Commercial Energy Codes Field Study Update

May 2019

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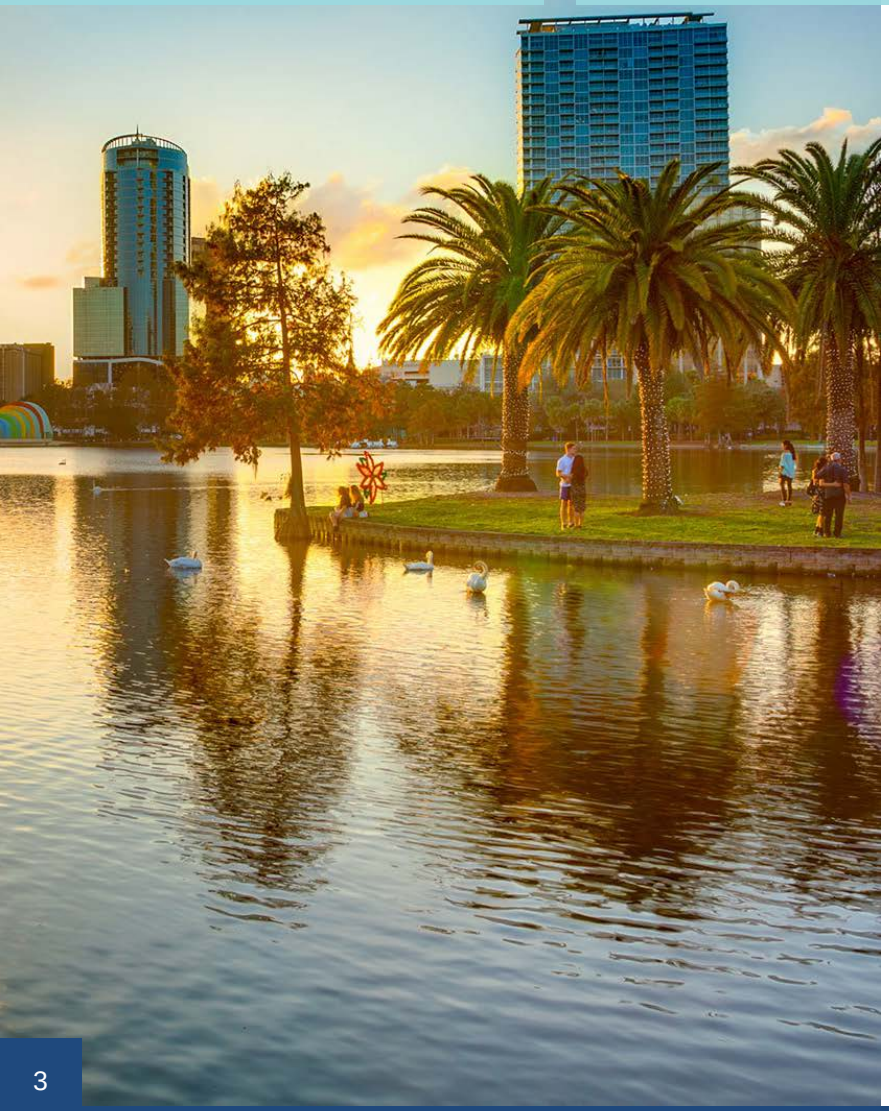
About IMT

Vision: A world where efficient buildings dramatically lower greenhouse gas emissions and positively transform our physical, social, and economic well-being.

Mission: Catalyze demand for high-performing buildings.

Target: 30% reduction in U.S. commercial, industrial, and multifamily building energy consumption by 2030; buildings contribute to electric grid flexibility and decarbonization

About the Field Study



Start: October 2016

Major Milestones:

- Completion of Sampling Plan
- Completion of data collection methodology, protocol and forms.
- Pilot of protocol
- Commence data collection

Current Progress: 50% data collected.

Next Steps: Analyze data, continue data collection and draft education materials

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Project **Partners**

US Department of Energy

Pacific Northwest National Lab

Institute for Market Transformation

Cadmus

University of Central Florida

Florida Solar Energy Center

Mozingo Code Group

Colorado Code Consulting

Nebraska Energy Office

University of Nebraska at Lincoln

Midwest Energy Efficiency Alliance

Southface

Goals of the Field Study

Develop a replicable, cost and time effective methodology for states to evaluate code compliance in commercial buildings.

Construct a data set across target climate zones and states to test and refine the methodology.

Develop training materials based on findings that can be leveraged by future education and outreach activities.

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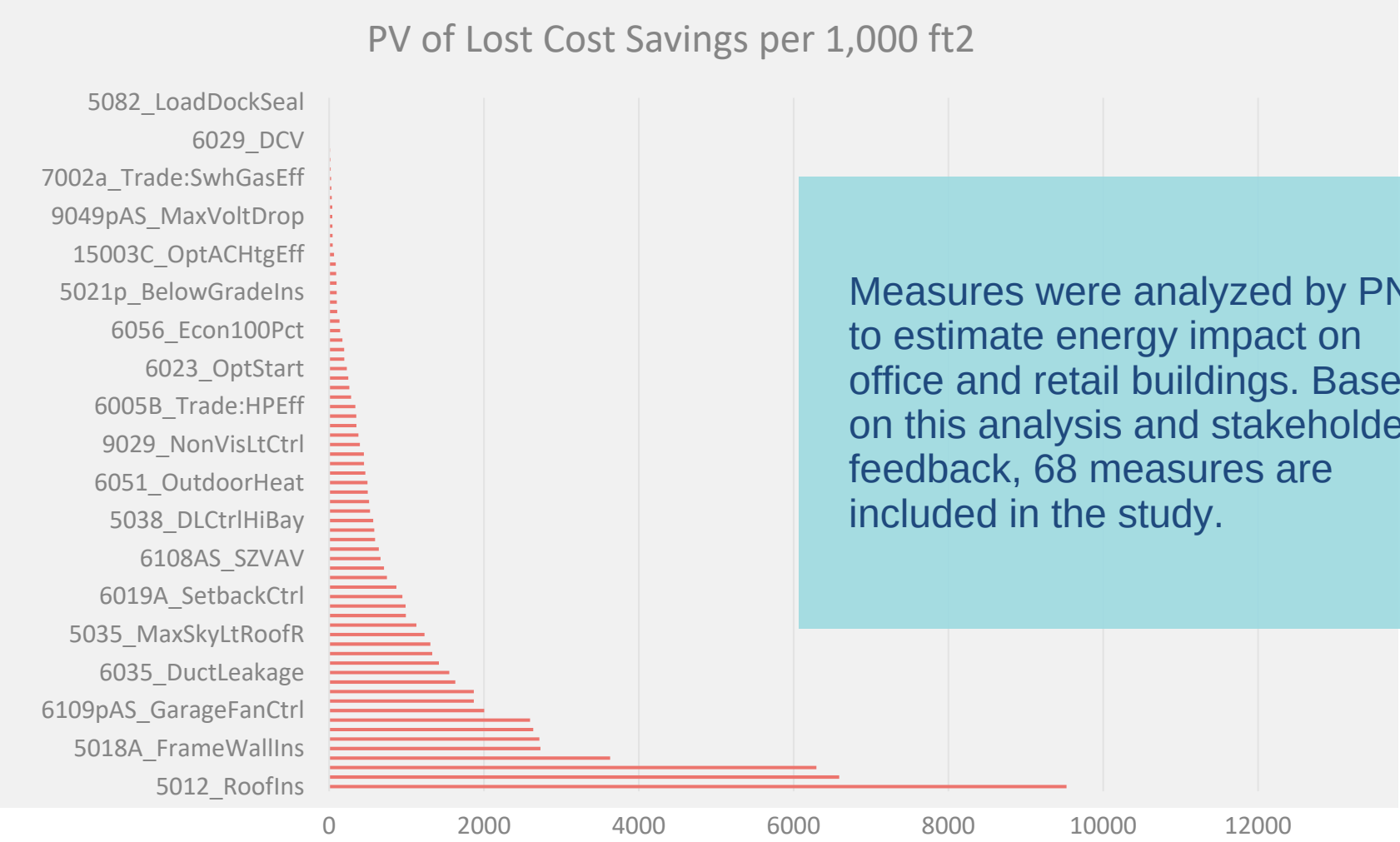
Potential Measure **Impact**



Measures were analyzed by PNNL to estimate energy impact on office and retail buildings. Based on this analysis and stakeholder feedback, 68 measures are included in the study.

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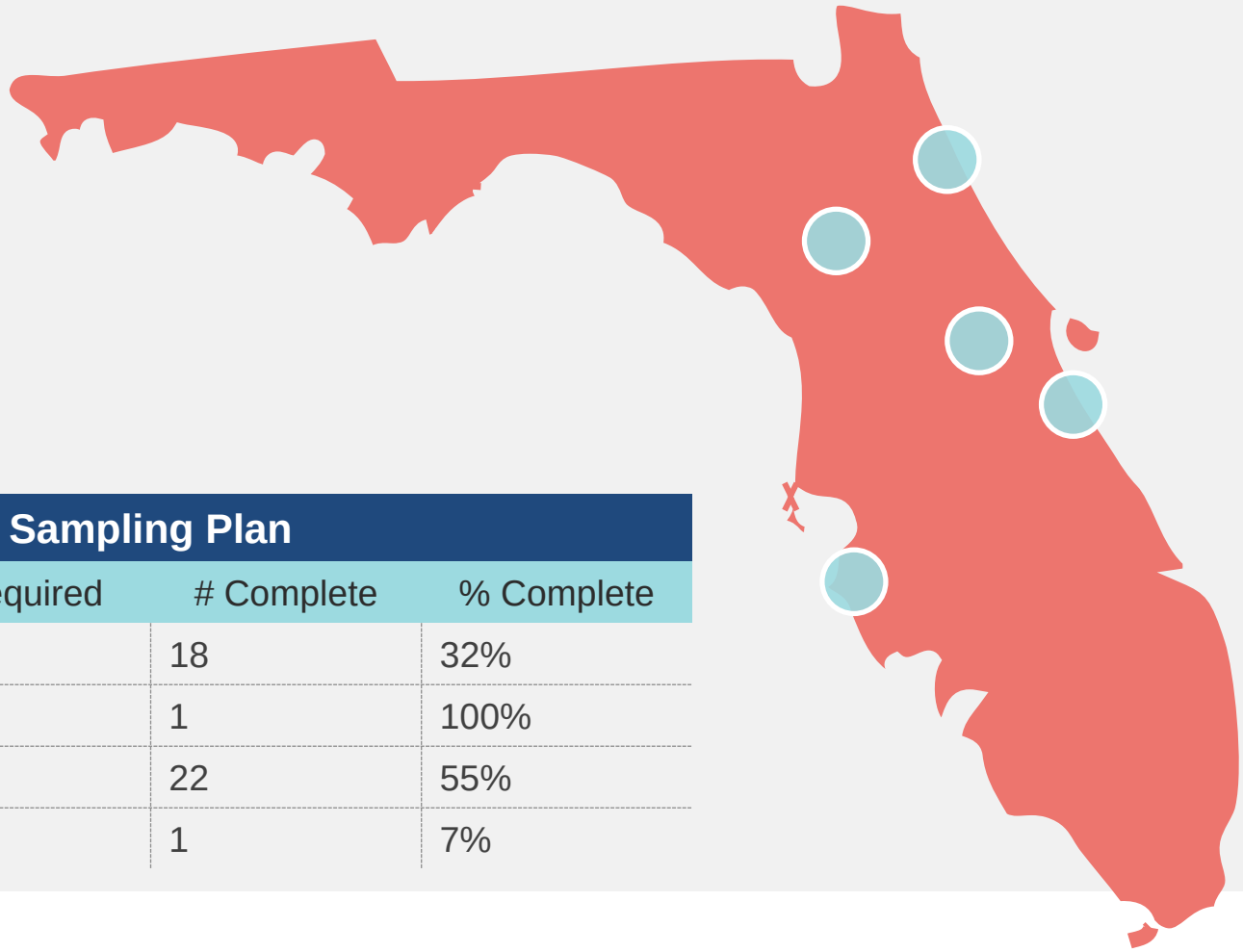
Study Areas : **CZ2A**



Sampling Plan			
Building Type	# Required	# Complete	% Complete
Small Office	56	18	32%
Large Office	1	1	100%
Small Retail	40	22	55%
Large Retail	14	1	7%

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Roof Insulation: $9,525

Interior LPD: $6,587

Automatic Lt Controls: $6,294

Add'tl Retail LPD: $3,628

Frame Wall Insulation: $2,729

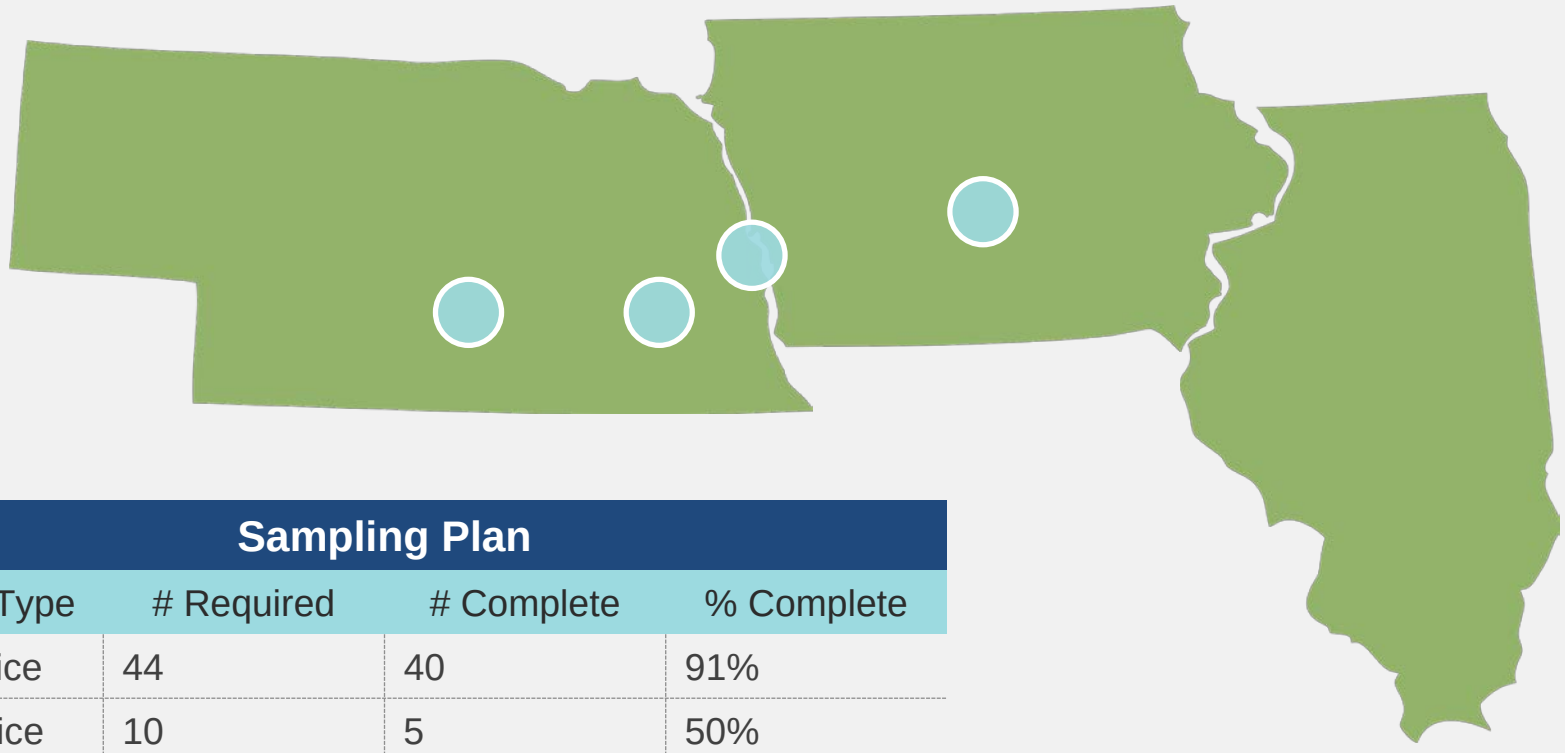
Duct Insulation: $2,714

Equipment Sizing: $2,635

Window to Wall Area: $2,594


Interior LPD: $3,636
Automatic Lt Controls: $2,974
Roof Insulation: $2,873
Equipment Sizing: $2,536
Night Fan Control: $2,065
Window to Wall Area: $1,689
Manual Lt Controls: $1,498
HVAC Pipe Insulation: $1,406

Study Areas : **CZ5A**



Sampling Plan			
Building Type	# Required	# Complete	% Complete
Small Office	44	40	91%
Large Office	10	5	50%
Small Retail	46	21	45%
Large Retail	8	3	37%

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Roof Insulation: $15,113
Interior LPD: $5,446
Automatic Lt Controls: $5,412
Frame Wall Insulation: $3,928
Mass Wall Insulation: $3,730
Window to Wall Area: $3,004
Additional Retail LPD: $2,995
Duct Leakage: $2,608


Roof Insulation: $4,341
Interior LPD: $3,022
Mass Wall Insulation: $2,617
Automatic Lt Control: $2,479
Equipment Sizing: $2,237
Duct Leakage: $1,845
Night Fan Control: $1,813
Window to Wall Area: $1,8,08

Pilot Phase

Data Collection Start: December 2017

Goals of Pilot:

- Work out the kinks
- PNNL review of early forms for additional training
- Gather baseline time breakdown of tasks
- Refine data collection protocol document with lessons learned

Major Hurdles Identified:

- Recruitment
- Data Entry time after site visit
- Learning curve on protocol

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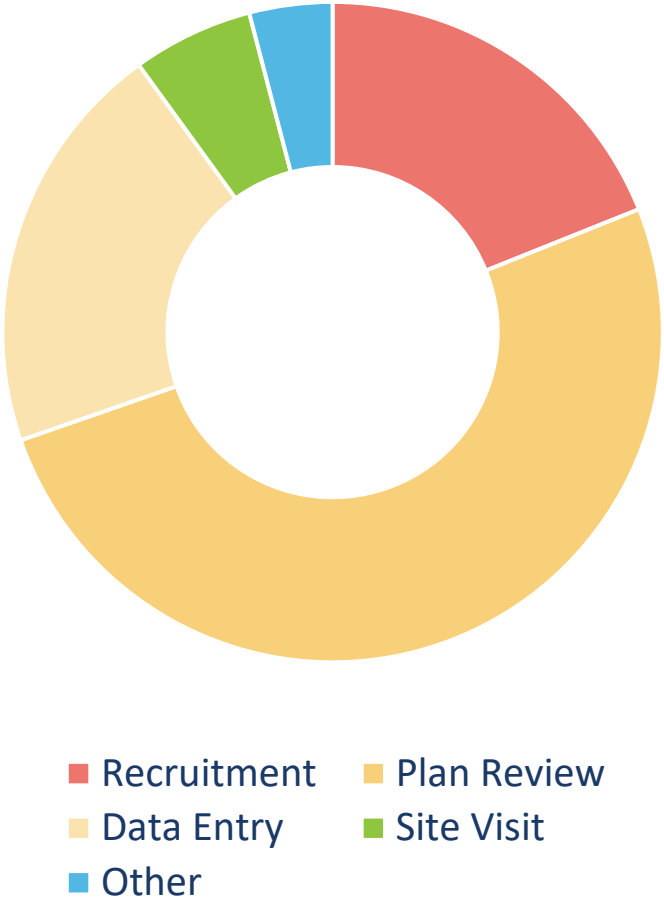
Time/Task Breakdown



Time Breakdown				
	2A	5A	Total	/Bldg
Recruitment	11.3	20.6	212	16.3
Plan Review	68.2	22.7	568	43.7
Data Entry	9.6	26.8	228	26.8
Site Visit	4.3	5.9	66.5	5.1
Other	4.2	3	46	3.5
Total	92.1	55.1	938.5	72.2

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Recruitment Strategies

Direct outreach to building departments for leads, permit data and access to buildings

Outreach to other building stakeholders – architects, designers, owners, developers

Idea formulated and tested during the pilot phase: Drop-Ins

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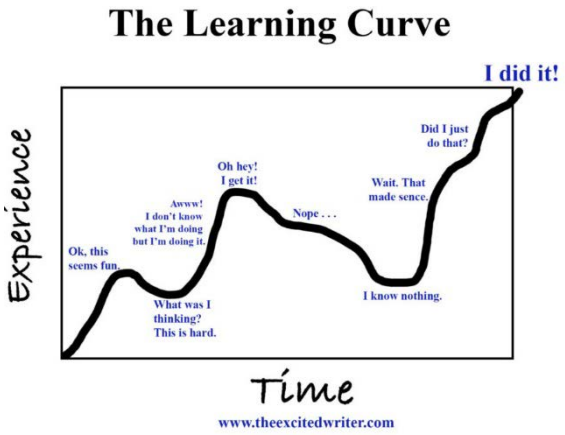
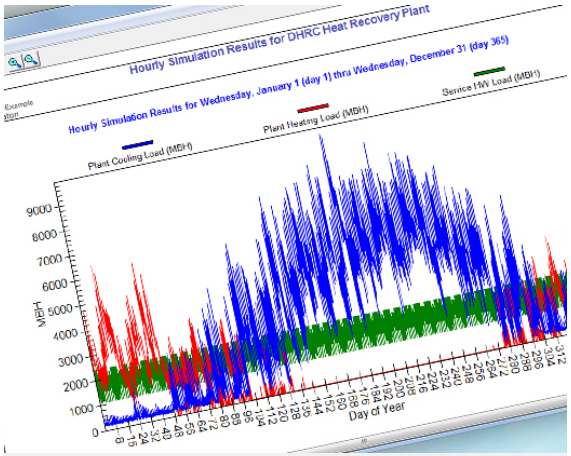
Refining **Data Entry**



Learning curve on the data collection forms and translation from field forms to PNNL form

Completing plan review entry or site visit first



Elimination of load sizing measure from data collection

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50% Data Collection

Data Collection Start: July 2018

Continuing Work:

- Work to fulfill sample
- Refine data collection protocol document with lessons learned

Major Hurdles Identified:

- Data Entry time after site visit
- Gaps in protocol based on primary build to 2012 IECC
- Gaps in protocol based on primary build to prescriptive compliance
- Lack of specificity in protocol

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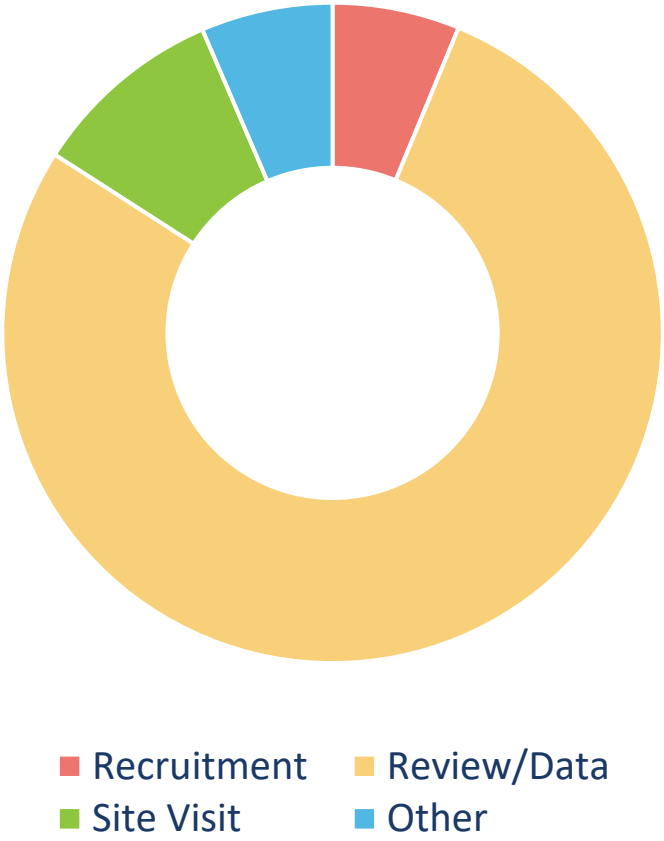
Time/Task Breakdown



Time Breakdown				
	2A	5A	Total	/Bldg
Recruitment	1.1	3.9	285	2.9
Review/Data Entry	22.9	44.7	1955	36.2
Site Visit	3.1	5.1	422	4.4
Other	3	3	289	3
Total	30.1	56.7	2952	46.6

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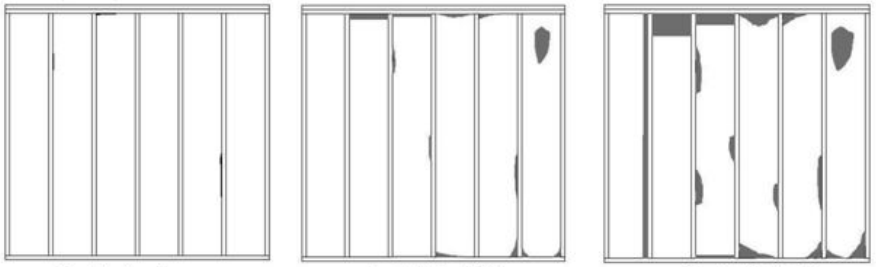
Insulation **Installation**



RESNET protocol for the effect of missing insulation on installation grade
Diagrams from the HERS Standards

IECC 2012 §C402.2.3

The minimum thermal resistance of the insulating materials installed in the wall cavity between framing members shall be as specified in Table C402.2

ISSUE:

When insulation is installed with gaps, the thermal resistance (R-value) is reduced from the value listed on the material.

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Fenestration Product Rating (NFRC)

IECC 2012 §C303.1.3

U-factors and SHGC of fenestration products shall be determined in accordance with NFRC and labeled by the manufacturer.

ISSUE:

Many commercial windows are field fabricated. Without a label (or a certificate) verifying the U-factor and SHGC is difficult.

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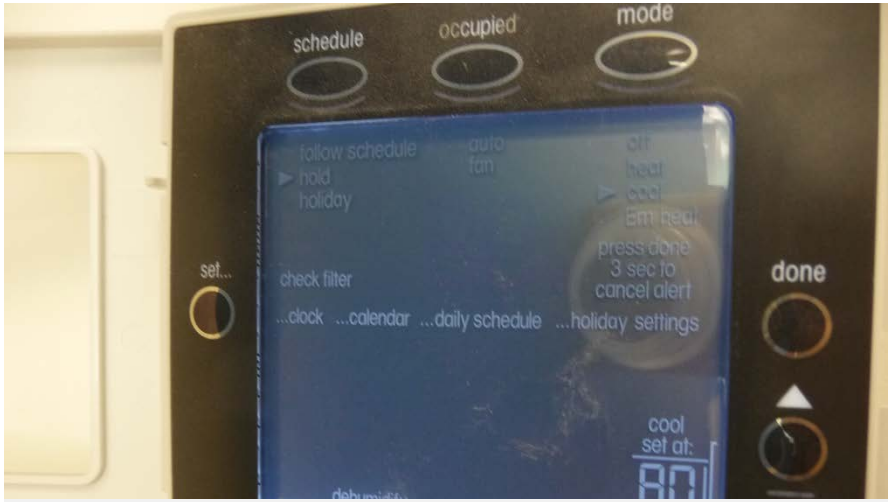
HVAC **Controls**

IECC 2012 §C403.2.4

Each heating and cooling system shall have set point overlap restriction, setback, automatic shutdown and start up capabilities, and damper controls.



ISSUE:

Different system types allow for varying degrees of sophistication. All need to be programmed properly at building turn over to be code compliant.

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Protection of HVAC **Pipe Insulation**

IECC 2012 §C403.2.8.1

Piping insulation exposed to weather shall be protected from damage, including that due to sunlight, moisture, equipment maintenance and wind.

ISSUE:

When insulation isn't protected from UV, it deteriorates quickly. The thermal resistance of the insulation is reduced – in some places to zero.

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Automatic Lighting **Controls**

IECC 2012 §C405.2.2.2

Occupancy sensors shall be installed in all classrooms, conference rooms, employee break rooms, private offices, restrooms, storage rooms…

ISSUE:

When lights aren't automatically controlled, they often don't get turned off. Does the bathroom light need to be on if no one is in there?

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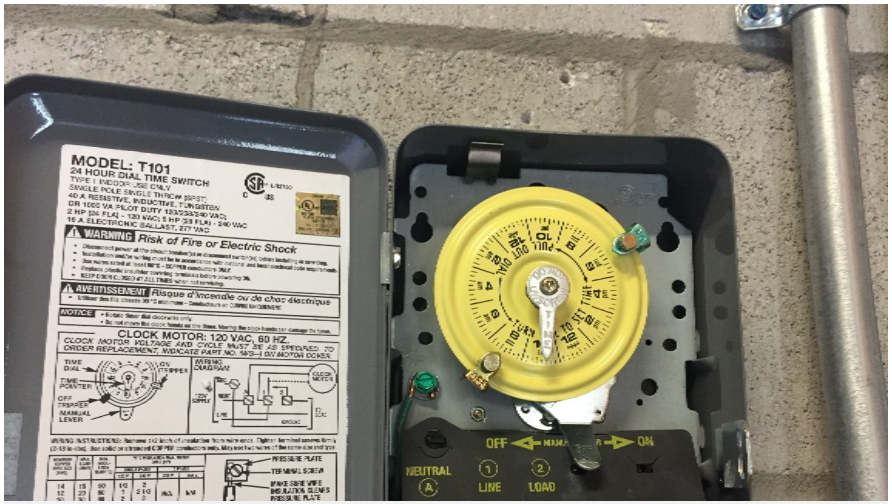
Exterior Lighting



IECC 2012 §C405.2.4

Lighting not designated for dusk-to-dawn operation shall be controlled by a photosensor and time switch or an astronomical time switch.

IECC 2012 §C405.6.2

The total exterior lighting power allowance for all exterior building applications is the sum of the base allowance plus individual allowances.

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Energy Model Coordination

IECC 2012 §C407.5.1

The standard reference design and proposed building shall be configured and analyzed as specified in Table C407.5.1(1).

ISSUE:

Table C407.5.1(1) includes a number of references to “as designed”. Where the model and the drawings diverge, the energy model is no longer valid.

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Data **Gaps**

Skylights (high bay spaces)

Boilers, Chillers, WSHP

VAV Systems

Waterside Economizers

Parking Garages

Onsite renewable option

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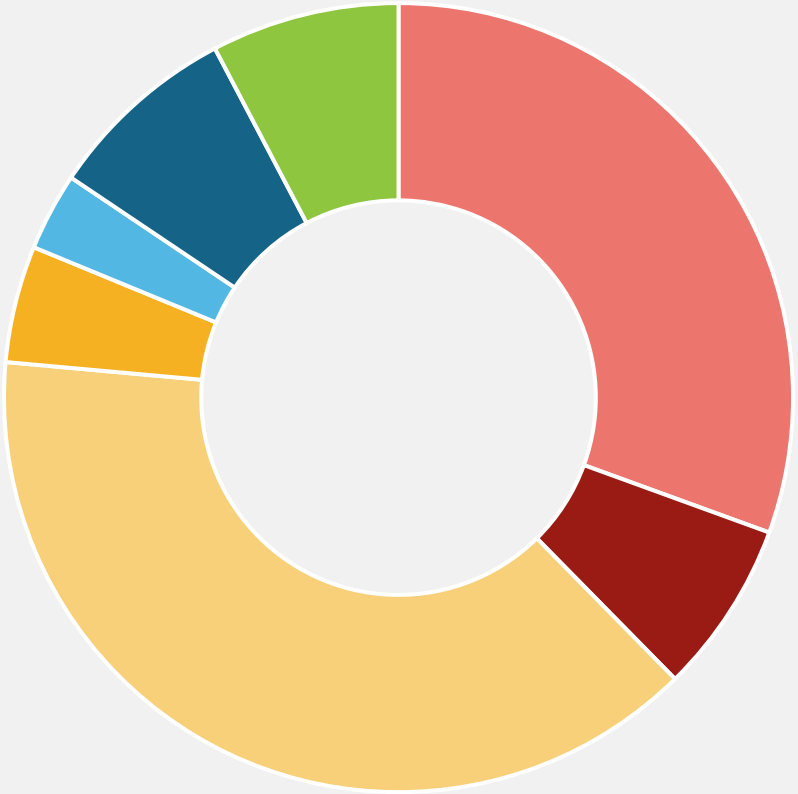
A Glimpse at PV **Savings**



Envelope
Windows
HVAC
Controls
Lighting
Controls
Hot Water

SQFT: 278,232

PV Lost: 1,271,144

PV/1,000 sqft: 4,568

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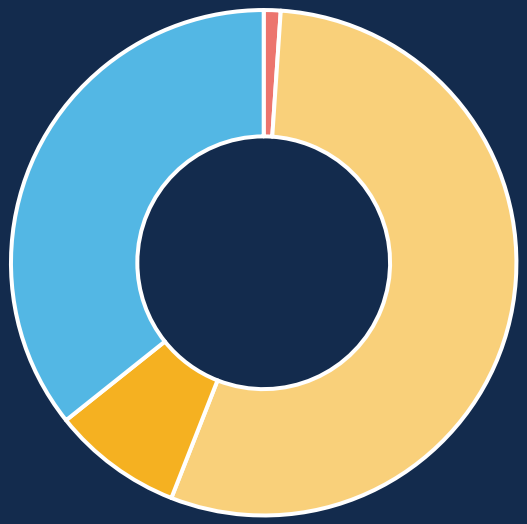
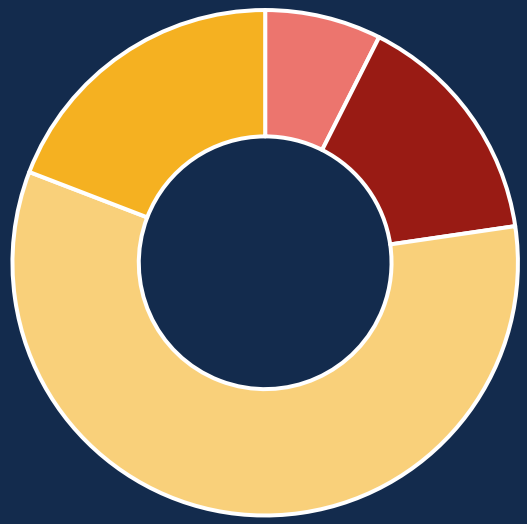
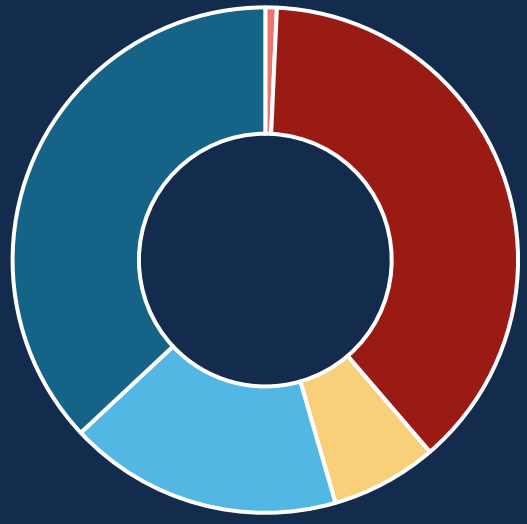
2A Office PV **Savings**



15,226 sqft
$21,525 PV Lost
$1,410/1,000 sqft



9,925 sqft
$6,567 PV Lost
$661/1,000 sqft



8,610 sqft
$41,789 PV Lost
$4,853/1,000 sqft

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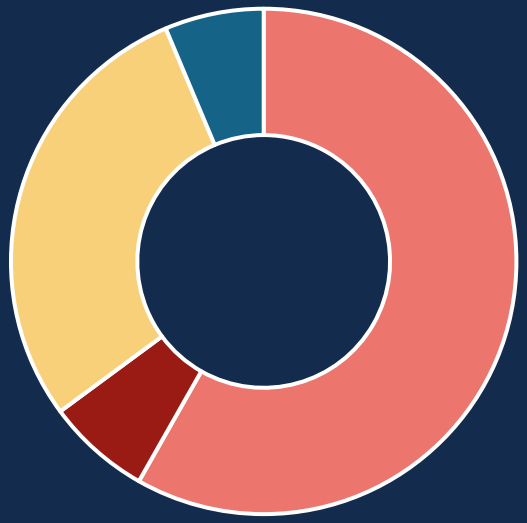
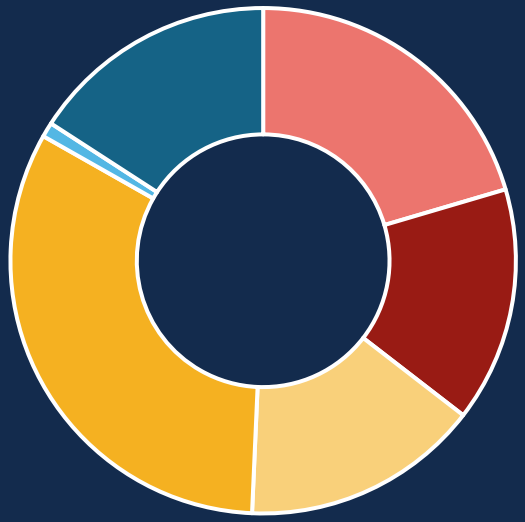
2A Retail PV **Savings**



8,320 sqft
$22,570 PV Lost
$2,712/1,000 sqft



79,574 sqft
$130,522 PV Lost
$1,640/1,000 sqft

39,837 sqft
$287,864 PV Lost
$7,226/1,000 sqft

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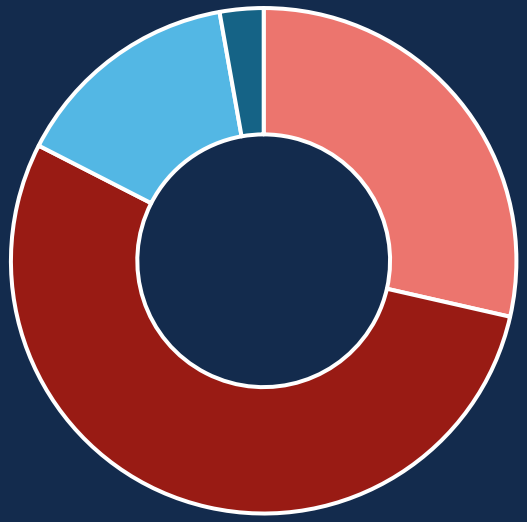
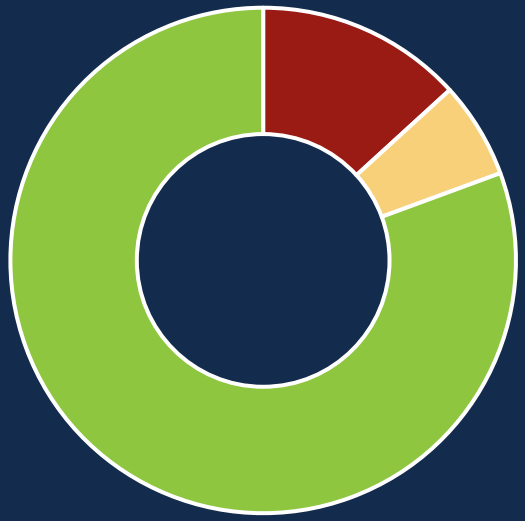
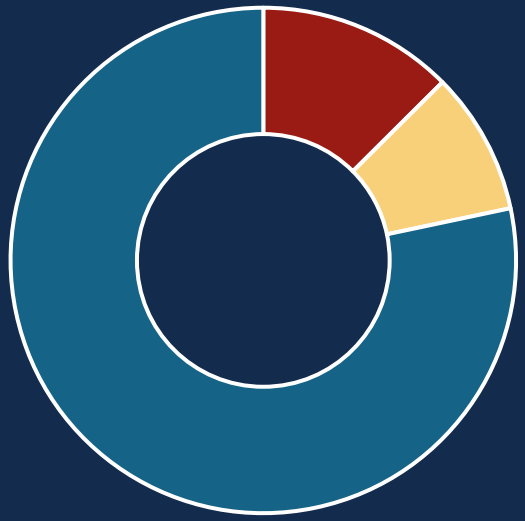
5A Office PV **Savings**



10,220 sqft
$21,092 PV Lost
$2,063/1,000 sqft



17,655 sqft
$113,265 PV Lost
$6,415/1,000 sqft



12,609 sqft
$64,020 PV Lost
$5,077/1,000 sqft

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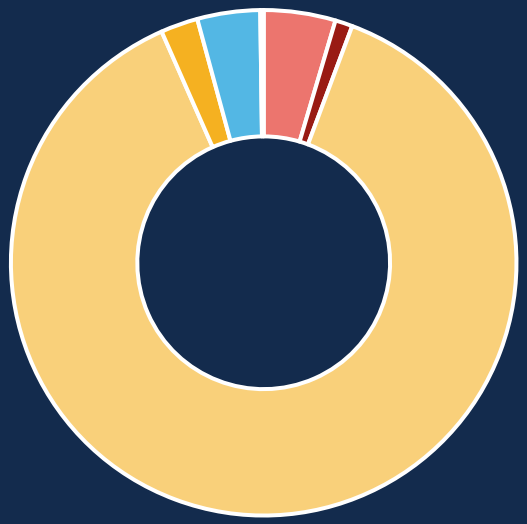
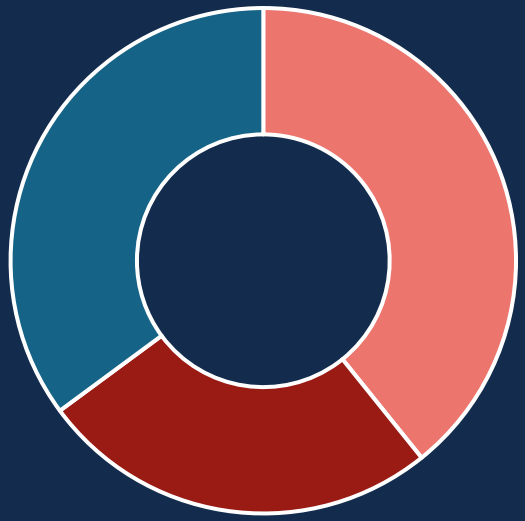
5A Retail PV **Savings**



52,238 sqft
$536,882 PV Lost
$10,277/1,000 sqft

9,728 sqft
$11,267 PV Lost
$1,158/1,000 sqft



14,250 sqft
$13,781 PV Lost
$967/1,000 sqft

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What's **Next**?

End: March 2020

Major Milestones:

- Complete 100% data collection
- Draft and pilot education materials
- Revise protocol based on lessons learned
- Analyze data

Questions We're Asking:

- Is there a "top ten"?
- Are there regional variations?
- Are there code variations (IECC/90.1)?
- Does energy modeling have a disproportionate impact?
- What else is in the data?

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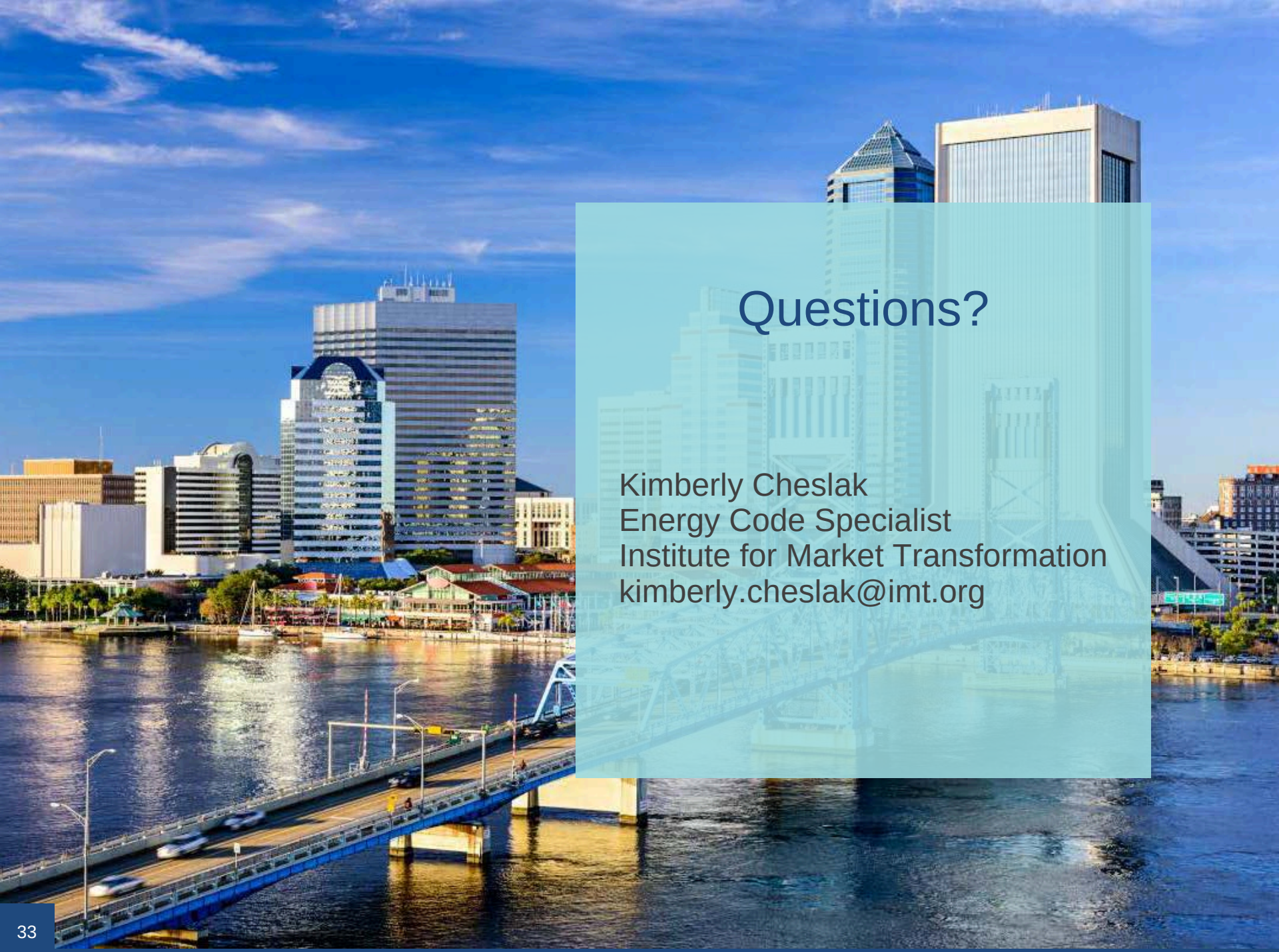

Questions?

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