Emerging Technology: Opportunities and Challenges Associated with Controls

David Jacobson, Jacobson Energy, Moderator

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?

Controls: Using EMS for EM&V

Alec Stevens, DMI

Alec Stevens, PE

Jacobson Energy Research LLC

David Jacobson

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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):

Data Type	Equipment Installed By	Type of Equipment	Duration
Trend data	Controls Contractor	Building Energy Management System	Permanent*
Meter data	Evaluation Contractor	Portable dataloggers	Temporary
Interval data	Utility Company	Utility gas or electric meter	Permanent

*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 CO_2, 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 shortcomings 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

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Controls as an Efficiency Measure: Opportunities and Challenges

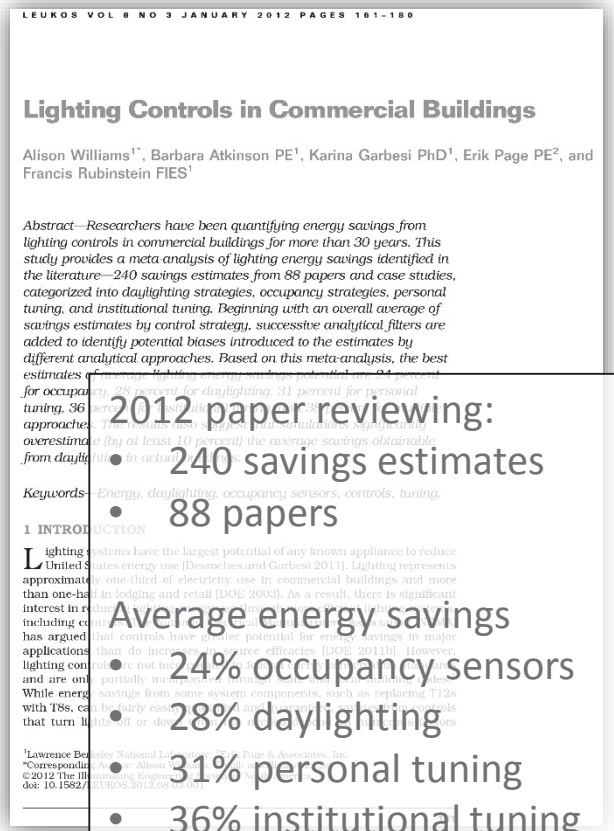
MICHAEL MYER

Pacific Northwest National Laboratory

EM&V Annual Public Meeting

U.S. DEPARTMENT OF ENERGY

Lighting Controls in Commercial Buildings



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Lighting Controls in Commercial Buildings

Alison Williams[1*], Barbara Atkinson PE[1], Karina Garbesi PhD[1], Erik Page PE[2], and Francis Rubinstein FIES[1]

Abstract—Researchers have been quantifying energy savings from lighting controls in commercial buildings for more than 30 years. This study provides a meta-analysis of lighting energy savings identified in the literature—240 savings estimates from 88 papers and case studies, categorized into daylighting strategies, occupancy strategies, personal tuning, and institutional tuning. Beginning with an overall average of savings estimates by control strategy, successive analytical filters are added to identify potential biases introduced to the estimates by different analytical approaches. Based on this meta-analysis, the best estimates of average lighting energy savings potential are 24 percent for occupancy, 28 percent for daylighting, 31 percent for personal tuning, 36 percent for institutional tuning, and 38 percent for multiple approaches. The results may suggest that studies significantly overestimate (by at least 10 percent) the average savings obtainable from daylighting in actual

Keywords—Energy, daylighting, occupancy sensors, controls, tuning.

1 INTRODUCTION

Lighting systems have the largest potential of any known appliance to reduce United States energy use [Desroches and Garbesi 2011]. Lighting represents approximately one-third of electricity use in commercial buildings and more than one-half in lodging and retail [DOE 2003]. As a result, there is significant interest in reducing lighting energy use, including controls. Research has argued that controls have greater potential for energy savings in major applications than do increases in source efficacies [DOE 2011b]. However, lighting controls are not implemented and are only partially implemented. While energy savings from some system components, such as replacing T12s with T8s, can be fairly easily quantified, savings from controls that turn lights off or dim

[1]Lawrence Berkeley National Laboratory, [2]Erik Page & Associates, Inc.
*Correspondin... Alison ...
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2012 paper reviewing:

- 240 savings estimates
- 88 papers

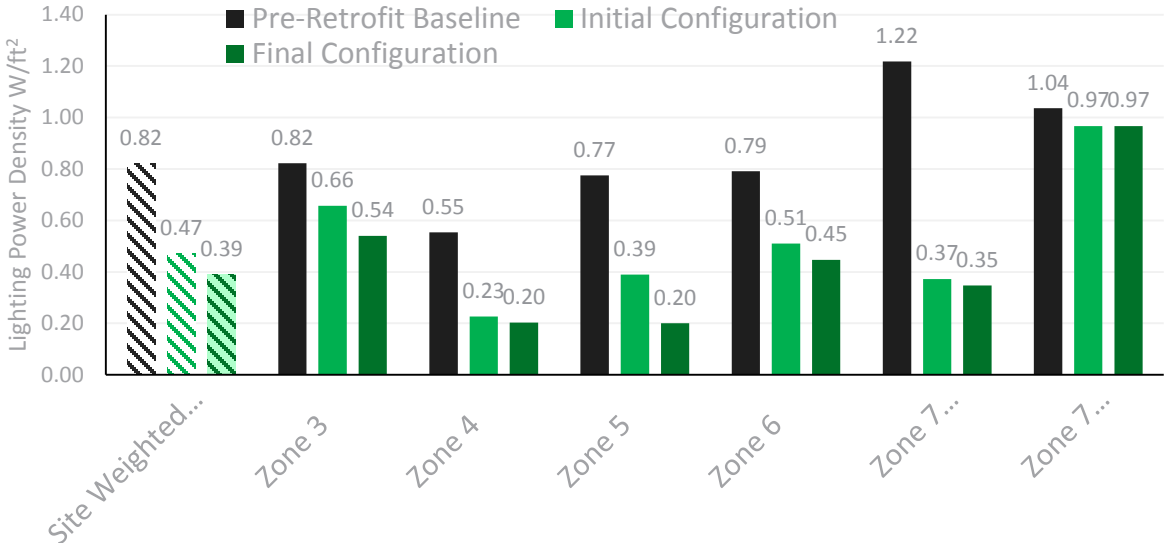
Average energy savings

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

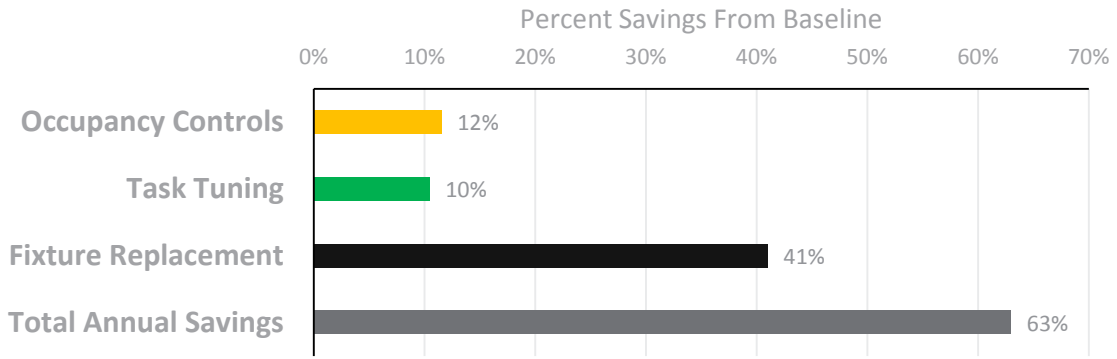
Baseline & Controls

- Non-LED loads
- Legacy controls

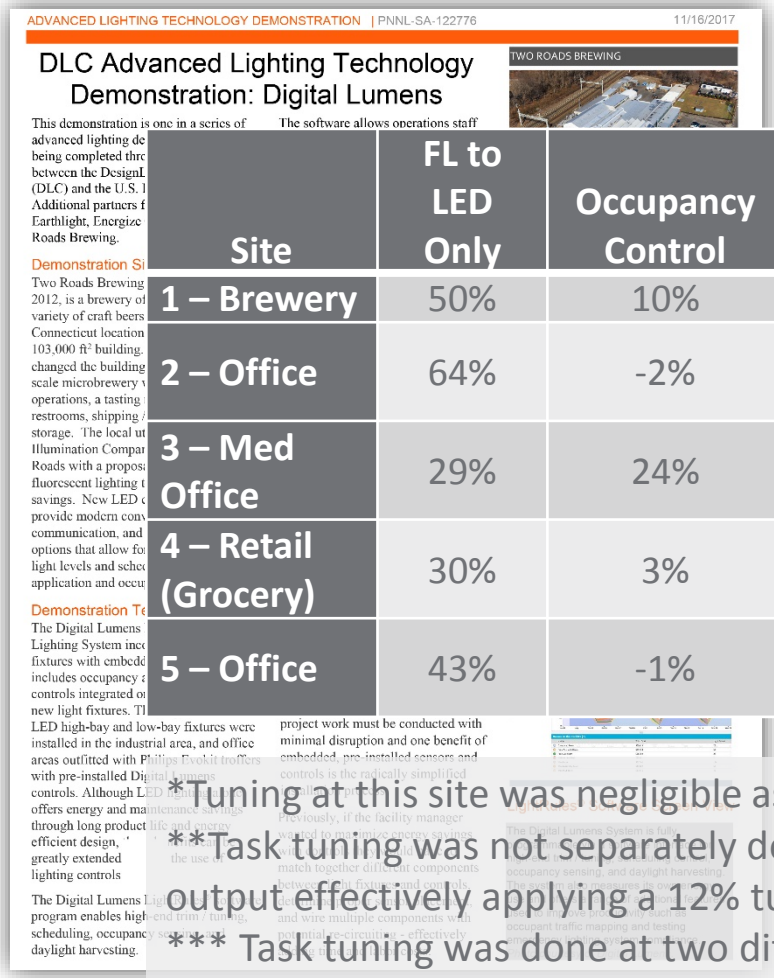
Govt. Office LPD – Total Site and Per Zone



Govt. Office – Savings by Retrofit Action



NEEP Field Evaluation
Baseline: Existing fluorescent system


ADVANCED LIGHTING TECHNOLOGY DEMONSTRATION | PNNL-SA-122776 11/16/2017

DLC Advanced Lighting Technology Demonstration: Digital Lumens

TWO ROADS BREWING

This demonstration is one in a series of advanced lighting de being completed thro between the DesignL (DLC) and the U.S. Additional partners f Earthlight, Energize Roads Brewing.

Demonstration Si

Two Roads Brewing 2012, is a brewery of variety of craft beers Connecticut location 103,000 ft² building. changed the building scale microbrewery operations, a tasting restrooms, shipping storage. The local ut Illumination Compar Roads with a propos fluorescent lighting savings. New LED provide modern conv communication, and options that allow fo light levels and sched application and occu

Demonstration Te

The Digital Lumens Lighting System inc fixtures with embedd includes occupancy controls integrated o new light fixtures. T LED high-bay and low-bay fixtures were installed in the industrial area, and office areas outfitted with Philips Evolve troffers with pre-installed Digital Lumens controls. Although LED offers energy and maintenance savings through long product life and energy efficient design, greatly extended lighting controls

The Digital Lumens program enables high-end trim / tuning, scheduling, occupanc daylight harvesting.

The software allows operations staff

project work must be conducted with minimal disruption and one benefit of embedded, pre-installed sensors and controls is the radically simplified

previously, if the facility manager

match together different components between light fixtures and controls

and wire multiple components with

The Digital Lumens System is fully occupancy sensing, and daylight harvesting

occupant traffic mapping and testing

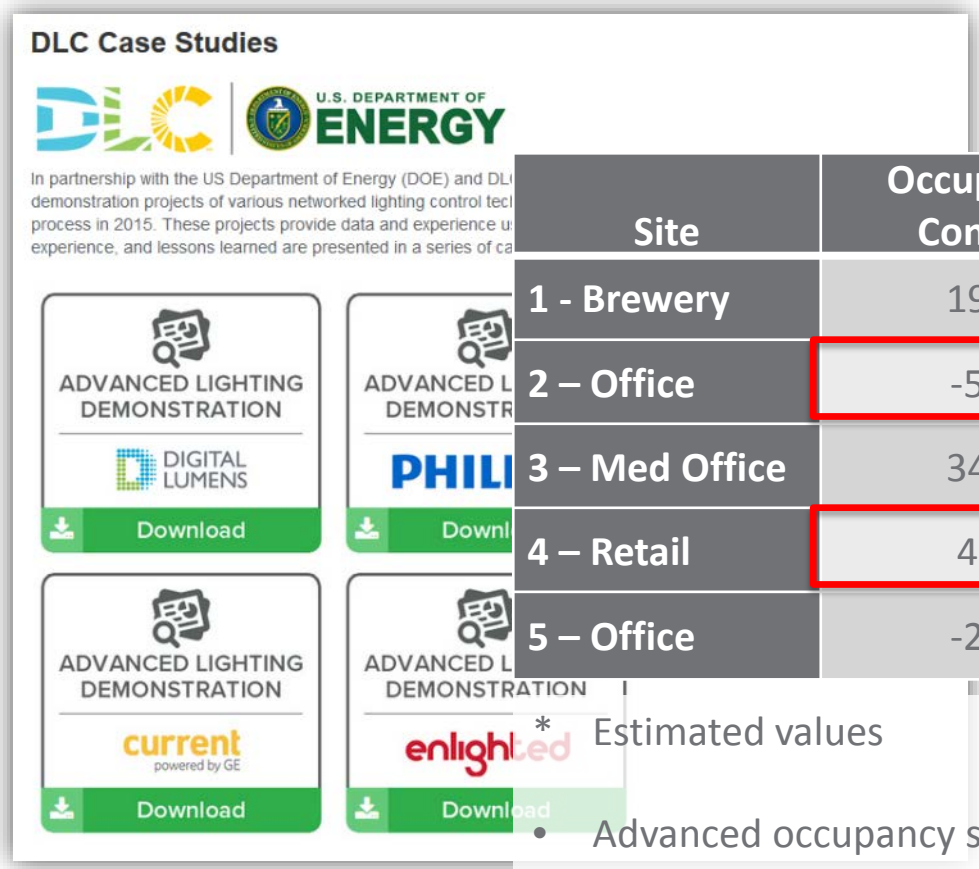
Site	FL to LED Only	Occupancy Control	Daylighting Control	Task Tuning	Total: LED with All Controls	Notes
1 – Brewery	50%	10%	6%	*	66%	
2 – Office	64%	-2%	5%	**	67%	Pre-retrofit occupancy sensors
3 – Med Office	29%	24%	9%	***	62%	
4 – Retail (Grocery)	30%	3%	~	33%	66%	
5 – Office	43%	-1%	4%	24%	70%	Pre-retrofit occupancy sensors

*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



Site	Occupancy Control	Daylight Control	Task Tuning
1 - Brewery	19%	13%	~ *
2 – Office	-5%	16%	12% *
3 – Med Office	34%	12%	34% *
4 – Retail	4%	~	47%
5 – Office	-2%	7%	43%

* 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 to leveraging of controls technologies

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Costs

- LED equipment saves significant energy → 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?

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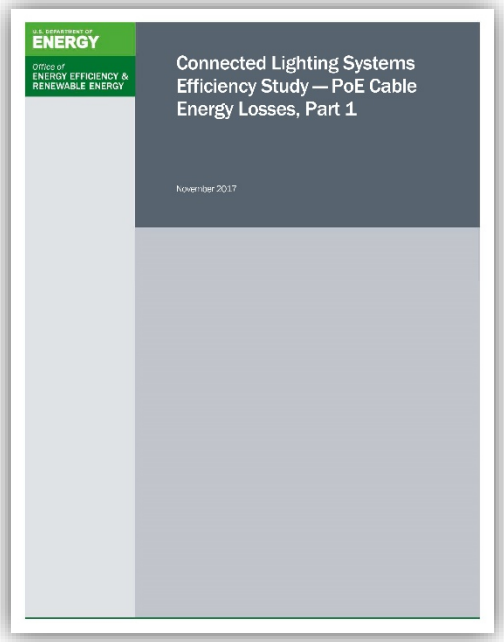
- Energy Reporting
  - DOE studying energy reporting accuracy
  - Smart power strips
  - Street lights
- Communication
  - No more isolated building systems
  - EMIS
    - Lighting
    - HVAC
    - Plugs
- Standardized data sets / structures
  - Building Energy Data Exchange Specification (BEDES)
  - DesignLights Consortium has standardized report guidelines as part of the Networked Lighting Control Systems



Integration with building control systems – EM&V opportunities?

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- 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

Advanced Measurement and Veritication Methods (M&V 2.0)

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Home » Assessment of Advanced Measurement and Verification Methods (M&V 2.0)