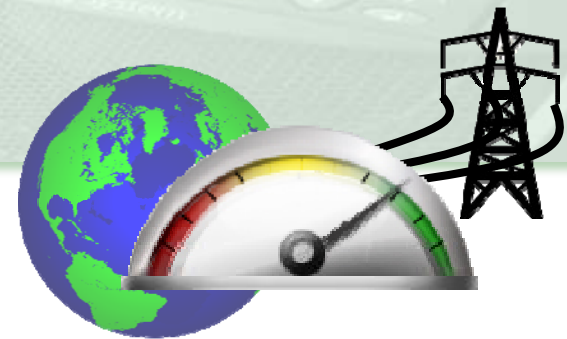


Greening of the Data Center

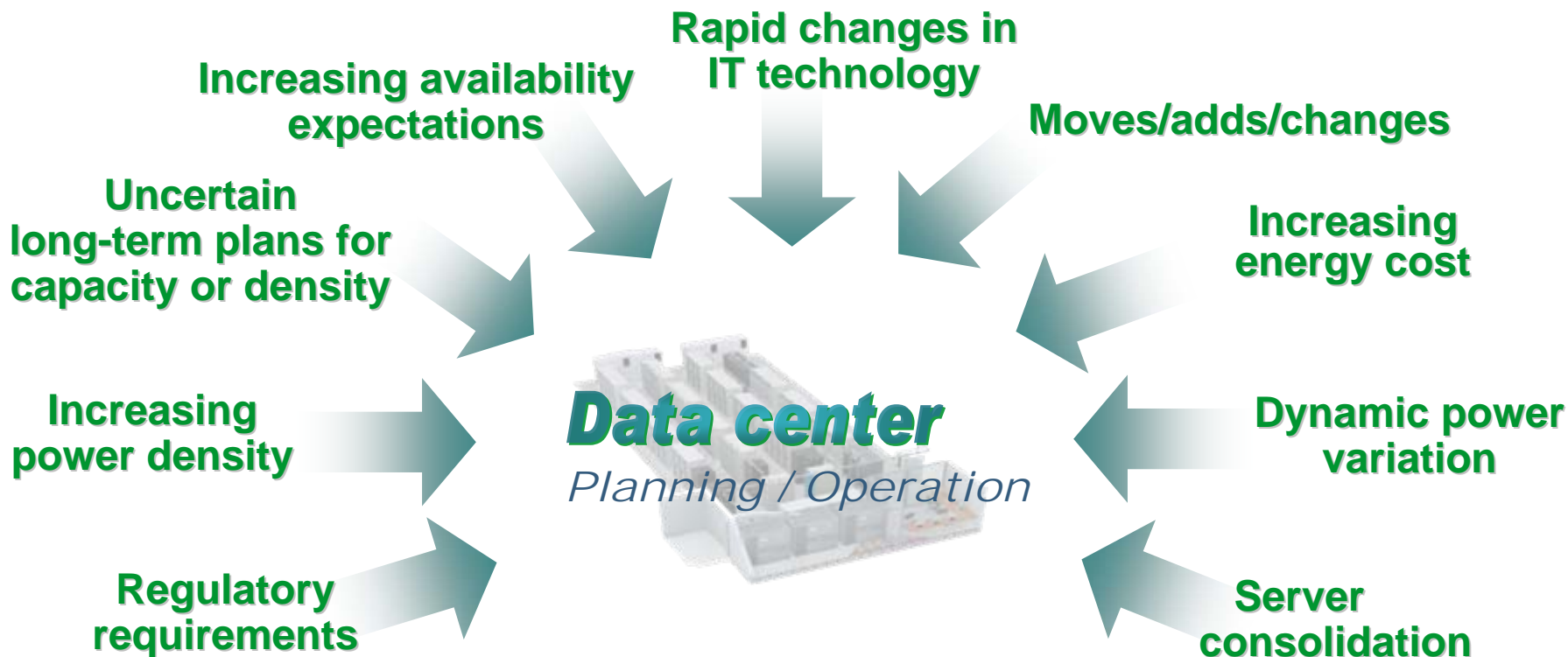
Are my current data centers efficient?

Reducing energy consumption

The ROI of efficiency improvement



Most pressures on data centers affect efficiency



We must change the way we design, install, operate, manage, and maintain data centers

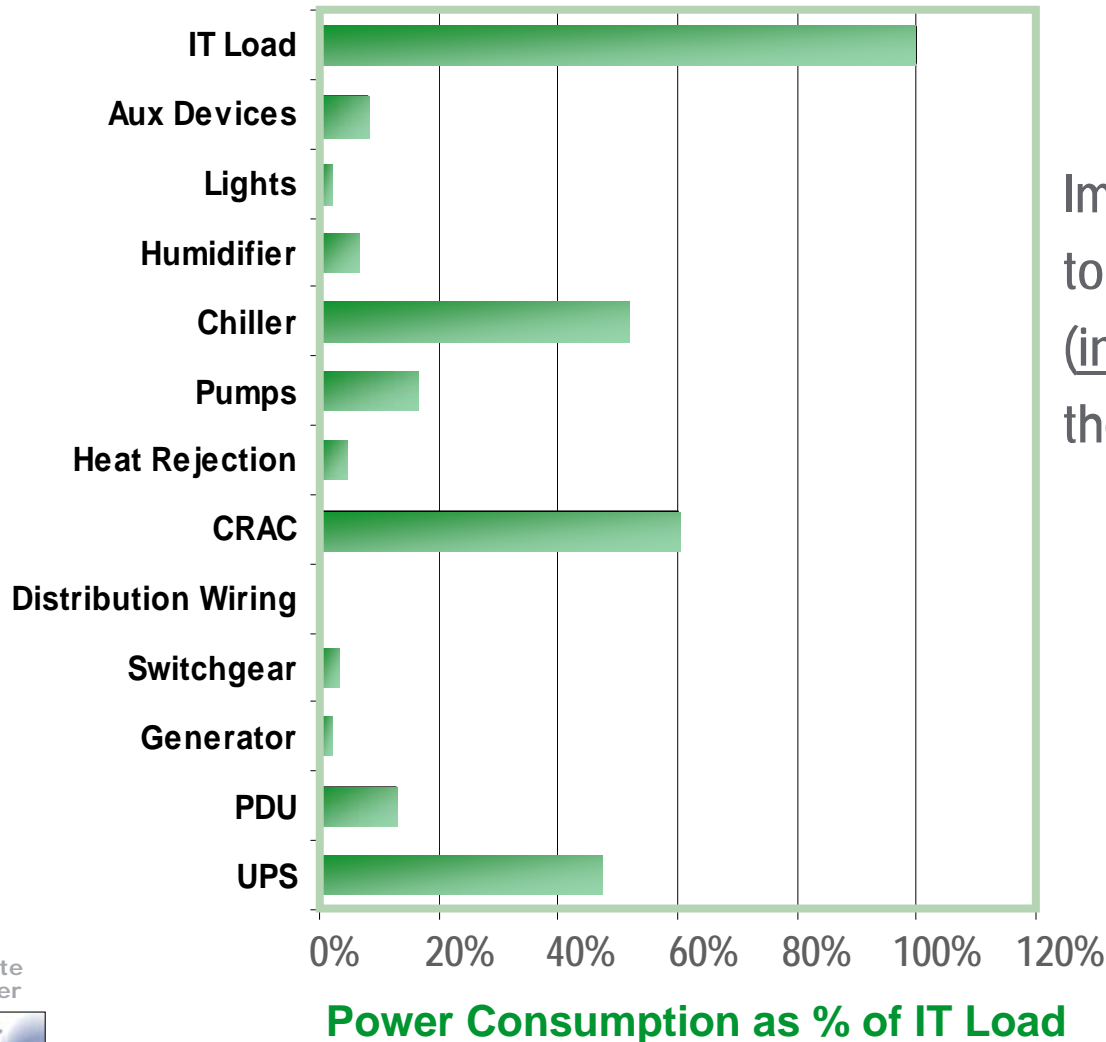
Key reference points

- **More than 50% of power** going into a typical data center goes to the power and cooling systems – **NOT to the IT loads**
- The typical 1MW (IT load) data center is continuously wasting about 400kW or **2,000 tons of coal per year** due to poor design
- **Every kW saved** in a data center saves about **\$1,000 per year**
- **Every kW saved** in a data center reduces carbon dioxide emissions by **5 tons per year**
- **Every kW saved** in a data center has a carbon reduction equivalent to **eliminating about 1 car from the road**
- A **1% improvement** in data center infrastructure efficiency (DCiE) corresponds to approximately **2% reduction** in electrical bills

Primary drivers of inefficiency

- Oversizing of power and cooling equipment
- Pushing cooling systems to cool densities higher than they were designed for
- Ineffective room layout
- Ineffective airflow patterns
- Redundancy (for availability)
- Inefficient power and cooling equipment
- Inefficient operating settings of cooling equipment
- Clogged air or water filters
- Disabled or malfunctioning cooling economizer modes
- Raised floor clogged with wires

Power consumptions compared to the IT load



Improving efficiency means working to reduce power consumption (increase efficiency) for each of these device categories

White paper



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Data for a typical tier 4 data center operating at 30% of rated load

Data Center Efficiency Calculator

Impact of alternative power and cooling approaches on energy costs



About this tool

INPUTS

Data center capacity

IT load

Electricity cost per kWh \$

UPS system

Power redundancy

Cooling system

Chiller

Air distribution

CRAC/CRAH redundancy

Heat rejection redundancy

Lighting

- Standby generator
- PDUs without transformers
- Blanking panels
- Economizer
- Dropped ceiling return
- Deep raised floor
- CRAC/CRAH on UPS
- Coordinated CRAC/CRAH
- N/A VFD heat rejection pumps
- N/A VFD chilled water pumps
- Optimized rack layout
- Optimized tile placement

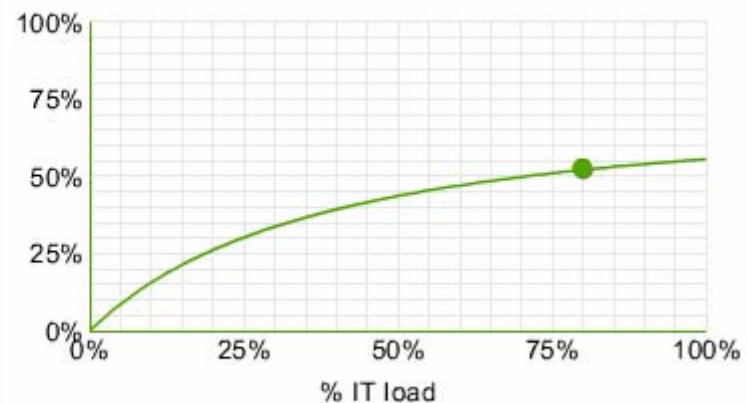
RESULTS

Data center infrastructure efficiency (DCiE)



Annual electricity cost

Efficiency curve



Data Center Carbon Calculator

Impact of changes in data center efficiency on energy costs and carbon footprint



INPUTS

[About this tool](#)

Data center infrastructure efficiency (DCiE)

Scenario 1: 55% (PUE= 1.8)


Scenario 2: 65% (PUE= 1.5)

IT load

Scenario 1: kW

Scenario 2: kW

Location of Data Center Australia (AUD)



Electricity cost per kWh: [Override map values](#)


CO2 emissions (kg/MWh):

Footprint	Avoided
<input type="text" value="0.924"/>	<input type="text" value="1.096"/>

RESULTS


	Scenario 1	Scenario 2
Utility input power (kW)	<input type="text" value="1,818"/>	<input type="text" value="1,538"/>
Total kWh per year	<input type="text" value="15,927,273"/>	<input type="text" value="13,476,923"/>
Electricity cost per year	<input type="text" value="\$ 1,693,865"/>	<input type="text" value="\$ 1,433,271"/>
CO2 tonnes per year (footprint)	<input type="text" value="14,717"/>	<input type="text" value="12,453"/>
Equivalency in cars	<input type="text" value="3,244"/>	<input type="text" value="2,745"/>

Savings from scenario 1 to scenario 2 equivalent to:




\$ 260,595

in Electricity cost per year*



2,686

Fewer tonnes of CO2 emissions per year**



592

Fewer cars on the road

* 15 year electricity cost savings: \$3,908,920
** 15 year reduction CO2 emissions: 40,284

Based on avoided equivalent tonnes of CO2

Sample statement of work for an electrical efficiency assessment

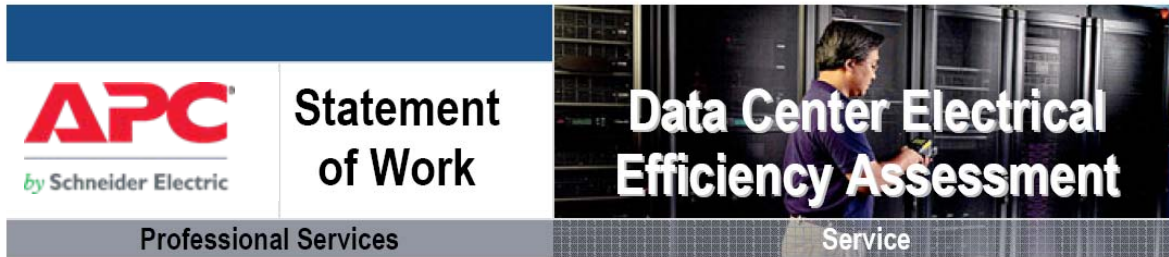


Table of Contents

- 1.0 Executive Summary
- 2.0 Features & Benefits
- 3.0 Details of Service
- 4.0 Deliverables
- 5.0 Assumptions
- 6.0 Scope of Responsibility
- 7.0 Project Work Details
- 8.0 Pricing

1.0 Executive Summary

The Data Center Electrical Efficiency Assessment provides an analysis of the Power and Cooling systems to determine the operating efficiency of the complete system. In addition, the system is benchmarked against the expected values of efficiency based on the inherent design, and against other similar data centers. The projected efficiency under changing IT loads such as a growth plan, is calculated.

Our service professionals will provide an accurate assessment of the factors that are limiting the achievable efficiency of the data center and will make recommendations for changes to maximize efficiency. This will include:

- Assessment and analysis of the data center's as-built electrical efficiency
- Breakdowns of losses into power, cooling, and lighting losses
- Breakdown of the cooling system losses into CRAH, humidification, and outdoor heat rejection losses.
- Breakdown of the power system losses into UPS and power distribution.
- Creating and providing a mathematical model of the data center that can be used for benchmarking or scenario analysis
- Comparing the actual efficiency to the efficiency that should be expected based on the design, and identifying any constraints that are preventing the system from achieving its expected efficiency
- Detailed recommendations for improving the efficiency of the data center, taking into consideration the constraints of the facility

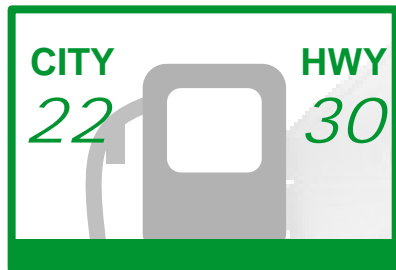
2.0 Features & Benefits

Typical findings of an electrical efficiency assessment

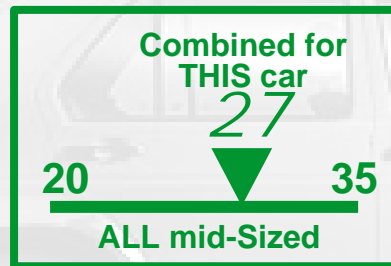
- Benchmark vs. comparable data centers – overall and by subsystem
- Operations problems impacting efficiency
- Configuration problems impacting efficiency
- Short-term quick efficiency improvement options
- Long-term opportunities

Four ways to express efficiency

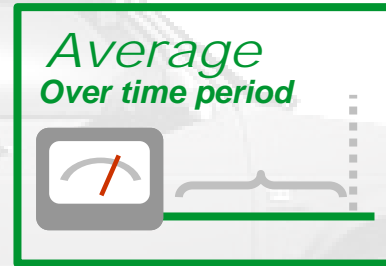
Manufacturer's
SPECIFICATION
for this car



Manufacturer's
BENCHMARKS
for similar cars



Actual
AVERAGE
during operation

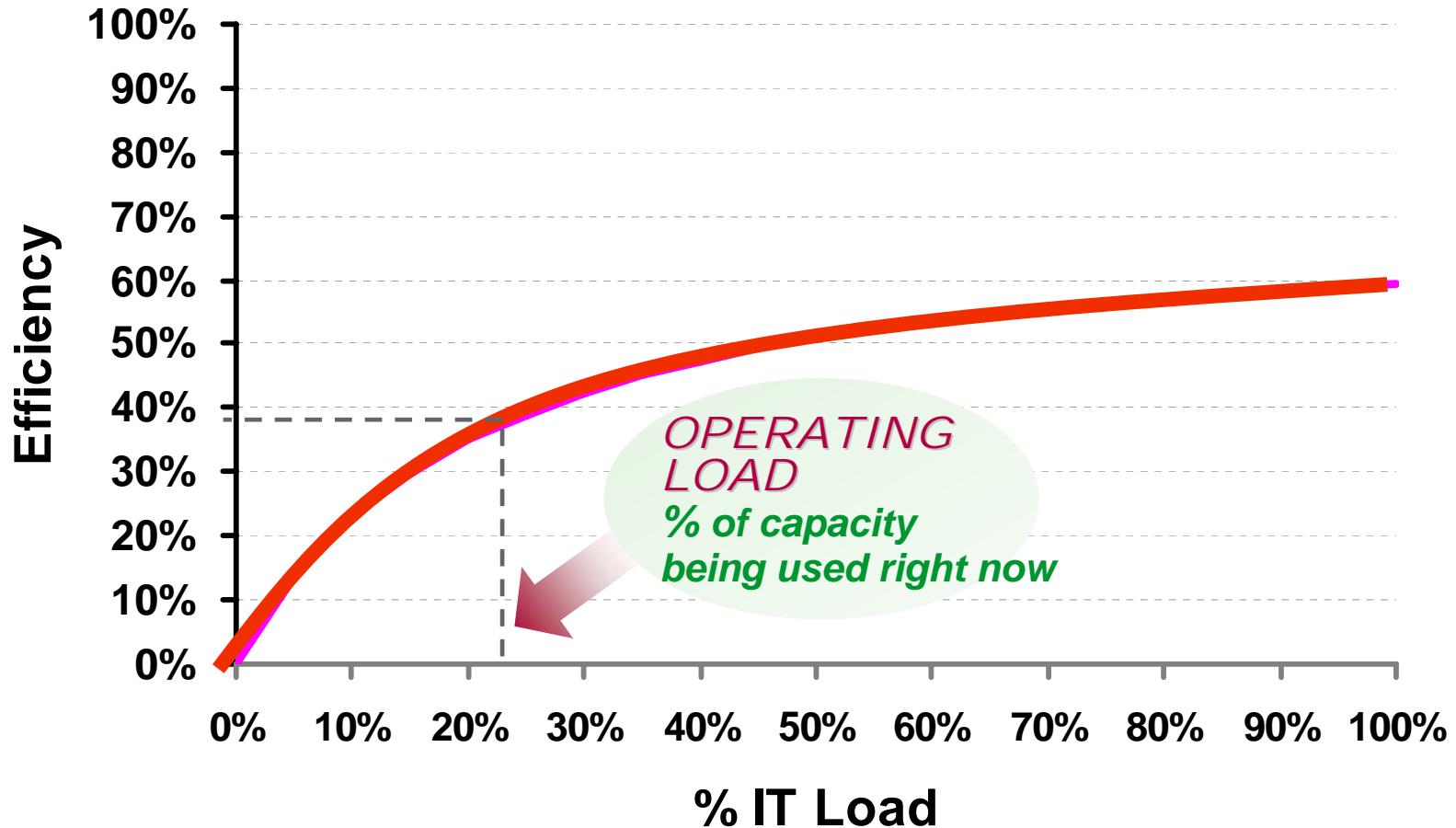


Actual
INSTANTANEOUS
during operation



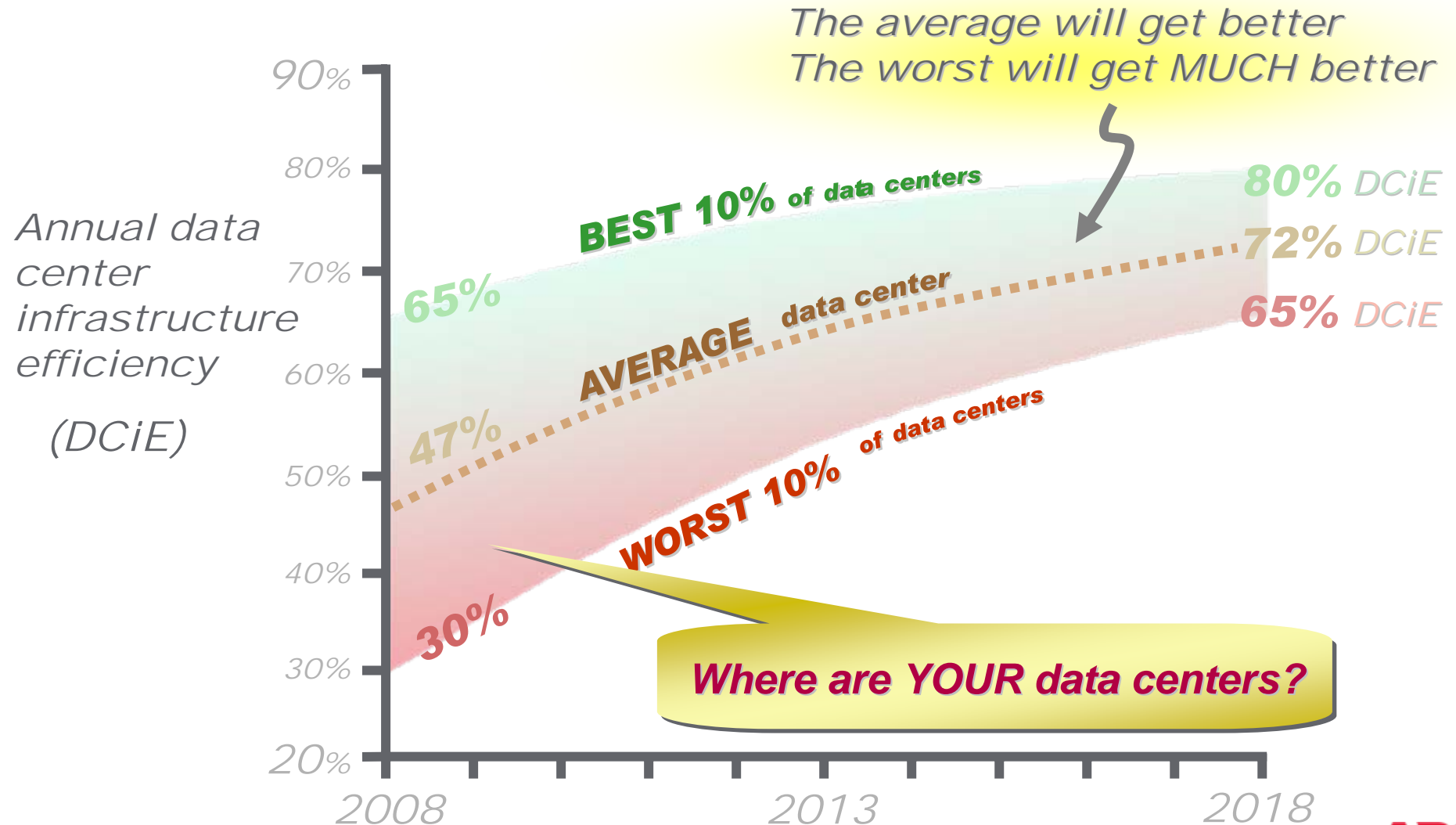
Beware! Much of existing published efficiency data is ambiguous regarding how it is expressed and what is included in the calculation

Data center efficiency as a function of IT load



Efficiency varies dramatically with load, so you can't specify it without specifying the load

A realistic data center infrastructure efficiency plan for the industry



Drivers of infrastructure efficiency gains

(Baseline: Average of existing installed base)

IMPROVEMENT	Device Gain	DCiE Gain	\$\$ saved over 15 years in a 1MW data center**
Move from room cooling to dynamic row/rack cooling	70%	8%	\$5,900,000
Cooling economizers	38%	4%	\$2,500,000
Right-sizing through modular power and cooling equipment	4%	4%	\$2,400,000
Higher UPS efficiency	8%	4%	\$1,900,000
415/240 V transformerless power distribution (NAM)*	4%	2.5%	\$1,500,000
Dynamic control of cooling plant (VFD fans, pumps, chillers)	25%	2.5%	\$1,200,000
TOTAL to get industry from 47% to 72% DCiE		25%	\$14,700,000

*No benefit outside of NAM; Transformer-based PDUs typically in NAM only

**\$\$ values based on \$.15 per kwhr electric cost, starting DCiE of 47%, ave density 8KW/rack

Is there an efficiency vs density tradeoff?

NO
They work together

- High density and high efficiency are related
- Many people think high density makes efficiency worse
 - ↳ Only true when trying to push existing data centers to cool high density
- *High density enables high efficiency* in a properly designed new data center or a pod in an existing data center
 - Shorter pipe lengths
 - Shorter air flow lengths
 - Less air mixing
 - Higher return air temperatures
 - ↳ Less pump power
 - ↳ Less fan power
 - ↳ Less humidification/dehumidification power and chiller power



The highest efficiency data centers will be high density data centers

Achieving high efficiency in high-density data centers

Products we offer as part of our solutions

- 1 **Row-based cooling**
- 2 **Ultra-high efficiency UPS**
- 3 **Capacity and energy management software for power, cooling, and racks**
- 4 **Scalable power and cooling equipment**
- 5 **High-efficiency AC power distribution**

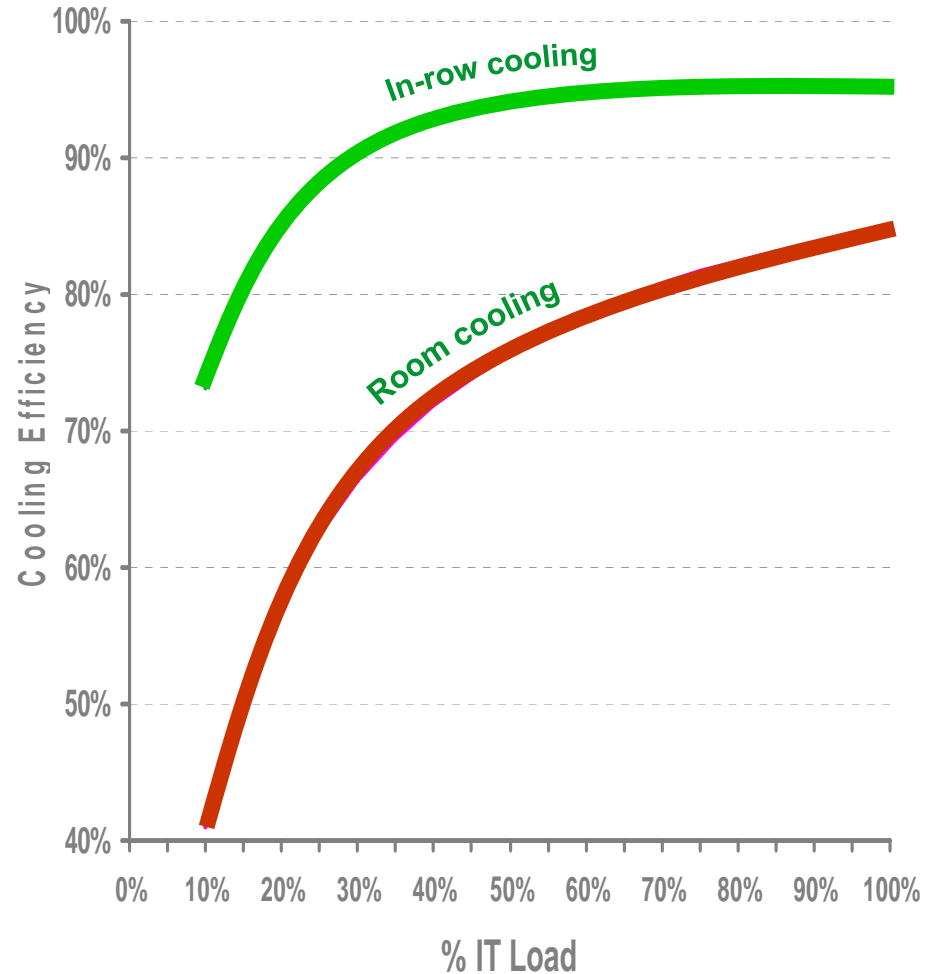
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paper



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Row-based cooling

- Inherently higher power density capability than room designs
- Fan power reduced by 50%
- Needless dehumidification / re-humidification is eliminated
- Need for high-bay areas and raised floors is reduced or eliminated (particularly for small installations)
- Cooling capacity can “follow” IT loads that move due to virtualization and server power management



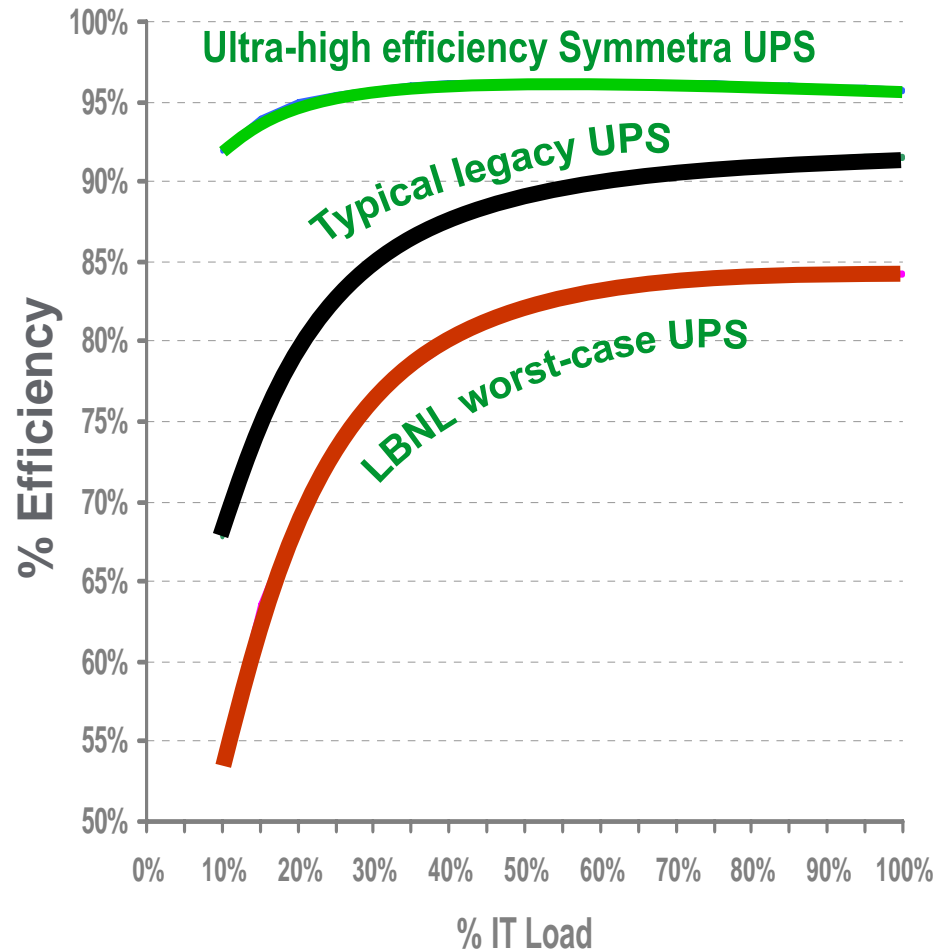
Cooling efficiency = useful cooling power / (power consumed + useful cooling power)

White paper



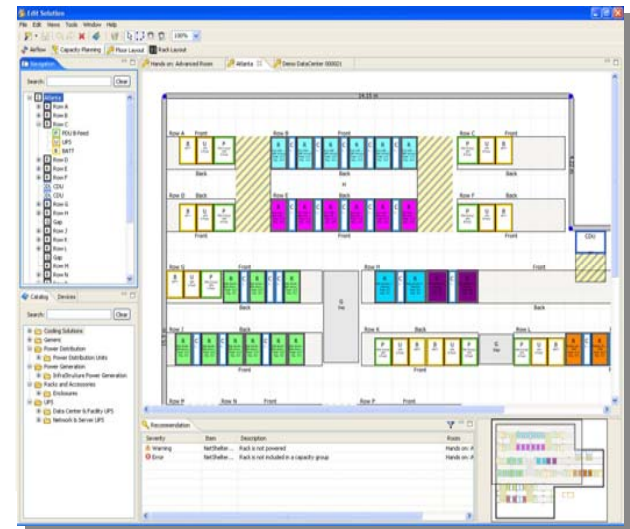
High-efficiency UPS

- UPS efficiency has large effect on data center efficiency because total IT load goes through it
- Improvement over typical from 80% to 96% efficiency at 20% load corresponds to loss reduction of 80%
- Electricity savings can pay for the UPS in many cases
- Side effect of high efficiency design: UPS is nearly silent



Capacity and energy management

- Poor utilization of capacity is a primary cause of inefficiency
- Software can identify available capacity (even by rack) and help prevent creation of stranded capacity
- Side effect is you can fit more IT equipment in the power and cooling “envelope” of the data center
- Energy management can identify efficiency improvement opportunities



InfraStruXure Central software
with Capacity Manager

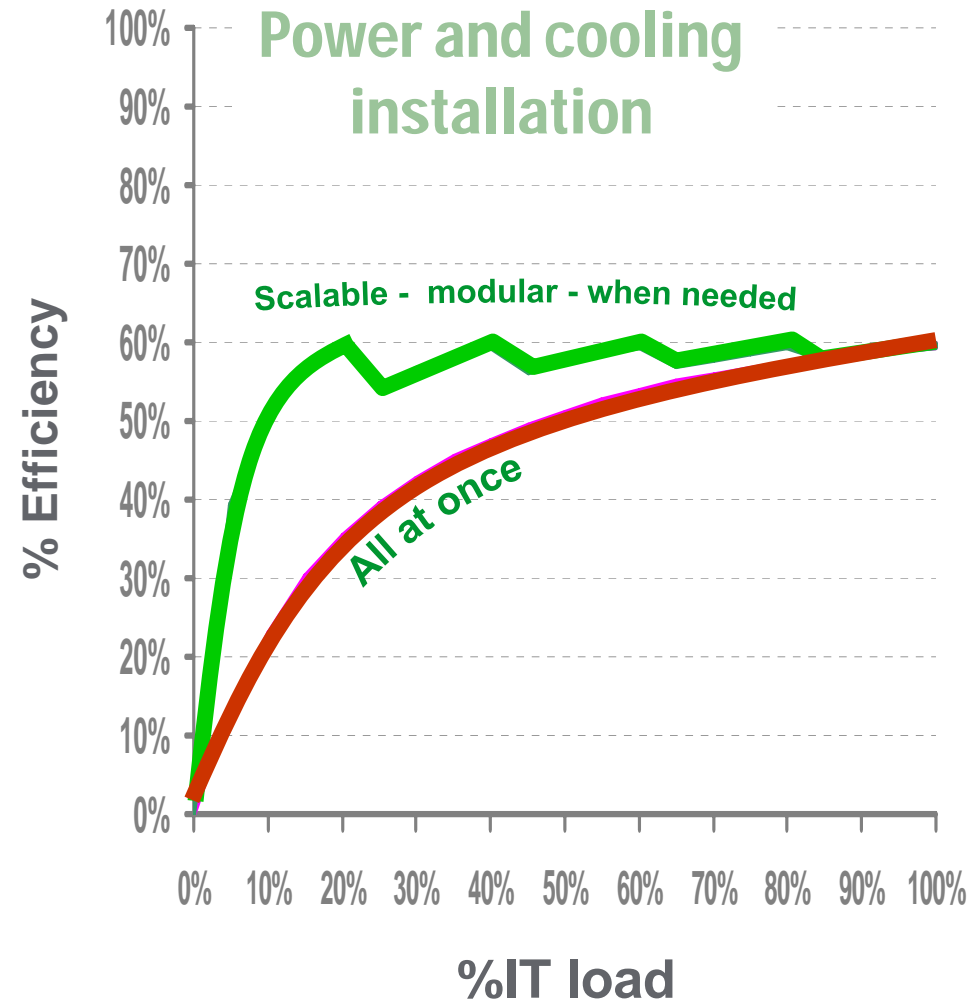
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Scalable power and cooling

- Over half the power and cooling losses in a data center are fixed and do not vary with the IT load (so efficiency degrades as IT load declines)
- Oversizing is therefore a primary contributor to inefficiency
- Virtualization and server power management will make this problem worse, if power and cooling are sized to peak IT loads that are not typical
- New power and cooling devices can scale in capacity, reducing fixed losses



Higher voltage AC power distribution (NAM Only)

- Distributes voltage to loads at international standard 400/230 instead of conventional US 208/120
- Eliminates the need for PDU transformers and associated losses
- Reduces copper requirements
- Overall efficiency increase of over 5% for a high availability data center
- By-product is that **4,000 lbs of copper** and **30,000 lbs of PDUs** are saved per MW, reducing floor loading and saving space

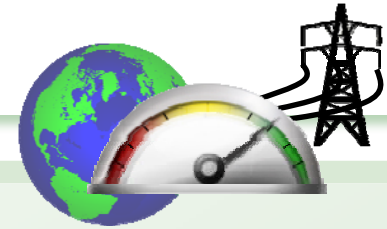


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Data center efficiency Summary



Are my data centers efficient?

Probably 5-20% less efficient than they could be; you can learn a lot from a data center efficiency assessment

How do I reduce energy consumption?

Identify the inefficiencies and correct them. Simple changes like temp settings can lead to remarkable improvements. Design new data centers and/or zones for high density. Use right-sized, high-efficiency power and cooling equipment

Does efficiency improvement have a good ROI?

Many improvements are essentially free during design of NEW data centers or zones. Most EXISTING data centers have significant quick-win opportunities that can be identified during an assessment