Emerging Technology: Opportunities and Challenges Associated with Controls

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Why The Focus on Controls?

- Many types, purposes and end uses – e.g. lighting, HVAC, building energy management systems (EMS), other
- Relevant for DR and EE programs
- Useful for evaluation and for savings - not limited to just the technology that they control
- “Smart” technologies and the integrated EE/DER environment are both growing; the DER environment needs to understand consumption patterns – both at end use levels and whole building, location-specific information and rapid feedback
- P.s. on accuracy: *For a sample of technologies like advanced LED lighting controls and VRF systems feedback is that accurate data acquisition is not a priority or if available not used.*

• What information can control technologies provide?
• What are the issues/barriers to successful leveraging of control technologies *to provide both additional savings and valuable EM&V data?*
• What recommendations do we have for strategies/best practices to make these support success?
Experience using EMS data in EM&V work
Background and definitions

DMI’s Role:

- Providing EM&V field work for impact evaluation studies
- Site-level field data collection and analysis
- Not (yet) EM&V 2.0 - a/k/a Advanced EM&V

Definition of Data Sources (in DMI’s opinion):

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Equipment Installed By</th>
<th>Type of Equipment</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trend data</td>
<td>Controls Contractor</td>
<td>Building Energy Management System</td>
<td>Permanent*</td>
</tr>
<tr>
<td>Meter data</td>
<td>Evaluation Contractor</td>
<td>Portable dataloggers</td>
<td>Temporary</td>
</tr>
<tr>
<td>Interval data</td>
<td>Utility Company</td>
<td>Utility gas or electric meter</td>
<td>Permanent</td>
</tr>
</tbody>
</table>

*May require configuration by evaluator
Using building EMS data for EM&V: Example 1

• CDA (Comprehensive Design Approach) Evaluation Study

• Example of using post-installation/Cx trend data to verify implementation of measures and to calibrate evaluation model
  • ECMs: Condensing Boilers, Heat Recovery, High eff. Chillers, Static Pressure Reset, Low dP filters, VFDs on fume hood exhaust fans, DCV in classrooms, and lighting.

• Specific examples of trend data use to verify and measure ECM performance
  • HW supply temp, AHU static pressure and VFD speed, space CO₂, and OA damper positions

• When analysis of trends is complete, adjust model inputs to reflect actual operations

• Trend data was not the only source of information for this study – supplemented other meter data collected by evaluator, such as motor kW, amperage, etc.
Using building EMS data for EM&V: Example 2

• HVAC retrofit measure evaluation-Particle Counters w VFD Control of Fans, Low Pressure Drop Filters

• Trend data was only source of specific ex post measurements – no supplemental metering by evaluator at equipment level
  • Site had restricted access to cleanroom areas and site operations did not allow shutdown of AHUs to install meters

• Specific examples of trend data use to verify and measure ECM performance
  • VFD speed, fan motor current, fan status, particle count readings

• Additional sources of data were used
  • Whole building interval data allowed a confirmation of pre / post energy use
  • TA vendor and installing contractor had collected fan current meter data using dataloggers
Pitfalls and shortcoming of using EMS data

• Data Accuracy
  • Important to verify accuracy of trended data points
  • Some values are more suspect than others
  • Can’t get make/model of sensors
  • Can’t verify whether any necessary calibration or maintenance steps were taken
  • Can’t verify whether the point on the front end screen is actually what it says it is

• Data availability
  • Most building operators will tell you that there are trends available, but “your mileage may vary”
  • Local operators usually unfamiliar with how to set up new trended points or extract data
  • Bringing in trained controls technician to set up trends typically adds cost
  • Not all building equipment connected
  • Site personnel unwilling or unable to share production data or other proprietary information

• Conclusions from field experience:
  • Not (yet) generally feasible to rely solely on EMS data for EM&V
  • Cannot easily rely on accuracy of trend data, but in many cases, trend data, if available, is better than no data
  • EMS trend data not reliable for measuring motor kW accurately, but revenue grade submeters are out there
Some Possible Solutions – How evaluators can help advance the energy efficiency industry

• More Stringent Requirements for Program Participation
  • Require demonstrated trending capabilities of key variable before final rebate payments is made
  • Stress test system to make sure controls measures don’t have unintended consequences

• Pre-Installation Trending of Controls Projects
  • For projects over a certain size require some trended data of pre-conditions for controls projects and non-controls projects where trending is needed
    • Consider paying for collection of pre-trending for larger project; part of engineering fee

• Accuracy of EMS sensors
  • Work with major EMS/controls manufacturers to determine accuracy of sensors ahead of time; pre-qualify

• Budget for Acquiring Trending Data in Impact Evaluations
  • If only way to get trend data is for customers to bring in their controls vendor to set up trending at a cost they do not want to bear, offer to reimburse them for reasonable charges to set up needed trending, often less than $1,000 per site
Emerging Technology: Opportunities and Challenges Associated with Controls

Michael Myer, PNNL
Controls as an Efficiency Measure: Opportunities and Challenges

MICHAEL MYER
Pacific Northwest National Laboratory
EM&V Annual Public Meeting
Lighting Controls in Commercial Buildings

2012 paper reviewing:
- 240 savings estimates
- 88 papers

Average energy savings
- 24% occupancy sensors
- 28% daylighting
- 31% personal tuning
- 36% institutional tuning
- 38% multiple approaches

Baseline & Controls
- Non-LED loads
- Legacy controls

Govt. Office LPD – Total Site and Per Zone

Govt. Office – Savings by Retrofit Action

- Pre-Retrofit Baseline
- Initial Configuration
- Final Configuration
<table>
<thead>
<tr>
<th>Site</th>
<th>FL to LED Only</th>
<th>Occupancy Control</th>
<th>Daylighting Control</th>
<th>Task Tuning</th>
<th>Total: LED with All Controls</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Brewery</td>
<td>50%</td>
<td>10%</td>
<td>6%</td>
<td>*</td>
<td>66%</td>
<td>Pre-retrofit occupancy sensors</td>
</tr>
<tr>
<td>2 – Office</td>
<td>64%</td>
<td>-2%</td>
<td>5%</td>
<td>**</td>
<td>67%</td>
<td></td>
</tr>
<tr>
<td>3 – Med Office</td>
<td>29%</td>
<td>24%</td>
<td>9%</td>
<td>***</td>
<td>62%</td>
<td></td>
</tr>
<tr>
<td>4 – Retail (Grocery)</td>
<td>30%</td>
<td>3%</td>
<td>~</td>
<td>33%</td>
<td>66%</td>
<td></td>
</tr>
<tr>
<td>5 – Office</td>
<td>43%</td>
<td>-1%</td>
<td>4%</td>
<td>24%</td>
<td>70%</td>
<td>Pre-retrofit occupancy sensors</td>
</tr>
</tbody>
</table>

*Tuning at this site was negligible as it only applied to a very few fixture in one area.

**Task tuning was not separately done at this site. Fixtures were shipped to the site with 88% output effectively applying a 12% tuning.

***Task tuning was done at two different steps at this site in direct coordination with both FL to LED replacement and Daylighting Control savings and therefore not separately.
## NEEP Field Evaluation

### Baseline: LED fixture

<table>
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<tr>
<th>Site</th>
<th>Occupancy Control</th>
<th>Daylight Control</th>
<th>Task Tuning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Brewery</td>
<td>19%</td>
<td>13%</td>
<td>~ *</td>
</tr>
<tr>
<td>2 – Office</td>
<td>-5%</td>
<td>16%</td>
<td>12% *</td>
</tr>
<tr>
<td>3 – Med Office</td>
<td>34%</td>
<td>12%</td>
<td>34% *</td>
</tr>
<tr>
<td>4 – Retail</td>
<td>4%</td>
<td>~</td>
<td>47%</td>
</tr>
<tr>
<td>5 – Office</td>
<td>-2%</td>
<td>7%</td>
<td>43%</td>
</tr>
</tbody>
</table>

*Estimated values

- Advanced occupancy sensors actually lead to cases of negative savings in outlier cases
- Greater sensor resolution / more sensitive?
- Differences in time settings?
Issues/ Barriers that impede successful leveraging of controls technologies

Costs

- LED equipment saves significant energy $\rightarrow$ limiting cost recoveries from controls
- Commissioning / user expectations / settings

- DesignLights Consortium has standardized report guidelines as part of the Networked Lighting Control Systems

- Energy Efficiency Lighting Program Committee

- Working Groups:
  - Developing data / recommendations for lighting information for TRMs
  - Energy Efficiency Program Design Guide
  - Energy Efficiency Best Practices
  - Energy Efficiency Lighting Quality Metric for Best Project Outcomes
Promising technologies solve current problems with EM&V of control systems?

- **Energy Reporting**
  - DOE studying energy reporting accuracy
  - Smart power strips
  - Street lights
  
- **Communication**
  - No more isolated building systems
  - EMIS
    - Lighting
    - HVAC
    - Plugs

- **Standardized data sets / structures**
  - Building Energy Data Exchange Specification (BEDES)
  - DesignLights Consortium has standardized report guidelines as part of the Networked Lighting Control Systems
Integration with building control systems – EM&V opportunities?

- Industry moving from widgets to systems
- The increase of systems leads to more complex M&V and controls
- Other Energy Benefits (OEBs) – beyond the specific system
  - Example – occupancy sensors part of lighting system interacting with HVAC and plug loads
- Non-energy benefits
  - Space utilization – using occupancy sensors to detect which spaces are used more / less frequently
  - Asset tracking – RFID tags on track occupancy for better space utilization and possibly greater energy savings
  - Many other non-energy related applications