Sustainability & AI: Strategies for the Future of Compute and Networking

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BRKGRN-2005

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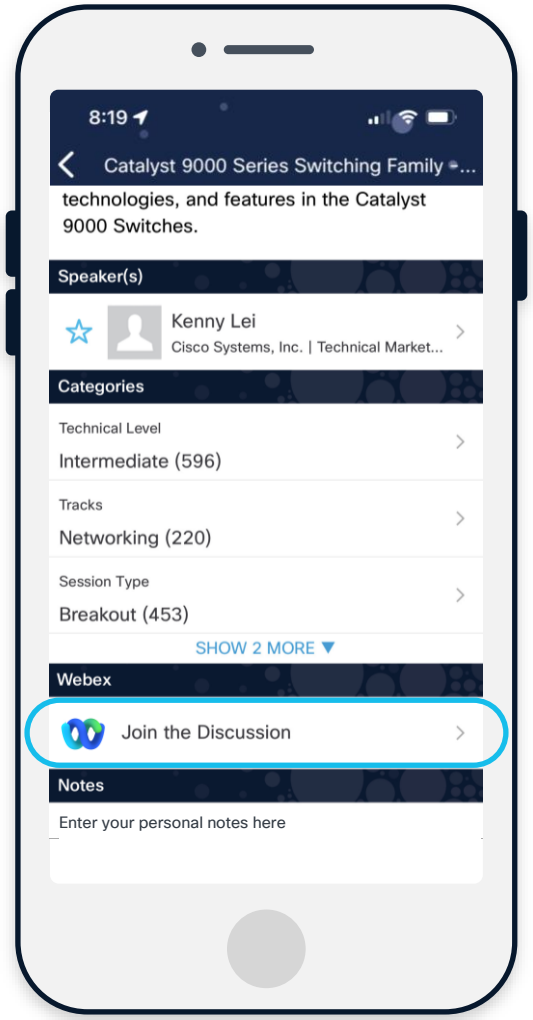


Abstract

When planning a new data center or upgrading an existing one, numerous factors must be considered to advance sustainability and efficiency.

In this session, key considerations such as energy consumption, space utilization, heat generation, CPU core optimization, and advanced cooling strategies for IT equipment will be explored. By leveraging advanced tools, we aim to craft state-of-the-art computing platforms that meet contemporary demands. A real-world case study will illustrate how these strategies have been successfully implemented, providing concrete evidence of their impact on energy efficiency and cost reduction. This session will equip you with practical strategies for improving energy efficiency, optimizing total cost of ownership, and leveraging AI-driven tools to enhance performance.

Join us to gain expert knowledge and actionable insights to stay ahead in the evolving landscape of data center design.

"Sustainability is about balance—whether in nature or in AI infrastructure."

Just like managing a beehive requires optimizing resources for long-term health, we must optimize compute and networking for a more sustainable digital future.

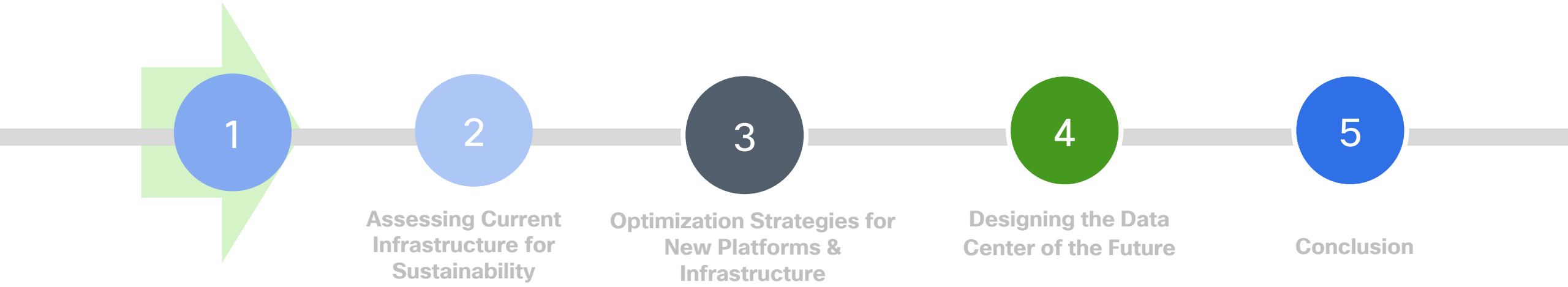
Faisal Azizullah
Principal Architect

"Sustainability isn't just about preserving resources; it's about creating a future where balance, innovation, and care for the planet become second nature."

David Stanford
Senior Director

Our Journey Today

Our Journey Today



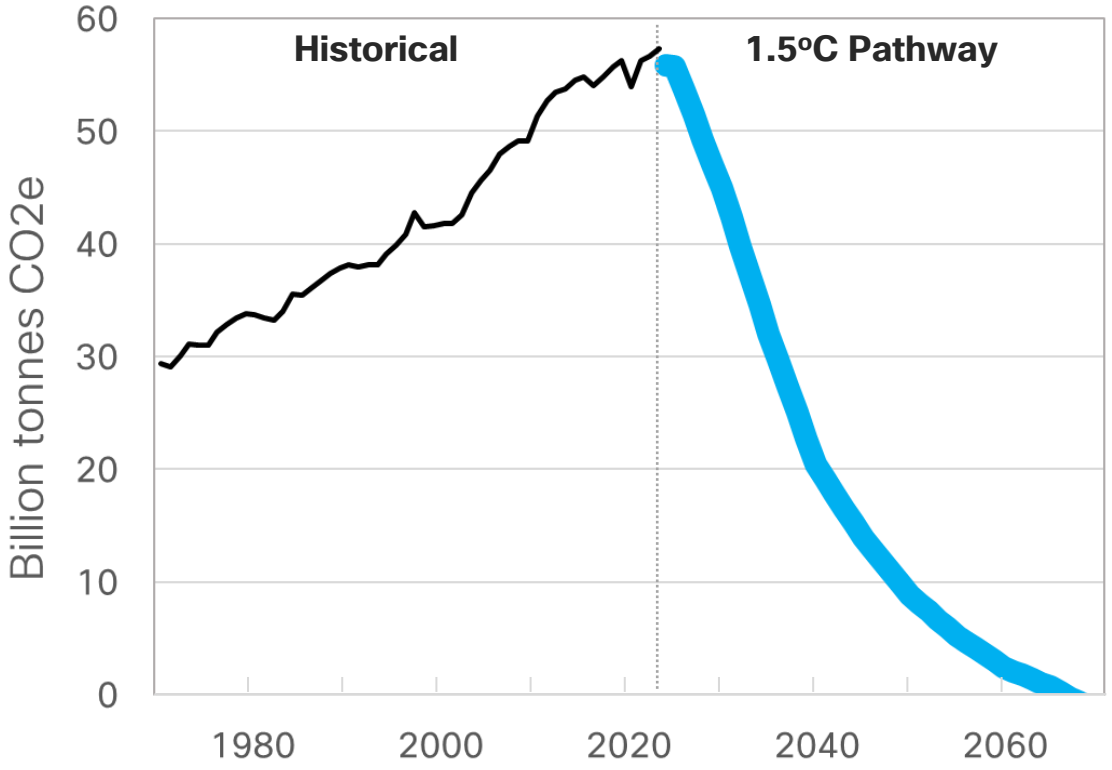
Introduction & Overview:

- Context and relevance of Sustainability & AI
- The Energy Challenge in IT/Data Center
- Objectives and Key Takeaways from the Session

Putting IT in Perspective

Total GHG emissions

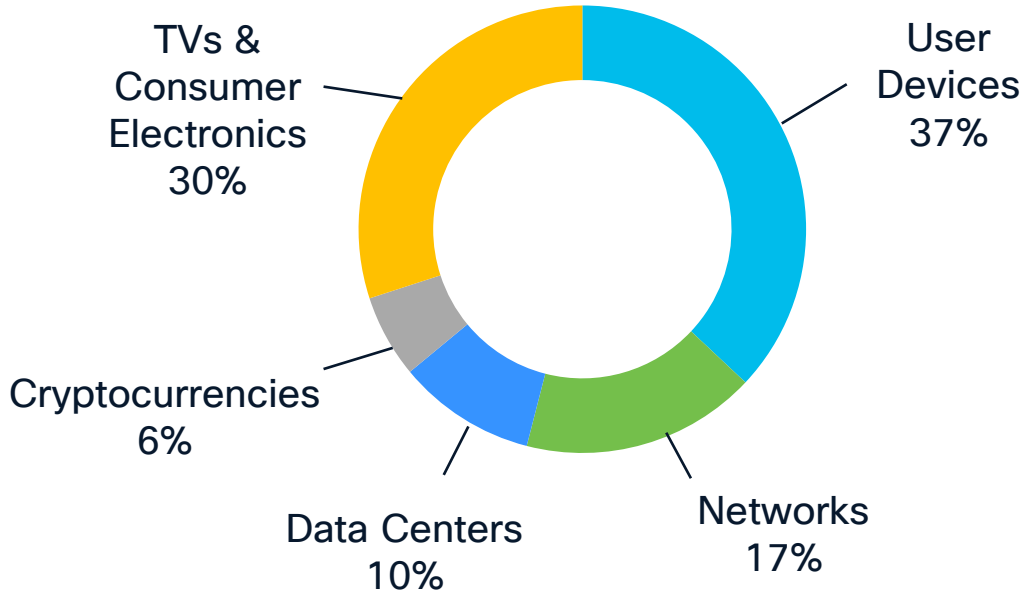
~60 Billion tonnes CO2e



Based on data from: EDGARv2024, Friedlingstein et al. 2023, IIASA (AR6 Scenario database)

Digital GHG emissions

~1.2 Billion tonnes CO2e (~2.1% Total)



Digital = ICT + Entertainment & Media

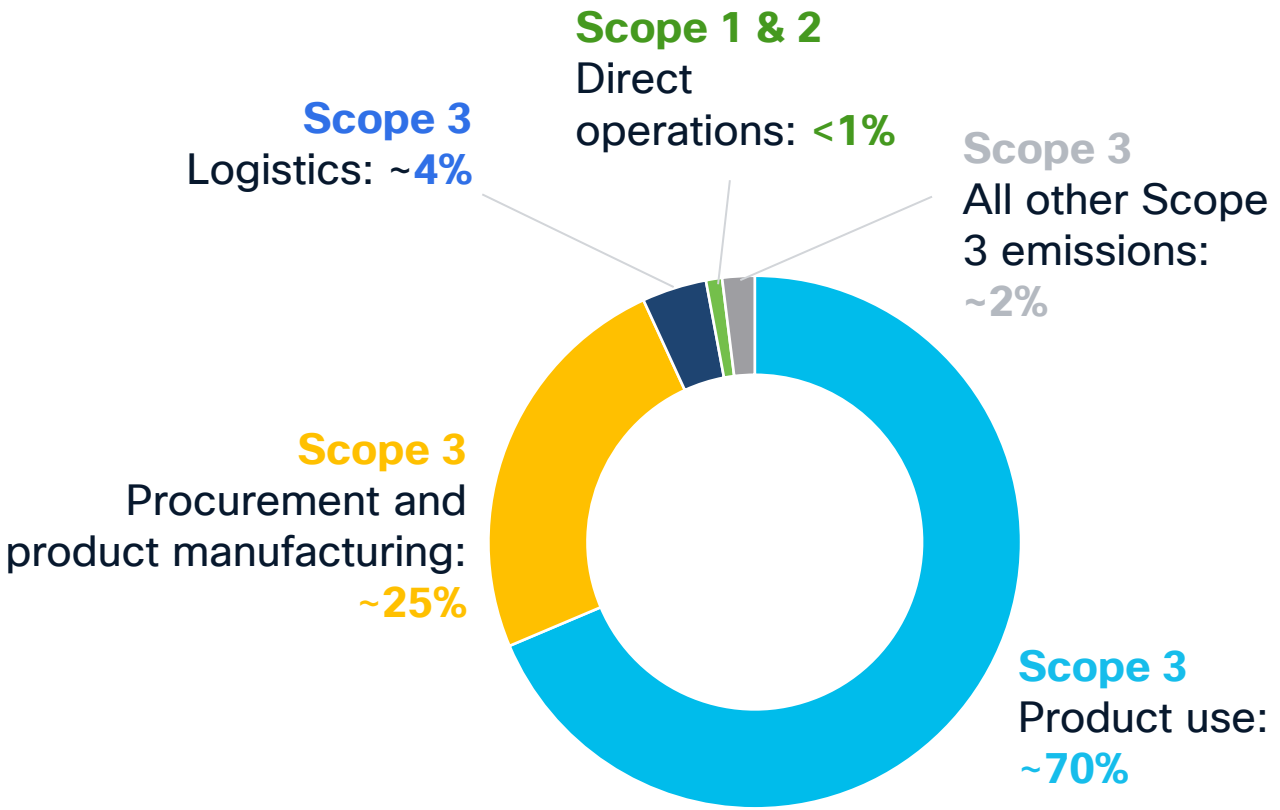
Source: Malmodin et al (2023, 2024)

Cisco's Goal

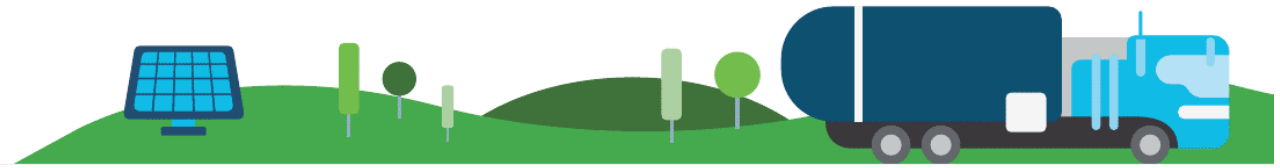
Net zero GHG emissions across our value chain by 2040

Our 2040 net-zero goal, and near-term targets are approved by the Science Based Targets initiative (SBTi).

SCIENCE BASED TARGETS
DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

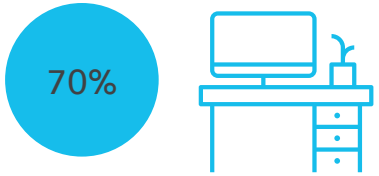


Source: Cisco 2024 Purpose Report



Cisco’s Net Zero Action Plan

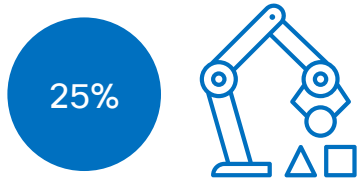
Product Use



Reducing emissions from the use of our products requires collaboration between Cisco and our customers. This means an emphasis on:

- Renewable electricity
- Product power efficiency
- Enhanced product data

Procurement and Product Manufacturing



Tackling emissions in these Scope 3 categories is a shared mission between Cisco and our suppliers. Together we will focus on:

- Renewables and energy efficiency in our supply chain
- Circular business transformation
- Supplier reporting and goal setting

Logistics

Transportation and distribution accounts for ~4% of our overall footprint. To reduce the impact of our logistics we are focusing on:

- Mode shifting
- Packaging
- Renewable and low-carbon fuels

Direct Operations

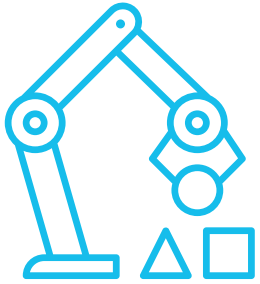
The emissions that arise from our operations are directly in our control. We seek to reduce them through:

- Renewable energy
- Energy management
- Electrification

Scope 3 | Scope 1 & 2

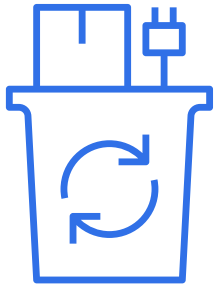
SOURCE: Cisco 2024 Purpose Report. NOTE: Other value chain activities (e.g. waste and business travel) are also accounted for in Scope 3, but do not represent a large share of emissions. Percentages shown may be rounded.

Cisco’s Circular Design Strategy



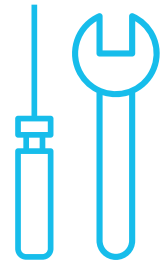
Material use

Standardize and modularize



Packaging and accessories

Smart energy consumption

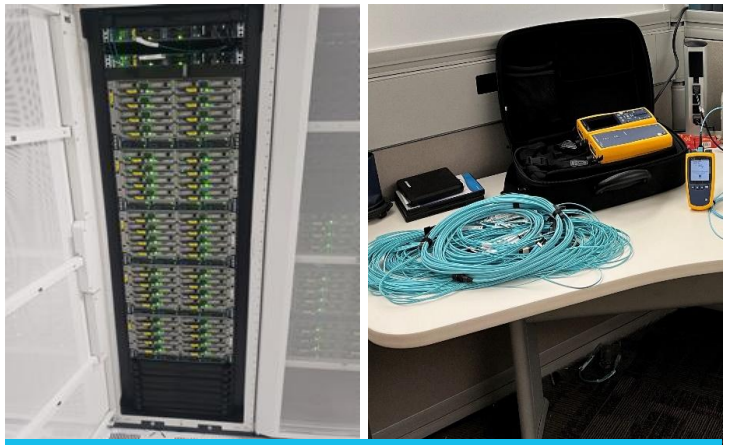


Disassembly, repair and reuse

of new Cisco products and packaging to incorporate Circular Design Principles by 2025

Reuse & Energy Management

Cisco IT Data Center



Reuse

- 90% of patch cables recertified
- 1,813 Cisco UCS servers sent to Cisco Refresh for reuse in 2021/22

Clean Energy

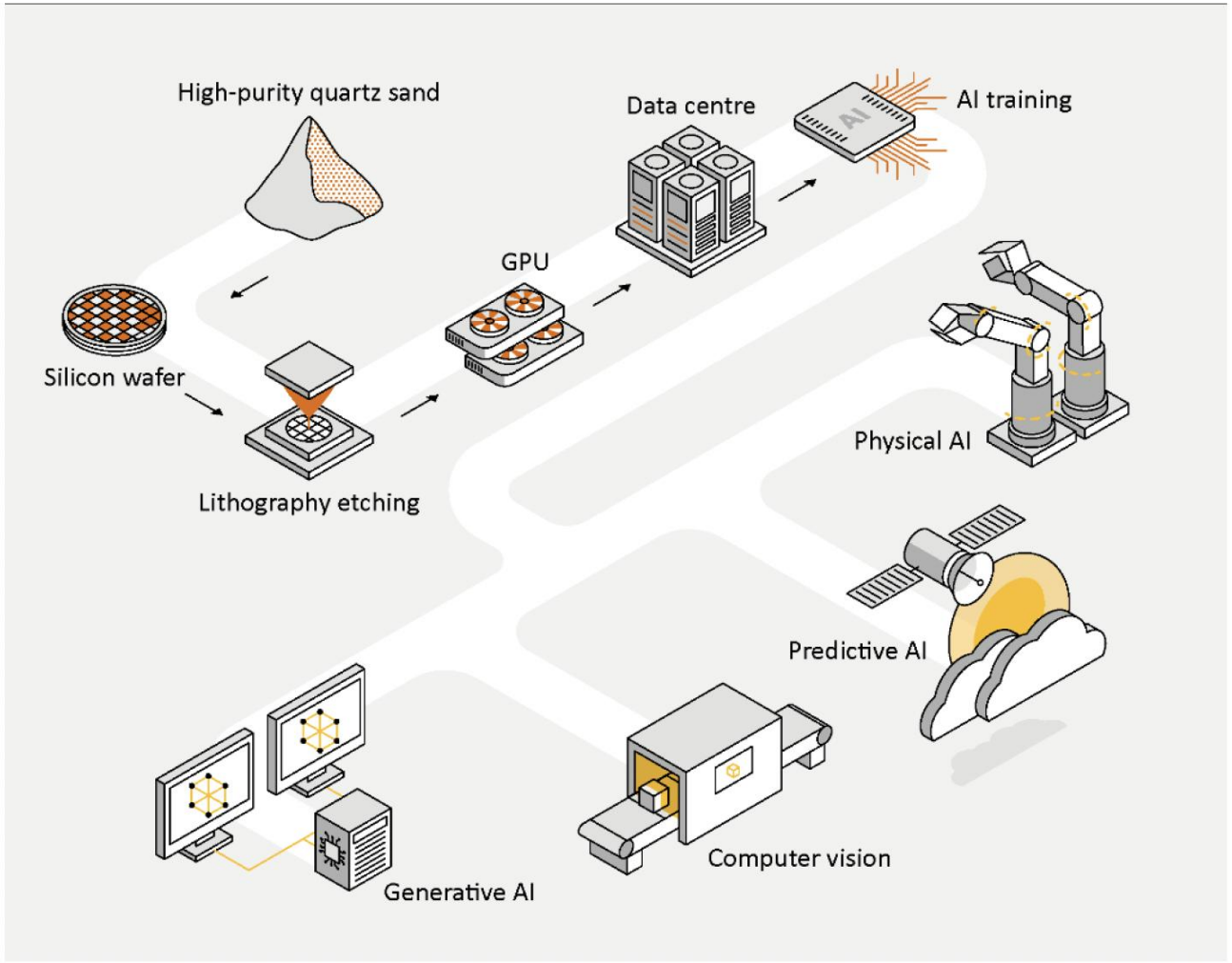
- On-site solar panels (~1.8MW)
- Air side economizers reduce energy consumption +50% of time

Cooling Optimization

- Hot air containment
- CRAH hoods, Samurai tiles
- Infrared audits
- Blanking & rack gap panels, tile cut foam
- Monitoring systems

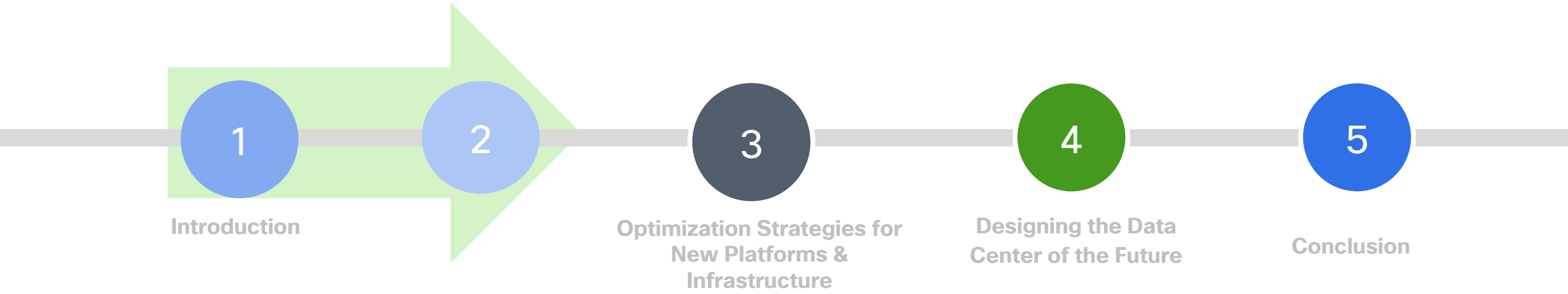
Source: Cisco on Cisco Whitepaper “Cisco IT Data Center Sustainability” https://www.cisco.com/c/en/us/solutions/collateral/enterprise/cisco-on-cisco/cisco-it-dc-sustainability-wp.html

Figure 1.9 ▷ Select AI infrastructure and types of applications



IEA. CC BY 4.0.

Our Journey Today



Assessing Current Infrastructure for Sustainability:

- Evaluating Data Center Maturity Levels
- Key Metrics Energy Utilization
- Tools for Assessment

Evaluating Data Center Maturity Levels

Cisco's Data Center Assessment Services

Cisco offers comprehensive assessments to evaluate and enhance data center maturity: evolution of a data center's architecture, efficiency, adaptability, and scalability

Key Services:

- Architecture Assessment
- Virtualization Architecture Blueprint
- Sustainability Priority Assessment

Benefits:

- Aligns IT infrastructure with business goals.
- Improves resource utilization and reduces costs.
- Enhances data center performance and resiliency.

References Cisco Data Center Architecture Assessment Service
End-to-End Data Center Assessments and Design Service

Sustainability Priority Assessment Service

Bridge the gap between sustainability priorities and an executable roadmap

Strategic Imperatives

Customer top priorities

Use cases

KPIs centered on business outcomes

Maturity Assessment

Current and future maturity of capabilities

Maturity target

Transformation Roadmap

Executable roadmap and initiatives

Includes risks and dependencies management

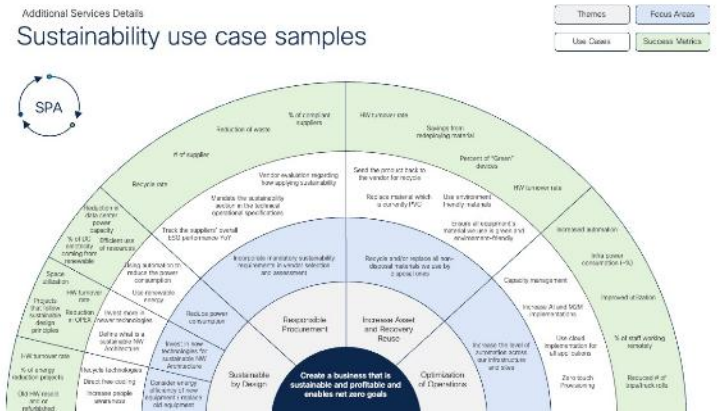
Enriched with Cisco knowledge base

Approach and Methodology

Sustainability Priority Assessment Service

Step 1

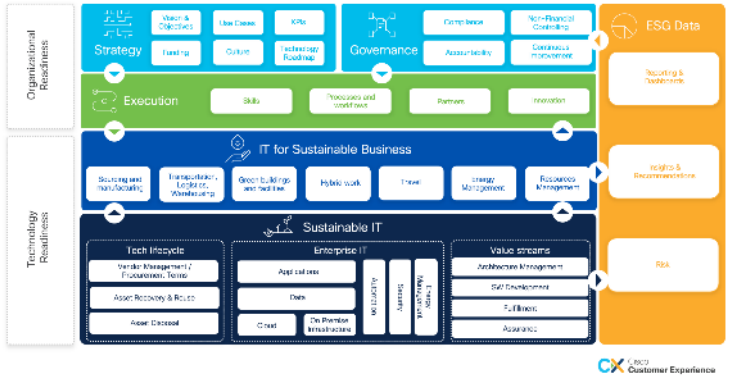
- Project kickoff and alignment on approach
- Select focus areas, prioritize and select use cases, define measures of success



- Transformation Priority Radar
- Sustainability Transformation Strategy Report

Step 2

- Maturity Assessment Workshops
- Current-state maturity analysis
  Target-state aspirations



Based on mature Cisco frameworks and best practices, tailored to individual customer priorities. Learn more: IDC Spotlight

Step 3

- Gap analysis / capabilities requirements
- Transformation roadmap creation*

Based on Cisco best practices, a tailored 2–3-year strategic transformation roadmap and risk mitigation plan will be created.

Step 4 : Iterative reviews and final recommendations

*This should be considered a representative timeline. The exact timings will be confirmed during project kickoff and are dependent on scope, Cisco resource, and customer stakeholder availability

Key Metrics for Sustainability for Data Centers

Power Usage Effectiveness (PUE)

Data Center Infrastructure Efficiency (DCiE)

Water Usage Effectiveness (WUE)

Carbon Usage Effectiveness (CUE)

Reusable Energy Factor (REF)

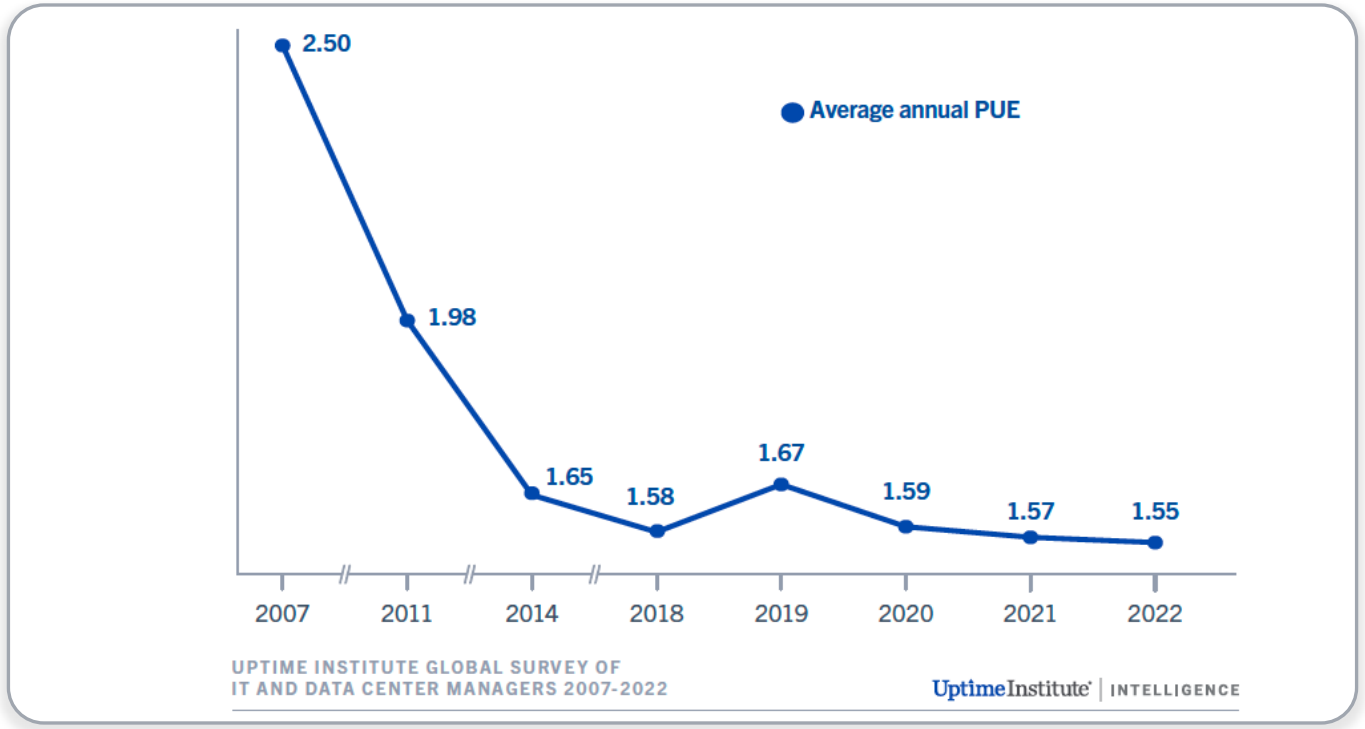
Cooling Efficiency & many others ...

Power Usage Effectiveness (PUE)

Key Metrics for Sustainability

Metric

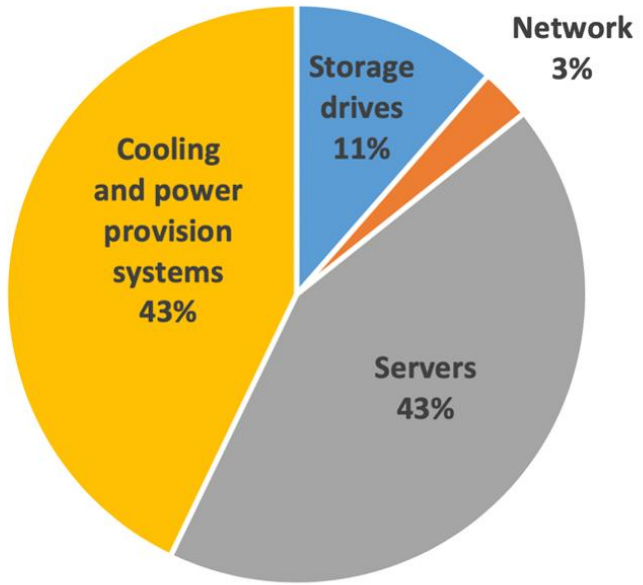
$$PUE = \frac{Total\ Facility\ Power}{IT\ Equipment\ Energy}$$



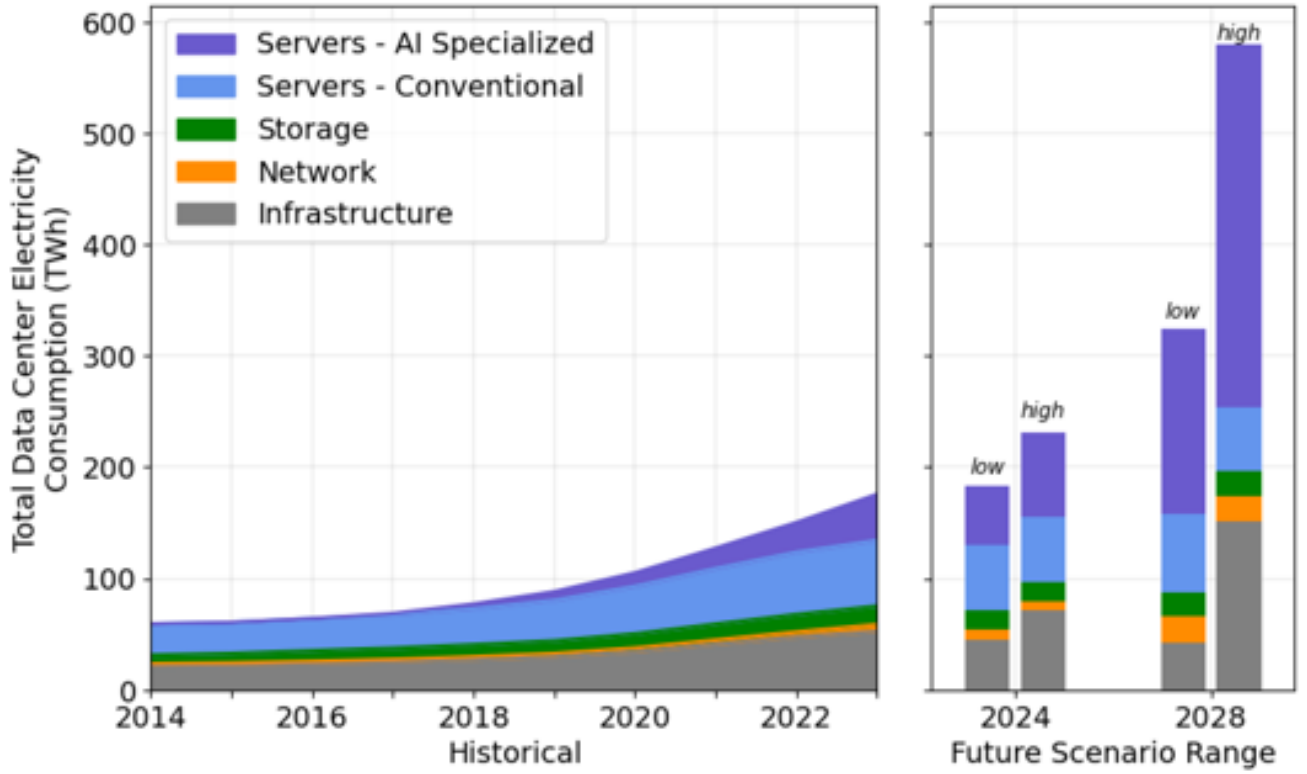
https://uptimeinstitute.com/uptime_assets/6768eca6a75d792c8eeede827d76de0d0380dee6b5ced20fde45787dd3688bfe-2022-data-center-industry-survey-en.pdf

PUE & Efficient Data Centers

Including AI Scenario



U.S. data center electricity use in 2014, by end use
Masanet and McCormick 2016
https://www.agci.org/research-reviews/how-much-energy-do-data-centers-really-use



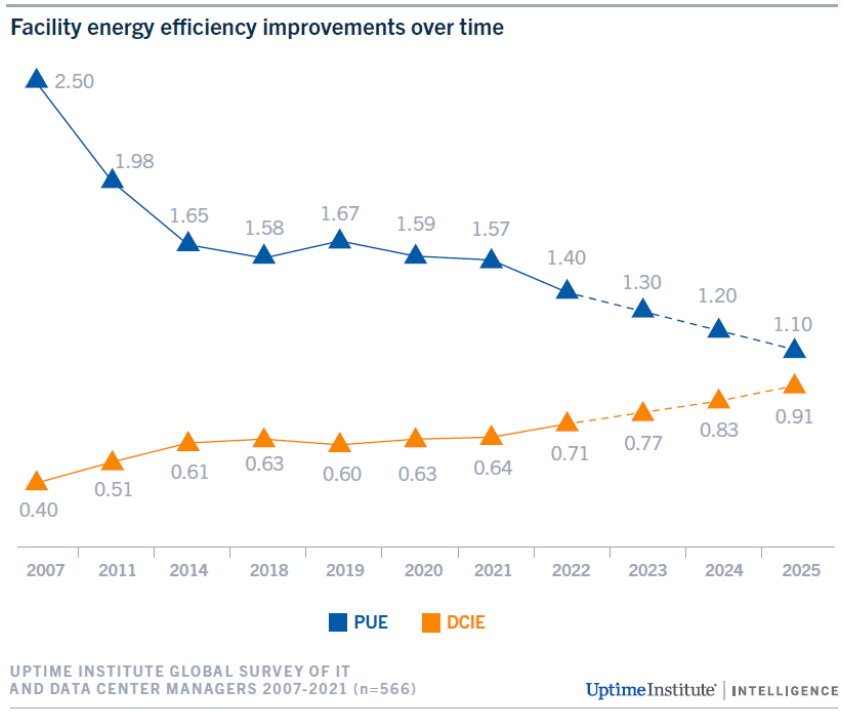
Shehabi et al. 2024 United States Data Center Energy Usage Report.
Lawrence Berkeley National Laboratory, Berkeley, California. LBNL-2001637
https://eta.lbl.gov/publications/2024-lbnl-data-center-energy-usage-report

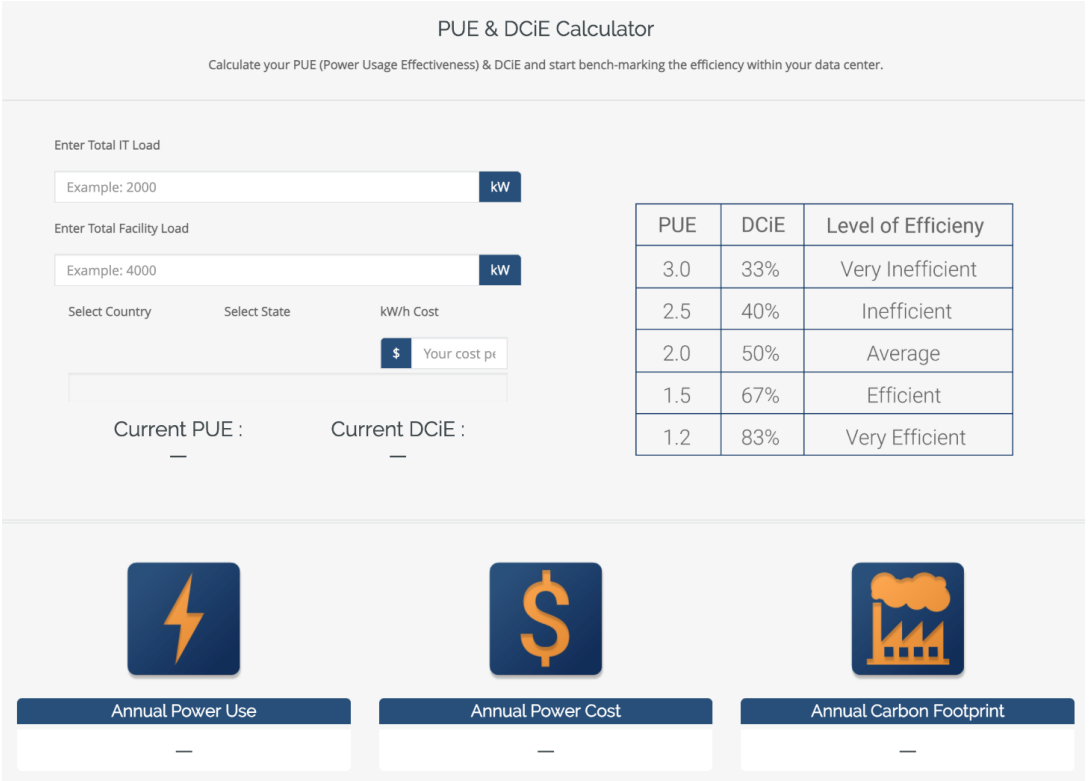
Data Center Infrastructure Efficiency (DCIE)

Key Metrics for Sustainability

Metric

$$DCIE = \frac{1}{PUE} = \frac{IT\ Equipment\ Energy}{Total\ Facility\ Power} \times 100\%$$





https://www.dailyhostnews.com/improving-it-efficiency-for-digital-sustainability
https://www.42u.com/measurement/pue-dcie.htm

“Cooler is Better” mentality coming to an end?

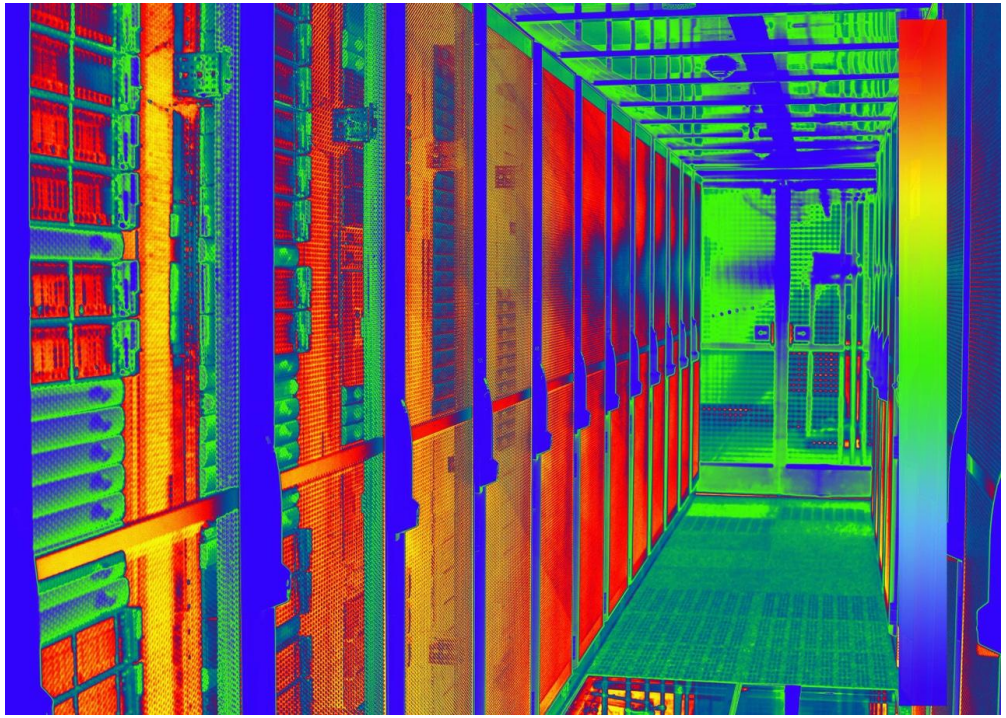
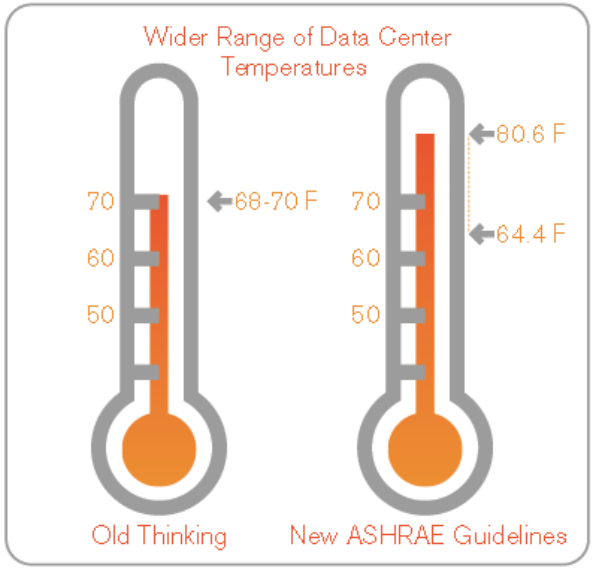


Image sources:
https://www.data centerknowledge.com/data-center-hardware/hot-in-here-is-raising-temperatures-in-data-centers-good-for-hardware-
www.facilitiesnet.com



ASHRAE temperature recommendations for Data Centers

- The safest option is to aim for 64.4° F which probably is not the most energy-efficient.
- Modern servers operate at higher temperatures, such as 73.4 ° F– 75.2 ° F server inlet temperature.
- Raising data center temperatures reduces cooling demand and energy use, saving costs and lowering carbon footprints, aligning with EED energy efficiency goals.

Water Usage Effectiveness (WUE)

Key Metrics for Sustainability

Metric

$$WUE\ [\text{l/Kwh}] = \frac{\textit{Data Center Water Consumption}}{\textit{IT Equipment Energy}}$$

Main hyperscalers have committed to being **water-positive** by 2030, returning more water to communities and the environment than it consumes in its direct operations.

Water Consumption	Hyperscale	Wholesale and Retail*
per day	550,000 gallons (2.1 million liters)	18,000 gallons (68,000 liters)
per year	200 million gallons (760 million liters)	6.57 million gallons (24.9 million liters)

**Average daily water consumption of a single data center building.*

References:

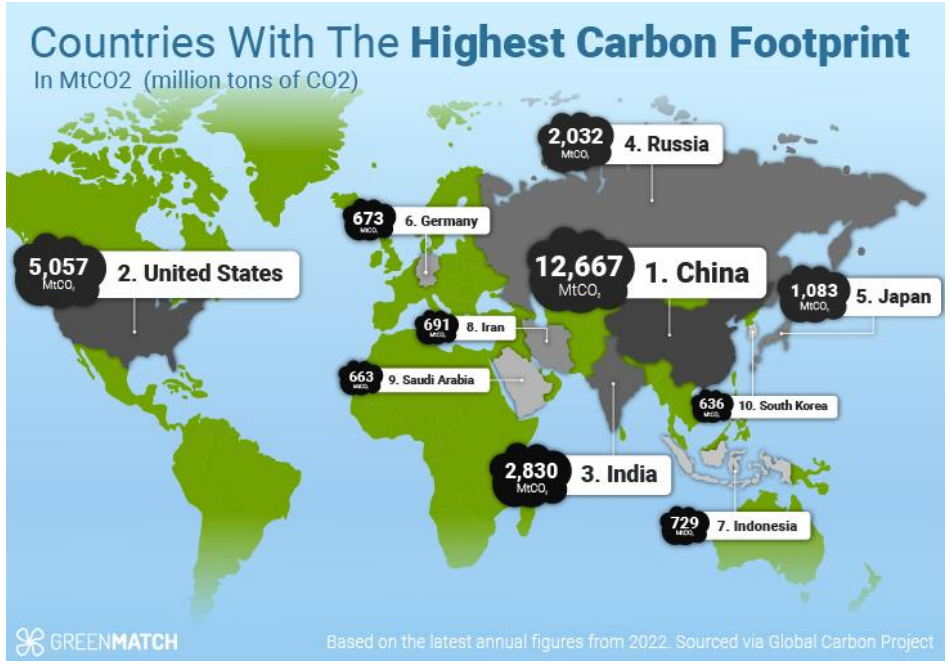
- https://dgtlinfra.com/data-center-water-usage/
- The water usage of data centres in Europe has to be reduced.
https://www.waternewseurope.com/european-data-centres-lead-on-water-conservation/
- https://press.aboutamazon.com/2022/11/aws-makes-water-positive-commitment-to-return-more-water-to-communities-than-it-uses-by-2030
- https://blogs.microsoft.com/blog/2020/09/21/microsoft-will-replenish-more-water-than-it-consumes-by-2030/
https://blog.google/outreach-initiatives/sustainability/replenishing-water/
- https://tech.facebook.com/engineering/2021/08/facebook-is-committed-to-being-water-positive-by-2030/

Carbon Usage Effectiveness (CUE)

Key Metrics for Sustainability

Metric

$$CUE\ [kgCO_2/kWh] = \frac{Data\ Center\ Total\ CO_2\ Emissions}{IT\ Equipment\ Energy}$$



Rank	Country	$MtCO_2$ (million tons of CO_2)	Percentage of World CO2 Emission
1	China	12,667	32.88%
2	United States of America	5,057	12.6%
3	India	2,830	6.99%
4	Russia	2,032	4.96%
5	Japan	1,083	2.81%

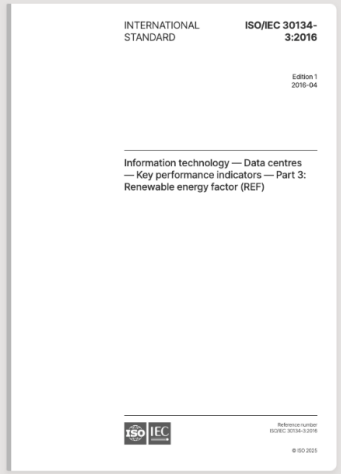
https://www.greenmatch.co.uk/blog/countries-with-the-highest-carbon-footprint

Renewable Energy Factor (REF)

Metric

$$REF = \frac{Renewable\ Energy}{Total\ Energy}$$

Standards Sectors About ISO Insights & news Taking part Store



ISO/IEC 30134-3:2016

Information technology — Data centres — Key performance indicators

Part 3: Renewable energy factor (REF)

Published (Edition 1, 2016)

This publication was last reviewed and confirmed in 2021. Therefore this version remains current.

↳ This standard has 1 amendment.

The Renewable Energy Factor (REF) metric helps to assess GHG emissions mitigation.

REF is the metric to measure the percentage of renewable energy (RE) versus the total energy usage in a data center.

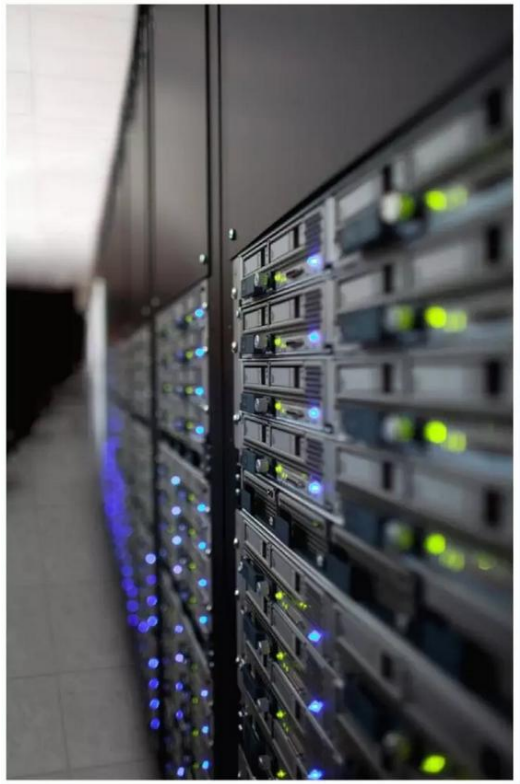
Tools for Assessment

UCS Power Calculator

The Cisco UCS Power Calculator is an online tool provided by Cisco to help customers estimate the energy consumption (kWh) and heat output of their Cisco Unified Computing System (UCS) hardware deployments.

Features and Use Cases

1. Component Selection
2. Configuration Options
3. Energy Consumption Estimates
4. Heat Output Calculation
5. Scenario Planning
6. Customizable Output



https://ucspowercalculator.cisco.com

Intel TCO Calculator: Optimize Your IT Costs

What is the Intel TCO Calculator?
The Intel TCO (Total Cost of Ownership) Calculator is an online tool that helps businesses evaluate and optimize the financial and operational costs of their IT infrastructure using Intel-based solutions.

Key Features:

- **Cost Comparison.**
- **Performance Analysis.**
- **Customizable Input Parameters.**
- **Energy Efficiency Insights.**
- **Upgrade Recommendations.**
- **ROI and Payback Period**

For IoT: https://estimator.intel.com/vpro-iot/
For Data Centers: https://xeonprocessoradvisor.intel.com/welcome

AMD EPYC Energy Efficiency Calculator

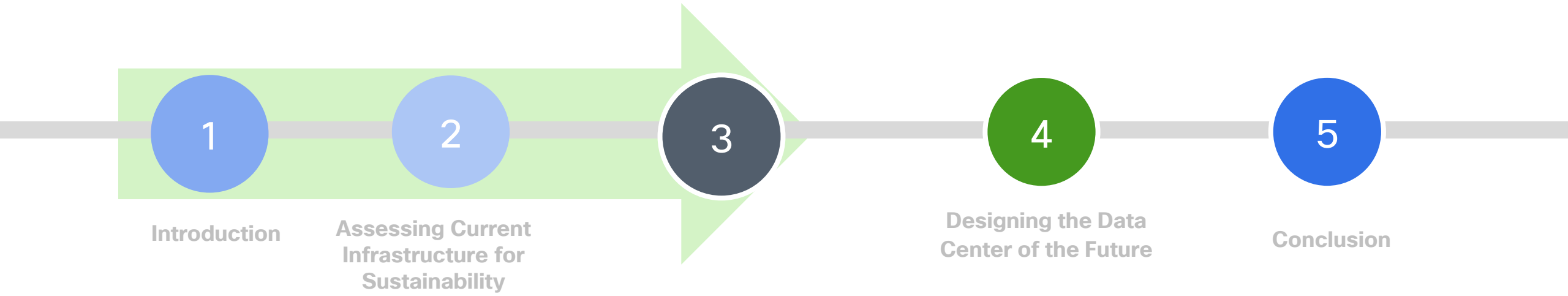
What is the AMD EPYC Energy Efficiency Calculator?

- A tool designed to evaluate the energy efficiency and performance-per-watt of AMD EPYC processors.
- Helps businesses assess the power and cooling requirements of workloads running on AMD platforms.

Key Features:

- Compare AMD EPYC processors with legacy or competitor platforms.
- Analyze energy consumption and heat output for specific workloads.
- Generate insights into energy savings and environmental impact of deploying AMD EPYC processors.

Our Journey Today



Optimization Strategies for New Platforms & Infrastructure:

- Self-sustaining infrastructure: methodology and examples of refresh and consolidation
- Compute, Storage and Networking Optimization Techniques
- AI-Powered Monitoring and Predictive Maintenance
- Case Study: Data Center Optimization in Action

Self-Sustaining Infrastructure: Methodology and Examples of Refresh and Consolidation

Self-Sustaining Infrastructure
The Why, the What and the How

WHY

Customers have lot of inefficient and often LDOS HW installed they are not upgrading for multiple reasons, including cost of renewals.

WHAT

Self-sustaining ICT solutions: accelerate infrastructure refresh through the evidence of a higher value and positive ROI, considering energy and space savings

HOW

Data-driven methodology showing how the new infrastructure is “paid for” by operational savings from old infrastructure

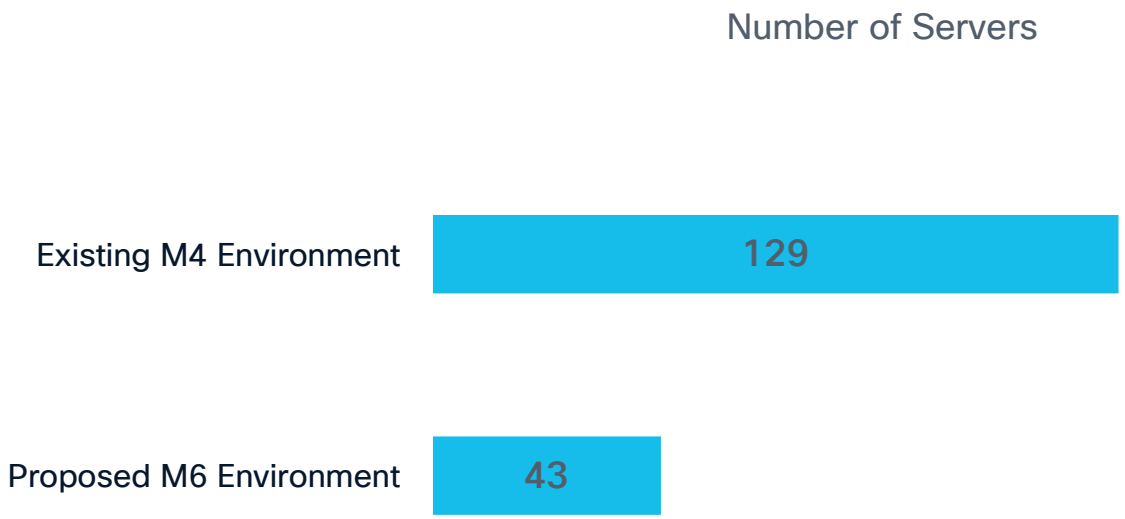
Finding the right balance: the self-sustaining infrastructure methodology

Data center modernization requires CAPEX investments

Data center modernization leads to OPEX savings

Savings Through Modernization

The benefits of refreshing assets and consolidation



$0.77M 3Year ROI from Modernization*

*Customer proposal, estimate derived from Cisco TCO tool, 2023

More Sustainable Data Cente

Compute

What if they didn't refresh?

Old UCSB-M3

New HCI solution – M5 based

18 Racks

8 Racks

= 0.89M/yr*

1.8 GWh/yr

0.52 GWh/yr

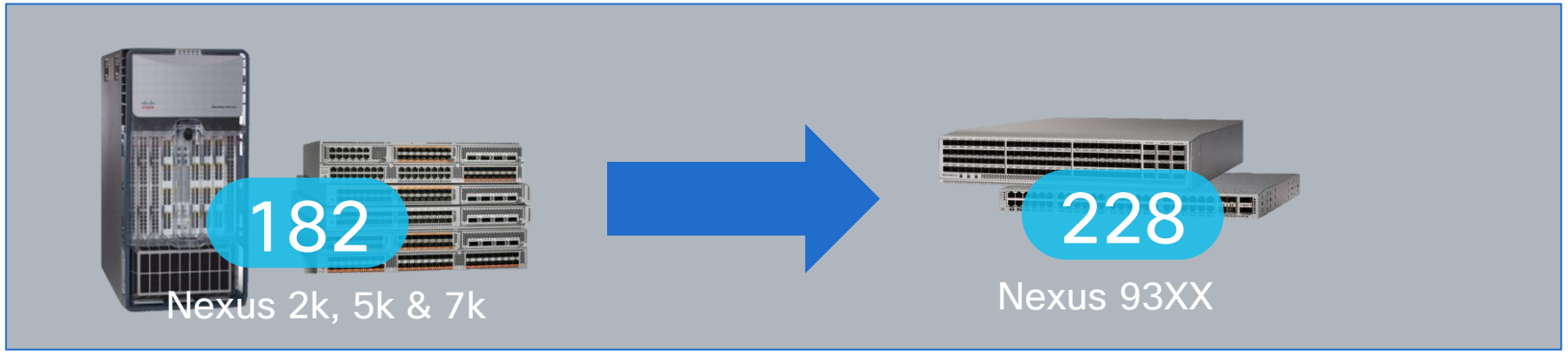
= 0.43M/yr**

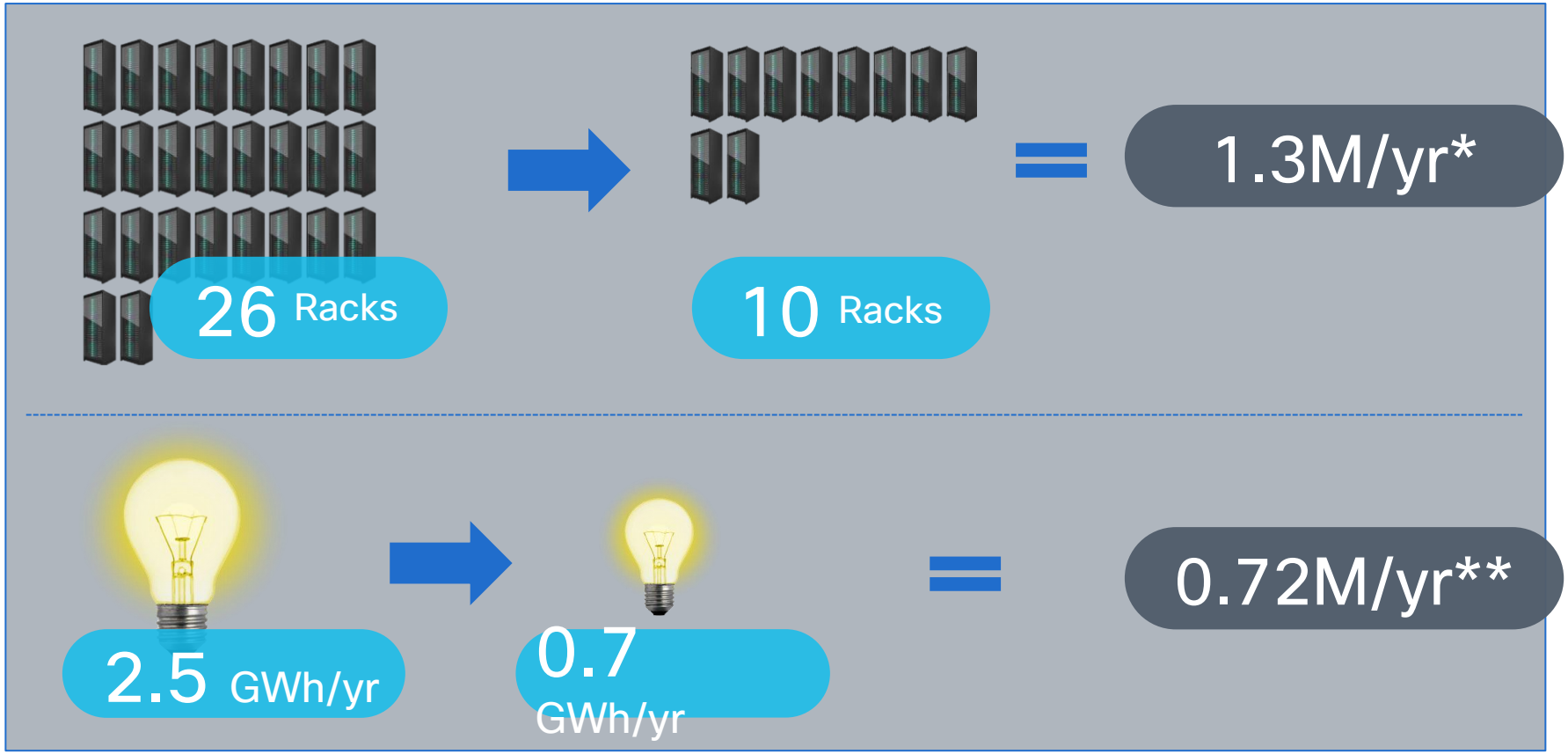
* 200$/U
https://www.servermania.com/kb/articles/how-much-does-it-cost-to-put-a-server-in-a-data-center/
NUMBERS MAY BE DIFFERENT BASED ON REGION/TIME

** 0.4/kWh
https://www.iea.org/reports/electricity-market-report-2023/executive-summary

More Sustainable Data Center

LAN





* 200$/U
https://www.servermania.com/kb/articles/how-much-does-it-cost-to-put-a-server-in-a-data-center/
NUMBERS MAY BE DIFFERENT BASED ON REGION/TIME

** 0.4$/kWh
https://www.iea.org/reports/electricity-market-report-2023/executive-summary

Compute, Storage and Networking Optimization Techniques

Cisco Cloud Networking

Generational improvement in efficiency

C9336C-FX2 – 36x100GE

9W / 100GE

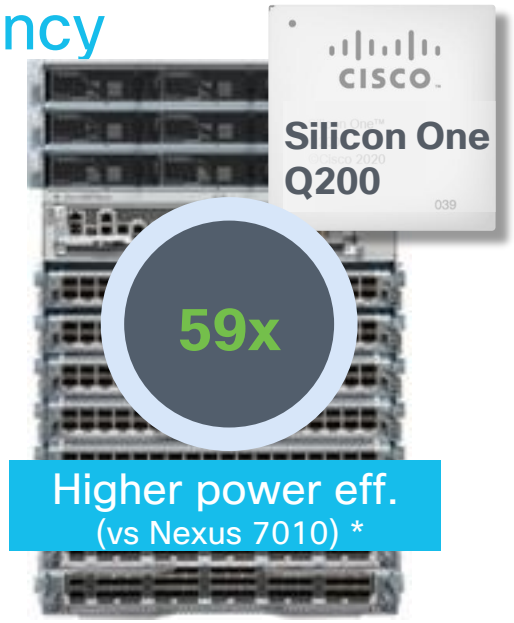
60%

CISCO GX2 7nm

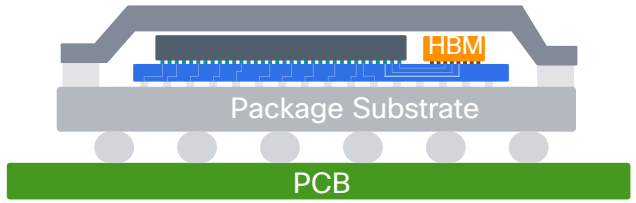
5W / 100GE

C9332D-GX2B – 32x400GE

(*) Cisco Sustainable Solutions ebook 2022



Nexus 9808



Silicon One w/HBM

Silicon Photonics

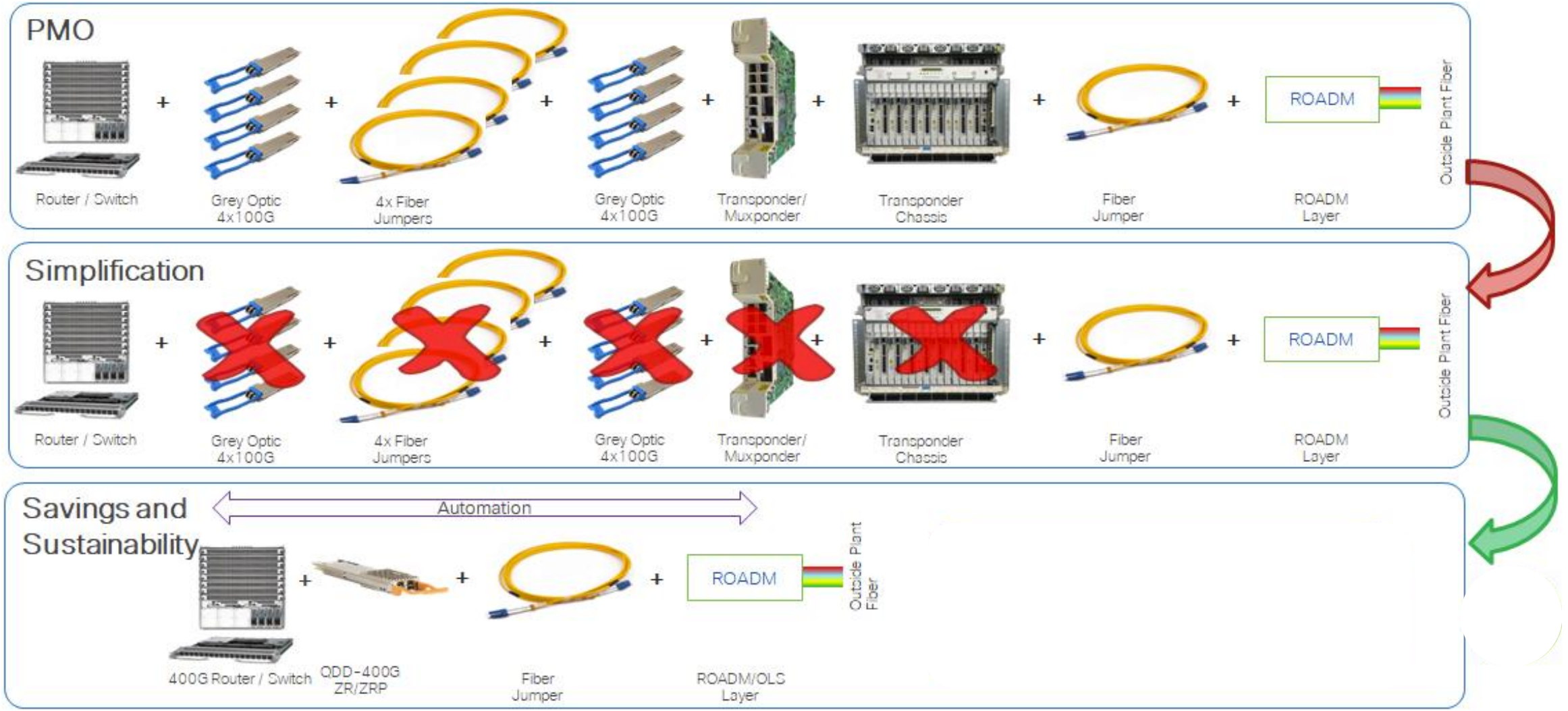
QDD-**400G**-FR4-S

QDD-**4X100G**-FR-S

36%

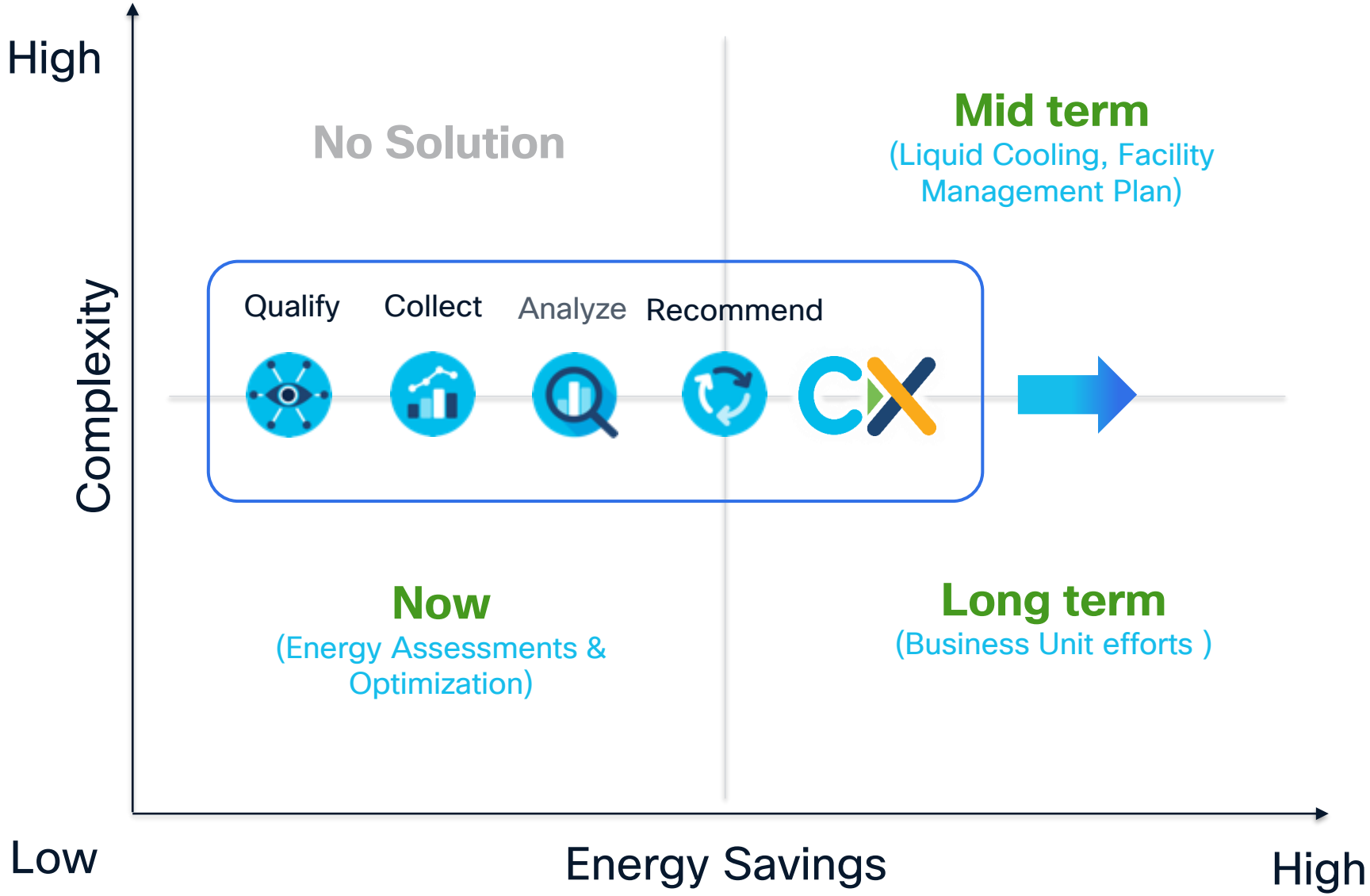
400GE optics vs 4x100GE ports
(port level consumption on silicon one with FR optics)

Simplification, Cost Savings and Sustainability



Case Study: Data Center Optimization in Action

CX Energy Consumption Optimization Pipeline



In-Depth Customer Analysis: UCS and ASR Comparison

	Current (kWh/Yr)	Future (kWh/Yr)
Energy savings	18,422.28	4,161.31
Heat	62,862.23	14,199.01
Heat MMBTU/YR	550.67	124.38

In-Depth Customer Analysis: UCS and ASR Comparison

Performance Insights			
	Legacy in Gbps Max	Modern FSA in Gbps Max	Gain
Uplink Speed	40	100	150%
Server link Speed	40	100	150%
FC Uplink	16	32	100%
Max Single flow BW per vNIC	40	100	150%
Max Single flow BW per vHBA	40	100	150%

In-Depth Customer Analysis: UCS and ASR Comparison

Rack Unit (Blade & Server	Total Chassis / Rack Server	RU size	Total- RU	**RU Reduction**
Legacy Chassis	3	6	18	
Legacy Rack Server	50	1	50	
Modern- Chassis	3	7	21	
Modern Rack Server	0	2	0	
				47
				323%

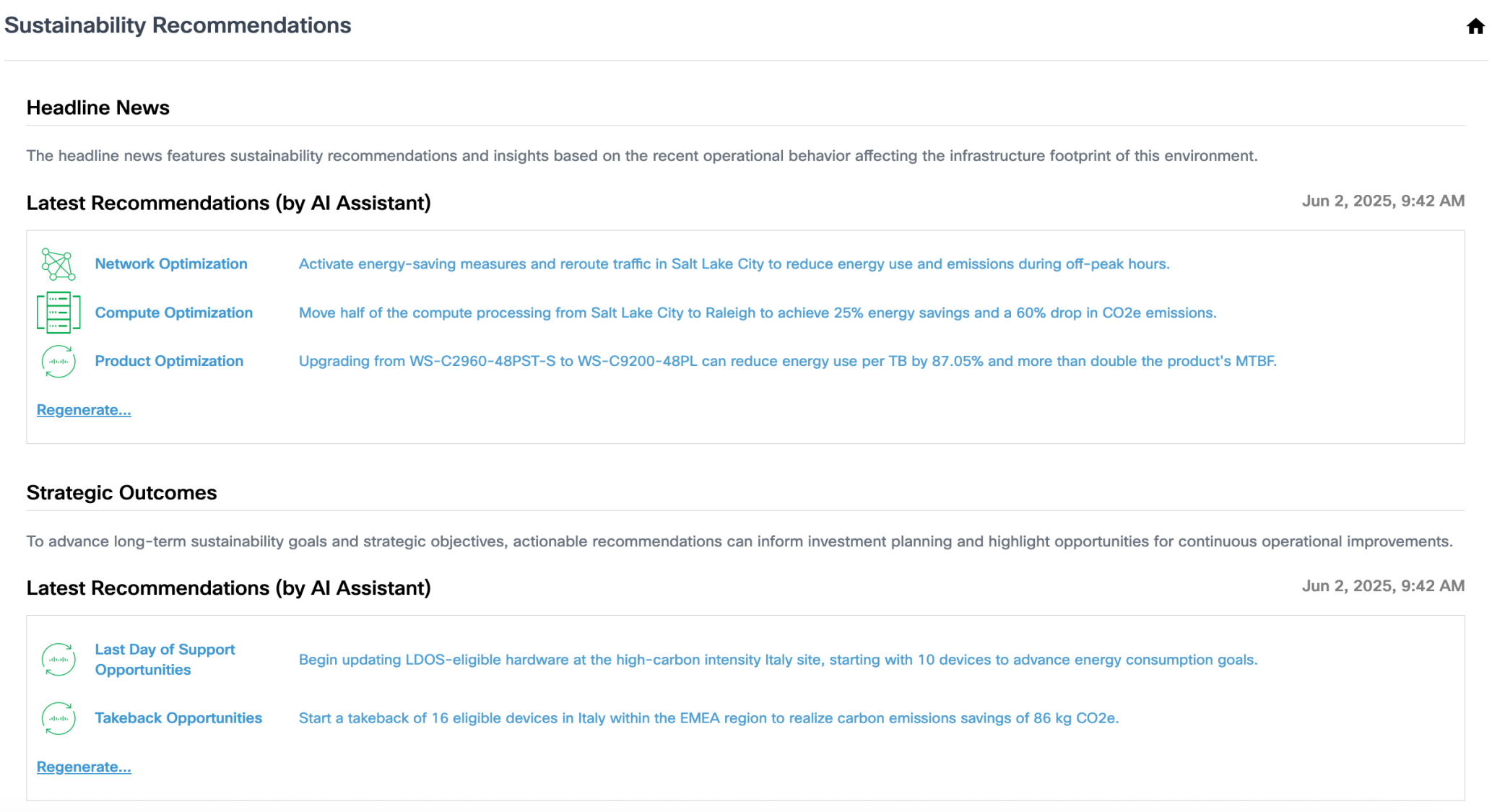
In-Depth Customer Analysis: UCS and ASR Comparison

BANDWIDTH	CHASSIS COUNT	PER CHASSIS BANDWDITH	TOTAL	CHASSIS BANDWDITH GAIN
Legacy	3	320	960	
Modern - FSA	3	1600	4800	
				400%

In-Depth Customer Analysis: UCS and ASR Comparison

Fabric Interconnect Switching	FI count	Per FI Bandwdith(Tbps)	Total	**FI Switching Bandwdith Gain**
Legacy	2	2	4	
Modern – FSA	2	7.2	14.4	
				260%

How can AI make this easier?



For illustration purposes only

Workload Optimization

Automation Workload Scheduling

When should we run AI intensive tasks?

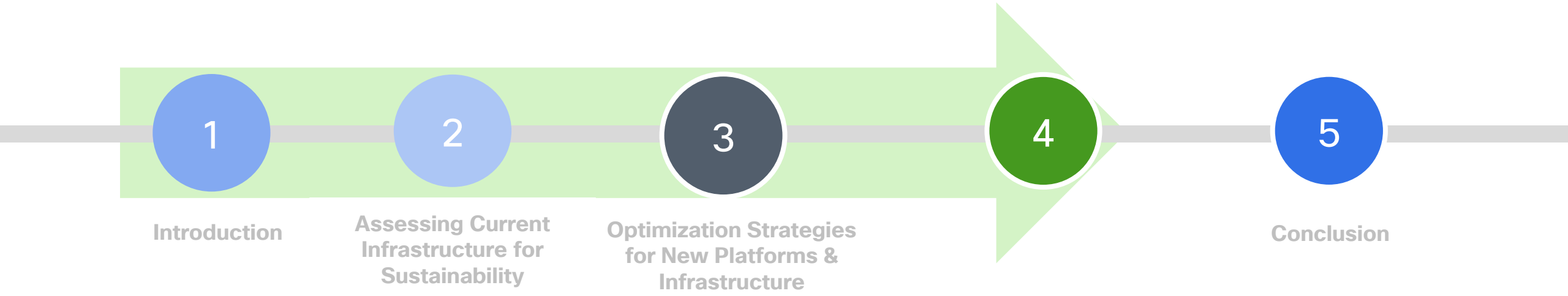
How can I determine this time?

Data Center Optimization

Where should we run our workloads?

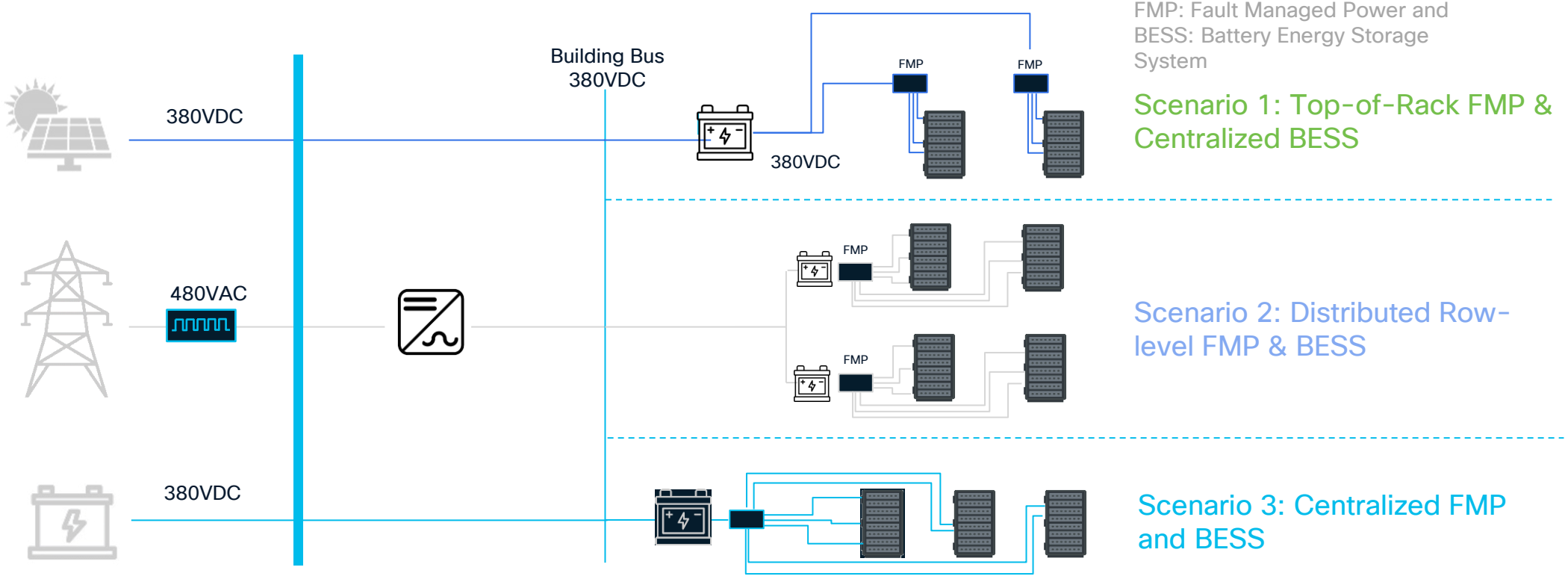
How do I determine this?

Our Journey Today



Designing the Data Center of the Future:

FMP Enabled Data Center



FMP: Fault Managed Power and BESS: Battery Energy Storage System

Power and energy efficiencies

New power technologies, optimized infrastructure, and renewable energy

Scalability and flexibility

Modular products, effective operations management systems,

Cost optimization

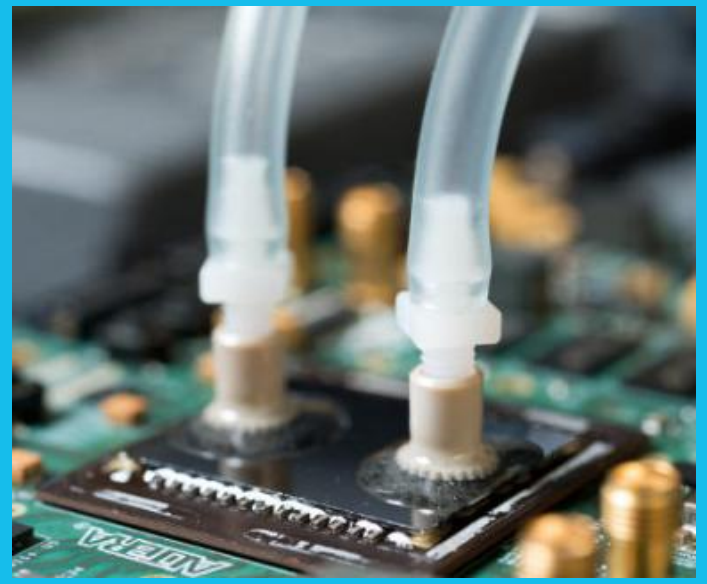
Longer product life cycles, less to buy and more energy savings over time

Regulatory compliance

No fines, penalties, reputational damage, or loss of customer base

Solutions for Liquid Cooling in the Data Center
Integrated, Multi-Vendor Deployment

Rear-Door Heat Exchange
20-40 kW per rack



Direct to Chip
150 kW per rack

Immersion
250 kW per rack

Energy Networking Before & After

AI-Ready Data Center Systems

BEFORE

- 10% or more in power factor (PF) loss
- 20–40% in AC/DC conversion losses
- 10–20% in transformer & phase balance loss
- 20%+ loss in idle load and power supply units
- 15% loss due to in-chassis fans
- 40–60% energy consumption in cooling

40%* **energy conversion loss**
resulting in power inefficiencies throughout transmission

AFTER

- Reduced transmission losses
- Real-time fault management
- Selective fault isolation in the network
- Dynamic load management
- Automated energy redistribution
- Low-voltage safe and efficient DC distribution
- Optimized for high-voltage DC (HVDC) long-distance power transmission

50%* **energy savings gained**
operationally more efficient using liquid cooling and FMP

*Illustrative example: Findings performed in lab environment

Our Journey Today

Cisco Services Call to Action

Next Steps

Explore our demos in the **Cisco Showcase** of the **World of Solutions**.

Meet with our **CX Subject Matter Experts**. Inquire about availability at the welcome desk in the CX Connections Lounge in the World of Solutions.

Attend our Center Stage and PSO sessions. Scan this code to view all our sessions.

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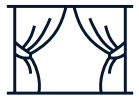

Visit the Cisco Showcase for related demos

Book your one-on-one Meet the Engineer meeting

Attend the interactive education with DevNet, Capture the Flag, and Walk-in Labs

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Thank you

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