Making the Case for Metering and Performance Measurement in Data Centers

2016 Better Buildings Summit

Wednesday, May 11, 9:45-11:00AM

Speakers

- Moderator
  - Steve Greenberg – Lawrence Berkeley National Laboratory
- Presenter/Panelists
  - Steve Greenberg – Lawrence Berkeley National Laboratory
  - Steve Naumann – U.S. Social Security Administration

Technical Assistance for Better Buildings Partners

Steve Greenberg, Lawrence Berkeley National Laboratory

U.S. DEPARTMENT OF ENERGY

Outline

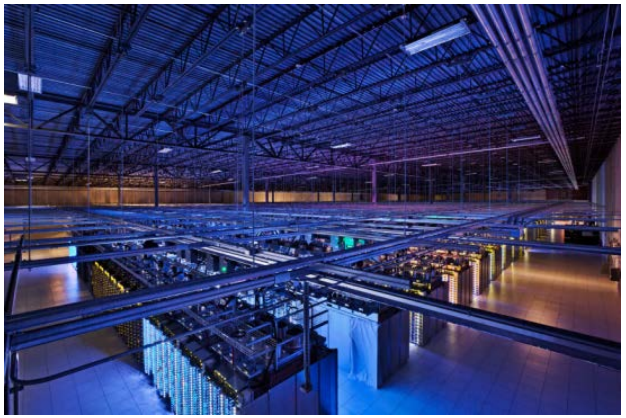
- Inspiration for metering and measurement
- Metering Guide
- Examples of Technical Assistance for Partners
- A word about Data Center Infrastructure Management

Inspiration for Metering and Measurement

- “You can’t manage what you don’t measure”
- It’s a requirement for Federal agencies per Executive Order 13693

Executive Order 13693 Mandates

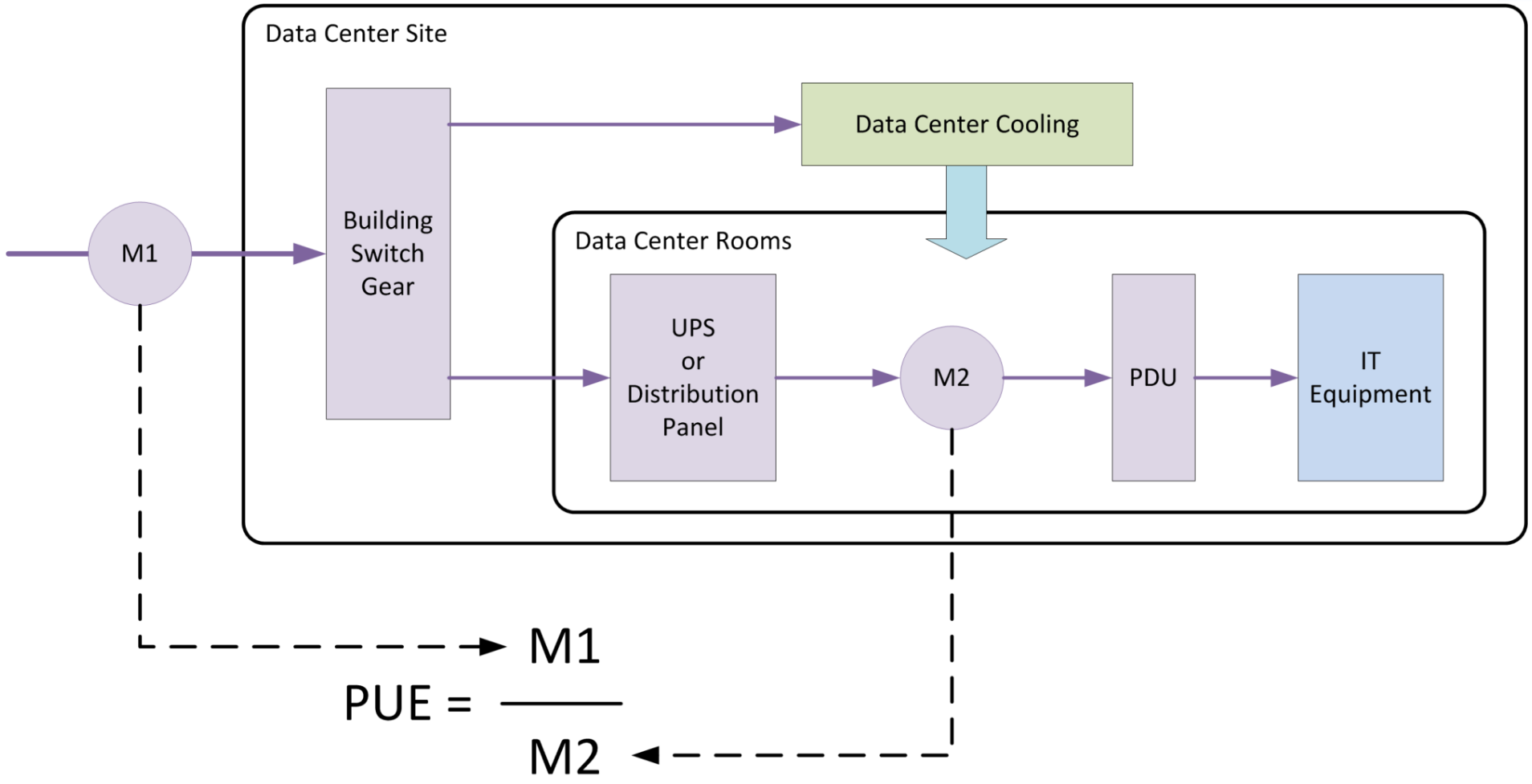
- Install and monitor advanced energy meters in all data centers by FY ‘18 --Section 3(a)(ii)(B)
- Target 1.2 to 1.4 PUE for new data centers --Section 3(a)(ii)(C)
- Target less than 1.5 PUE for existing data centers (same)



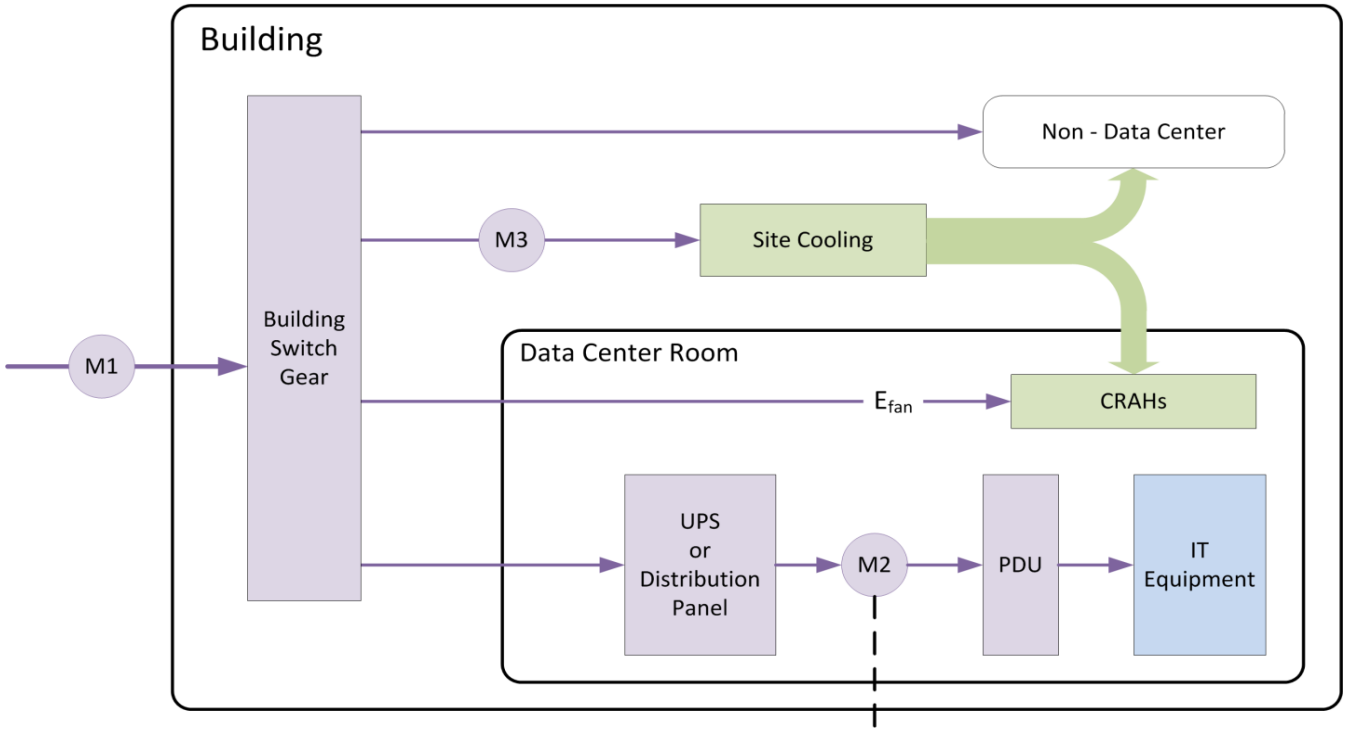
Metering Guide

- Metering Steps
  - Plan
  - Implement
  - Use
- Addressing Challenges
- Data Center Metering and Resource Guide (Version 2.1), 2016. Available at https://datacenters.lbl.gov/resources/data-center-metering-and-resource-guide

Data Center Types: 1. Stand-alone



Data Center Types: 2. Embedded, w/additional metering beyond UPS output

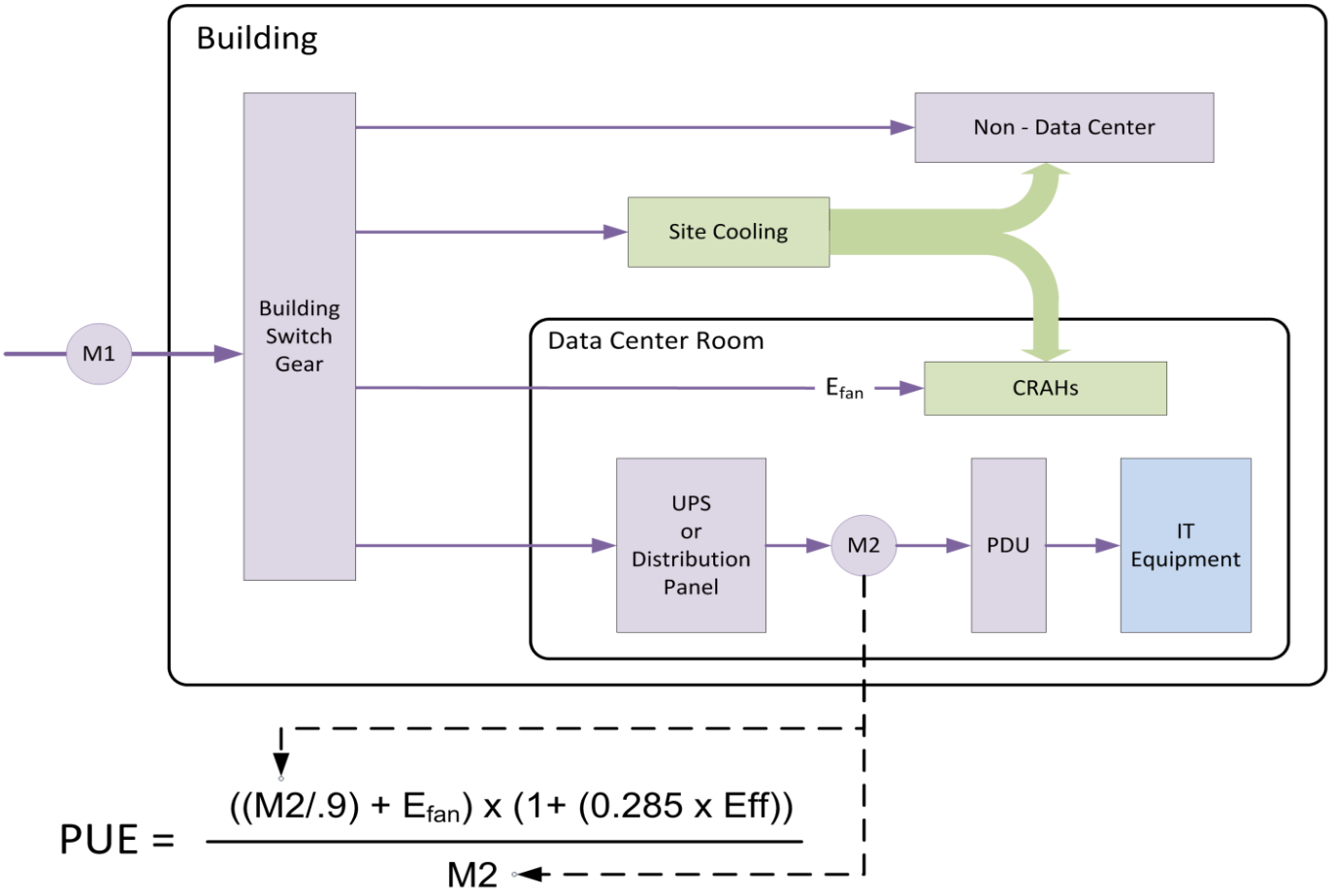


2a. Chiller Plant input (M3)

$$PUE = \frac{((M2/.9) + E_{fan}) \text{ X } (1+ (0.285 \text{ X } Eff))}{M2}$$

Where E_{fan}= CRAH fan energy use
Eff = average chiller plant efficiency in kW/ton (M3 is used to calculate; see "Data Center Metering and Resource Guide")

Data Center Types: 3. Embedded, no additional metering beyond UPS output



3a. Water-cooled chiller plant with CRAHs

Eff = (Chiller efficiency + 0.2) kW/ton, where chiller efficiency can be obtained from Chiller Efficiency Table and 0.2 represents typical additional load of chilled water/condenser water pumps and cooling tower fans.

Technical Assistance for Partners

- Help with baseline PUE
- Help with opportunities for improvement
- Examples:
  - Lawrence Berkeley Lab 50B-1275
  - “Agency X”
  - Lawrence Berkeley Lab CRT

Lawrence Berkeley National Laboratory Room 50B-1275 “the case-study king”

45-year-old data center
5600 square feet
~450 kW IT load
7 CRACs 15 to 30 tons of cooling each in 2-4 stages
Down-flow units (raised floor)
Water-cooled
Other cooling including rear doors, enclosed racks, AHU

Numerous case studies

Lawrence Berkeley National Laboratory Room 50B-1275, con't

Assistance:

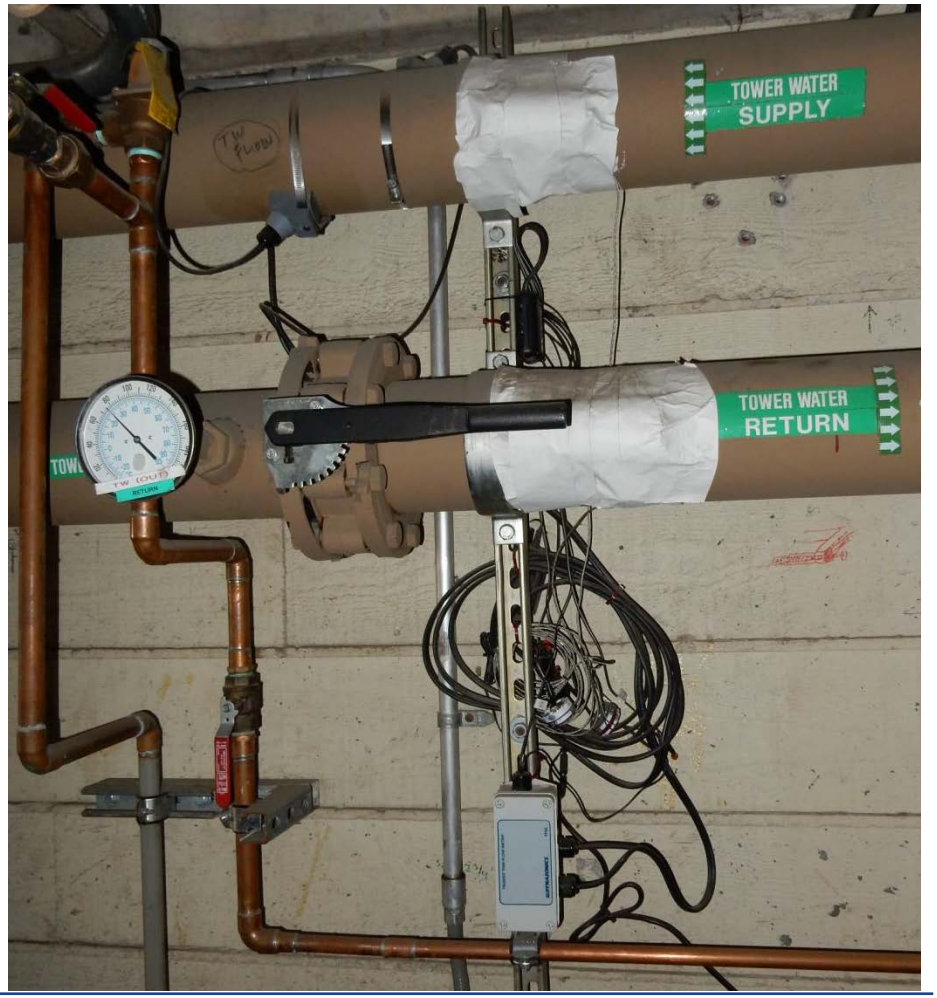
- **Determining PUE based on existing and proposed metering**
- **Determining how to update metering based on changes**
  - **CHW plant (VFD pumps, new cooling tower)**
  - **In-room (chilled water to rear doors, UPS)**
  - **Triage based on cost vs. effect on PUE**

LBNL Room 50B-1275, con't

Electric metering

LBNL Room 50B-1275, con't

Thermal metering



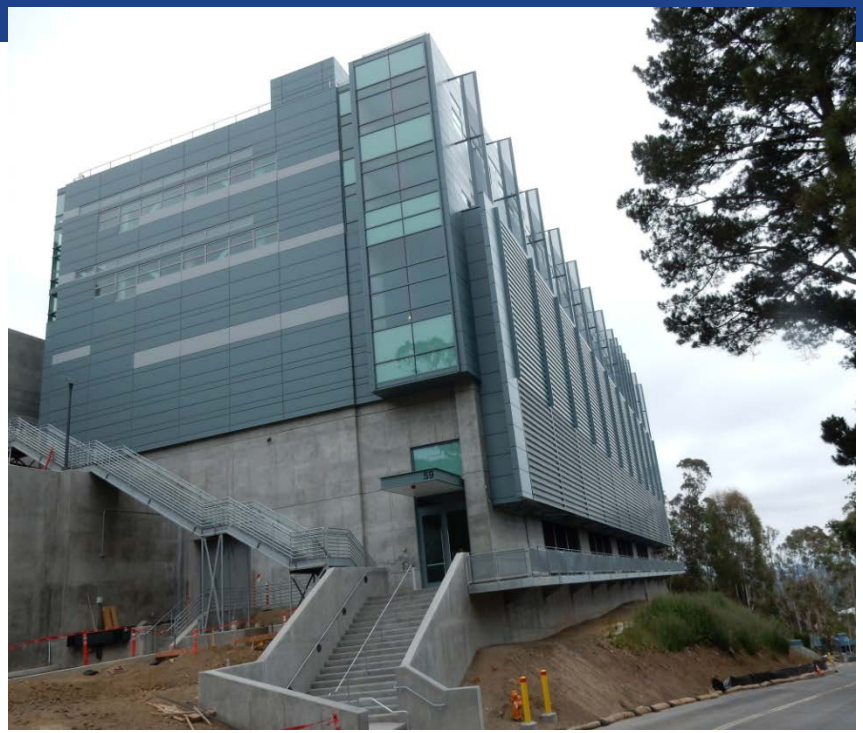
Agency X

- Technical assistance:
  - Help with determining PUE
    - Embedded DC with shared chiller plant
    - Submetering recommendations
  - References to consultants for more-detailed assessment
  - Help with specific questions
  - Helped drop PUE from 2.3 to 1.7 with operational changes only

Lawrence Berkeley National Laboratory
Building 59: the Computational Research and Theory Facility
"the multi-megawatt supercomputer center"

- **Brand-new supercomputer center, embedded**
- **142,000 square feet total**
- **7 MW IT load to start, then up to 17, then ???**
- **IT load will dominate building**
- **2 large AHUs for air-cooled loads**
- **4 cooling towers with heat exchangers for water-cooled loads**
- **Water-cooled supercomputers**
- **Air and water side economizers**
- **Air-side heat recovery for heating offices**
- **IT loads cooled without compressors**

LBNL Building 59



Lawrence Berkeley National Laboratory Building 59, con't

Technical Assistance:

- **Help with determining PUE**
- **Help with the reviews and commissioning of meter location, accuracy, and reporting capability**
- **Help with identifing meter additions needed**
- **Triage based on cost vs. effect on PUE**

Lawrence Berkeley National Laboratory Building 59, con't

Data Center Infrastructure Management

- "All things to all people"
  - IT (utilization, inventory, operational alarms)
  - Power, Space, Cooling
  - Planning
- Great for large Data Centers
- Over-commitment risk for smaller Centers
  - High cost to initiate
  - High cost (internal and external) to maintain
- Need to right-size to balance costs and benefits

Thank you! Questions?

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Building the Case for Metering

Better Buildings Summit, May 2016

Steve Naumann, Director, National Support Center

Social Security Administration

National Support Center
Urbana, MD

National Support Center Key Energy Points

- LEED Gold Certified ✹
- Uptime Institute certified Tier 3 Data Center
- DOE Better Buildings Challenge
- Hot-Aisle-Containment of IT equipment ✹
- High density computing & Energy Star equipment
- Electric metering down to the branch circuit
- Convergent monitoring of IT equipment: PUE, heat maps, Smart Racks ✹
- Free cooling below 55° roughly 145 days per year…~$240k/yr ✹
- Photovoltaic Solar Array 1.3MW …~$152K/yr ✹
- 6MW now, 10MW in the future
- Passive Solar heated water, rainwater reclamation, reduced flow fixtures
- Instant-on and LED lighting throughout the complex
- Southern facing floor-to-ceiling windows in the office building to help offset heating costs
- Indigenous grasses - less mowing - reduces fuel costs and air pollutants
- Solar powered parking lot lights
- Pervious parking lot and under grass grid for building maintenance access road

Photo-Voltaic Solar Array

Data Center Optimization Management

- **DCOM** Strategic areas:
- Energy Efficiency
- + Project Management
- + IT, Facilities and Security Co-Management of Operations
- **All add up to cost savings**

Managing IT

- **High Density Computing/Hot-aisle-containment**
  - Asset Management and RFID
  - Configuration Management
  - Consolidation and Virtualization….Virtual 1st!
- **Convergent Monitoring** – using real time environmental metrics to manage IT
  - JBOC and JBOD….our goal
  - Instant PUE and trending
  - move cyclical workloads to spread the heat load evenly
- **Storage**
  - Deduplication
  - Virtualization
  - e-vault
- **Network**
  - Top-of-Rack switches
  - Virtualization

Be Green Save Green

- Do what works best for your organization
- Leverage your location…Solar, Wind, Cold
- Negotiate your energy costs
- Virtual First Policy
- Co-Location
- Cloud
- Retro-fit…cold-aisle containment
- Turn up the heat
- Challenge the status quo

Why Monitor?

- Now a mandate for Federal Departments / Agencies
- Show-back, Charge-back
- Offset operational costs / re-invest / fund new projects
- Make improvements in whitespace layout / facilities
- Categorize usage between facilities, compute, storage and network
- Trend usage, plan for future cyclical workloads / customers
- Map energy and resources consumed to application optimization
- More robust SLAs
- Helps illustrate data centers as application eco-systems

Thank you!

Let’s discuss!