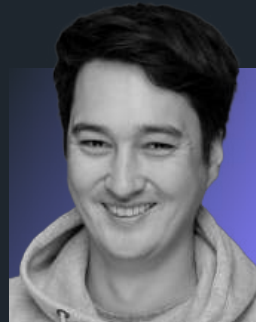# Energy efficiency in data centers

measured, not guessed!

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Professor
SDEA

Martin Hirschvogel
CPO
Checkmk GmbH

Babak Falsafi
President, Professor & CEO

- **President** of the Swiss Datacenter Efficiency Association (SDEA)

- **Professor** in the School of Computer and Communication Sciences at EPFL Lausanne (Switzerland)

- **Founding Director** of EcoCloud, an industrial/academic consortium investigating sustainable cloud and datacenter technologies

- **CEO** at CodeDepot, a startup enabling organizations to accelerate AI deployment with a Git-native platform

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DATACENTERS ARE
BOOMING

GLOBAL MARKET GROWTH

[Technavio]

3x

$247 B — 2017

$732 B — 2027

- **14.2% CAGR** of global colocation DC market from 2022–2030

- **34% CAGR** of global hyperscale DC market from 2021–2030

- **55% increase** in DC power consumption from 2022 to 2023
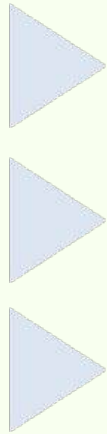
DATACENTERS ARE
EVERYWHERE

EDGE CLOUD

ENTERPRISE CLOUD

PUBLIC CLOUD

Users & Devices

[Src: Peterson, et. al.]

Fast Decision Making /
Digital Sovereignty

Long-Term Analytics
Global Data

DATACENTERS ARE
BOOSTED BY TRENDS

PROLIFERATION OF AI

- 6x / year compute density growth
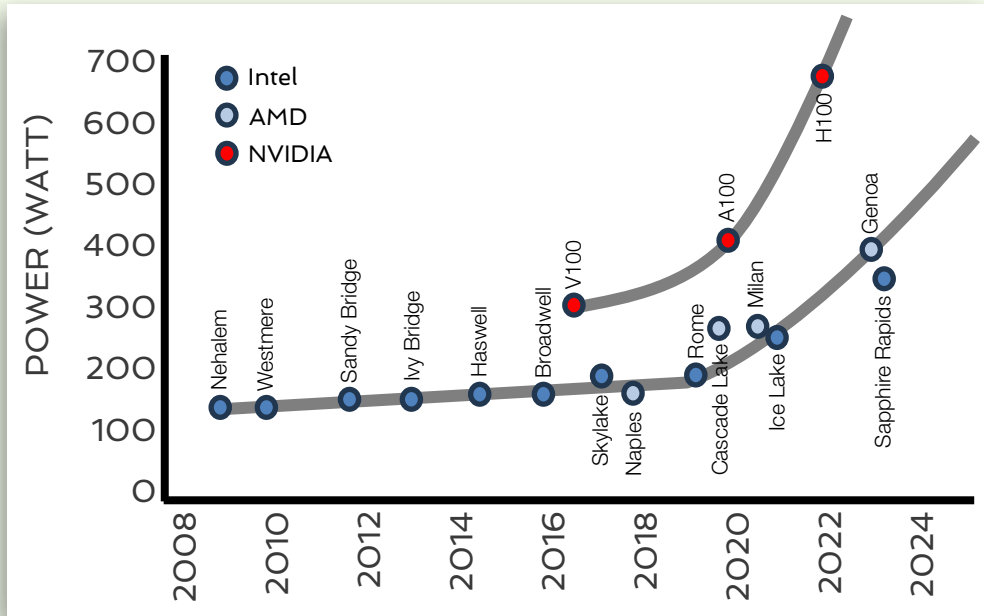- 30% CAGR in AI power consumption from 2024-2028

ARRIVAL OF EDGE CLOUDS

- IoT streaming data over 5G
- 22% CAGR in Edge DC market from 2021-2026

DATACENTER ARE
ENERGY HOGS

CLOUD & AI SERVER CHIPS

END OF MOORE'S LAW

- Five decades of doubling density

- Silicon now at limits of physics

IT POWER SHOOTING UP

- Larger chips, higher clocks

- Building more servers
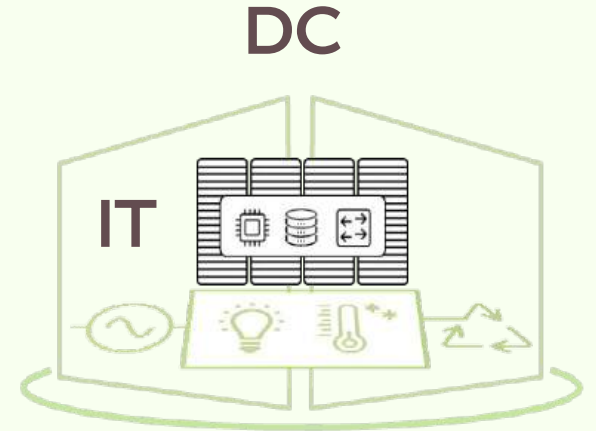
- Energy is shifting to IT

TODAY'S EFFICIENCY METRIC
POWER USAGE EFFECTIVENESS (PUE)

$$\text{PUE} = \frac{\text{Total DC Power}}{\text{IT Power}}$$

DC

IT

➢ PUE has been around for two decades

LIMITS OF PUE
WHY TODAY'S EFFICIENCY METRIC IS OUTDATED

⚠️ **PUE** DOESN'T MEASURE IT EFFICIENCY
Inefficient or underutilized servers make PUE look good

⚠️ **PUE** SHOWS NO END-TO-END ENERGY FLOW
Ignores heat recovery or on-premises renewables
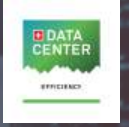
⚠️ **PUE** DOESN'T MEASURE CARBON FOOTPRINT
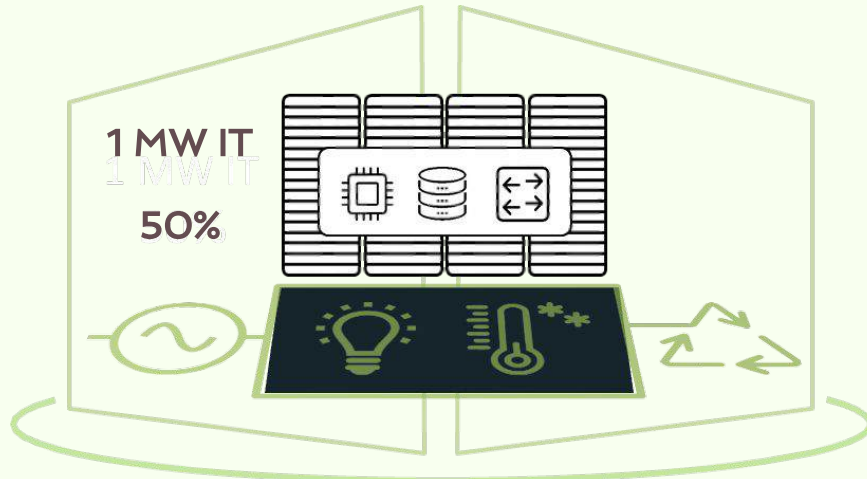PUE is just ingress electricity – ignores the source and CO_2

LIMITS OF PUE
ELECTRICITY GOES TO IT

2 MW DC in 2010

20 MW DC in 2020

1 MW IT

50%

16 MW IT

83%

PUE = 2.0
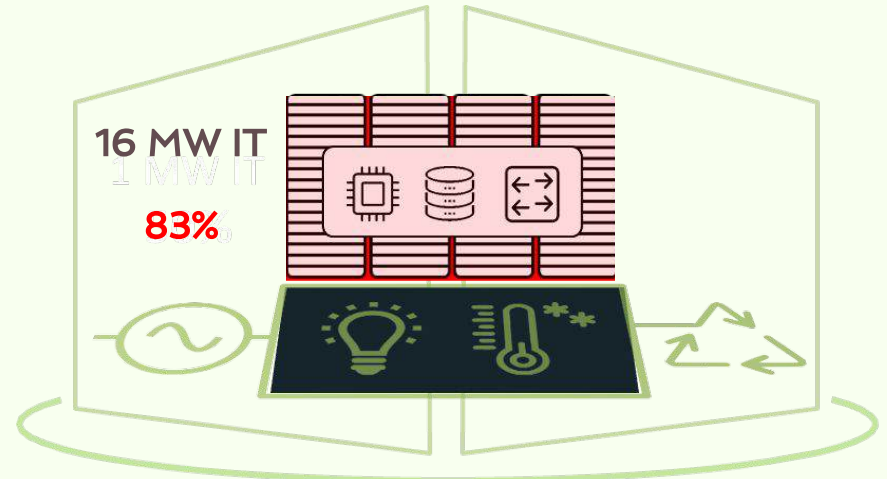
PUE = 1.2

FULL-STACK EFFICIENCY
RELEVANT METRICS

DC EFFICIENCY

IT EFFICIENCY

CO$_2$ FOOTPRINT

Power Usage Effectiveness, enhanced with on-premise renewables and heat recycling

Utilization of IT components (servers, storage, network), technology excellence & operating temperature

Sustainability of the DC's ingress energy sources to calculate the CO$_2$ emissions of the DC operations

SWISS DATACENTER EFFICIENCY ASSOCIATION

SDEA is a consortium of industrial and academic sustainability pioneers, united in crafting a measurable approach to datacenter efficiency and emissions.

The goal was to introduce a first-of-its-kind datacenter efficiency label to decarbonize datacenters and significantly reduce their overall energy consumption.

info@sdea.ch | sdea.ch

WHO WE ARE

asut

EcoCloud

Hewlett Packard Enterprise

Lucerne University of
Applied Sciences and Arts
HOCHSCHULE LUZERN

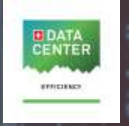SWISS DATACENTER ASSOCIATION

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DATA CENTER EFFICIENCY

How to measure IT efficiency?
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Monitor

Customize

Setup

Help

Commands | Hosts | Export | Display | Help

Host	CPU utilization (last 365d)	Memory utilization (last 365d)	CPU cores	Memory installed (
monitoring.lan.tribe29.com	33.53%	35.71 %	4	15.62 GiB
review.lan.tribe29.com	30.34%	60.86 %	8	11.69 GiB
play.checkmk.com	22.52%	22.57 %	2	15.44 GiB
webinar.aws.tribe29.com	18.87%	37.36 %		7.65 GiB
build-fra-003.lan.tribe29.com	16.9%	9.52 %	24	165.99 GiB
lists.checkmk.com	16.88%	52.55 %	2	3.84 GiB
build-fra-001.lan.tribe29.com	16.05%	11.15 %	24	165.76 GiB
build-fra-002.lan.tribe29.com	15.55%	11.54 %	24	165.76 GiB
nyc-fra-001.tribe29.com	15.27%	62.14 %	24	293.51 GiB
		55.94 %	24	293.49 GiB
		75.36 %	4	5.79 GiB
language.lan.tribe29.com	14.19%	77.78 %	24	4 GiB

Historical efficiency calculation
Based on 365 day averages

10

Off-the-shelf analysis for …

Key metrics

Current scope
- CPU
- Memory
- Filesystems for directly attached storage

IT infrastructure

Scope
- Virtualization nodes
- Bare-metal servers

Built-in calculation
- Nutanix
- vSphere
- Linux, Windows for bare-metal + virtualization host OS

Easily extensible: Built using 'Metrics History' function

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Note: 365 day averaging is computation intensive. Focus is compute infrastructure, e.g. hypervisor nodes. Not VMs. Use filters to limit calculation to only the relevant pieces for Linux/Windows thus.

Data Center Efficiency Calculator

Drop files here or click to upload

2/8 file(s) selected

File details

File name	Type	Rows Total	Invalid	
it_efficiency_servers_cpumem_linux-2024-05-29_08-59-46.csv	Lin/Win(CPU,MEM)	98	0	🗑
it_efficiency_servers_cpumem_esxi-2024-04-02_11-08-01.csv	ESXi(CPU,MEM)	22	0	🗑

Results

	Unweighted	Weighted
Memory utilization	34.93%	39.31%
Number of hosts	120	120
CPU utilization	6.69%	7.01%
Number of hosts	120	120

Overall IT efficiency
Combine multiple sources

How to get certified for IT efficiency?

Data collection	Data clean-up (optional)	IT efficiency calculation	Navigator & Label
➜ Built-in Checkmk ➜ For all major systems ➜ Easily extensible & customizable ➜ Export to .csv	Exclude irrelevant data points (if not done in data collection)	Import multiple .csv exports for overall efficiency calculation	
Checkmk	**Any text editor**	checkmk.com/measure-your-it	**SDEA**

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SDEA NAVIGATOR

🖥 navigator.sdea.ch | Launch this June

PUE⁺ ITIE CO₂

DC INFRASTRUCTURE ENERGY EFFICIENCY INDEX

IT INFRASTRUCTURE ENERGY EFFICIENCY INDEX

CO₂ EQUIVALENTS FOR ELECTRICITY MIX USED

SDEA LABEL
CERTIFYING DC EFFICIENCY & EMISSIONS

- **UNIQUE**
  Full-stack (w/IT) efficiency & emissions

- **TIMELY**
  Projected DC growth & climate impact

- **COMPREHENSIVE**
  Captures end-to-end DC energy flow

- **COMPLEMENTARY**
  Accepts other certifications & DC flows

- **DISCOUNT FOR CHECKMK CLIENTS**
  - Certification Fee: **WAIVED**
  - 3-Year Label Fee: **30% OFF**

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