Data Center of the Future

Energy Measurement, Monitoring and Management

CISCO

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Agenda

- Introduction to Cisco's definition of Energy Efficiency
- Electrical Efficiency in Data Centers
- Process to Establish Energy Efficiency Benchmarks
- Building the Business Case
- Implementation
- Reporting and Monitoring
- Q&A

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Introduction to Energy Efficiency

There may never be a "one-size-fits-all" efficiency metric so why wait for it?

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Energy Efficiency is a Subjective Concept

How Does Cisco "Qualitatively" Define Energy Efficiency Today?

- Lowest Energy Capacity Option to Deliver or Support a Service
- Highest Utilization of IT Assets to Support a Given Work Unit and Service
- Efficiency Benchmarks are Needed to Establish a Specific Business Case
- Employee Productivity and Lifestyle Implications are Considered
- Fluid Definition Using Energy Equivalents Interchangeably in Analysis

How Does Cisco "Technically" Define Energy Efficiency Today?

- Defined Variables: Useful Watts, Wasted Watts, Work Units, Services
- Useful Watts = Electrical Energy used by a product and/or architecture
- Wasted Watts = Electrical Energy lost to conversion and distribution
- Work Units = Switching, Routing, Processing, Storing, Application Specific
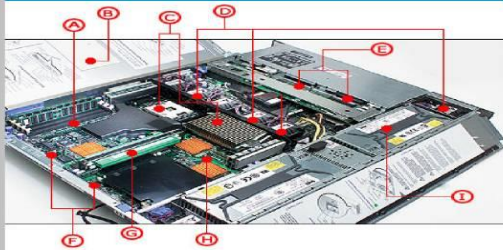- Services = as examples; email, web commerce, disaster recovery, etc

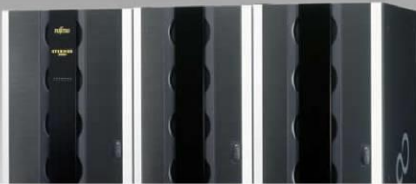# Electrical Efficiency in Data Centers

A Clear Path to Green Starts with
Clear Metrics

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Simple Data Center Layout
(Energy Demand, Distribution and Supply)

© 2007 Emerson Network Power

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Data Center Energy Consumption Model
5,000 sq. ft. Data Center

Equipment Category	Energy Consumption
Computing	588 kW
Lighting	10 kW
UPS & Distribution Losses	72 kW
Cooling Power Draw for Computing & UPS Losses	*429 kW
Building Switchgear / MV Transformer / Other Losses	28 kW
Total Power Draw	**1,127 kW**

Power and Cooling 48%
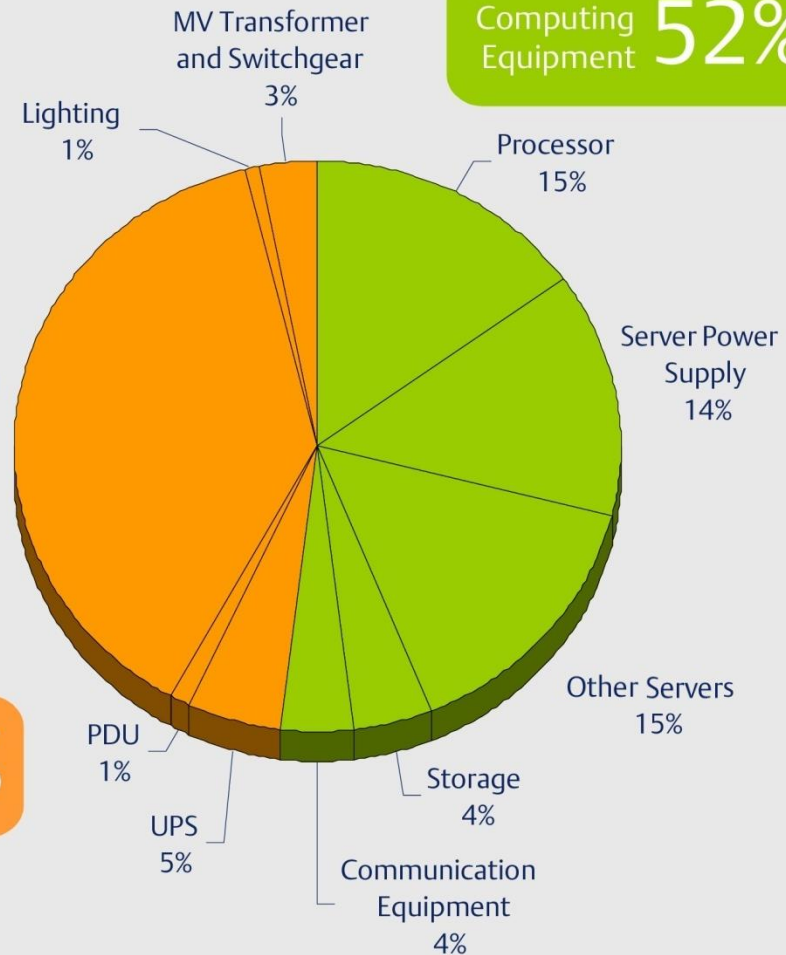
* Cooling load assumes chilled water based cooling system

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Computing Equipment 52%

MV Transformer and Switchgear 3%

Lighting 1%

Processor 15%

Server Power Supply 14%

Cooling 38%

Other Servers 15%

PDU 1%

UPS 5%

Storage 4%

Communication Equipment 4%

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The 'Cascade' Effect

Server Component

1 W Saved Here

-1.0W
DC-DC

Saves an additional .18 W here

-1.18 W
AC-DC

and .31 W here

-1.49 W
Power Distribution

and .04 W here

-1.53 W
UPS

and .14 W here

-1.67 W
Cooling

and 1.07 W here

-2.74 W
Switchgear/ Transformer

and .10 W here

-2.84 W

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1 Watt saved at the server component level results in <u>cumulative savings</u> of about 2.84 Watts in total consumption

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Energy Logic: Cascade Savings Strategies

	Strategy	Initial data center	Optimized data center	Saving (kW)	%	
1.	Low-power processor	91 W / processor (average)	70 W / processor	111	10%	30%
2.	High-efficiency power supplies	AC-DC ➝ 79% DC-DC ➝ 85%	AC-DC ➝ 90% DC-DC ➝ 88%	124	11%	
3.	Server power management	Power consumption: 80% of full load when idle	45% of full load when idle	86	8%	
4.	Blade servers	All rackmount	20% blades	7	1%	
5.	Server virtualization	No virtualization	20% servers virtualized	86	8%	11%
6.	Power distribution architecture	208V AC	415V AC provides 240V single-phase	20	2%	
7.	Implement cooling best practices	Hot-aisle / Cold-aisle	Optimized cold aisle and chilled water temp, no mixing of hot and cold air	15	1%	
8.	Variable-capacity cooling	Fixed capacity cooling	Variable capacity refrigeration and airflow	49	4%	11%
9.	High-density supplemental cooling	Floormount cooling only	Floormount plus supplemental cooling	72	6%	
10.	Monitoring and optimization	No coordination between cooling units	Cooling units work as a team	15	1%	

Initial data center load: 1,127 kW   **Total savings**   **585 kW**   **50%+**

© 2007 Emerson Network Power

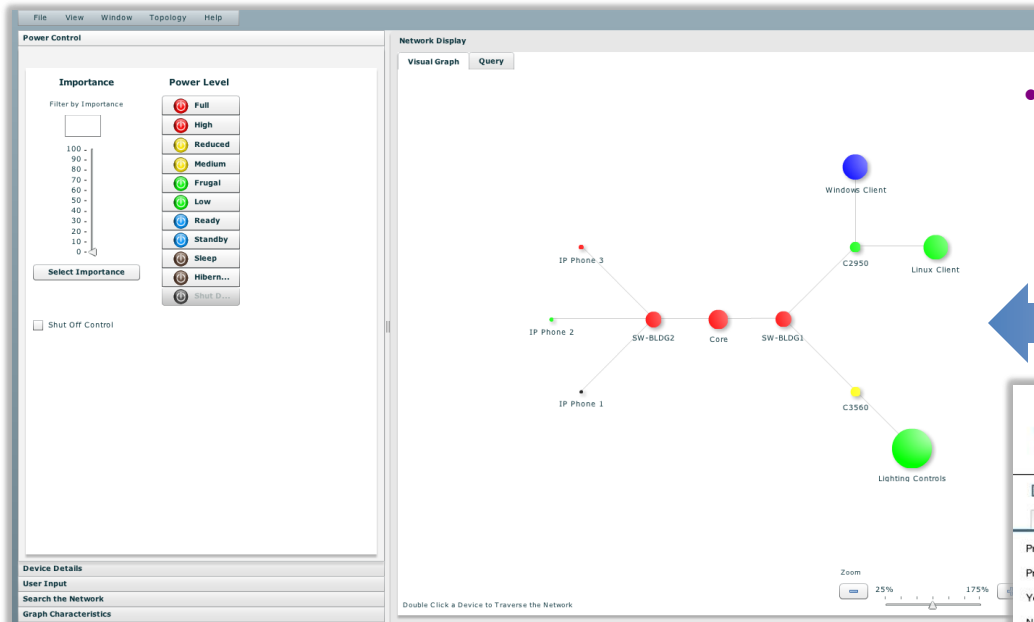◻ IT Hardware Choices   ◻ Operational Best Practices   ◻ Power & Cooling Product Efficiencies

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- **Cisco's first energy monitoring and management application**

- Free, open and leverages existing Cisco install base to manage IT and facilties infrastructure through Cissco IOS® software

Planning tools available to build the business case and deploy EnergyWise across the enterprise
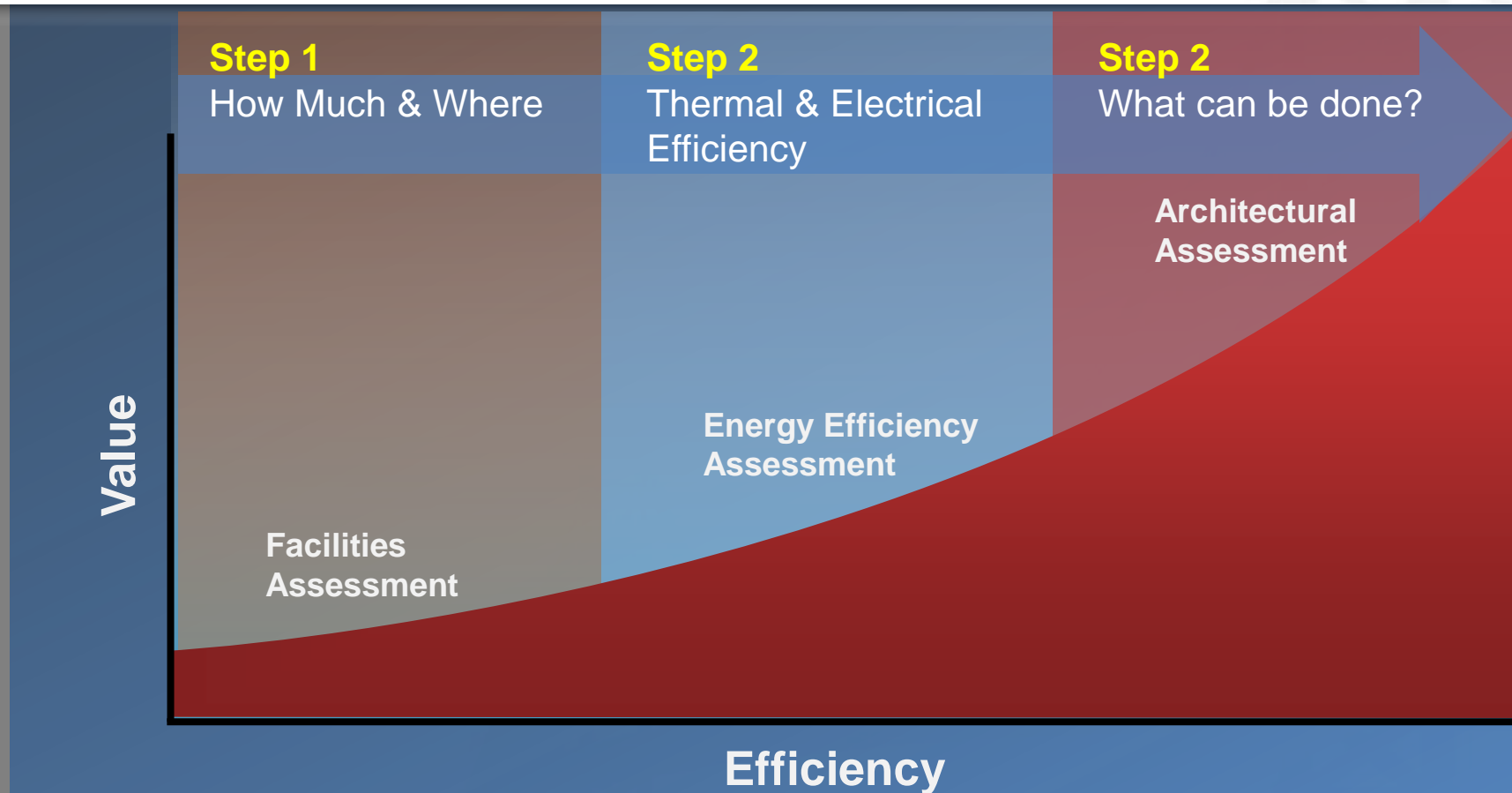
Process to Establish Efficiency Benchmarks

IT Operative Efficiency

Cisco Advanced Services Methodology

Step 1
How Much & Where

Step 2
Thermal & Electrical Efficiency

Step 2
What can be done?

Architectural Assessment

Energy Efficiency Assessment

Facilities Assessment

Value

Efficiency

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Cisco Data Center Efficiency Services

"**Buying energy efficient technology is a fine idea, but you end up much farther ahead by rethinking how you use all the technology in the data center you have.**"

Source: Information Week, September 03, 2007

Cisco Data Center Facilities Assessment Service
Increase the Life and Capacity of your Data Center Facilities
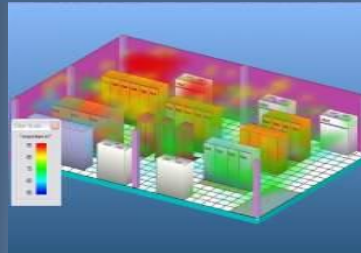
Cisco Data Center Energy Efficiency Assessment Service
Benchmark and Increase Data Center Efficiency
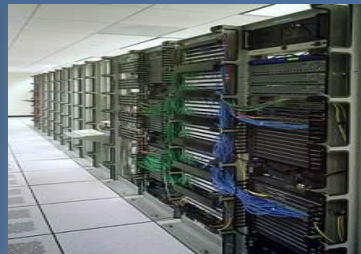
Cisco Data Center Architecture & Energy Management Service
Increase the Adaptability and Scalability of Your Data Center

Building the Business Case

How to Start Energy Efficiency Initiatives

Getting Started

- Identify a specific problem or project

- Install the data collection system

- Aggregate the data

- Visualize

  - Real-time dashboard of value metrics

    – Carbon Footprint, PUE, Operating cost, consumption, capacity

  - Ad-hoc reporting

    - Trending, Leverage MS Excel

Key issues that need to be resolved for all Data Centers and Labs

- How do we measure and record baselines?
- Are we using a consistent methodology across the business?
- How do we share progress out to the entire company?
- How soon is a material change visible?
- How are we recognizing achievement?
- How do we share data in a secure fashion between business organizations? Third parties that are contracted to provide services?
- Are the best minds and skill sets in the company able to contribute to other locations through a standard environment?

Key Challenges

- What are the impact of changes made to our environment? i.e. changes from original state
  - Move floor tile configurations
  - Implement virtualization

- Visibility of multi-vendor environment – i.e. smart power-strips and temperature/ humidity sensors
  - ServerTech
  - APC
  - Cyberswitching
  - Sensorsoft
  - Cisco
  - Others

Key Challenges cont'd...

- Lack of collaborative monitoring/trending platform - from the PDU down to the rack and device level available to both IT and Facilities personnel

- Lack of Real-time and Ad-hoc trending to understand the impact of adds/moves and changes on the existing environment

Solution: Cisco and OSIsoft Two infrastructures

The PI System– is a Real-time and Historical Infrastructure for data

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CONNECT	MANAGE	ANALYZE	PRESENT
Collect data from hundreds of sources.	Gather and archive large volumes of data. Scale to meet your growing business needs.	Access real-time or historical role-based data for the entire enterprise at any time.	View data, identify problems, and take corrective action with familiar, easy-to-use graphical tools.
INTERFACES	**SERVERS**	**ANALYTICS**	**VISUALS**

Cisco - Intelligent Network Infrastructure

CISCO

1

How PI is deployed at Cisco
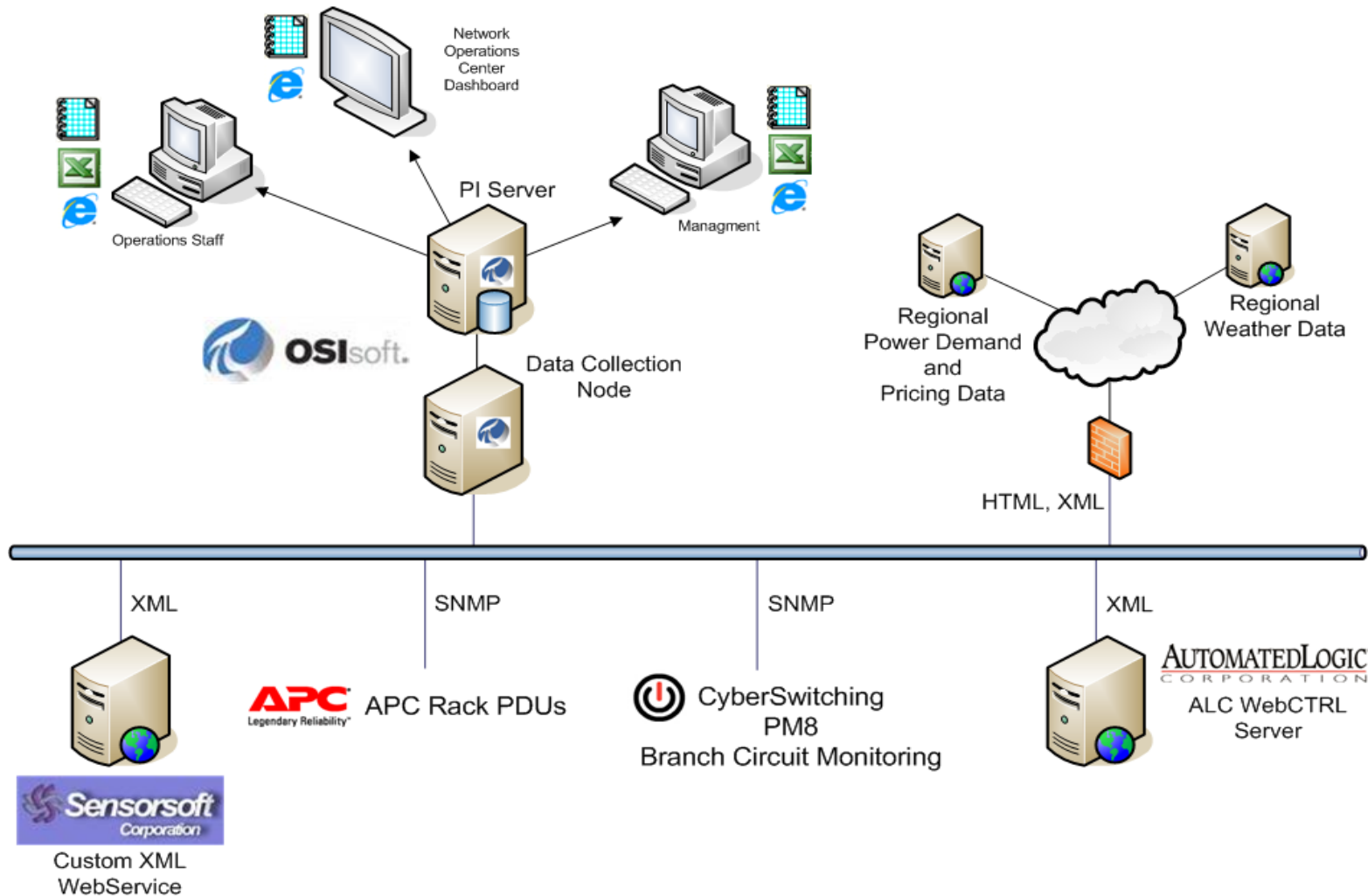
Collaboration Real-Time Dashboard

PUE over 60 Days

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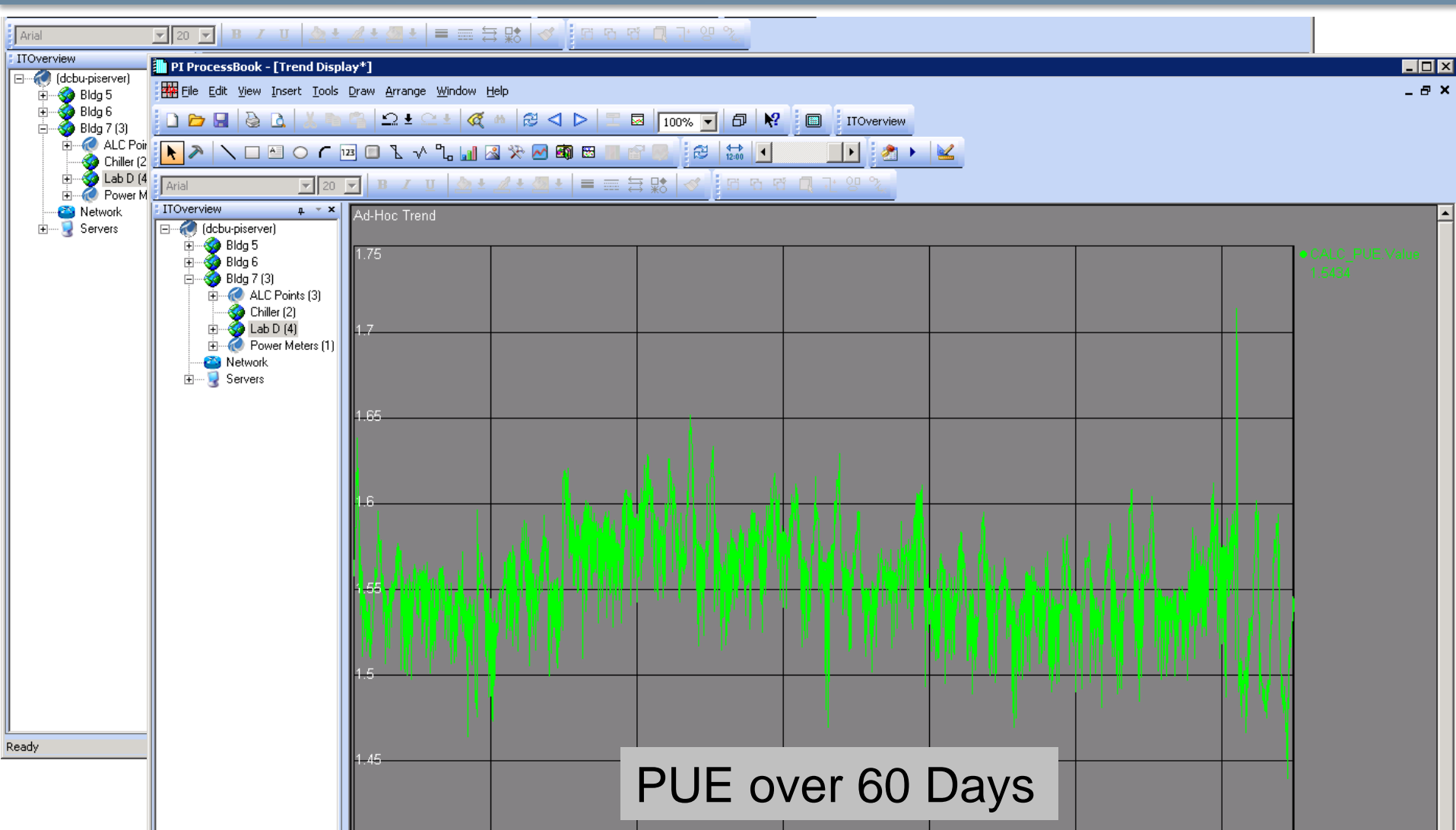
Map data to Floor Layout Environmental Sensors
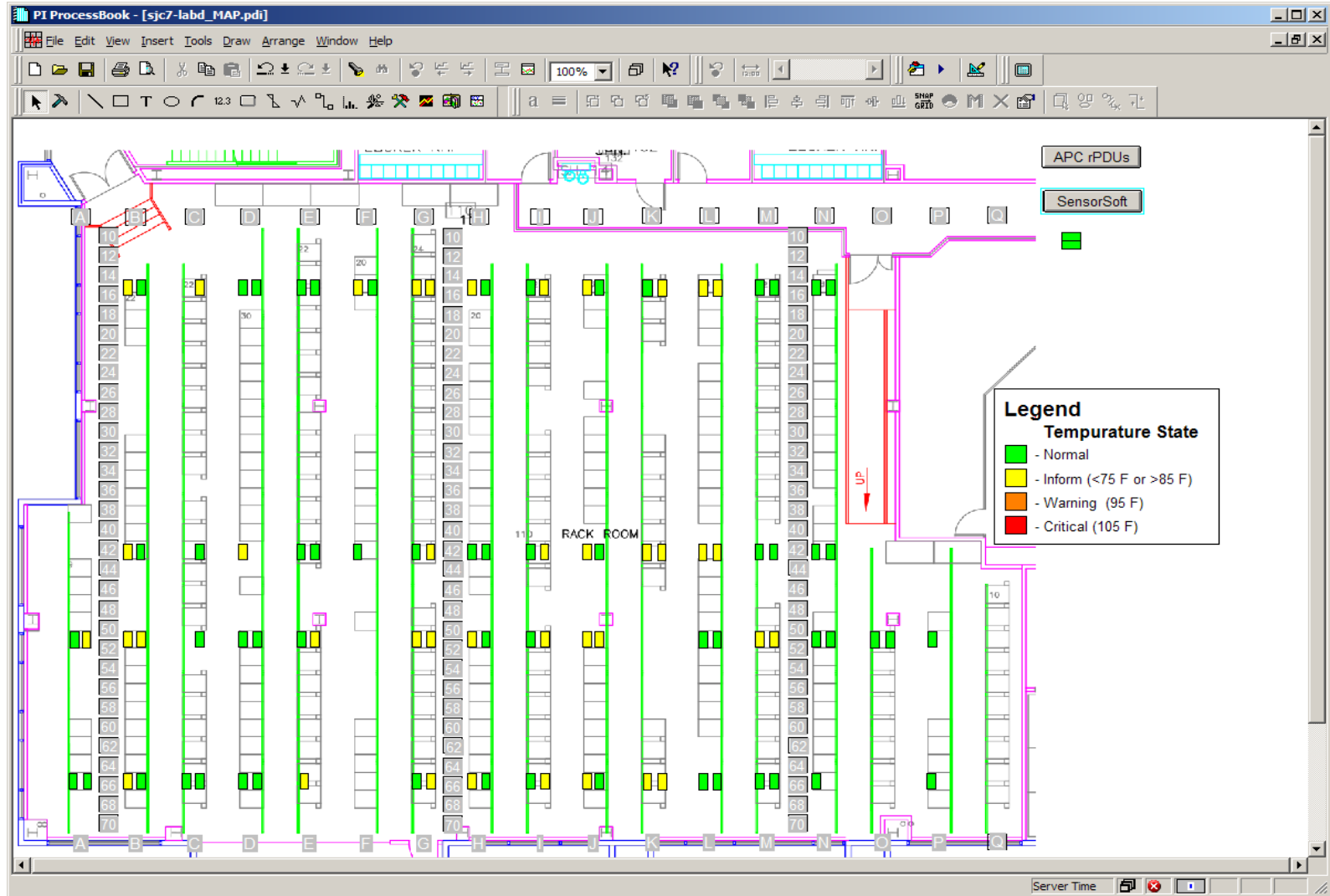
Drill Down to a Specific Device
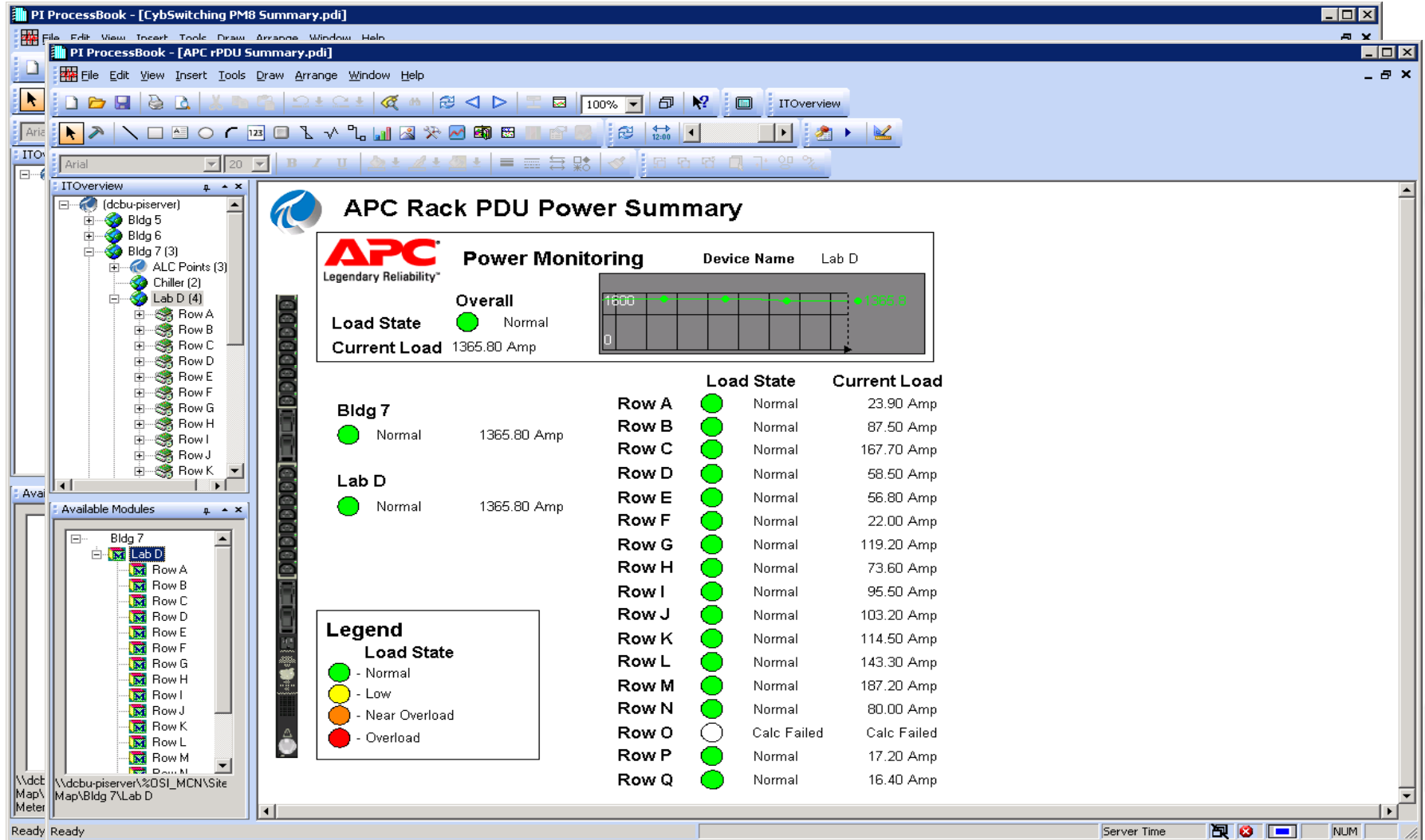
Building Management System Chiller Water Flow


45 Days of GPM
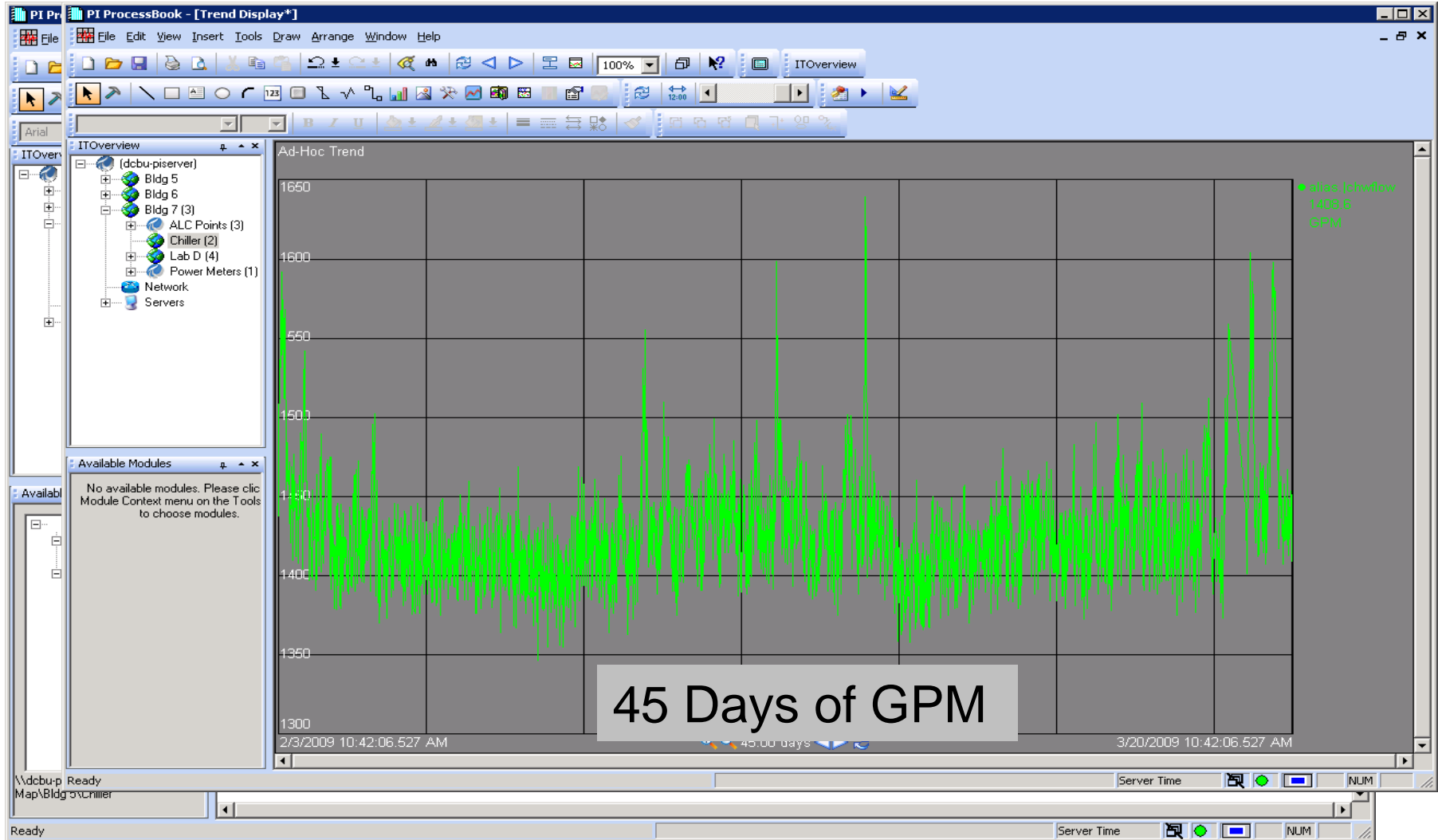
Building Management System Chiller- Demand

45 days
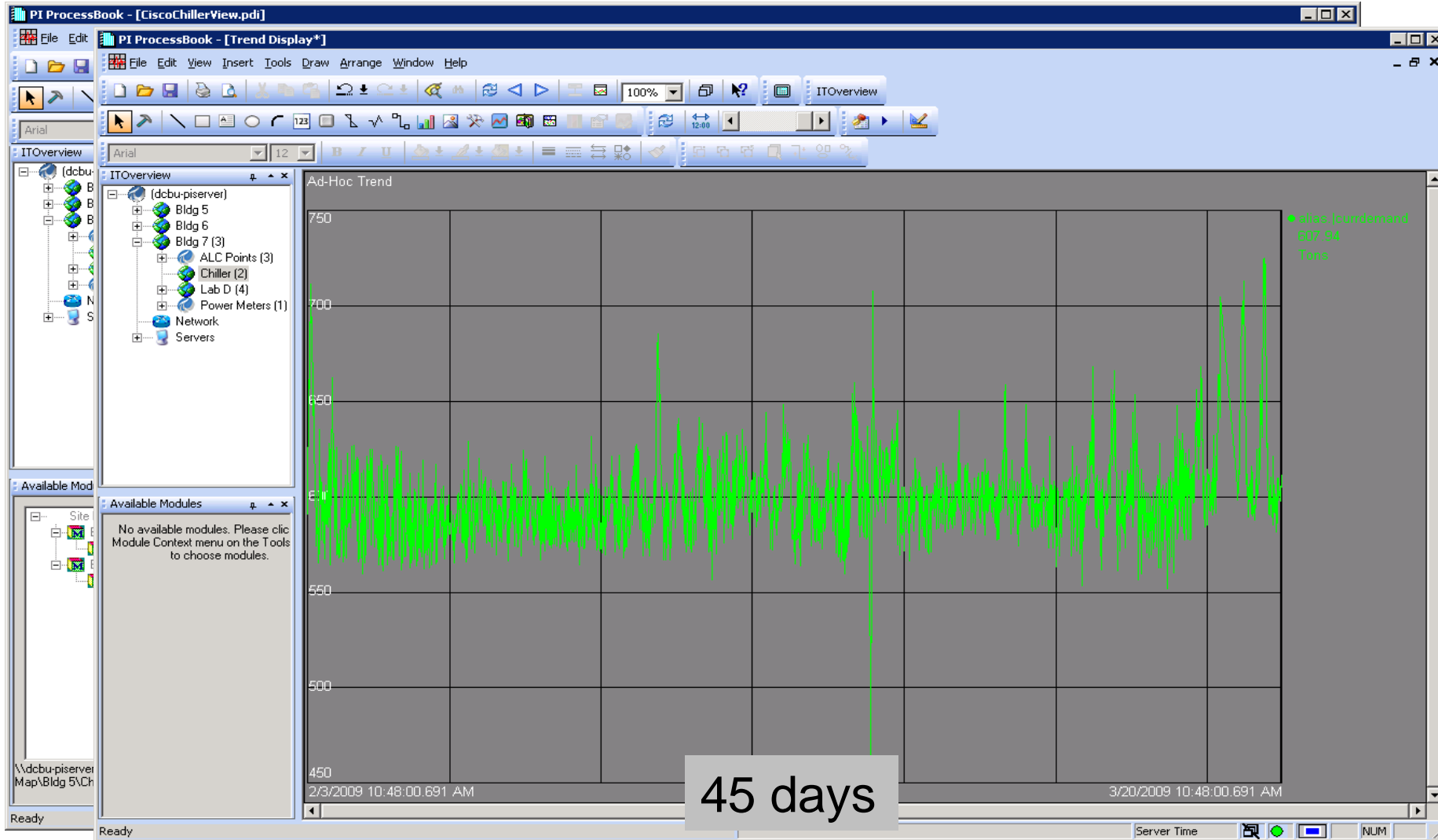
Building Management System Transformer load

Sum of both Meters

Individual Meters

Data Sou...
ALC BM...

March 2009
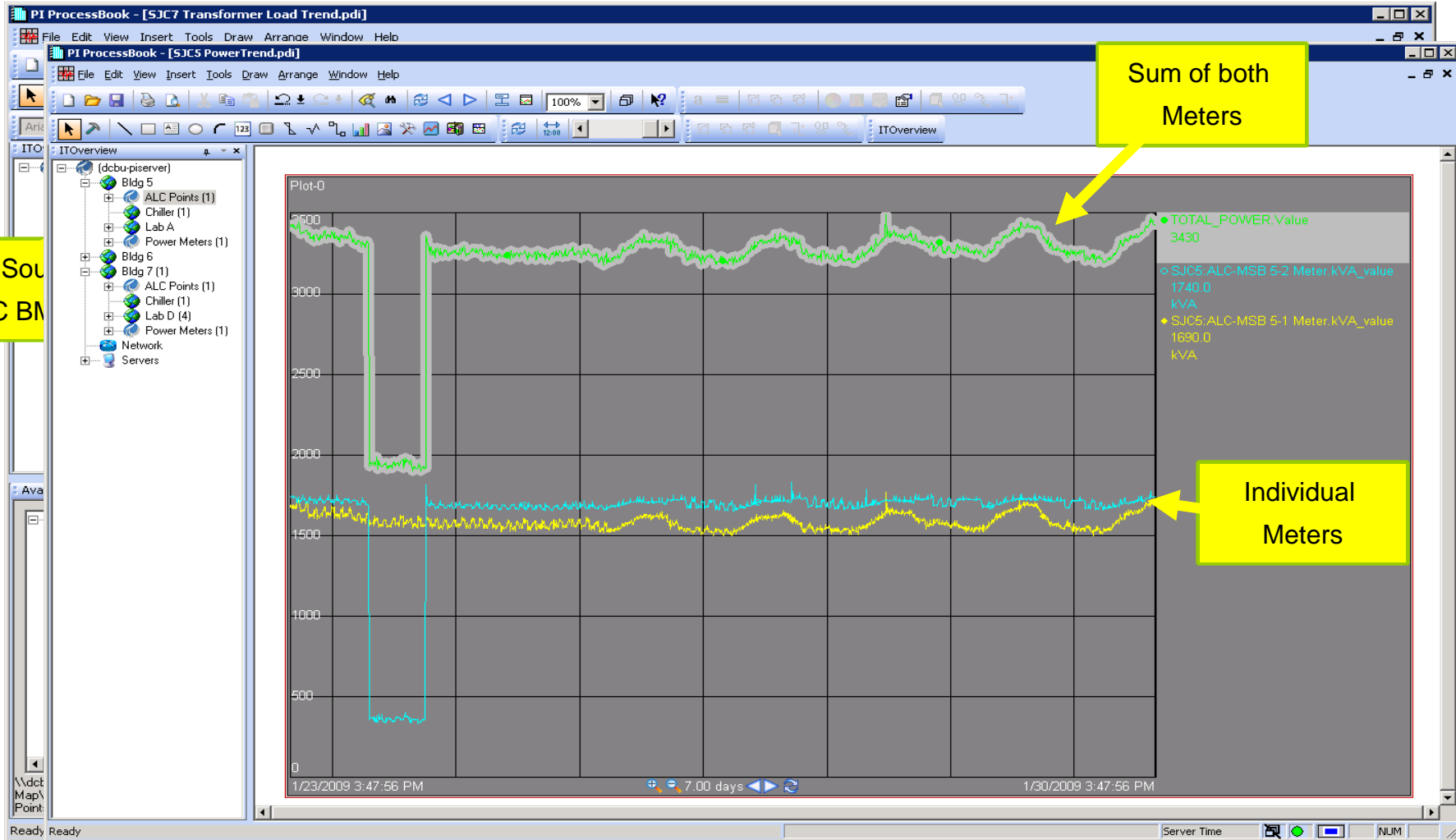
Benefits and Outcomes

- Collaboration securely across Facilities and IT – enabling access to data that was previously silo'd
- Enabling operational trending and corporate real-time reporting
- Establishing a benchmark of mechanical and power usage to better understand performance over time and the effectiveness of projects and changes made to the environment
- One version of the truth" of power, mechanical, and environmental data.
  - How is an asset operating and what is its power consumption based on the environment
- Drill down capability to continually improve efficiency
  - i.e. "I see there is an issue, I need to look at the data, the value is in having the data."

What's next? Now that an infrastructure is in place, all applications can access the data
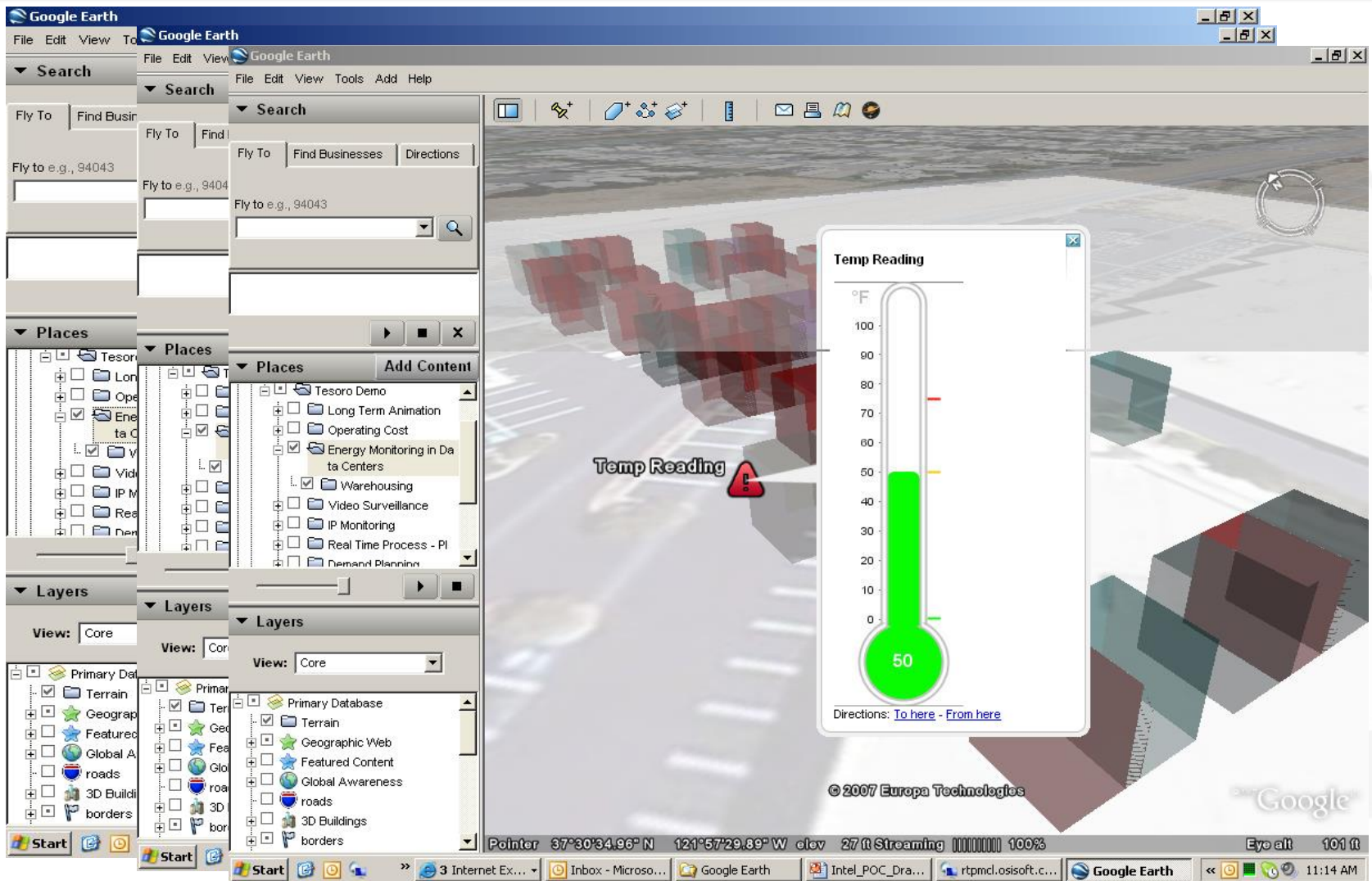
Implementation

What can be Implemented Today

Cisco Efficiency Assurance Program

"The Efficiency Assurance Program is Cisco's central program for energy efficient solutions and offers learning resources, planning tools and implementation services for EnergyWise, Energy Efficient Data Center, Unified Communications and Connected Real Estate."

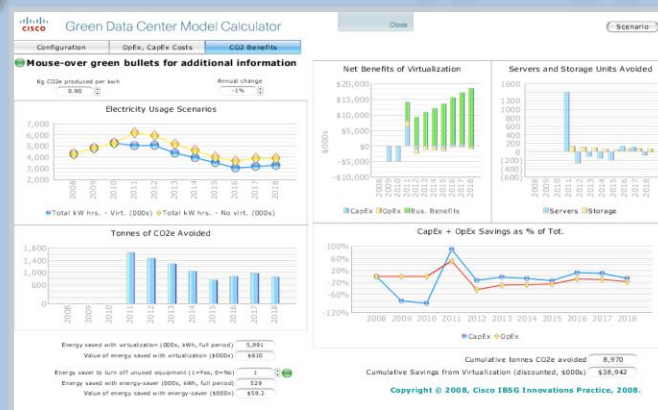# Cisco's Approach to Energy Efficient Solutions

- Energy efficiency through energy management applications, reference designs, virtualization technologies and support through Advanced Services
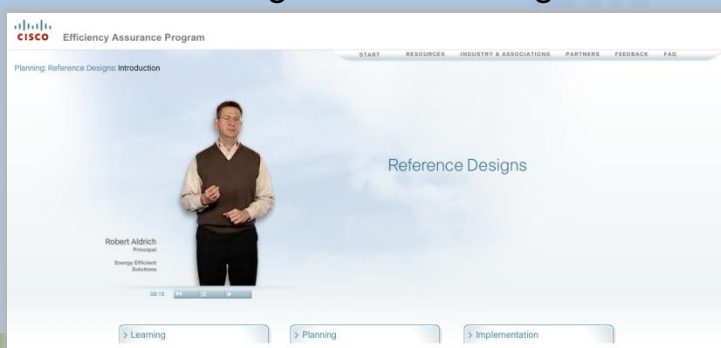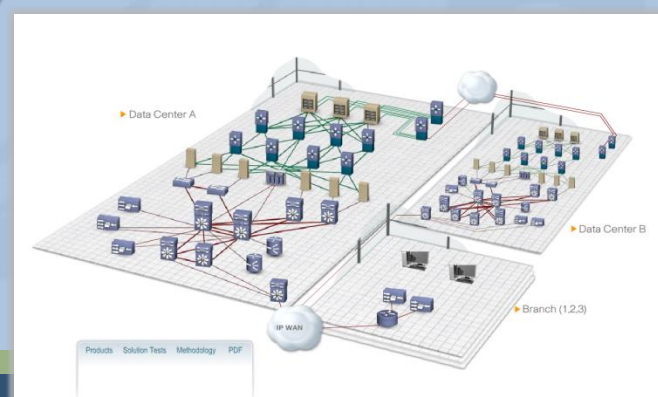
1 Product Efficiency & Carbon
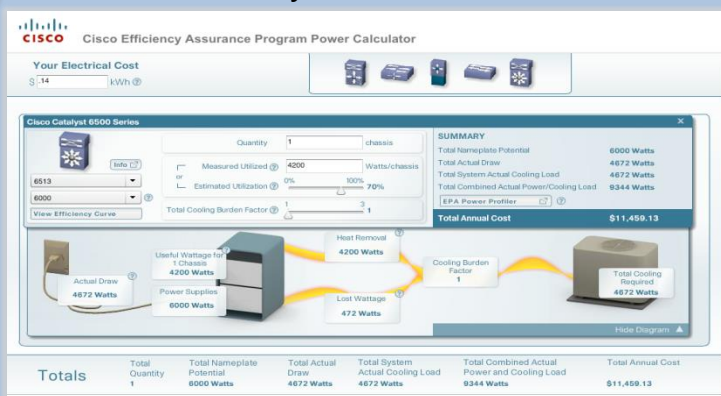
2 Data Center Virtualization & carbon

3 Reference Designs and Learning Center

4 Cisco Validated Architectures

Cisco's Internal GHG Reduction Initiative
Tools we are using

Cisco Efficiency Assurance Program Product Efficiency Calculator

Your Electrical Cost

$ .07 kWh ⓘ

Help

Cisco Nexus 7000 Series   X

Quantity 1 chassis

Info ⓘ

7000 ▾

6000 ▾ ⓘ

View Efficiency Curve

Measured Utilized ⓘ 4200 Watts/chassis

or

Estimated Utilization ⓘ 0% 100% **70%**

Total Cooling Burden Factor ⓘ 1 3 1

SUMMARY

Total Nameplate Potential	**6000 Watts**
Total Actual Draw	**4649 Watts**
Total System Actual Cooling Load	**4649 Watts**
Total Combined Actual Power/Cooling Load	**9297 Watts**

EPA Power Profiler ⓘ

Total Annual Cost   **$5,701.29**

Heat Removal
4200 Watts

Useful Wattage for
1 Chassis
4200 Watts

Cooling Burden
Factor
1

Total Cooling
Required
4649 Watts

Actual Draw
4649 Watts

Power Supplies
6000 Watts

Lost Wattage
449 Watts

Hide Diagram ▲

Totals	Total Quantity	Total Nameplate Potential	Total Actual Draw	Total System Actual Cooling Load	Total Combined Actual Power and Cooling Load	Total Annual Cost
	1	**6000 Watts**	**4649 Watts**	**4649 Watts**	**9297 Watts**	**$5,701.29**

Cisco's Internal GHG Reduction Initiative
Tools we are using

July 2008, Publicly Announced 25% Absolute Reduction 2007-2012

- Global, Enterprise Wide Effort across Owned & Leased Properties

$150M USD Paid for Energy in FY 2006
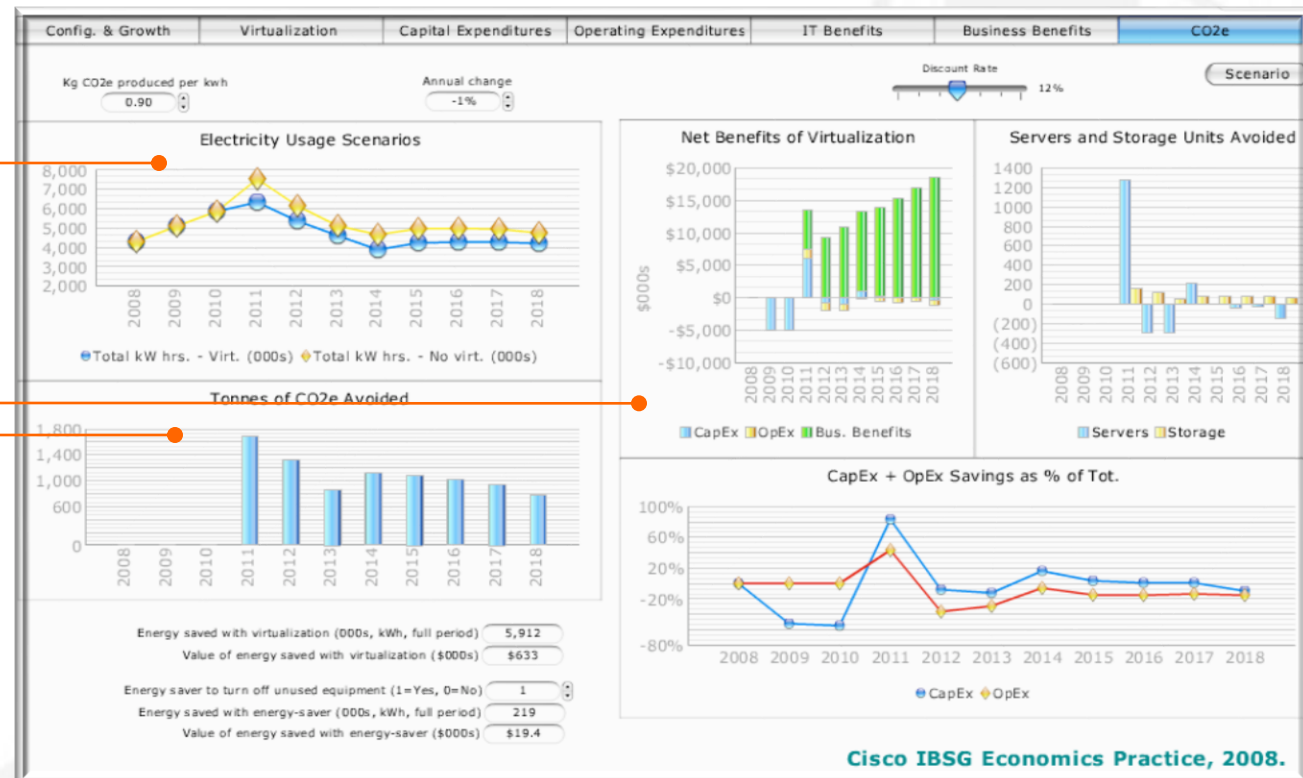
~80% Labs & Data Centers

Project Stakeholders

- Workplace Resources
- IT; Labs & Data Center
- Strategic, Corporate

Cisco IBSG Economics Practice, 2008.

Cisco Energy Efficient Data Center Solutions: Incremental Savings Across Infrastructure

Energy Efficient Data Center Solutions & Products	Description	Power & Cooling Savings*
Solution: Storage Virtualization **Products:** MDS, Nexus Series	Increasing storage utilization allows for the decommissioning of underutilized assets and the setting of higher utilization policies by storage administrators	4%
Solution: Application Delivery **Products:** Application Control Engine	Using a service module form factor versus appliances for SSL Offload and Server Load Balancing provides incremental power savings	1%
Solution: Security Services **Products:** Firewall Services Module	Using a service module form factor versus appliances for firewall services provides incremental power savings related to security	1%
Solution: Networked CRAC **Products:** Catalyst Series or Equivalent	Simply connecting Computer Room Air-Conditioning (CRAC) and "synching" them through Cisco partner technology can eliminate "demand fighting" between CRAC units	9%
Solution: LAN/SAN Consolidation **Products:** Nexus Series	Unified Fabrics and Fiber Channel over Ethernet (FCoE) reduces network infrastructure and structured cabling requirements	1%
Solution: Right-Sizing **Products:** NA, Planning Consideration	Planning for UPS and CRAC using tested nominal draw of Cisco products helps to mitigate "cascaded inefficiency"	1%
Advanced Services		
Efficiency Assessment Services	Provides first and second level analysis in order to calculate an actual ROI for implementation and validate estimates	Operative Efficiency Benchmarking
* estimates based on total IT consumption and cooling burden for 5MW data center	**Total Estimated Savings***	17%

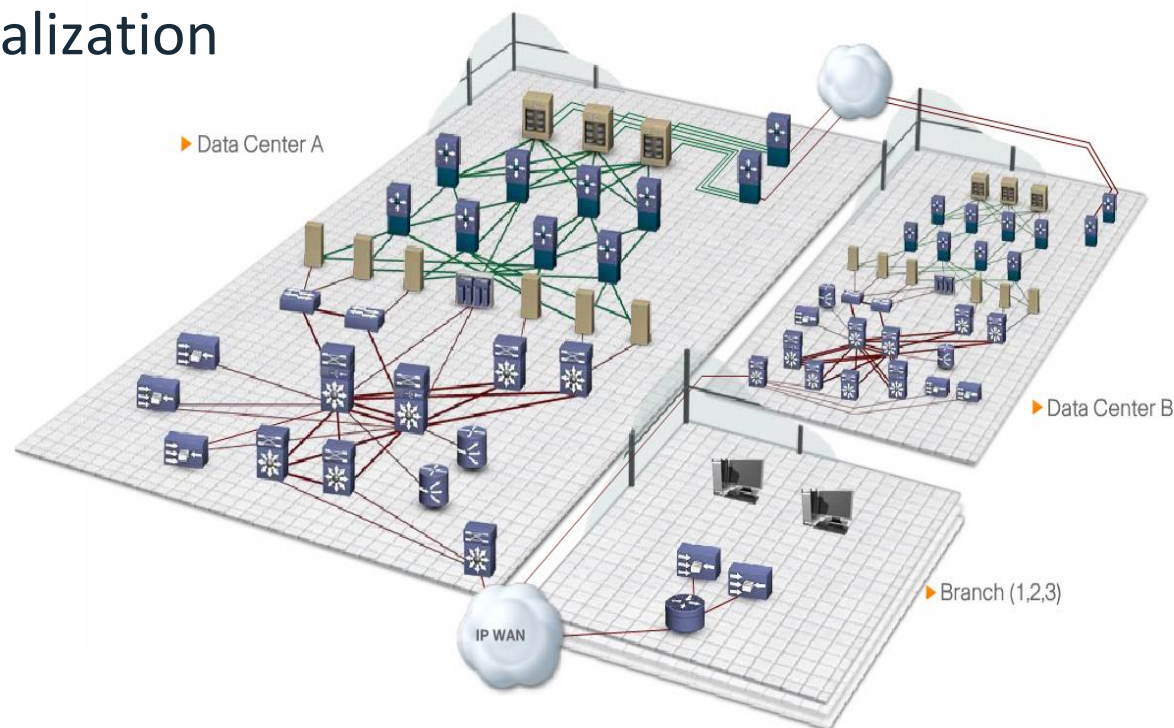OSIsoft®

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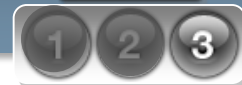
Efficiency Tier

Network Enabled Service Delivery

- Provides Efficiency Gains of Scale across IT Infrastructure

Network is an Ideal Platform for Storage and Services Virtualization

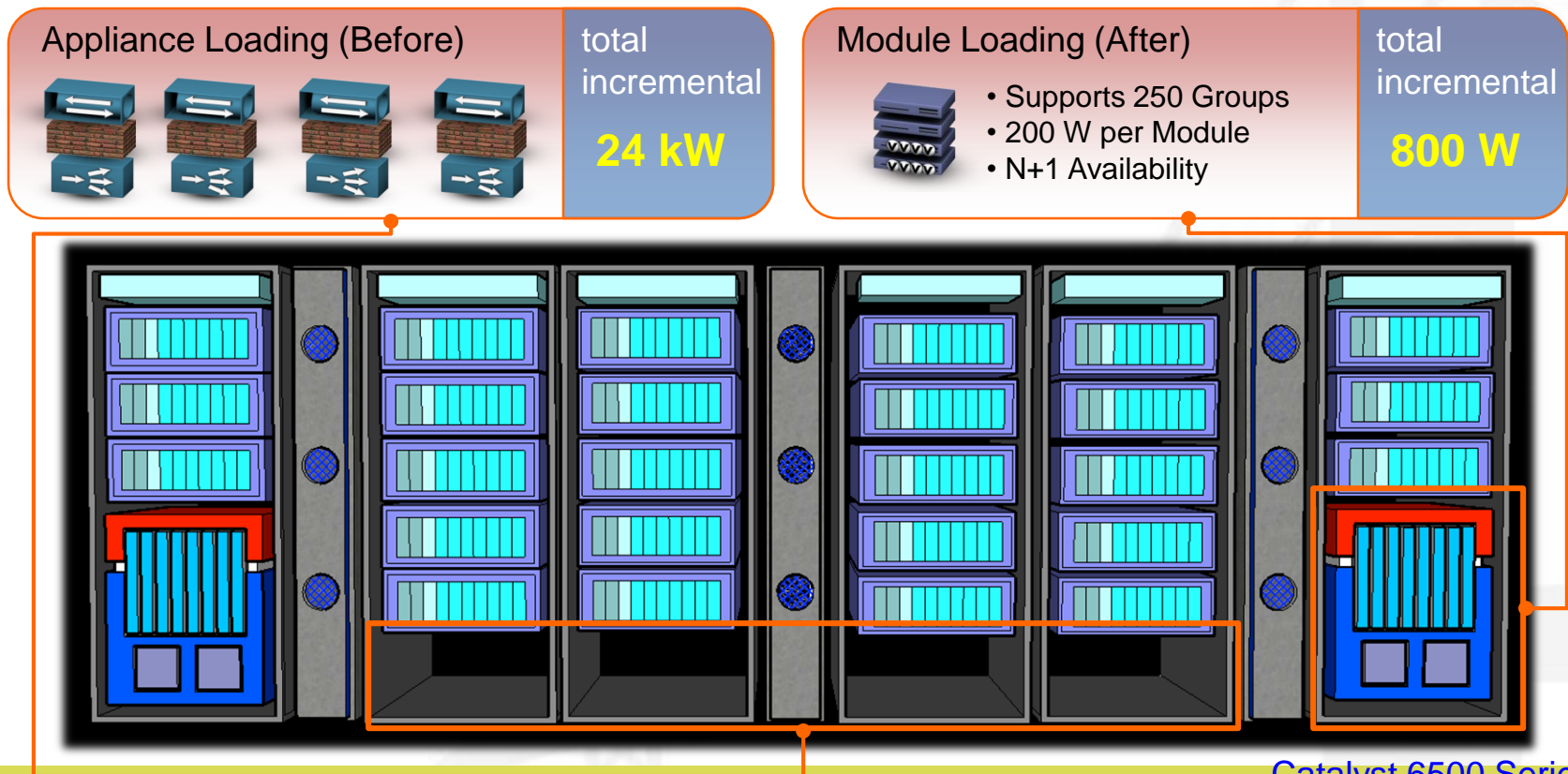Compute Load Balancing
SSL Offload
Security
LAN/SAN Consolidation

Data Center A

Data Center B

Branch (1,2,3)

IP WAN

35

Server Networking
Achieving Modular "Service Density"

More Efficient Services Delivery

- Reduces Total Power Supply Count and Scales More Effectively

  Cisco IT Deployment of Firewall & Application Delivery Service Modules

Appliance Loading (Before)	total incremental 24 kW

Module Loading (After)	total incremental 800 W

- Supports 250 Groups
- 200 W per Module
- N+1 Availability

Catalyst 6500 Series

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Storage Area Networking
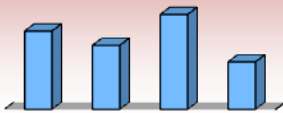# Increasing Utilization through Virtualization

Under-Utilized IT Assets Waste Electricity

- Storage may have Already Surpassed Servers for Total IT Power

Cisco IT was at 36% Total Storage Utilization in 2006

As of October 2008 Cisco IT is at 66% Utilization using IVR
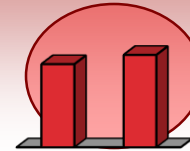
Storage Islands (Before)		Total Avg. Utilization
	• SAN per BU • Hard to Scale • Complex Design	**36%**

Storage Pool (After)		Total Avg. Utilization
	• Storage Pool • Easier to Scale • Simple Design	**66%**

MDS & Nexus Series
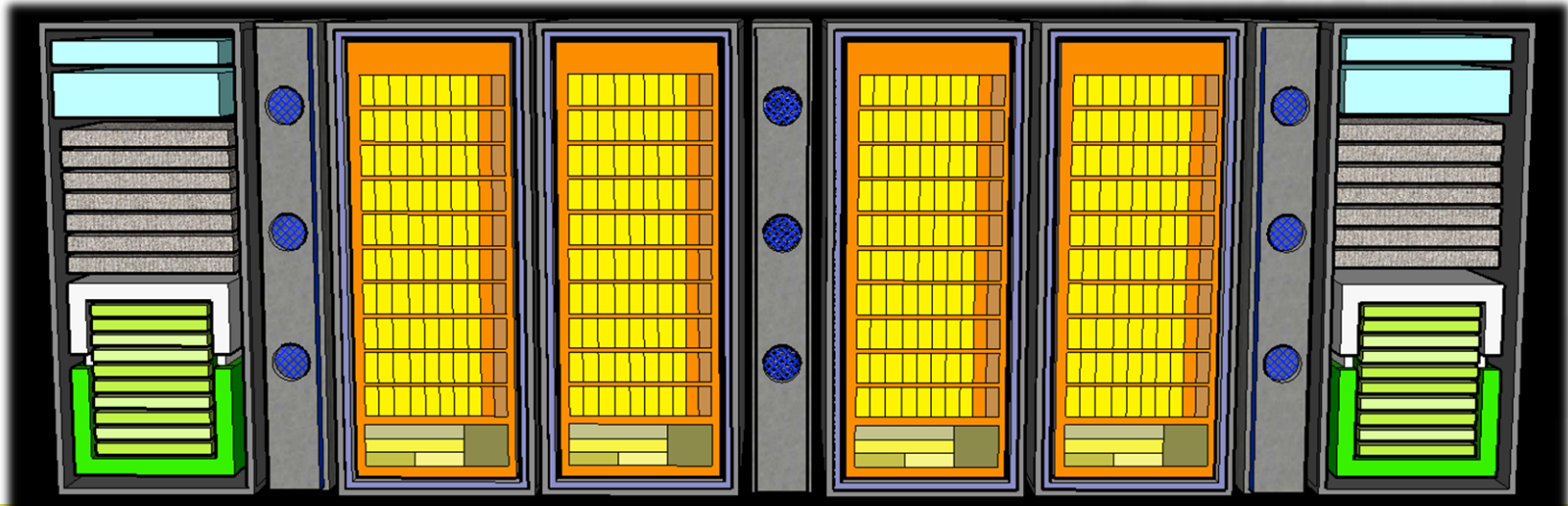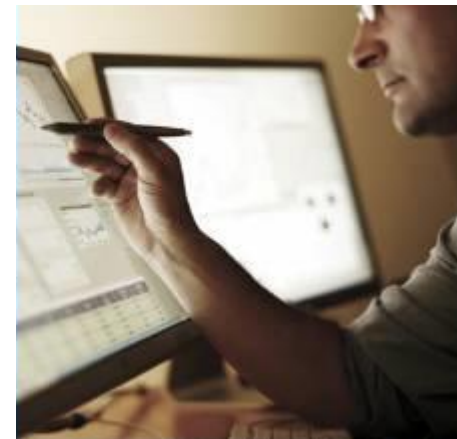
www.cisco.com/go/efficiency
www.cisco.com/go/energywise

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Questions?

Thank you very much…

CISCO

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