End-use Load Profiles for the U.S. Building Stock

Technical Advisory Group meeting #1
November 27, 2018

Eric Wilson, NREL
Andrew Parker, NREL
Natalie Mims Frick, LBNL
Agenda

• Meeting housekeeping items
• U.S. DOE Building Technologies Office
• Project background, overview, and team
• Project timeline and outcomes
• Technical Advisory Group members and responsibilities
• Overview of EPRI Conditional Demand Analysis
• Overview of Northeast Energy Efficiency Project (NEEP) regional research
Meeting housekeeping items

• We’re recording the webinar and will post it on our web site.

• Because of the large number of participants, everyone is in listen-only mode.

• Please use the chat box to send us your questions and comments any time during the webinar.

• Moderated Q&A will follow, with the presenters responding to questions typed in the chat box.

• The recording and webinar slides will be posted on the project website (once created).
End-use load/savings profiles are...

- the **most essential** data resource currently missing for Time-Sensitive Valuation of Energy Efficiency (TSV-EE)
- needed for **R&D prioritization, utility resource and distribution system planning, state and local energy planning and regulation**
- critical for widespread adoption of **grid-interactive and efficient buildings**.

Existing profiles are often **outdated, regionally limited, based on small sample size, and limited to a subset of the building stock** because of the high cost of the historical sub-metering approach.

Source: Navigant Massachusetts RES 1 Baseline Load Shape Study
Solution: a hybrid approach

- Best-available submetering study data
- Ongoing collection of whole-building AMI metering data
- Customer survey data for large samples, facilitating conditional demand analysis
- Other proven disaggregation techniques (e.g., inverse modeling of weather-dependent end uses)
- Other emerging data sources (e.g., time-use surveys, smart thermostats, energy monitors, daytime/nighttime population)
Background: DOE Building Stock Models

- DOE-funded, NREL-developed models of the U.S. building stock
- 100,000s of statistically representative physics-based building energy models (BEM)
- Use DOE’s flagship BEM tools OpenStudio and EnergyPlus
- Produce hourly load profiles, but calibration to-date has focused on annual energy consumption
1. Establish technical advisory group
2. Identify load profile use cases, data requirements, existing data sources, and critical gaps
3. Address data gaps with critical data collection and disaggregation techniques
4. Incorporate stochastic occupancy into ComStock/ResStock
5. Calibrate ComStock and ResStock statistical building stock models
6. Publish end-use load profiles and documentation
Project Team – Industry

Northeast Energy Efficiency Partnerships (NEEP)

Elizabeth Titus  Claire Miziolek

Electric Power Research Institute (EPRI)

Chris Holmes  Krish Gomatom

...and many others on the technical advisory group
Regional Energy Efficiency Organizations
- Midwest Energy Efficiency Alliance
- Northwest Energy Efficiency Alliance
- Northeast Energy Efficiency Partnerships
- Southeast Energy Efficiency Alliance

Regulators
- Georgia Public Service Commission
- Hawaii Public Service Commission
- Indiana Utility Regulatory Commission
- Michigan Public Service Commission

Utilities and RTOs
- Ameren
- Bonneville Power Administration
- Commonwealth Edison
- Consolidated Edison
- CPS Energy
- DTE Energy
- Duke Energy
- Indiana Power & Light
- PacifiCorp
- PJM
- Southern Company
- Xcel Energy
Consultants

• Cadmus
• Elevate Energy
• Energy Futures Group
• The Greenlink Group
• ICF
• Navigant
• Solar Investment, Inc
• Seventhwave
• Synapse Energy Economics
• TRC Solutions
• Tom Eckman
• Oracle

Research

• Electric Power Research Institute
• Clarkson University
• Pacific Northwest National Laboratory

NGOs

• ACEEE
• Environmental Defense Fund
• National Association of State Energy Officials (NASEO)

Government

• US Department of Energy
• New York State Energy Research and Development Authority (NYSERDA)
• City of New York
• City of Boulder
Project Timeline

Year 1

- Collect/review existing data
- Targeted data collection through planned and ongoing sub-metering studies
- Statistical disaggregation of certain end uses from existing AMI data
- Data analysis
- Occupancy and end-use schedules with diversity
- Stochastic event modeling capabilities

Year 2

- Report on critical gaps
- Rigorous calibration of building stock end-use models

Year 3

- Lessons learned & future recommendations
- Calibrated building stock models
- Load profile library, documentation, & user guide

Beyond

- EE/DR savings profiles
- Ongoing additions to load profile library

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1 For example, conditional demand analysis, or inverse (changepoint/degree day) models (KEMA 2009)
The project will result in:

- **Validated end-use load profiles** for U.S. building stock at both aggregate and individual building scales

- Calibrated building stock end use **models with ability to estimate EE/DR savings profiles for existing and emerging technologies**

- **Documentation** of load profile use cases, critical gaps, model methodology, and user guide
<table>
<thead>
<tr>
<th>Building Types</th>
<th>End-Uses</th>
<th>Building Types</th>
<th>End-Uses:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Small Office</td>
<td>• Heating</td>
<td>• Single-Family Detached</td>
<td>• Heating</td>
</tr>
<tr>
<td>• Medium Office</td>
<td>• Cooling</td>
<td>• Multifamily (low-rise)</td>
<td>• Cooling</td>
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<tr>
<td>• Large Office</td>
<td>• Interior Lighting</td>
<td>- Single-Family Attached</td>
<td>• Furnace/AC fan</td>
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<tr>
<td>• Stand-alone Retail</td>
<td>• Exterior Lighting</td>
<td>- 2 - 4 Units</td>
<td>• Boiler pumps</td>
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<td>• Strip Mall</td>
<td>• Interior Equipment</td>
<td>- 5+ Units</td>
<td>• Vent. fans</td>
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<tr>
<td>• Primary School</td>
<td>• Exterior Equipment</td>
<td></td>
<td>• Water heating</td>
</tr>
<tr>
<td>• Secondary School</td>
<td>• Fans</td>
<td></td>
<td>• Interior Lights</td>
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<tr>
<td>• Outpatient Healthcare</td>
<td>• Pumps</td>
<td></td>
<td>• Exterior Lights</td>
</tr>
<tr>
<td>• Hospital</td>
<td>• Heat Rejection</td>
<td></td>
<td>• Misc. plug loads</td>
</tr>
<tr>
<td>• Small Hotel</td>
<td>• Humidification</td>
<td></td>
<td>• Refrigerator</td>
</tr>
<tr>
<td>• Large Hotel</td>
<td>• Heat Recovery</td>
<td></td>
<td>• Clothes washer</td>
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<tr>
<td>• Warehouse (non-ref.)</td>
<td>• Water Systems</td>
<td></td>
<td>• Clothes dryer</td>
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<tr>
<td>• Quick Service Restaurant</td>
<td></td>
<td></td>
<td>• Dishwasher</td>
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<tr>
<td>• Full Service Restaurant</td>
<td></td>
<td></td>
<td>• Cooking Range</td>
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<tr>
<td>• Mid-rise Apartment</td>
<td>• Refrigeration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• High-rise Apartment</td>
<td>• Generators</td>
<td></td>
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<tr>
<td>• Supermarket</td>
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Stochastic building loads

Washing Machine Load Profiles

Refrigerator Load Profiles
# Key Milestones and Deliverables

<table>
<thead>
<tr>
<th>Year 1</th>
<th>• Establish TAG</th>
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<tr>
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<td>• Publish Market Needs, Use Cases and Data Gaps report that discusses applications of end-use load profiles, use cases and identify gaps in existing data</td>
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<td>Year 2</td>
<td>• Produce working but uncalibrated model of national residential and commercial building stocks that generates end-use load profiles</td>
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<td>• Develop models to represent stochastic behavior of discrete end-use events in building operation</td>
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<td>Year 3</td>
<td>• Complete a calibrated model of national residential and commercial building stocks that generates average and typical end-use load profiles</td>
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<td>• Publish Technical Project Documentation that describes technical details, assumptions and methodologies used to develop and calibrate the models and create end-use load profiles</td>
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<td>• Publish User’s Guide describes approach, results, and applications (e.g., load forecasting, resource planning, program, and policy design)</td>
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TAG Responsibilities

- **Review materials provided in advance** of quarterly calls and annual meetings
- Be prepared to **contribute to thoughtful conversation** to guide review of technical choices and decision-making
- **Review two draft reports** and provide comments and feedback
- Help the project team produce useful and industry-accepted load profiles
- Help disseminate results
In-person TAG Meeting
March 5–6
Golden, Colorado

Based on polled availability, meeting will be:

- 12–5 pm on March 5
- 9am–1pm on March 6

The TAG meeting will use facilitated work groups to:

- Identify use cases
- Identify data sources
- Identify data gaps
In-person TAG Meeting
March 5–6
Golden, Colorado

- Small meeting rooms will be available on morning of March 5 and afternoon of March 6 for side meetings, calls, etc.
- Call-in option will be available

Any non-U.S. citizens, contact Barbara.VanDyke@nrel.gov as soon as possible to complete paperwork (at least 30 days in advance)
Electric Power Research Institute (EPRI) - Conditional Demand Analysis

Chris Holmes
cholmes@epri.com
Northeast Energy Efficiency Partnerships (NEEP)
Questions?

Please use the chat box to send us your questions and comments any time during the webinar. You may want to direct your question to a specific presenter.
Thank you

Eric Wilson, eric.wilson@nrel.gov
Andrew Parker, andrew.parker@nrel.gov
Natalie Mims Frick, nfrick@lbl.gov

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