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
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 Types: 1. Stand-alone

Data Center Site

- Building Switch Gear
- Data Center Cooling

Data Center Rooms

- UPS or Distribution Panel
- M2
- PDU
- IT Equipment

PUE = \frac{M1}{M2}
Data Center Types: 2. Embedded, w/additional metering beyond UPS output

2a. Chiller Plant input (M3)

\[ \text{PUE} = \frac{(\text{M2}/.9) + \text{E}_{\text{fan}}) \times (1 + (0.285 \times \text{Eff}))}{\text{M2}} \]

Where \( \text{E}_{\text{fan}} \) = 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

\[
PUE = \frac{((M2/0.9) + E_{fan}) \times (1 + (0.285 \times \text{Eff}))}{M2}
\]

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
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
• 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
Technical Assistance:

• Help with determining PUE

• Help with the reviews and commissioning of meter location, accuracy, and reporting capability

• Help with identifying meter additions needed

• Triage based on cost vs. effect on PUE
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!