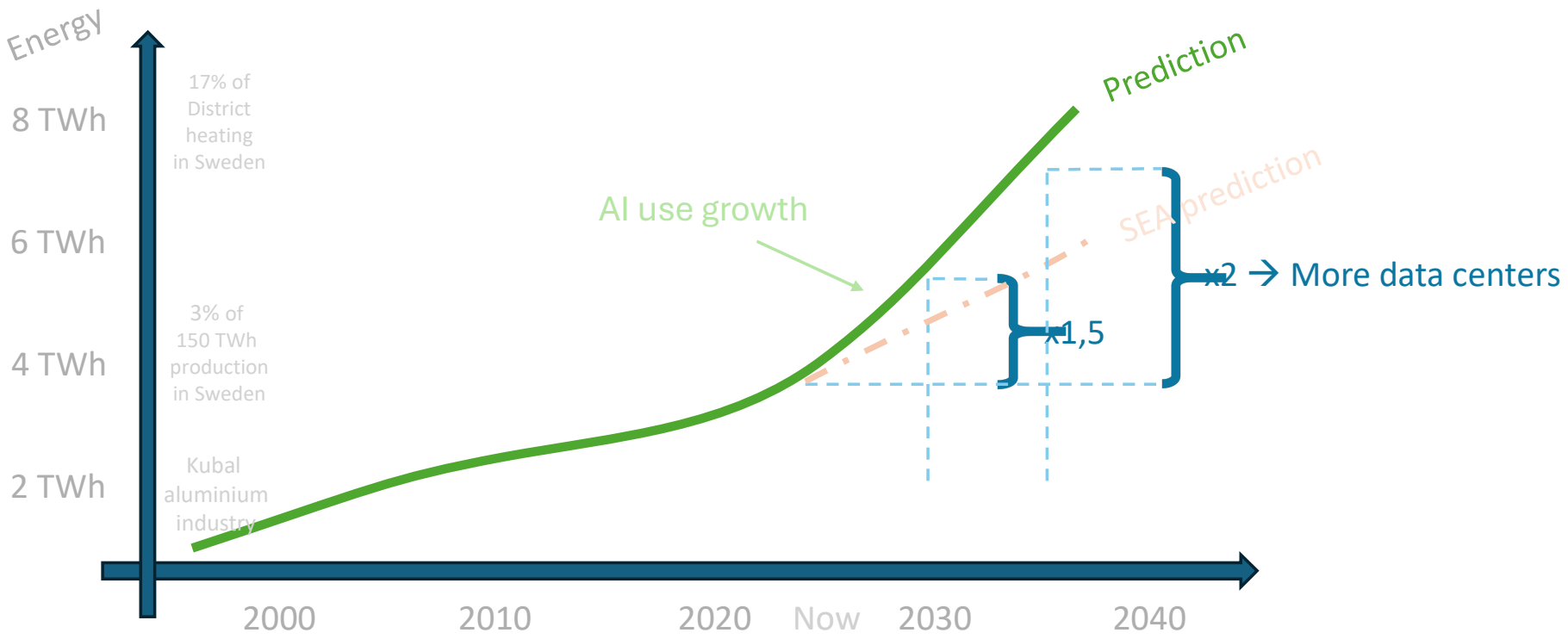
Sources: RISE 2025

Global electricity demand in data centers



Sources: Electricity 2024 Global trends- Analysis and forecast to 2026, IEA 2024 - EPRI, Powering Intelligence, White Paper, May 2024 - Global Data Center Demand Forecast (McKinsey), 2024

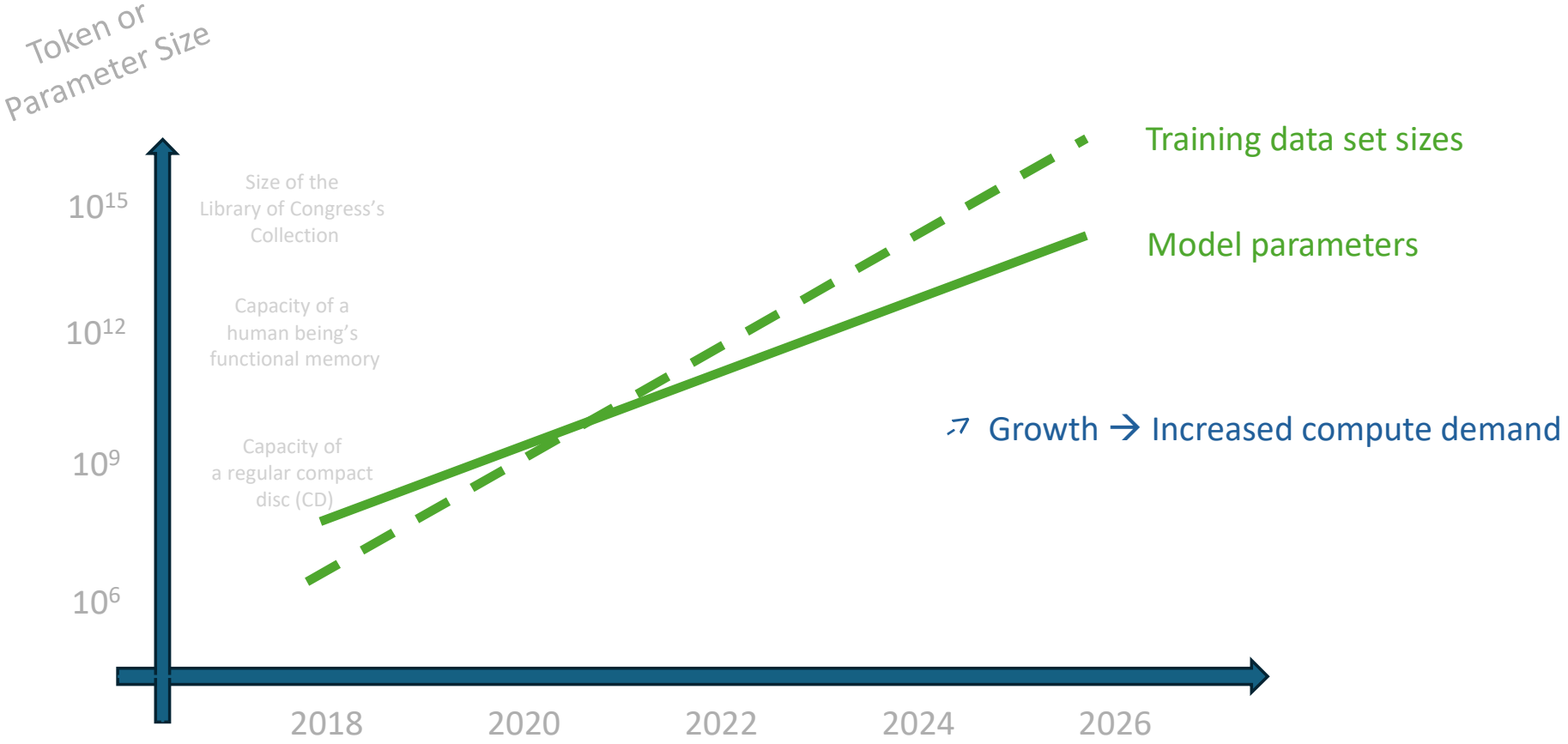
Swedish electricity demand for data centers



Message: In Sweden, electricity consumption driven by AI demand is projected to increase by 1.5 times over the next five years and double within ten years. By then, it could account for 4–5% of the country's total electricity production.

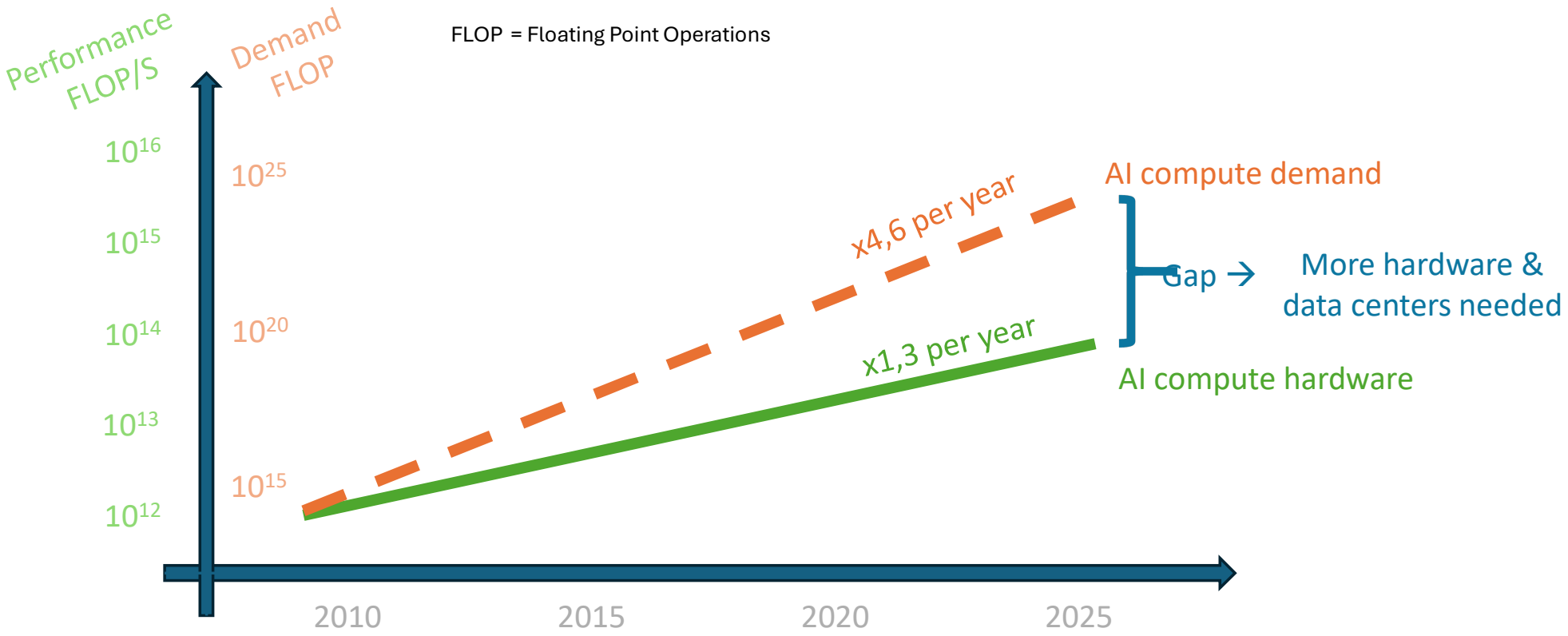
Sources: Energianvändning i digitala system, datacenter och kryptovaluta, Energimyndigheten, 2023

Size of AI models and training data used



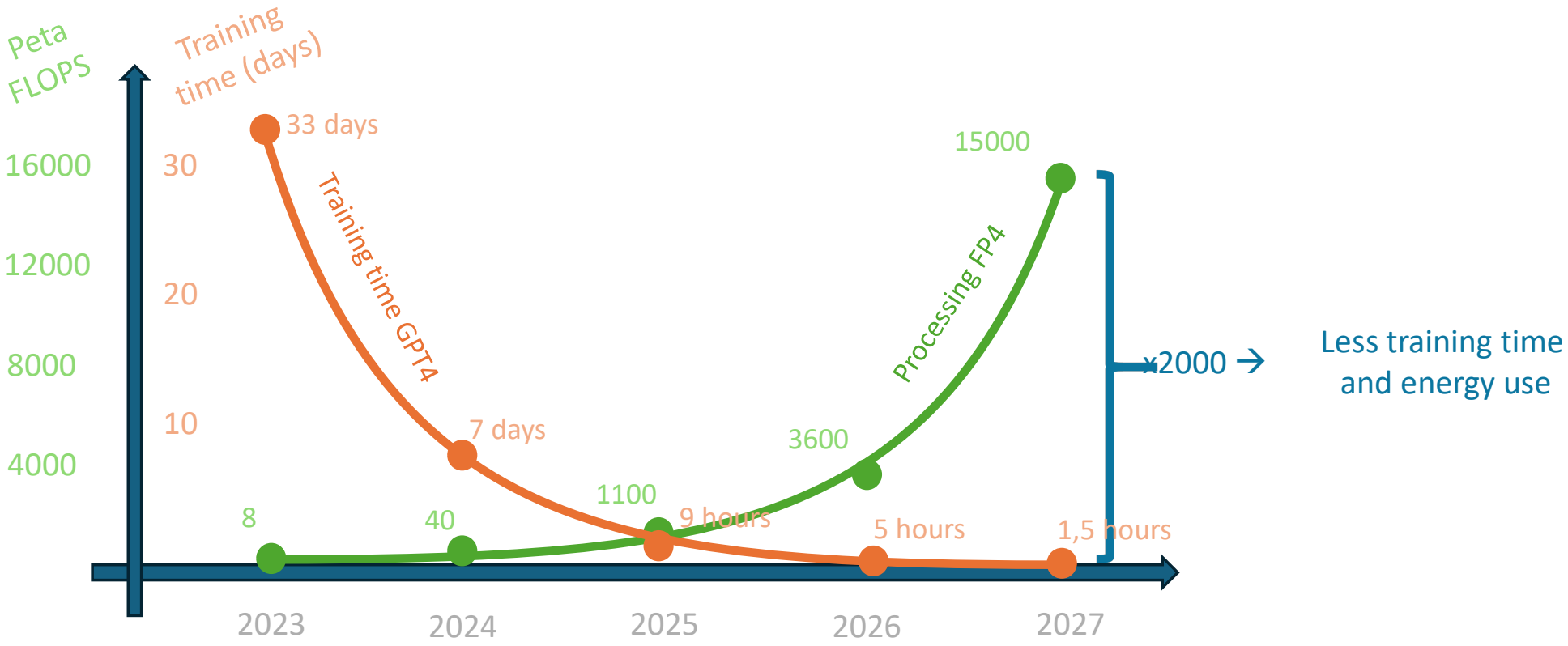
Sources: Trends in Training Dataset Sizes, Epoch AI, Sep 20, 2022

AI compute demand & hardware capability



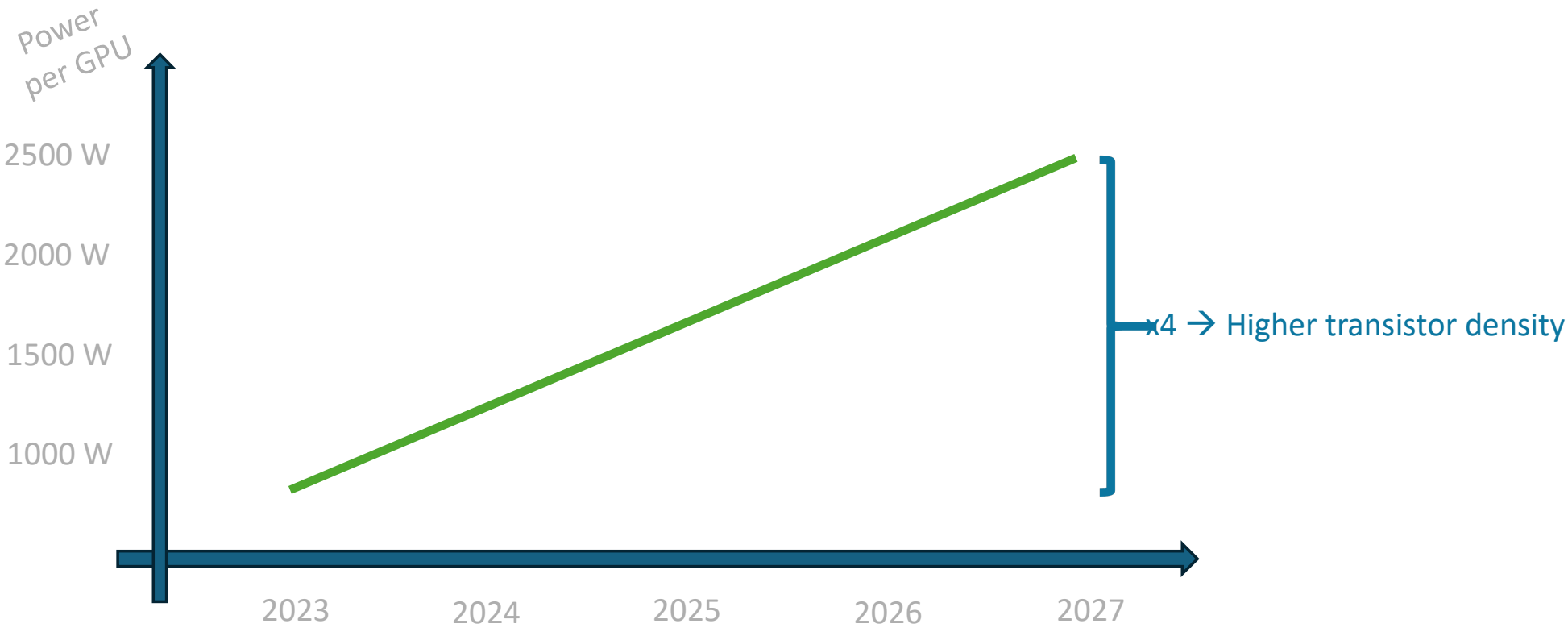
Sources: Keynote: Anastasiia Nosova at Green Computing in the AI Era conference 2025

Development of compute performance in Nvidia GPUs



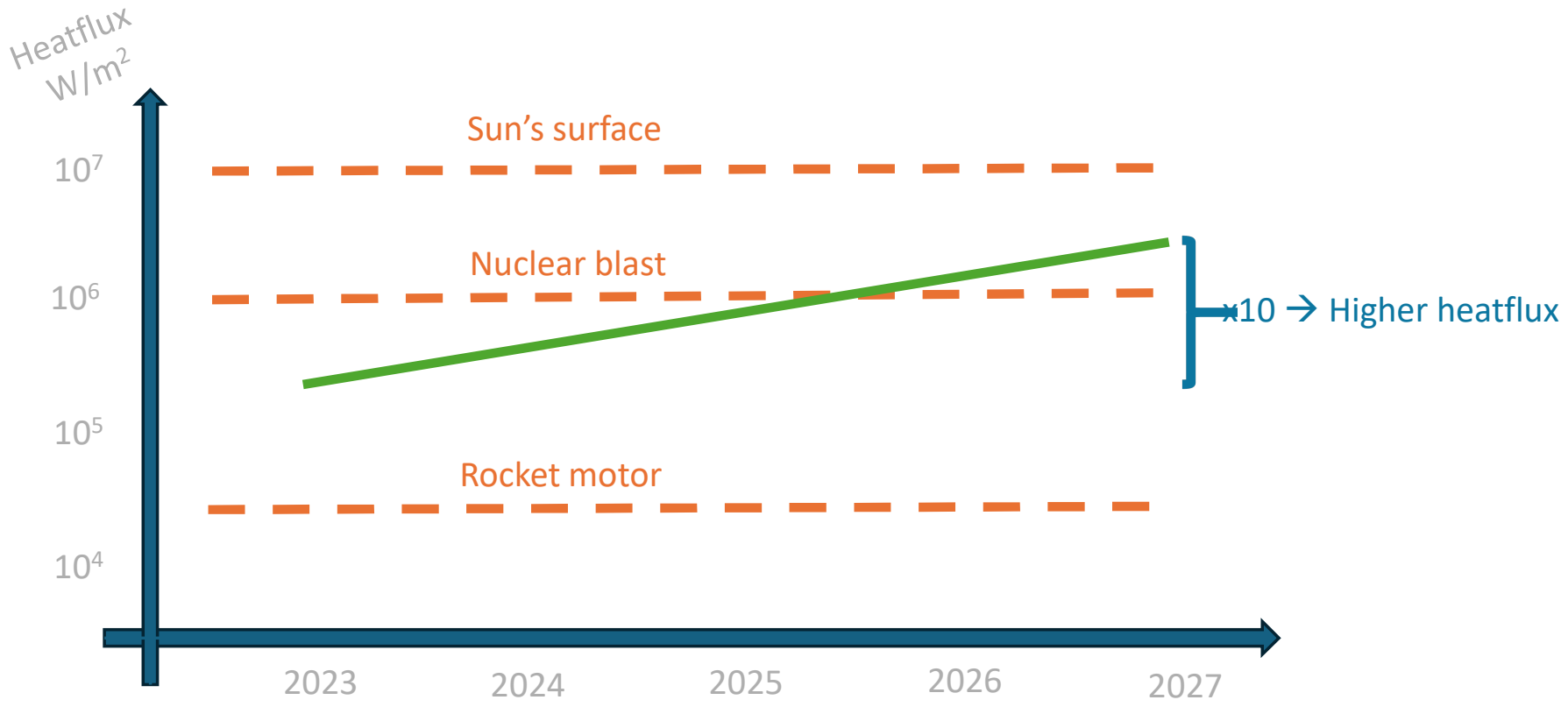
Sources: GTC 2025 Keynote, Jensen Huang, Founder and CEO, NVIDIA, 2025

Development of power in Nvidia GPUs



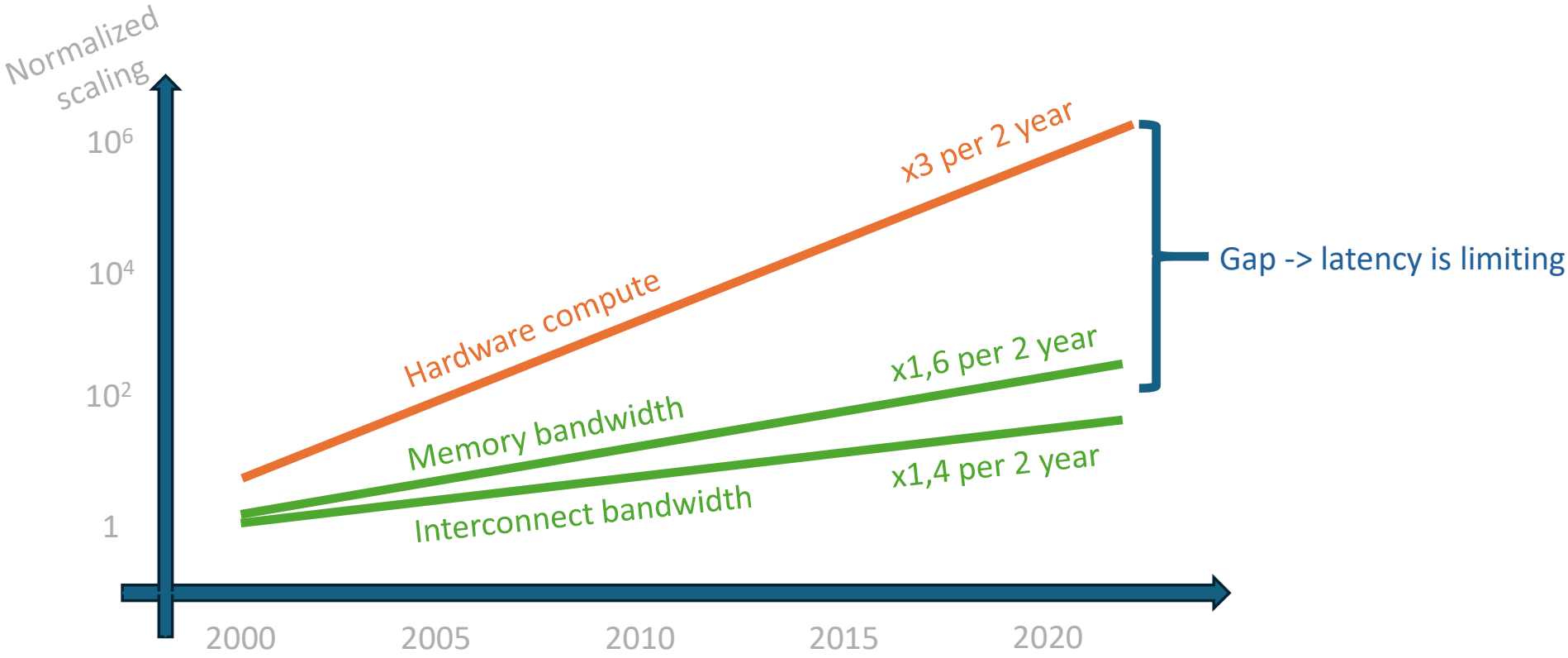
Sources: GTC 2025 Keynote, Jensen Huang, Founder and CEO, NVIDIA, 2025

CPU/GPU heat flux (power per area)



Sources: Oktay, Sevgin, Robert Hannemann, and Avram Bar-Cohen. "High heat from a small package." *Mech. Eng.;(United States)* 108, no. 3 (1986).

Improvement of Memory and Interconnect bandwidths



Sources: AI and Memory Wall, Amir Gholami, Rise Lab, Mar 29, 2021

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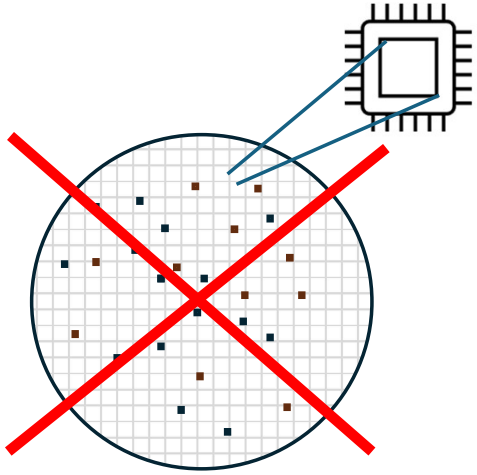
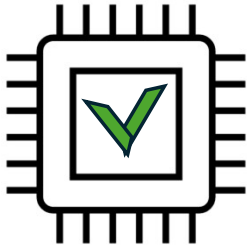
Chip design is limited by the physics



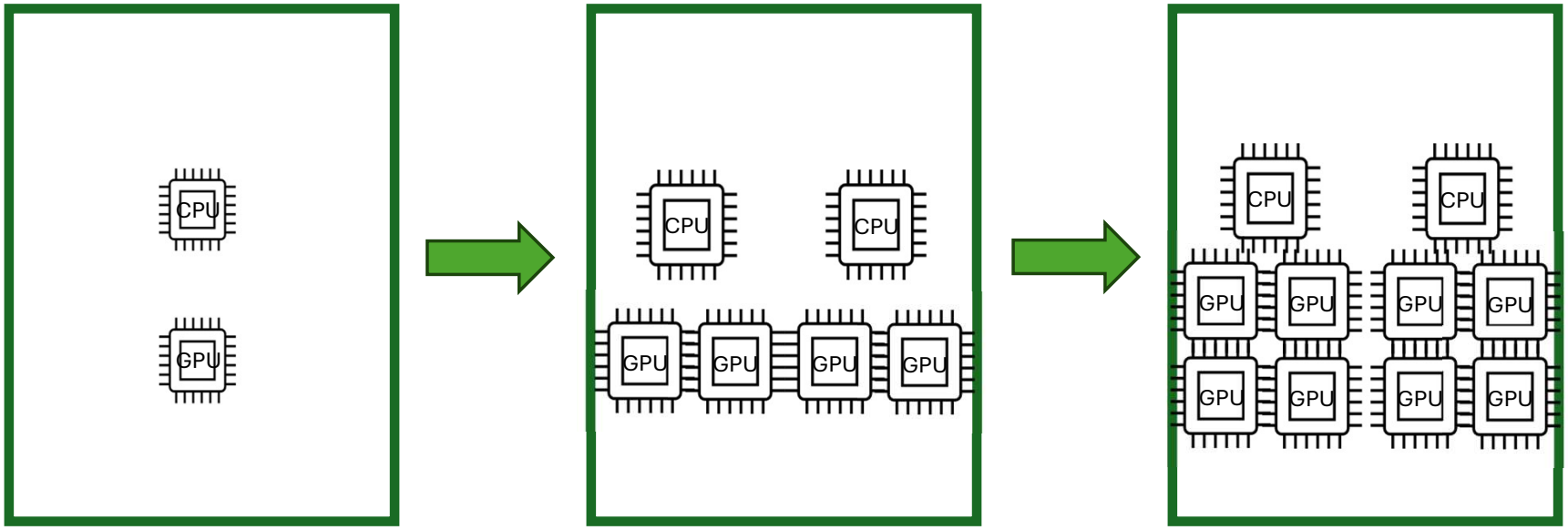


Utopia: One super chip
+ Could enable fast RAM/COM
- Faulty parts of the silicon
- Difficult to power and cool
- Difficult to package

Solution: Several large chips
- Need fast communication
+ Possible to make fault-free
+ Possible to power and cool
+ Possible to package

Sources: GTC 2025 Keynote, Jensen Huang, Founder and CEO, NVIDIA, 2025

Increased density in rack & server design



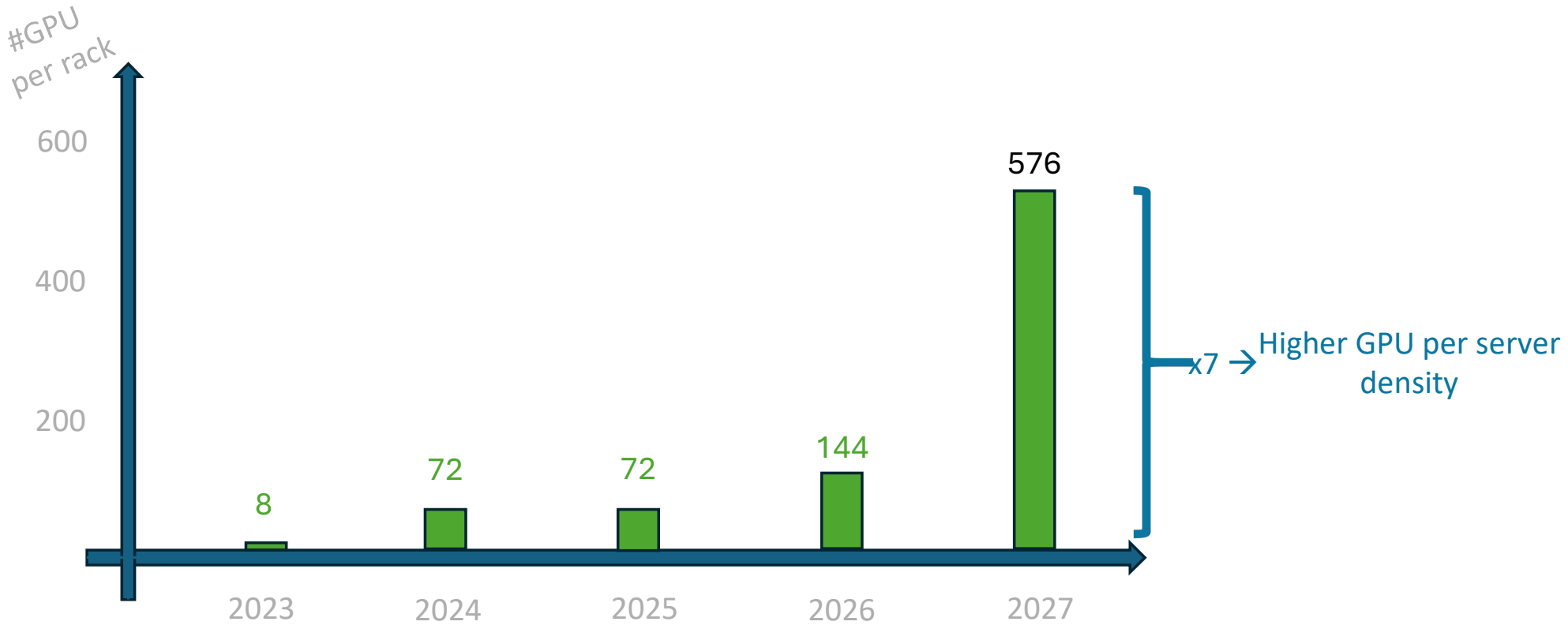
Old server

Server now

Future server

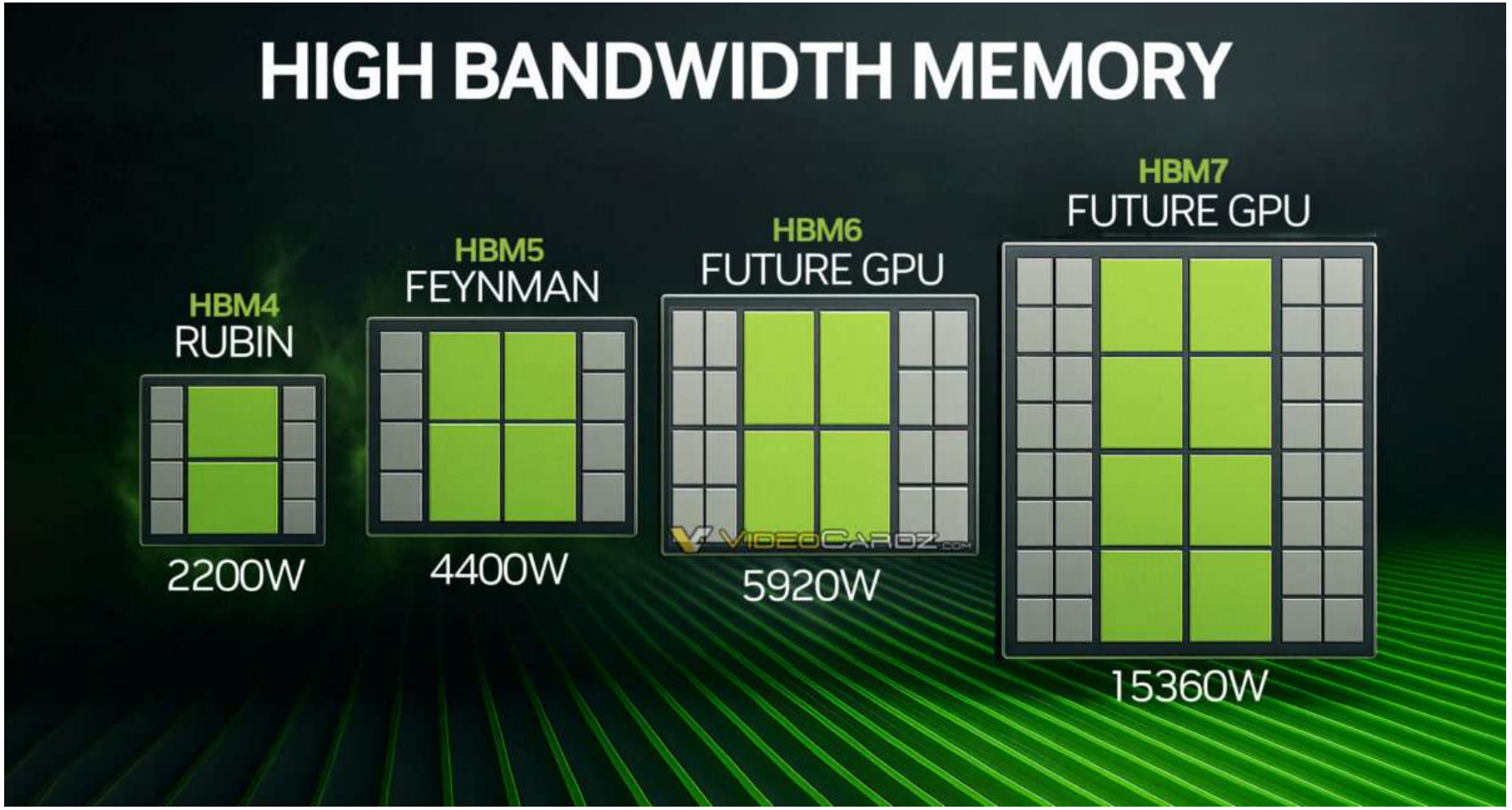
Sources: GTC 2025 Keynote, Jensen Huang, Founder and CEO, NVIDIA, 2025

Development of number of Nvidia GPUs in one rack



Sources: GTC 2025 Keynote, Jensen Huang, Founder and CEO, NVIDIA, 2025

Development of power for Nvidia GPUs



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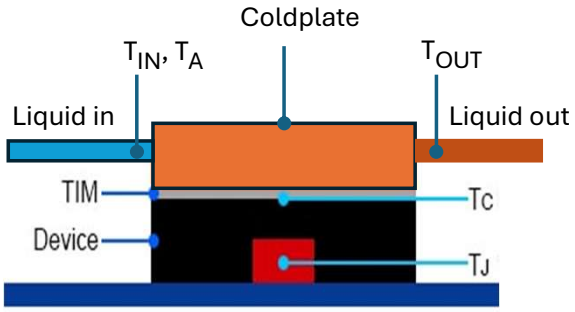
How will a 1 bragawatt rack look like?

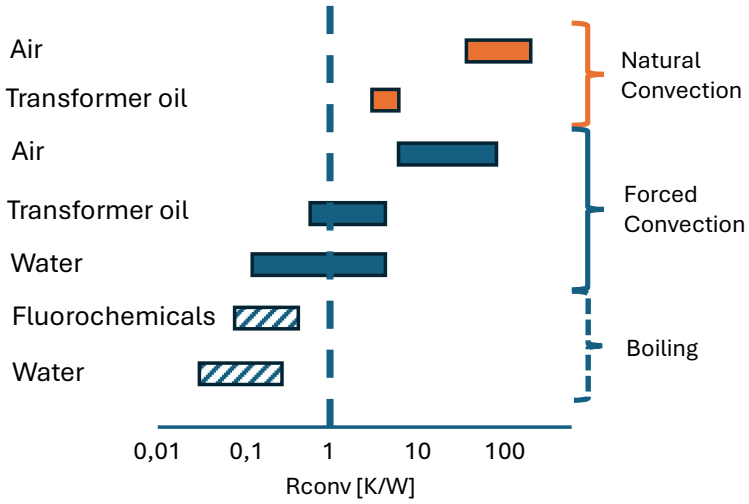
1 MW/rack, 1 MW CDU, 1 MW UPS

Challenges with higher heatflux

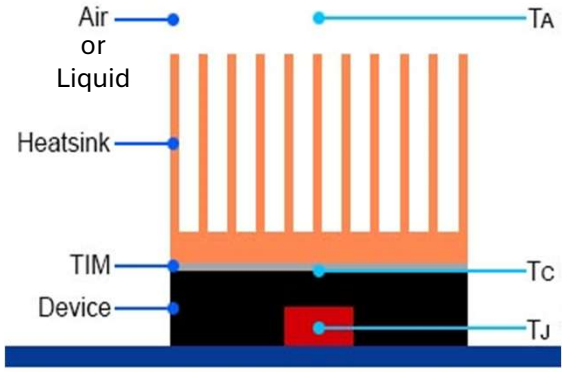


T_{IN}, T_A = Ambient temperature
T_C = Case temperature
T_J = Junction temperature
TIM = Thermal Interface Material

On-chip



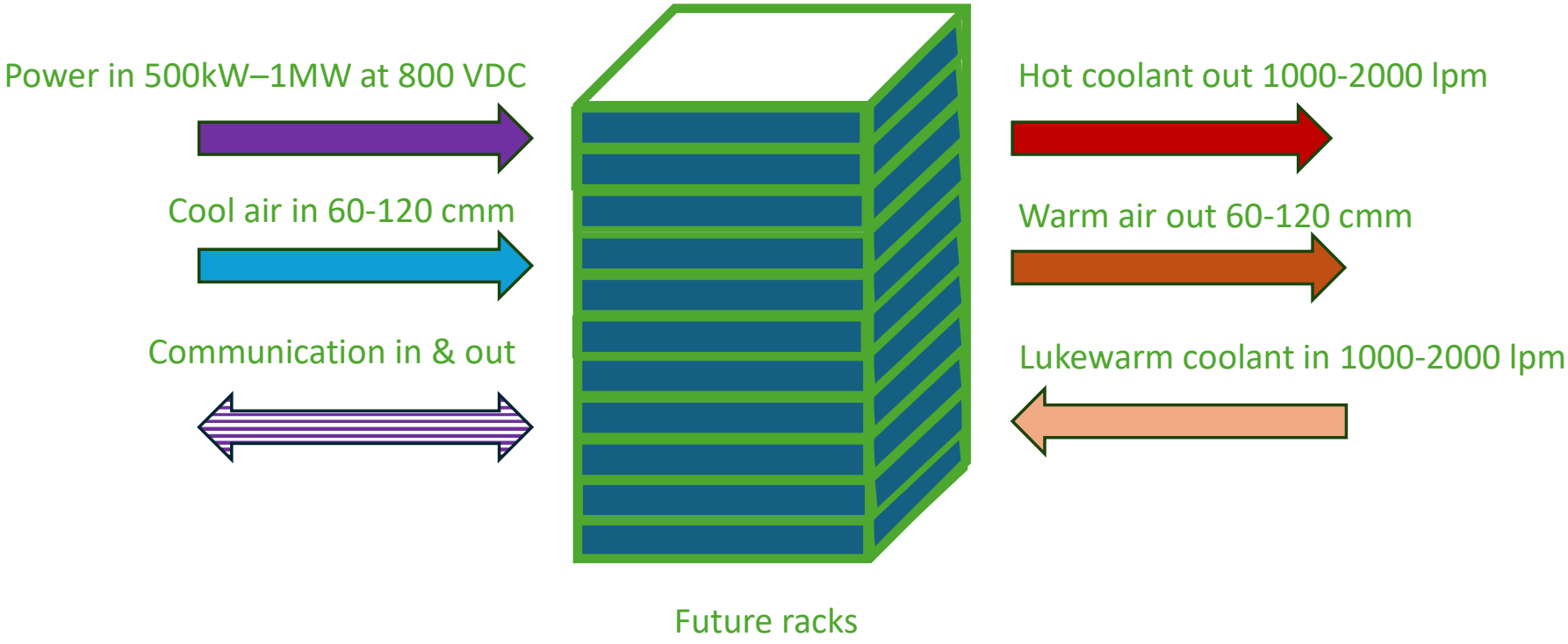
Server now



Immersion

Sources: Ahmed El-Neama based on Tummala, R.R. 2001. Fundamentals of Microsystems Packaging. McGraw-Hill.

Challenges with higher GPU density per rack



Sources: RISE 2025

Sustainable Data Centres: Powering Digital Growth Responsibly

Core pillars for a sustainable data center

Energy Efficiency

Optimized cooling, server utilization, and power management. Real-time monitoring, and transparent reporting that enables continuous efficiency improvements and accountability.

Powered by Renewables

Transition to 100% clean energy through solar, wind, and hydroelectric sources with battery storage for grid independence.

Circular Design

Reuse, repair, and recycle IT and building materials. Equipment refurbishment, component harvesting, and responsible e-waste management extend lifecycle and reduce material demand.

Water-Wise Operations

Closed-loop cooling systems, rainwater harvesting, and greywater recycling minimise freshwater withdrawal and wastewater discharge.

Heat res-use and grid flexibility

Re-use of excess heat in community heating, industry processes, farming or on-site to improve other metrics as well as supporting the grid with frequency stabilization.

Sources: RISE 2025

Needed development in the industry

- Power Distribution
  The entire power delivery chain—from high-voltage input to rack-level busbars—must be redesigned to minimize energy losses and maximize flexibility in handling dynamic loads.
- Energy Storage
  Emerging technologies such as supercapacitors, hydrogen fuel systems, and advanced battery chemistries should be considered to manage power spikes, enhance sustainability, and support grid flexibility.
- Power Electronics
  Efficient and reliable power conversion is essential from rack-level distribution down to the chip, requiring innovations in voltage regulation and energy management.
- Coolant Distribution
  Liquid cooling systems must be optimized for low-loss thermal transport and balanced flow across the facility to ensure consistent and efficient heat removal.
- Chip Heat Transfer
  Minimizing thermal resistance in the cooling loop—from the chip to the first heat exchanger—is critical. This includes optimizing thermal interface materials (TIM), cold plates, liquid flow, pumps, valves, and manifolds.
- Hybrid Cooling Design
  Future racks will require hybrid cooling approaches, combining liquid cooling for high-performance GPUs with air cooling for supporting electronics to maintain overall system efficiency.
- Heat Rejection – re-use
  Heat rejection systems must operate efficiently at the highest possible temperatures and adapt to diverse climate conditions to ensure sustainable thermal management.
- Sustainability – Life cycle assessment
  The complete data center including IT server needs to be properly understood regarding long-term sustainability, renewables and the 9R, Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle and Recover.

Sources: RISE 2025

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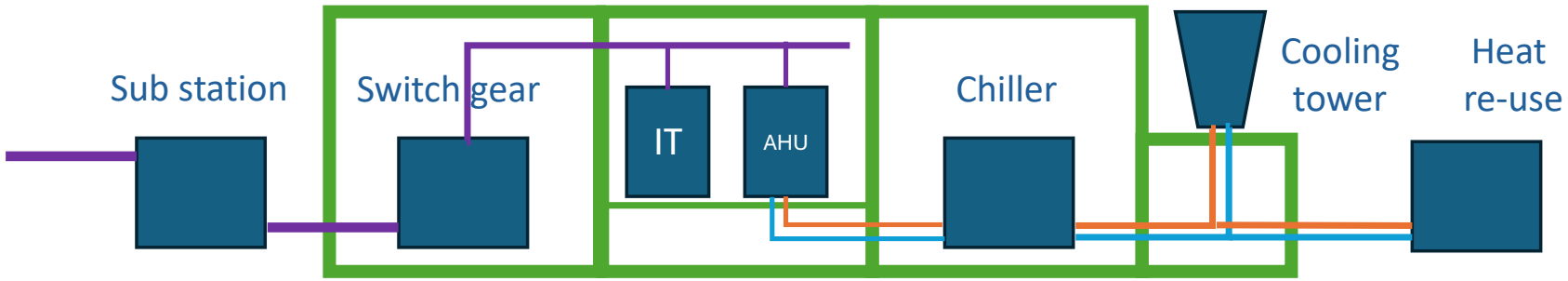
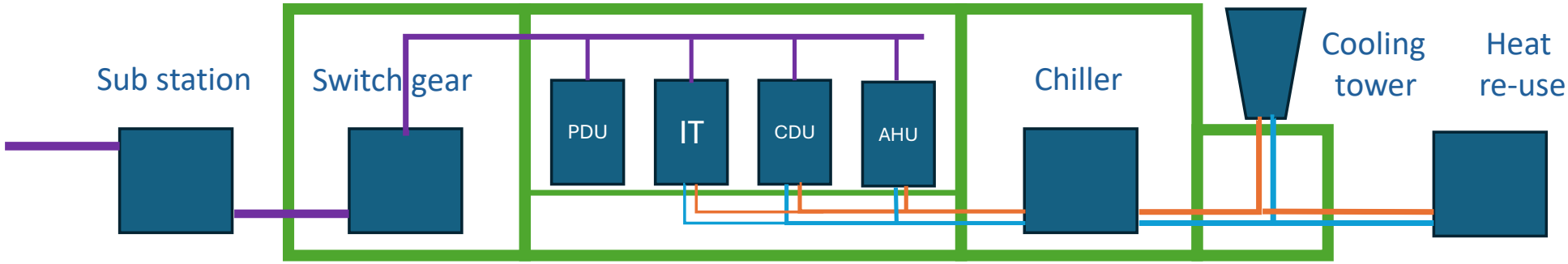
Simplified infrastructure

100 MW Air cooled DC



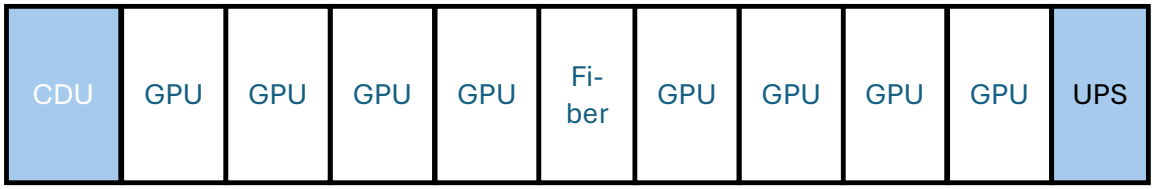
1 GW Liquid cooled DC



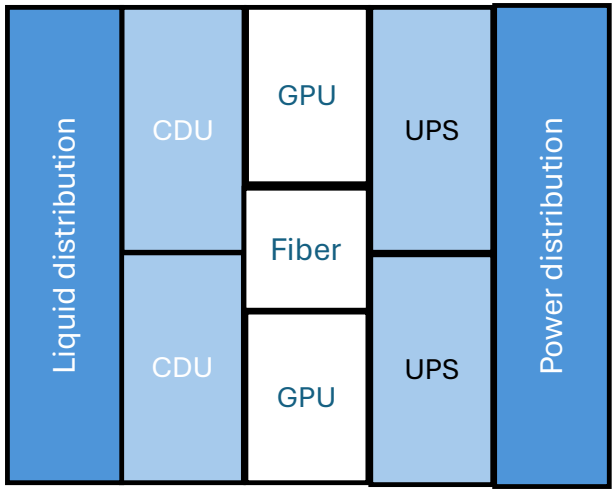
Sources: RISE 2025

How will it look like?

25 kW/rack (HPC supercomputer)

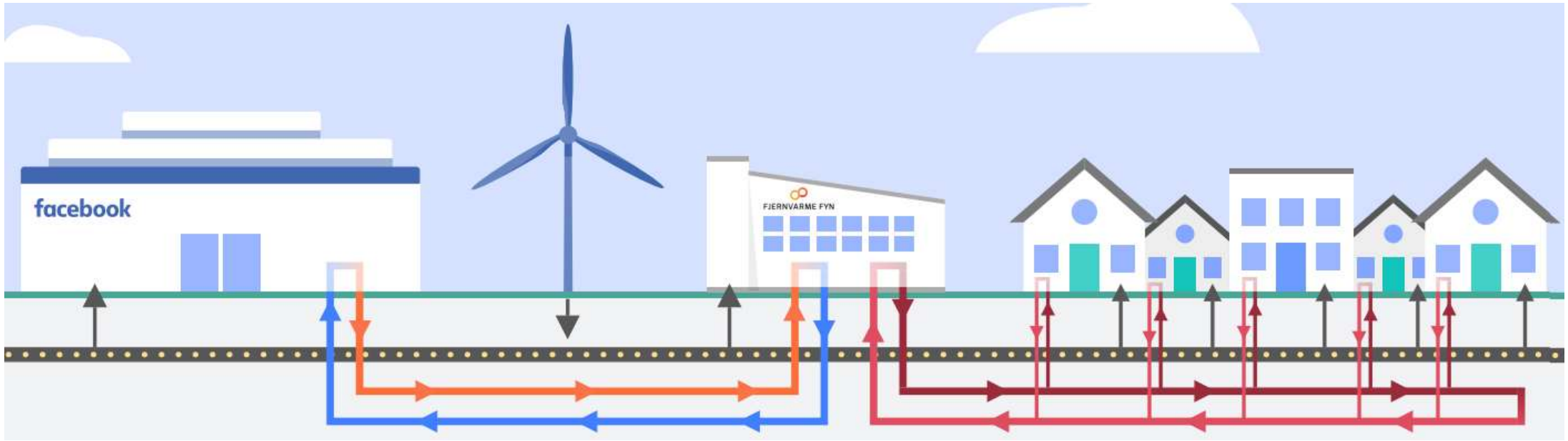


1 MW/rack



Heat reuse from data centers.

Heat pumps are commonly used to upgrade the low-grade heat from the data center, but could it be used elsewhere?



Source:https://sustainability.fb.com/

DC excess heat – Greenhouse

Medium-Scale Data Center

Power Capacity: 1 MW
Type of Farming Facility: Modular Container/ Greenhouse structure
Full capacity of Farming surface: 2400-5000 m2
Inspiration: Team design
Vision picture DC-GH: BTDC

Investment

200 000
to
900 000 €
Establishment cost

Business model

3-5 Farmers
Community/ Sharing/
Independent/
Middle-hand model

Greenhouse

(3000 m2)
Even or
Uneven heat dist.

DC 1 MW

x 410

1734 ton **CO2**eq/year

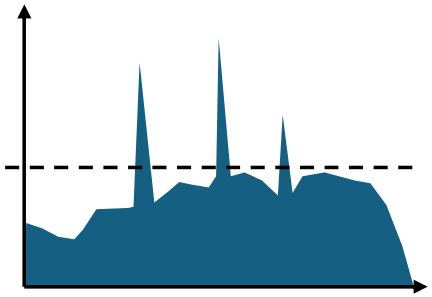
3185 Tons
Peat

x 1

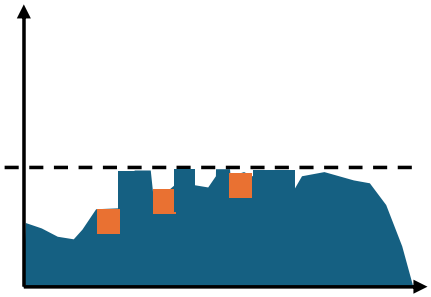
2293 ton**CO2**eq/year

Sources: RISE 2020

Electrical grid integration

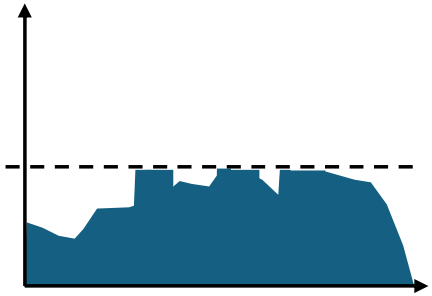


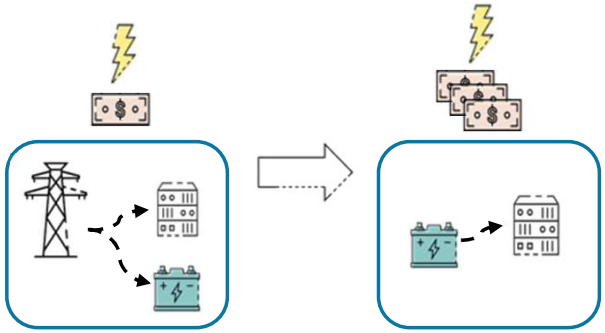
Peak shaving

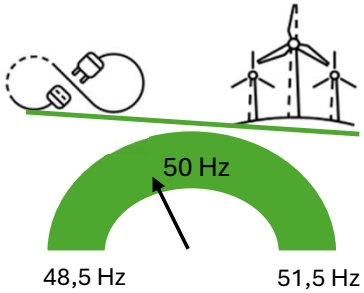


Energy arbitrage

Ancillary services

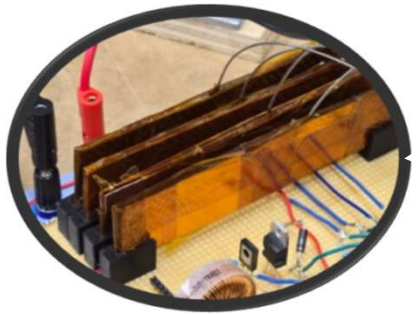


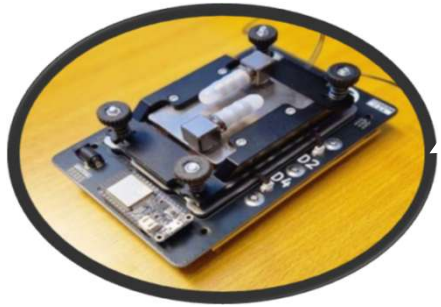


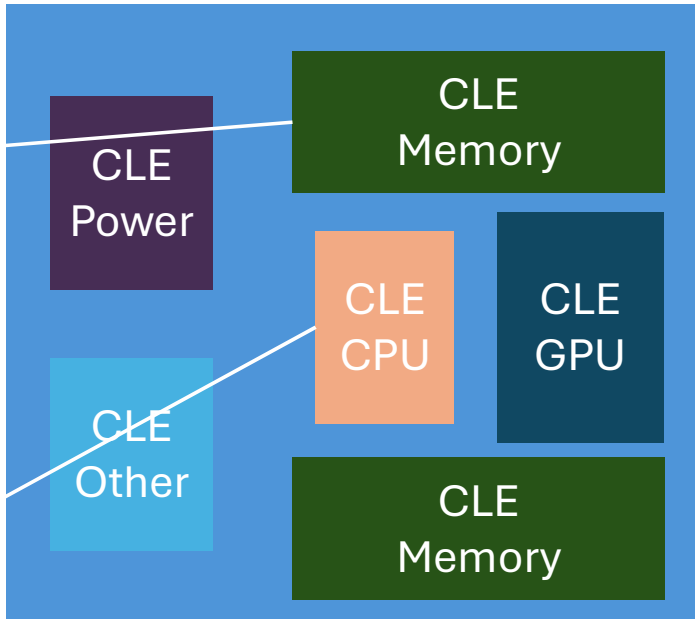


Sources: RISE 2023

What if we can use a Server Emulator?







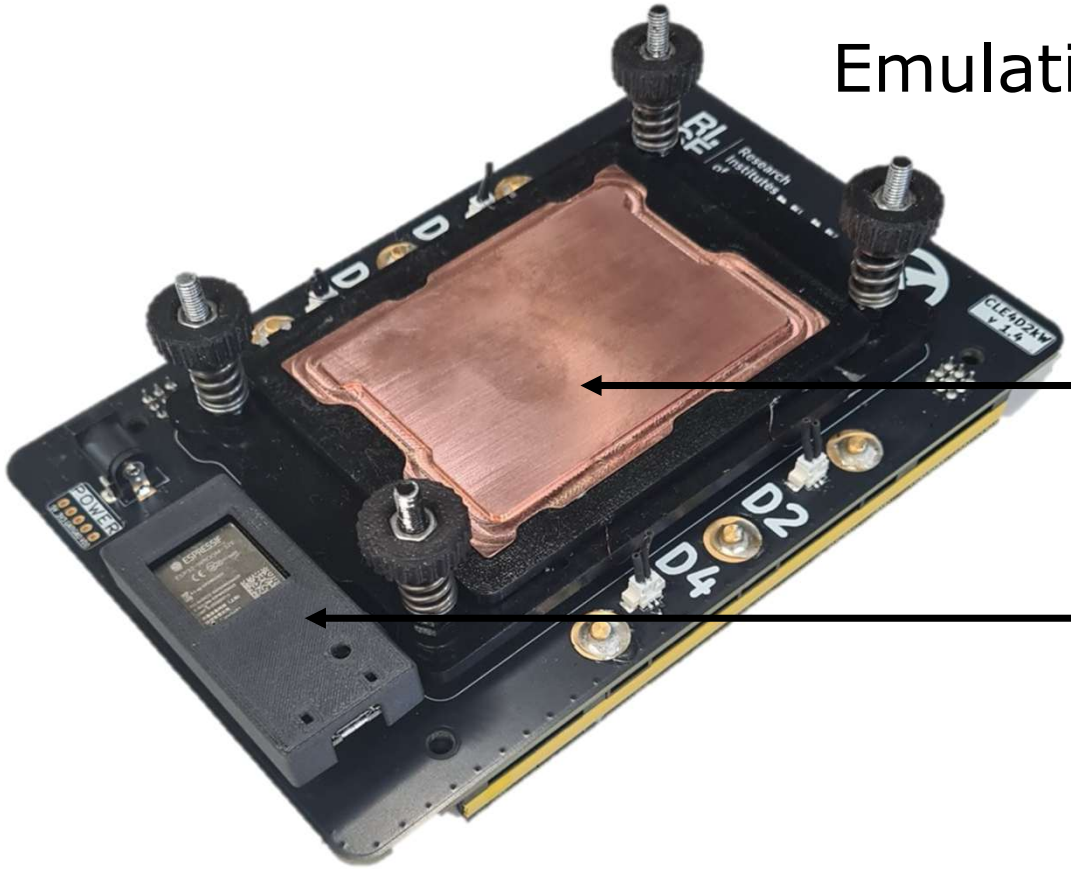
- Look like a server
- Accurately emulating real chip
- High Power Density
- Compatible with different cooling technologies
- Modular server design
- Can meet future standards

A server emulator consists of one or more CLE, Chip Load Emulators

Sources: RISE 2025

RISE Chip Load Emulator single unit

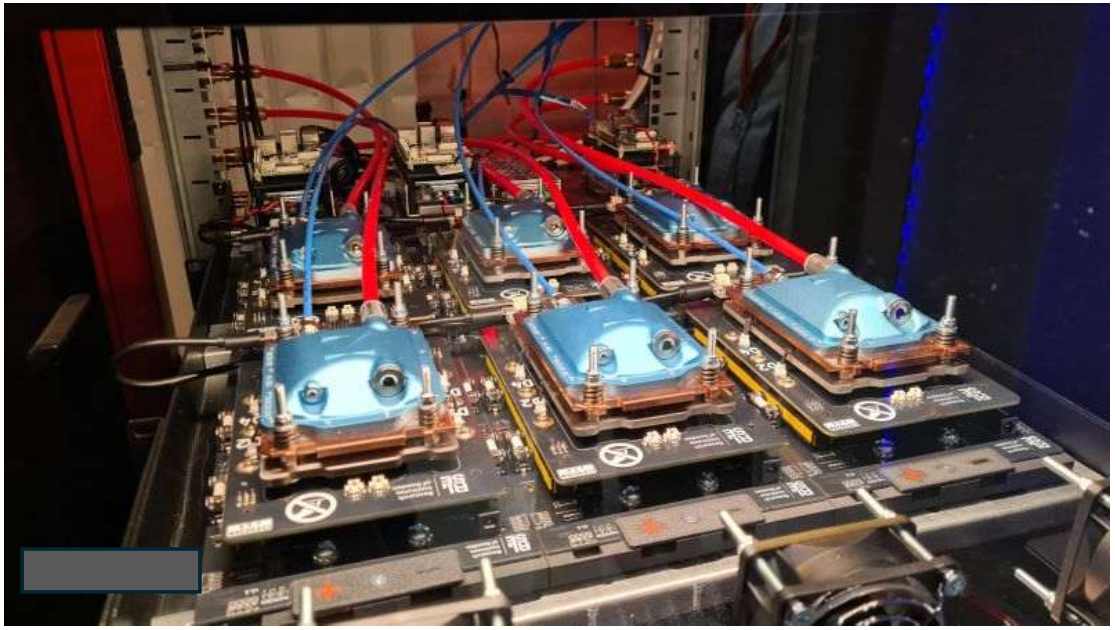
Emulating LGA4677-1 Sapphire Rapids



- Power (0-2000W)
- Temperature (0-100°C)
- Integrated control
- Built in safety features

Sources: RISE 2025

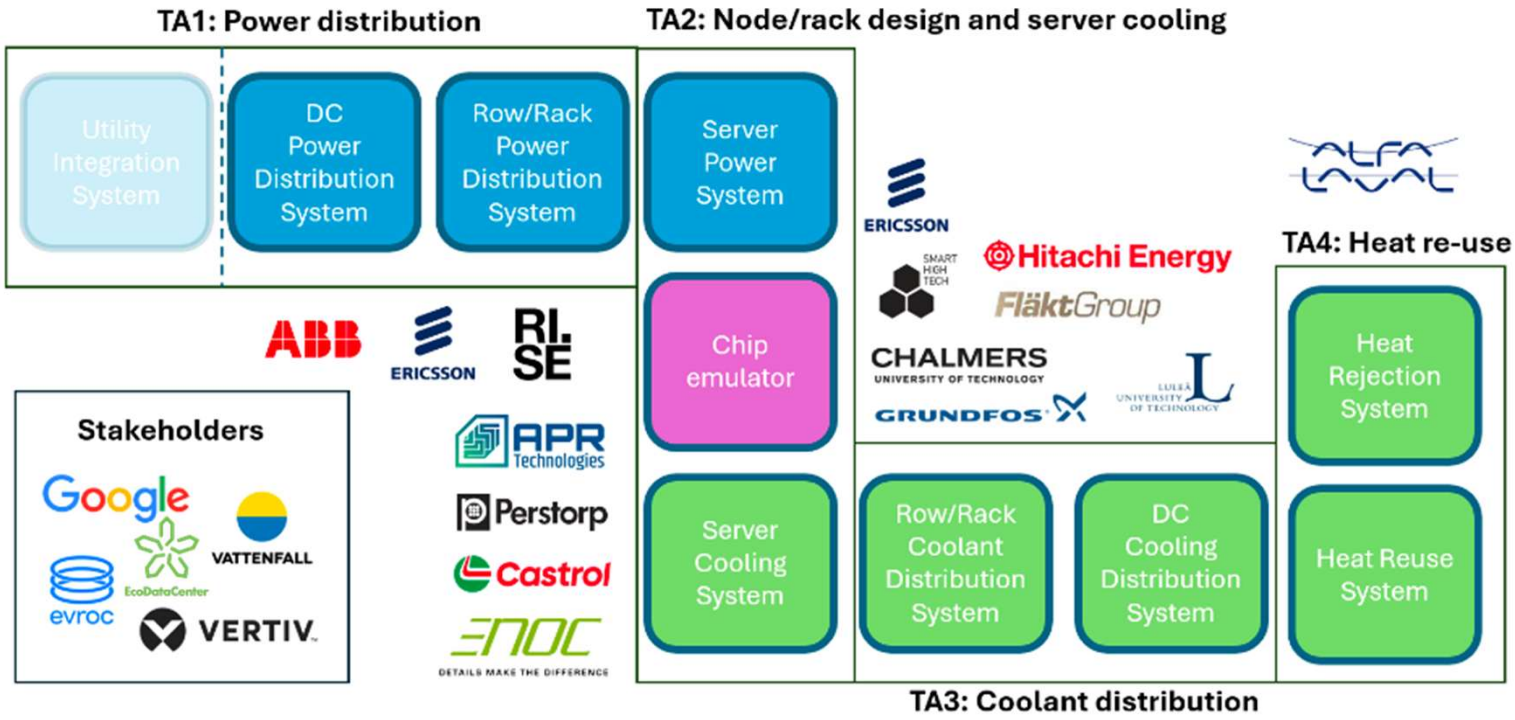
RISE 2U Server Emulator single unit



- Power (0-12000W)
- Temperature (0-100°C)
- Integrated control
- Monitoring of CLEs

Sources: RISE 2025

The H-DINI project



Goals

- *The project goal is to develop technologies and systems for power-dense AI compute with efficient power delivery and thermal performance.*
- *Demonstrate system solutions for selected technology areas*
- *Total budget €6M*

Sources: RISE 2025

Conclusions

- Demanding AI applications require more energy and most of the energy become excess heat.
- New micro processors and algorithms improve performance and energy efficiency.
- The new micro processors will have heat fluxes like nuclear reactors that requires liquid cooling.
- Sustainable data centers are energy efficient, use renewable energy, have circular design, use water wisely and interact with the energy grids (electricity & heat)
- Europe has a strong facility industry that needs some love

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