Increased Energy Savings with Advanced Lighting and Controls

2013 RESNET Building Performance Conference
February 27th, 2013

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Savings through energy efficiency

Lighting Power Densities

&

Calculate Energy Savings

in

Multifamily Projects

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Energy Savings

- Utility Sponsored Programs
  - Yes
  - No
- Ratings
  - Builder
  - Homeowners
  - Banks
  - Utilities
- Savings
  - Dollar Savings
  - kWh
  - kW
- Baselines
  - Code
  - Reference Home
  - DPU
  - Regulators

Codes and regulations are squeezing lighting savings.

A new approach is needed that embraces changes in technologies and building practices while delivering accurate and cost effective savings.

Multifamily projects provide a great opportunity for this new approach.

SF/MF Projects, Ratings & Realities

SF/MF Projects, Ratings & Realities

SF – Low Rise	MF – High Rise
Many EE & Green standards/programs	Few EE & Green standards/programs
HERS Ratings & Raters	Licensed Professionals/Unions
Quick Development Time Line	Long Development Time Line
Residential meters & HVAC systems	Commercial meters & HVAC systems
“Larger” per unit square footage	“Smaller” per unit square footage
Unique design features	Standard design features
Lighting is a design “afterthought”	Lighting is a design requirement
Ample opportunity to screw in CFLs	Minimal opportunity to screw in CFLs

Lighting Power Density (LPD)

TABLE 9.6.1 Lighting Power Densities Using the Space-by-Space Method
ANSI/ASHRAE/IESNA Standard 90.1-2007

In cases where both a common space type and a building-specific type are listed, the building specific space type shall apply.

Common Space Types	LPD, watts/sf	Building-Specific Space Types	LPD, watts/sf
Office – Enclosed	1.1	Gymnasium/Exercise Center	
Office – Open Plan	1.1	Playing Area	1.4
Conference/Meeting/Multipurpose	1.3	Exercise Area	0.9
Classroom/Lecture/Training	1.4	Courthouse/Police Station/Penitentiary	
For Penitentiary	1.3	Courtroom	1.9
Lobby	1.3	Confinement Cells	0.9
For Hotel	1.1	Judges' Chambers	1.3
For Performing Arts Theater	3.3	Fire Stations	
For Motion Picture Theater	1.1	Engine Room	0.8
Audience/Seating Area	0.9		
For Gymnasium	0.4		
For Exercise Center	0.3		
For Convention Center	0.7		
For Penitentiary	0.7		
For Religious Buildings	1.7		
For Sports Arena	0.4		
For Performing Arts Theater	2.6		
For Motion Picture Theater	1.2		
For Transportation	0.5		
Laboratory	1.4	Manufacturing	
Restrooms	0.9	Low Bay (<25 ft Floor to Ceiling Height)	1.2
Dressing/Locker/Fitting Room	0.6	High Bay (≥25 ft Floor to Ceiling Height)	1.7
Corridor/Transition	0.5	Detailed Manufacturing	2.1
For Hospital	1.0	Equipment Room	1.2
For Manufacturing Facility	0.5	Control Room	0.5
Stairs – Active	0.6	Hotel/Motel Guest Rooms	1.1
Active Storage	0.8	Dormitory – Living Quarters	1.1
For Hospital	0.9	Museum	
Inactive Storage	0.3	General Exhibition	1.0
For Museum	0.8	Restoration	1.7
Electrical/Mechanical	1.5	Bank/Office – Banking Activity Area	1.5
Workshop	1.9	Religious Buildings	
Sales Area	1.7	Worship Pulpit/Choir	2.4
		Fellowship Hall	0.9

Lighting Power Density (LPD)

- **Lighting Power Density (LPD)**
  Max lighting *power per unit* area of a building classification of space function.

- **Power per Unit (W/ft2)**
  LPD are expressed as watts per square foot.

- **ANSI/ASHRAE/IESNA Standard 90.1-2007**
  Table 9.5.1 sets a Lighting Power Allowance of 0.7 W/ft2 for MF buildings.

- **ENERGY STAR Multifamily High Rise**
  National Prescriptive Path Requirements: "*Overall in-unit lighting power density may not exceed 0.75 W/ft2. When calculating overall lighting power density, use 1.1 W/ft2 for spaces where lighting is not installed.*"

- **Example**: 1000 sf apartment *(100% lamped)*
  x .75 W/sf power allowance
  750 W power allowance/apartment

MA Multifamily High Rise Pilot

3 Year Pilot Sponsored by NSTAR and National Grid

MF Pilot Assumptions

- 2006 IEEC
- CFL direct install & credit for HE hard-wired fixtures
- 14 lamps, 65 watts, 4.5 hours day each apartment
- % lamp counts (0% HE lighting requirements)
- 50% & 100% HE installation thresholds

MF Pilot Results

- 24 projects & 1301 units
- ~10 lamps, 65 watts, 3.5 hours day each apartment
- Installation thresholds varied from 0 to 100%
- CFL direct install doesn't work

- 1,493,000 kWh @ 14 lamps/apt (1,066,570 kWh @ 10 lamps/apt)
- ~820 kWh/apt/year claimed savings against 0% HE requirement

MA Multifamily High Rise Program

MF Program Assumptions

- 2009 IEEC
- LPD assessment for lamps and controls
- .75 w/sf LPD (1.1 w/sf un-lamped)
- Inventory all hard-wired fixtures
- Lighting savings for Controlled lamps = 30%
- ≥ 15% & 25% threshold improvements over LPD

- Lighting Savings Goal of 175 Watts per unit (~22%)

  800 W LP allowance

  - 625 W LP design

  175 W savings

Converting W to kWh

$$\frac{W \times \text{hrs/day} \times \text{days/yr}}{W/kW}$$

$$\frac{\cancel{W} \times \text{hrs/day} \times \text{days/yr}}{\cancel{W}/kW}$$

$$\frac{\cancel{W} \times \text{hrs/}\cancel{\text{day}} \times \cancel{\text{days}}\text{/yr}}{\cancel{W}/kW} = kWh/yr$$

$$\frac{175\ W \times 3.5\ \text{hrs/day} \times 365\ \text{days/yr}}{1000\ W/kW} = 225\ kWh/yr$$

Here's the Problem & Solution

Counting Bulbs

- 820 kWh/apt/year savings
  - 0% HE requirement
  - 100% installation rate
- 205 kWh/apt/year savings
  - 75% HE requirement
  - 100% installation rate

Cost of Savings

~ $0.59 Watt

Calculating LPD

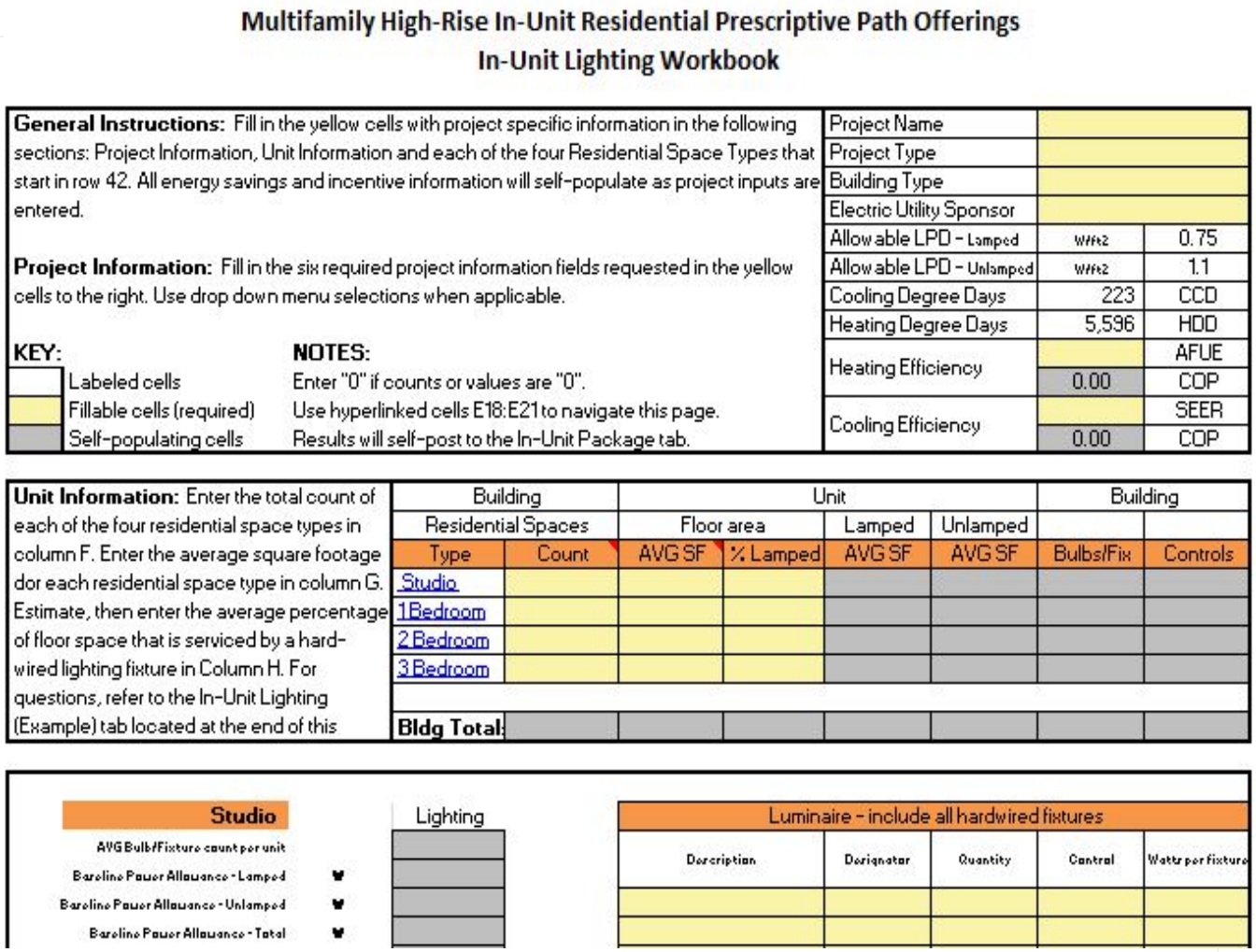
- 225 kWh/apt/year savings
  - 0.75 w/sf LPD
  - 22% LPD improvement

~ $0.25 Watt

LPD Calculator

Calculating Savings

- Minimal Inputs
- HVAC Impact
- Architectural Plans
- Lighting Schedules
- Totals & Averages
- Lamped vs. Unlamped
- Lighting Savings
- Control Savings



Multifamily High-Rise In-Unit Residential Prescriptive Path Offerings
In-Unit Lighting Workbook

General Instructions: Fill in the yellow cells with project specific information in the following sections: Project Information, Unit Information and each of the four Residential Space Types that start in row 42. All energy savings and incentive information will self-populate as project inputs are entered.

Project Information: Fill in the six required project information fields requested in the yellow cells to the right. Use drop down menu selections when applicable.

KEY:
- Labeled cells
- Fillable cells (required)
- Self-populating cells

NOTES:
Enter "0" if counts or values are "0".
Use hyperlinked cells E18:E21 to navigate this page.
Results will self-post to the In-Unit Package tab.

Project Name		
Project Type		
Building Type		
Electric Utility Sponsor		
Allowable LPD - Lamped	W/ft2	0.75
Allowable LPD - Unlamped	W/ft2	1.1
Cooling Degree Days	223	CDD
Heating Degree Days	5,596	HDD
Heating Efficiency		AFUE
	0.00	COP
Cooling Efficiency		SEER
	0.00	COP

Unit Information: Enter the total count of each of the four residential space types in column F. Enter the average square footage dor each residential space type in column G. Estimate, then enter the average percentage of floor space that is serviced by a hard-wired lighting fixture in Column H. For questions, refer to the In-Unit Lighting (Example) tab located at the end of this

Building		Unit				Building	
Residential Spaces		Floor area		Lamped	Unlamped		
Type	Count	AVG SF	% Lamped	AVG SF	AVG SF	Bulbs/Fix	Controls
Studio							
1 Bedroom							
2 Bedroom							
3 Bedroom							
Bldg Total:							

Studio		Lighting
AVG Bulb/Fixture count per unit		
Baseline Power Allowance - Lamped	W	
Baseline Power Allowance - Unlamped	W	
Baseline Power Allowance - Total	W	

Luminaire - include all hardwired fixtures				
Description	Designator	Quantity	Control	Watts per fixture

LPD Calculator

Calculating Savings

- Minimal Inputs
- HVAC Impact
- Architectural Plans
- Lighting Schedules
- Totals & Averages
- Lamped vs. Unlamped
- Lighting Savings
- Control Savings

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NOTES:
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Results will self-post to the In-Unit Package tab.

Project Name	Old Colony	
Project Type	New Construction	
Building Type	Low-Income	
Electric Utility Sponsor	NSTAR	
Allowable LPD - Lamped	W/ft2	0.75
Allowable LPD - Unlamped	W/ft2	1.1
Cooling Degree Days	223	CDD
Heating Degree Days	5,596	HDD
Heating Efficiency	92	AFUE
	0.92	COP
Cooling Efficiency	13.5	SEER
	3.36	COP

Unit Information: Enter the total count of each of the four residential space types in column F. Enter the average square footage dor each residential space type in column G. Estimate, then enter the average percentage of floor space that is serviced by a hard-wired lighting fixture in Column H. For questions, refer to the In-Unit Lighting (Example) tab located at the end of this

Building		Unit				Building	
Residential Spaces		Floor area		Lamped	Unlamped		
Type	Count	AVG SF	% Lamped	AVG SF	AVG SF	Bulbs/Fix	Controls
Studio	4	567.0	65%	368.55	198.45	32	12
1 Bedroom	34	717.0	75%	537.75	179.25	0	0
2 Bedroom	34	867.0	75%	650.25	216.75	0	0
3 Bedroom	10	1017.0	65%	661.05	355.95	0	0
Bldg Total:	**82**	**66,294**	**73%**	**48,477**	**17,817**	**32**	**12**

Studio		Lighting
AVG Bulb/Fixture count per unit		8
Baseline Power Allowance - Lamped	W	276.4
Baseline Power Allowance - Unlamped	W	218.3
Baseline Power Allowance - Total	W	**494.7**
Design Power Allowance - Lamped	W	195.0

Luminaire - include all hardwired fixtures				
Description	Designator	Quantity	Control	Watts per fixture
CFL - Screw	CS - 34	2	No	12
CFL - Screw	CS - 34	3	No	12
CFL - Pin	CP - 35	3	Yes	45

LPD Calculator

Studio		Lighting	
AVG Bulb/Fixture count per unit		8	
Baseline Allowance - Lamped	W	276.4	
Baseline Allowance - Unlamped	W	218.3	
Baseline Allowance - Total	W	**494.7**	
Design Usage - Lamped	W	195.0	
Design Usage - Unlamped	W	218.3	
Design Usage - Total	W	**413.3**	
Lighting Savings (W)	W	81.4	
Wattage Reduction	%	**16.5%**	Assumes
Hours of Operation	**hrs/yr**	1277.5	3.5
Lighting Savings per unit	**kWh/yr**	104.0	hrs/day
		Controls	
Design Usage Controlled	W	135.0	
% design wattage controlled	%	32.7%	Assumes
% reduction attributed to controls	%	30.0%	30%
Control Savings per unit	W	40.5	Savings
Control Savings per unit	**kWh/yr**	51.7	
Lighting Savings per unit	**kWh/yr**	104.0	
Lighting & Control Savings per unit	**kWh/yr**	155.7	
Savings over baseline	%	44.1%	
Lighting & Control Savings per unit type	**kWh/yr**	**623.0**	

Luminaire - include all hardwired fixtures				
Description	Designator	Quantity	Control	Watts per fixture
CFL- Screw	CS - 34	2	No	12
CFL- Screw	CS - 34	3	No	12
CFL - Pin	CP - 35	3	Yes	45
Totals		**8**	**3**	**195**

What About…

Commercial lighting savings?

Illumination levels – foot candles?

Other Applications?

- Dormitories
- Assisted Living
- Hotels
- Any unique LPD or “residential” operating schedule

HERS Raters?

- Plans analysis
- Installation verification (Sampling)

Agenda

- Lighting in Ratings
- MA Residential New Construction Program
- IECC 2012
- Lighting Controls
- MA Advanced Lighting & Controls Pilot

Lighting in Ratings

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REM/Rate: Rating vs. Audit

- Simplicity vs. Savings
  - REM/Rate Rating
    - CFL % and Pin-based FL % of interior fixtures
    - Exterior and Garage Fixtures %
  - REM/Rate Audit
    - Ability to enter in actual watts per fixture
    - Average operating use (MA uses 2.8 hrs./day)
  - Benefits of an audit over rating
    - Capturing savings missed out on
    - Lower HERS index

REM/Rate: Rating vs. Audit

REM/Rate Project Example:

- Rating
  - 80% CFL installation in hard wired screw based fixtures
  - HERS Index – 60
  - **Interior kWh/yr. – 1,151.2**
  - **Exterior kWh/yr. – 203.4**
  - **Garage Lighting kWh/yr. – 100.0**
  - **Annual Cost - $258**
- Audit
  - HERS Index – 64
  - **Interior kWh/yr. – 853.4**
  - **Exterior kWh/yr. – 69.5**
  - **Annual Cost - $163**

RESNET's Definition

RESNET's Definition of a Qualifying Light Fixture

- A light fixture comprised of any of the following components:
  - a) fluorescent hard-wired (i.e. pin-based) lamps with ballast;
  - b) screw-in compact fluorescent bulb(s); or
  - c) light fixture controlled by a photo cell and motion sensor.

- Should REM be used for calculating lighting savings?

MA New Homes Program

- Design
  - Program Administrators (PA's) pay for CFL lamps and verification from approved Program CFL list to HERS raters
  - Lighting savings not calculated in REM
    - Deemed Savings per lamp used (i.e. 48.7 kWh for screw based CFLs)
- Raters verify lamp count during final inspection (CFLs, pin-based, LED)
- Program requires 80% of hard wired fixtures to include a HE lamp
  - 30% over IECC 2009
  - 5% over IECC 2012
  - MA Baseline design is decreasing

What do other states enforce?

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IECC 2012

Coming to a state near you!

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Gearing up for IECC 2012

- What's changing?
  - 50% increased to 75% high efficacy lamps in permanently installed lighting fixture
    - Low-voltage lighting shall not be required to utilize high efficacy lamps
- LED Demand Increasing
  - Prices dropping
  - Ability to install in a magnitude of fixtures
  - Annual savings low
  - Lifetime savings HIGH!
- What does this mean for MA?

What is a high efficacy lamp?

- IECC's definition of high efficacy: Compact fluorescent lamps, T-8 or smaller diameter linear fluorescent lamps, or lamps with a minimum efficacy of:
  - 60 lumens per watt for lamps over 40 watts;
  - 50 lumens per watt for lamps over 15 watts to 40 watts;
  - 40 lumens per watt for lamps 15 watts or less

Lighting Controls

Let's save more by using less!

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Dimmers, Occupancy Sensors, Motion Sensors, Timers, OH MY!!!!

- Options
  - Basic
  - Advanced
- Benefits
  - Increased lighting savings
  - Enhance lighting options
  - Increase lamp life
- CFLs vs. LEDs
  - Dimmable CFLs aren't perfect
  - LEDs are ideal for controls
- Where to install and why, thoughts?

MA Advanced Lighting and Controls Pilot (ALCP)

nationalgrid
THE POWER OF ACTION

NSTAR
ELECTRIC
GAS

Western Massachusetts Electric
The Northeast Utilities System

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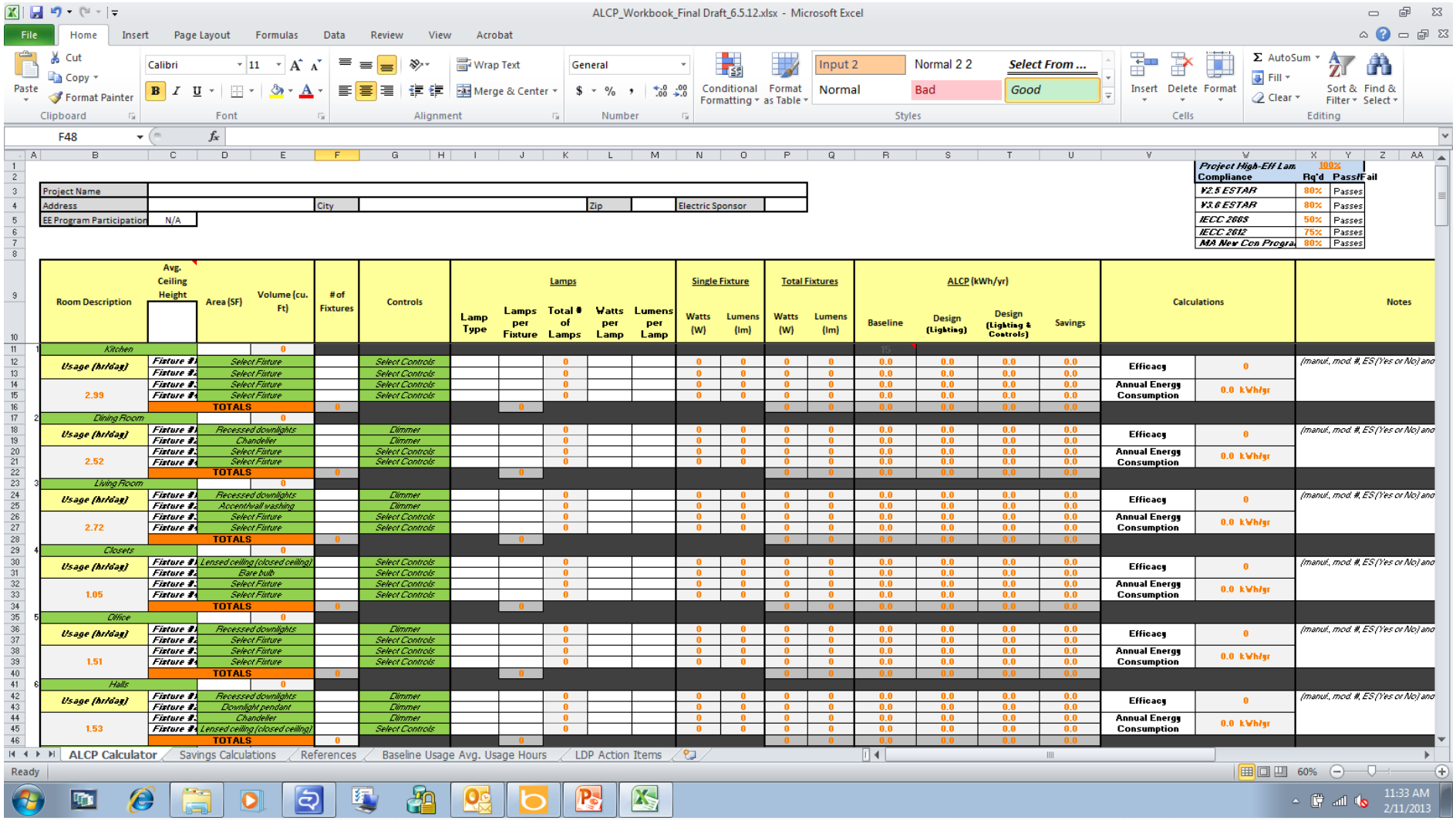
The Design

- Active new construction or renovation projects over 500 sq. ft.
- Formerly known as Lighting Design Pilot (LDP)
- Incentive was for LED, HE pin-based fluorescent and lighting controls only (i.e. dimmers, timers, occupancy sensors)
  - 2010 – 2011 project incentives
  - 2012 changes
- Final inspection was conducted by a HERS rater on behalf of the PA's

ALCP Savings Tool



Pilot Benchmarks

- ALCP Benchmark Home
  - Total fixture lumens
  - 15 lumens conversion per watt from HE to incandescent
    - Example: 900 lm (HE lamp)/15 lm/W = 60W incandescent
  - Average operating hours (2.8 for MA)

- MA Utility Calculation
  - Total lamp count (CFL, LED, etc.)
  - Baseline wattage and HE wattage (Deemed Savings)
    - Example: CFLs – Baseline Wattage 65
    - Example: CFLs – HE Wattage 15
  - Average operating hours (2.8 for MA)

Pilot Benchmarks Contd.

- HERS Reference Home
  - Conditioned Floor Area
  - Average kWh for square footage
- DOE Build America Home
  - Fixture Floor Area
  - Average kWh for square footage (different from HERS Reference Home)

Pilot Calculations

- ALCP Calculation
  - Total fixture watts
  - Average operating hours (based on room type)
    - Example: 2.99 hrs./day for a Kitchen
  - Lighting controls multipliers
    - 10% for dimmers; 20% for occupancy sensors

- Utility Calculation
  - Total lamp count (CFL, LED, etc.)
  - Total wattage gathered at field inspection
  - Average operating hours (2.8 for MA)

Savings Comparison

Project Example:

- ALCP Benchmark – 1,727.7 kWh/yr.
- MA Standard Utility – 2,548.6 kWh/yr.
- HER Reference Home – 7,917.6 kWh/yr.
- DOE Build America – 5,495.9 kWh/yr.

Pilot Results

- Findings
  - 58.8% savings against ALCP Reference Home
  - 70% against Utility Reference Home
  - Lighting controls increased lighting savings on average 3.3%
    - Proper planning can increase this to 5 or 10%
      - Lower than anticipated as there were several projects that didn't understand where to install controls
- 36 projects went through the ALCP
- Ultimately the PA's need to discover innovative ways to claim more savings as IECC 2012 approaches

Confused? Ally Up!!!

- Certified Lighting Designers
- Why?
  - Help identify high efficacy products and control strategies to save even more energy.
  - What do they do?
    - Assess space use and needs
    - Where you should and shouldn’t lamp?
    - Lighting challenges
    - Innovative solutions

Questions?

Thank you!

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