Put a Meter On It! Submetering Energy and Water Use

Wednesday, May 17
2:00-3:15 pm
Panelists

- Sam Dib, Aquicore
- Jonathan Flaherty, Tishman-Speyer
- Dale Sartor, Lawrence Berkeley National Laboratory
- Bruce Lung, U.S. Department of Energy (Moderator)
Sam Dib

Aquicore
Better Building Summit Presentation

Sam Dib
Agenda

1. Why Submeter?
2. The Real-Time Advantage
3. Applications of Submetering
4. Hurdles
5. Key Takeaways
6. The Next Big Thing
Nice to Meet You!

Sam Dib
VP, Customer Experience
Aquicore
What is Submetering?

submetering
noun | sub·mē′təring

The installation of additional meters beyond the main feed to break out individual and granular insights on all types of energy.
Real-Time Submetering Data

- Peanut butter without the jelly
- Real time = interval data collected within minutes of occurrence (1-15 min)
- Manual data collection is inefficient and error-prone
- Meter management
- Real-time commissioning during installation
Submetering Applications

- Operational improvements and energy savings
- Tenant billing
- Compliance, sustainability, management reporting, and LEED/Energy Star
- Fault detection, equipment alerts, and M&V
Hurdles of Implementing Submetering

- Understanding your existing facility
- Cost
- Implementation
- Data interpretation and analysis
Overcoming the Hurdles

- Audit your existing infrastructure
- Install meters and data collection system at the same time
- Use wireless networks to minimize labor, installation time, and disturbance to tenants
- Use cloud platform to minimize on-site IT and software costs
- Use a provider with experience in metering installation
- Shop for the best energy management platform to get the most out of your data
Key Takeaways

1. Submetering and real-time data collection go hand-in-hand.

2. Have a goal. Know what you’re measuring and for what purpose.

3. Use a third-party with expertise that can provide a complete hardware, software & installation solution or the tools to DIY.
What’s Next?

- IoT (sensors, lower costs of hardware, DIY solutions)
- Less expensive, faster implementation
- Easy access to data, better visibility
- Using submetering data for improved building design
Thank you!
sam@aquicore.com
Sub-Metering Overview

May 17, 2017
I. Sub-meter Architecture and Systems
Energy and Environmental Management Systems

**Utility Meters**

- **Base Building Meters**
- **Data Acquisition Device**
- **Tenant Sub-Meters**
- **Tenant Loads**

**Utility Data Feeds (Urjanet)**

**Typical Building**

- **Energy Management System (MACH Energy)**
  - **User** - Building Engineers
  - **Purpose** – Improve building performance and lower operational costs
  - **Deployed** – All US Properties

- **Demand Response Software (CPower)**
  - **User** - Building Engineers + ISO
  - **Purpose** – Profit/Revenue
  - **Deployed** – Most US Properties

- **Environmental Management Software (Credit360)**
  - **User** – Sustainability, Investors + Tenants
  - **Purpose** – Reporting / Compliance
  - **Deployed** – Globally

- **Tenant Meter Software (EMSys)**
  - **User** - Tenants + PM
  - **Purpose** - Billing and tenant energy usage / performance
  - **Deployed** – Select NY, MA and CA Properties

**KEY**

- Device
- Meter

**Frequency of Communication**

- Data
- Electricity, Gas and/or Steam
II. Equipment
Data Acquisition Device

A8812

Approximately $1,500
Typical Tenant Sub-Meter Design
Multi Channel Meter

Approximately $4,000 - $5,000
Single Channel Meter

Approximately $1,200
Remote Terminal Unit

Approximately $6,500
Dale Sartor

Lawrence Berkeley National Laboratory
Practical Considerations for Metering and Power Usage Effectiveness

Dale Sartor, PE
Lawrence Berkeley National Laboratory
Washington DC, May 17, 2017
Power Usage Effectiveness

- The ratio of total energy use to that of the information technology (IT) equipment
- A measure of how efficiently the data center infrastructure uses energy

\[
PUE = \frac{\text{Total Data Center Facility Annual Energy Use}}{\text{IT Equipment Annual Energy Use}}
\]
Power Usage Effectiveness, cont.

Power Usage Effectiveness (PUE)

Data center number

PUE
# PUE Measurement Categories Recommended by the Green Grid

Table 1: PUE measurement categories recommended by this task force.

<table>
<thead>
<tr>
<th></th>
<th>PUE Category 0*</th>
<th>PUE Category 1</th>
<th>PUE Category 2</th>
<th>PUE Category 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT energy measurement location</td>
<td>UPS output</td>
<td>UPS output</td>
<td>PDU output</td>
<td>IT equipment input</td>
</tr>
<tr>
<td>Definition of IT energy</td>
<td>Peak IT electric demand</td>
<td>IT annual energy</td>
<td>IT annual energy</td>
<td>IT annual energy</td>
</tr>
<tr>
<td>Definition of Total energy</td>
<td>Peak Total electric demand</td>
<td>Total annual energy</td>
<td>Total annual energy</td>
<td>Total annual energy</td>
</tr>
</tbody>
</table>

*For PUE Category 0 the measurements are electric demand (kW).
Green Grid’s 3 Level Approach

Focus on Level 1, the default for Better Buildings
Note table assumes standalone data centers where total is measured by the utility inputs

<table>
<thead>
<tr>
<th></th>
<th>Level 1 (L1)</th>
<th>Level 2 (L2)</th>
<th>Level 3 (L3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT Equipment Energy</td>
<td>UPS Outputs</td>
<td>PDU Outputs</td>
<td>IT Equipment Input</td>
</tr>
<tr>
<td>Total Facility Energy</td>
<td>Utility Inputs</td>
<td>Utility Inputs</td>
<td>Utility Inputs</td>
</tr>
<tr>
<td>Measurement Interval</td>
<td>Monthly/Weekly</td>
<td>Daily/Hourly</td>
<td>Continuous (15 minutes or less)</td>
</tr>
</tbody>
</table>
Figure 12. Control volume for a dedicated data center
Figure 13. Control volume for a data center within a mixed-use building
Infrastructure Components

- Energy using Power and HVAC components contributing to the total data center energy use
- Each could require one or more meters in an embedded data center
PUE Calculation Diagram
Getting Started

- Data Center Metering and Resource Guide
  - A practical guide to measuring PUE

2e. Embedded w/metering

2e. UPS input (M4) and CRACs and Condensers Input (M5)

PUE = \( \frac{(M5 + M4) \times 1.03}{M2} \)
Data Center Types: 3. Embedded, no additional metering beyond UPS

3a. Water-cooled chiller plant with CRAHs

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

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.
## Assumed Chiller Plant Efficiencies

### Chiller Efficiency Table (Edited from Table 6.8.1C - ASHRAE 90.1 – 2010)

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Size Category</th>
<th>Minimum Efficiency</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air- Cooled Chillers</strong></td>
<td>&lt;150 ton</td>
<td>≤ .960</td>
<td>kW/ton-IPLV</td>
</tr>
<tr>
<td></td>
<td>&gt;150 ton</td>
<td>≤ .941</td>
<td>kW/ton-IPLV</td>
</tr>
<tr>
<td><strong>Water - Cooled Chillers</strong></td>
<td>&lt;75 ton</td>
<td>≤ .630</td>
<td>kW/ton-IPLV</td>
</tr>
<tr>
<td>Positive Displacement</td>
<td>≥75 ton and &lt; 150 ton</td>
<td>≤ .615</td>
<td>kW/ton-IPLV</td>
</tr>
<tr>
<td></td>
<td>≥150 ton and &lt; 300 ton</td>
<td>≤ .580</td>
<td>kW/ton-IPLV</td>
</tr>
<tr>
<td></td>
<td>≥300 ton</td>
<td>≤ .540</td>
<td>kW/ton-IPLV</td>
</tr>
<tr>
<td><strong>Water - Cooled Chillers</strong></td>
<td>&lt; 300 ton</td>
<td>≤ .596</td>
<td>kW/ton-IPLV</td>
</tr>
<tr>
<td>Centrifugal</td>
<td>≥300 ton and &lt; 600 ton</td>
<td>≤ .549</td>
<td>kW/ton-IPLV</td>
</tr>
<tr>
<td></td>
<td>≥600 ton</td>
<td>≤ .539</td>
<td>kW/ton-IPLV</td>
</tr>
</tbody>
</table>
While such compromises allow one to estimate PUE, it does not allow one to track performance and improvement.
Meter What is Important

- Need to meter enough to show changes (improvements with energy efficiency measures)
- Compromises reduce ability to compare to others but perhaps not to self
  - Estimate some loads such as:
    - Generator heaters
    - Lights
    - Transformer and cable losses
  - Estimates based on:
    - Engineering calculations
    - One time measurements of constant loads
- Assume efficiencies
  - Chiller plant (see prior table)
  - UPS (use manufacturer’s curves)
Examples of getting to PUE at LBNL data centers

- Building 50A-1156: the hodgepodge
- Building 50B-1275: the case-study king
- Building 59: the many-megawatt supercomputer center
Lessons Learned Determining PUE at LBNL

- Is case-by-case—every center is different
- Take advantage of existing meters
- Minimize estimation
- Involves numerous meters

- How much is enough?
- How much is too much?
Other Needs

- Sub-metering often required to calculate PUE but also desirable for evaluation
  - TGG Level 2 and 3
  - Partial PUE (system level metrics and benchmarking)

- Metering environmental conditions
  - Measure temperature at inlet to IT equipment (top and bottom of rack)
  - Facilitates air management
  - Provides confidence to increase temperatures
  - Thermal maps can convert hundreds of measurement points into one picture:

- IT Metrics
  - Utilization
Resources

- Data Center Metering and Resource Guide
  datacenters.lbl.gov/resources/data-center-metering-and-resource-guide

- PUE: a Comprehensive Examination of the Metric
  thegreengrid.org/en/Global/Content/white-papers/WP49-PUEAComprehensiveExaminationoftheMetric

- Center of Expertise for Energy Efficiency in Data Centers
  datacenters.lbl.gov/
Speaker Contact Information

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