ComStock Standard Dataset Release

Commercial 2024 Release 2

Chris CaraDonna, Janghyun Kim, Marlena Praprost, Andrew Parker, Henry Horsey, Lauren Klun, Florian Antretter, Amy Van Sant, and Jie Xiong

NREL Webinar

January 9, 2025

Photo from iStock-627281636

Acknowledgments

This work is the culmination of several years of research efforts.

We would like to thank the following for helping make this possible:

- ComStock™ and ResStock™ teams
- OpenStudio® and EnergyPlus® teams
- Lawrence Berkeley National Laboratory
- Argonne National Laboratory
- Pacific Northwest National Laboratory
- U.S. Department of Energy Building Technologies Office.

Agenda

1. Standard Dataset Release: Background
2. Our Approach to Stock Modeling With ComStock
3. 2024 Release 2: New Measure Scenarios
4. Accessing the Dataset
5. Next Steps (Future Releases and New Measures)
6. Q&A

Project Background

Problem Statement

A lack of credible and relevant information leads to uncertainty in decision making and outcomes for cities, states, utilities, and other major stakeholders.

Which energy efficiency pathways will…

- Reduce grid strain in my city?
- Be feasible in my building stock?
- Maximize reduction in utility bills?

EULP, EUSS, and SDR Road Map

- The **End-Use Load Profiles** (EULP) project (2019-2021):
  - Created a public dataset for calibrated energy models of the U.S. commercial and residential building stock using ComStock and ResStock.

- The **End-Use Savings Shapes** (EUSS) follow-on project (2022-2024):
  - Added the impact of several energy efficiency “what-if” scenarios (“measures”) to the baseline stock models.
  - Two residential and three commercial dataset releases presented since 2022.

- The **Standard Dataset Release** (SDR) project (2025+):
  - Our new name for the EUSS project to better represent the full scope.
  - “End-use savings shapes” are still included in the dataset.

Alignment and Impact

We are putting information into the hands of decision makers.

This effort supports the U.S. Department of Energy's (DOE) goals to increase building energy efficiency and to do so in ways that prioritize affordability and resilience.

What the Datasets Provide

- Building stock characterization
- How, where, and when buildings use energy
- Information on time-sensitive value of energy resources
- Potential impacts of energy efficiency and demand flexibility.

How the Information Is Used

- Energy efficiency decision-making
- Building performance standard and code development
- Technology potential and impact analysis
- Utility-integrated resource plans and load forecasts
- Policy and rate design.

Terminology

ComStock “Baseline”

Describes how and when energy is used in buildings **today.**

Public database of 150,000 individual building models and their energy end-use load profiles.

ComStock “Measure Scenarios”

Describe how and when energy is used in **“what-if” scenarios.**

Adds measure impact profiles for energy efficiency, demand flexibility, etc. packages versus the ComStock baseline.

2024 Commercial Standard Dataset Release 2 Data represents the building stock circa 2018 using 2018 actual meteorological year (AMY) weather.

What is in the Standard Dataset Release?

Updated ComStock Baseline Model

- Improvements and new features since last release.

Existing Measure Scenarios

- 30 measures from past dataset releases are re-simulated with the updated ComStock baseline.

New Measure Scenarios

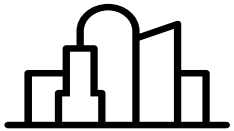
- 9 new measure scenarios.

Previous commercial datasets will remain available.

Our Approach to Stock Modeling

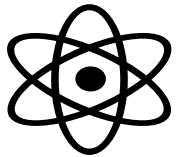
ComStock Workflow

ComStock



Building stock characteristics database

- Variation in building type, size, location, vintage, heating fuel, etc.
- **Over 80** probability distributions of various attributes.



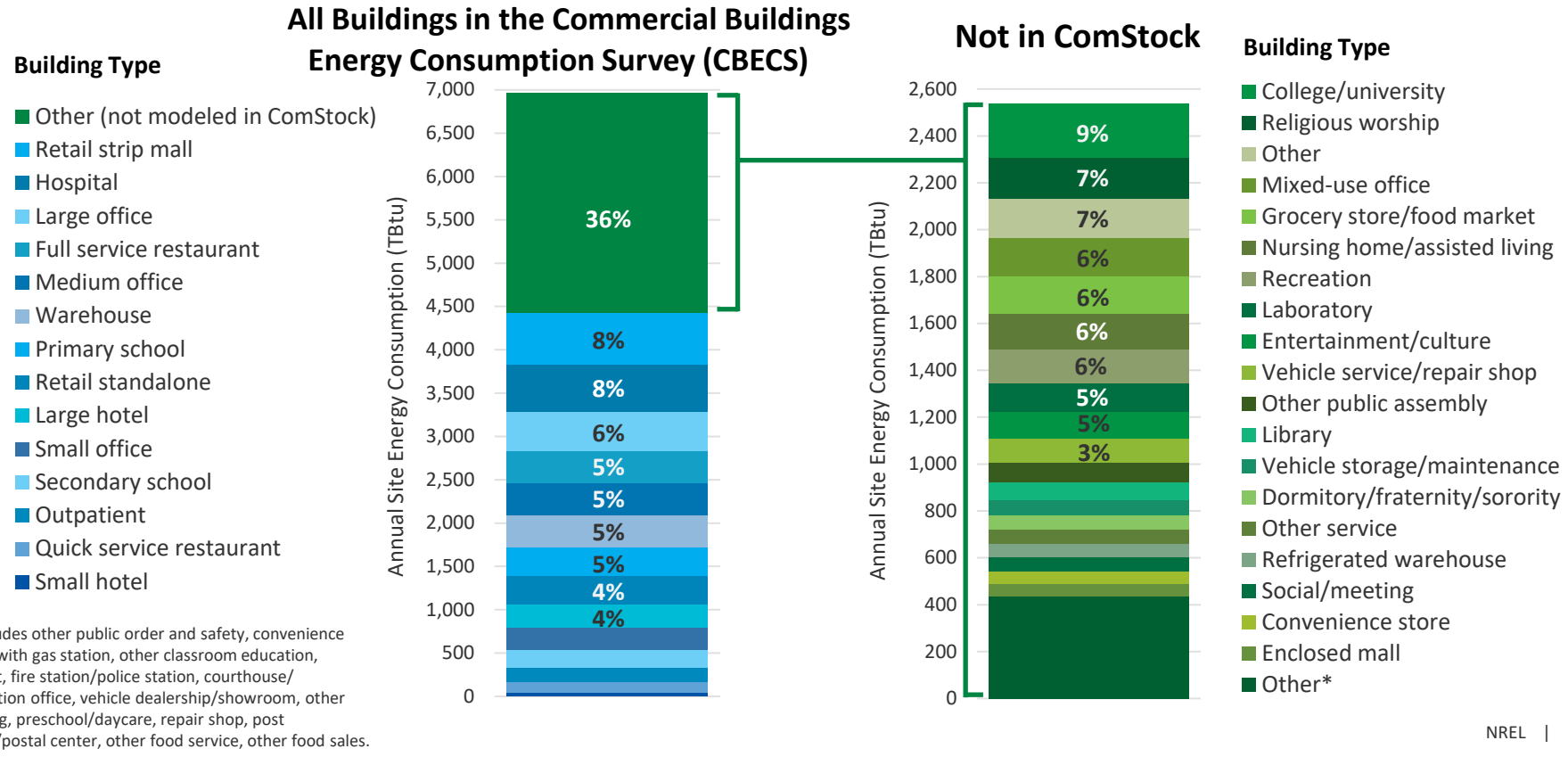
Physics-based computer modeling

- Representative set of **150K** OpenStudio energy models
- Apply “what-if” scenarios to models (efficiency, etc.).

High-performance computing

- Simulate models
- Process and publish data
- Apply scaling factors.

What Does ComStock Model?



* Includes other public order and safety, convenience store with gas station, other classroom education, vacant, fire station/police station, courthouse/ probation office, vehicle dealership/showroom, other lodging, preschool/daycare, repair shop, post office/postal center, other food service, other food sales.

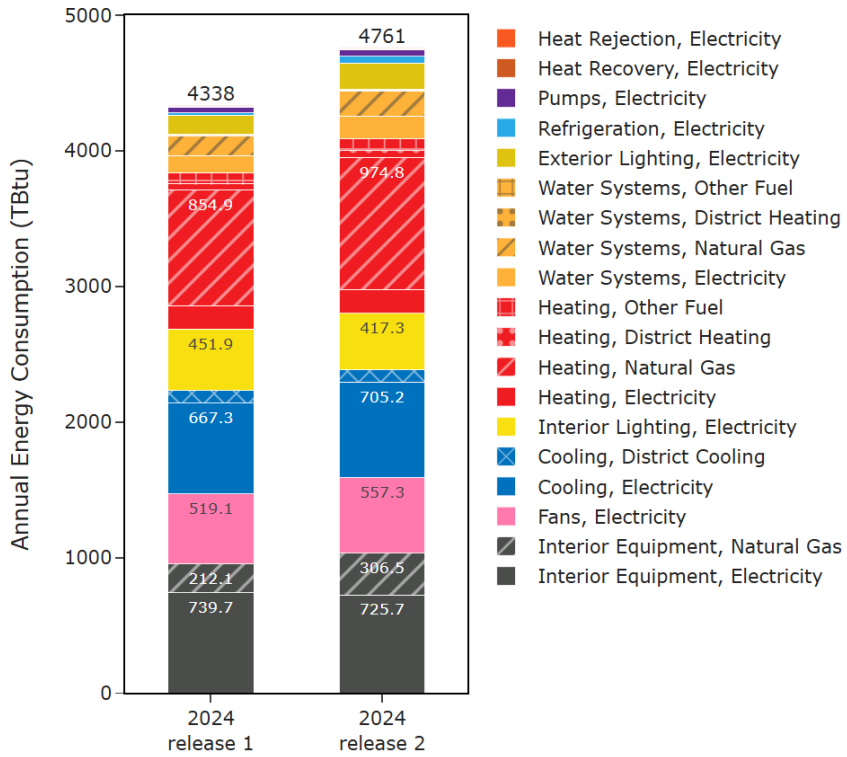
ComStock Baseline Updates Since Last Release

Continuous Improvements:

- New sampling methodology to increase geospatial resolution
- Updated to OpenStudio 3.8.0
- General bug fixes.

Upcoming Future Improvements:

- New building types
  - Grocery stores
  - Other public buildings
- Improved zoning methodology
- Improved water draw profiles
- Update to CBECS 2018 for HVAC distributions
- Electrical panel sizing
- Further calibration.



Full change log available on GitHub

New Sampling Methodology

New sampling approach enables higher-resolution analyses.

- Increased geospatial resolution enables **higher confidence when analyzing smaller or rural geographies**.
  - Please continue to exercise common sense with sample size when using localized data.
- Building models are reused across census tracts when they align with key sampled traits
  - E.g., building type, area, weather & building code region, and HVAC system.
- Modeling **more diversity** of **low-frequency building types** and fewer high-frequency building types where additional diversity is not helpful.
  - Better representation of stock variability.
- Annual results files available at various aggregations to manage file size.
  - **Changes to dataset are discussed in "Accessing the Dataset" section of this presentation.**

Link

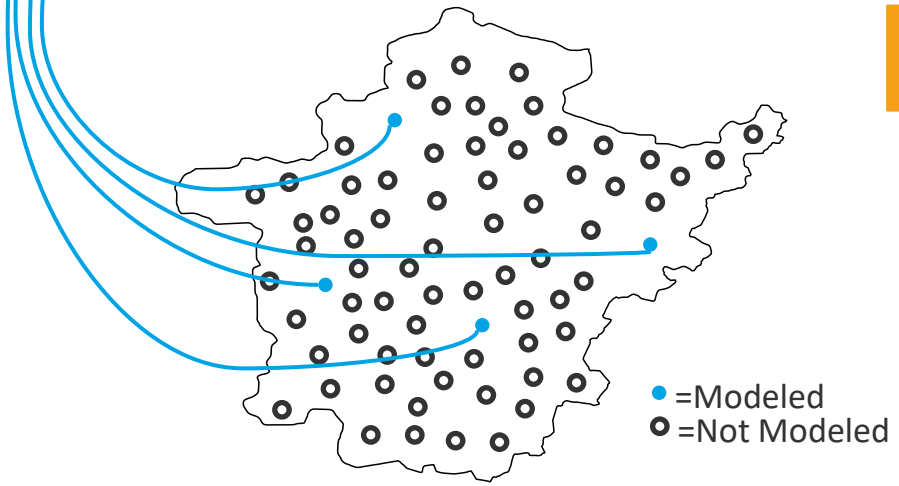
- User Resource Guide for New Sampling

Previously

Pick buildings at random in each county and then model them

Building Type	Bldg SqFt	Bldg Vintage
Primary School	34,567	1995
Retail	23,456	1964
Small Office	1,234	1945
Strip Mall	12,345	2002

Multiply the results by nationally calculated scaling weights



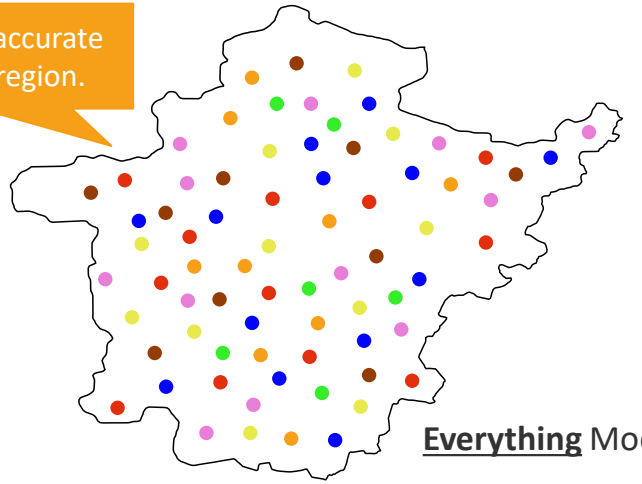
Now

Models are reused across census tracts when they align with key sampled traits (building type, area, and HVAC system)

Building Type	Bldg Sqft	Bldg Vintage
Primary School	34.5k, 12.3k, …	1995, 1968, …
Retail	23.4k, 3.4k, …	1964, 1998, …
Small Office	1.2k, 2,345, …	1945, 1955, …
Strip Mall	45.3k, 5.6k, …	2002, 1984, …

Assign modeled buildings to represent each known building and weight so square footage matches

Higher & more accurate resolution for region.



Everything Modeled

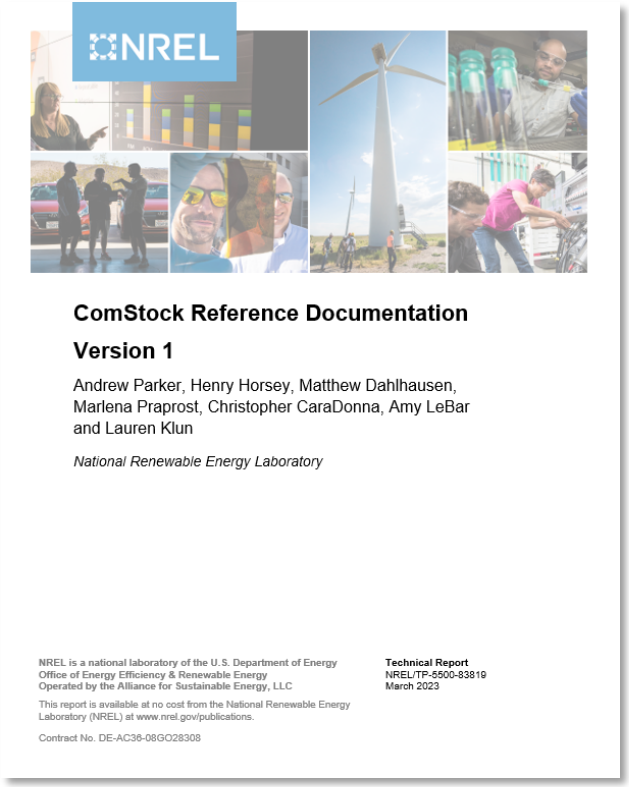
ComStock Documentation

This document serves as a guide and resource for the methodology and assumptions behind ComStock.

Links

- ComStock Documentation
- Introduction to ComStock slides

Questions? Email comstock@nrel.gov



Resources – Segmentation Reports

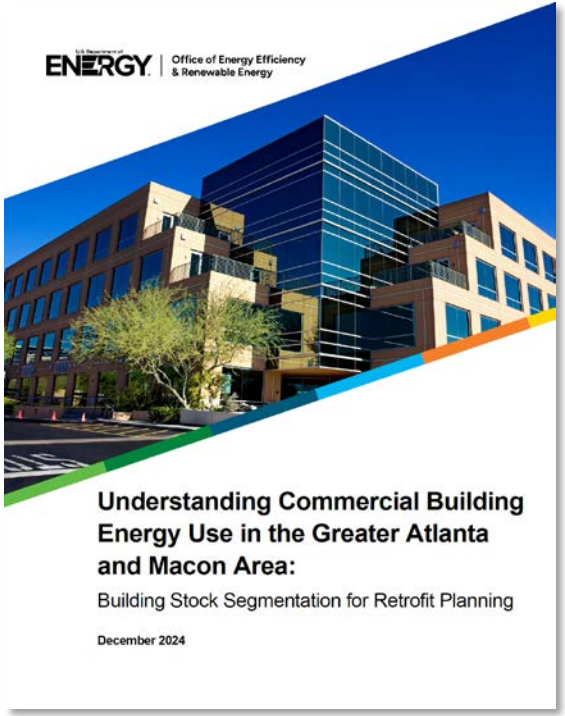
ComStock Phase II Segmentation Reports will be available from February 2025.

- A series of reports providing energy data and building characteristics for local geographies (“clusters”).
- Helps policymakers understand local energy use and emissions and identify building stock segments for retrofit opportunities.
- Reports available for more than 80 clusters in the U.S.

Reports to be published here in February.

Link

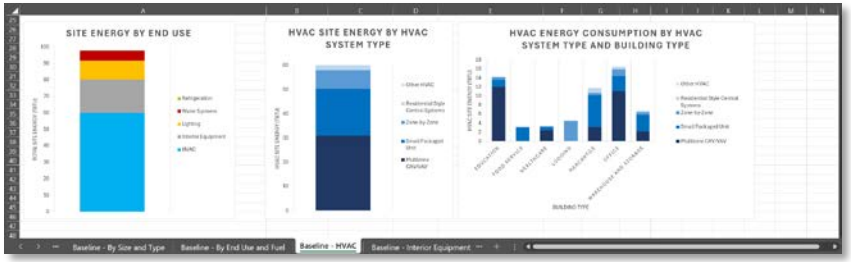
- Energycodes Segmentation Website

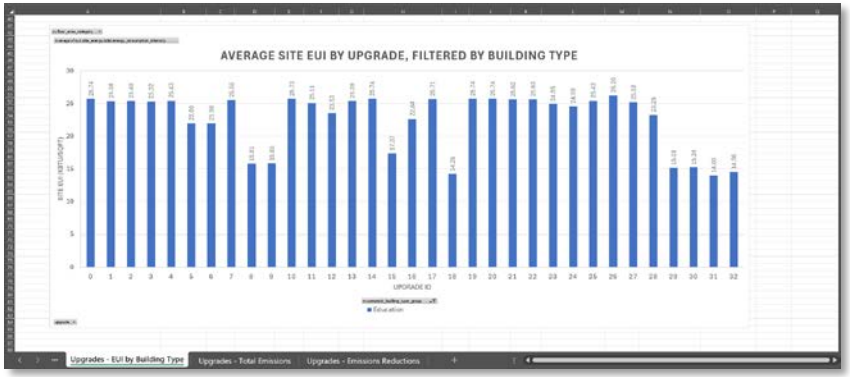


Resources – BPS Technical Assistance Network

Building stock analysis for jurisdictions is available through the BTO Technical Assistance Network.

- Receive building performance standards (BPS) program development support using ComStock data.
- Workbook with local building stock data to set performance targets and prioritize measures and technologies.





Links

- [Buildings Performance Standards Website]
- [Form to request Technical Assistance]

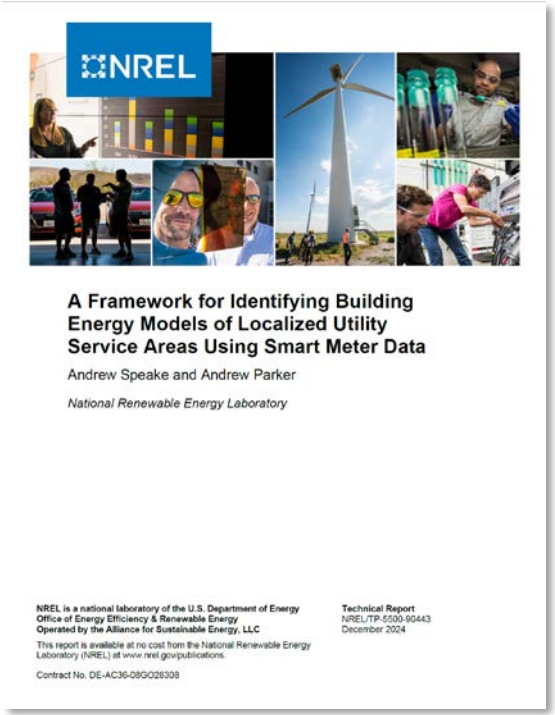
New Use Case Highlight – AMI Matching Framework

New Framework to Identify Building Energy Models Using Smart Meter Data

- Methodology aligns utility smart meter data with ResStock load profiles.
- Demonstrated ResStock as potential solution for modeling residential energy demand at local grid resolutions for long-term load forecasting.

Links

- Advanced Metering Infrastructure (AMI) Matching Framework Report



Standard Dataset Release: Commercial 2024 Release 2

Technology Modeling, Results Observations, and Discussion

Please Note

- The ComStock model is **continuously updated** with new information, methods, and improved quality assurance/quality control procedures. Datasets are now released in 3-month increments for 2025.

- Measures are **not intended to be comprehensive** of a given technology. As additional data become available, measure results may be updated.

- The measure result summaries in this presentation are intended to be **high-level observations** to introduce the dataset. For more detailed conclusions, please watch for updates on the publications section of our website or explore the dataset.

ComStock Measure Documentation Website

Comprehensive documentation is available for each measure.

Describes the modeling methodology, assumptions, limitations, relevant ComStock baseline features, and observations from results.

Also find all EUSS/SDR webinar slides and recordings.

Access at: ComStock Documentation Site

Existing Measures From Previous Releases

30 Existing Measures, Including:

- LED lighting
- Demand flexibility
- Ground-source heat pumps
- Envelope improvements
- Heat pump rooftop units (RTU)
- Air-to-water heat pumps
- Electric cooking equipment
- HVAC outdoor air strategies
- Variable refrigerant flow
- Measure packages.

Included in the new dataset, but not discussed in this presentation.

Access full list at: ComStock Documentation Site

New Measures for SDR 2024 Release 2

Measure Name	Description	% of Stock Floor Area Applicable
Ideal Thermal Air Loads	Provides ideal thermal heating and cooling loads for ComStock models.	100%
Heat Pump RTU, Standard Performance, Electric Backup	Replaces gas and electric RTUs with 'standard efficiency' HP-RTUs.	34%
Heat Pump RTU, Standard Performance w/ Higher Lockout Temperature	Replaces gas and electric RTUs with 'standard efficiency' HP-RTUs that use a higher minimum lockout temperature of 32°F.	
Heat Pump RTU, Standard Performance w/ Improved Roof Insulation	Combines standard performance HP-RTU and improved roof insulation measures.	
Heat Pump RTU, Cold Climate Heat Pump RTU Challenge, Electric Backup	Replaces gas and electric RTUs with HP-RTUs that meet the specification of the Commercial Cold Climate Heat Pump Challenge.	
Package: Standard Performance HP-RTU or ASHP Boiler + LED Lighting	Combines either standard performance HP-RTU or ASHP boiler measures with LED lighting.	90%
Demand Flexibility, Lighting Control for Building Peak	Dims lights by 30% during daily 4-hour demand events with timing optimized to reduce daily building peak demand.	68%
Demand Flexibility, Lighting Control for Avoided Greenhouse Gas Emissions	Dims lights by 30% during daily 4-hour demand events with timing optimized to avoid greenhouse gas emissions.	
Package: Thermostat and Lighting Control for Load Shed	Combines thermostat and lighting controls demand flexibility measures for load shedding.	

Ideal Thermal Air Loads

Ideal Thermal Air Loads

Measure Concept

- Provides raw heating and cooling loads for ComStock models
- Reported as district energy in annual and timeseries data
- Agnostic of existing HVAC system.

Performance Assumptions

- Heating/cooling loads delivered at 100% efficiency without fans/pumps
- Design outdoor airflow perfectly mixed with supply and follows building occupancy
- Constant cooling sensible heat ratio of 0.75
- No active humidity control.

Applicability

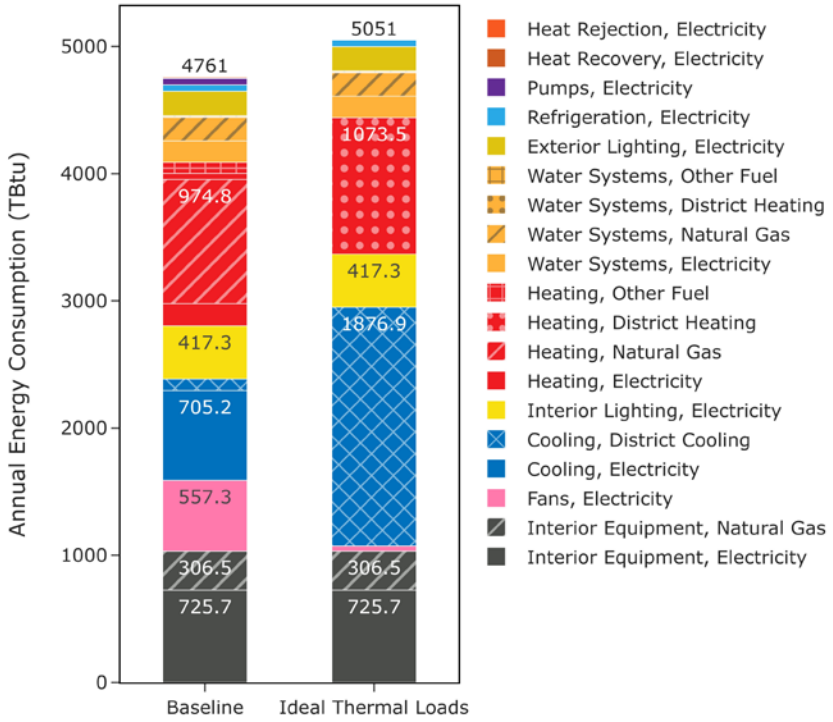
- Applicable to all models—100% stock floor area

This measure is **informational only** for studying building loads and does not represent a technology

Ideal Thermal Air Loads

- All heating/cooling usage reported as “district” energy, regardless of starting fuel.
- **Cooling** energy is **2.4x higher** because direct expansion (DX) systems with a coefficient of performance (COP) of 2-4 are replaced with ideal air at 100% efficiency (COP of 1).
- **Heating** energy is **reduced** because gas combustion systems with efficiencies of ~80% are replaced with ideal air at 100% efficiency.
- Minimal **remaining fan** energy is from zone exhaust fans – otherwise, HVAC fans are removed.

Stock Site Energy by Fuel and End Use



Standard Performance Heat Pump Rooftop Units

Standard Performance Heat Pump Rooftop Units

Measure Concept

- Replaces existing gas and electric RTUs
- Average performance of HP RTU derived from existing manufacturer performance maps
- Uses reverse-cycle defrost
- Sized to cooling with electric supplemental heating used to address any unmet load.

Applicability

- Gas and electric resistance RTUs
  - About **34%** of stock floor area
  - Not applicable to kitchens and unconditioned spaces.

What is “standard performance” ?

Based on common characteristics from actual products:

- Two stages of heat pump cooling
- Single-stage heat pump heating (i.e., all compressors running at the same time)
- Heat pump minimum lockout temperature of 0°F (-17.8°C)
- (For units with capacity of 5 tons and below) SEER of 14 and HSPF of 8
- (For units with capacity of 6 tons and above) IEER between 10.8-14.1 and COP at 47°F between 3.2-3.5
- Capacity and efficiency retention at 0°F compared to rated conditions at 47°F ~ 40%.
- Supplemental electric heat can operate simultaneously with heat pump.

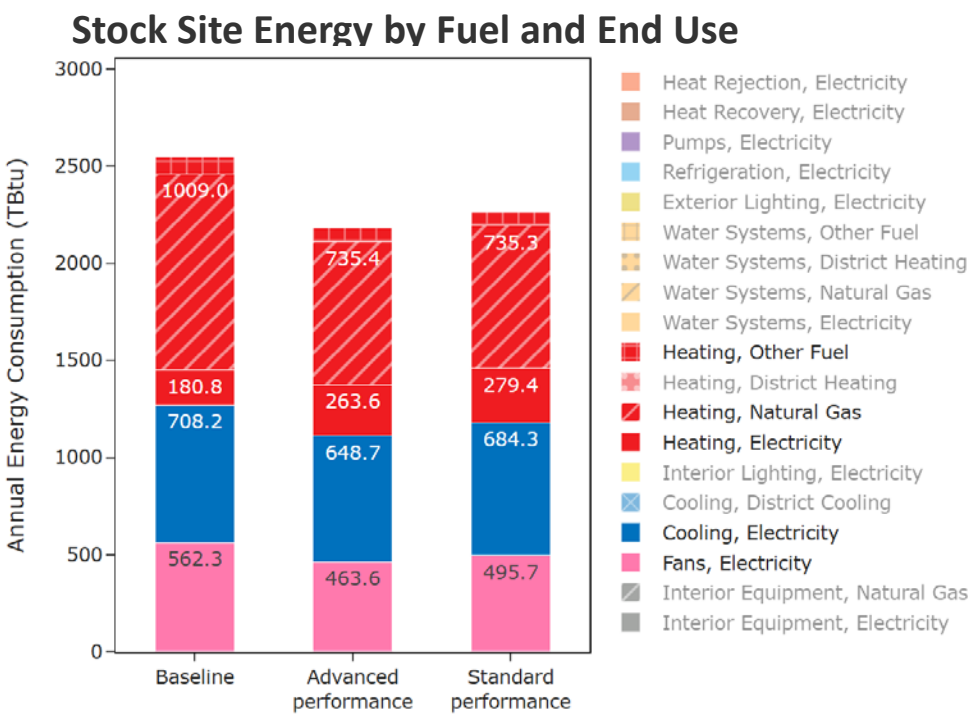
Standard Performance Heat Pump Rooftop Units

Standard Performance vs. Baseline:

- **27.1%** stock **heating natural gas** savings (273.8 TBtu)
- **-54.6%** stock **heating electricity** savings (-98.6 TBtu)
- **11.8%** stock **fan electricity** savings (66.6 TBtu)
- **3.4%** stock **cooling electricity** savings (23.9 TBtu)
- Cooling and fan savings from replacing older, less efficient RTUs with newer, higher efficiency staged RTUs.

Standard vs. Advanced Performance:

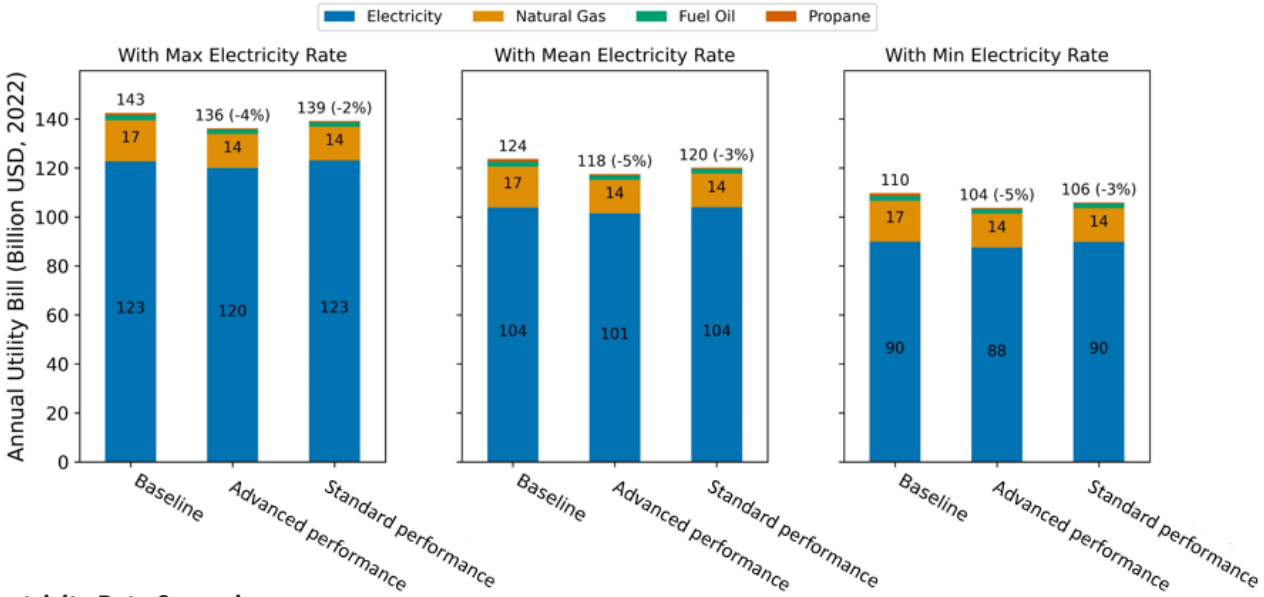
- Advanced performance uses top-of-the-line, variable speed compressors and fans (from previous release)
- Annually, standard performance uses **more stock electric heating, cooling, and fans** compared to advanced performance.



Standard Performance Heat Pump Rooftop Units

Commercial Building Stock Annual Utility Bills

Plot shows maximum, mean, and minimum applicable electricity rate.



- Stock utility bills decrease by 2-3% (~$4 billion annually) compared to baseline
- Standard performance shows lower cost savings compared to advanced performance
- **Results vary considerably by climate.**

Electricity Rate Scenarios

- Many electricity rates are applied to each building model based on geographical location match against U.S. Utility Rate Database.
- Max/Mean/Min electricity rates show each of those many applicable electricity rates.
- Rates for other fuel types are only applied one rate per building.

Standard Performance Heat Pump Rooftop Units With Higher Lockout Temperature

Standard Performance Heat Pump Rooftop Units With Higher Lockout Temperature

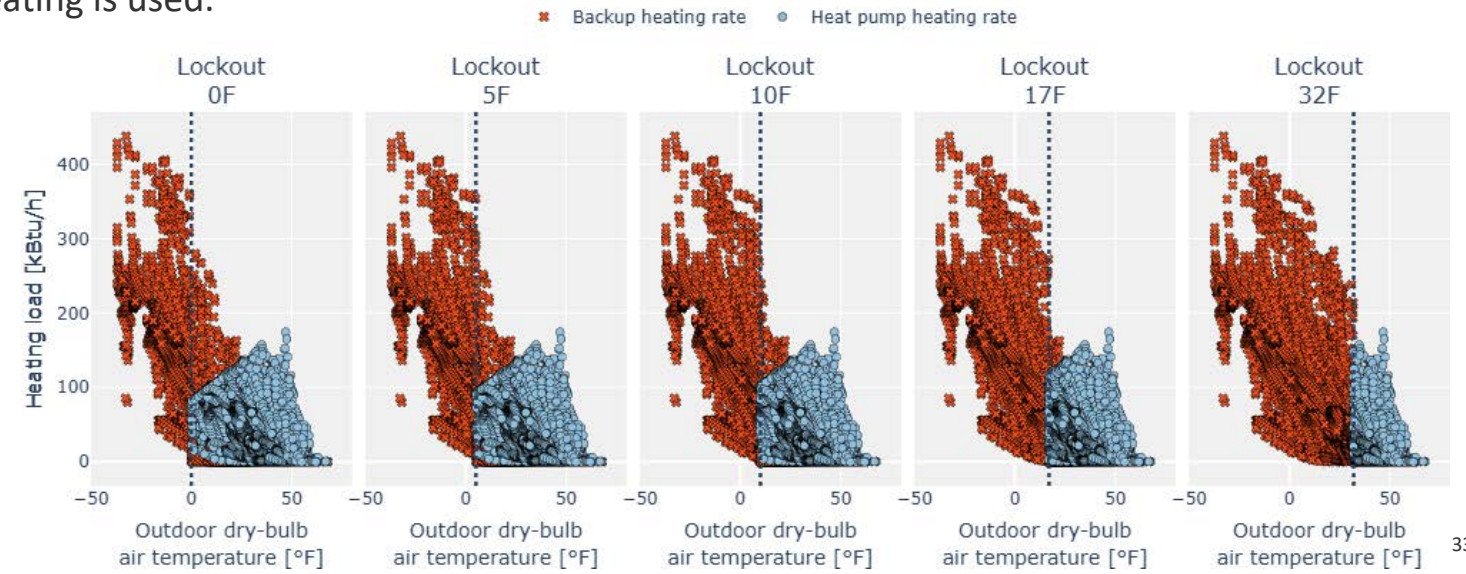
Measure Concept

- Applies higher compressor lockout temperature (32°F) for HP RTU to understand the impact of different lockout temperature
- Standard performance HP RTU with electric supplemental heating is used.

Applicability

- Gas and electric resistance RTUs
  - About **34%** of stock floor area
  - Not applicable to kitchens and unconditioned spaces.

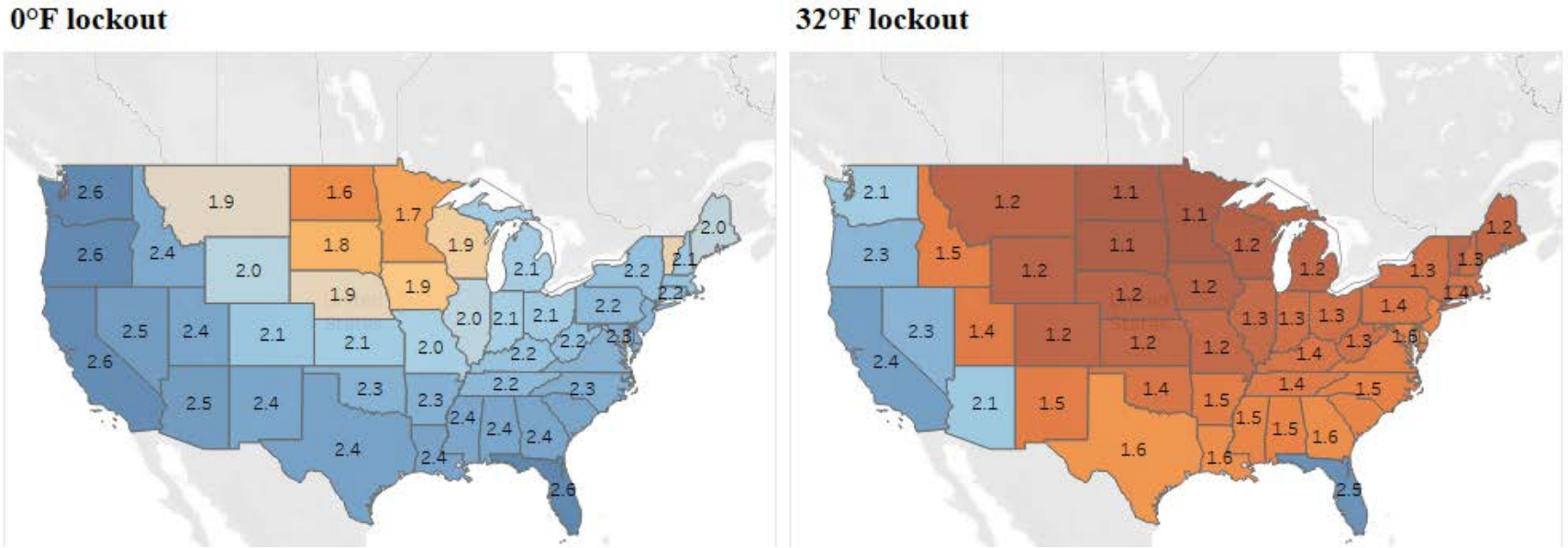
What is compressor lockout temperature?



Standard Performance Heat Pump Rooftop Units With Higher Lockout Temperature

What is the impact of changing the lockout temperature from 0°F to 32°F?

Median of annual average total heating COPs by state

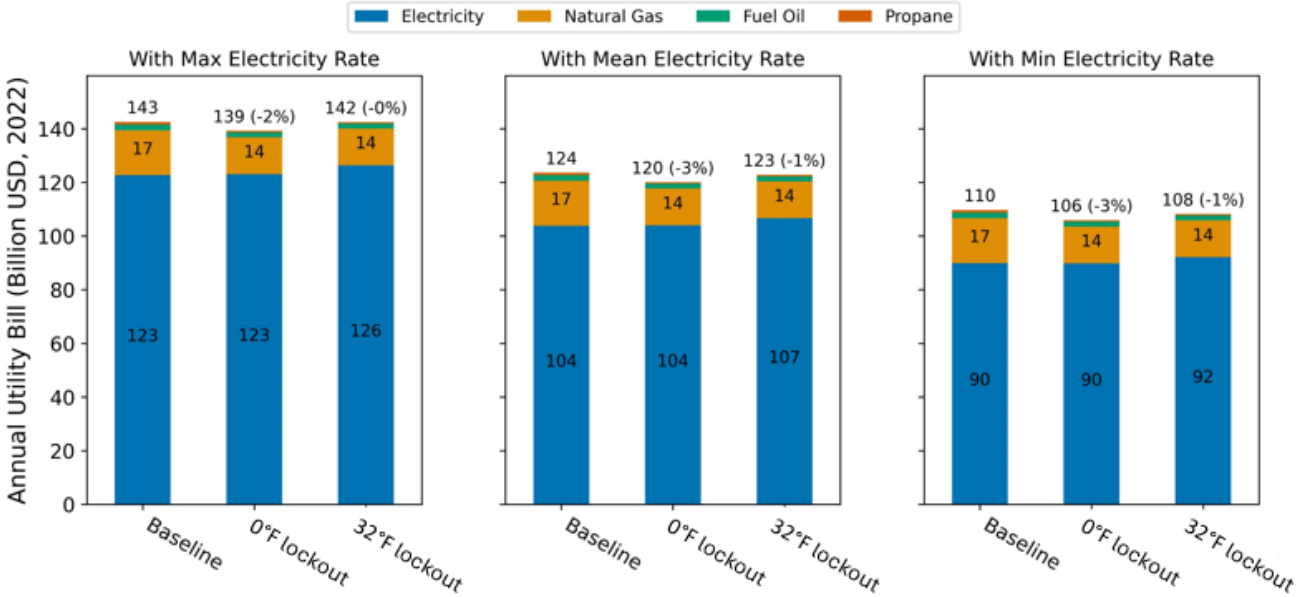


COPs presented include impacts of supplement heat, crankcase heat, and reverse-cycle defrost, but not supply fan.

Standard Performance Heat Pump Rooftop Units With Higher Lockout Temperature

Commercial Building Stock Annual Utility Bills

Plot shows maximum, mean, and minimum applicable electricity rate



- Using 32°F lockout decreases utility bill savings potential compared to 0°F lockout.
- **Results vary considerably by climate.**

Electricity Rate Scenarios

- Many electricity rates are applied to each building model based on geographical location match against U.S. Utility Rate Database.
- Max/Mean/Min electricity rates show each of those many applicable electricity rates.
- Rates for other fuel types are only applied one rate per building.

Standard Performance Heat Pump Rooftop Units With Improved Roof Insulation

Standard Performance Heat Pump Rooftop Units With Improved Roof Insulation

Measure Concept

- Combines 2 measure scenarios:
  - Standard Performance HP-RTU
  - Improved Roof Insulation
- Investigates the combined impact of improving roof insulation with HP-RTU retrofit.

Applicability

- Buildings with gas or electric RTUs
  - About **34%** of stock floor area
  - Roof insulation applied when existing roof insulation is less than target value (>**99% buildings**).

Roof Insulation Targets

From Advanced Energy Design Guidelines

ASHRAE Climate Zone	1	2	3	4	5	6	7	8
R-Value (hr ft^2 F/British thermal unit)	21	26	26	33	33	33	37	37

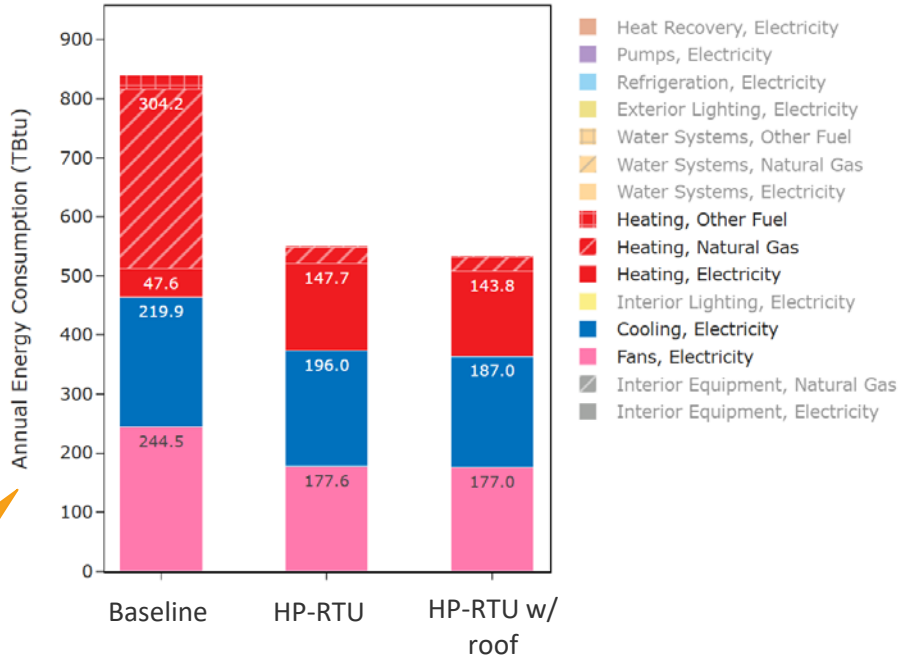
Standard Performance Heat Pump Rooftop Units With Improved Roof Insulation

What are the additional savings from improved roof insulation in *applicable* buildings?

- **1%** stock **heating gas** savings (3.7 TBtu)
- **1%** stock **heating electricity** savings (4 TBtu)
- **5%** additional **cooling electricity** savings (9 TBtu)
- Savings generally higher for buildings will fewer numbers of stories, and therefore higher ratio of roof area to floor area.

Only buildings applicable to measure

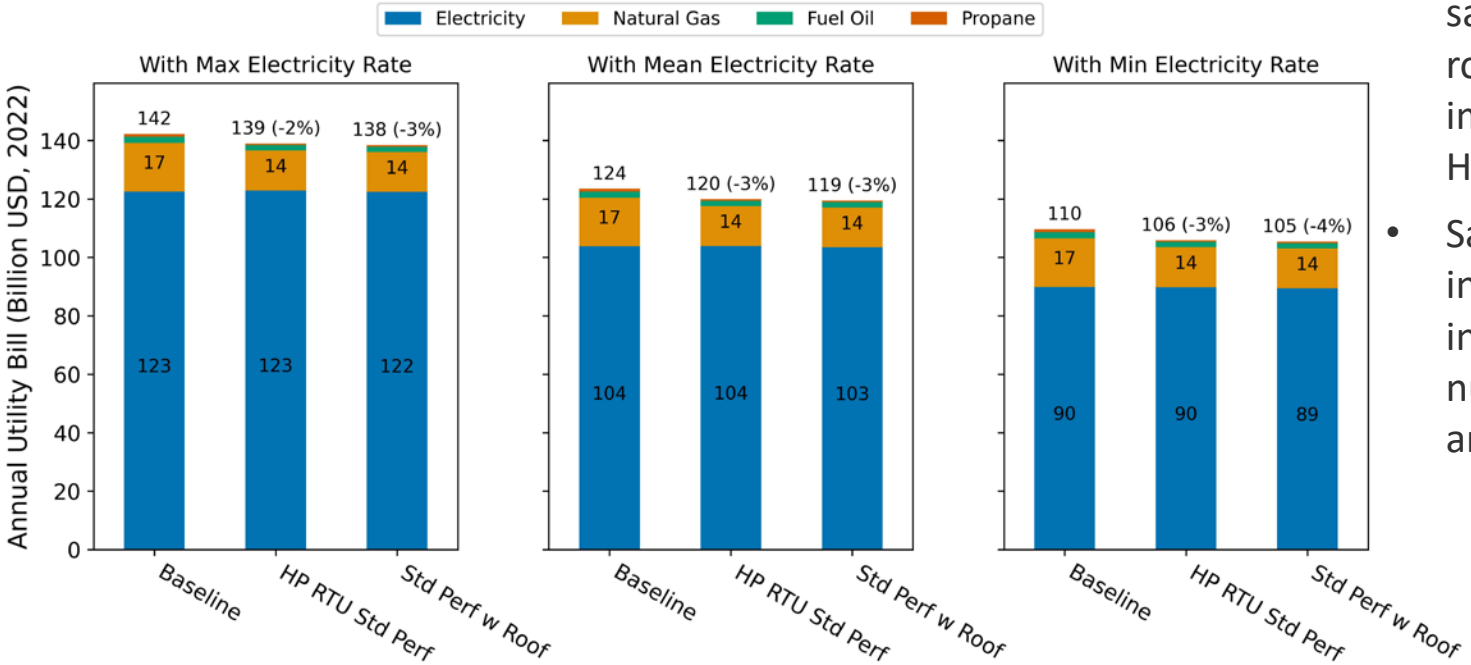
Applicable Stock Site Energy by Fuel and End Use



Standard Performance Heat Pump Rooftop Units With Improved Roof Insulation

Commercial Building Stock Annual Utility Bills

Plot shows maximum, mean, and minimum applicable electricity rate



- **~$1 billion** annual stock utility bill savings for adding roof insulation improvements to HP RTU.
- Savings for individual buildings influenced by number of stories and other factors.

HP-RTUs Satisfying the Commercial Building Heat Pump Technology Challenge Specification

HP-RTUs Satisfying the Commercial Building Heat Pump Technology Challenge Specification

The Commercial Building Heat Pump Technology Challenge (HP Challenge) is developing a performance specification to increase HP-RTU readiness in colder climates.

Measure Concept

- Replace gas and electric RTUs with HP-RTUs that meet the HP Challenge specification.

Applicability

- Buildings with gas or electric RTUs
  - About **34%** of stock floor area.

Key Modeling Assumptions

- 100% heating capacity at 5°F compared to rated cooling capacity
- >70% heating capacity at -10°F compared to rated cooling capacity
- >1.3 COP at -10°F and > 1.7 COP at 5°F
- Compressor lockout occurs below -10°F
- Sized to design cooling load – electric supplemental heating[1] for remaining loads
- Additional details are available in the performance specifications and measure documentation
- Performance curves represent **one pathway** to meeting specification.

[1]The specification permits dual fuel supplemental heat, which may be studied in future work.

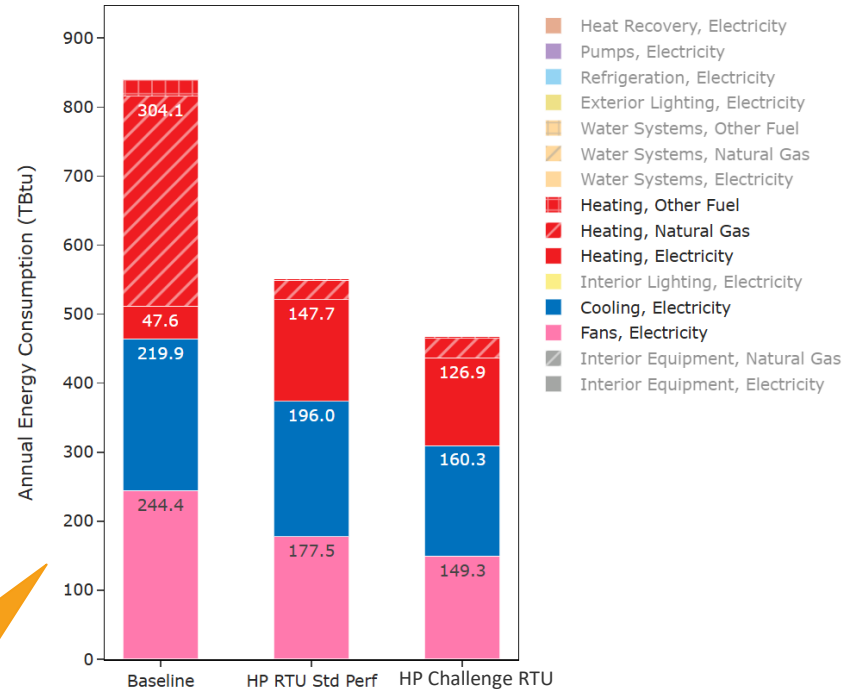
HP-RTUs Satisfying the Commercial Building Heat Pump Technology Challenge Specification

How does the HP Challenge HP-RTU compare to Std. Perf. HP-RTUs in *applicable* buildings?

- **14% electric heating** savings (21 TBtu)
- Improved capacity and efficiency at lower temperatures increases overall heating efficiency
- Results vary considerably by climate
- Fan and cooling savings attributable to expected efficiency and staging improvement with HP Challenge units.

Only buildings applicable to measure

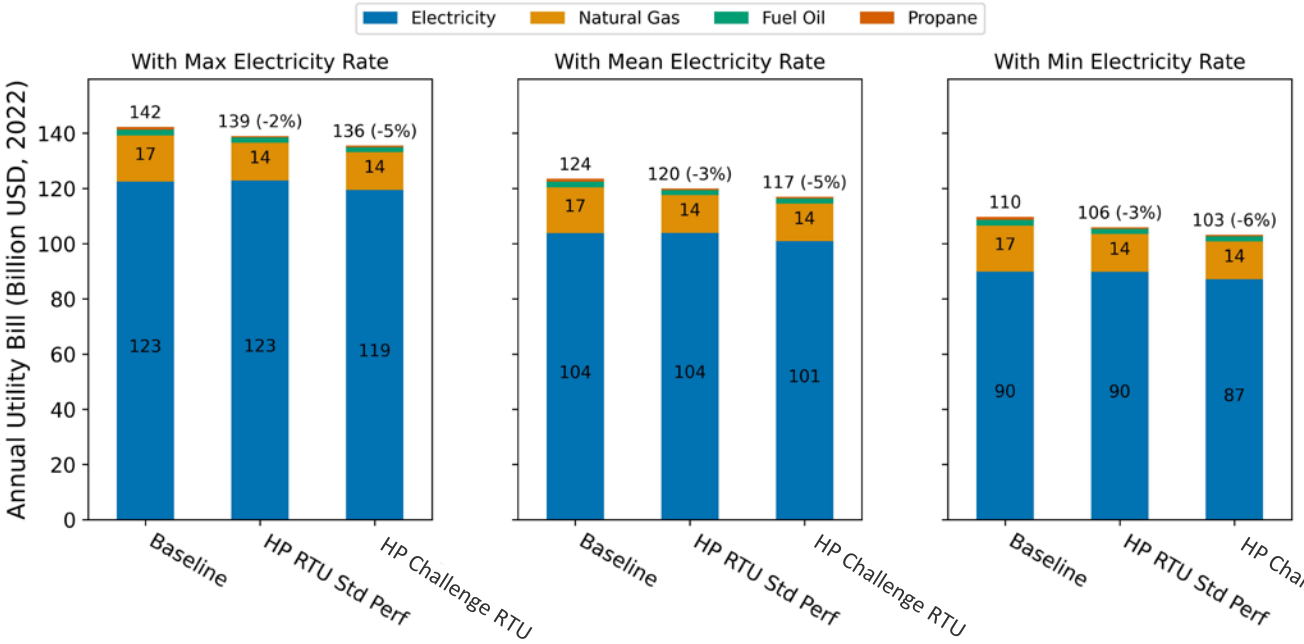
***Applicable* Stock Site Energy by Fuel and End Use**



HP-RTUs Satisfying the Commercial Building Heat Pump Technology Challenge Specification

Commercial Building Stock Annual Utility Bills

Plot shows maximum, mean, and minimum applicable electric rate



- HP Challenge RTU shows **$5-6 billion utility bill savings** annually against the baseline building stock.
- **Additional $3 billion savings** for HP Challenge RTU compared to using today's standard performance HP-RTUs.
- Results vary considerably by climate.

Not all buildings show energy bills savings.

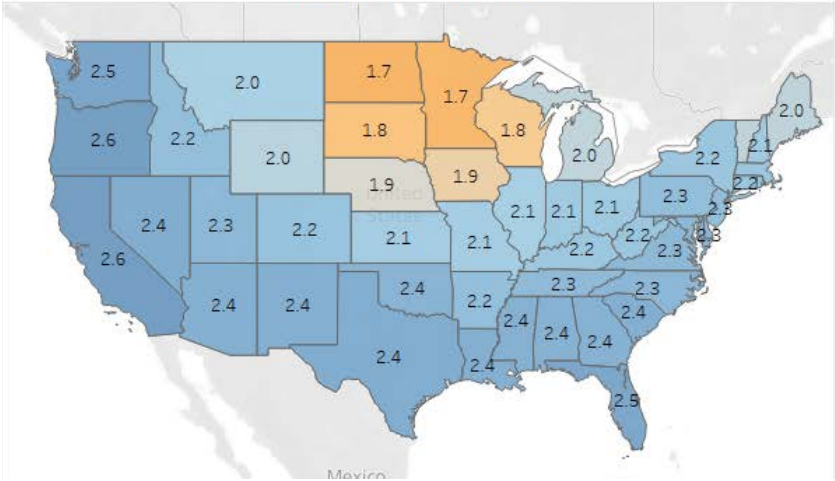
HP-RTUs Satisfying the Commercial Building Heat Pump Technology Challenge Specification

What performance gains does the Challenge HP-RTU offer?

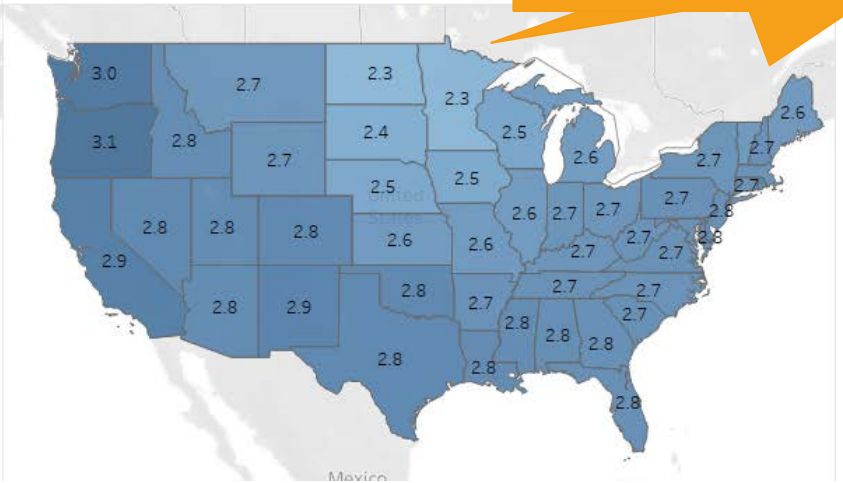
Median of annual average total heating COPs by state

Improved performance in the coldest regions.

Standard Performance HP-RTU



HP Challenge HP-RTU



COPs presented include impacts of supplement heat, crankcase heat, and reverse-cycle defrost, but not supply fan.

Package 3: LED Lighting + HP-RTU Standard Performance + ASHP Boiler

Package 3: LED Lighting + HP-RTU Standard Performance + ASHP Boiler

Package Concept:

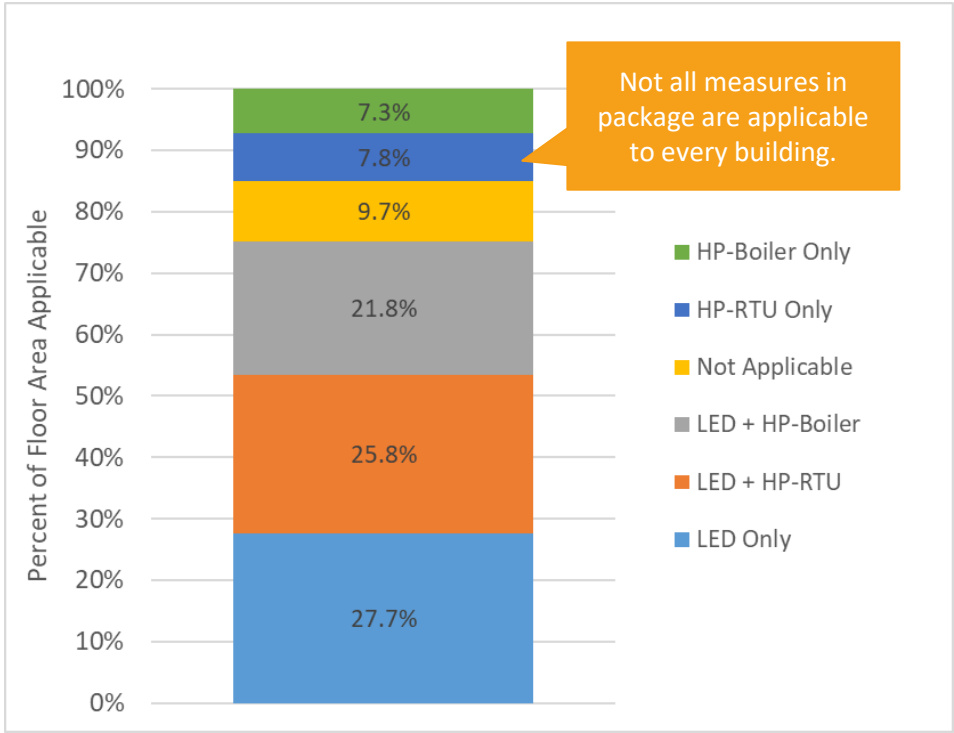
Combination of three measures from previous and current SDR releases:

- Standard Performance HP-RTU
  - Replaced RTUs with HP-RTUs
- ASHP Boiler
  - Replaced boilers with water-to-air HP
- LED Lighting
  - Replaces non-LEDs with LEDs.

Applicability

- Package 3 is applicable to **90%** of stock
- Applicable floor area by individual measure:
  - Standard Performance HP-RTU – **34%**
  - ASHP Boiler – **29%**
  - LED Lighting – **75%**
  - Not applicable – **10%.**

Applicability: % Floor Area per Measure Combination



Package 3: LED Lighting + HP-RTU Standard Performance + ASHP Boiler

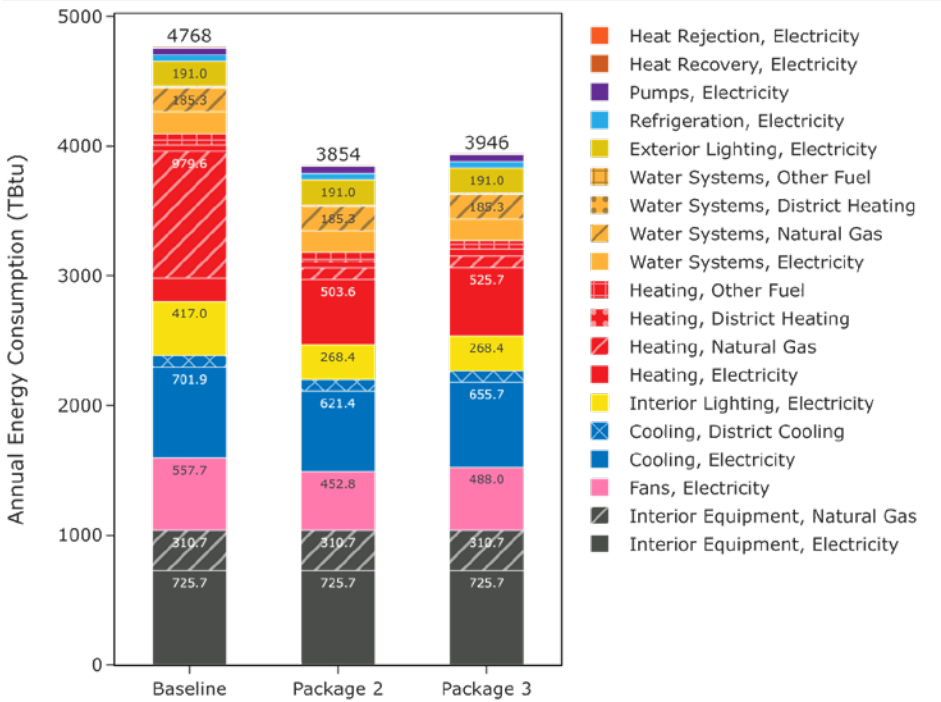
Compared to Baseline, Package 3 demonstrates:

- **91%** stock **heating gas** savings (889 TBtu)
- **–198%** stock **heating electricity** savings (–349 TBtu)
- **36%** stock **lighting** electricity savings (149 TBtu)
- **7%** stock **cooling** electricity savings (46 TBtu)
- **13%** stock **fan** electricity savings (70 TBtu)

Compared to Package 2 (LED Lighting + *HP-RTU Advanced Performance* + ASHP Boiler), Package 3 demonstrates:

- **Reduced savings** for electric heating, fans, and cooling
- Due to efficiency difference between HP-RTU measures

Stock Site Energy by Fuel and End Use: Package 2 vs. Package 3



Demand Flexibility Measures

Demand Flexibility Measures

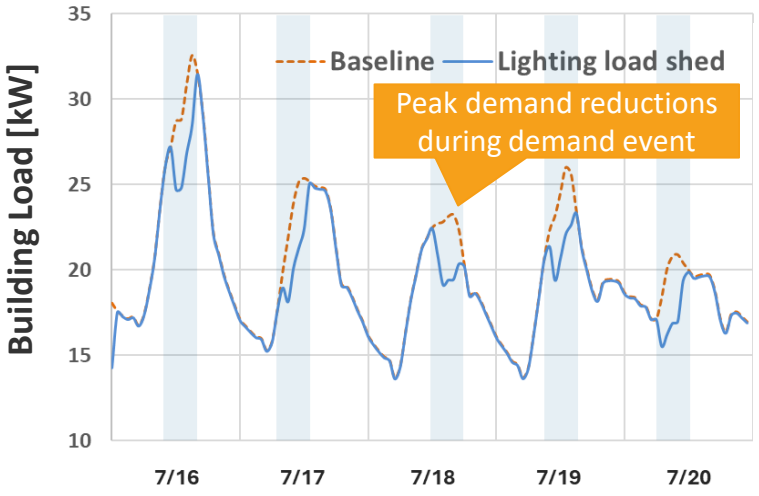
Measure Scenarios and Objective Summary

- All current measures apply daily, 4-hour events
- Applies to offices, schools and warehouses (68% stock floor area)
- Objective function determines the timing of demand flexibility events

Measure		Concept	Objective Function		Applicability (% stock floor area)	New measure for this dataset?
			Building Peak load reduction	Emissions reduction		
Thermostat control	Load shed	**2°C setback** w/ 2-hour post peak rebound control	O		68%	
	Load shift	**1°C pre-condition** pre-peak for 2 hours	O			
Lighting control		30% light dim	O	O		O
Package: thermostat and lighting control for load shed		Matches individual measures	O			O

Lighting Controls for Load Shedding

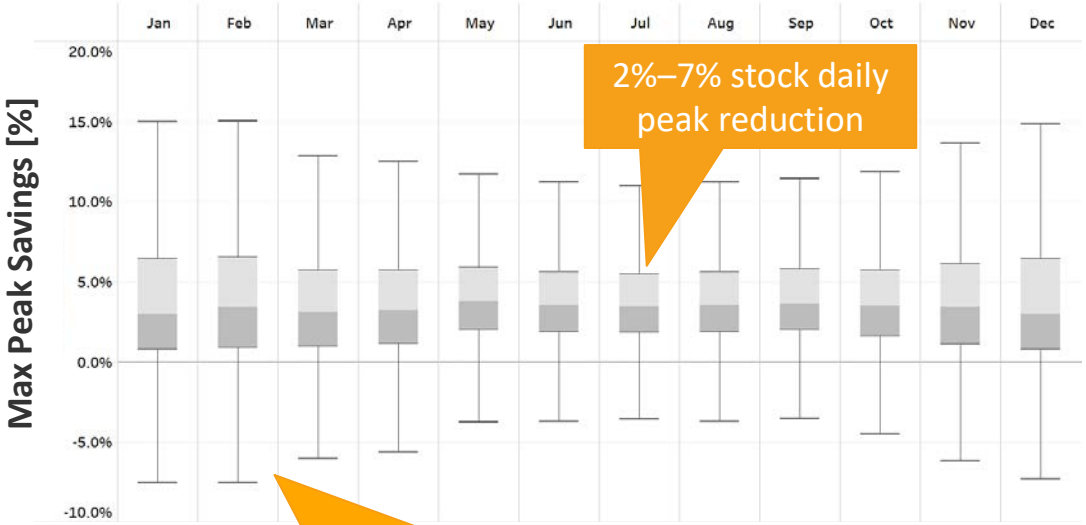
Single Load Profile



= 4-hour demand event

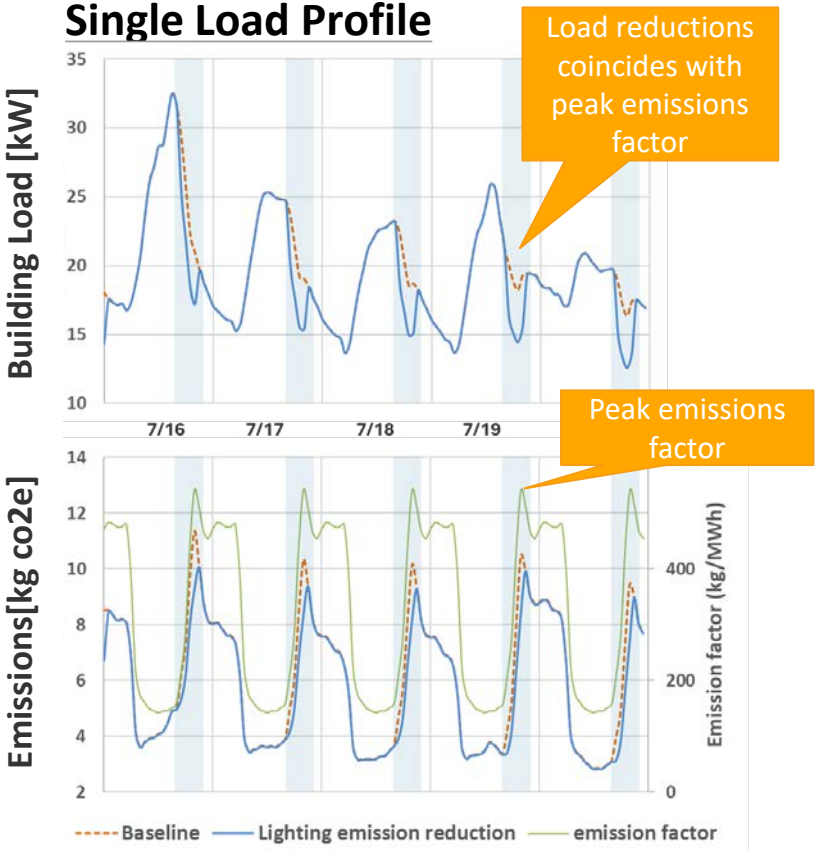
Stock Peak Load Savings

Maximum daily peak reduction for each month



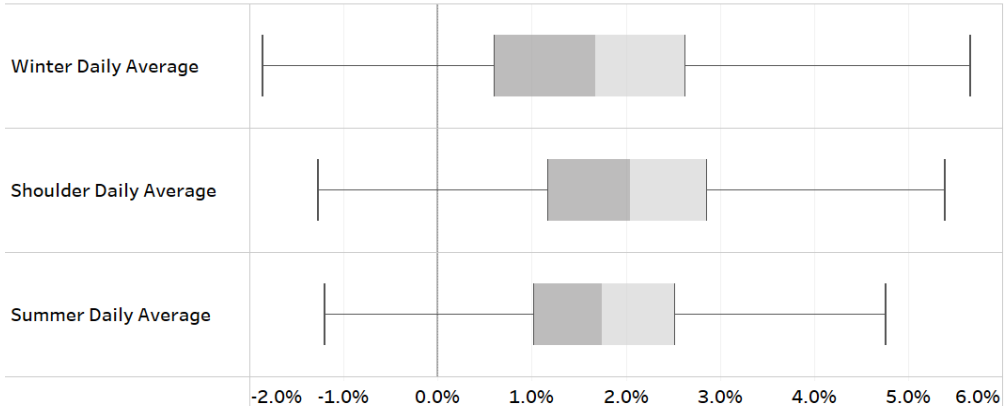
Lighting Controls for Emissions Reduction

Single Load Profile



Emissions Savings

Average daily Emissions Savings for applicable buildings by seasons



Emissions Savings with Cambium LRMER Mid Case [%]

1%–3% stock daily emissions reduction

The grid emissions scenario used for emissions calculation is the **Cambium 2022 Long-Run Marginal Emissions Rate (LRMER) Mid Case Levelized over 15 years starting in 2023**, for generalizability.

Package 6: Thermostat and Lighting Control for Load Shedding

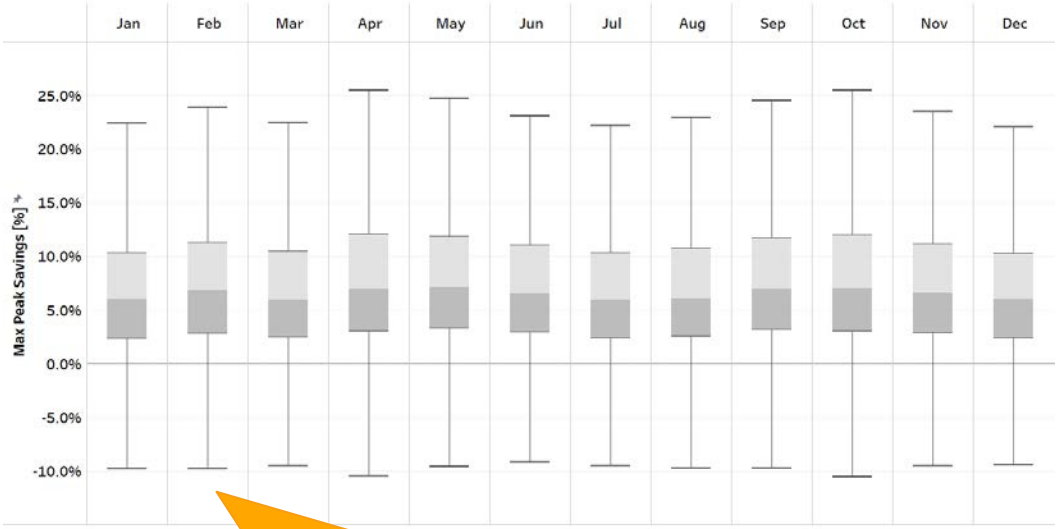
Package Concept

- Objective: **Building-level daily** peak load reduction
- Combine
  - Thermostat control for load shedding
  - Lighting control for load shedding
- Share applicability with individual demand flexibility measure.

Stock Peak Load Savings

Maximum daily peak reduction for each month

3%–12% stock daily peak reduction



Negative savings are combined results of rebound effects and increased heating load from dimmed lights.

Accessing the Dataset

Accessing the Data

	Metadata	Individual Load Profiles	Aggregate Load Profiles	Data Viewer	Full Database
Data Format	.csv and .parquet files	.csv and .parquet files	.csv and .parquet files	Dashboard with .csv exports	Amazon S3 bucket
Time Scale	Annual	15-minute intervals	15-minute intervals	Customizable	Annual or 15-minute intervals
Grouped by	Individual building ID (tract, county, state, and PUMA)	Individual building ID	Geograhies: climate zone, ISO/RTO region, state	Customizable	Customizable
Fields by	Building input characteristics	-	-	-	Building input characteristics
	Energy consumption	Energy consumption	Energy consumption	Energy consumption	Energy consumption
	Energy savings	Energy savings	Energy savings	Energy savings	Energy savings
	Emissions	-	-	-	Emissions
	Calculated fields	-	-	-	Calculated fields
Accessed via	OEDI	OEDI	OEDI	ComStock.nrel.gov	Scripting languages

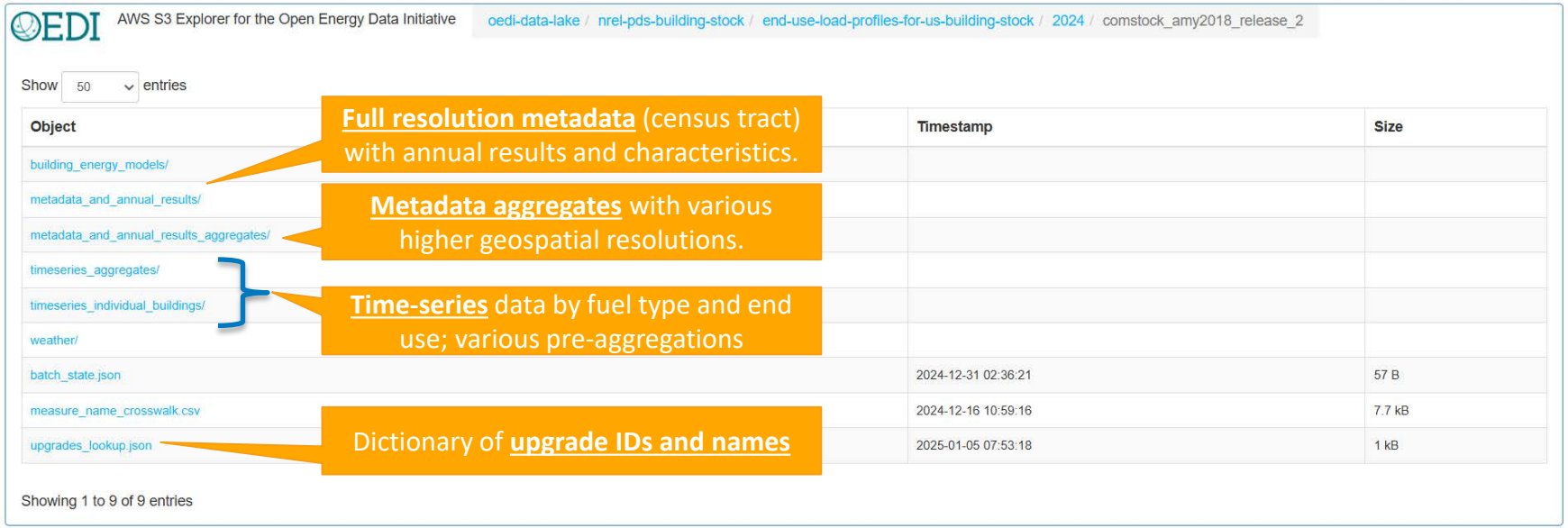
OEDI = Open Energy Data Initiative

Field Naming Convention

Prefix or Name	Description	Example
in.	Inputs of building characteristics and geospatial codes	in.window_type
out.	Simulation outputs	out.electricity.refrigeration.energy_consumption
calc.	Calculated values such as totals and % savings	calc.weighted.electricity.cooling.energy_consumption..tbtu
weight	Value for scaling single model results to national scale	4.8960474
bldg_id	Unique ID of the building model	3324
upgrade	Unique ID number for upgrade	5
model_count	Number of models aggregated (time-series files)	5334
applicability	Upgrade names	FALSE
Second Level		
out.[fuel type]	Fuel type: electricity, natural gas, etc.	out.natural_gas.water_systems.energy_consumption
out.emissions	Emission values	out.emissions.electricity.egrid..co2e_kg
out.params	Model parameters and summary statistics	out.params.dx_cooling_average_cop..cop
out.qoi	Quantities of interest such as peak demand	out.qoi.maximum_daily_use_summer_kw..kw
out.site_energy	Total of all end uses, site energy	out.site_energy.total.energy_consumption
Third Level		
out.[fuel type].[end use]	End uses: heating, cooling, lighting, water systems, etc.	out.electricity.heating.energy_consumption
Units		
..foo	".." denotes the start of the unit name	..kWh_per_ft2

Data dictionary available at OEDI

Open Energy Data Initiative (OEDI) Folder Structure



Access at: OEDI

New Sampling: Full Resolution Annual Files

Option 1: Full census-tract geographic resolution data

Full dataset at highest resolution (census tract)

- Files organized by state and county to manage file size
- **Basic:** Fewer attributes, smaller file size. **Full**: All attributes, larger file size.
- **CSV:** Compatible with Excel, larger size. **Parquet:** Compact, requires programming.
- **Recommendation:** Only use full resolution data for sub-county level analyses (by tract, city, etc.)

Folder Structure on OEDI

/metadata_and_annual_results
/by_state_and_county
/basic
/csv
/parquet
/full
/csv
/parquet

Available on OEDI

New Sampling: Annual Results Aggregations

Option 2: Lower Resolution Aggregates

Various aggregations provide smaller, more manageable file sizes with lower resolution.

- **National:** State is highest geospatial resolution, combined into a single larger file.
- **By State:** Same data as *National*, but divided by state for smaller file sizes.
- **By State and County:** County is the highest resolution
- **By State and PUMA:** PUMA is the highest resolution
- Consistent Basic/Full and CSV/Parquet structure for all.

Folder Structure on OEDI

/metadata_and_annual_results_aggregates
- /national
  - /basic (csv, parquet)
  - /full (csv, parquet)
- /by_state
  - /basic (csv, parquet)
  - /full (csv, parquet)
- /by_state_and_county
  - /basic (csv, parquet)
  - /full (csv, parquet)
- /by_state_and_puma
  - /basic (csv, parquet)
  - /full (csv, parquet)

Available on OEDI

Example Metadata File

Building ID

County

Building Type

Building Area (unweighted)

Annual Electricity Peak kW (unweighted)

Annual Natural Gas Consumption (unweighted)

	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AP	AQ	AR	
1	in.building_id	in.window_type	in.building_subtype	in.county	in.comstock_building_type	in.rotation..degrees	in.number_of_stories	in.sqft	in.hvac_system_type	in.wall_construction_type	in.weekday_operating_hours..hr	in.weekday_opening_time..hr	in.weekend_operating_hours..hr	in.weekend_opening_time..hr	out.electricity.total.peak_demand..kW	out.district_cooling.cooling.energy_consumption	out.district_heating.heating.energy_consumption	out.natural_gas.total.energy_consumption
2	55	Double - No LowE	NA	G0100030	Outpatient	225	3	37500	PSZ-AC with ele	Mass	8	8.75	8.75	6.75	288.54417	0	0	41180.55556
3	324	Single - No LowE -	NA	G0101250	Hospital	270	3	350000	VAV air-cooled	SteelFramed	8.5	8.5	12	4.75	2537.623	0	0	2049280.556
4	457	Double - LowE - Cl	NA	G0100830	Hospital	90	2	150000	VAV air-cooled	SteelFramed	8.75	8	14.75	7.75	1112.82938	0	966591.667	312955.5556
5	496	Double - No LowE	NA	G0100350	Hospital	270	2	150000	VAV chiller with	Mass	13.75	6.25	6	11.5	1016.74873	0	0	1320636.111
6	758	Double - No LowE	NA	G0100730	Outpatient	0	4	75000	PSZ-AC with gas	Mass	7.5	8.25	11.25	10.25	412.52324	0	0	176772.2222
7	766	Double - LowE - Ti	NA	G0100550	Hospital	0	7	37500	PVAV with gas b	SteelFramed	8.75	7	11	5.75	292.54247	0	0	426252.7778
8	1122	Single - No LowE -	NA	G0100950	Hospital	315	3	150000	PVAV with gas b	WoodFramed	9.5	7	6	11.5	1264.01005	0	0	3154086.111
9	1934	Double - LowE - Ti	NA	G0100730	Hospital	270	5	1000000	PVAV with gas b	SteelFramed	9	7.5	7.25	9.75	6813.14901	0	0	6029661.111
10	2357	Double - LowE - Cl	NA	G0100730	Outpatient	180	2	75000	PSZ-AC with gas	WoodFramed	9.5	6.75	10.75	4.75	374.63398	0	0	179880.5556
11	3324	Single - No LowE -	NA	G0100950	Hospital	270	3	350000	VAV chiller with	Mass	9	7.5	8.25	7	2152.99659	0	0	2584791.667
12	3640	Double - LowE - Cl	NA	G0100170	Hospital	90	3	350000	VAV air-cooled	SteelFramed	9.75	7	12	5.5	2544.36643	0	847533.333	334913.8889
13	3801	Single - No LowE -	NA	G0100730	Outpatient	180	3	75000	PSZ-AC with gas	Mass	8.5	7.5	10.75	11	489.49215	0	0	170322.2222
14	5764	Single - No LowE -	NA	G0200500	Hospital	270	1	75000	VAV chiller with	WoodFramed	9	8	10	6.75	329.3614	0	0	2559697.222
15	6058	Double - No LowE	NA	G0400190	Outpatient	45	1	37500	PSZ-AC with gas	SteelFramed	8.25	5.5	8.75	9.25	294.87621	0	0	65736.11111
16	6194	Single - No LowE -	NA	G0400130	Outpatient	225	1	75000	PSZ-AC with ele	SteelFramed	7.75	6.5	11.25	6.75	600.52446	0	0	83033.33333
17	6447	Double - No LowE	NA	G0400190	Outpatient	180	2	17500	PSZ-AC with ele	WoodFramed	6.5	6.5	10.5	8.5	99.54627	0	0	18208.33333
18	6752	Double - LowE - Ti	NA	G0400130	Outpatient	180	1	37500	PSZ-AC with ele	SteelFramed	7	7	17.5	5.25	209.44043	0	0	42166.66667
19	7153	Double - LowE - Cl	NA	G0400130	Outpatient	315	1	37500	PSZ-AC with ele	SteelFramed	7.75	9.5	7.25	10	310.28772	0	0	40255.55556
20	7500	Single - No LowE -	NA	G0400190	Outpatient	225	1	37500	PSZ-AC with ele	Mass	7.25	8.75	15.5	4.5	331.52824	0	0	41991.66667
21	7516	Double - No LowE	NA	G0400130	Outpatient	0	1	37500	PSZ-AC with ele	Mass	7	6.5	10.75	9.75	283.39981	0	0	40002.77778
22	7535	Double - No LowE	NA	G0400190	Outpatient	0	1	17500	PSZ-AC with gas	SteelFramed	9	8.5	10	10.75	122.88107	0	0	32330.55556
23	7662	Single - No LowE -	NA	G0400130	Outpatient	135	2	75000	PSZ-AC with ele	SteelFramed	10.25	6.5	11	12	592.7709	0	0	91941.66667

Example Time-Series File

Building ID

Timestamp

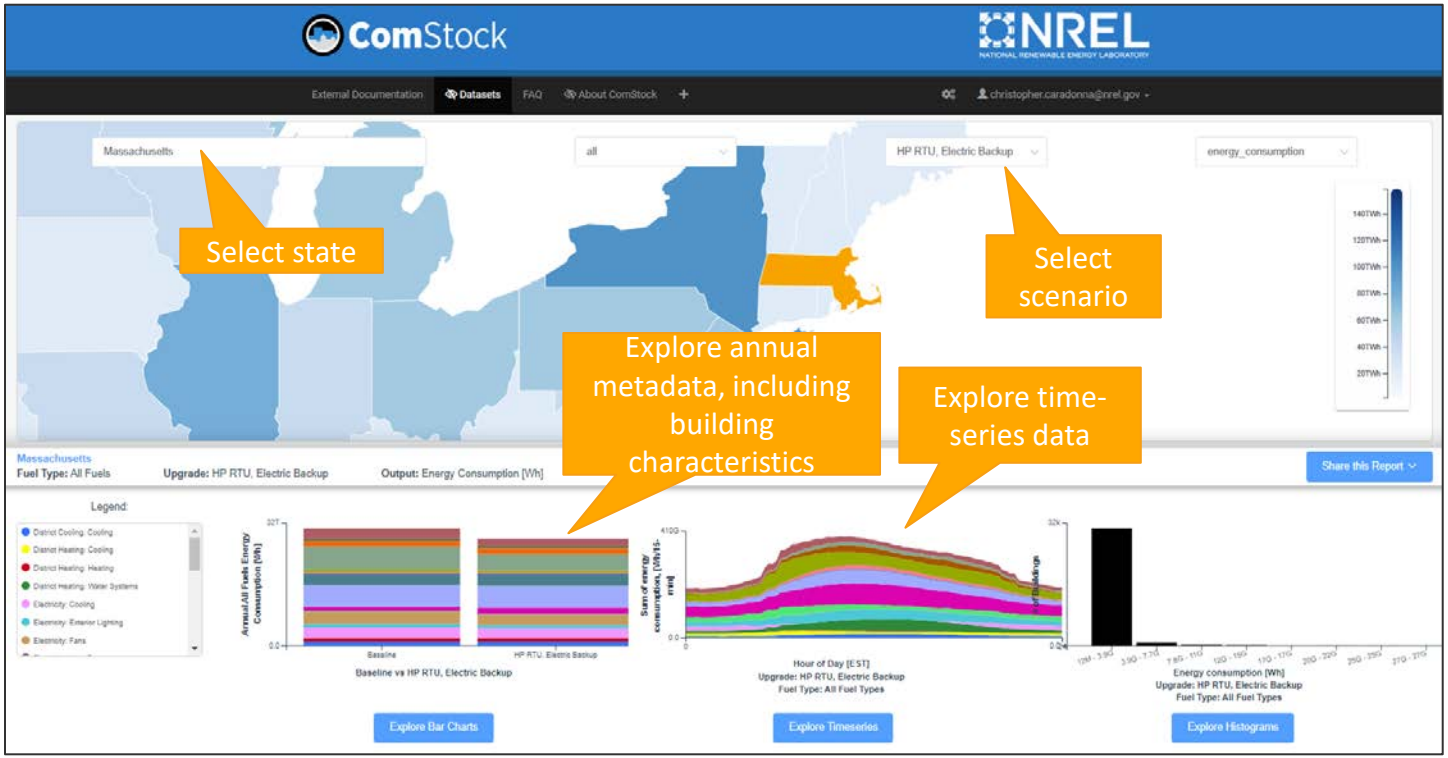
Exterior Lighting Consumption (kWh)

Interior Lighting Consumption (kWh)

Gas Heating Consumption (kWh)

	B	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	bldg_id	timestamp	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	out.electricity.refrigeration.energy_consumption	out.electricity.water_systems.energy_consumption	out.natural_gas.heating.energy_consumption	out.natural_gas.interior_equipment.energy_consumption	out.natural_gas.water_systems.energy_consumption
2	5324	1/1/2018 0:15	0	1.2107	3.4499	0	0	0	2.3114	0.3319	0.0003	0	0	0	0	0.278477731
3	5324	1/1/2018 0:30	0	1.2107	3.4499	0	0	0	2.1577	0.2885	0.0003	0	0	0	0	0.763094899
4	5324	1/1/2018 0:45	0	1.2107	3.4499	0	0	0	1.8502	0.2017	0.0003	0	0	0	0	0.678523028
5	5324	1/1/2018 1:00	0	1.2107	3.4499	0	0	0	1.6965	0.1583	0.0003	0	0	0	0	0.262133379
6	5324	1/1/2018 1:15	0	1.2107	3.4499	0	0	0	1.2485	0.1461	0.0003	0	0	0	0	0.801860046
7	5324	1/1/2018 1:30	0	1.2107	3.4499	0	0	0	1.0245	0.1399	0.0003	0	0	0	0	0.608005027
8	5324	1/1/2018 1:45	0	1.2107	3.4499	0	0	0	0.5764	0.1277	0.0003	0	0	0	0	0.242852543
9	5324	1/1/2018 2:00	0	1.2107	3.4499	0	0	0	0.3524	0.1216	0.0003	0	0	0	0	0.834873996
10	5324	1/1/2018 2:15	0	1.2107	3.4499	0	0	0	0.5835	0.0811	0.0003	0	0	0	0	0.524560196
11	5324	1/1/2018 2:30	0	1.2107	3.4499	0	0	0	0.6991	0.0608	0.0003	0	0	0	0	0.298359756
12	5324	1/1/2018 2:45	0	1.2107	3.4499	0	0	0	0.9302	0.0203	0	0	0	0	0	0.420222982
13	5324	1/1/2018 3:00	0	1.2107	3.4499	0	0	0	1.0457	0	0	0	0	0	0	0.053723496
14	5324	1/1/2018 3:15	0	1.2107	3.4499	0	0	0	1.0449	0.0026	0	0	0	0	0	0
15	5324	1/1/2018 3:30	0	1.2107	3.4499	0	0	0	1.0445	0.0039	0	0	0	0	0	0
16	5324	1/1/2018 3:45	0	1.2107	3.4499	0	0	0	1.0437	0.0065	0	0	0	0	0	0
17	5324	1/1/2018 4:00	0	1.2107	3.4499	0	0	0	1.0433	0.0078	0	0	0	0	0	0
18	5324	1/1/2018 4:15	0	1.2107	3.4499	0	0	0	1.0424	0.0104	0	0	0	0.438	0	0
19	5324	1/1/2018 4:30	0	1.2107	3.4499	0	0	0	1.042	0.0117	0	0	0	0.3853	0	0
20	5324	1/1/2018 4:45	0	1.2107	3.4499	0	0	0	1.0412	0.0143	0	0	0	0.2948	0	0
21	5324	1/1/2018 5:00	0	1.2107	3.4499	0	0	0	1.0408	0.0156	0	0	0	0.16	0	0
22	5324	1/1/2018 5:15	0	1.2107	3.4499	0	0	0	1.04	0.0183	0	0	0	0.1943	0	0
23	5324	1/1/2018 5:30	0	1.2107	3.4499	0	0	0	1.0396	0.0196	0	0	0	0.2245	0	0
24	5324	1/1/2018 5:45	0	1.2107	3.4499	0	0	0	1.039	0.0215	0	0	0	0.2503	0	0.474015352
25	5324	1/1/2018 6:00	0	1.2107	3.4499	0	0	0	0.9423	0.0579	0	0	0	0.278	0	0

ComStock Data Viewer

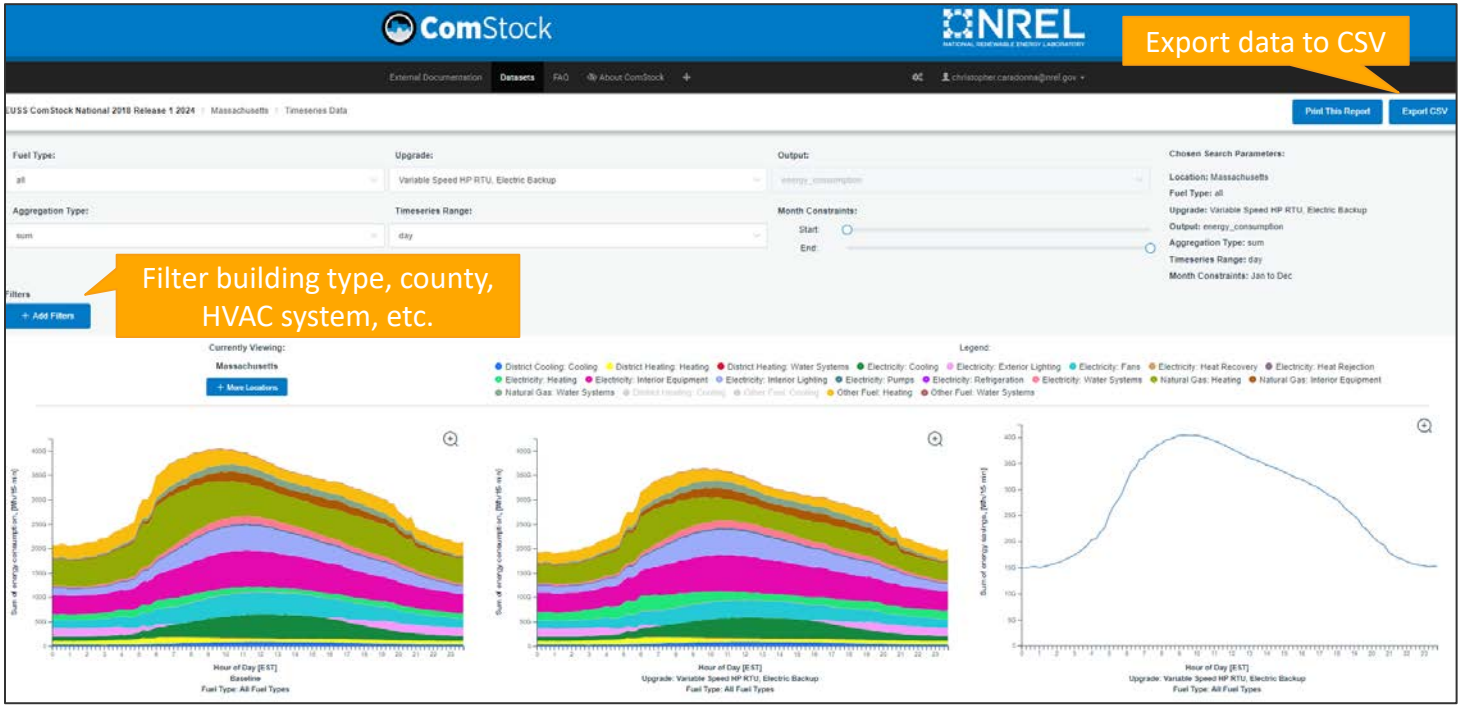


- Visualize data
- Export to csv
- Custom timeseries aggregations

Requires free account

Access at: ComStock.nrel.gov

ComStock Data Viewer



- Visualize data
- Export to csv
- Custom timeseries aggregations

Requires free account

Access at: ComStock.nrel.gov

A Few Reminders

- Only use higher-resolution annual files from OEDI when needed
- With higher resolution data, weather files will not be as locally specific
- Building IDs may now be used across census tracts with locally specific weights
- All time stamps are time-period-ending and are in EST
- Annual metadata files provide weighting factors for national scaling. Columns with “weighted” in the title already have this factor applied
- Check your sample sizes on custom aggregations—too few samples can increase uncertainty
- All “out.” columns without units denoted are in kWh.
  (This is driven by current limitations with the data viewer.)

Next Steps

Commercial SDR FY25

List for Next Release:

Measure Name	Description
Electric resistance boilers	Replace gas boilers with electric resistance boilers
Condensing gas boiler retrofit	Replace gas boilers with higher-efficiency condensing gas boilers
HP-RTU using NREL lab testing data	Replace gas and electric RTUs with HP-RTUs: performance curves developed using NREL lab data
Photovoltaics for 40% roof coverage	Add solar PV equating to 40% rooftop coverage
Various demand flexibility measures	Thermostat pre-cooling/heating, thermostat load shed, plug load shed, lighting load shed with grid peak objective functions

Additional 2025 releases expected in May, August, and November.

Email us with measure/package requests for future releases: **comstock@nrel.gov**

Q&A

comstock@nrel.gov

www.nrel.gov

NREL/PR-5500-92766

This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by U.S. Department of Energy Office of Building Technologies. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

Photo from iStock-627281636

NREL
Transforming ENERGY