NREL Transforming ENERGY

BUILDING SCIENCE AND INNOVATION

Elaina Present, Eric Wilson, Andrew Parker (NREL)
Natalie Mims Frick (LBNL)

# End-Use Load Profiles for the U.S. Building Stock

## Research Vision

End-use load profiles describe *how* and *when* energy is used in buildings on an hourly or subhourly basis. These profiles:

- Are the **most essential** missing data resource for time-sensitive valuation of energy efficiency (DOE internal survey)
- Enable analysis of energy efficiency (EE) technologies for R&D prioritization, utility resource and distribution system planning, and state/local energy planning and regulation
- Are the foundation for understanding energy flexibility in the building stock, and the EE/Demand Response (DR) relationship
- Potentially influence $7.8 billion spent annually on ratepayer-funded EE and DR programs in the United States, as well as $20 billion in annual utility transmission infrastructure spending.

### Challenge

Existing end-use load profiles:

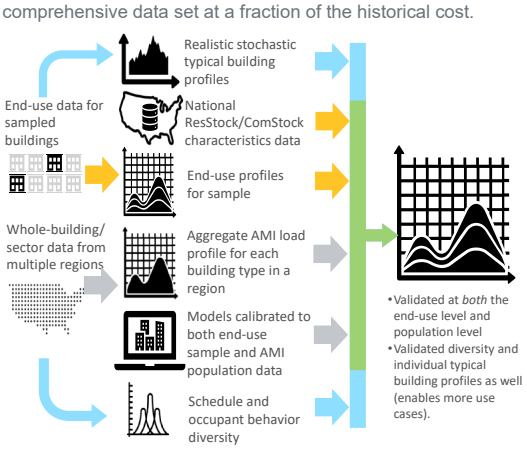
- Are often outdated and limited to certain regions and building types because of the high cost of traditional end-use submetering
- Are insufficient for numerous emerging use cases furthering grid-interactive and efficient buildings.

### Opportunity

- New ResStock™ and ComStock™ models statistically represent energy use of U.S. buildings
- Models produce hourly end-use load profiles, but most calibration efforts to date have focused on annual energy use.

## Objective and Approach

This project's hybrid approach combines best-available ground truth data, such as submetering studies and statistical disaggregation of whole-building interval meter data, with the reach, cost-effectiveness, and granularity of physics-based and data-driven building stock modeling to deliver a nationally comprehensive data set at a fraction of the historical cost.




**The ultimate outcome of this project will be public:**

- **End-use load profiles for every location in the United States, at both the aggregate (e.g., utility, county) and individual building levels**
- **Calibrated building stock energy models.**

## Research Progress

In the first 10 months of the 3-year project, progress was focused in the following areas:

### Stakeholder Engagement

- Created technical advisory group with more than 60 members representing utilities, regulators, experts and consultants, energy efficiency regional organizations, and vendors
- Three meetings to date focused on identifying market needs, use cases, data gaps, and data sources for the project.

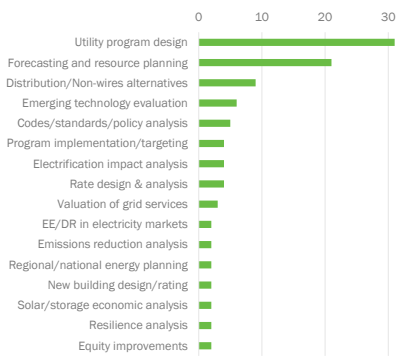
**"This was as good as it gets for engaging people across different locations and disciplines."**

- JJ Vandette, technical advisory group member


*Organizations represented by the advisory group*

### Use Case Understanding

- Identified approximately 75 use cases for end-use load profiles and load modeling
- Collected input on highest-priority use cases.




### Data Requirements Driven by Use Cases

- Identified key data attributes for the top priority load profile use cases
- Proposed data requirements to meet the maximum practical number of uses cases.

| Time Resolution | Geographic Resolution | Occupancy | Electrical Characteristics |
|---|---|---|---|
| *15-minute* | *Utility territory* | *Stochastic* | *Real power* |
| • *Highest impact cases require only hourly results*<br>• *PV planning is the only top use case that requires less than 15-minute data* | • *Distribution System Planning requires feeder-level data*<br>• *A "mix-and-match" approach from a bank of load profiles could help build specific utility and feeder level information* | • *This is a significant gap and will require new modeling techniques* | • *Some distribution system planning use cases might benefit from reactive power* |

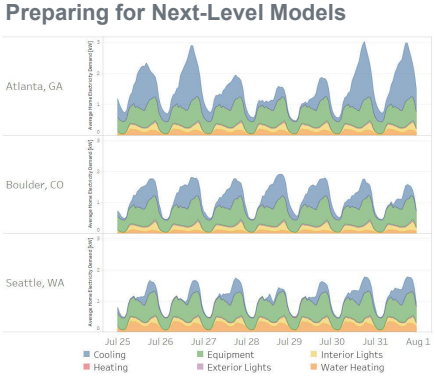
*Technical advisory group members identified their highest-priority use cases of end-use load profiles, presented as a graph of use case categories (left). The team translated these to data requirements (right).*

### Data Outreach

- Leveraging a variety of ground-truth data:
  - Advanced Metering Infrastructure (AMI) data
  - End-use submeter data
  - Load research data
  - Model input data (including survey results from the U.S. Census, U.S. Energy Information Administration, and others)
- Acquired or actively pursuing around 30 data sources from around the United States
- Selected examples:


**Still seeking data. Maybe yours?** Greatest data needs: commercial end-use, cold climate

### Preparing for Next-Level Models




*Example of current residential model outputs*

- Categorized approximately 500 current high-level inputs for ResStock/ComStock
  - Documented current and potential future data sources for each input
  - Identified highest priority data gaps
- Completed initial literature review on residential stochastic occupant behavior models
- Progress developing commercial building stochastic occupant behavior.

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