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
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.
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.
Study Areas: CZ2A

<table>
<thead>
<tr>
<th>Building Type</th>
<th># Required</th>
<th># Complete</th>
<th>% Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Office</td>
<td>56</td>
<td>18</td>
<td>32%</td>
</tr>
<tr>
<td>Large Office</td>
<td>1</td>
<td>1</td>
<td>100%</td>
</tr>
<tr>
<td>Small Retail</td>
<td>40</td>
<td>22</td>
<td>55%</td>
</tr>
<tr>
<td>Large Retail</td>
<td>14</td>
<td>1</td>
<td>7%</td>
</tr>
</tbody>
</table>
Intermediate 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

<table>
<thead>
<tr>
<th>Building Type</th>
<th># Required</th>
<th># Complete</th>
<th>% Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Office</td>
<td>44</td>
<td>40</td>
<td>91%</td>
</tr>
<tr>
<td>Large Office</td>
<td>10</td>
<td>5</td>
<td>50%</td>
</tr>
<tr>
<td>Small Retail</td>
<td>46</td>
<td>21</td>
<td>45%</td>
</tr>
<tr>
<td>Large Retail</td>
<td>8</td>
<td>3</td>
<td>37%</td>
</tr>
</tbody>
</table>
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
Time/Task Breakdown

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

<table>
<thead>
<tr>
<th>Task</th>
<th>2A</th>
<th>5A</th>
<th>Total</th>
<th>/Bldg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recruitment</td>
<td>1.1</td>
<td>3.9</td>
<td>285</td>
<td>2.9</td>
</tr>
<tr>
<td>Review/Data Entry</td>
<td>22.9</td>
<td>44.7</td>
<td>1955</td>
<td>36.2</td>
</tr>
<tr>
<td>Site Visit</td>
<td>3.1</td>
<td>5.1</td>
<td>422</td>
<td>4.4</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>3</td>
<td>289</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>30.1</td>
<td>56.7</td>
<td>2952</td>
<td>46.6</td>
</tr>
</tbody>
</table>
Insulation Installation

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.
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.
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.
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.
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?
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.
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.
Data Gaps

- Skylights (high bay spaces)
- Boilers, Chillers, WSHP
- VAV Systems
- Waterside Economizers
- Parking Garages
- Onsite renewable option
A Glimpse at PV Savings

SQFT: 278,232
PV Lost: 1,271,144
PV/1,000 sqft: 4,568

- Envelope
- Windows
- HVAC
- Controls
- Lighting
- Hot Water
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
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
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
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
End: March 2020

Major Milestones:
• Complete 100% data collection
• Draft and pilot education materials
• Revise protocol based on lessons learned
• Analyze data

What’s Next?

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?
Questions?

Kimberly Cheslak
Energy Code Specialist
Institute for Market Transformation
kimberly.cheslak@imt.org