A LIGHTING STUDY TO STAND THE TEST OF TIME

IEPEC International Energy Program Evaluation Conference

NMR Group, Inc.

Exploring the Results of a Residential Lighting Study Designed to Produce Lasting Data

IEPEC 2015
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BACKGROUND

Why Update Lighting HOU?

HOU Drives Savings
Last Study 2009
Concerns HOU Changed

Project Background

Multi-state Study (848 Homes)
Most Comprehensive Study in US

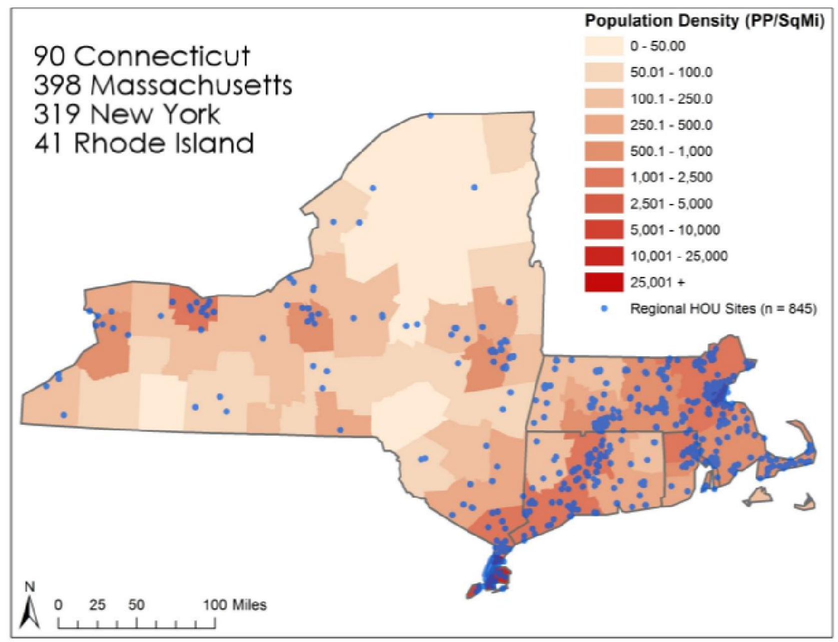
Objectives:
- Account for Rapid Market Change
- Update HOU by Room
- Explore Estimates by Categories
- Coordinate with Ongoing Studies

Concurrent Studies

Massachusetts Socket Saturation Study
New York Socket Saturation Study
Massachusetts Low-Income HOU Study
National Grid New York EnergyWise Study
Manhattan High-Rise HOU Study

4,642 Loggers Analyzed
8 Months of Data
143 Days Installed on Avg.
12 Minute/Day C.I.
8 Room Types
9 Household Types

Dec-12
Jul-13



DATA COLLECTION

Lighting Inventory

- Thorough
- Need for weighting
- Need for selection

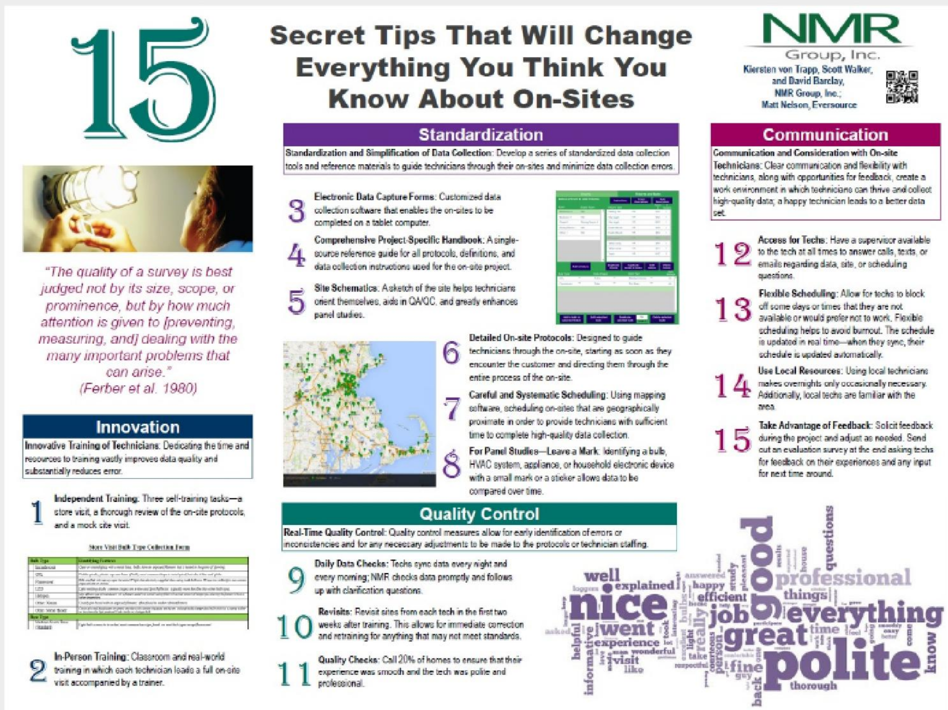
Logger Installation

- Single family **8**
- Multifamily **6**
- Target by room type
- Random selection

Field Protocols

- Comprehensive training
- Confirmation of usage
- Revisits (5%)
- QA/QC Calls (20%)

Want more? See Kiersten at Poster Session!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Secret Tips That Will Change Everything You Think You Know About On-Sites

NMR Group, Inc.

Kiersten von Trapp, Scott Walker, and David Barclay, NMR Group, Inc.; Matt Nelson, Eversource

"The quality of a survey is best judged not by its size, scope, or prominence, but by how much attention is given to [preventing, measuring, and] dealing with the many important problems that can arise."
(Ferber et al. 1980)

Innovation

Innovative Training of Technicians: Dedicating the time and resources to training vastly improves data quality and substantially reduces error.

1 **Independent Training:** Three self-training tasks—a store visit, a thorough review of the on-site protocols, and a mock site visit.

Store Visit Bulb Type Collection Form

2 **In-Person Training:** Classroom and real-world training in which each technician leads a full on-site visit accompanied by a trainer.

Standardization

Standardization and Simplification of Data Collection: Develop a series of standardized data collection tools and reference materials to guide technicians through their on-sites and minimize data collection errors.

3 **Electronic Data Capture Forms:** Customized data collection software that enables the on-sites to be completed on a tablet computer.

4 **Comprehensive Project-Specific Handbook:** A single-source reference guide for all protocols, definitions, and data collection instructions used for the on-site project.

5 **Site Schematics:** A sketch of the site helps technicians orient themselves, aids in QA/QC, and greatly enhances panel studies.

6 **Detailed On-site Protocols:** Designed to guide technicians through the on-site, starting as soon as they encounter the customer and directing them through the entire process of the on-site.

7 **Careful and Systematic Scheduling:** Using mapping software, scheduling on-sites that are geographically proximate in order to provide technicians with sufficient time to complete high-quality data collection.

8 **For Panel Studies—Leave a Mark:** Identifying a bulb, HVAC system, appliance, or household electronic device with a small mark or a sticker allows data to be compared over time.

Quality Control

Real-Time Quality Control: Quality control measures allow for early identification of errors or inconsistencies and for any necessary adjustments to be made to the protocols or technician staffing.

9 **Daily Data Checks:** Techs sync data every night and every morning; NMR checks data promptly and follows up with clarification questions.

10 **Revisits:** Revisit sites from each tech in the first two weeks after training. This allows for immediate correction and retraining for anything that may not meet standards.

11 **Quality Checks:** Call 20% of homes to ensure that their experience was smooth and the tech was polite and professional.

Communication

Communication and Consideration with On-site Technicians: Clear communication and flexibility with technicians, along with opportunities for feedback, create a work environment in which technicians can thrive and collect high-quality data; a happy technician leads to a better data set.

12 **Access for Techs:** Have a supervisor available to the tech at all times to answer calls, texts, or emails regarding data, site, or scheduling questions.

13 **Flexible Scheduling:** Allow for techs to block off some days or times that they are not available or would prefer not to work. Flexible scheduling helps to avoid burnout. The schedule is updated in real time—when they sync, their schedule is updated automatically.

14 **Use Local Resources:** Using local technicians makes overnights only occasionally necessary. Additionally, local techs are familiar with the area.

15 **Take Advantage of Feedback:** Solicit feedback during the project and adjust as needed. Send out an evaluation survey at the end asking techs for feedback on their experiences and any input for next time around.

KEY TAKEAWAYS^

8	Areas
8	Room Types
9	Income and Home Types
3	Bulb Types
1,728	Data Breakdowns

HOU Vary Widely by Room Type*

	Overall	DNY		Overall	DNY
	5.6	3.6		2.1	3.6
	4.1	7.0		1.7	3.2
	3.3	4.5	?	1.7	3.2
	2.8	4.0			

*All Bulb HOU; See paper for Efficient and Inefficient HOU

Higher HOU in Downstate New York

Efficient Bulb HOU Significantly Higher

Overall	DNY
3.0	5.2

Overall	DNY
2.3	3.0

h

Similar HOU Across Income and Home Types

^Footnotes in a presentation!? Now we're talking!

NUMBERS!

Efficient vs. All Bulb

Differential Socket Selection
Shifting Usage
Increasing Usage (Snapback)

Snapback Adjustment

Regional	3.0 - 0.1 = 2.9
DNY	5.2 - 0.4 = 4.8

Inputs

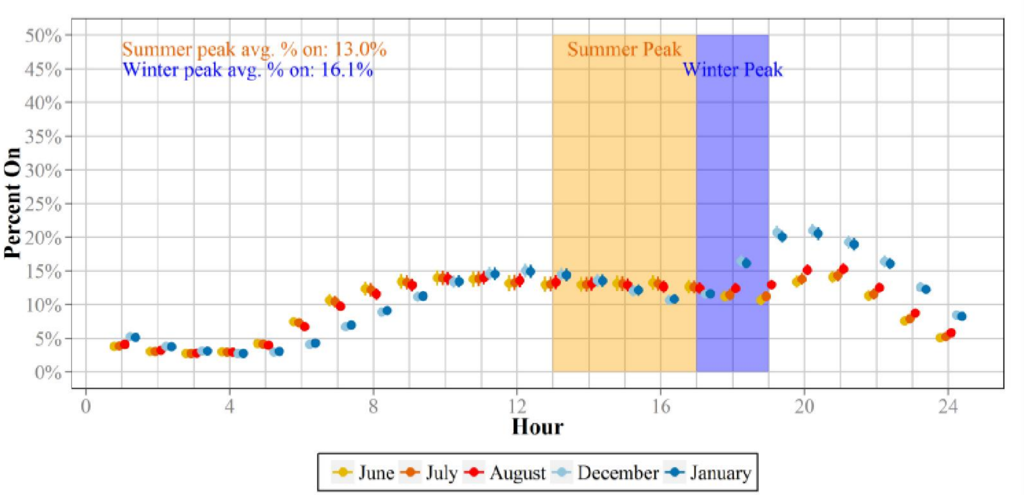
1,922	CFLs
475	Fluorescents
30	LEDs
2,109	Incadescents
106	Halogens

Outputs

HOU Estimates
Load Shapes
Coincidence Factors

Tools

HOU Calculator
Load Shape Data Viewer



Coincident Factors

ISO-NE Winter	20%	Regional
ISO-NE Summer	13%	Regional
NYSO Peak Hour	9%	UNY
	19%	DNY

BENCHMARKING

- **Other studies CFL only**
- **Efficient HOU Comparisons**

HOU	Year	Area
3.0	2014	Northeast (CT, MA, RI, UNY)
5.2	2014	Downstate New York
2.8	2014	Massachusetts Low Income
2.8	2009	Northeast (CT, MA, RI, VT)
3.2	2004	Northeast (MA, RI, VT)
3.0	2011	Maryland
1.9	2010	California (IOUs)
2.3	2005	California (IOUs)
1.9	2010	Pacifict Northwest
2.5	2011	North Carolina
2.7	2011	South Carolina
2.8	2010	Ohio
2.7	2012	Illinois

PLANNING A STUDY?

Sample Design Considerations

Sample by room type

Cluster analysis

Weight results

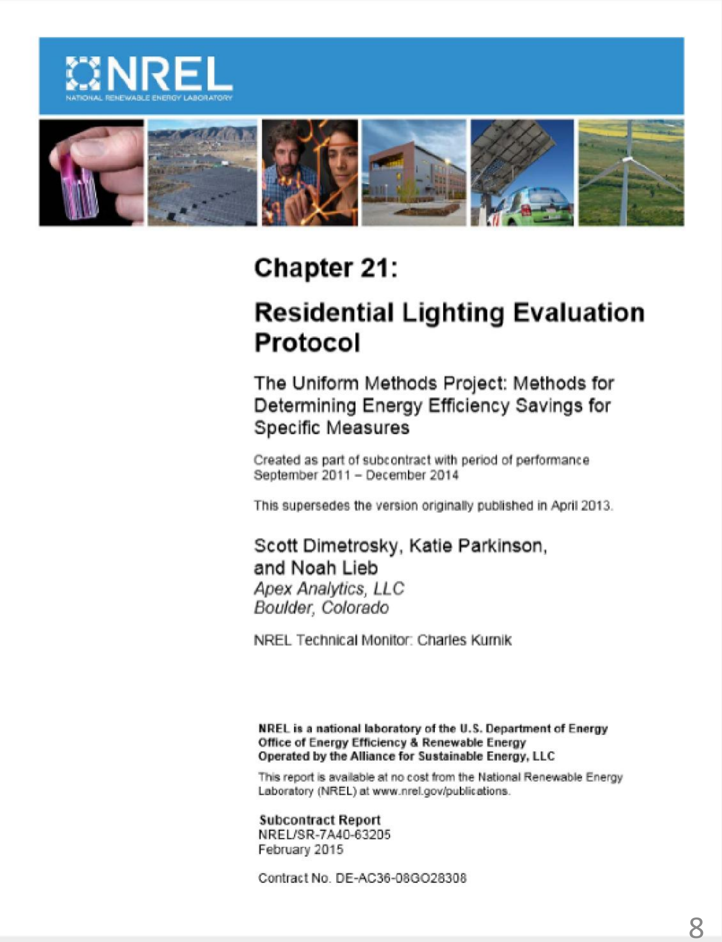
Inefficient and efficient bulbs

Combine efforts

Room-by-Room Coefficient of Variation

Bathroom	1.38
Bedroom	1.15
Dining room	1.10
Exterior	0.89
Kitchen	0.93
Living space	1.04
Other	1.60
Household	1.20

More Details: See Uniform Methods Project


NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Chapter 21:

Residential Lighting Evaluation Protocol

The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures

Created as part of subcontract with period of performance September 2011 – December 2014

This supersedes the version originally published in April 2013.

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DISSCUSSION

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ARE YOU TURNED ON?

INTERNATIONAL ENERGY PROGRAM EVALUATION CONFERENCE

NMR Group, Inc.

A Hierarchical Modeling Approach for Estimating Lighting Hours of Use

IEPEC 2015
August 11, 2015

Lisa Wilson-Wright
David Barclay
Andrew Correia

*Floppy disk. An ancient data storage medium.
http://tinyurl.com/UmFloppyWhat

www.nmrgroupinc.com

DATA PREPARATION

Sample Design

Cluster sample
Strata
- Room type (8 rooms)
- Home type (SF, MF, and HR)
- Income (low/non-low)
- Bulb type

Weighting

Premise weight
Room weights
Bulb type weights

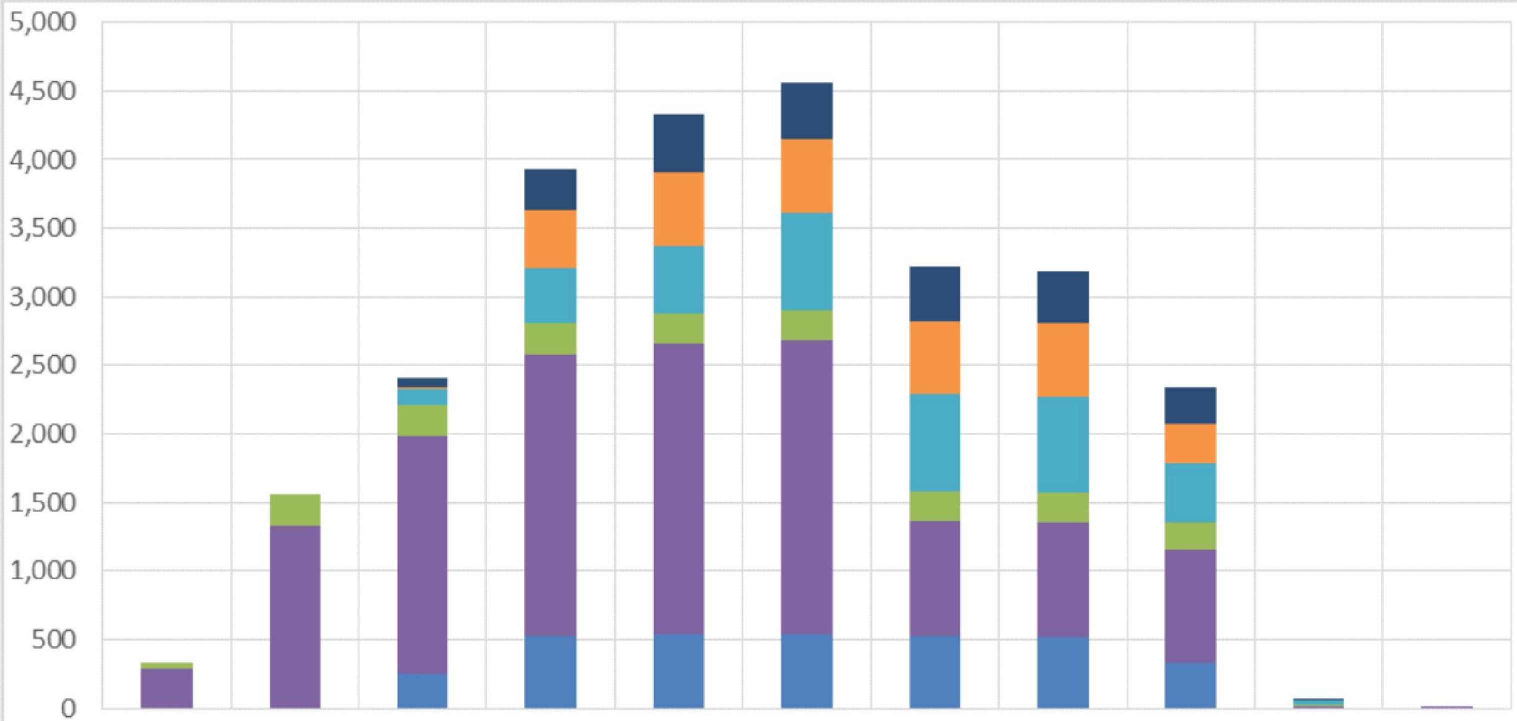
Data Cleaning

Conservative approach
Obvious flickering
Exterior exposed to sun
Confirm extreme HOU

Data Annualization

Sinusoid model
Weekend
Weekday

LOGGERS BY MONTH



	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13
DNY			73	294	419	410	400	387	270	7	
MHT			16	421	542	536	535	530	281	7	
UNY			108	399	487	710	705	699	431	27	
RI	50	229	230	227	224	222	219	217	200	15	
MA	284	1,335	1,736	2,060	2,110	2,138	831	835	824	13	6
CT			250	524	546	543	534	523	335	2	
Total	334	1,564	2,413	3,925	4,328	4,559	3,224	3,191	2,341	71	6

CONFIRMATION OF HOU

Self-Reported Estimate	# of Loggers	Avg. HOU Recorded
Total # of Loggers	3,506	3.06
Less than 1 hour per day	191	1.03
1-2 hours per day	392	2.30
3-4 hours per day	274	4.06
5-6 hours per day	333	4.12
7-9 hours per day	59	7.85
10-14 hours per day	63	10.45
15-20 hours per day	29	10.33
24 hours per day/always	45	9.24
Never/Almost never	90	1.23
Infrequent Use	1,294	1.86
Frequent Use	504	4.13
Don't know	232	3.06

Self-reported daily usage
Not completely accurate
Good relative crosscheck

PRELIMINARY MODELS

CT
2.5 - 3.2
All Bulb
HOU

MA
2.4 - 2.8
All Bulb
HOU

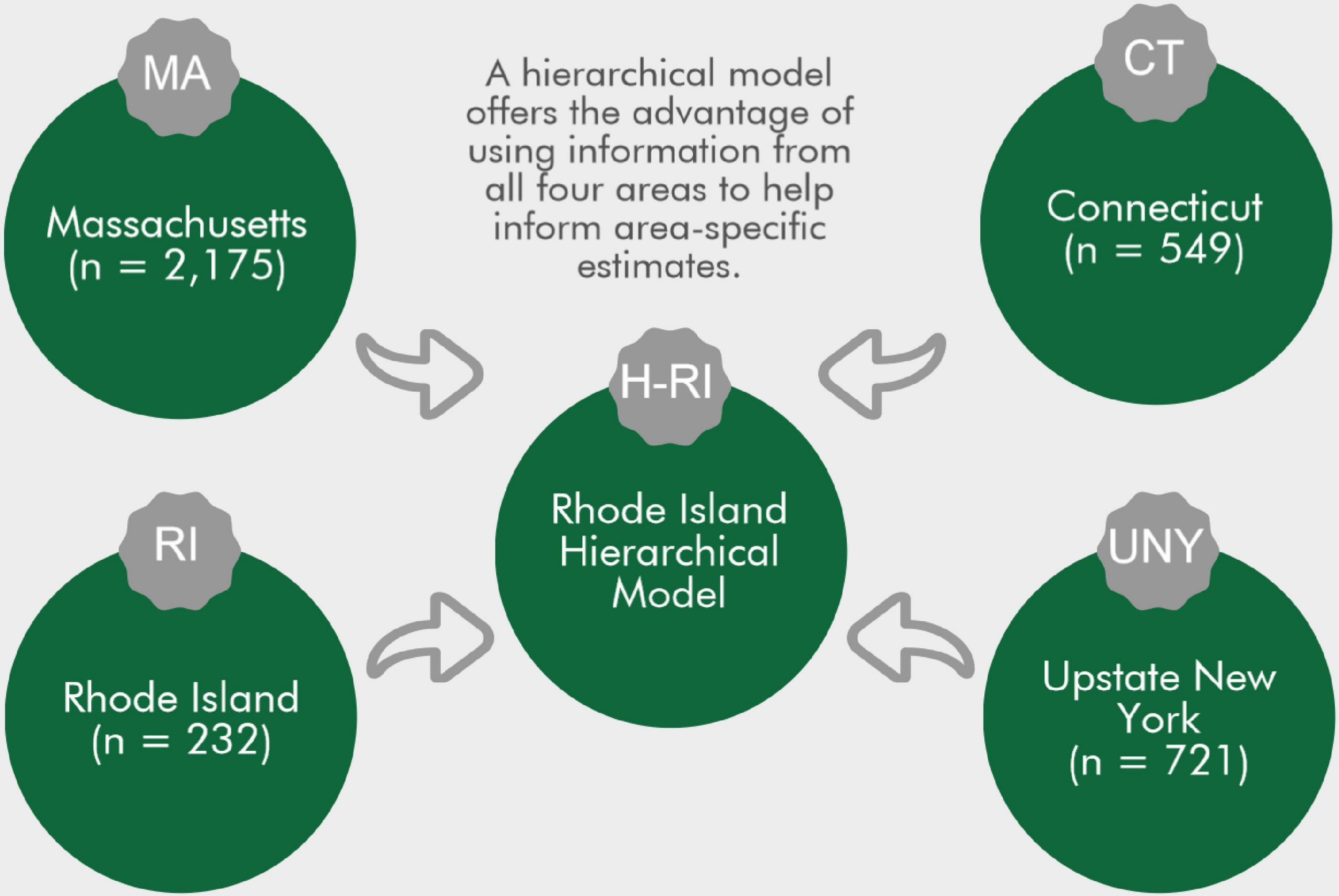
RI
2.2 - 3.5
All Bulb
HOU

UNY
2.1 - 2.8
All Bulb
HOU

DNY
3.5 - 4.7
All Bulb
HOU

MHT
3.4 - 4.4
All Bulb
HOU

Illustration of Hierarchical Model



WAIT! WHAT ABOUT DNY?!

Breathe. Don't Panic!

Not included in hierarchical models

Separate robust models for:
- **Manhattan High-Rise**
- **Downstate New York**
- **NYSERDA**

Did you say Manhattan high-rise? Yes.

Check out Scott's Solar Shading Quick Take on Wednesday!*

What Light Through Yonder Window Breaks?

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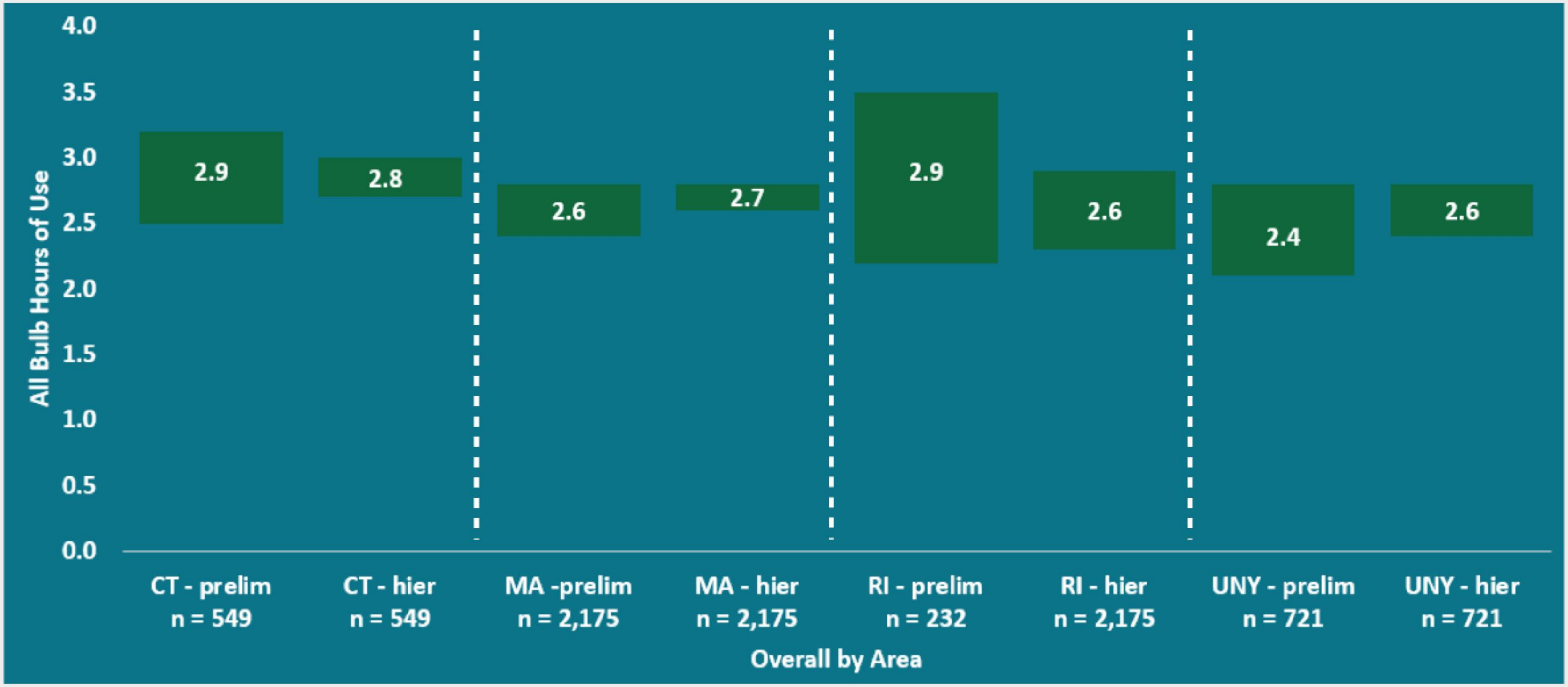
Methods to Study the Effects of Urban Canyons on Lighting Usage

*Last shameless plug, we promise.

MODEL COMPARISON



Point estimates similar
Reduced standard error
Tighter error bands

REGRESSION COEFFICIENTS

Variable	Level	Coefficient	90% Confidence Interval*
Efficient Bulb	Yes	0.631	(0.455, 0.806)
	No		
Income	Low Income	0.007	(-0.261, 0.273)
	Non-Low Income		
Education	Grad/Adv. Degree	-0.635	(-1.288, -0.082)
	Bachelor's Degree	-0.587	(-1.253, -0.019)
	Some College	-0.778	(-1.420, -0.248)
	HS or GED	-0.728	(-1.362, -0.176)
	Less than HS		
Own/Rent	Rent	0.532	(0.249, 0.821)
	Own		
Under 18	Yes	0.598	(0.362, 0.824)
	No		
Home Type	Multi Family	-0.157	(-0.470, 0.154)
	Single Family		

* Intervals that do not contain zero correspond to statistical significance at 90% confidence.

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