End-Use Load Profiles – A New Public Dataset for U.S. Residential and Commercial Buildings

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Webinar

October 28, 2021

Logistics

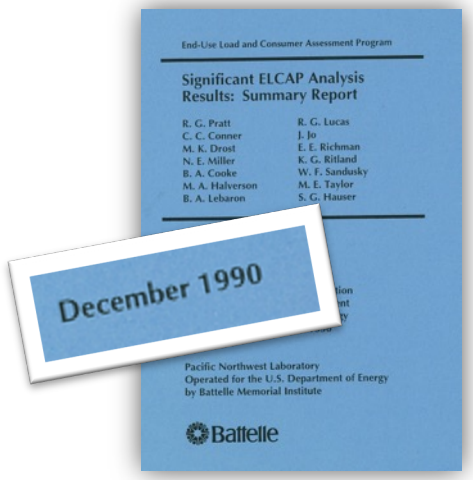
- We are recording the webinar.
- Because of the large number of participants everyone is muted.
- Please use the Q&A box to send us questions at any time during the presentations.
- We will put the link to the slides in the Q&A box. We will send links to the recording and slides to everyone that registered for the meeting a few days after the webinar.

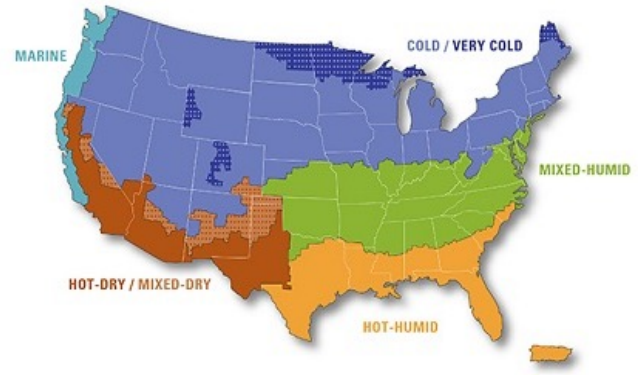
Today’s agenda

- Opening remarks from David Nemtzow, U.S. Department of Energy’s Building Technologies Office Director
- Project Overview, Methodology, and Results
- How to Access the End-Use Load Profiles Dataset
- Conclusion
- Q&A

Motivation and Overview

Problem





A national end-use submetering study to develop end-use load profiles (EULP) covering all building types and end uses would be prohibitively expensive.

Project Team

The 3-year project was funded by DOE Building Technologies Office, with cost-share provided by NYSERDA and MassCEC, and in-kind contributions from EPRI, data partners, and TAG members.

DOE National Laboratories

NREL Transforming ENERGY

BERKELEY LAB
Lawrence Berkeley National Laboratory

Argonne NATIONAL LABORATORY

Industry Partners

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Northeast Energy Efficiency Partnerships

neea Northwest Energy Efficiency Alliance

60 other organizations represented on technical advisory group

Technical Advisory Group

In-kind participation by 62 organizations

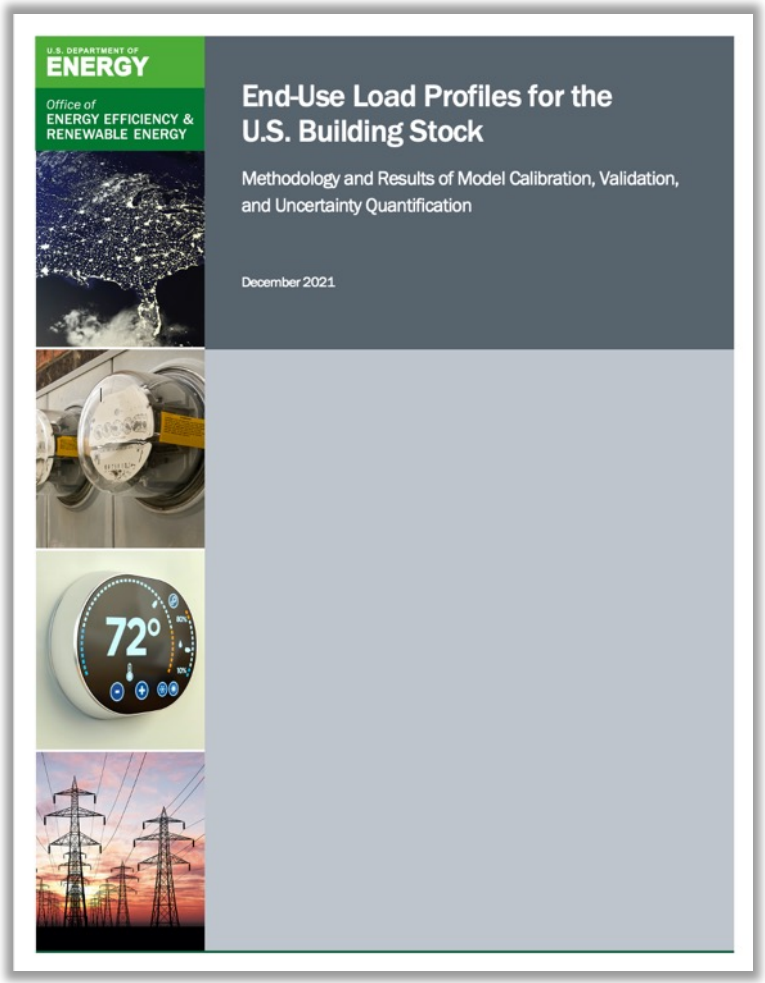
EULP Use Cases

- Identified 60 EULP use cases
- 10 most mentioned use cases were prioritized
  - Electricity Resource Planning
  - Energy Efficiency Planning
  - Policy and Rate Design
  - Transmission and Distribution System Planning
  - Program Impact Evaluation
  - Demand-Response Planning
  - Improved Building Energy Modeling
  - Electrification Planning
  - Emissions Analysis
  - PV Planning
- Use cases informed data requirements for modeling
- See *Market Needs, Use Cases, and Data Gaps* report and webinar for details

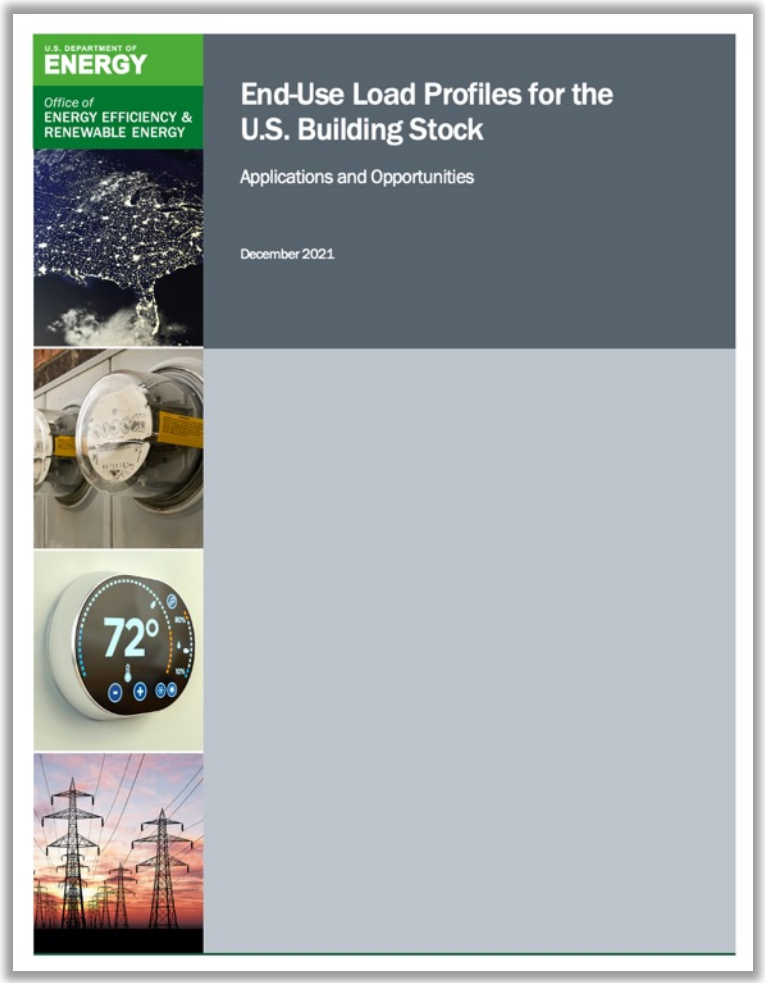
Methodology

Two reports coming this winter

Methodology and Results

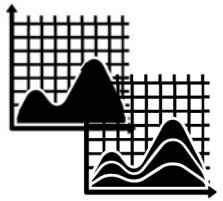


Applications and Opportunities



Approach

900,000 physics-simulation models
statistically representing the U.S. building stock



Calibrated and validated with the best-available load data
- 2.3 million meters of data from 11 utilities
- 15 end-use metering datasets

70+ model improvements,
supported by building stock data

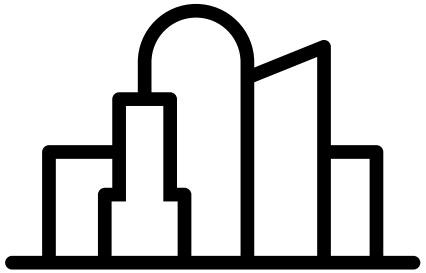
Published accuracy and uncertainty
metrics to inform user confidence

The novel approach delivers a nationally-comprehensive dataset, at a fraction of the cost of a national sub-metering study.

Calibrated models enable more accurate evaluation of “what-if” technology deployment impacts

900,000 physics-simulation models statistically representing the U.S. building stock

ComStock ResStock



Building stock characteristics database

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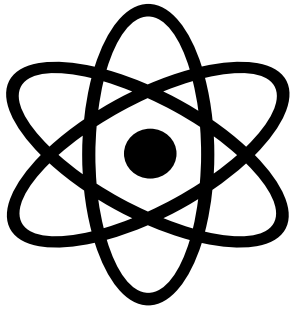

Physics-based computer modeling

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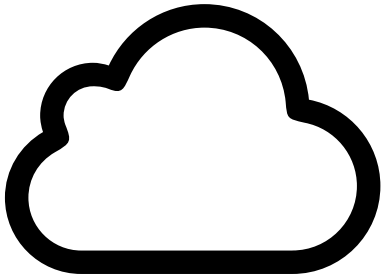


High-performance computing

- DOE-funded, NREL-developed models of the U.S. building stock
- 1,000s–100,000s of statistically representative physics-based building energy models (BEM)
- Leverage decades of DOE investment in BEM tools EnergyPlus and OpenStudio
- Produce hourly load profiles, but prior calibration had focused on annual energy consumption

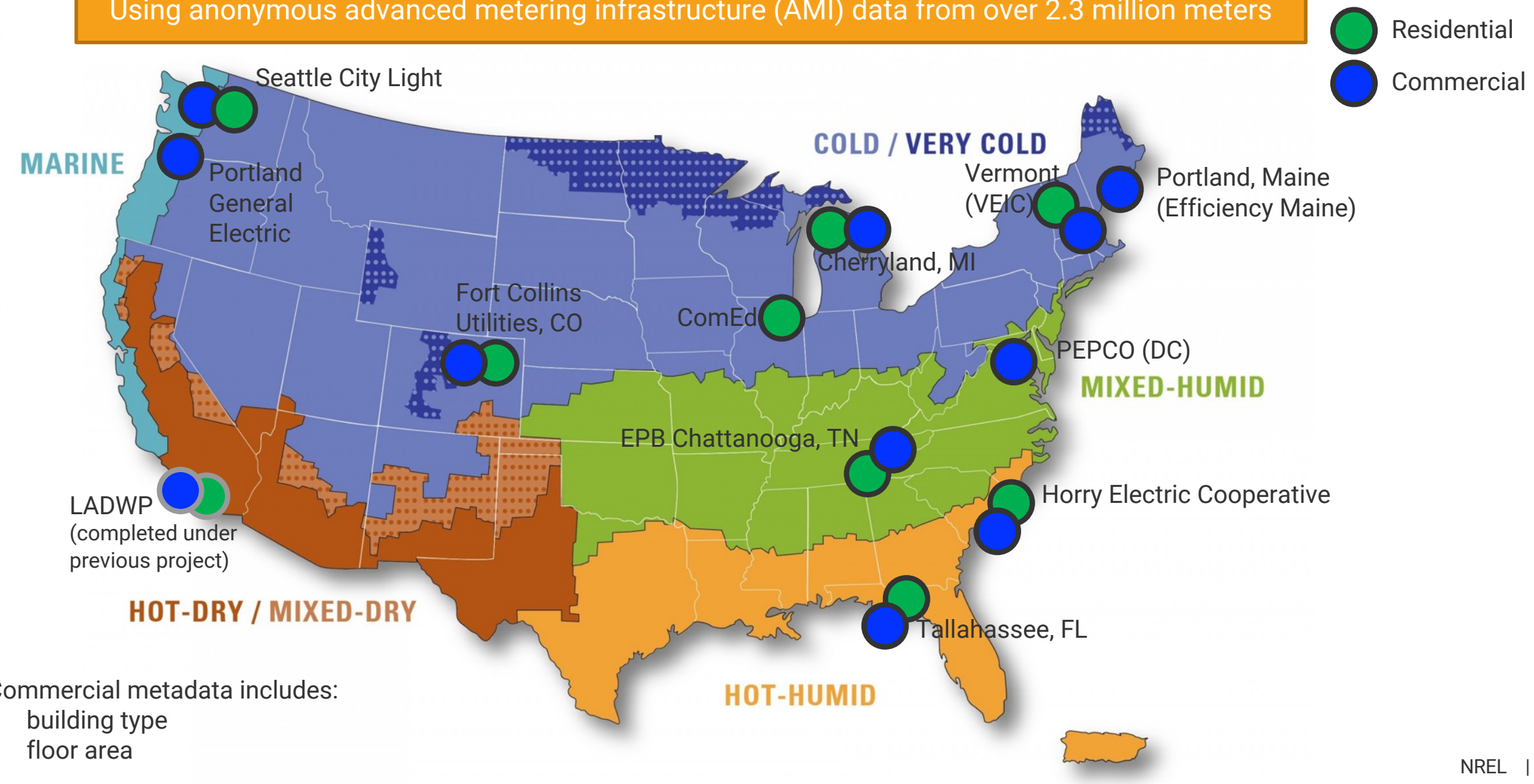
Calibrated and validated with the best-available load data
Data Gathering Partners

We are grateful for these organizations who shared data, helped find data, or already had a data-sharing program in place!

Adams 12 Five Star Schools
AES Indiana
Alliance Center
Ameren Missouri
Bert Brains
Bonneville Power Administration
Center for Energy and Environment
Center for the Built Environment
Cherryland Electric Cooperative
City of Fort Collins Utilities & Colorado State University
City of Tallahassee Utilities
Clarkson University
ComEd
DNV
ecobee
Ecotope
Efficiency Maine
Elevate
EPB
Florida Solar Energy Center (FSEC)
Horry Electric Cooperative
Hot Water Research
kW Engineering
Los Angeles Department of Water and Power
Massachusetts Energy Efficiency Advisory Council
Massachusetts Program Administrators
National Rural Electric Cooperative Association
New City Energy
New York State Energy Research and Development Authority
Northeast Energy Efficiency Partnerships
Northwest Energy Efficiency Alliance
NV Energy
PacifiCorp
Pecan Street
PEPCO & Exelon
Portland General Electric
Powerhouse Dynamics
Resource Central
Seattle City Light
Southern Company
VEIC & Green Mountain Power
Xcel Energy

Calibrated and validated with the best-available load data
Utility meter data and metadata

Using anonymous advanced metering infrastructure (AMI) data from over 2.3 million meters

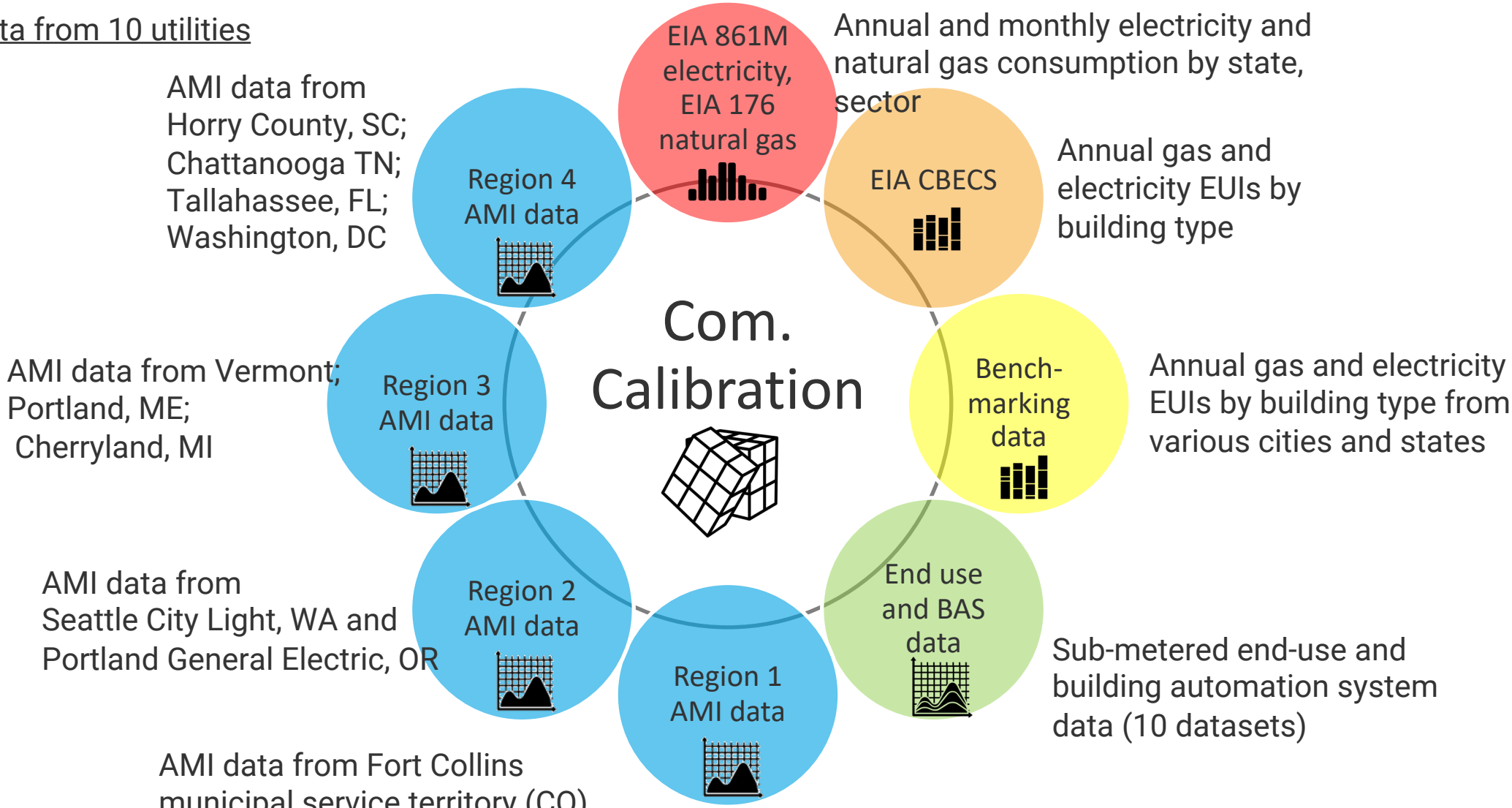


Commercial metadata includes:

- building type
- floor area

Commercial Calibration/Validation Data Sources

AMI data from 10 utilities



Residential Calibration/Validation Data Sources

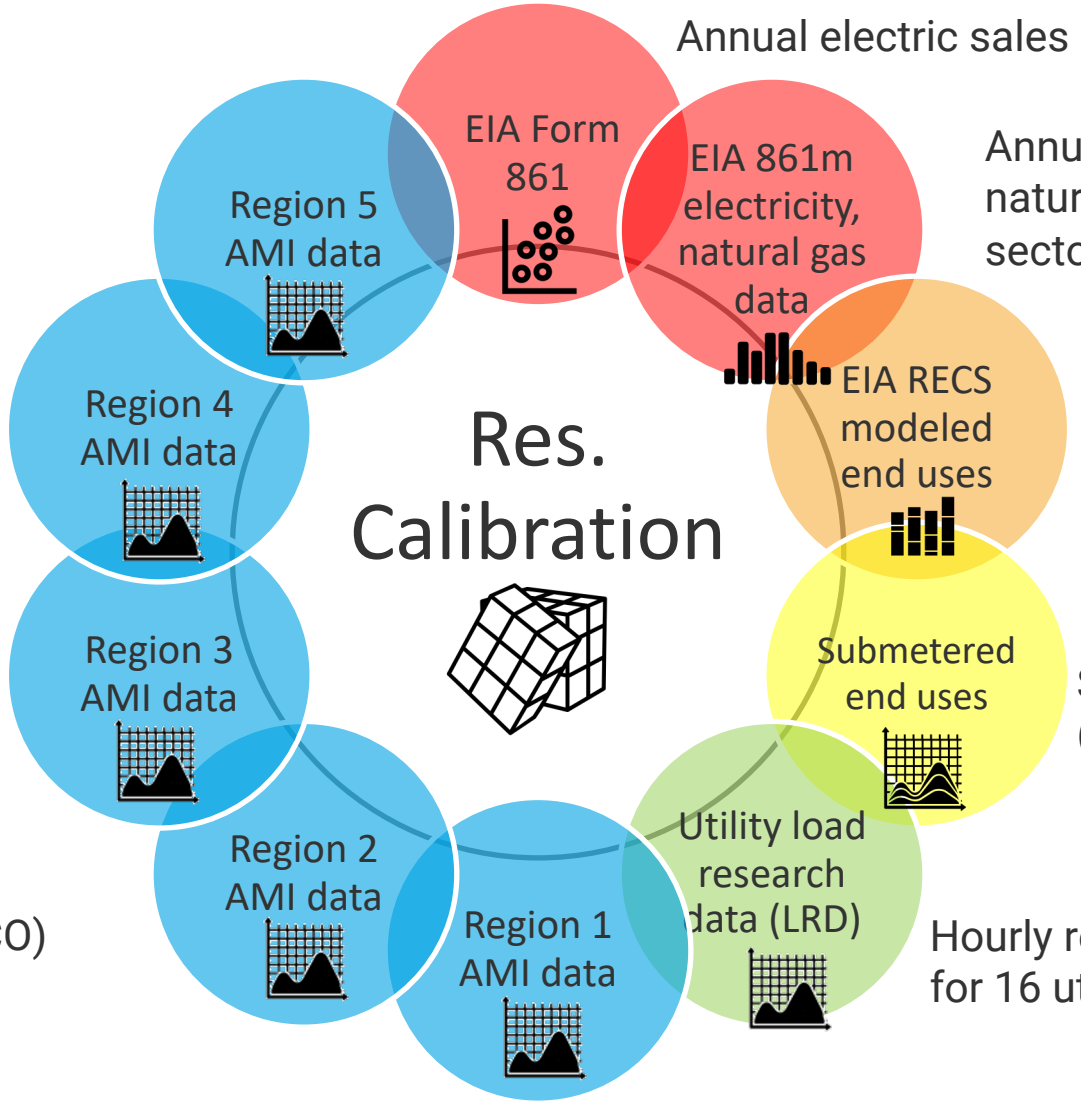
AMI data from 8 utilities

AMI data from Vermont; Cherryland, MI

AMI data from Electric Power Board of Chattanooga, TN, Horry Electric (SC), and City of Tallahassee, FL

AMI data from Seattle City Light, WA

AMI data from Fort Collins municipal service territory (CO)



Annual electric sales of all utilities in U.S.

Annual and monthly electricity and natural gas consumption by state, sector

Annual end-use loads of occupied dwelling units
- Building type
- Climate zone
- Fuel (electricity, natural gas, propane, fuel oil)

Sub-metered end-use load data (5 datasets)

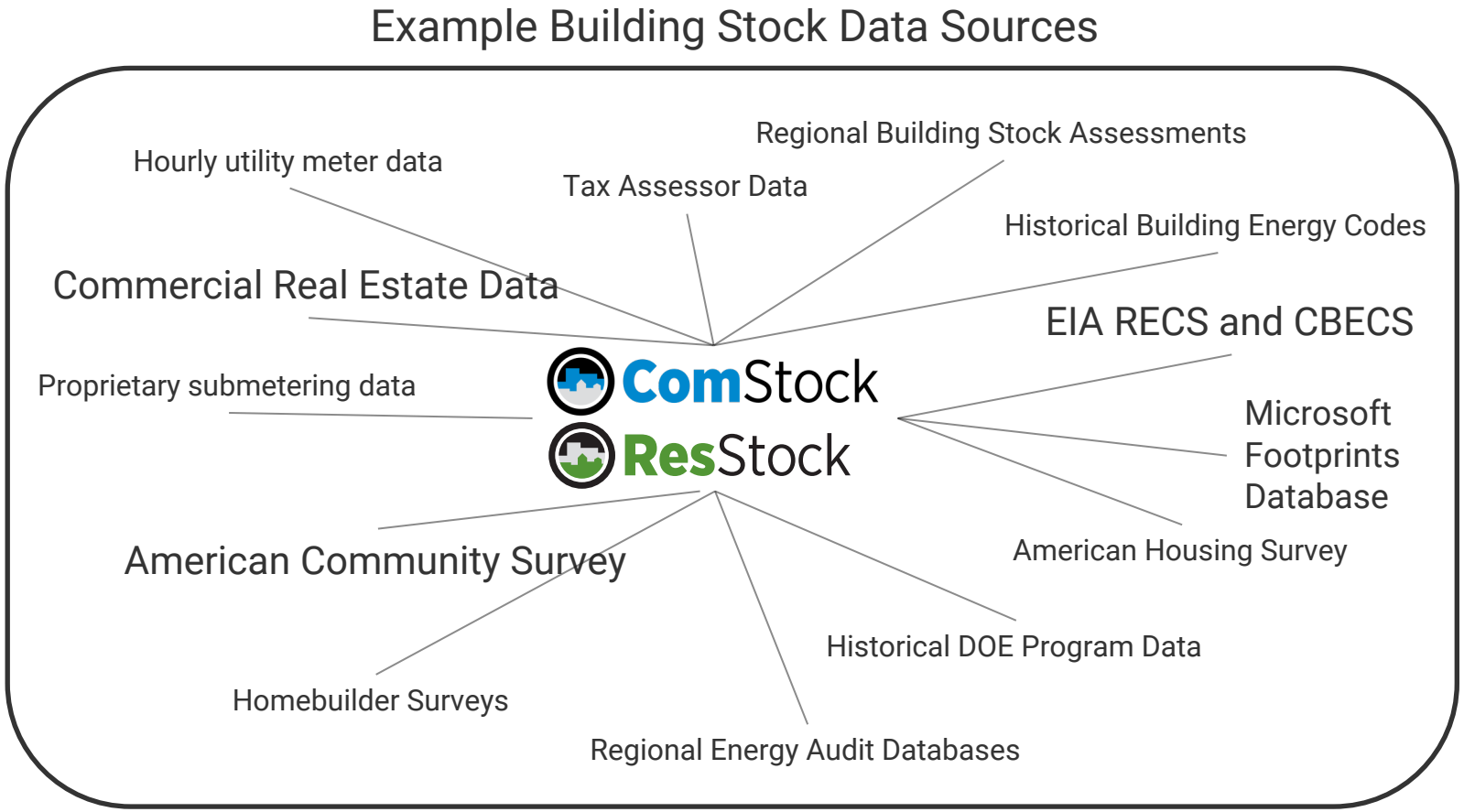
Hourly residential sector load profiles for 16 utilities around U.S.

Advanced metering infrastructure (AMI) data from ComEd service territory (IL)

Calibration
70+ model improvements, supported by building stock data

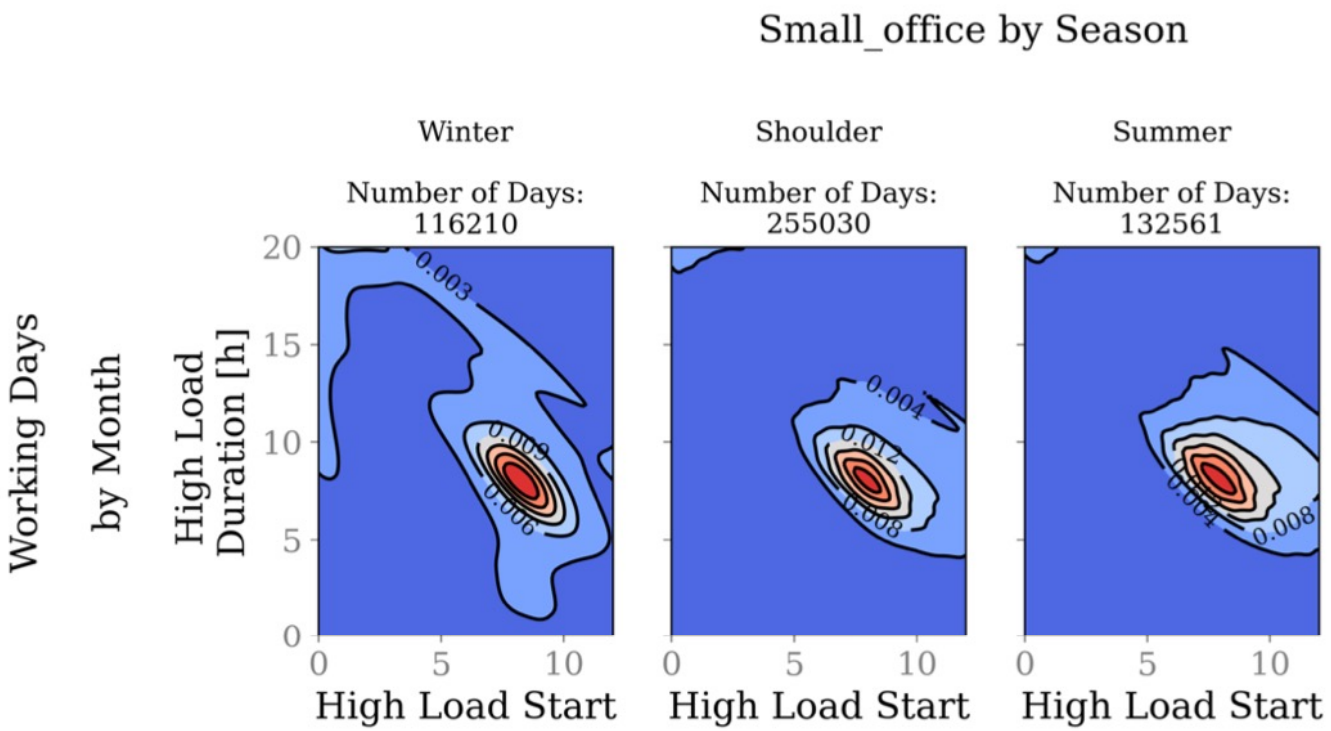
Calibration

- Not automated tuning to minimize error
- Found and analyzed stock data with increased accuracy, diversity, or resolution
- All model updates will be thoroughly documented in forthcoming report



Calibration
Example Improvement – Commercial

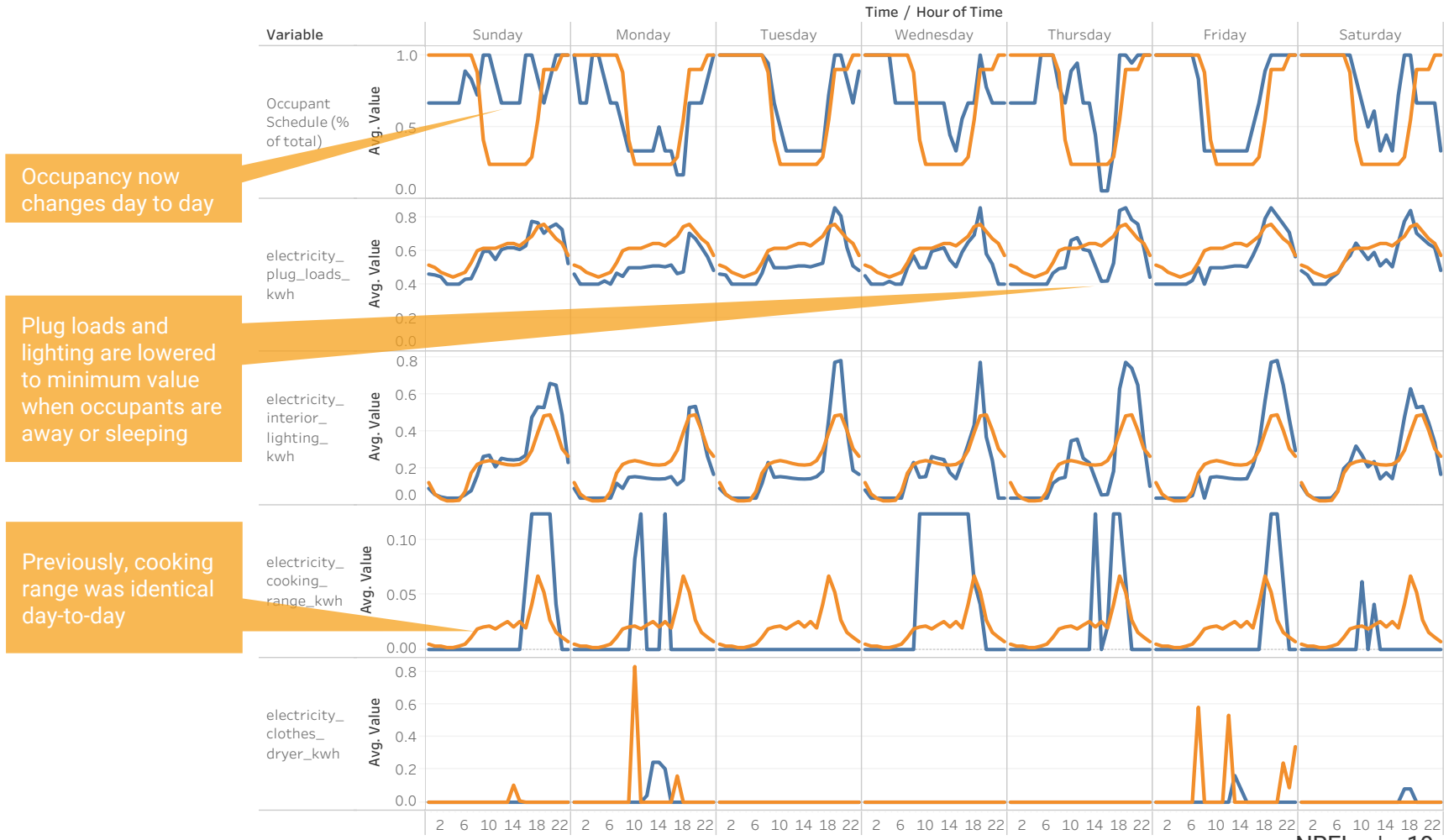
- Extracted probability distributions for commercial building **hours of operation** from seven datasets of meter data
- For example, most small office buildings start operation of lights, HVAC, etc. between 7 am and 11 am and the operation lasts 5–10 hours:



Calibration
Example Improvement – Residential

- Developed new occupant behavior model
- Uses 24-hour activity logs from 55,000 people (American Time Use Survey)
- Validated against sub-metered end-use data

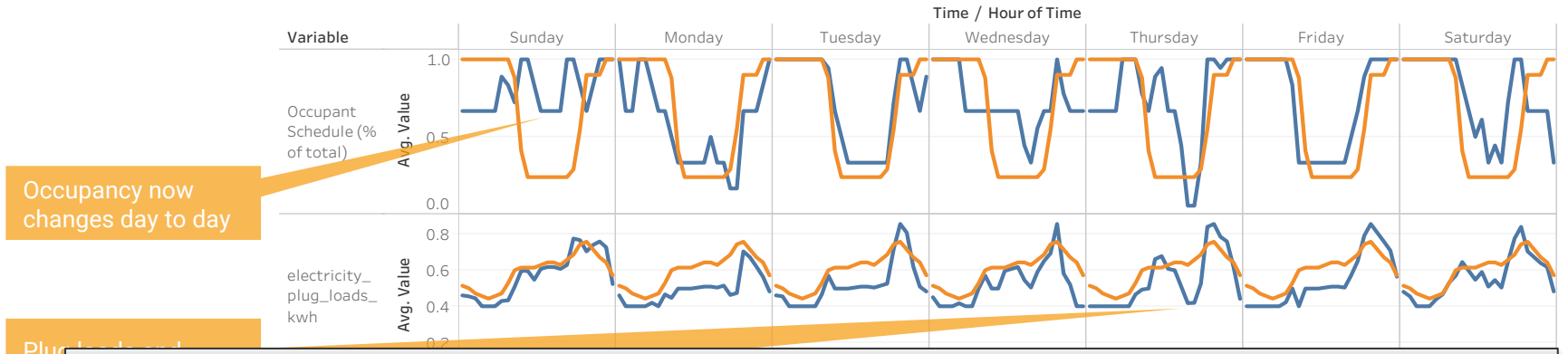
Example Before and After for a typical week in one household

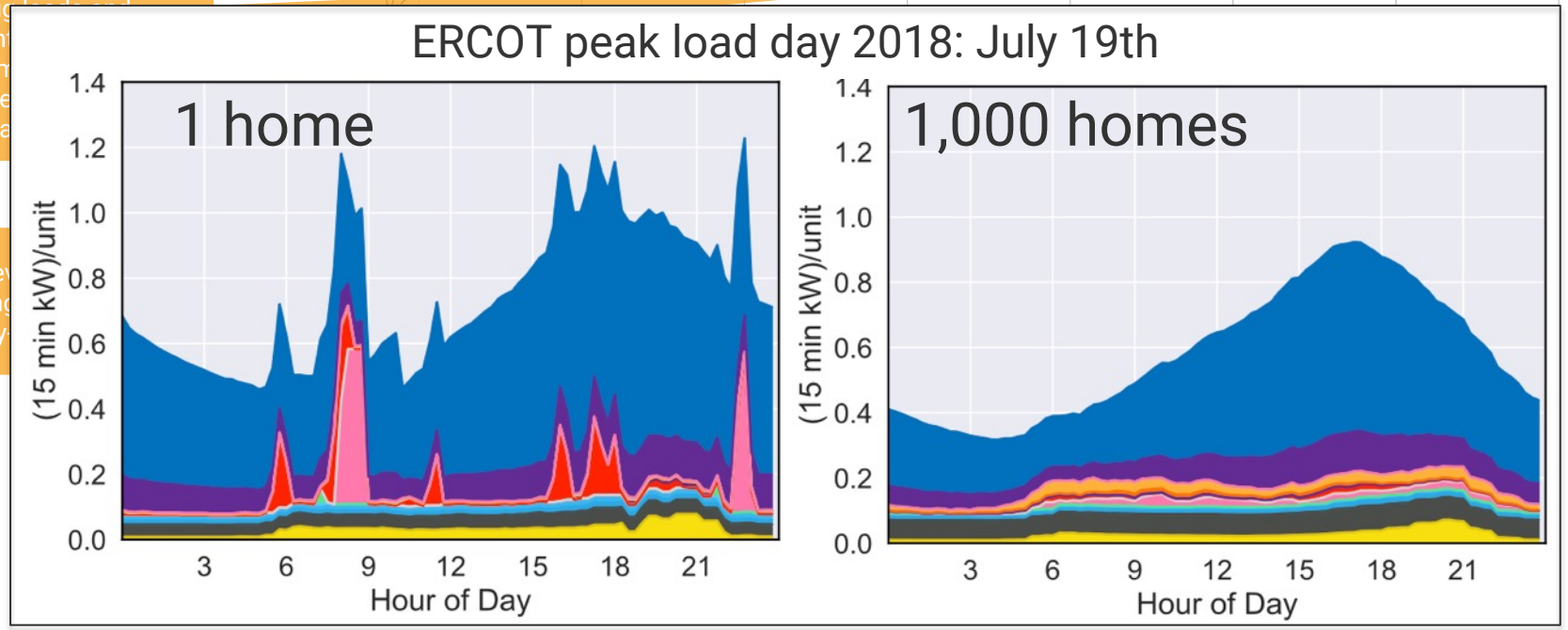


Calibration
Example Improvement – Residential

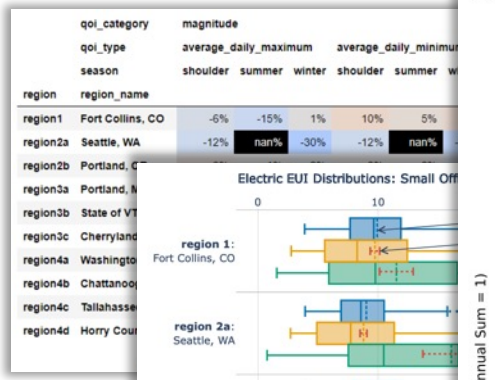
- Developed new occupant behavior model
- Uses 24-hour activity logs from 55,000 people (American Time Use Survey)
- Validated against sub-metered end-use data
- Captures more realistic individual household behavior, and how that diversity smooths out in aggregate

Example Before and After for a typical week in one household

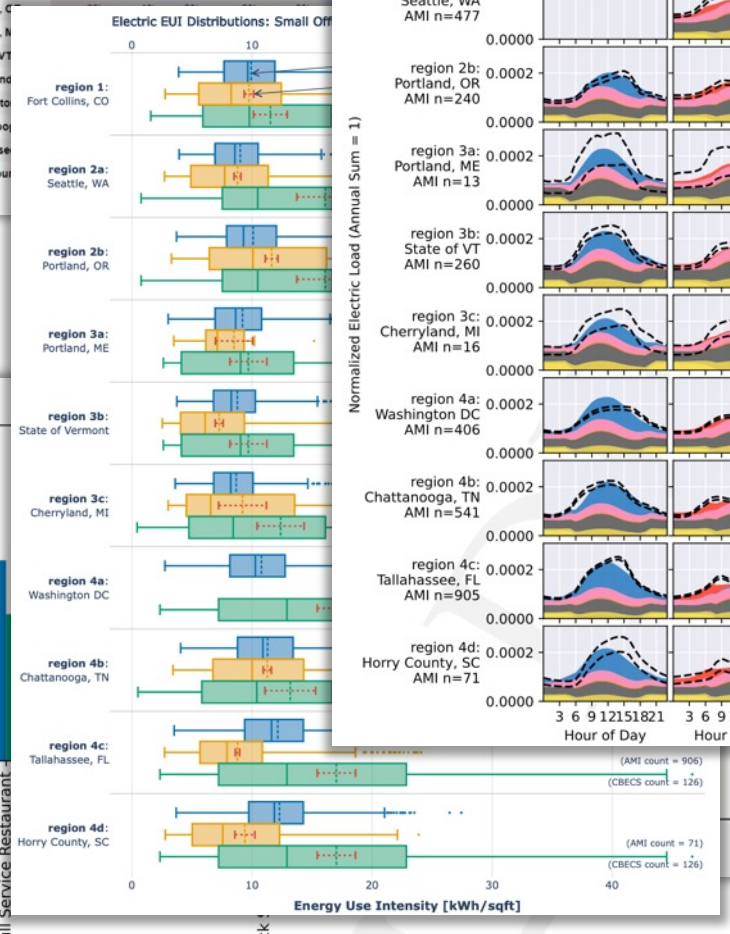


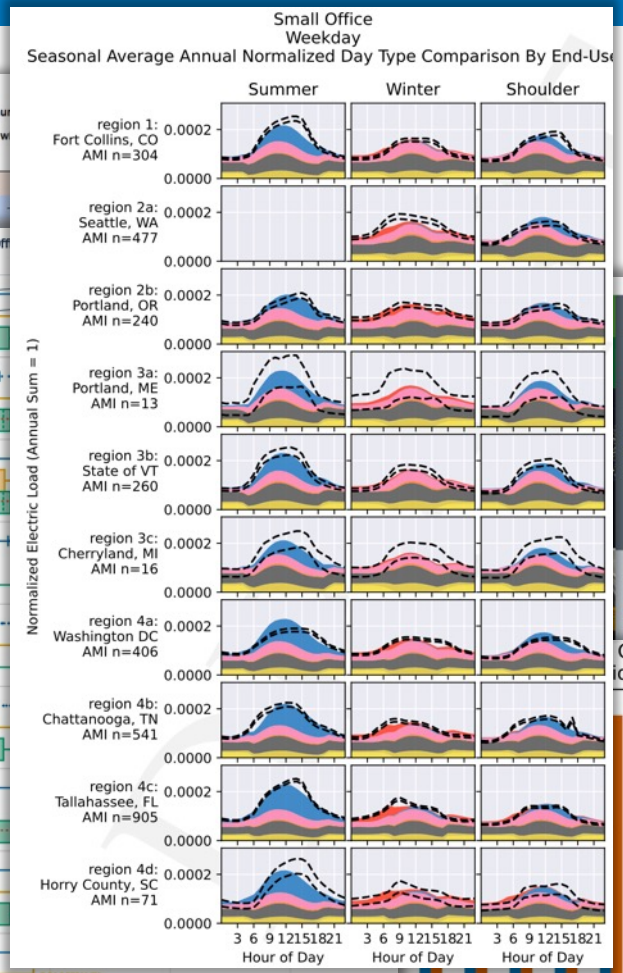


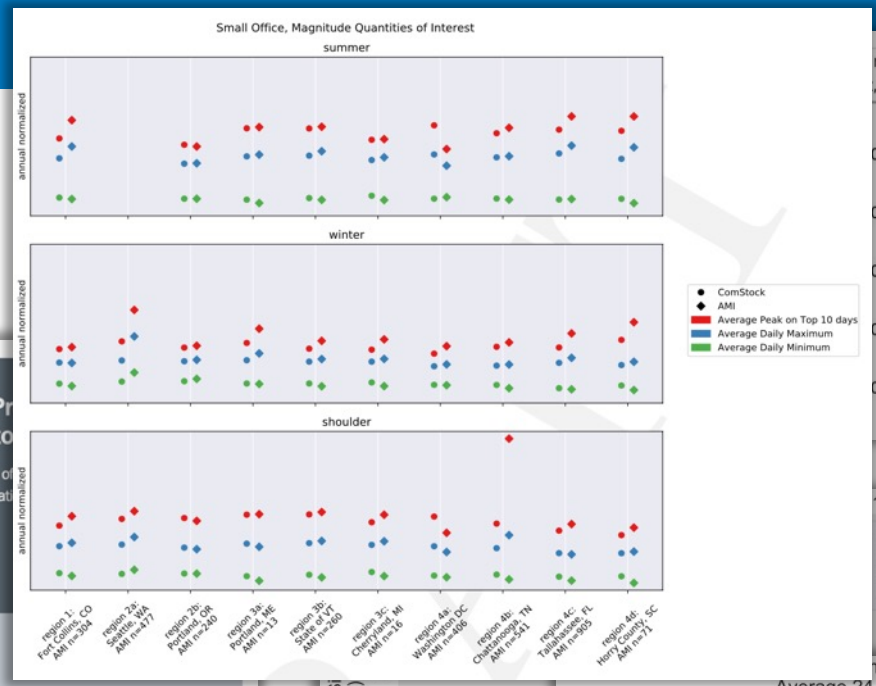
Published accuracy and uncertainty metrics to inform user confidence (report coming this winter)

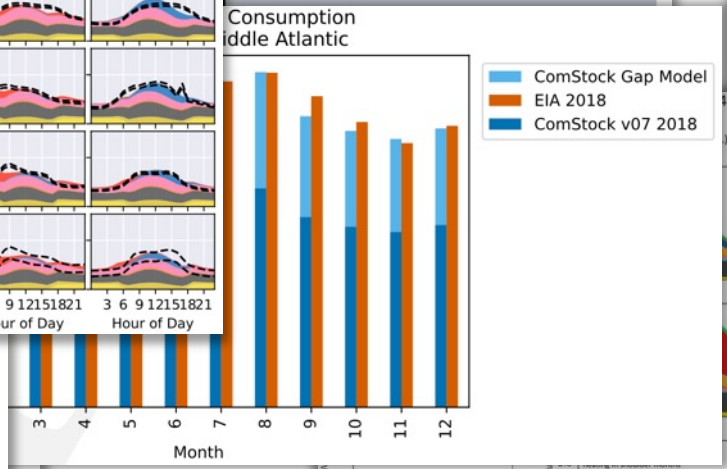


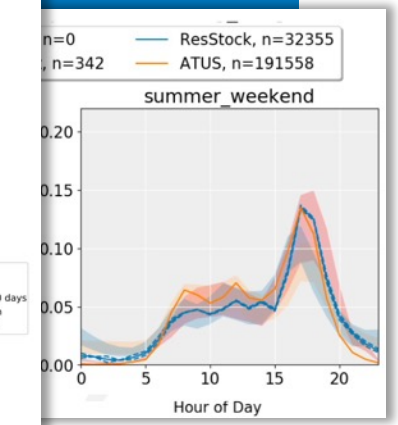
region	region_name	qoi_category	magnitude					
		qoi_type	average_daily_maximum			average_daily_minimum		
		season	shoulder	summer	winter	shoulder	summer	w
region1	Fort Collins, CO		-6%	-15%	1%	10%	5%	
region2a	Seattle, WA		-12%	nan%	-30%	-12%	nan%	
region2b	Portland, OR							
region3a	Portland, ME							
region3b	State of VT							
region3c	Cherryland							
region4a	Washington							
region4b	Chattanoog							
region4c	Tallahasse							
region4d	Horry Cou							

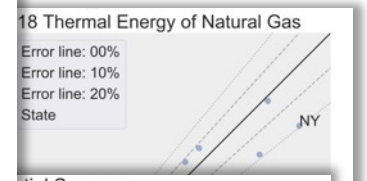


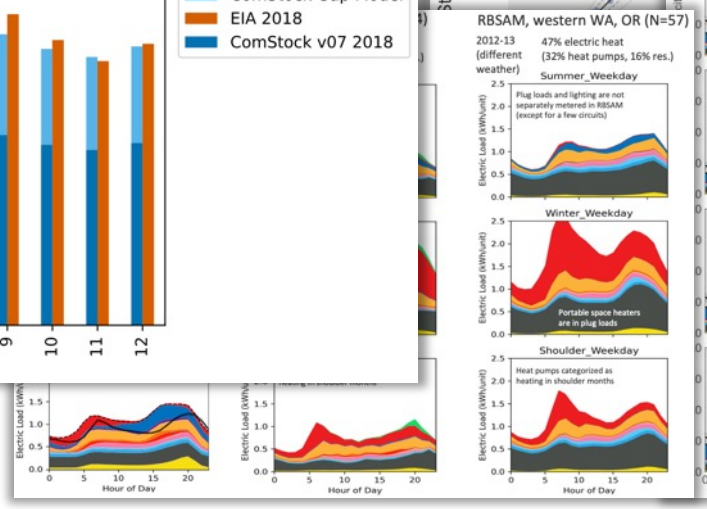


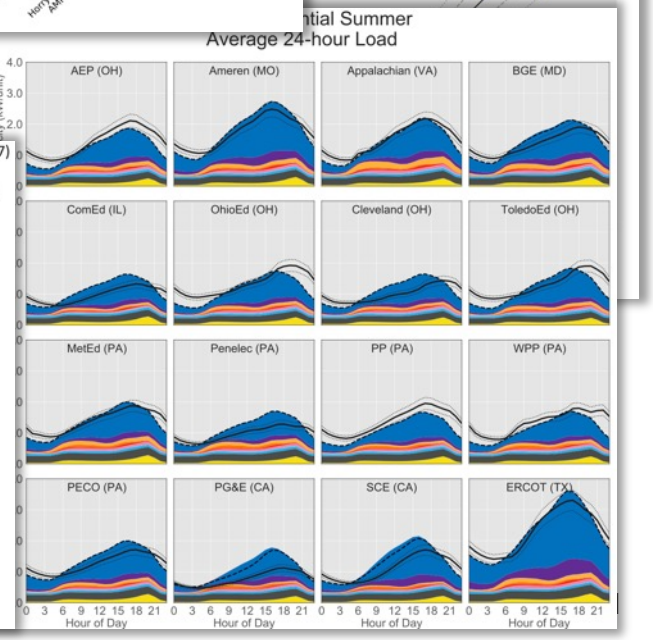




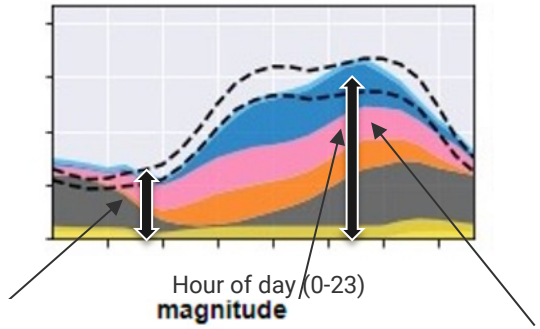








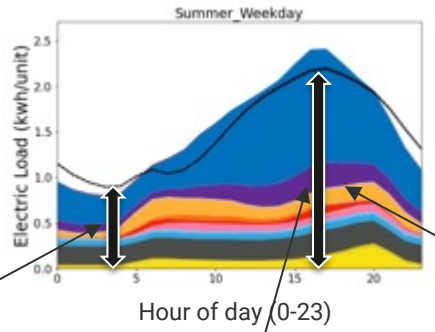
Example reporting of final model errors for quantities of interest
Commercial meter data



	qoi_category	magnitude								
	qoi_type	average_daily_minimum			average_daily_maximum			top10_peak_maximum		
	season	shoulder	summer	winter	shoulder	summer	winter	shoulder	summer	winter
region	region_name									
region1	Fort Collins, CO	10%	5%	8%	-6%	-15%	1%	-11%	-17%	-3%
region2a	Seattle, WA	-12%	nan%	-21%	-12%	nan%	-30%	-8%	nan%	-30%
region2b	Portland, OR	0%	0%	-6%	3%	-1%	-2%	3%	2%	-3%
region3a	Portland, ME	21%	13%	1%	6%	-2%	-11%	-1%	-1%	-16%
region3b	State of VT	10%	6%	10%	-4%	-6%	-5%	-3%	-2%	-11%
region3c	Cherryland, MI	15%	15%	13%	-6%	-4%	-5%	-9%	-1%	-14%
region4a	Washington DC	6%	-5%	1%	11%	18%	-4%	23%	30%	-11%
region4b	Chattanooga, TN	21%	4%	12%	-19%	-2%	-2%	-52%	-5%	-6%
region4c	Tallahassee, FL	18%	-2%	4%	3%	-9%	-9%	-8%	-12%	-17%
region4d	Horry County, SC	34%	17%	18%	-3%	-14%	-6%	-10%	-13%	-19%

Normalized shape QOI errors for small office buildings

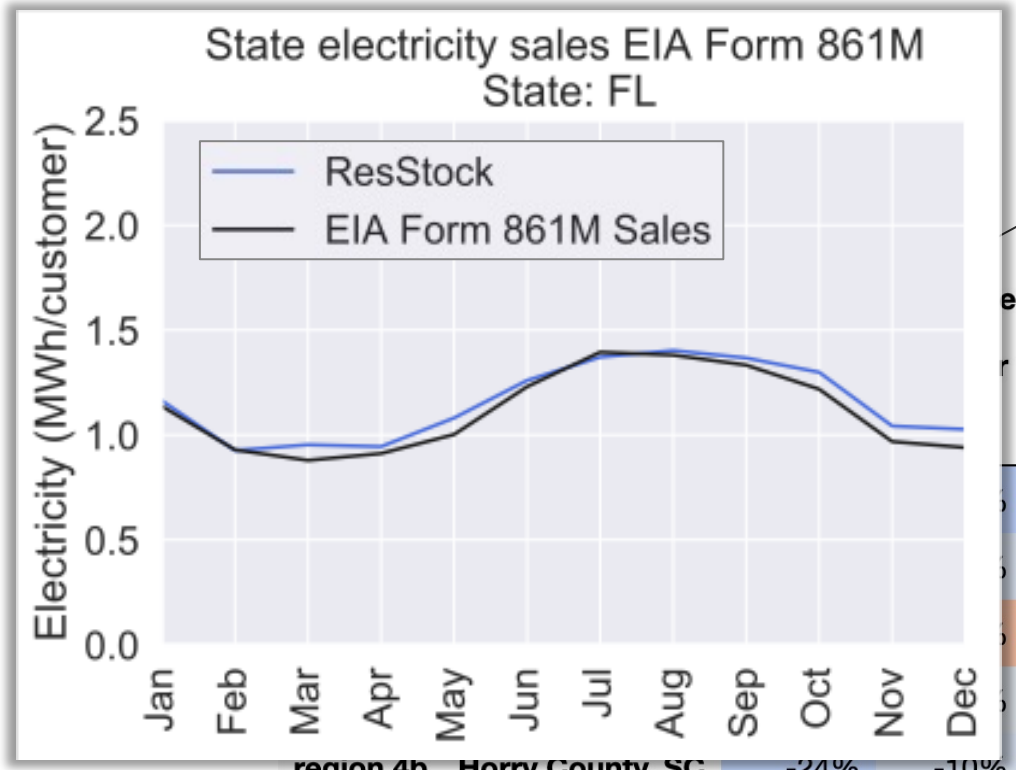
Example reporting of final model errors for quantities of interest
Residential meter data

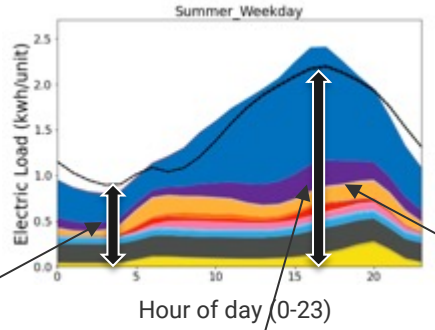


	qoi_category	magnitude								
	qoi_type	average_daily_base			average_daily_peak			top_10_average_daily_peak		
	season	shoulder	summer	winter	shoulder	summer	winter	shoulder	summer	winter
region	region_name									
region 1	ComEd, IL	-29%	-27%	-30%	-1%	7%	-11%	4%	1%	-18%
region 2	Fort Collins, CO	-2%	-9%	-4%	24%	38%	4%	33%	17%	10%
region 3	Seattle, WA	29%	35%	6%	46%	61%	8%	35%	57%	3%
region 4a	Chattanooga, TN	-11%	-4%	-16%	32%	25%	7%	47%	24%	19%
region 4b	Horry County, SC	-24%	-10%	-27%	-11%	-7%	-18%	-10%	-7%	-14%
region 4c	Tallahassee, FL	-2%	-8%	7%	41%	24%	62%	81%	24%	128%
region 5a	Cherryland, MI	-24%	-34%	-26%	-11%	0%	-16%	-9%	6%	-22%
region 5b	State of VT	-13%	-20%	-19%	1%	16%	-4%	0%	8%	-4%

Magnitude QOI errors for whole residential sector

Example reporting of final model errors for quantities of interest
Residential meter data

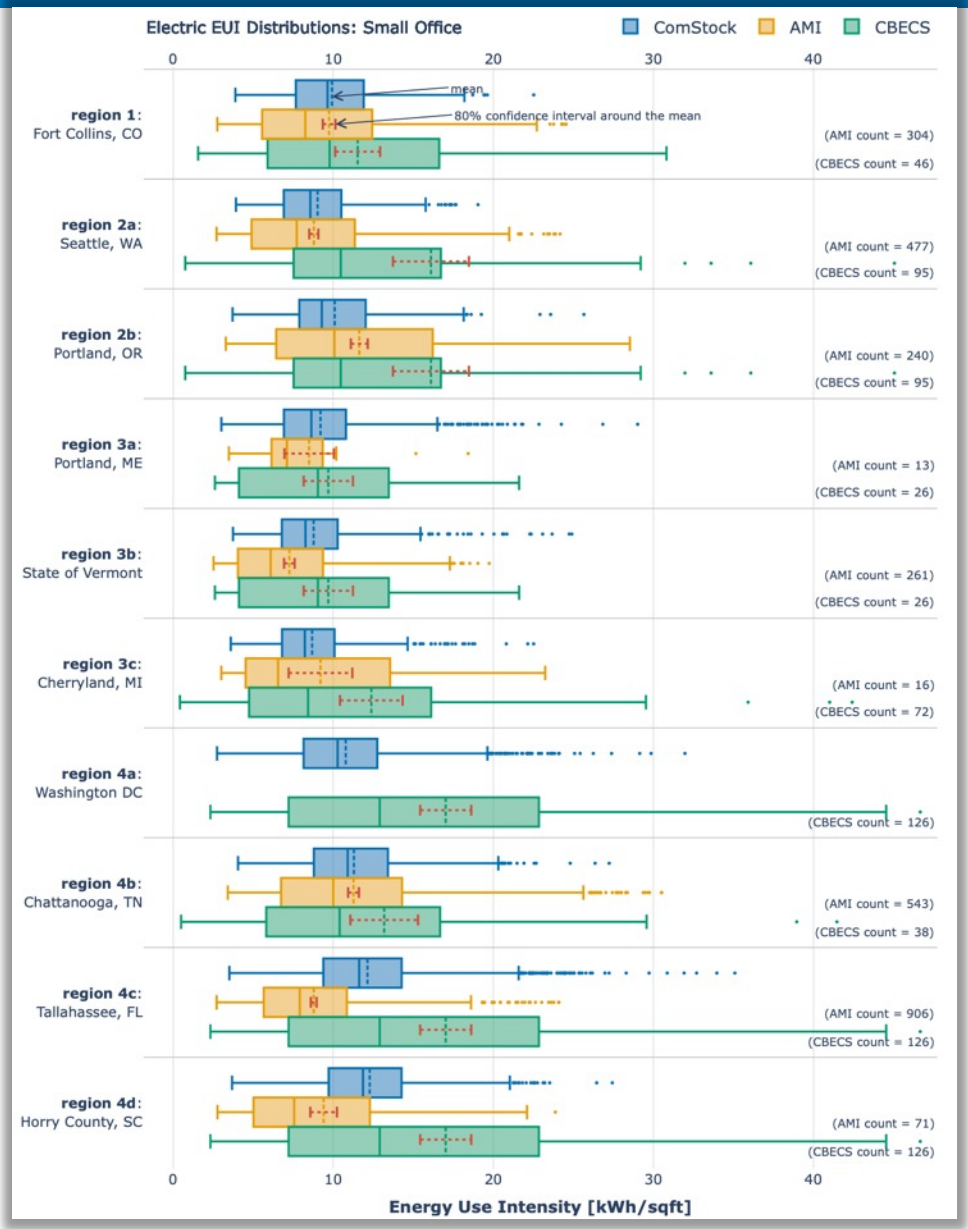


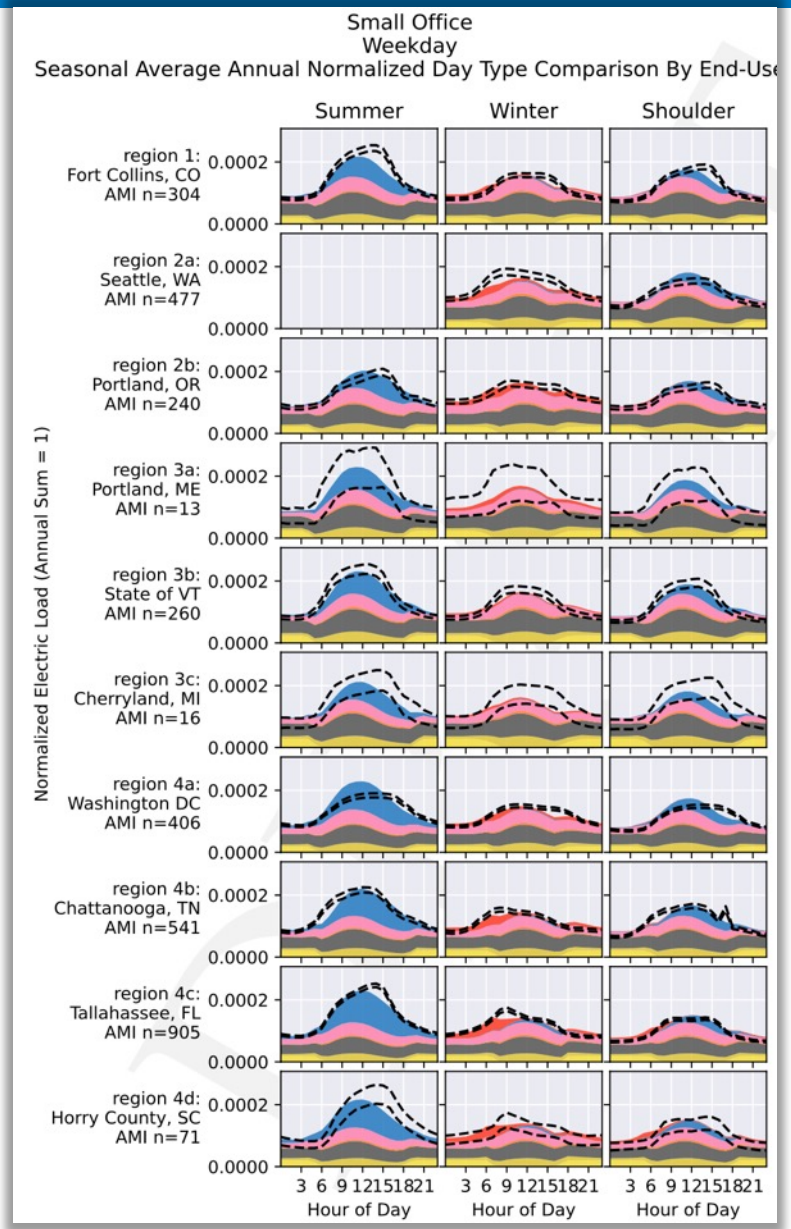


					average_daily_peak			top_10_average_daily_peak			
				winter	shoulder	summer	winter	shoulder	summer	winter
				-30%	-1%	7%	-11%	4%	1%	-18%
				-4%	24%	38%	4%	33%	17%	10%
				6%	46%	61%	8%	35%	57%	3%
				-16%	32%	25%	7%	47%	24%	19%
region 4b	Horry County, SC	-24%	-10%	-27%	-11%	-7%	-18%	-10%	-7%	-14%
region 4c	Tallahassee, FL	-2%	-8%	7%	41%	24%	62%	81%	24%	128%
region 5a	Cherryland, MI	-24%	-34%	-26%	-11%	0%	-16%	-9%	6%	-22%
region 5b	State of VT	-13%	-20%	-19%	1%	16%	-4%	0%	8%	-4%

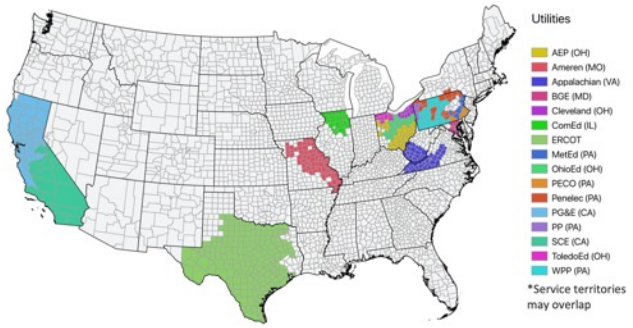
Magnitude QOI errors for whole residential sector

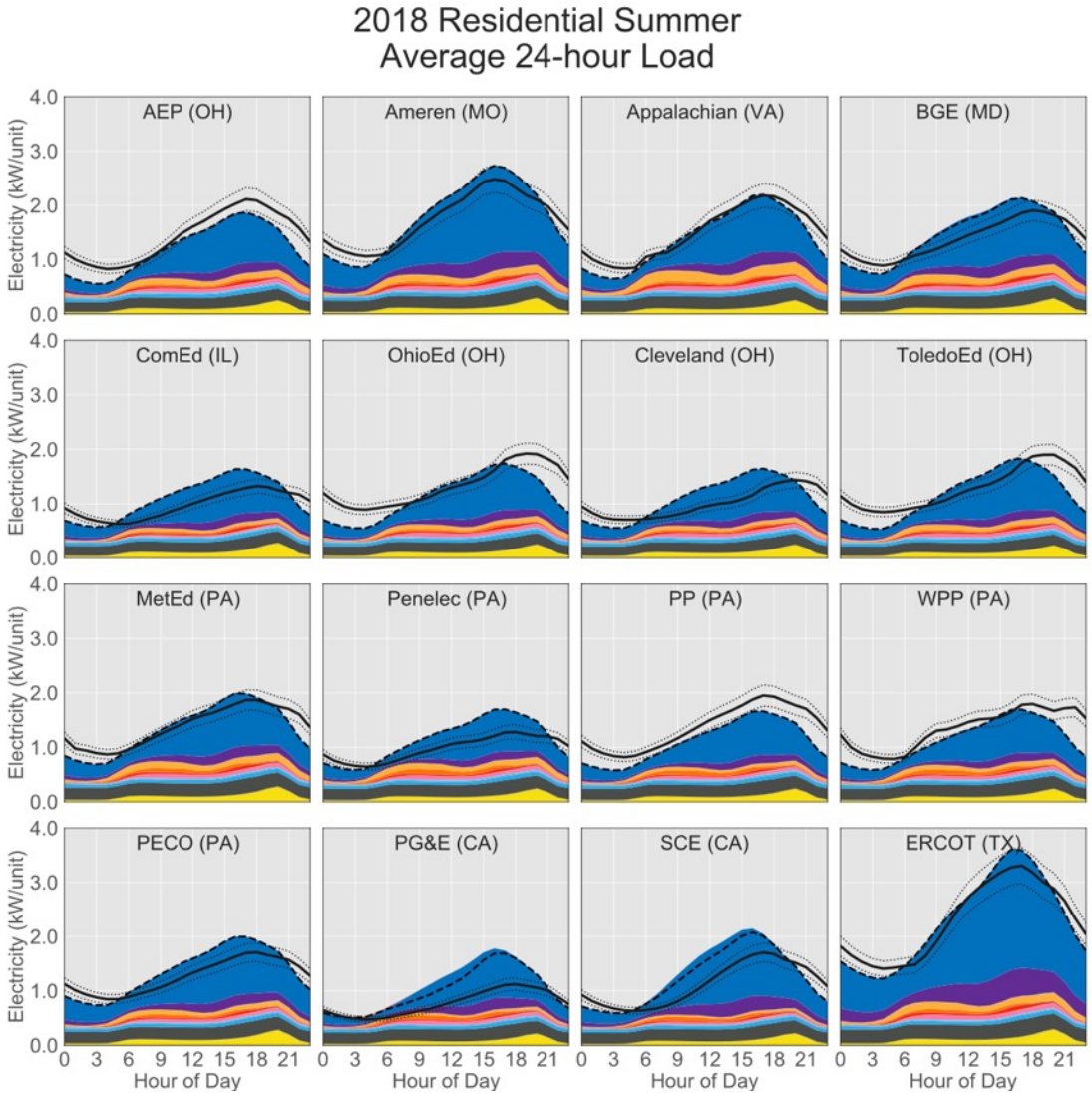
Example validation comparisons
Commercial meter data

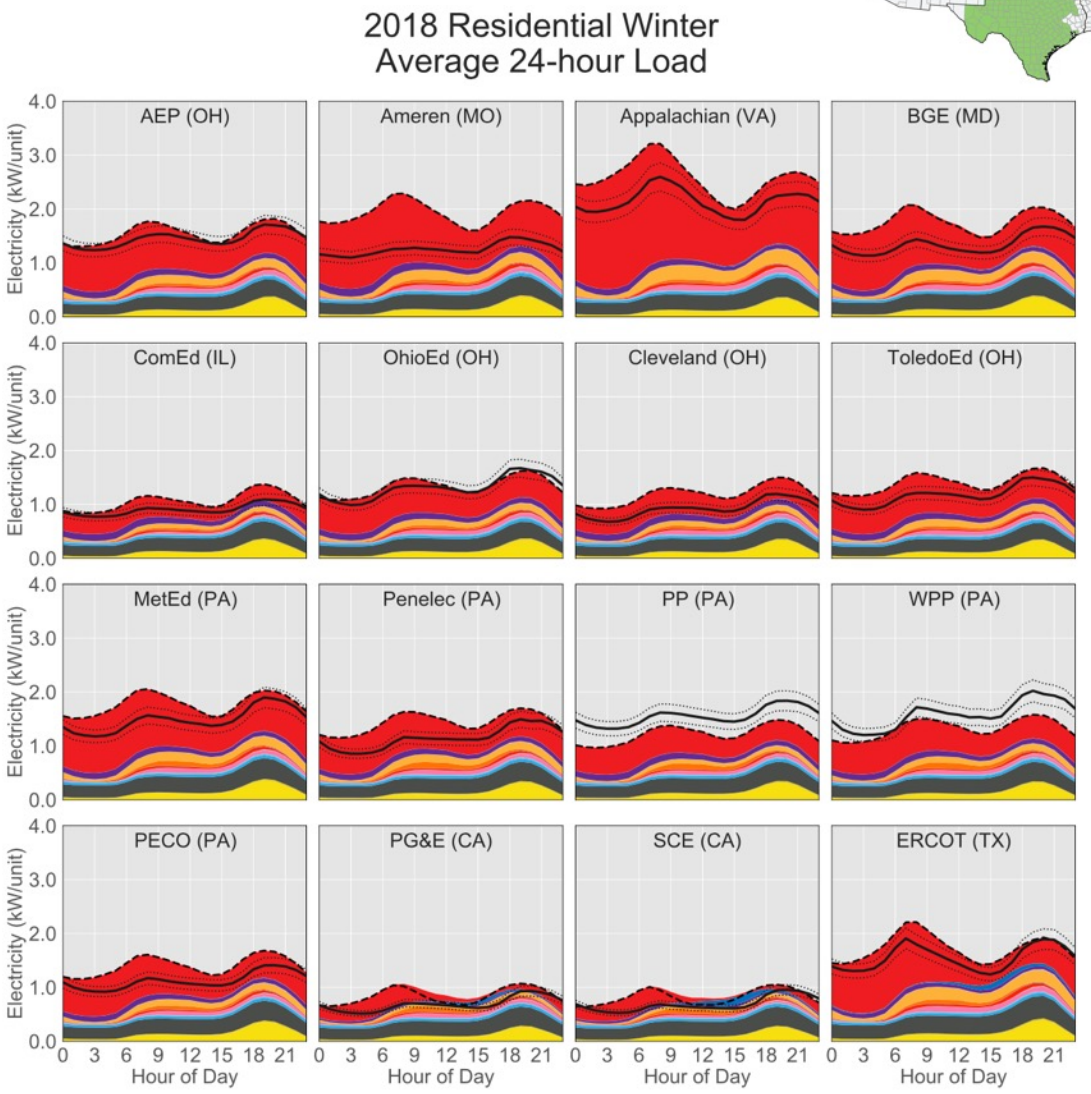


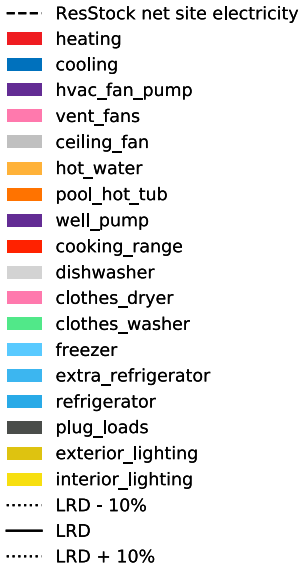


Example validation comparisons
Residential meter data







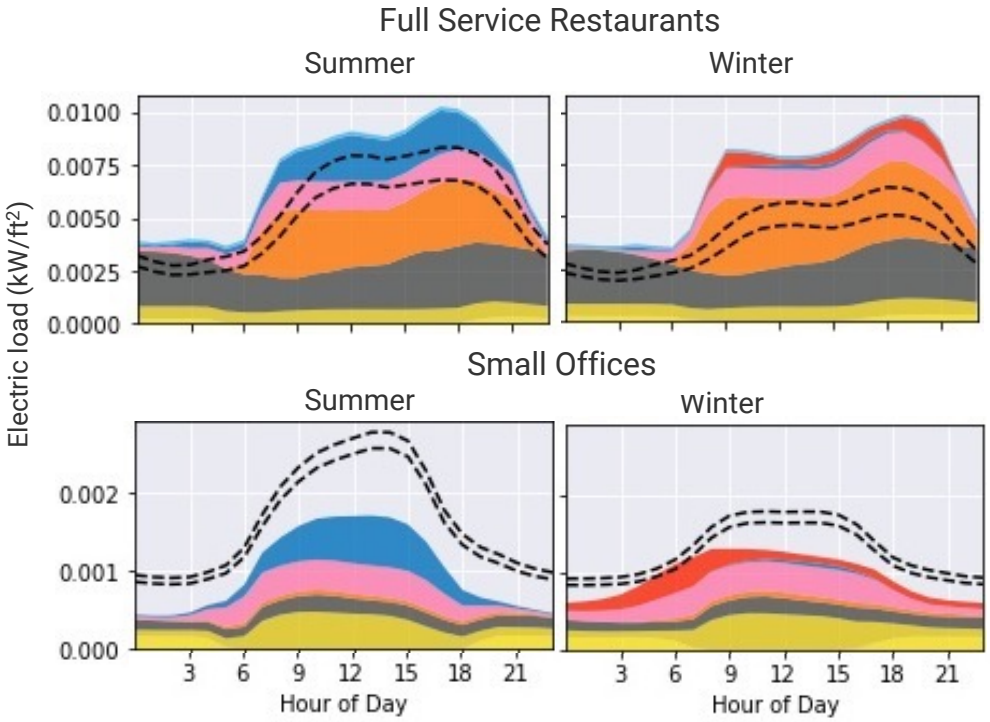


How much did accuracy improve?

Commercial Example:

Avg. Weekday, Fort Collins, CO

Before



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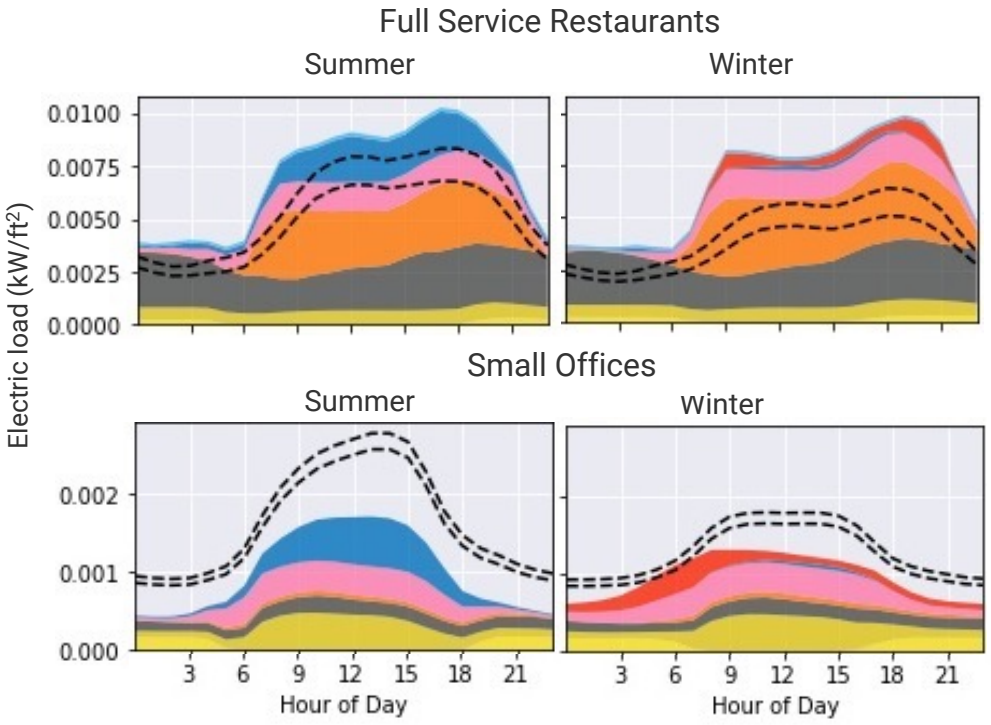
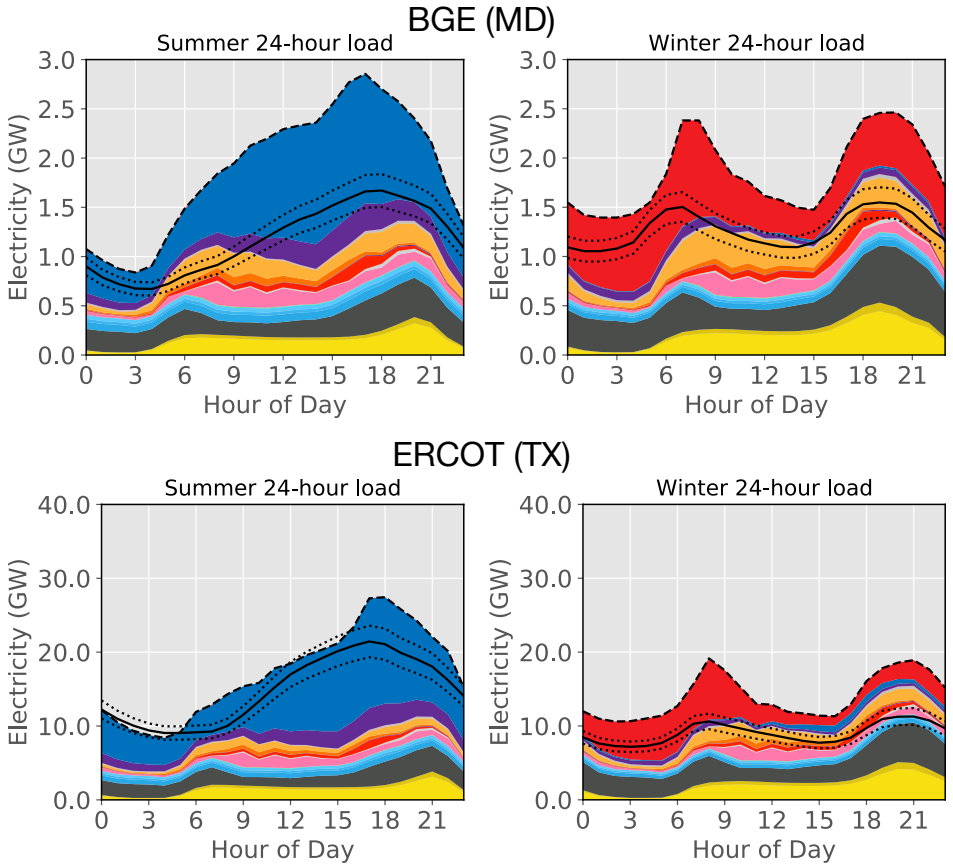


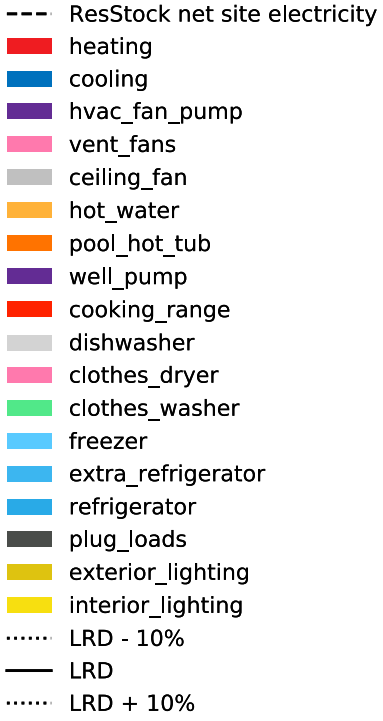
After

How much did accuracy improve?

Residential Example:

Before
(2012 data)

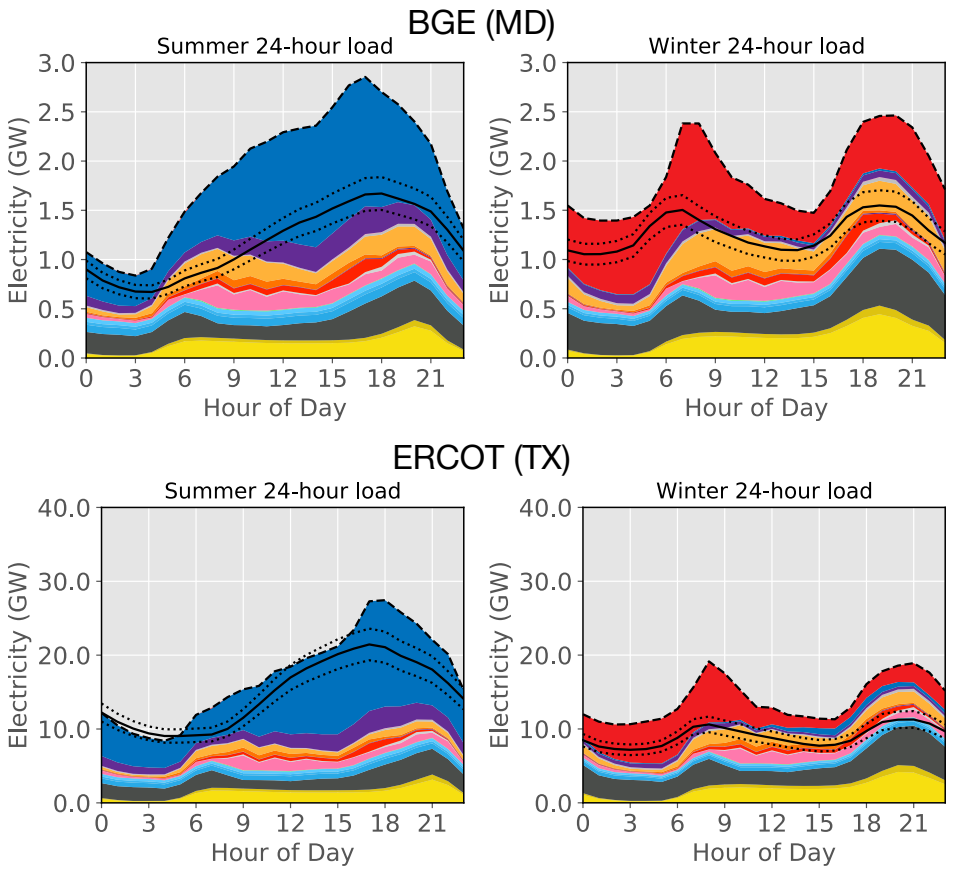




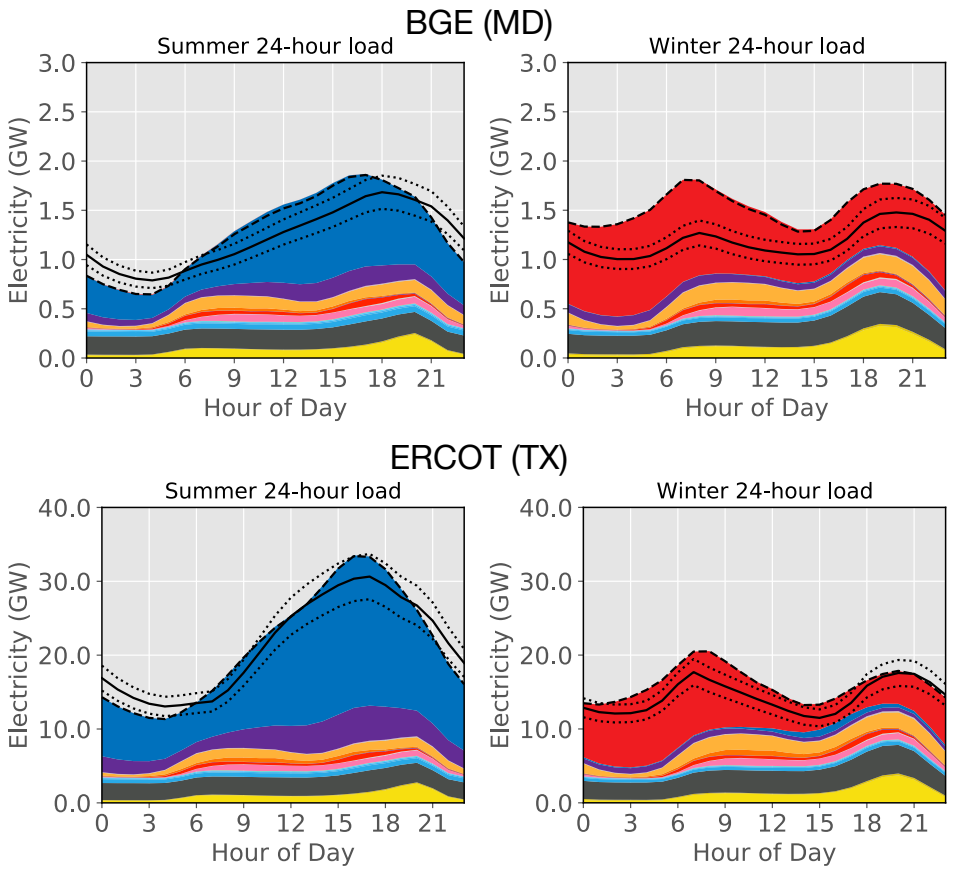
How much did accuracy improve?

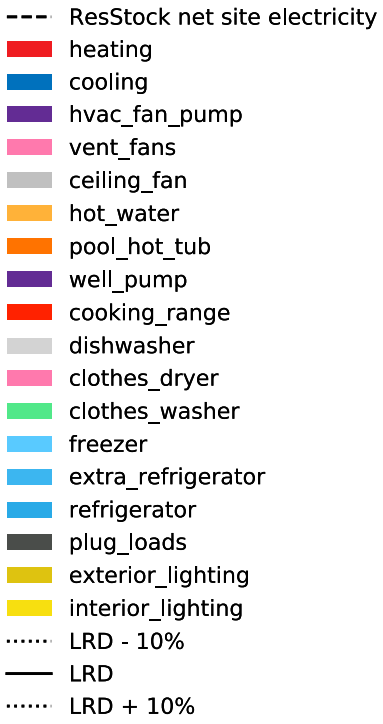
Residential Example:

Before
(2012 data)



After
(2018 data)

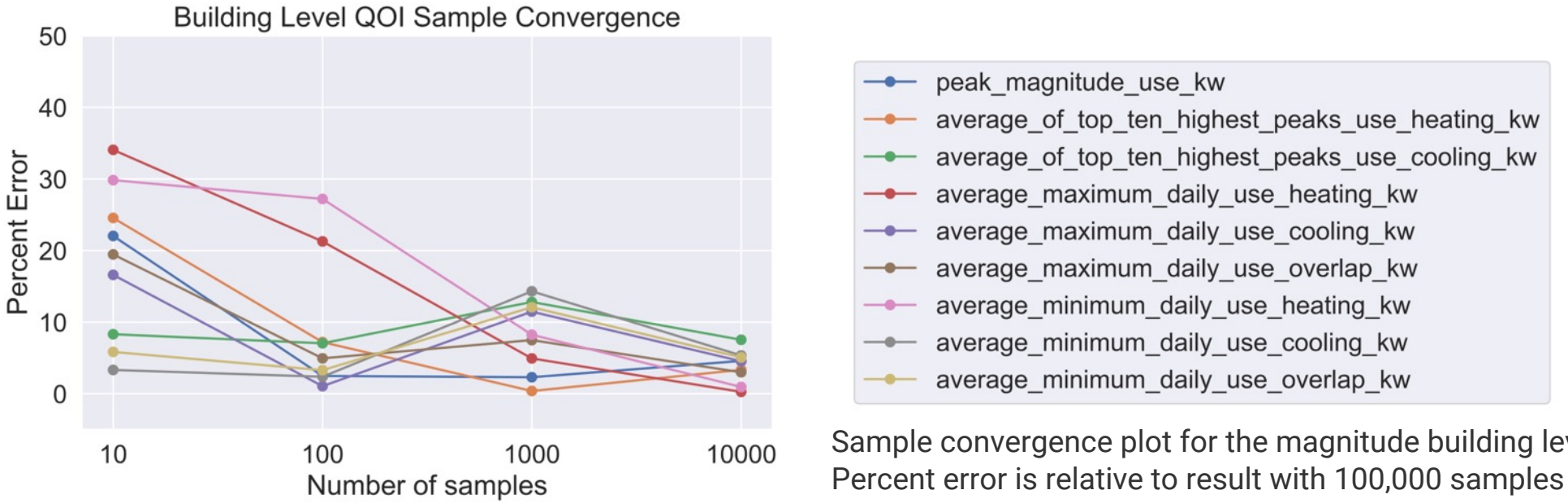




How much uncertainty is there in the results?

- Developed and applied a first-of-its-kind approach to quantifying uncertainty in building stock models
- Used machine learning surrogate models to evaluate millions of permutations of model inputs in order to propagate input uncertainty ranges through to outputs; e.g.,
  - ResStock: 5–12% uncertainty in peak magnitude
  - ComStock: 4–11% uncertainty in peak magnitude

- Uncertainty due to sampling is in the 0–15% range for quantities of interest (higher in smaller aggregations using <1,000 models)

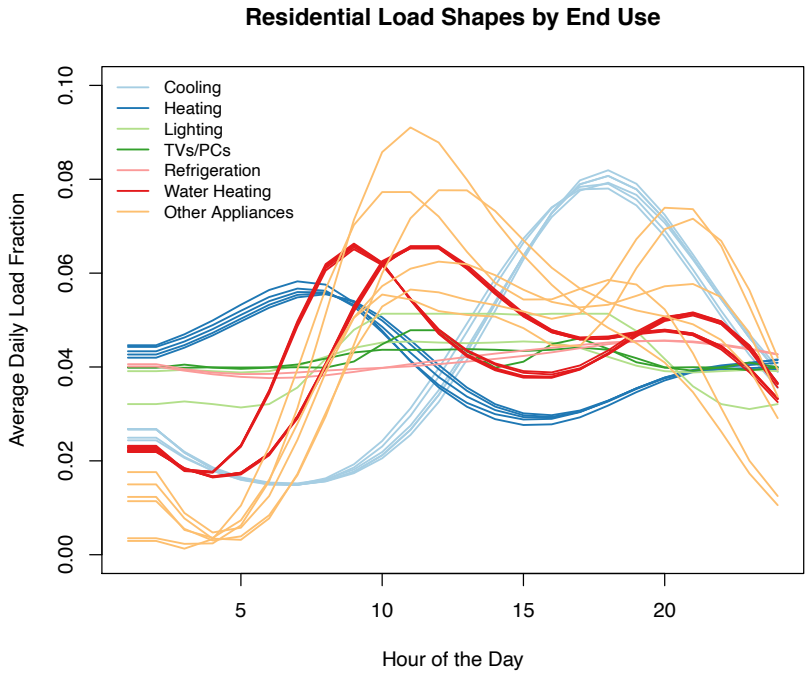


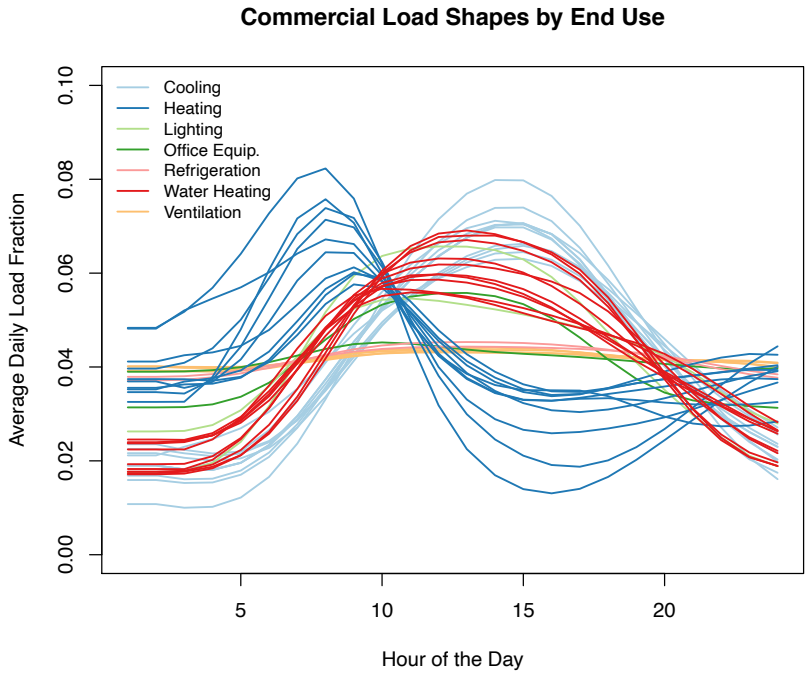
Sample convergence plot for the magnitude building level QOIs
Percent error is relative to result with 100,000 samples

How do the results compare to previously available national data?

EPRI Load Shape Library – End Use

- Collected from a range of sources dating back to 2000
- "Users should treat the LSL data as a sample reference. Confidence and precision levels of the data are unknown."
- Shapes, not magnitudes
- 24-hours for 6 day types





Source data: http://loadshape.epri.com/enduse

How do the results compare to previously available national data?

“Commercial and Residential Hourly Load Profiles for all TMY3 Locations in the United States” on OpenEI.org

- From a 10-year-old solar energy analysis
- Widely used by industry and academia (368 citations)
- Commercial: 16 ASHRAE 90.1-2004 EnergyPlus Prototype Models simulated in all TMY3 locations
- Residential: 3 IECC 2009 EnergyPlus models simulated in all TMY3 locations

Both OpenEI.org datasets

- Represent just one construction vintage
- Lack diversity in characteristics and operation (e.g., no electric space heating outside of Hot-Humid, no AC in all marine climates)
- Individual building profiles; can’t be used to understand aggregate load impacts

How to access the dataset

Visit the Project Website for…

nrel.gov/buildings/end-use-load-profiles.html

Dataset Access

At the most fundamental level, this dataset is the output of approximately 900,000 (550,000 ResStock plus 350,000 ComStock) building energy models. The output of each building energy model is 1 year of energy consumption in 15-minute intervals, separated into end-use categories. The dataset has also been formatted to be accessible in three ways—via pre-aggregated load profiles in downloadable spreadsheets, a web viewer, and a detailed format that can be queried with big data tools—to meet the needs of many different users and use cases.

- ⊕ Pre-Aggregated Load Profiles in Downloadable Spreadsheets
- ⊕ Web Data Viewers
- ⊕ Full Dataset of Individual Building/Dwelling Unit Load Profiles
- ⊕ Building Energy Models

Technical Advisory Group

A technical advisory group guided the dataset development to ensure that the direction and outcomes of the work were aligned with market needs. The technical advisory group included roughly 100 representatives from organizations that were likely to use the resulting load profiles in their work, including utility companies, utility program implementers, grid operators, consultancies, research centers, state regulatory agencies, and regional energy efficiency organizations.

Technical advisory group presentations are available for the dates below:

Sept. 20, 2021
April 21, 2021
Jan. 28, 2021
Sept. 22, 2020
May 26, 2020
March 5, 2020
Dec. 17, 2019
June 18, 2019
March 5, 2019
Nov. 27, 2018

Frequently Asked Questions

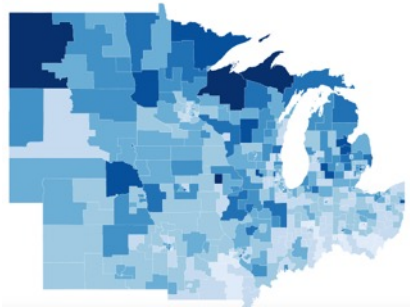
- ⊕ Are these load profiles measured or simulated?
- ⊕ What do the end-use categories mean?
- ⊕ How are the residential and commercial building types defined?
- ⊕ What year do the profiles represent?
- ⊕ What day of the week do the profiles start on?
- ⊕ What if I want other weather years?
- ⊕ Can I use the profiles as load savings shapes (i.e., time of saving energy)?
- ⊕ Can I use the profiles to analyze building electrification with heat pumps?
- ⊕ Do the profiles include the effects of COVID-19?
- ⊕ How do I know what weather data is associated with each profile?
- ⊕ Can I use just one profile for a location?
- ⊕ What is the difference between load shapes and load profiles?
- ⊕ Can you share the utility meter data that you used for calibration and validation?
- ⊕ Where does information on the building stock come from and how does it get assigned to each location?
- ⊕ How should I cite the dataset?

Pre-aggregated Load Profiles

Aggregate files | Web Viewer | Full database

Pre-aggregated EULPs by building type for:

- U.S. States (contiguous)
- ASHRAE Climate Zones
- DOE Building America Climate Zones
- Electric System ISOs
- U.S. Census Public Use Microdata Areas (PUMA)*
- U.S. Counties



Example of PUMA resolution
~200k people; ~2,400 in U.S.

Format:

- CSV files (for Excel, etc. ease of use)
- Two years: 2018 and TMY3 weather

Additional Data:

- Count of models included per aggregation
- List of model IDs per aggregation
- Model characteristics by ID

Access the dataset at: nrel.gov/buildings/end-use-load-profiles.html

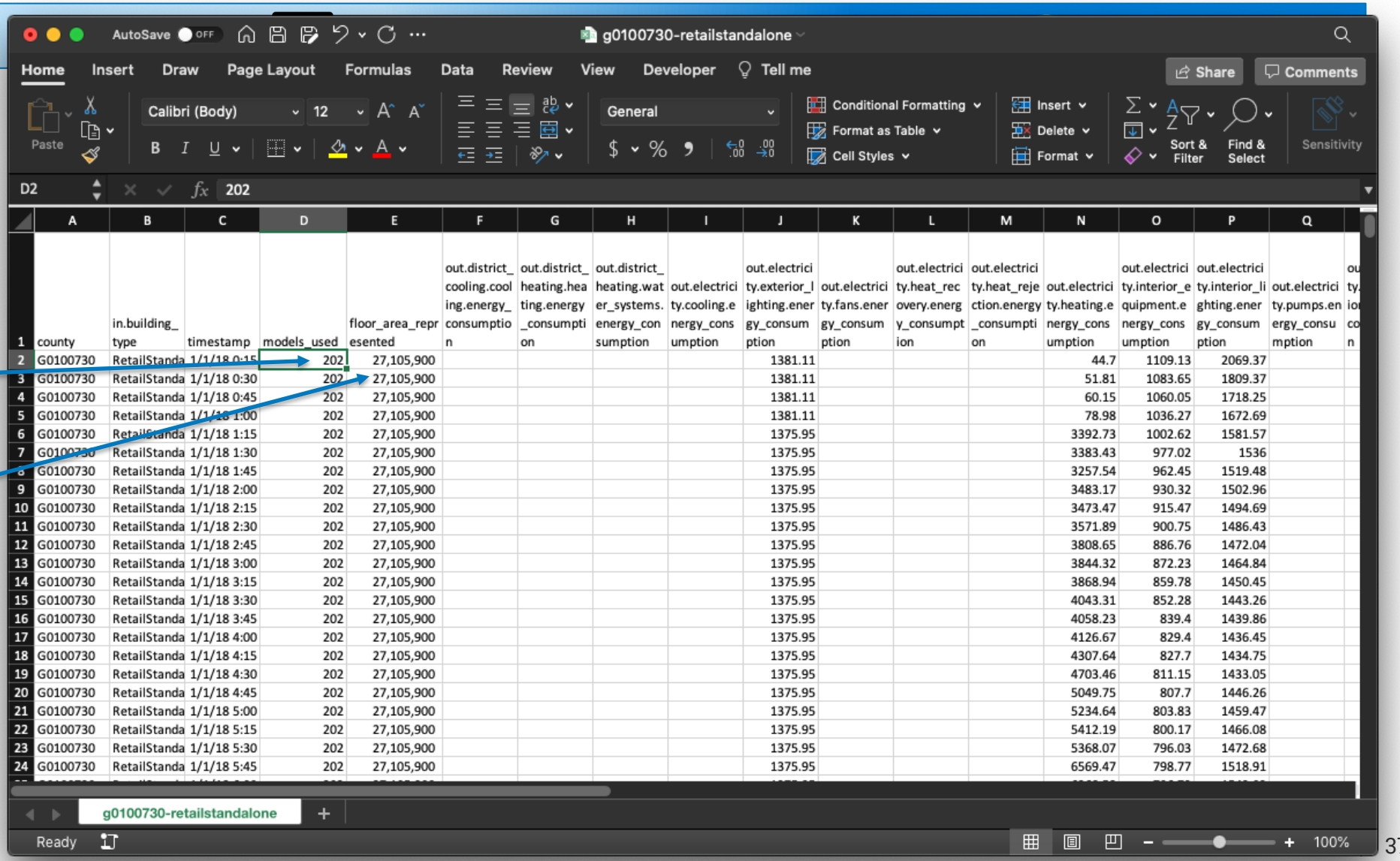
Pre-aggregated Load Profiles

Aggregate files

Example pre-aggregated file for Jefferson County, AL (Birmingham), retail buildings

Results based on 202 building energy models

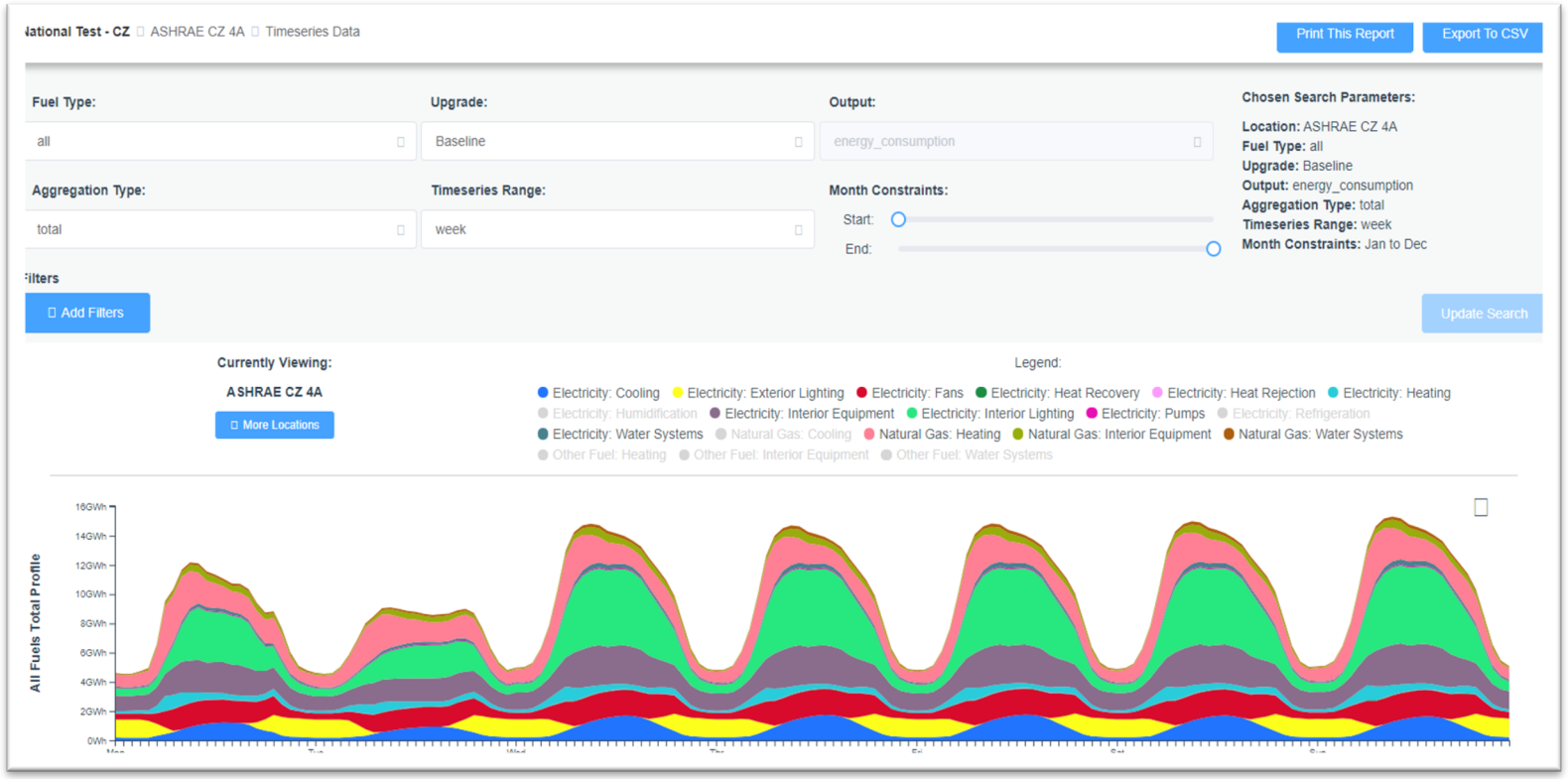
Results represent 27M ft^2 of retail space



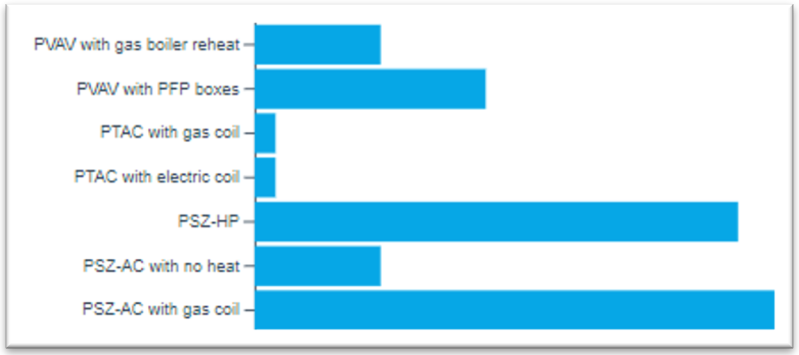
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	county	in.building_type	timestamp	models_used	floor_area_represented	out.district_cooling.cooling.energy_consumption	out.district_heating.heating.energy_consumption	out.district_heating.water_systems.energy_consumption	out.electricity.cooling.energy_consumption	out.electricity.exterior_lighting.energy_consumption	out.electricity.fans.energy_consumption	out.electricity.heat_recovery.energy_consumption	out.electricity.heat_rejection.energy_consumption	out.electricity.heating.energy_consumption	out.electricity.interior_equipment.energy_consumption	out.electricity.interior_lighting.energy_consumption	out.electricity.pumps.energy_consumption
2	G0100730	RetailStanda	1/1/18 0:15	202	27,105,900					1381.11				44.7	1109.13	2069.37	
3	G0100730	RetailStanda	1/1/18 0:30	202	27,105,900					1381.11				51.81	1083.65	1809.37	
4	G0100730	RetailStanda	1/1/18 0:45	202	27,105,900					1381.11				60.15	1060.05	1718.25	
5	G0100730	RetailStanda	1/1/18 1:00	202	27,105,900					1381.11				78.98	1036.27	1672.69	
6	G0100730	RetailStanda	1/1/18 1:15	202	27,105,900					1375.95				3392.73	1002.62	1581.57	
7	G0100730	RetailStanda	1/1/18 1:30	202	27,105,900					1375.95				3383.43	977.02	1536	
8	G0100730	RetailStanda	1/1/18 1:45	202	27,105,900					1375.95				3257.54	962.45	1519.48	
9	G0100730	RetailStanda	1/1/18 2:00	202	27,105,900					1375.95				3483.17	930.32	1502.96	
10	G0100730	RetailStanda	1/1/18 2:15	202	27,105,900					1375.95				3473.47	915.47	1494.69	
11	G0100730	RetailStanda	1/1/18 2:30	202	27,105,900					1375.95				3571.89	900.75	1486.43	
12	G0100730	RetailStanda	1/1/18 2:45	202	27,105,900					1375.95				3808.65	886.76	1472.04	
13	G0100730	RetailStanda	1/1/18 3:00	202	27,105,900					1375.95				3844.32	872.23	1464.84	
14	G0100730	RetailStanda	1/1/18 3:15	202	27,105,900					1375.95				3868.94	859.78	1450.45	
15	G0100730	RetailStanda	1/1/18 3:30	202	27,105,900					1375.95				4043.31	852.28	1443.26	
16	G0100730	RetailStanda	1/1/18 3:45	202	27,105,900					1375.95				4058.23	839.4	1439.86	
17	G0100730	RetailStanda	1/1/18 4:00	202	27,105,900					1375.95				4126.67	829.4	1436.45	
18	G0100730	RetailStanda	1/1/18 4:15	202	27,105,900					1375.95				4307.64	827.7	1434.75	
19	G0100730	RetailStanda	1/1/18 4:30	202	27,105,900					1375.95				4703.46	811.15	1433.05	
20	G0100730	RetailStanda	1/1/18 4:45	202	27,105,900					1375.95				5049.75	807.7	1446.26	
21	G0100730	RetailStanda	1/1/18 5:00	202	27,105,900					1375.95				5234.64	803.83	1459.47	
22	G0100730	RetailStanda	1/1/18 5:15	202	27,105,900					1375.95				5412.19	800.17	1466.08	
23	G0100730	RetailStanda	1/1/18 5:30	202	27,105,900					1375.95				5368.07	796.03	1472.68	
24	G0100730	RetailStanda	1/1/18 5:45	202	27,105,900					1375.95				6569.47	798.77	1518.91	

Web Viewer (beta)

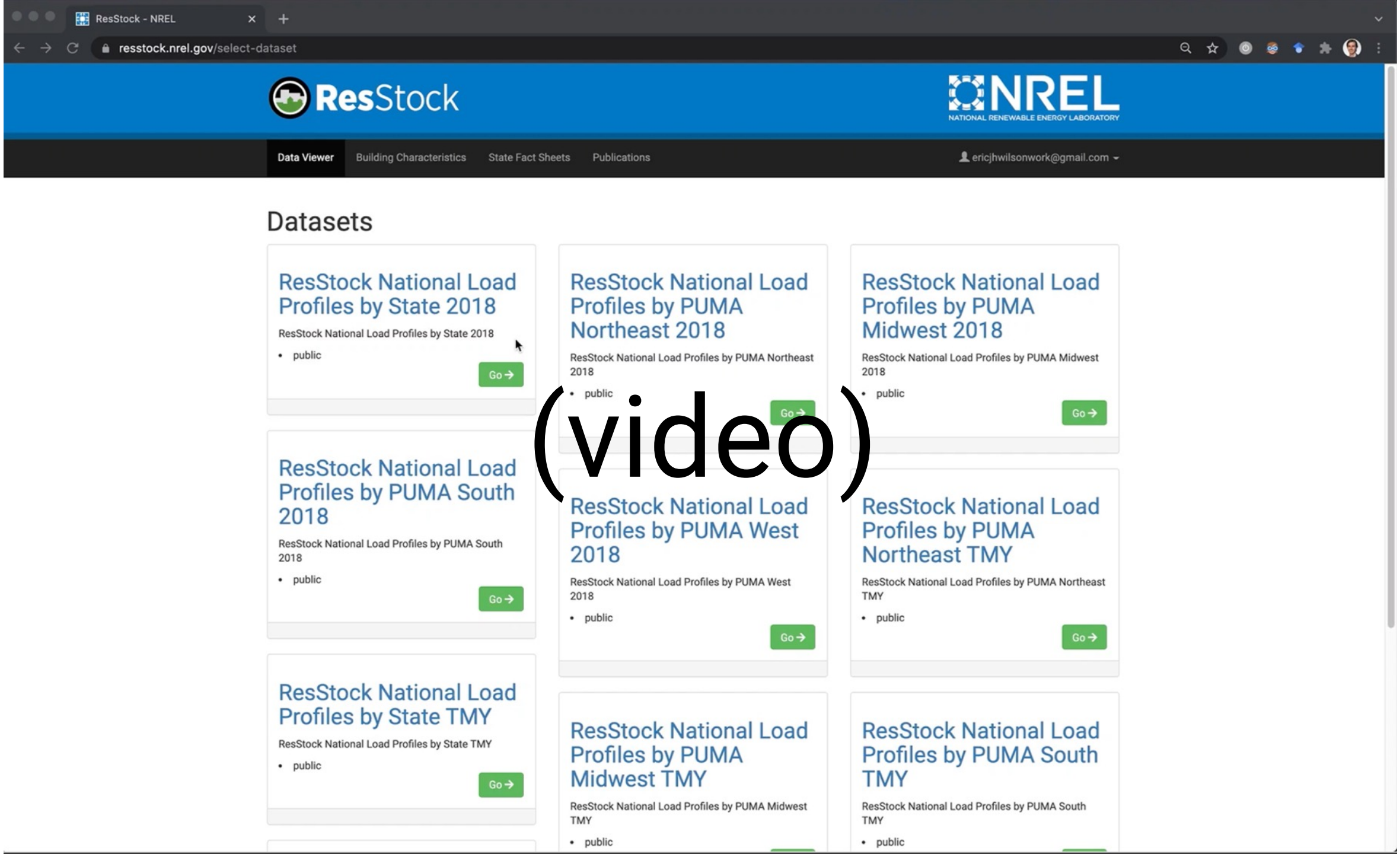
Aggregate files | Web Viewer | Full database



- View end-use load profiles
- View distributions of building characteristics
- Filter by building characteristics
- Filter by geography (state or PUMA)
- Select time window
- Download CSV for custom aggregations



Access the dataset at: nrel.gov/buildings/end-use-load-profiles.html


ResStock - NREL
resstock.nrel.gov/select-dataset
ResStock
NREL
NATIONAL RENEWABLE ENERGY LABORATORY
Data Viewer
Building Characteristics
State Fact Sheets
Publications
ericjhwilsonwork@gmail.com
Datasets
ResStock National Load Profiles by State 2018
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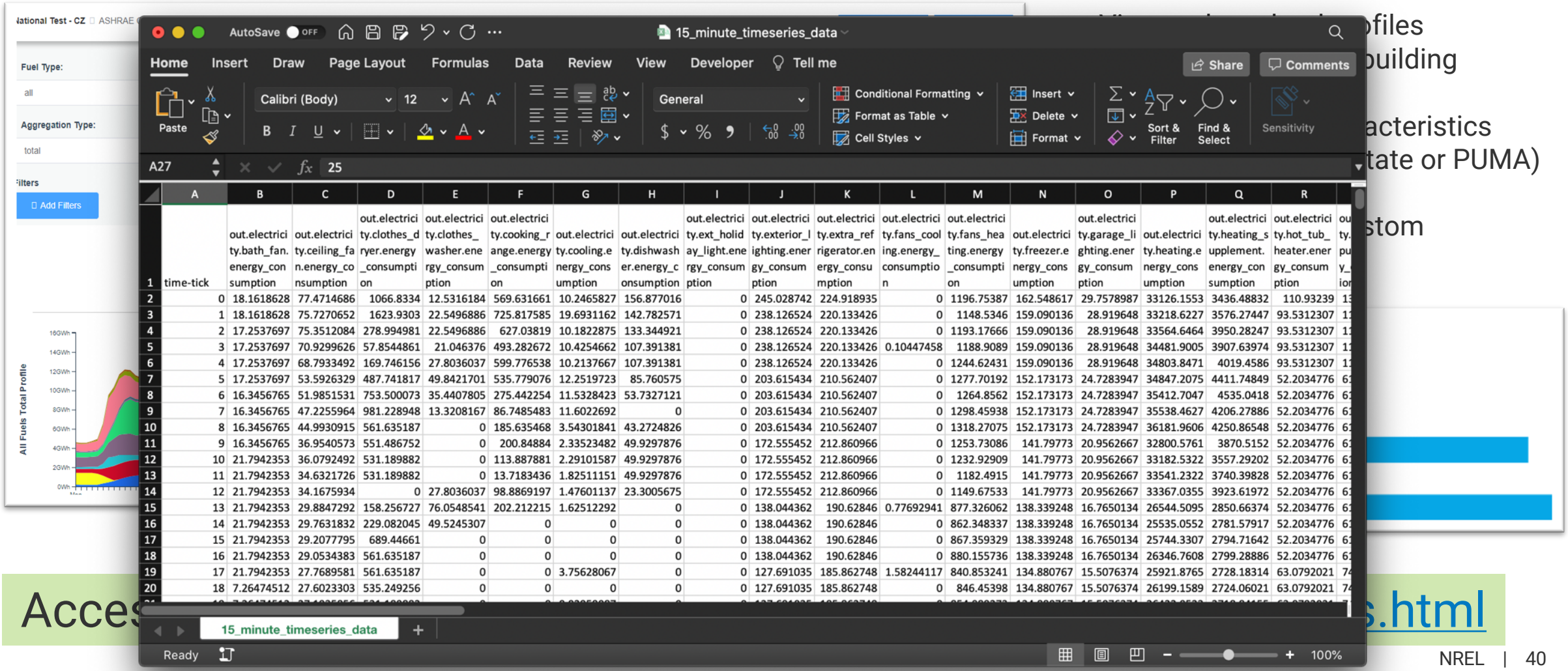
public

Web Viewer (beta)

Aggregate files | Web Viewer | Full database



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Full Database – Load Profiles & Models

Aggregate files | Web Viewer | Full database

Individual Building End Use Load Profiles
- 550,000 residential dwelling units
- 350,000 commercial buildings
- Full dataset is 16 terabytes
- Will provide instructions for loading this dataset using one cloud-based big-data analysis tool

Format:
- Folders with a series of Apache parquet* files
- In Amazon S3 bucket or similar
- Two years: 2018 and TMY3 weather

Additional Data:
- Model characteristics by ID
- Models in OpenStudio (.osm) form
- Weather data (TMY3 and 2018)

Access the dataset at: nrel.gov/buildings/end-use-load-profiles.html

*https://parquet.apache.org/

Conclusion

Next Steps

- Sign up to receive updates about the project at: nrel.gov/buildings/end-use-load-profiles.html
- Access the end-use load profiles and let us know if you have questions: load.profiles@nrel.gov
- Forthcoming reports will be posted on NREL and LBNL's websites
  - End-Use Load Profiles for the U.S. Building Stock: **Methodology and Results** of Model Calibration, Validation, and Uncertainty Quantification
  - End-Use Load Profiles for the U.S. Building Stock: **Applications and Opportunities**
- We will reach out in Q1 of 2022 with follow-up information and questions
- Stay tuned: End-use savings shapes
- Poll questions

Publications and software

Publications

- Eric Zhang, L., Platthotam, S., Reyna, J., Merket, N., Sayers, K., Yang, X., Reynolds, M., Parker, A., Wilson, E., Fontanini, A., Roberts, D., & Muehleisen, R. (2021). High-Resolution Hourly Surrogate Modeling Framework for Physics-Based Large-Scale Building Stock Modeling. Sustainable Cities and Society, 103292. https://doi.org/10.1016/j.scs.2021.103292
- Van Hove, M., Fennell, P., Weinberg, L., Bennett, G., Delghust, M., Forthuber, S., Jakob, Mata, E., Nageli, C., Reyna, J., & Catenazzi, G. (2021). Challenges and Lessons Learned in Applying Sensitivity Analysis to Building Stock Energy Models. I17th IBPSA International Conference and Exhibition, Building Simulation 2021.
- Han Li, Zhe Wang, Tianzhen Hong, Andrew Parker, Monica Neukomm. 2021. "Characterizing patterns and variability of building electric load profiles in time and frequency domains." Applied Energy.
- Carlo Bianchi, Liang Zhang, David Goldwasser, Andrew Parker, Henry Horsey. 2020. "Modeling occupancy-driven building loads for large and diversified building stocks through the use of parametric schedules." Applied Energy.
- Andrew Parker, Kevin James, Dongming Peng, Mahmoud A. Alahmad. 2021. "Framework for Extracting and Characterizing Load Profile Variability Based on a Comparative Study of Different Wavelet Functions." IEEE Access 8: 217483-217498.
- Elaina Present, Chris CaraDonna, Eric Wilson, Natalie Frick, Janghyun Kim, Rajendra Adhikari, Anna C. McCreery, Elizabeth Titus. 2020. Putting Our Industry's Data to Work: A Case Study of Large-Scale Data Aggregation: Preprint. Golden, CO: National Renewable Energy Laboratory.
- Natalie Mims Frick, Eric Wilson, Janet Reyna, Andrew Parker, Elaina Present, Janghyun Kim, Tianzhen Hong, Han Li, Tom Eckman. 2019. End-Use Load Profiles for the U.S. Building Stock: Market Needs, Use Cases, and Data Gaps. Berkeley, CA: Lawrence Berkeley National Laboratory.
- Natalie Mims Frick. 2019. "End Use Load Profile Inventory." September.
- Elaina Present, Eric Wilson. 2019. "End Use Load Profiles for the U.S. Building Stock."

Software

- OpenStudio Occupant Variability Gem and Non Routine Variability Gem (more info at IBPSA newsletter)

Presentations

- Technical Advisory Group (TAG) presentations (2019-2021) - Berkeley Lab and National Renewable Energy Lab websites.
- E. Wilson. October 2021. A New Public Dataset for U.S. Residential and Commercial Buildings. American Council for an Energy Efficient Economy (ACEEE) 2021 Energy Efficiency as a Resource Conference. October 2021.
- A. Fontanini. July 2021. International Building Performance Simulation Association (IBPSA)-USA Research Committee. End-Use Load Profiles for the U.S. Building Stock: Residential Stock Model Calibration and Validation.
- E. Present and N. Frick. June 2021. CEE Summer Conference - Using Load Shapes to Capture Modern Energy Use and Find Opportunities for Efficiency Breakout Session. End-Use Load Profiles for the U.S. Building Stock. E. Present. May 2021. Intranational Energy Program Evaluation Conference (IEPEC) Webinar Series – A New Look at Load Profiles. End-Use Load Profiles for the U.S. Building Stock.
- A. Parker. May 2021. Efficiency Exchange 2021 Conference. Northwest End Use Load Research: How three Organizations are Using the Data.
- E. Wilson. August 2020. Efficiency Exchange Webinar. Valuing Capacity Savings.
- E. Wilson. December 2019. E Source interview. Exploring business customer nuances.
- E. Present. October 2019. Northeast Energy Efficiency Partnerships (NEEP) webinar. Introducing End-Use Load Profiles for the U.S. and the Northeast.
- E. Wilson. May 2019. Building Technologies Office Peer Review. End-Use Load Profiles for the U.S. Building Stock.

Questions?

Eric.Wilson@nrel.gov

nrel.gov/buildings/end-use-load-profiles.html

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