Lighting Control Evaluation Protocol

DOE Uniform Methods Project

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Agenda

- Measure Types & Descriptions
- Program Application & Delivery Strategies
- Savings Calculations
- Role of the Implementer
- Role of the Evaluator
- EM&V Procedures
- Metering Requirements
- Other Lighting Control Evaluation Issues
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Lighting Measure Description & Type

Measure Description

- Lighting Control measures reduce or turn off lighting in response to space occupancy or ambient lighting levels in the space.

Measure Types

- Sweep Controls / Energy Management Systems (EMS) / Time Clocks
  - Systems that shut off lighting at a set time, typically after normal operating hours;
- Occupancy Sensors (OS)
  - Turn lights on or off based on a space occupancy conditions;
- Dimming Controls
  - Stepped dimming dual ballast (inboard/outboard)
  - Dual ballast high low (HID 400W/275W)
  - Continuous Daylight Dimming

Program Application & Delivery Strategies

Program Application

- The protocol applies to the installation of commercial, industrial, and nonresidential lighting control measures in customer facilities resulting from energy-efficiency programs;
- Will have varying delivery methods, depending on target markets and customer types;
- Protocol methods apply to all programs, issues with customer and baseline equipment data vary and are unique to each program.
- Primary program distinction is Retrofit vs. New Construction
- Secondary program distinction is Prescriptive vs. Custom

Program Application & Delivery Strategies

Delivery Types

- Incentive and Rebate
  - Administrators pay program participants in target markets for installing lighting control measures based on annual energy savings ($/kWh) for each installed measure or based on demand savings ($/kW);
  - Programs may pay rebates for specific lighting control equipment types with the program utilizing assumptions about replaced equipment, for example: ceiling-mounted occupancy sensors;
  - Incentive programs often collect more detailed baseline data than do rebate programs: controlled equipment wattages, and hours of operation. These programs do not always collect data about controlled fixtures.

Increased administrative efficiency is exchanged for less certainty about baseline conditions and, therefore, savings!

Program Application & Delivery Strategies

Delivery Types

- Direct Install
  - Contractors are engaged through a program install lighting control equipment in customer facilities;
  - The programs pay contractors directly, while the customers receive a lighting control measure free or at a reduced cost;
  - Can be classified as targeting either retrofit (serving existing facilities) or new construction markets;
  - The dilemma in establishing baselines for new construction energy codes for commercial, industrial, and nonresidential facilities:

ASHRAE Standard 90.1 or IECC defines lighting controls under section 9.4.1: *Mandatory for interior lighting in buildings larger than 5,000 sq. ft.*

Savings Calculations

Equation 1: Lighting Control Electric Energy Savings

$$\textbf{kWh Save}_{lc} = \textbf{kW}_{controlled} * \textbf{EFLH} * \textbf{CSF}$$

where:

$kWh\ Save_{lc}$ = Annual kWh savings resulting from the lighting control project

$kW_{controlled}$ = Sum (Fixture Wattage * Quantity Fixtures) for controlled fixtures

EFLH = Annual Equivalent Full Load Hours

CSF = Control Savings Factor is the annualized reduction factor calculated across the EFLH

Savings Calculations

Equation 2: Interactive Cooling Electric Energy Savings

$$\mathbf{kWh_{interact\ -\ cool} = kW_{cool} \times IF_c \times Hours_{cool}}$$

where:

$kWh_{interact\ –\ cool}$ = Interactive cooling savings due to lighting control project

kW_{cool} = Mean kW reduction coincident with the cooling hours

$Hours_{cool}$ = Hours when the space is in cooling

If_c = Interactive cooling/heating factor, ratio of cooling energy reduction per unit of lighting energy; due to reduction in lighting waste heat removed by HVAC system

Savings Calculations

Equation 3: Interactive Cooling Electric Energy Savings

$$\mathbf{kWh_{interact\text{ - }heat} = kW_{heat} \times IF_h \times Hours_{heat}}$$

where:

$kWh_{interact - heat}$ = Interactive heating savings due to lighting control project (negative)

kW_{heat} = Mean kW reduction coincident with the heating hours

$Hours_{heat}$ = Hours when the space is in heating mode

IF_h = Interactive heating factor, ratio of heating energy increase per unit of lighting energy; due to reduction in lighting heat removed by HVAC system

Savings Calculations

Equation 4: Total Annual Energy Savings

$$\textbf{kWh Save}_{\textbf{total}} = \textbf{kW Save}_{\textbf{lc}} + \textbf{kWh}_{\textbf{interact – cool}} + \textbf{kWh}_{\textbf{interact –heat}}$$

where:

$kWh\ Save_{total}$ = Total Annual kWh savings including interactive effects

$kWh\ Save_{lc}$ = Annual kWh savings resulting from the lighting control project

$kWh_{interact - cool}$ = Interactive cooling savings due to lighting control project

$kWh_{interact - heat}$ = Interactive heating savings due to lighting control project

Role of the Implementer

Primary Responsibilities of Implementer

- Ensure the collection of data required to track program activity and calculate savings at the project level
- Maintain a record of program activity including anticipated savings by project
- Specify the data reporting format either by supplying a structured form (spreadsheet) or by specifying the data fields and types used when submitting material to the program
- Data should be structured to allow verification of the project installation
- Conduct third party verification using random sampling on 10% of projects so that contractors cannot predict which projects will be inspected

Role of the Implementer

Lighting Control Required Data Fields

Field	Note
Location	Floor number, room number and other decsriptions
Usage group	
Location cooling	Yes/no
Location cooling type	Water cooled chiller, air cooled chiller, packaged DX, etc.
Location cooling fuel	Electric, non-elecric
Location heating	Yes/no
Location heating type	Boiler steam/hydronic, heat pump, forced air, strip heat, etc.
Location heating fuel	Electric, non-electric
Controlled fixture type	From lookup table supplied by implementer, manufacturers cut sheet
Controlled fixture count	
Controlled fixture wattage	From lookup table supplied by implementer, manufacturers cut sheet
Pre-control EFLH	Requirement for pre-metering depends on control type
Control Savings Factor	Will be calculated using pre/post or post only data
IF_c	Interactive factor for cooling, from lookup table, optional
IF_h	Interactive factor for heating, from lookup table, optional
kWh_{save}	Will be calculated using pre/post or post only data

Role of the Evaluator

Primary Responsibilities of the Evaluator

- Determine the energy savings that result from the operation of lighting control efficiency programs.
- Select and review a representative random sample of completed projects using efficient sample design
- Conduct on-site measurement and verification activities on the selected sample projects using program tracking data provided by Implementer
- Calculate on-site savings estimates for sample projects and calculate program realization rate (ratio of evaluated savings to implementer savings)
- Provide report documenting evaluation methods, results and recommendation for future tracking savings estimates

EM&V Procedures

IPMVP Option

- Primarily Option A – Retrofit Isolation: Key Parameter Measurement approach will be used
- Key parameters to be measured are the EFLH and CSF variables in Equation 1
- Method of metering depends on the type of control and physical characteristics of the lighting being controlled
- Complex lighting control measures may be evaluated using Option D – Calibrated Building Simulation, particularly if there was a model created initially to calculate tracking savings

EM&V Procedures

Metering requirements for Various Types of Lighting Controls

- Lighting sweep controls, EMS, and time clock measures require pre- and post-installation metering
- Occupancy sensor measures can be determined effectively with pre-installation metering only if a lighting event logger with infrared occupancy sensor capability is used.
- Most dimming applications can be measured using post-installation data only when it is accurate to assume the uncontrolled kW would be equal to the controlled lighting operating at full power.
- Event loggers are typical lighting loggers that monitor the on/off operation of lighting, using a photocell
- Power loggers monitor the interval power consumption of controlled lighting circuits.

Lighting Control Measure	Metering Requirements		Metering Type
	Pre-Installation	Post-Installation	
Lighting Sweep Controls/EMS/Time Clock	Yes	Yes	Event or Power Logger
Occupancy Sensors	Yes	Yes/No	Event/Event &Occupancy Logger
Stepped Dimming (Dual Ballasts)	No	Yes	Event Logger
Dual Ballast (Hi/Low HID)	No	Yes	Power Logger
Continuous Daylight Dimming	No	Yes	Power Logger

Other Lighting Control Evaluation Issues

- Overlap and consistency with commercial lighting protocol
- Various TRMs assume different control factors, operating hours, diversity factors: M&V results will be site specific.
- Inclusion of interactive effects
- Multiple controls projects
- Demand savings calculations
- Coincidence factor development for use in ISO/RTO energy efficiency capacity markets

Questions

Any Questions?