# Considerations on Data Center Sustainability

CISCO Live !

Arvind Durai,
CCIE R/S and Security
Director Solution Integrations,
Customer Experience

# Cisco Webex App

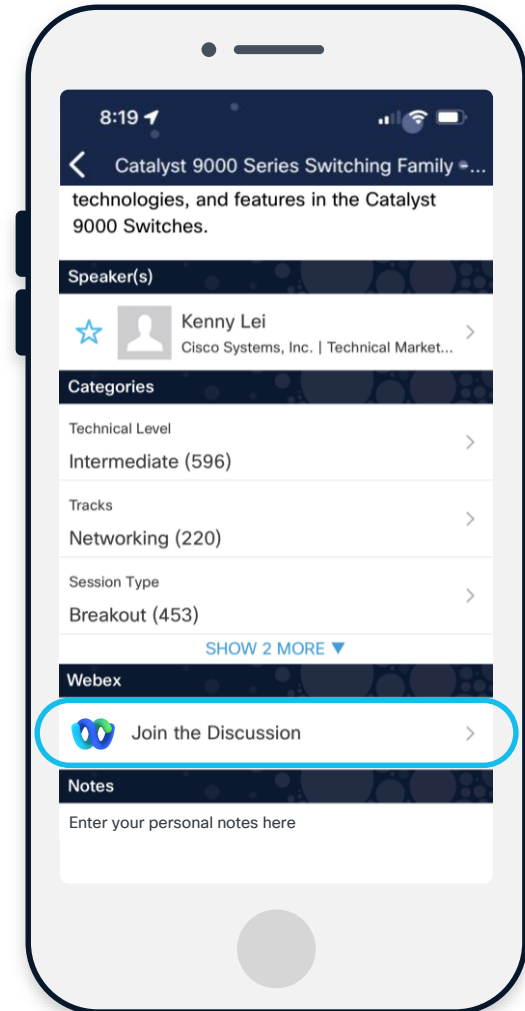## Questions?

Use Cisco Webex App to chat
with the speaker after the session

## How

**1** Find this session in the Cisco Live Mobile App

**2** Click "Join the Discussion"

**3** Install the Webex App or go directly to the Webex space

**4** Enter messages/questions in the Webex space

**Webex spaces will be moderated by the speaker until June 13, 2025.**

# Arvind Durai

- 25 years with Cisco Customer Experience
- Has worked with 100+ customers in enterprise architecture, technology designs and operational simplification
- 17 years of Active Cisco live presenter
- Co-authored five Cisco Press Books
  - Cisco Firewall Services Module
  - Virtual Routing in the Cloud
  - TCL Scripting for Cisco IOS
  - IP Multicast vol1 & 2
  - IEEE Standards for Smart Grid
- CCIE R/S and Security #7016

# Agenda

# Sustainability

Moving up the boardroom agenda

- Limiting global warming to 1.5 ºC below pre-industrial levels calls for world CO2 emissions to be reduced by 45% before 2030 and achieve net-zero by 2050[1]

- Many companies now embracing a net-zero strategy, and this is often reflected in CEO bonus[2]

- ICT sector (datacenters, networks, user devices) generates 2.1% of global GHG emissions, 2x aviation sector, on a different trend [3]

- ICT sector has a dual responsibility: decrease its own emissions and overcompensate by delivering incremental savings elsewhere [4]

- Global e-waste of 74 Mt by 2030, 2x from 2014. Only 22.3% percent recycled. Disposed high-value raw materials valued at $62B [5]

- Sustainability and Circular Economy: two faces of the same coin.

- Visibility, measurement, actions: it is now or never!
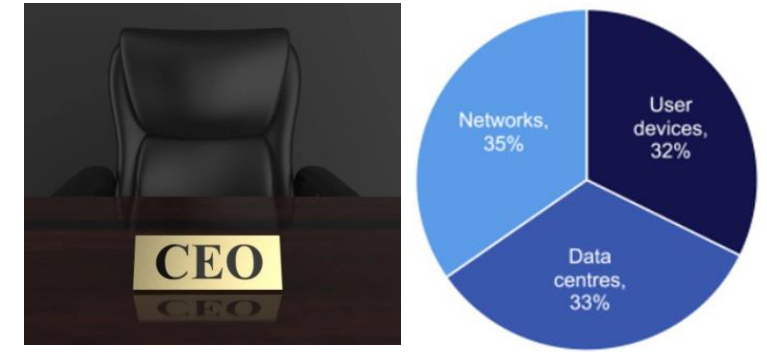


1- source: IPCC report, April 2022
2- source: Perillon blog, April 2021
3- source: World Bank, 2024
4- source: Sciencedirect, 2021
5- source: Global e-waste monitor, 2020 and 2024

# Why Now?

⚠️ Urgent global problem
How can ICT help?

👥 Customer, investor &
employee pressure

📊 Legislation, reporting
standards, scrutiny

💲 Business efficiencies
& new opportunities

"Transitioning to a net-zero world is one of the greatest challenges humankind has faced"

United Nations

**80%**
Companies now reporting on sustainability
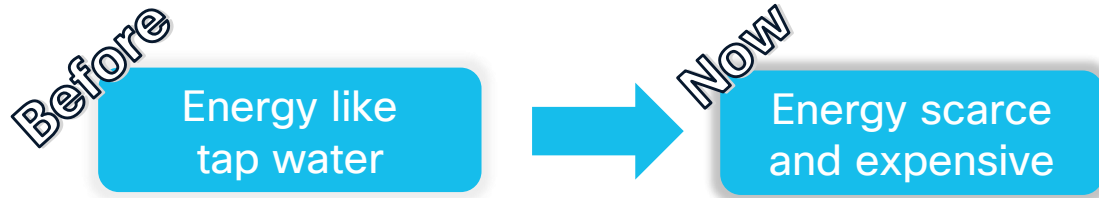
142 countries with a Net Zero target

NEWS

Hiring criteria for 40% of millennials

# How To Change The Status Quo?


Before: **Energy like tap water** → Now: **Energy scarce and expensive**

**International agreements and regulations**
> COP21 Climate Change Conference (Paris, 2015), focus on 1.5 ℃ pathway
> ...COP28 (Dubai), COP29 (Baku)...
> Impose limits by law (e.g. EPBD- Energy Performance of Buildings Directive)

**Policy proposals from various sources**
> Make those polluting the environment pay
> Move taxation from income to $CO_2$ emissions
> «Ville du quart d'heure» , «City 30» model
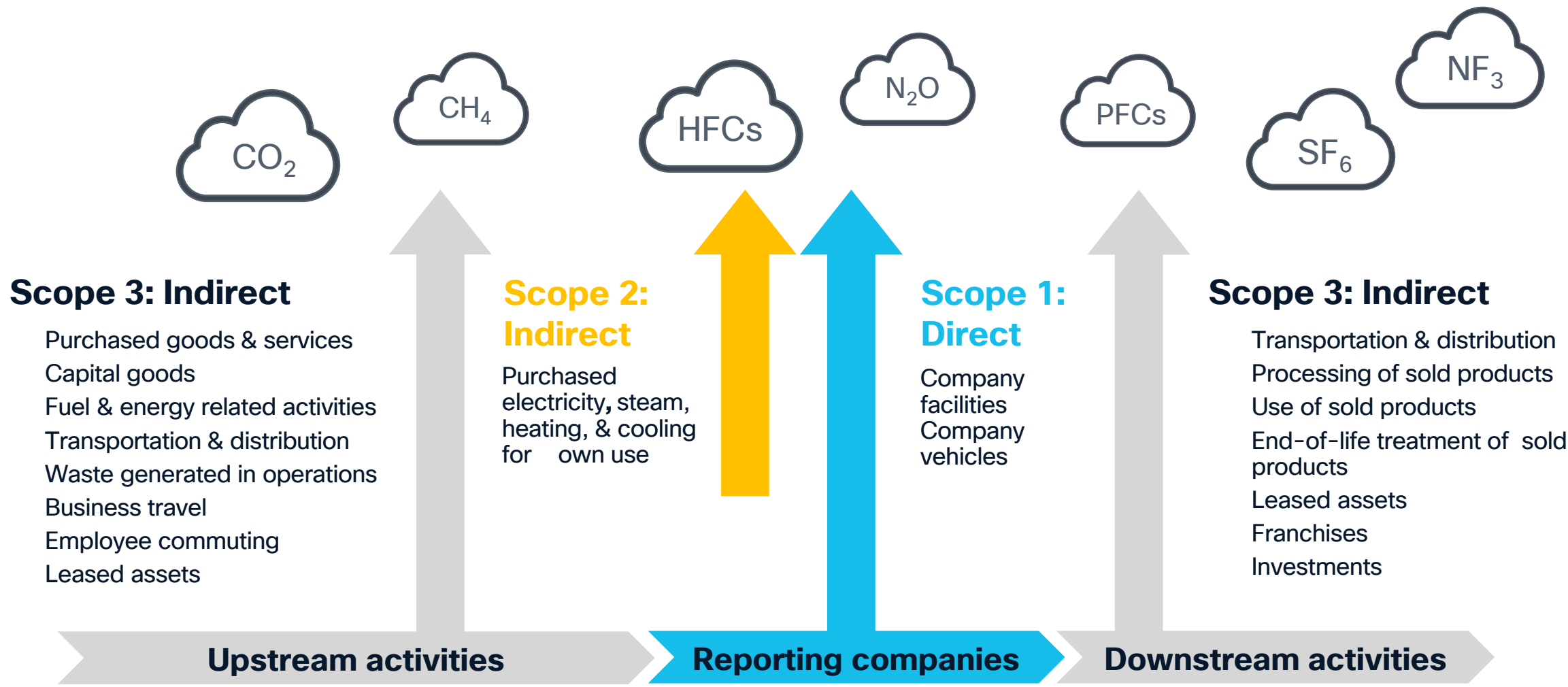
**Individual actions**
> Citizen activism (e.g., Fridays for Future), climate quitters, sustainability-minded consumption


15 min city
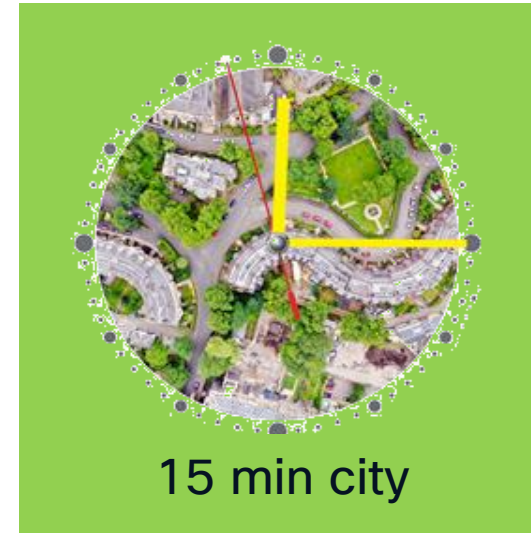
**Actions on a different timescale:**
- Lifestyle change, save energy, reduce waste
- Improve energy efficiency of products, incorporate circular design principles
- Change the way we produce and distribute energy, use alternates to fossil fuels

# What are scope 1, 2, & 3?

$CO_2$  $CH_4$  HFCs  $N_2O$  PFCs  $SF_6$  $NF_3$

**Scope 3: Indirect**

Purchased goods & services
Capital goods
Fuel & energy related activities
Transportation & distribution
Waste generated in operations
Business travel
Employee commuting
Leased assets

**Scope 2: Indirect**

Purchased electricity, steam, heating, & cooling for  own use

**Scope 1: Direct**

Company facilities
Company vehicles

**Scope 3: Indirect**

Transportation & distribution
Processing of sold products
Use of sold products
End-of-life treatment of  sold products
Leased assets
Franchises
Investments

**Upstream activities**       **Reporting companies**       **Downstream activities**

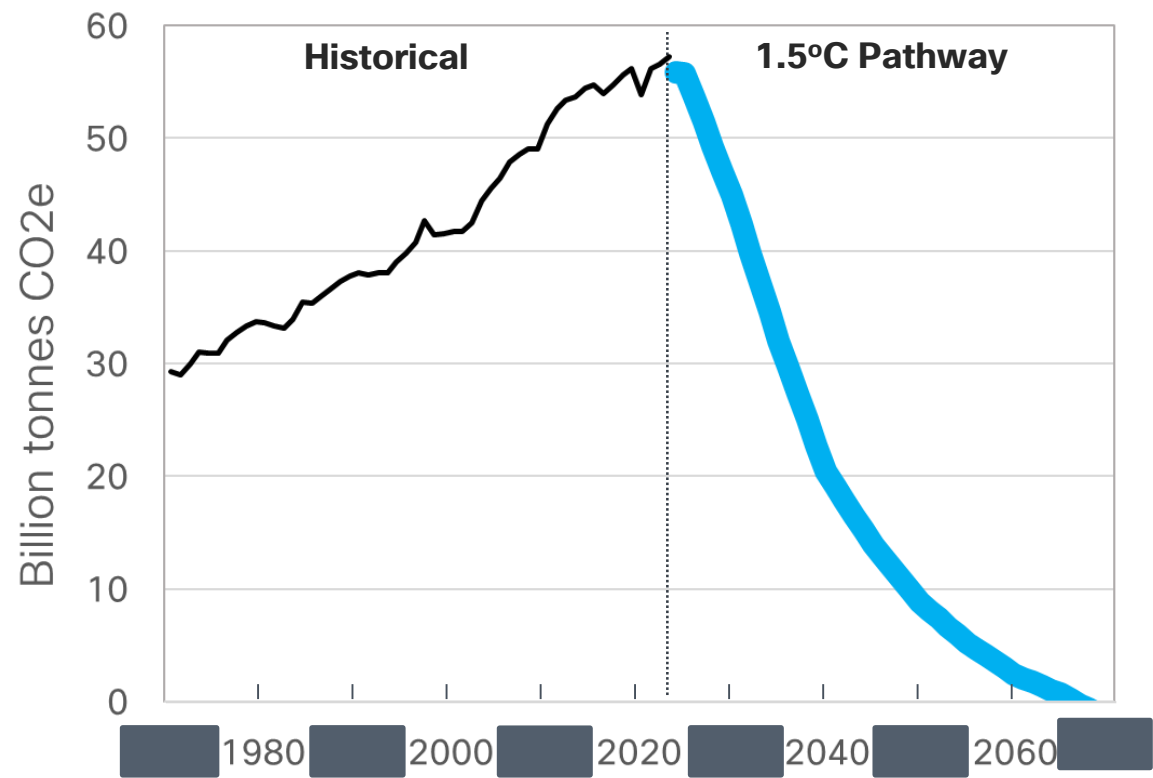Based on: Greenhouse Gas Protocol, Technical Guidance for Calculating Scope 3 Emissions

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# IT Sustainability: Real or Fake?

- Endless hunting for environmentally sustainable computing solutions

- Use of renewable energy

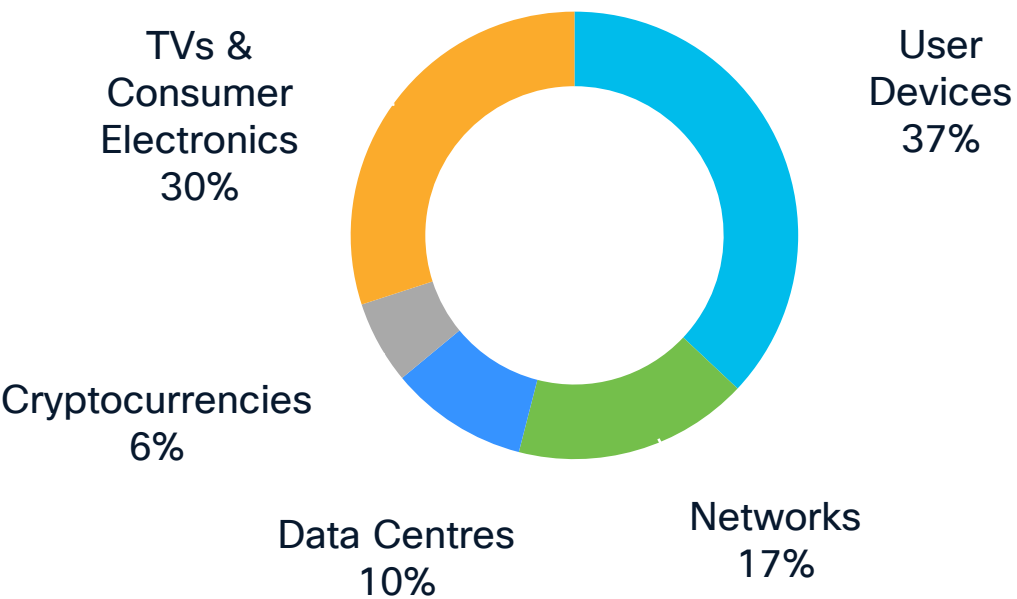- Digital transformation, global sustainability and healthy economy

# Putting IT in Perspective

## Total GHG emissions
### ~60 Billion tonnes CO2e



Historical | 1.5°C Pathway

Billion tonnes CO2e (y-axis: 0, 10, 20, 30, 40, 50, 60)

x-axis: 1980, 2000, 2020, 2040, 2060

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

## Digital GHG emissions
### ~1.2 Billion tonnes CO2e (~2.1% Total)



- TVs & Consumer Electronics 30%
- User Devices 37%
- Cryptocurrencies 6%
- Data Centres 10%
- Networks 17%

Digital = ICT + Entertainment & Media

Source: Malmodin et al (2023, 2024)

# ICT Dual Responsibility

## A Negative Calories "Food" for Sustainability

### "Sustainability in IT"

- Renewable Energy
- Data Centre Modernization
- Cloud Migration
- Energy Optimization
- Increased Asset Utilization
- Equipment Modernization
- Extended Life
- Remanufactured Equipment
- Supplier Management

**2-4%**

**15%**

### "Sustainability by IT"

- Connected Transport
- E-Work / Hybrid Work
- E-Health
- E-Learning
- E-Commerce
- Smart Buildings
- Smart Grid
- Smart Agriculture
- Smart Manufacturing

Based on Exponential Roadmap 1.5.1 (2020)
Smarter 2030 (GeSI 2015), Malmodin (2015)

# Transforming Data Center Infrastructure

Optimize efficiency, visibility, performance and cost across your networking and compute infrastructure

## Design

### Incorporate Circularity

Solutions designed to use less energy and resources, reducing waste in systems.

## Deploy

### Increase Energy Efficiency

Modern architectures enabling consolidation, power and cooling optimization and future-readiness
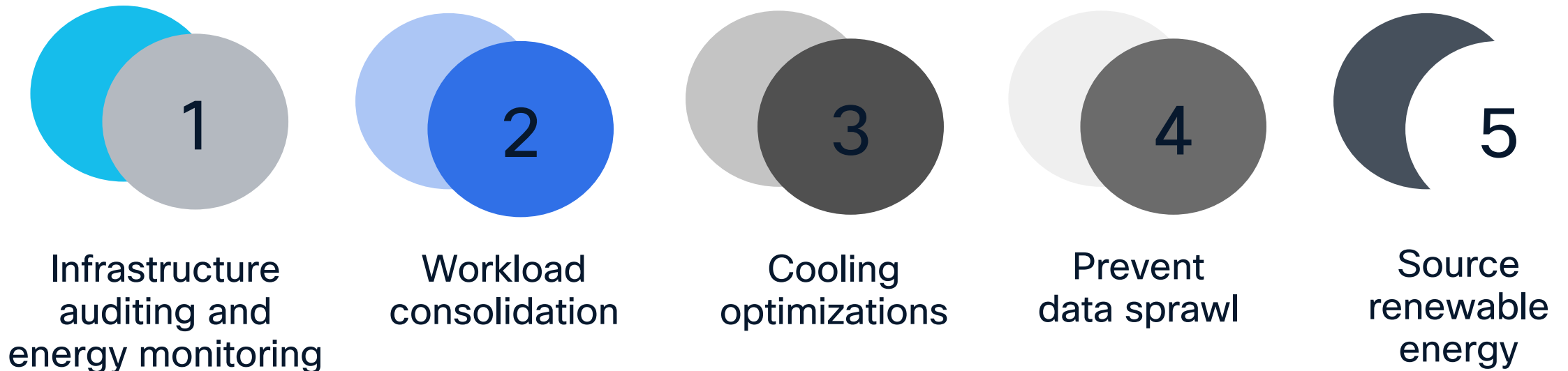
## Operate

### Monitor Sustainability Metrics

Real-time visibility of energy consumption and GHG contribution

# It is a life cycle play

# Pragmatic Approach To Data Center Sustainability

- The journey starts inside the walls of your premises

- Focus on what you can control

**1** Infrastructure auditing and energy monitoring

**2** Workload consolidation

**3** Cooling optimizations

**4** Prevent data sprawl

**5** Source renewable energy

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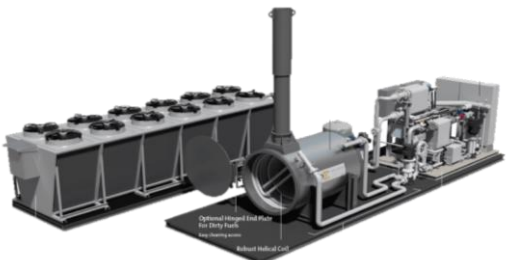
# The Shining Future ...

## 2 YEARS AGO



100 Mega Watt
Small Modular
Reactor

~30 kW racks

100 Mega Watt
Data Center

3% Heat Recovery
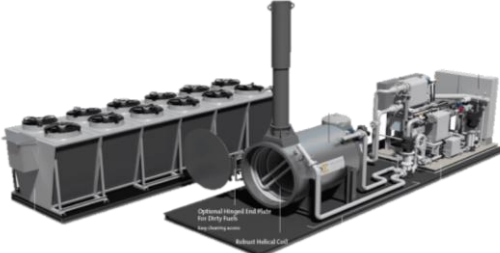Generation (HRG)
= 3+ Mega Watt

## TODAY

2.5 Giga Watt
Data Center
Utilizing Nuclear
Power

~100-200 kW
Racks

3% Heat Recovery
Generation (HRG)
= 30+ Mega Watt

**10X**

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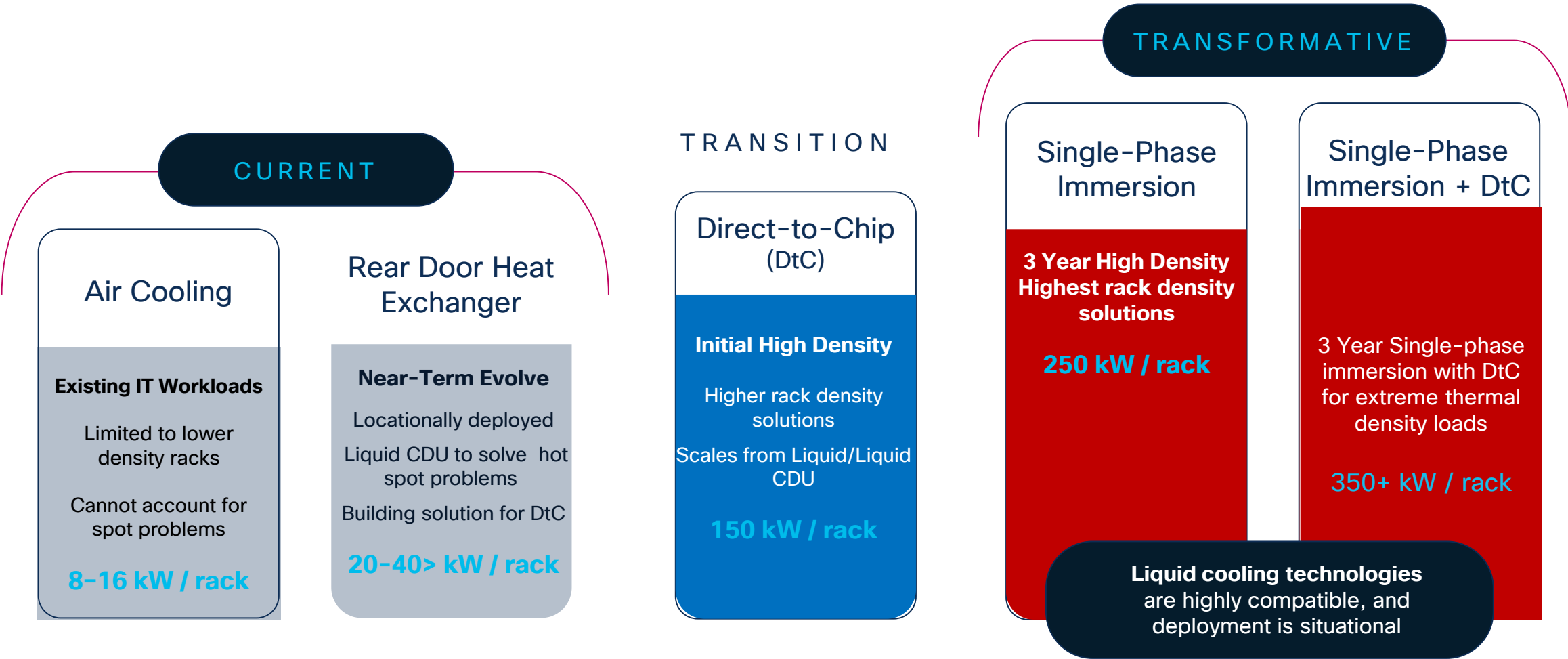
# Transition for Scaling Data Center Cooling

The journey starts where you are

**TRANSFORMATIVE**

**CURRENT**

**TRANSITION**

## Air Cooling

**Existing IT Workloads**

Limited to lower density racks

Cannot account for spot problems

**8-16 kW / rack**

## Rear Door Heat Exchanger

**Near-Term Evolve**

Locationally deployed

Liquid CDU to solve hot spot problems

Building solution for DtC

**20-40> kW / rack**

## Direct-to-Chip (DtC)

**Initial High Density**

Higher rack density solutions

Scales from Liquid/Liquid CDU

**150 kW / rack**

## Single-Phase Immersion

**3 Year High Density Highest rack density solutions**

**250 kW / rack**

## Single-Phase Immersion + DtC

3 Year Single-phase immersion with DtC for extreme thermal density loads

**350+ kW / rack**

**Liquid cooling technologies** are highly compatible, and deployment is situational

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# Energy Consumption Now A Key Concern

## Energy consumption can represent up to <u>30%</u> of IT datacenter costs
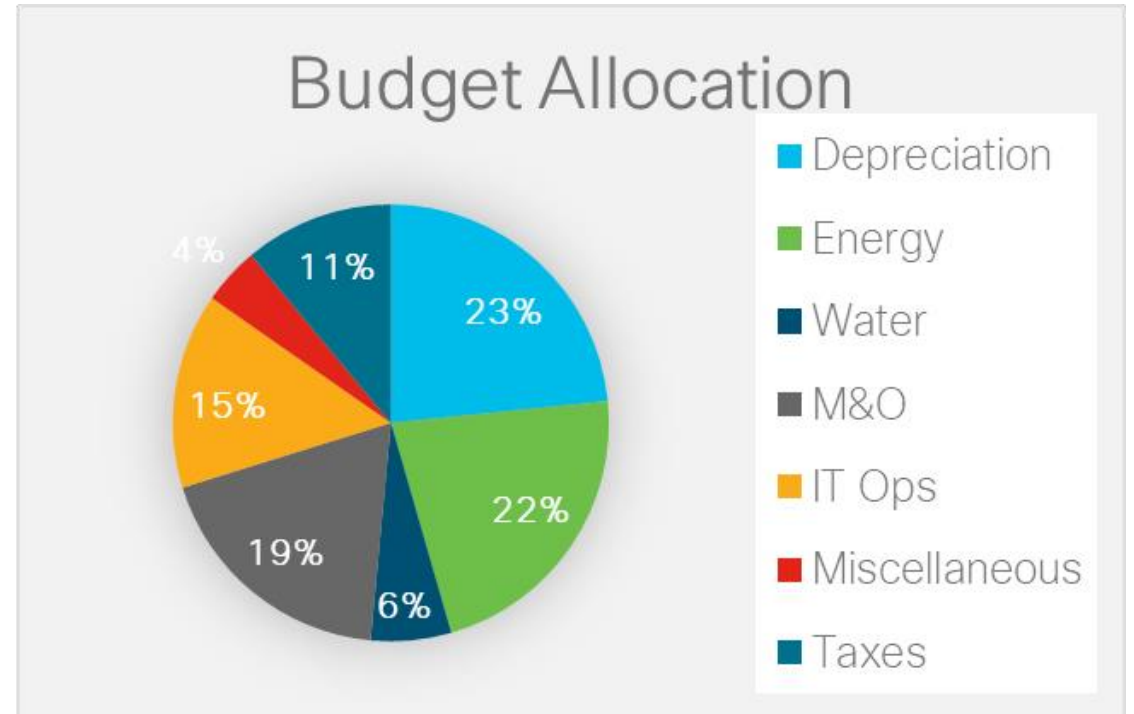




Numbers vary depending on datacenter location, mixed building vs pure datacenter, year and cost of energy

https://www.arcserve.com/blog/data-centers-what-are-costs-ownership
https://newsroom.cisco.com/c/r/newsroom/en/us/a/y2023/m06/at-cisco-live-a-journey-to-sustainability.html

# The Four Pillars of IT Operational Efficiency

$$IT_{energy\_eff} = \frac{IT\ work}{Energy}$$

Key contributors:
- Product energy efficiency
- Product utilization level
- Energy proportionality
- Service uptime

# Sustainability Is Not Just Energy Efficiency



Leading by example

CISCO Refresh

More than 99% of returned products sent to reuse or recycling
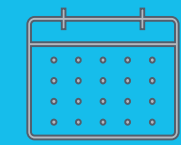
CIRCULAR & SUSTAINABLE DESIGN
Define · Planning · Research · Concept · Prototype · Deliver

Modular design   Extended use

## Circular Economy

Make

Waste is a resource
Unwanted products are remanufactured, reused, or recycled.

Use

Reuse & Recycle
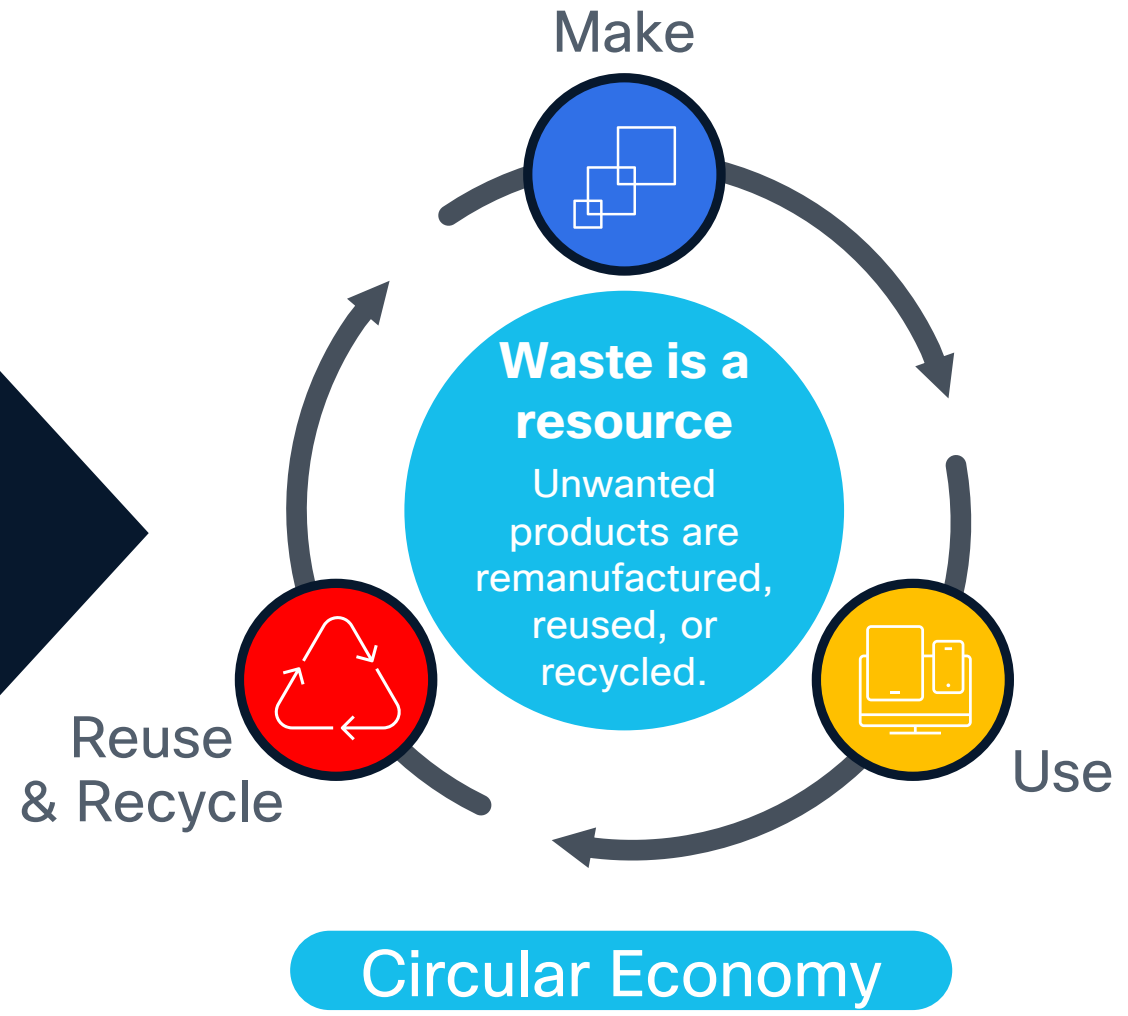
# The Plan For Possible

Key Cisco Sustainability Goals

## Clean Energy Transitions

Net zero across our value chain by 2040

Reduce absolute Scope 1 & 2 GHG emissions 90% by 2025[1]

Reduce absolute Scope 3 emissions from purchased goods and services, upstream transportation and distribution, and use of sold products 30% by 2030[1]

## Circular Transformation

100% of new Cisco products and packaging incorporate Circular Design Principles by 2025

70% of our component and manufacturing suppliers by spend will achieve a zero-waste diversion rate at one or more sites by 2025

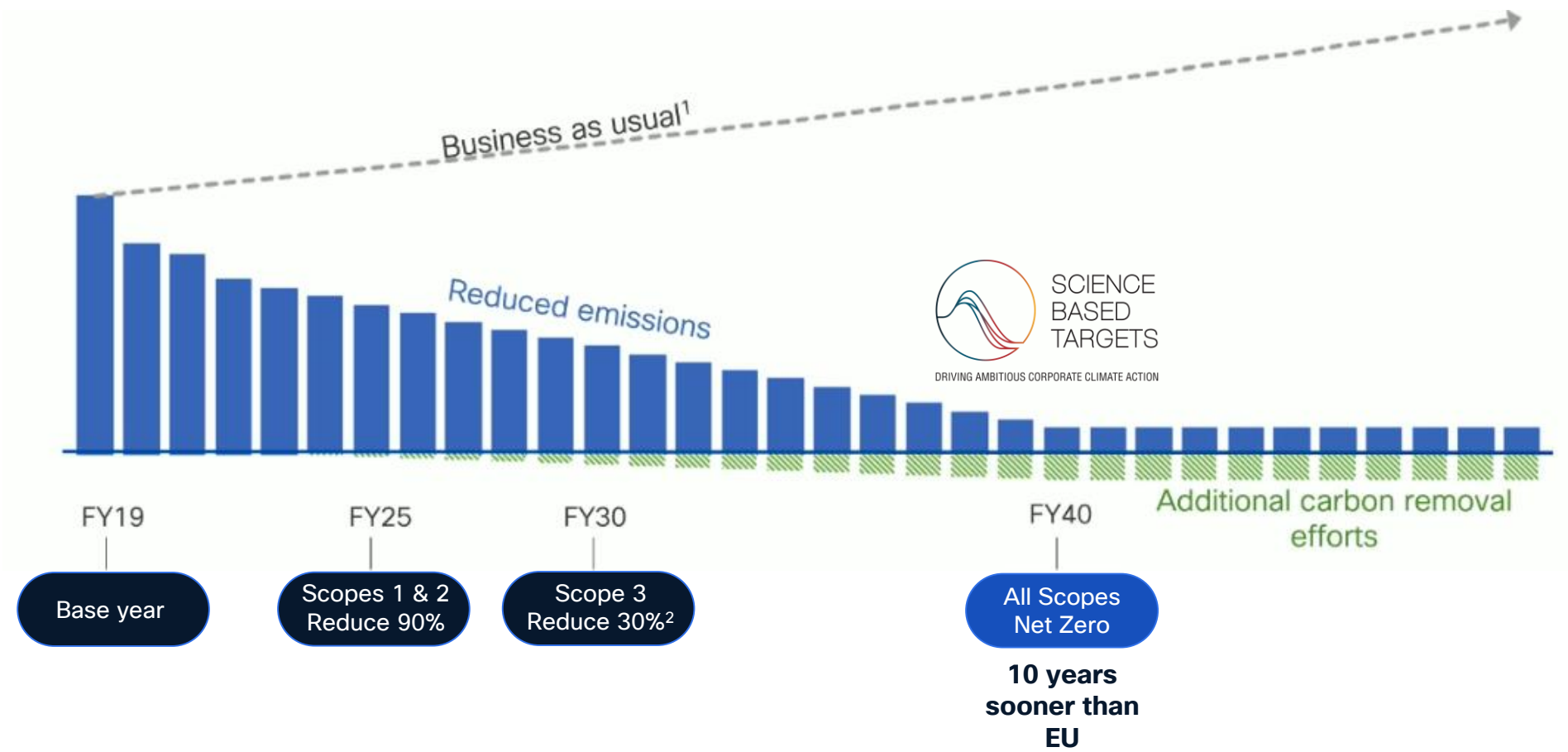50% of plastic used in our products (by weight) will be made of recycled content by 2025[2]

## Resilient Ecosystems

The Cisco Foundation will invest $100 million over 10 years to fund nonprofit grants and impact investing in climate solutions

[1] FY19 base year

[2] Excluding those plastics contained in commodity components sourced from suppliers (e.g., plastic screws, fans, and cables)

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# Cisco's Net Zero Emissions Roadmap



FY19 — Base year
FY25 — Scopes 1 & 2 Reduce 90%
FY30 — Scope 3 Reduce 30%[2]
FY40 — All Scopes Net Zero

**10 years sooner than EU**

Business as usual[1]

Reduced emissions

SCIENCE BASED TARGETS
DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

Additional carbon removal efforts

[1] This chart is for illustrative purposes only. BAU assumes a 1.7% annual growth across all scopes of emissions, based on 2022 European Commission data showing the average yearly percentage growth of $CO_2$ emissions between 1990 and 2021.

[2] The baseline and progress reported for our fiscal 2030 goal includes a subset of Scope 3 Category 1 (purchased goods and services from manufacturing, component, and warehouse suppliers), a subset of Scope 3 Category 4 (upstream transportation and distribution from Cisco purchased air transportation), and all of Scope 3 Category 11 (use of sold products).

# Cisco Product Design Initiatives for Sustainability



Improve power efficiency

Compliance and eco-labels

Data-driven sustainability approach and tooling

Modularity, reliability, repairability and extended lifetime

Committed to 100% product return, less e-waste

Partner enablement, certifications and sales programs around sustainability

Circular design principles into 100% of new products and packaging by FY25
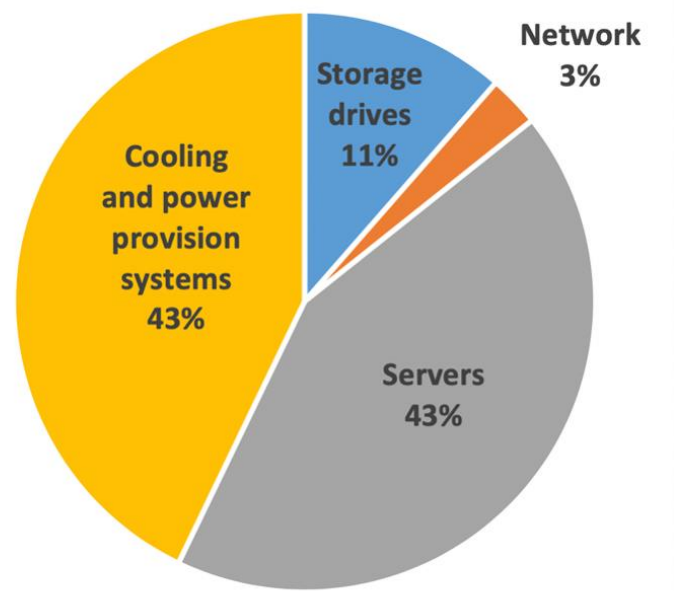
Software-driven IT assets optimizations

Rethinking recycling: plastic reduction in products and packaging, recycled plastic
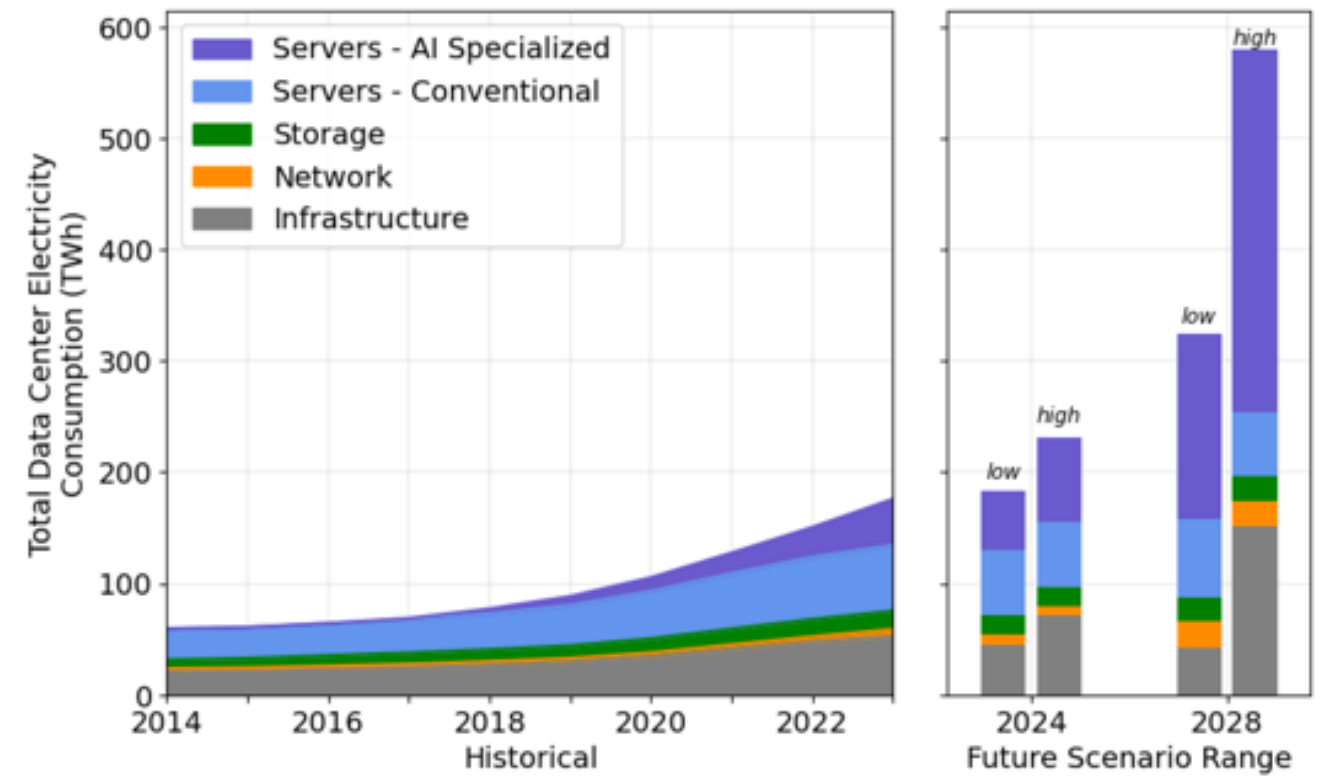
# More Sustainable Computing Makes An Impact

Last 10 years, including AI Scenario
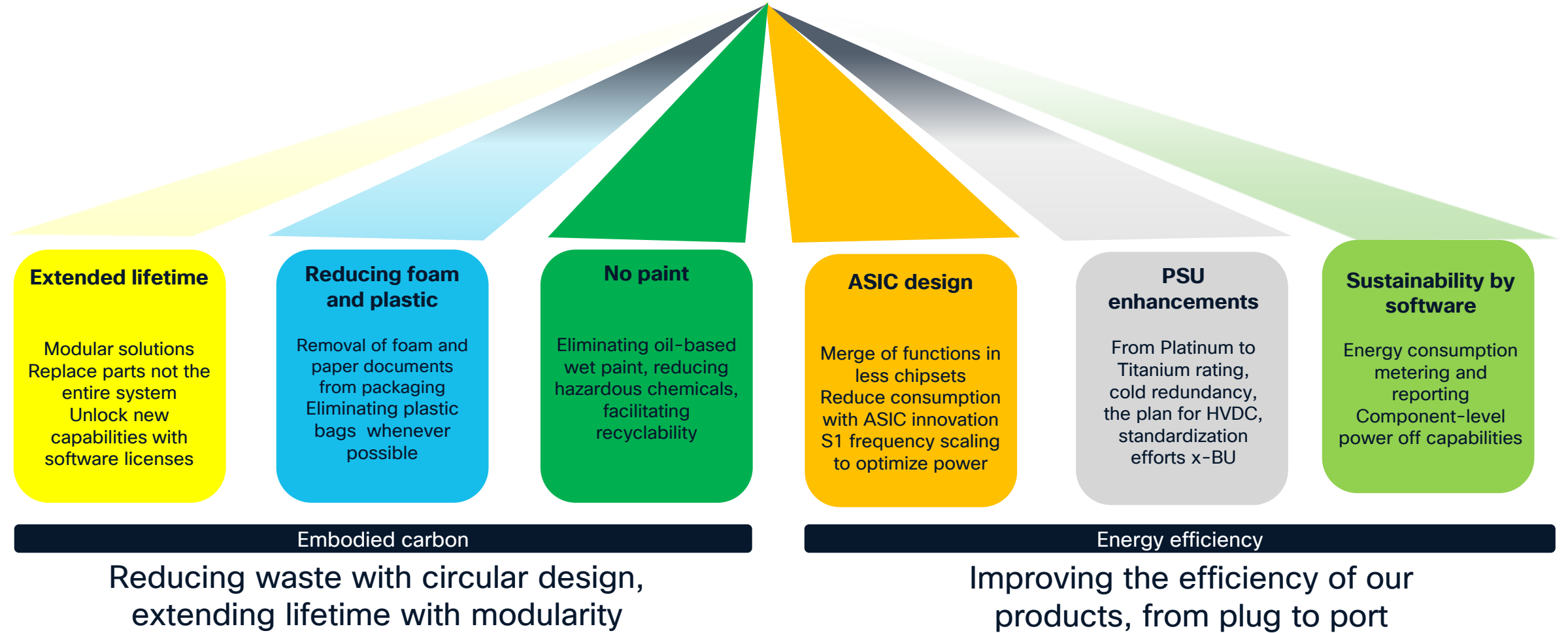
**PUE = 1.75 in 2014, trending down**



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 Networking Product Sustainability

Lower embodied carbon, less material waste

**Extended lifetime**

Modular solutions
Replace parts not the
entire system
Unlock new
capabilities with
software licenses

**Reducing foam
and plastic**

Removal of foam and
paper documents
from packaging
Eliminating plastic
bags whenever
possible

**No paint**

Eliminating oil-based
wet paint, reducing
hazardous chemicals,
facilitating
recyclability

**ASIC design**

Merge of functions in
less chipsets
Reduce consumption
with ASIC innovation
S1 frequency scaling
to optimize power

**PSU
enhancements**

From Platinum to
Titanium rating,
cold redundancy,
the plan for HVDC,
standardization
efforts x-BU

**Sustainability by
software**

Energy consumption
metering and
reporting
Component-level
power off capabilities

Embodied carbon

Energy efficiency

Reducing waste with circular design,
extending lifetime with modularity

Improving the efficiency of our
products, from plug to port

Note: plan of work, some capabilities not yet available
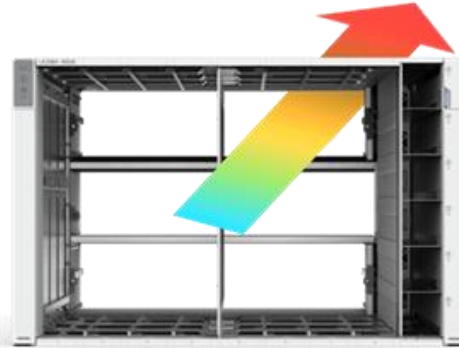
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# UCS X-Series Architecture

Reducing materials, innovating with cooling and power distribution
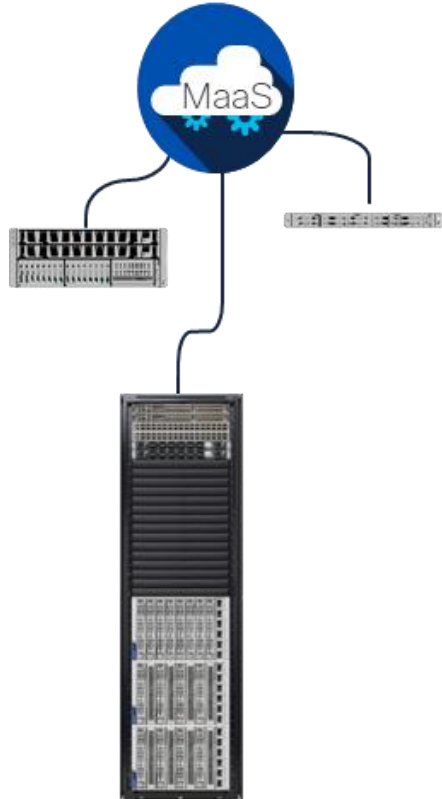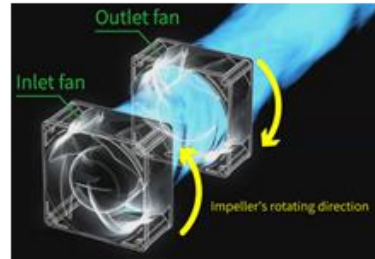


MaaS

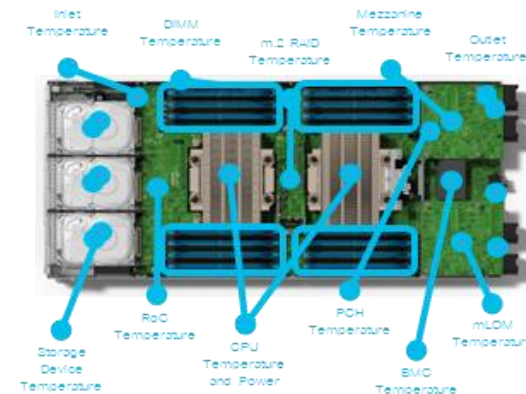Top PSU efficiency

No midplane obstruction
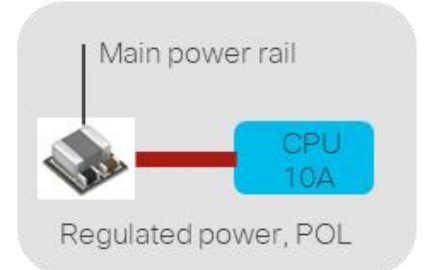
Zone-based cooling

Optimized power distribution

Cloud-based MaaS

Unified fabric

Management / Ethernet / Storage

Dual counter-rotating fans

Outlet fan / Inlet fan / Impeller's rotating direction

Multiple localized sensors

Inlet Temperature / DIMM Temperature / m.2 RAID Temperature / Mezzanine Temperature / Outlet Temperature / Storage Device Temperature / RoC Temperature / CPU Temperature and Power / PCH Temperature / BMC Temperature / mLOM Temperature

POL voltage regulators

Main power rail / Regulated power, POL / CPU 10A

# Cisco M7 Energy Efficiency Optimizations

Higher workload consolidation leads to energy, footprint and TCO savings

- Technological improvements, higher core count, scalable GPU support, PCIe 5.0

Optimized heat sinks and overall airflow design

- Supports top bin CPUs with no memory limitation
- Postpone liquid cooling adoption with air cooling efficiency

DDR5 memory enhanced performance and power efficiency

- Higher bandwidth facilitates consolidation, 30% higher power efficiency

Intel 4th and 5th Gen Xeon Scalable Processors improved energy profile
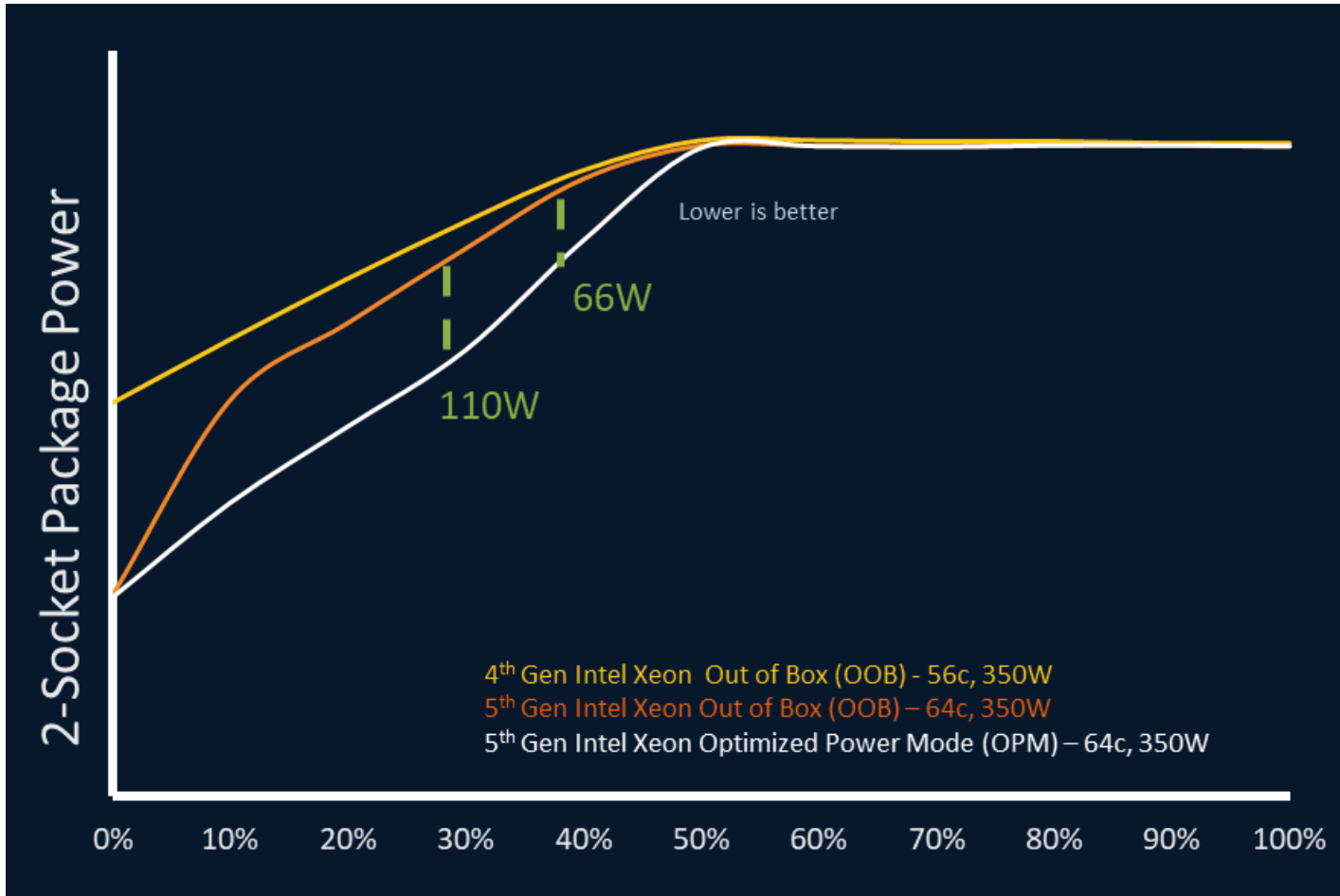
- Application accelerators: boost performance at the same power level for selected workloads

New BIOS-level power saving mode, configurable by policy with Intersight or UCSM

- Leverage Optimized Power Mode: tangible power savings with minimal performance impact

# Higher Efficiency At Lower Server Utilization



Chart axes: Y-axis "2-Socket Package Power", X-axis from 0% to 100%. Annotations: "Lower is better", "66W", "110W".

Legend:
- 4th Gen Intel Xeon Out of Box (OOB) - 56c, 350W
- 5th Gen Intel Xeon Out of Box (OOB) – 64c, 350W
- 5th Gen Intel Xeon Optimized Power Mode (OPM) – 64c, 350W

- 5th Gen Xeon architecture delivers improved Performance/Watt out of the box

- Reduced idle power over 4th Gen Xeon

- Optimized Power Mode 2.0, lower power & cooling costs

- At 30-40% utilization, realize up to 110W server power savings

- Easy button configuration with Intersight or UCSM

Source: Intel. Results measured by Intel on Intel Reference Systems. Results may vary.

# Consolidation With High Core Count AMD CPUs

Enterprise-class modular UCS X-Series M8 compute node with AMD chipsets for compute-intensive workloads

**Industry Unique**

**Greater workload consolidation**

leading to energy efficiency and power savings

**More cores per CPU**

for fast performance, even with single socket servers

**Advanced security features**

with AMD Infinity Guard and AMD Secure Encrypted Virtualization

**Management at scale**

through Cisco Intersight cloud operations platform

**World-record performance**

including 17 performance world records

**Excellent economics**

with low OpEx and efficient software licensing costs

AMD EPYC CPU

Genoa - Bergamo - Turin

# Consolidation to M7: Impact on Sustainability
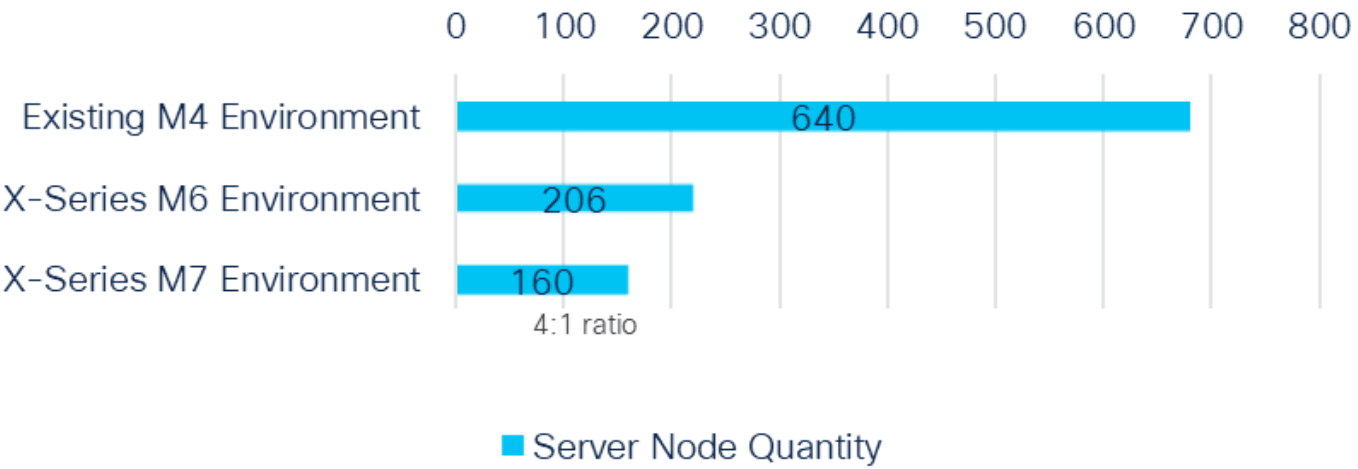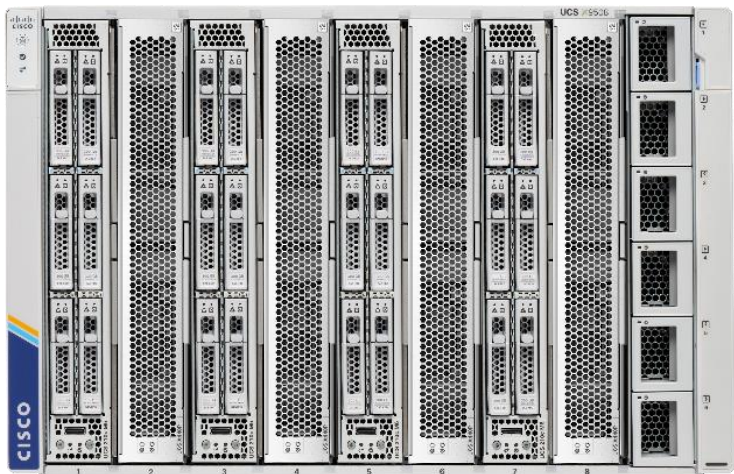


Assumed 50% load on both old and new hardware

Server Node Quantity:
- Existing M4 Environment: 640
- X-Series M6 Environment: 206
- X-Series M7 Environment: 160 (4:1 ratio)

**856,921 kWh of energy reduced**

**Avoiding 317 MtCO$_2$e**

**Up to 15x less hardware vs competing rack servers
Significant reduction in weight and raw materials**
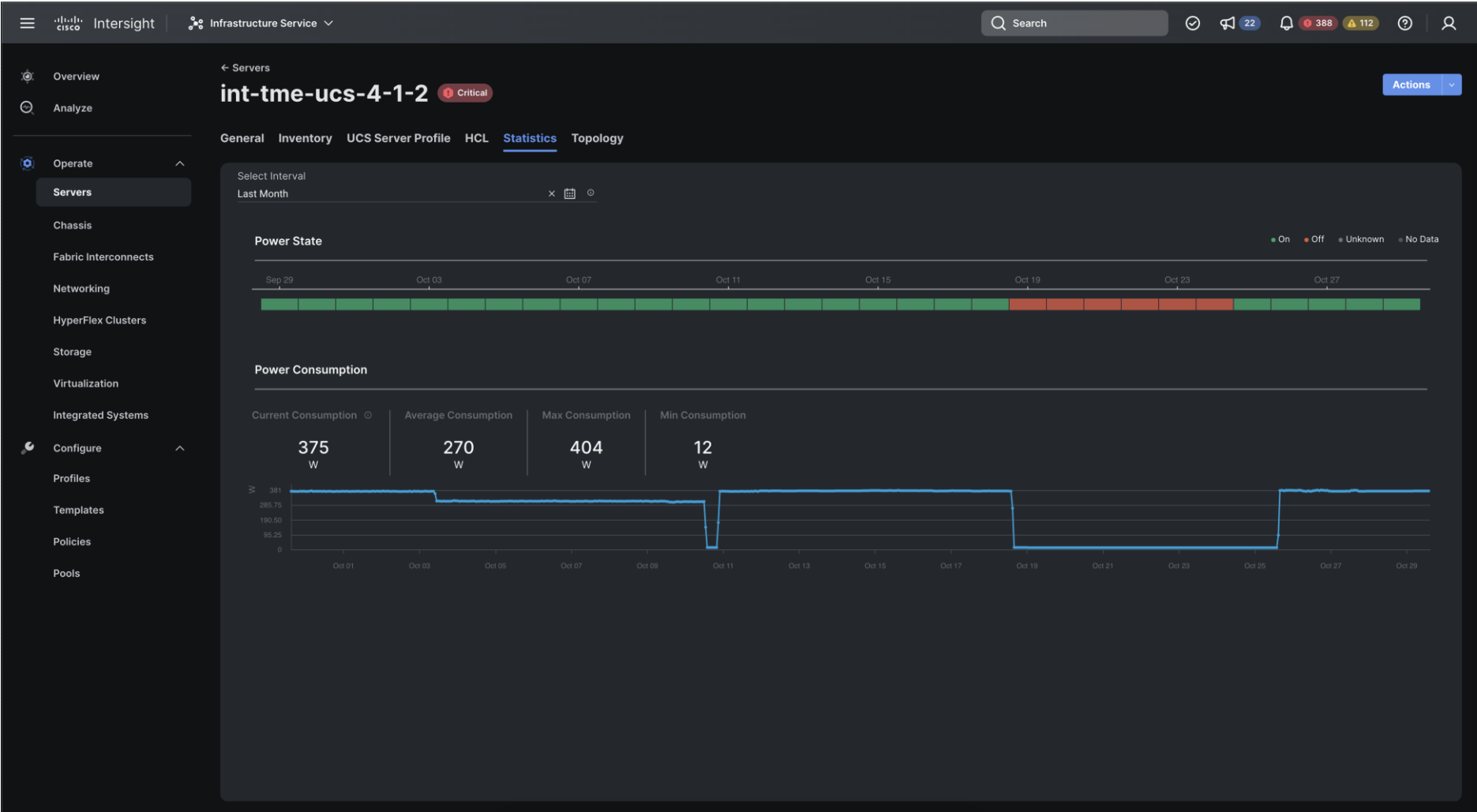
Source: UCS power calculator and EPA conversions

# Intersight Energy and Power Metrics

- Entire Infrastructure view of power usage and history

- Default view of widgets and collected data

- More enhancements planned
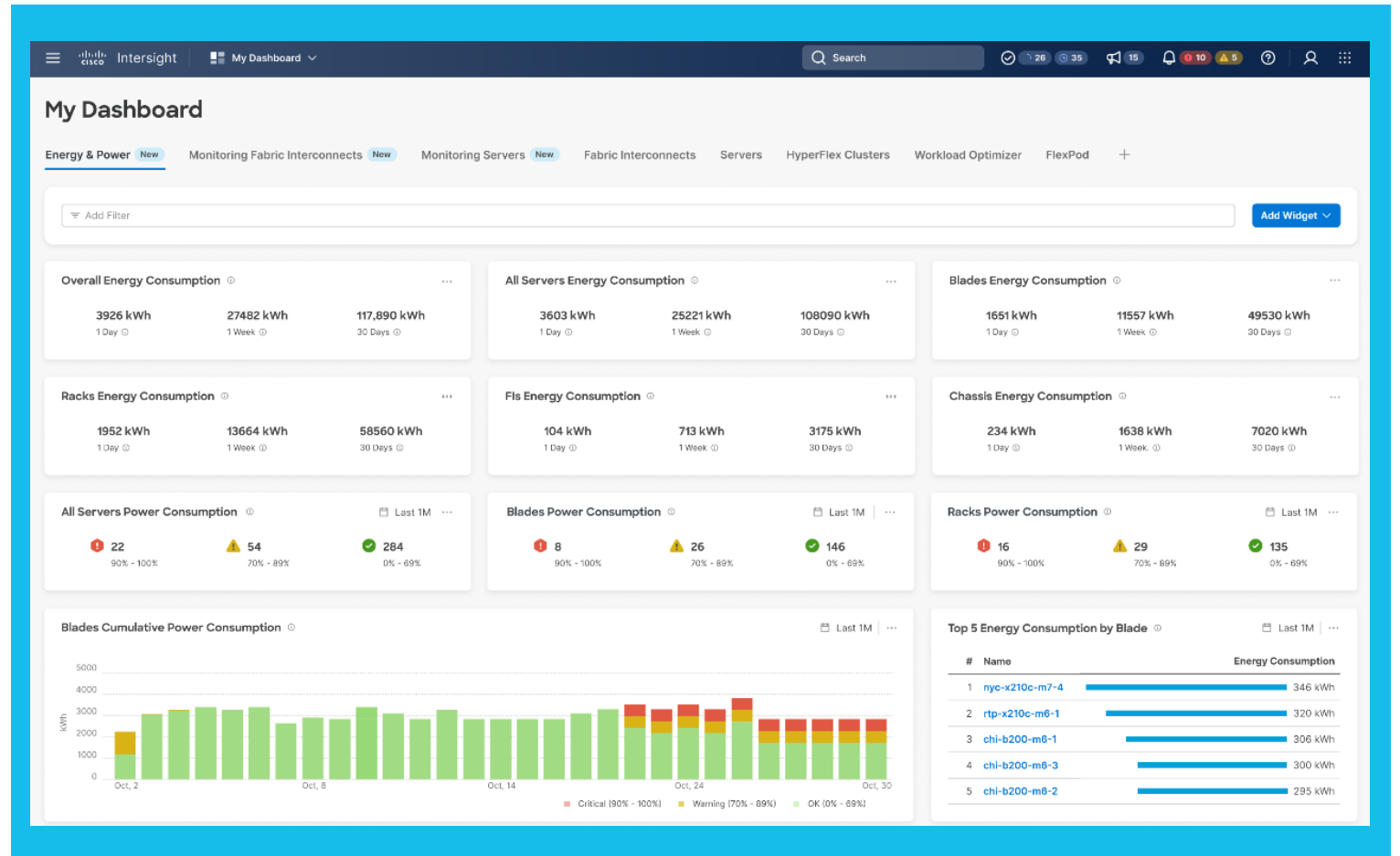


"Visual is for illustrative purposes only."

# Visibility & Trending Server Power Utilization



"Visual is for illustrative purposes only."

# UCS X-Series: Award Winning Compute System

## Computing Purpose-Built for a More Sustainable, AI-Powered Future



**Powered by Intel Xeon and AMD EPYC processors**

Silverlinings cloud innovation award_2023

Category winner for innovative and impactful products that are literally "purpose-built" for a more sustainable future

One of the best servers in the market for customers making purchasing and deployment sustainability benefits

The X-Series' modular design means fewer things to build, transport, power, and dispose of at the end of their useful life



Seal_business_sustainability_awards_2023

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# The Only Power Efficient Cloud Networking Portfolio

Cloud Networking

**Cisco Nexus 9000 and MDS 9000 portfolio of modular directors and fixed fabric switches**

Selected models only

| Load | 80 plus basic | Bronze | Silver | Gold | Platinum | Titanium |
|------|---------------|--------|--------|------|----------|----------|
| | | | | Efficiency | | |
| 10% | - | - | - | - | - | 90.00% |
| 20% | 80.00% | 81.00% | 85.00% | 88.00% | 90.00% | 94.00% |
| 50% | 80.00% | 85.00% | 89.00% | 92.00% | 94.00% | 96.00% |
| 100% | 80.00% | 81.00% | 85.00% | 88.00% | 91.00% | 91.00% |

From wall plug      To chassis

PSU

Power efficiency by design

>94%
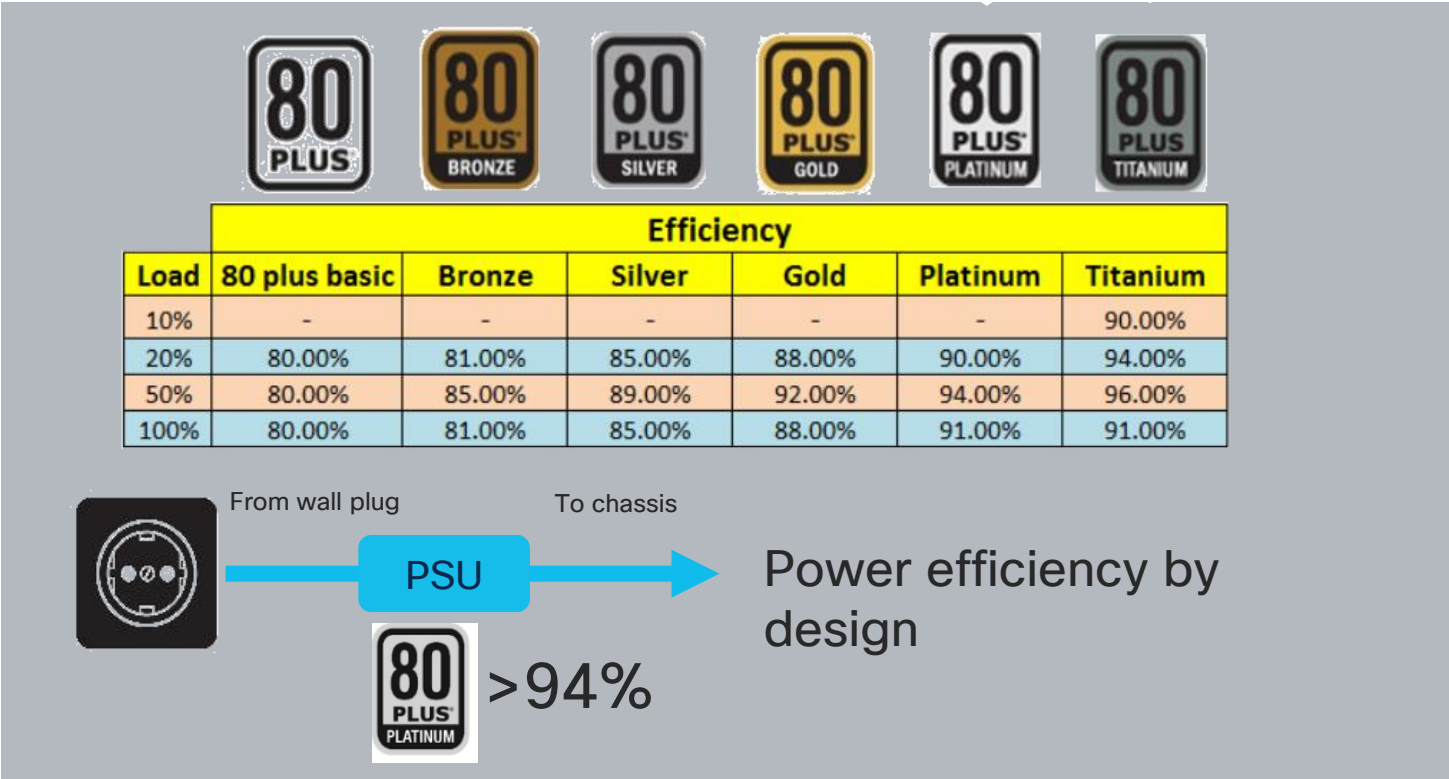
# Cisco Cloud Networking

Generational improvement in efficiency

2017

C9336C-FX2 – 36x100GE

9W / 100GE

**60%**

**5W** / 100GE

C9332D-GX2B – 32x400GE

2021

**Silicon One Q200**

**59x**
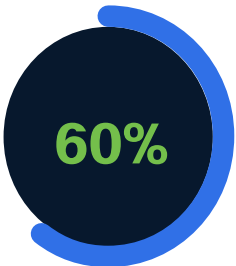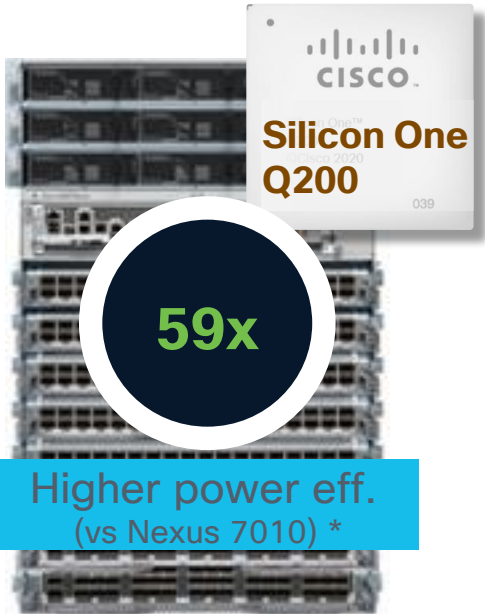
Higher power eff.
(vs Nexus 7010) *

Nexus 9808
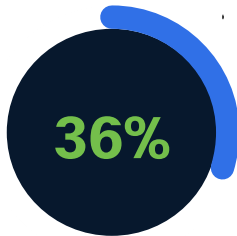
HBM
Package Substrate
PCB
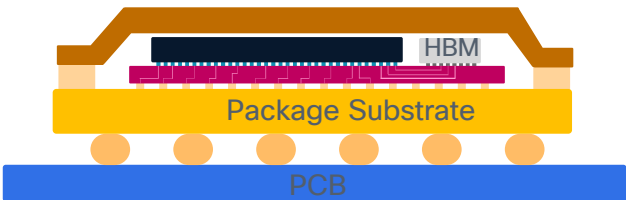
Silicon One w/HBM

Silicon Photonics

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

**36%**

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

Cisco Sustainable Solutions ebook 2022

# DC Architecture Sustainability w/ Breakouts

Cisco-Panduit-Keysight case study
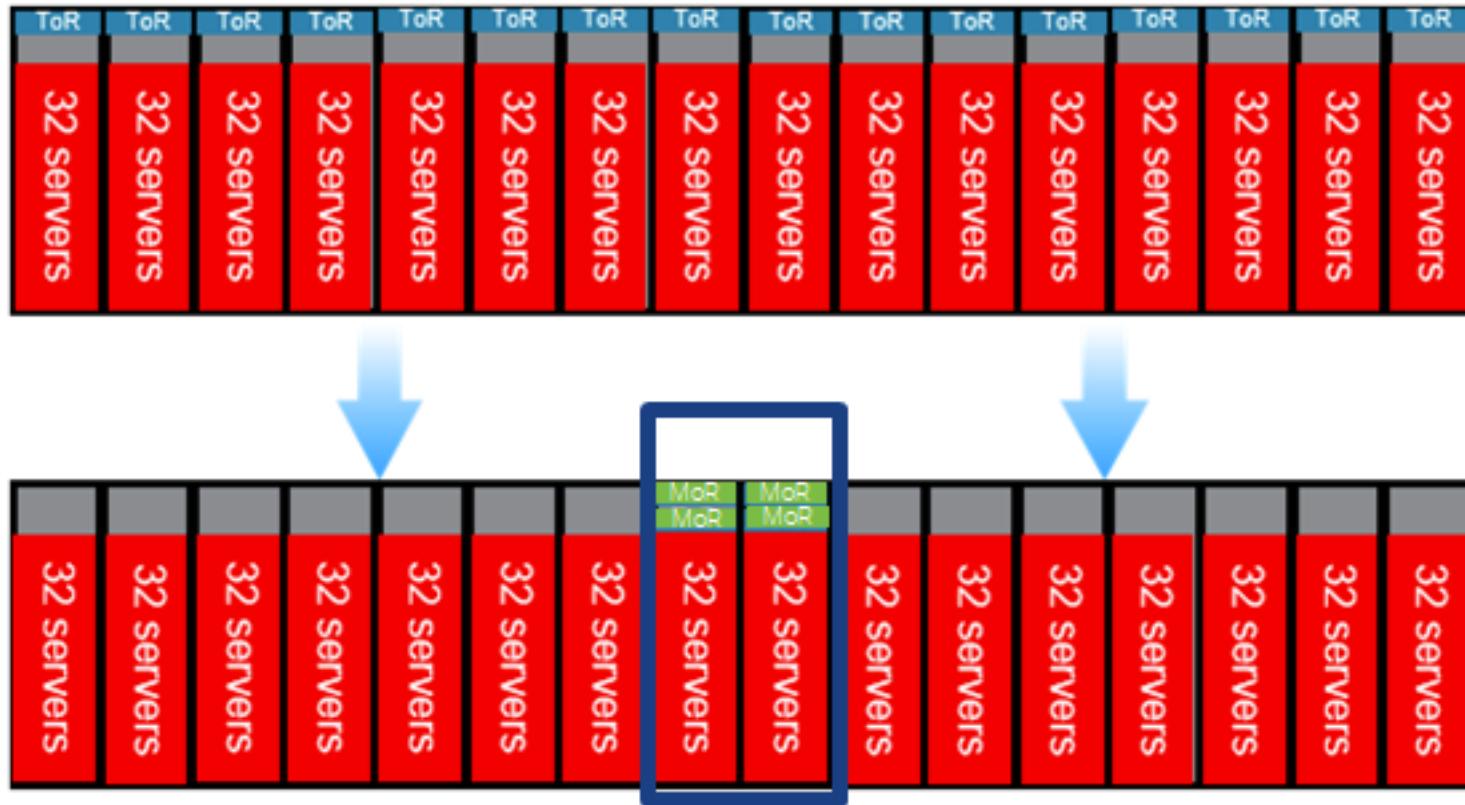


- *Scenario setup - 32 1RU servers per cabinet 16 Cabinet Row*
- 32 downlinks 16 uplinks  2:1 oversubscription

**Traditional Architecture**
- One 100G Nexus 9364C-GX ToR switch (2RU) per cabinet
- 16 switches for the row
- One port per server
- Each switch serving 32 servers

**New Architecture**
- Four 400G Nexus 9364D-GX2A MoR switches (2RU) per (16) cabinets
- One port can service 4 servers with 4 to 1 (SR4.2) breakouts
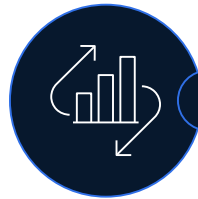- Each switch serving 128 servers

**Power savings ***
- 8.68kW (or a 53.3%) per row

* <u>Energy optimized and scalable breakout architecture</u>
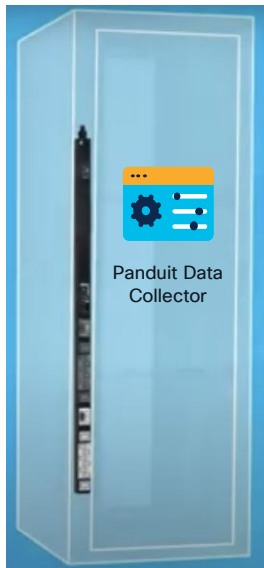
# Cisco Nexus Dashboard – Operate

Leverage the power of telemetry and analytics
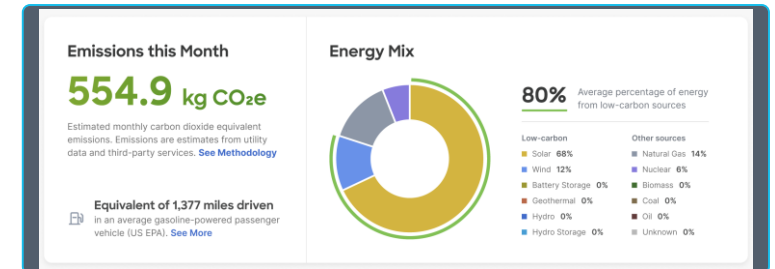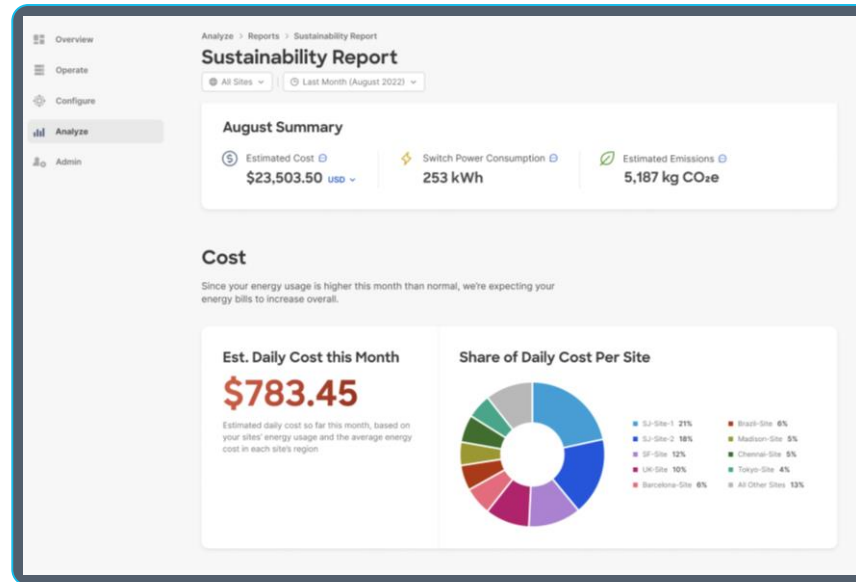


Analytics

**Analyze**
Sustainability

Understand the GHG emissions from electricity consumption of managed devices

Learn about the energy sources your sites consume

Get historical views and progress, including energy consumed and cost

Integrate to Panduit PDUs for increased visibility

Panduit Data Collector

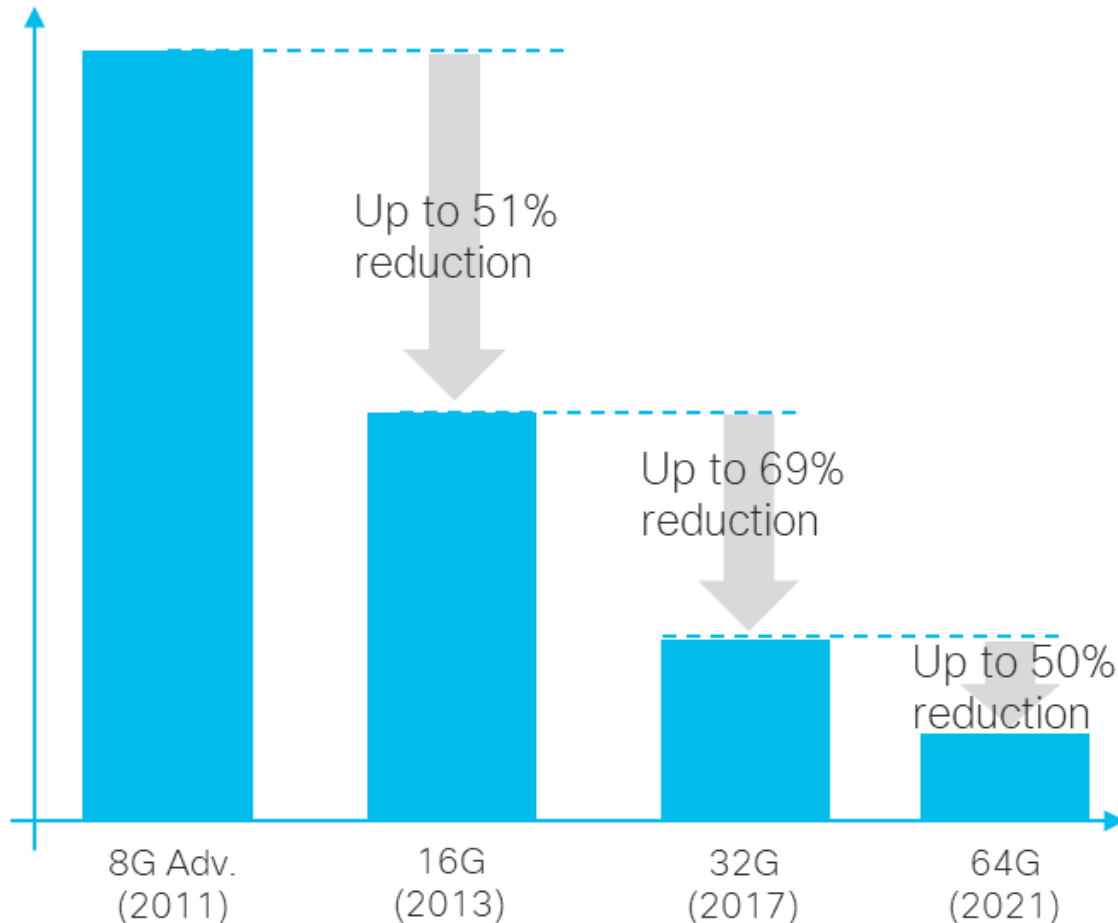Cisco Nexus Dashboard

# Innovation Driving Efficiency Gains Over 10 years

Storage Networking with MDS 9000 Series

$gCO_2e/TB$ emissions

Up to 51% reduction

Up to 69% reduction

Up to 50% reduction

8G Adv. (2011)

16G (2013)

32G (2017)

64G (2021)

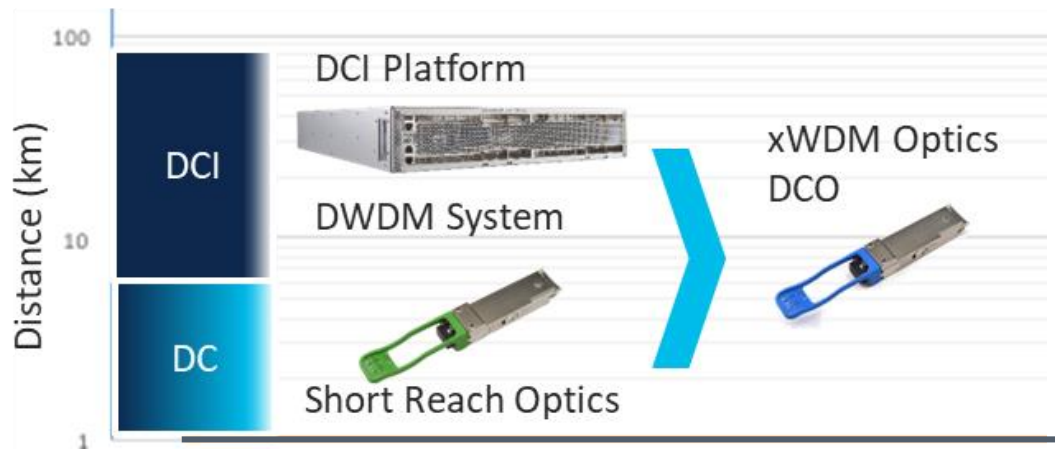Reduce GHG emissions by approximately 92%* compared to previous solutions

Notable milestones ☁️

1. Visualize real-time environmental data
2. Improve ASIC efficiency at each iteration
3. Include energy optimizations by software

*Source: Cisco calculations

CISCO

# More Sustainable Optical Networking

## Extended Reach Optics



- Save raw materials of external optical transport solutions, cutting weight by up to 95%

- Cut energy consumption by up to 80% in the optical layer by using DCO

- Backward compatibility with existing switches

- Multiple speeds and distances supported

## 100G Single Lambda and Breakout
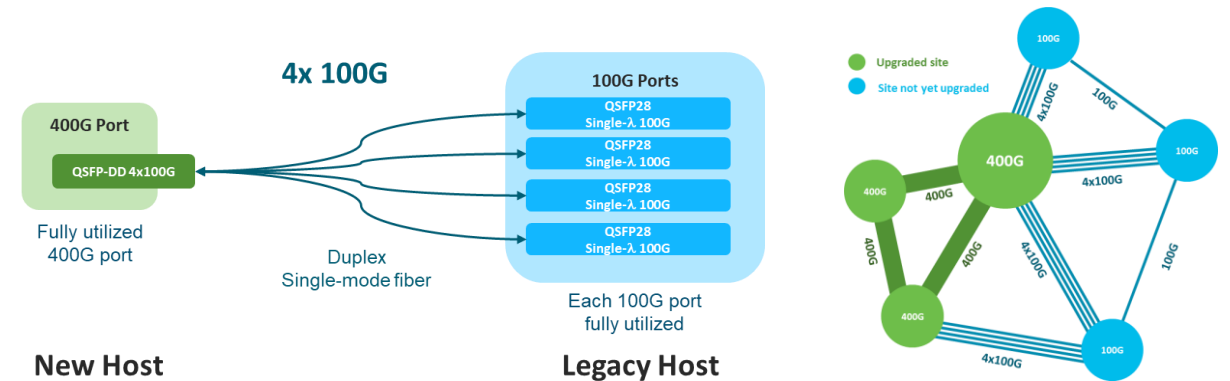


- Split high-speed signals with optical breakout cables, patch panels as alternative to breakout cables

- Upgrade your network when needed, reuse of 100G single lambda optics while connecting to 400G ports

- Reuse of lower speed optics inside 400G switches

- Save 6 watts while going 400G vs 4x 100G

# Case Study: ClusterPower



clusterpower

## Who

- ClusterPower owns and operates the first Tier III data center in Romania



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**ClusterPower Advances IT Sustainability**

Romania's first hyperscale data center is powered by green energy.

## Challenges

- Establish Romania's first hyperscale data center
- Improve sustainability with clean energy
- Support the largest and highest performance digital projects and workloads

## Solution

- Cisco UCS X-Series Modular System
- Cisco Application Centric Infrastructure (ACI)
- Cisco Intersight cloud operations platform

## Results

- Built Southeastern Europe's first Tier III data center
- Achieved a Power Usage Effectiveness (PUE) rating of 1.1
- Created a blueprint for regional expansion

Source: https://www.cisco.com/c/en/us/about/case-studies-customer-success-stories/clusterpower.html

# Datacenter Sustainability with Cisco Technologies

## The why

- We must limit temperature increase at 1.5°C
- 83% of companies have sustainability as one of top criteria for IT buying decisions
- CIOs rely on infrastructure vendors to help them meet their ESG goals
- High energy cost, scarcity of raw materials

## Cisco ambitious sustainability goals

- Net zero by 2040 (SBTi validated)
- 90% reduction for Scope 1 and 2 GHG emissions by 2030
- 50% plastic recycled by 2025
- 98% reuse/recycle of take-back IT assets
- Helping customers decarbonize their supply chain
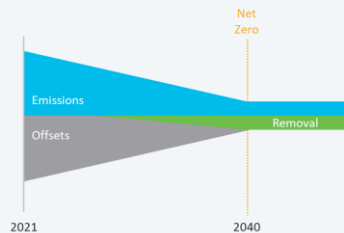


## Sustainability programs

- Cisco Refresh
- Cisco Green Pay
- Send IT back
- Cisco Plus
- Environmental Sustainability Specialization
- Sustainability Black Belt Academy training
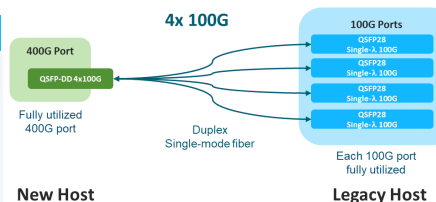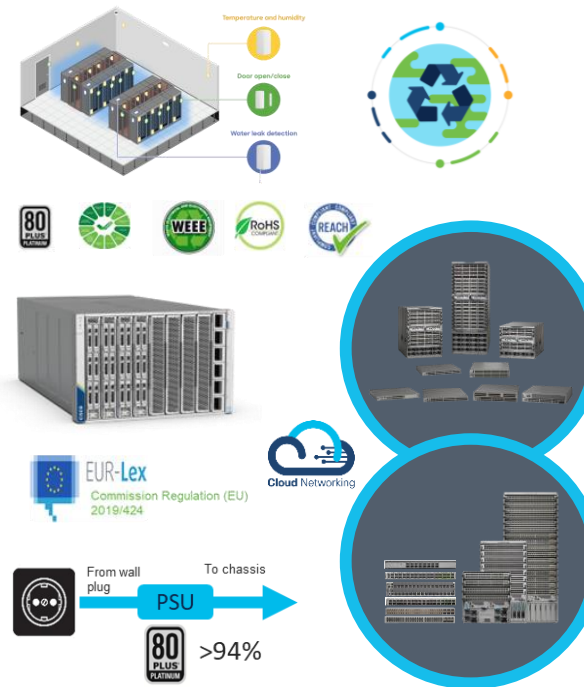
## Where power goes
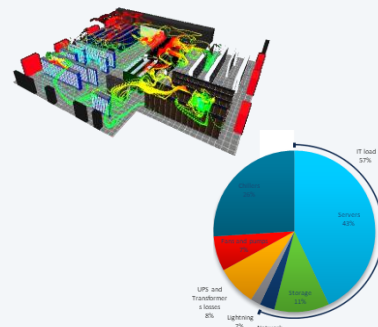


## Cisco business direction

- Power efficient infrastructure
- Raw materials savings and extended lifetime
- Software tools for IT assets optimization with continuous and automatic monitoring
- Packaging optimizations
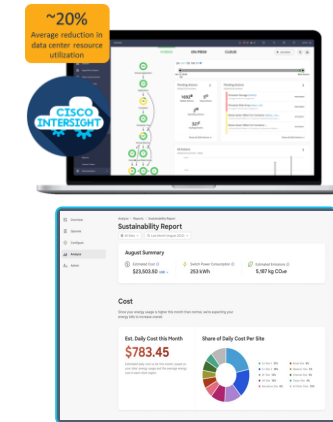- Digitization of industries
- Sustainability programs

## Cisco Technologies

- UCS X series
- Nexus and MDS
- Nexus Dashboard, Intersight
- Silicon photonics
- Meraki sensors for datacenter



EUR-Lex
Commission Regulation (EU) 2019/424

From wall plug → PSU → To chassis
80 PLUS PLATINUM >94%

**4x 100G**

400G Port
QSFP-DD 4x100G
Fully utilized 400G port

100G Ports
QSFP28 Single-λ 100G
QSFP28 Single-λ 100G
QSFP28 Single-λ 100G
QSFP28 Single-λ 100G

Duplex Single-mode fiber
Each 100G port fully utilized

New Host — Legacy Host

DCI Platform
DWDM System
Short Reach Optics
xWDM Optics
DCO

## Cisco IT sustainability framework

- 100% renewable energy in US, 72% at worldwide level
- Growing on-site solar panels (~1.8MW), planning for 10MW
- 38% less datacenters, 40% reduced monthly power capacity
- 27% power reduction per VM
- 90% patch cables recertified
- 1,813 Cisco UCS servers sold for reuse
- Infrared scanning to identify heat leakages

~20% Average reduction in data center resource utilization

CISCO INTERSIGHT

Sustainability Report
August Summary
Cost
Est. Daily Cost this Month
$783.45

## Testimonials

- Cisco on Cisco: Cisco IT sustainability framework
- Partnership: BT and Cisco expand business e-waste takeback service
- Case study: WPP
- Case study: ClusterPower

# Complete your session evaluations

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**Contact me at**: adurai@cisco.com

Thank you

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