This presentation provides a quick introduction to the ComStock and its datasets.

Agenda

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3 ComStock Use Cases

4 Accessing the Data

Introduction to ComStock

What Is ComStock?

The commercial building sector stock model, or ComStock™, is a highly granular, bottom-up model that uses:

- Multiple data sources
- Statistical sampling methods
- Advanced building energy simulations

…To create **public datasets** describing the annual and subhourly (15-minute) energy consumption and potential energy savings for the U.S. commercial building stock, for geographies at the county level and below.

The commercial building sector stock model, or ComStock™, is a highly granular, bottom-up model that uses multiple data sources, statistical sampling methods, and advanced building energy simulations to estimate the annual and subhourly (15 minute) energy consumption of the commercial building stock across the United States. ComStock offers data for geographic resolutions at the county level or below.

"Stock" in the context of this presentation is referring to the supply or inventory of the commercial buildings for a given geography. The national or U.S. building stock refers to all commercial buildings in the United States, ~6 million buildings.

ComStock produces public datasets about the U.S. commercial building stock that include trillions of rows of data. Don't worry though; the dataset has been broken into manageable chunks that can be loaded into popular programs such as Microsoft Excel.

The ComStock datasets identify where energy is consumed geographically, in what building types and for which end uses, and at what times of day.

Simultaneously, ComStock identifies the impact of efficiency measures: how much energy do efficiency measures save; where, or in which use cases, do measures save energy; when, or at what time of day do savings occur; and which building stock segments have the greatest savings potential.

Problem Statement

A lack of credible and relevant information results in inaction by cities, states, utilities, and other major stakeholders.

Will electrification of buildings…
- Reduce carbon emissions in my city?
- Be feasible for my building stock?
- Overload the grid?

The goal of this work is to help cities, states, utilities, and other stakeholders have the information and resources needed to make informed decisions about their building stock.

Alignment and Impact

We are putting information in the hands of decision makers

ComStock supports U.S. Department of Energy (DOE) goals to increase building energy efficiency, accelerate building electrification, and do so in ways that prioritize equity, affordability, and resilience.

What the Datasets Provide

- Building stock characterization
- When and how buildings use energy
- Potential impacts of energy efficiency
- Information on time-sensitive value of energy resources
- Potential impacts of building electrification.

How the Information Is Used

- Electrification planning
- Emissions analysis
- Decarbonization
- Utility-integrated resource plans and load forecasts
- Policy and rate design.

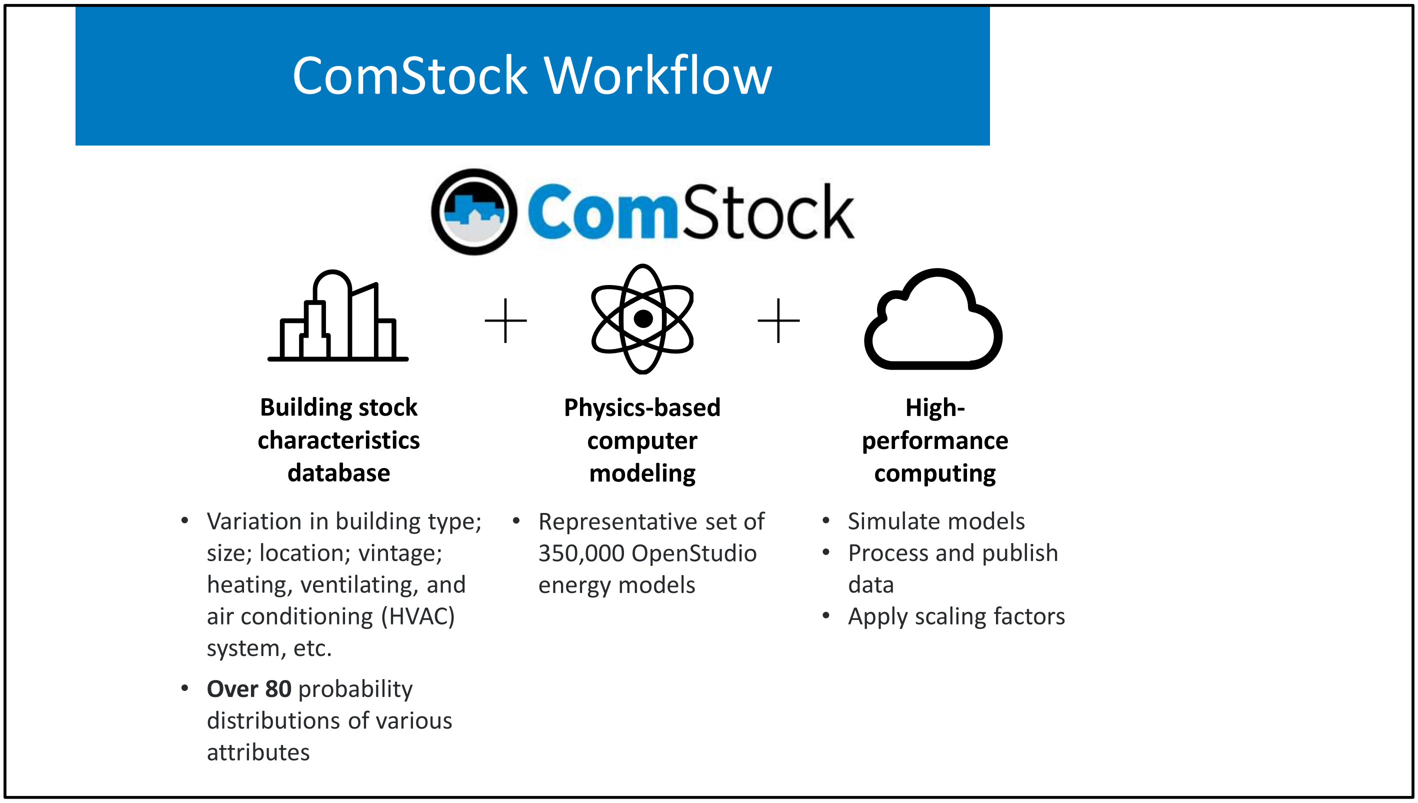
So, we are putting information into the hands of decision makers.

The datasets provide various information;

- building stock characterization – size, type, # of stories, wall construction, window type, etc
- when and how buildings use energy, and
- potential impacts of energy efficiency and electrification scenarios on the building stock

And there are various use cases for the data including,

- electrification planning
- emissions and decarbonization analysis, and
- utility resource planning and load forecasting
- policy and rate design



So, how does ComStock work?

The workflow can be broken into 3 categories:

1. Building stock characteristics database, where we seek to understand prominent building characteristics, and their prevalence, in the building stock
2. Physics based computer modeling, or building energy modeling, and
3. High performance computing for simulations and data processing.

How Representative Is the Dataset?

Real Life:
Every pixel is a building

ComStock/ResStock:
Every pixel is a model

The low-res puppy picture is great for many use cases, but not all (e.g. counting whiskers)

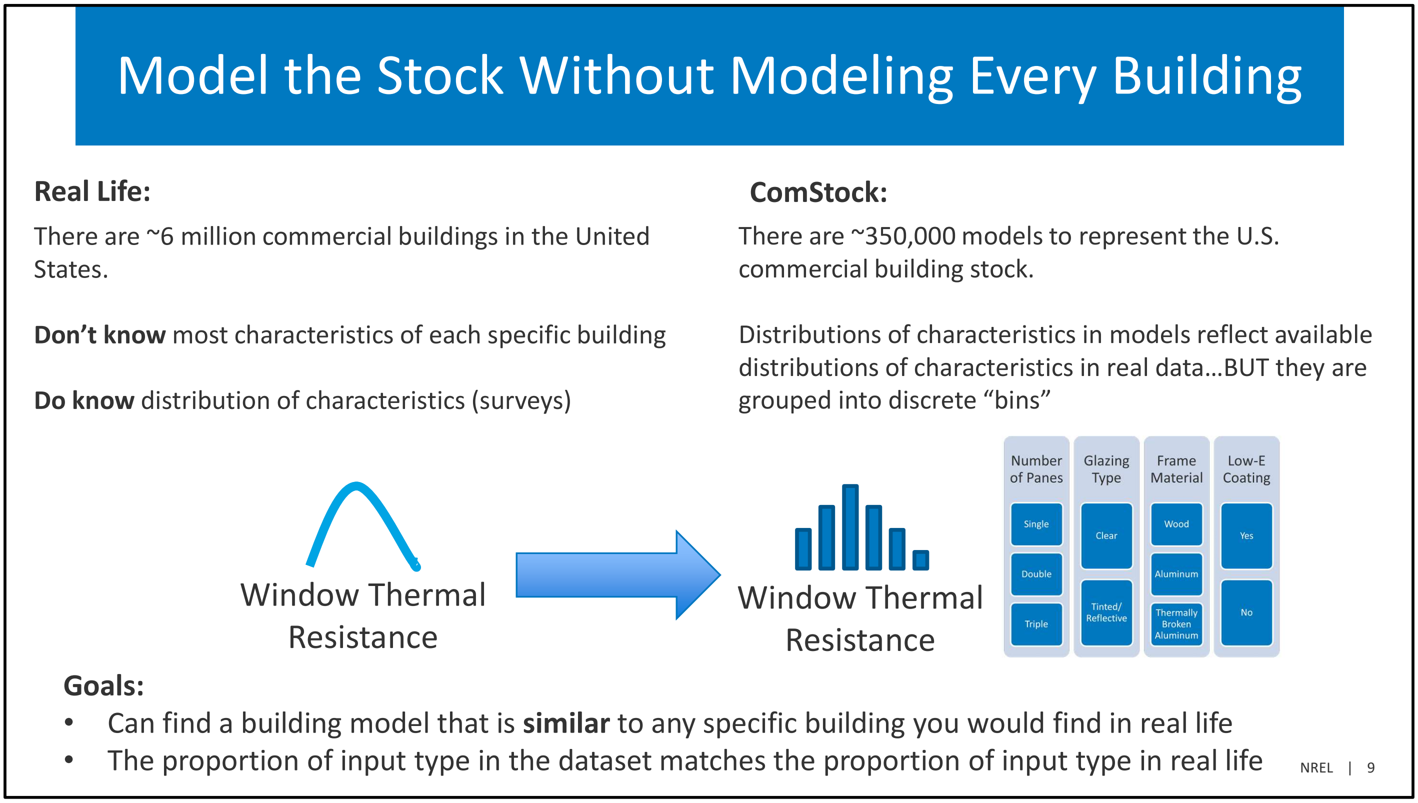
Puppy image by Jonathan Kriz, 2010: https://www.flickr.com/photos/27587002@N07/5170590074

Quick Explanation:
With datasets, the question often arises, “how good is it?” The datasets produced by the ComStock and ResStock teams are sort of like these two pictures. The puppy on the left represents the actual building stock. For our picture of the commercial and residential building stock to be this clear, we’d have to know details about every single building in the U.S. The picture on the right is what we’re going for. We have collected enough data from a variety of sources to make informed estimates of the buildings that are likely to exist in local geographies and the opportunities for intervention. It’s not perfect, but you can still get a sense of what the picture is and know it’s a puppy with floppy ears, a cute nose, and two eyes.

Detailed Explanation:
ComStock uses the available building characteristic datasets to identify the distribution of the building stock characteristics in each of its 350,000 modeling archetypes. In this way, ComStock models the building stock, not individual buildings. Consider the puppy pictures. The puppy on the left represents the fidelity theoretically possible in modeling every building in the U.S. individually. The puppy on the right represents the fidelity of modeling

the building stock, where every pixel is a modeled archetype. There is enough fidelity to see that the picture represents a puppy with floppy ears and a cute nose.

The ComStock equivalent of this analogy is that we have just enough information to answer the two key questions that ComStock poses: how is energy used in the U.S. building stock and what is the impact of energy saving technologies. The goal in developing the set of 350,000 modeling archetypes is to be able to accurately assess the United States commercial building stock today with enough resolution both typologically and geographically to help key decision makers take actionable information from the model.



To construct our pixelated puppy picture, we need to identify the characteristics of each pixel, or archetypical model. We achieve this through a sampling process. The goal of the sampling process is to have the proportion of each characteristic in the sampled archetypical buildings match the proportion of the same characteristic in real life.

Let’s think about exterior windows, for example. In the real world, there is a distribution of thermal resistances (which is the key thermodynamic input for our models) due to the variety of types, sizes, frame types, and conditions of windows. It is impractical to attempt to know every detail of every (or even many) individual windows. However, from survey data we know the distributions for the number of panes in windows, the type of glazing, the frame, and exterior coatings. The building characteristic database (which includes this survey data) is used to bin windows using those four properties, and from that to estimate the distribution of window thermal resistance.

Additional Details: Currently, ComStock assembles all input distributions as an n-dimensional joint probability distribution, which is then sampled using a space-filling sampling algorithm. The goal of the sampling algorithm is to minimize the largest void, or “gap,” between individual samples. Each sample generated by the sampling algorithm defines the input characteristics for a single building energy model (BEM). This results in hundreds of thousands of BEMs (millions when alterations to the building stock are also considered).

Example of Select ComStock Building Characteristic Inputs

Location and Envelope Basics		Heating and Cooling		Energy Code Followed During Last Replacement	
Building ID	810	**Heating**	Central Single-Zone RTU Furnace	**HVAC**	DOE Ref 1980-2004
City	St. Clair County, Alabama	**Heating Fuel**	Natural Gas	**Service Water Heating**	DOE Ref 1980-2004
IECC Climate Zone	3A	**Cooling**	PSZ-AC with gas coil DX	**Interior Equipment**	DOE Ref 1980-2004
Building Type	Stand Alone Retail	**Setpoints and Offsets**	Heating: 67°F/7°F	**Exterior Lighting**	90.1-2013
Year Built	1977		Cooling: 70°F/8°F	**Roof**	DOE Ref Pre-1980
Floor Area	3,000 sq ft	**Service Water Heating Fuel**	Electricity	**Walls**	DOE Ref Pre-1980
Stories	1	**Occupancy Schedule**		**During Original Building Construction**	DOE Ref Pre-1980
Windows	Double - No LowE - Clear – Aluminum	**Weekday Operating Hours**	9.25	**Interior Equipment**	
Average U Value	0.225 (Btu/ft2)	**Weekday Opening Time**	7.75	**Interior Lighting Generation**	Gen2 T8 Halogen
Window to Wall Ratio	0.18	**Weekend Operating Hours**	16.5	**Lighting Base to Peak Ratio**	0.5
Wall Type	Metal	**Weekend Opening Time**	6.25	**Equipment Base to Peak Ratio**	0.1

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Here we can see some examples of building characteristic property fields for a single ComStock building ID.

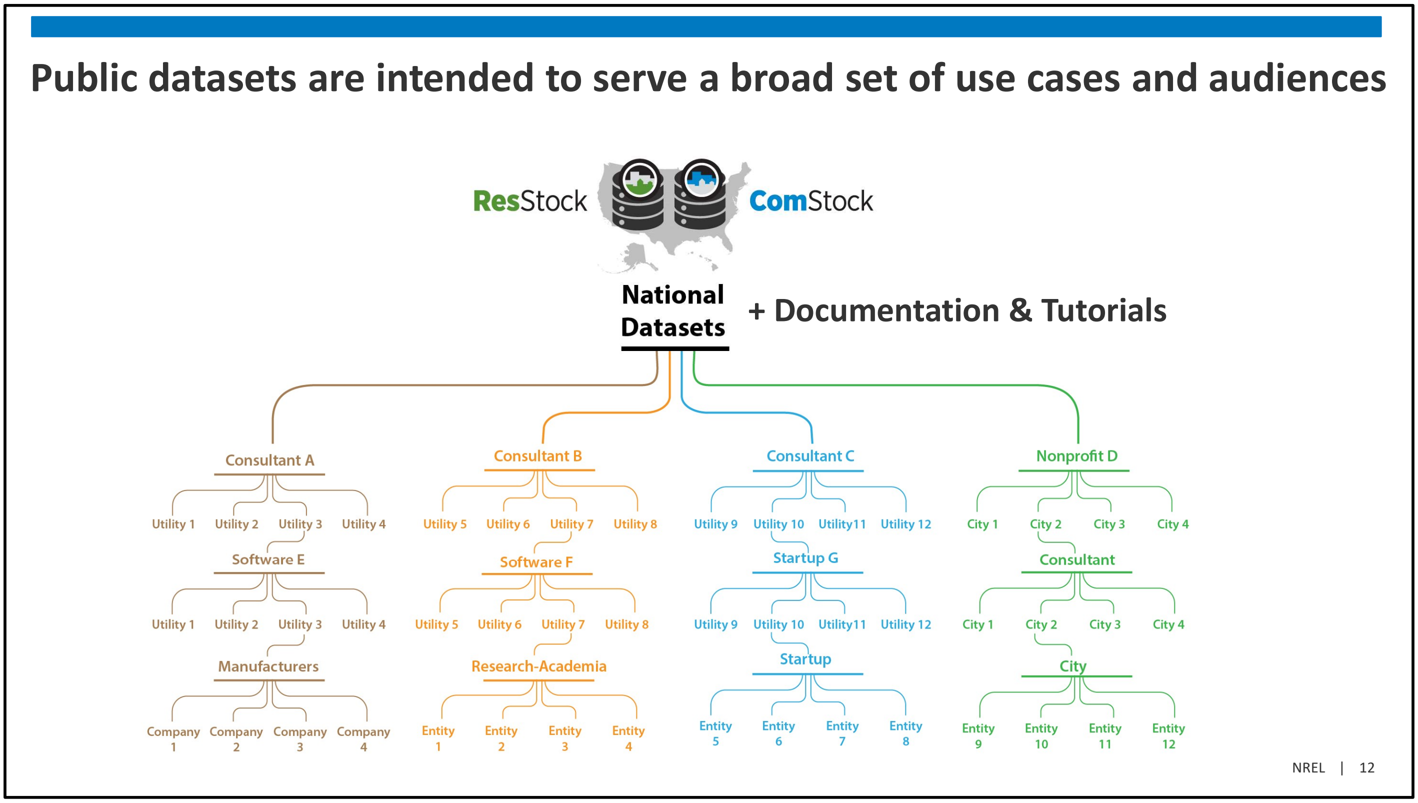
Many of these are informed by the probability distributions discussed previously, while others are informed by energy code standards and other assumptions.

Note that the energy code followed informs some of the performance metrics for a given building system. For example, the HVAC energy code followed will determine heating and cooling efficiencies, prevalence of energy efficiency features such as heat recovery or economizers, and so on…

These are a function of when the building was built, but they also include an equipment turnover rate for which a newer energy code may be followed.

What’s in the Dataset?

So now let’s get into what is included in the publicly available ComStock dataset.



Before diving into the details, we'd like to mention that these datasets strive to serve a broad set of use cases and audiences. Our users range from PhDs at universities to utility engineers, software companies, non-profit, start ups, building portfolio owners or staff at an elected official's office.

The goal is that most users find the information they need to perform analysis readily available in our dataset. The downside is that niche use cases may not currently be covered. The ComStock team attempts to balance the diverse needs of its user base.

Our intention is to publish accompanying guidance to assist existing and new participants in the energy analysis space. These documents will generalize methods and techniques developed by the ComStock team to enable repeatable analysis, performed outside the national labs, at a lower technical and financial burden than is currently possible today.

Building Characteristics

Use Type

What the building is used for

- *Office*
- *School*
- *Hospital*
- *Hotel*
- *Restaurant*
- *Retail*
- *Warehouse*

**16 building types*

Envelope

How the building is constructed

- *Floor area*
- *Wall type*
- *Insulation*
- *Window type*

Age

Age of the building and the equipment in it

- *Year built*
- *Energy code followed during last replacement for six characteristics*

Occupancy Schedules

Operating hours for each building

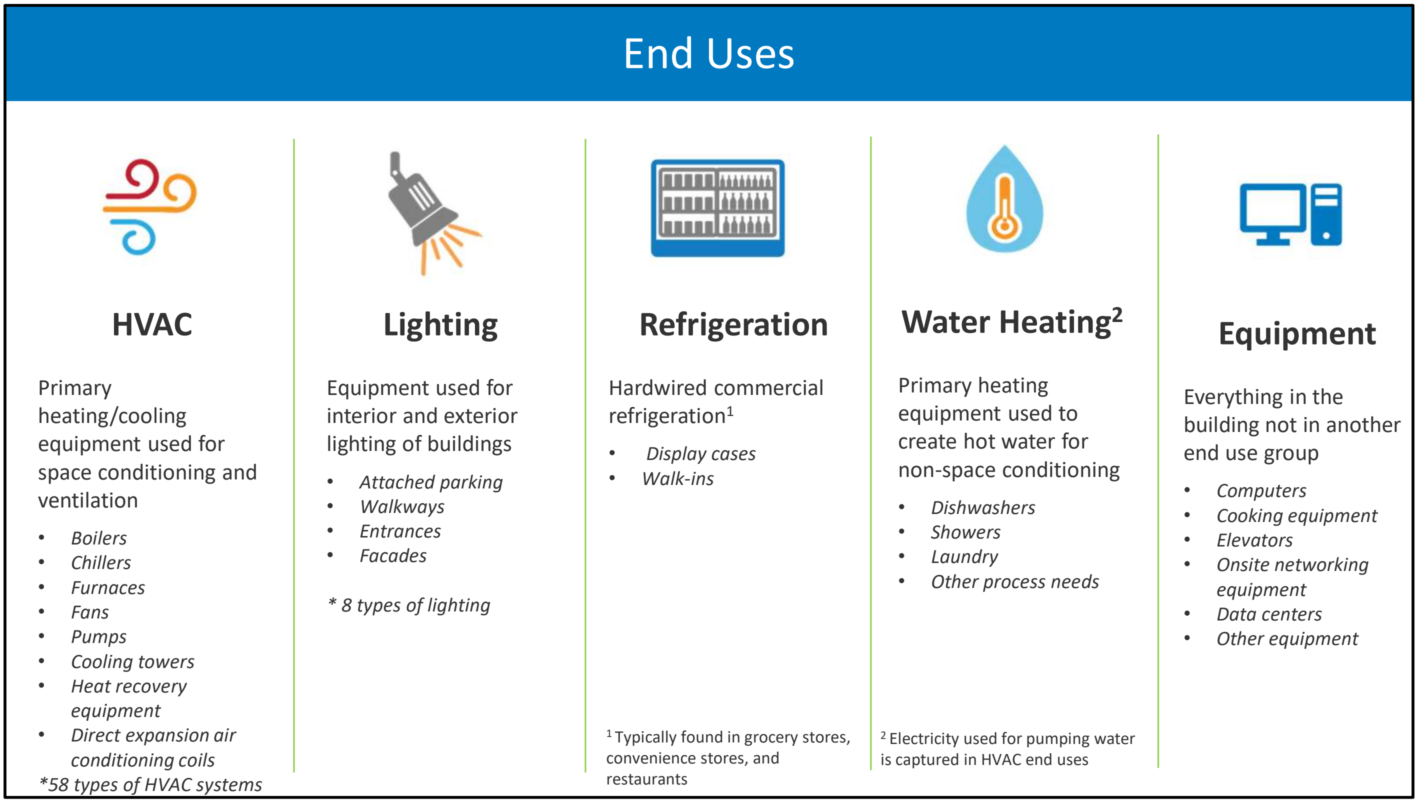
- *Weekday opening time and operating hours*
- *Weekend opening time and operating hours*

Location

Where the building is located

- *Census Public Use Microdata Area (PUMA)*
- *County*
- *State*
- *Independent system operator (ISO) region*

First off, we have the building characteristics that are used as inputs to create the building energy models. These include things like the building type, envelope, age of the building and its components, occupancy schedules and where the building is located with varying levels of geographic specificity.



This slide provides an overview of the 5 end use groups that ComStock provides results for. Each building model has annual and timeseries energy consumption for interior equipment, HVAC, lighting, refrigeration and water heating end uses.

The dataset includes additional levels of detail on each of these groups. For example, there are 58 types of HVAC systems and 8 types of lighting.

Fuel Types

Electricity

Electricity consumed by the building

- *Generated by the utility (offsite)*

Natural Gas

Natural gas supplied to and consumed by the building[1]

Other

Fuel oil + propane[2]

- *Typically provides heating and water heating in buildings with no access to natural gas distribution pipes*

District Heating[3]

Hot water or steam generated at a central plant and distributed to buildings via underground pipes

- *Generation by combustion of natural gas in large boilers, some systems may use coal or fuel oil*

District Cooling[3]

Chilled water generated at a central plant and distributed to buildings via underground pipes

- *Generation by running large cooling equipment (chillers) operated using utility-supplied electricity, or sometimes using natural gas combustion*

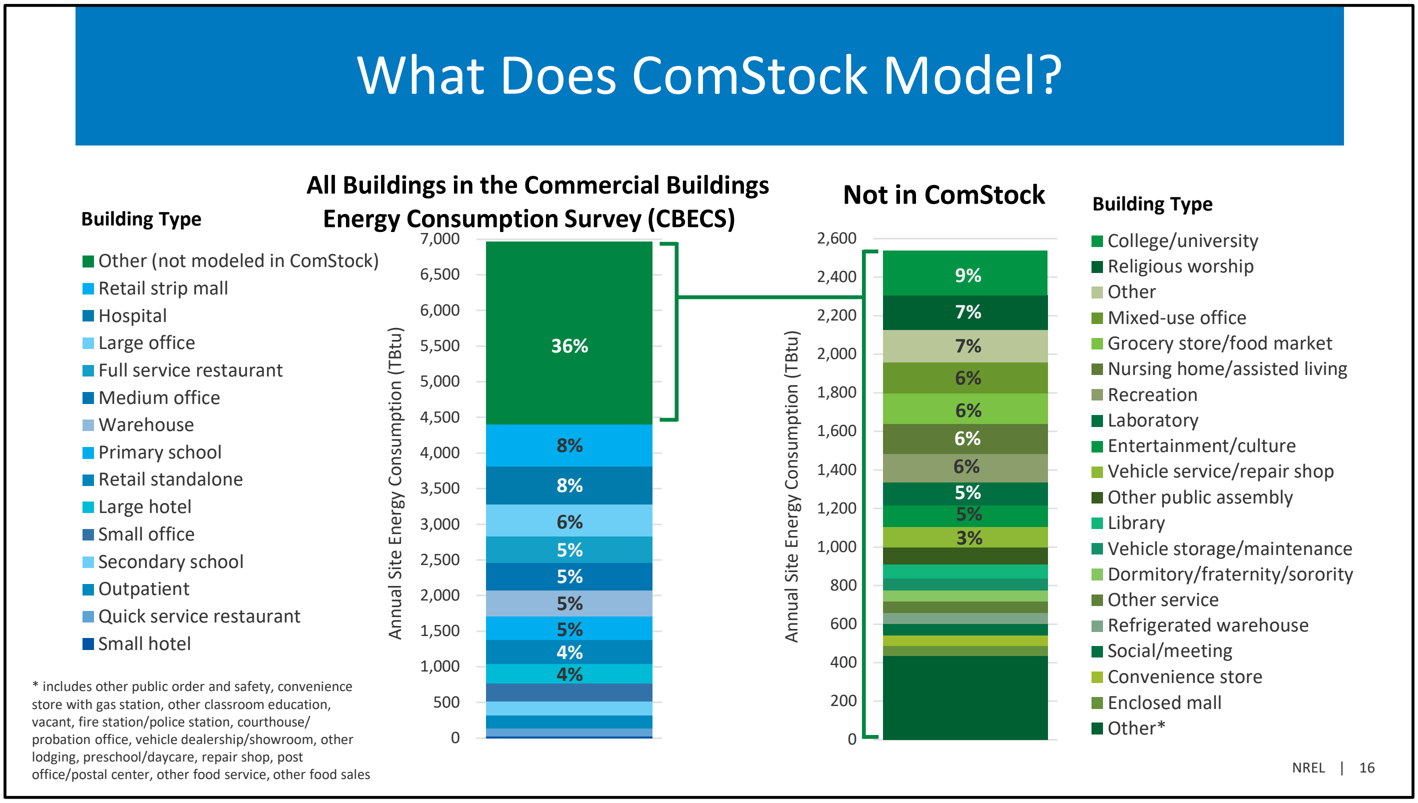
[1] Does not include natural gas consumed by the utility to generate electricity

[2] Often found in rural areas or urban areas where geographic challenges to natural gas pipelines exist

[3] Systems typically found in large metropolitan areas or on higher education campuses, healthcare campuses, and military installations

These end uses are further broken down by five fuel types. In ComStock, there are annual and timeseries data available for whole-building consumption for each fuel type as well as broken out by end use.

Please note, for District Heating and Cooling the values in the dataset are the steam/hot water/chilled water energy consumption, not the energy used to create that resource or move it to the building.



Any estimate of the energy consumption of the U.S. commercial building stock relies heavily on an estimate of how much floor area of each type of building exists in each part of the country. The ComStock dataset uses several different datasets, including CoStar, to figure out how many buildings of each type, vintage, and size exist in each county.

ComStock weights the floor area of individual building models to match the square footage found in CBECS on a national level. This figure shows the building types not represented in the ComStock model (36%), on a CBECS Principal Building Activity Plus basis, and their relative contribution to the commercial building energy use in the United States.

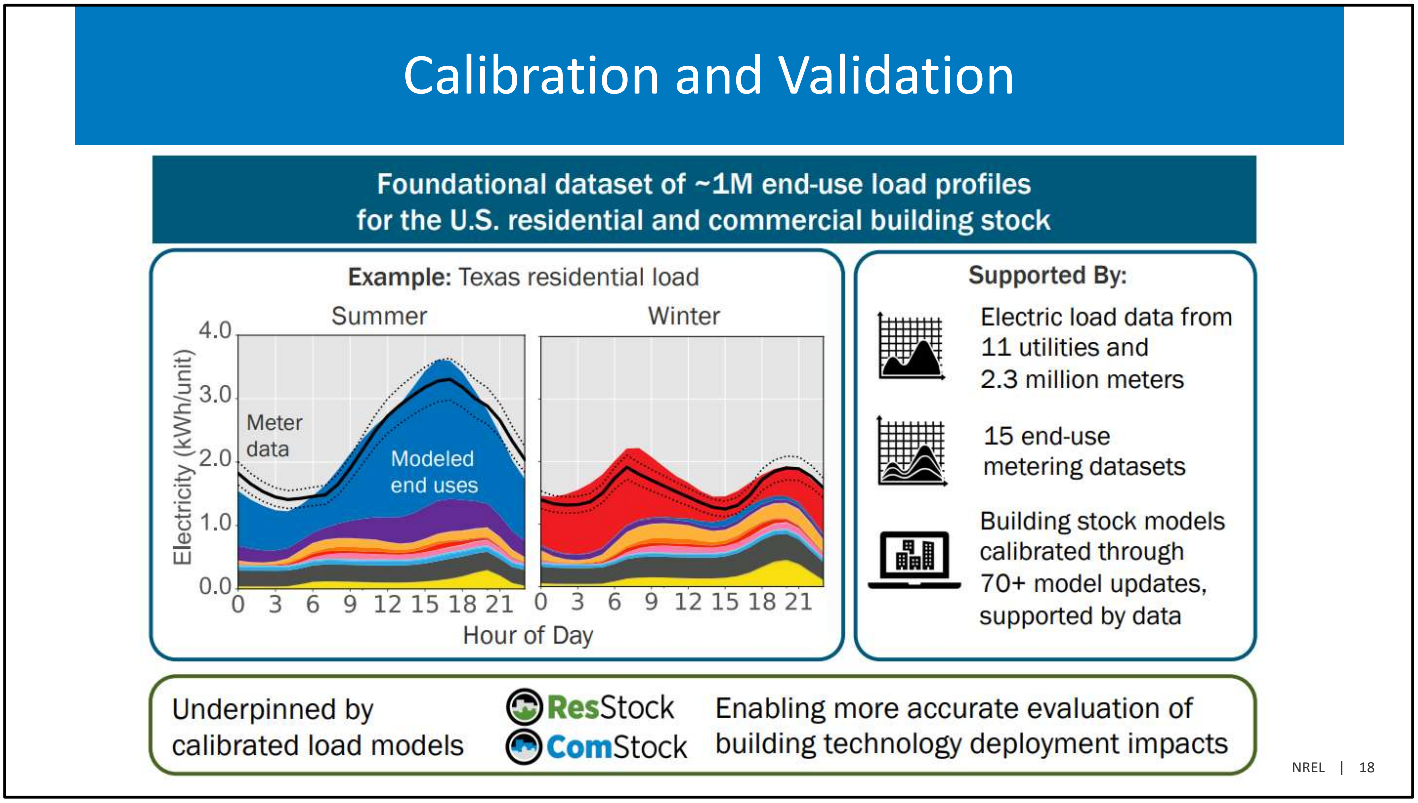
Available Energy Efficiency Measures

Measure Name	Description	% of U.S. Stock Floor Area
Roof Top Unit (RTU) Heat Pump (HP)	Replace gas and electric RTUs with HP-RTU.	45%
Rooftop Ventilator + HP Split System	Replace gas and electric RTUs with rooftop ventilator + HP split system in small commercial buildings (<20,000 ft^2).	11%
Air to Water HP Boiler Retrofit	Replace gas boilers with heat pump boilers.	18%
LED Lighting	Upgrade all lighting to LED.	65%
Exterior Wall Insulation	Add exterior wall insulation panels.	98%
Secondary Windows	Add secondary windows.	>99%
Window Replacement	Replace windows.	>99%
Window Film	Add window film to windows.	>99%
Roof Insulation	Add roof insulation.	>99%

* New energy efficiency measures are released every 6 months

The ComStock dataset includes energy efficiency measures in addition to the baseline energy consumption data. This is the list of currently available (March 2023) measures and the percentage of the U.S. stock building floor area that they are applicable to. New measures are released every 6 months.

Please visit our website https://www.comstock.nrel.gov to find the current list of “Available Datasets”.



The ComStock and ResStock team worked with more than 30 data sharing partners over three years to obtain the empirical data used for calibration and validation. This involved navigating privacy concerns and data transfer issues in order to obtain customer meter data and building metadata from a dozen utilities. We developed an approach to process the meter data, associate it with building characteristics, and clean it for use in validation. This effort focused almost exclusively on electricity consumption.

Please visit the End Use Load Profiles Project page and project publications to learn more about the methodology and results of the model calibration, validation and uncertainty quantification.

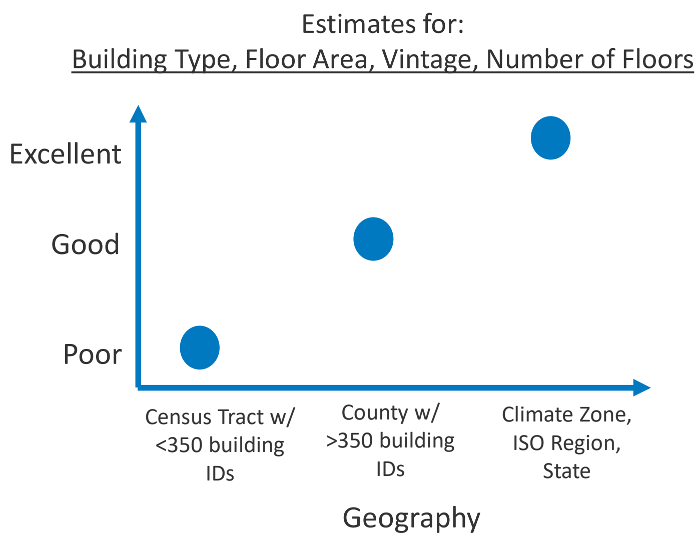
EULP Website: https://www.nrel.gov/buildings/end-use-load-profiles.html
Full Technical Report: https://www.nrel.gov/docs/fy22osti/80889.pdf
Executive Summary: https://www.nrel.gov/docs/fy22osti/82689.pdf

Geographic Resolution

What's the geographic resolution of the ComStock dataset?

It depends
on the characteristics you care about →

Please visit our website to find detailed documentation and guidance on this topic.



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A frequently asked question is, "How granular do ComStock datasets get geographically?" The answer, unfortunately, is not simple. It depends on which part of the dataset you're using and the question you are trying to answer.

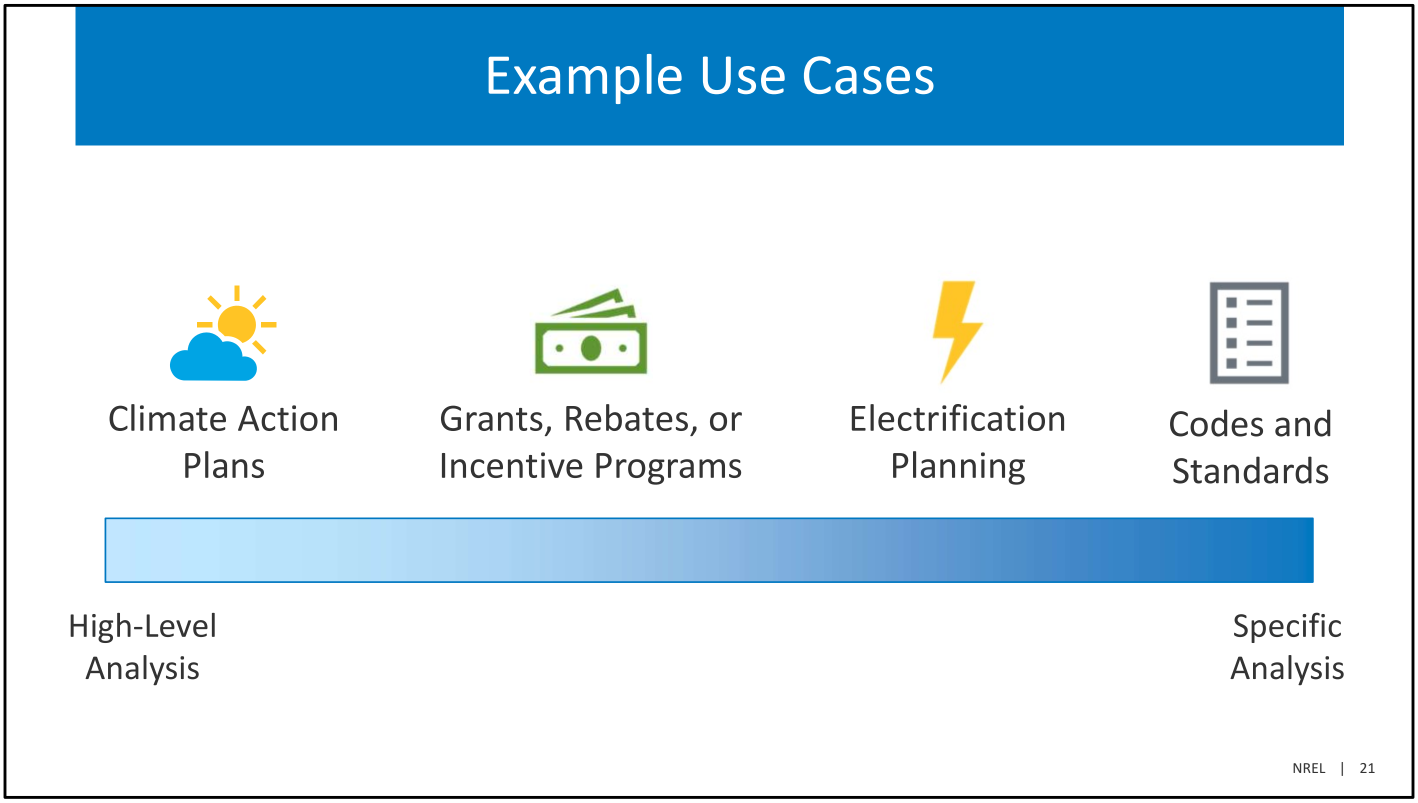
The plot on this chart provides users with a general idea of how you can think about the data relative to geography. For example, if your problem statement is, "I want to understand the annual energy use by building type for the city of Richmond, CA," the dataset can provide good resolution assuming the geography you selected has more than 350 building samples or building IDs in the dataset.

The probability distributions for the building characteristic fields are described in Table 2 of our reference documentation. Many of the fields in the CBECS data source are only resolved to the census division level while data sources such as CoStar, Lightbox and others are resolved to the census tract and below. To determine how good a probability distribution is, one must understand the data source and then make a judgement call. For example, the data source for the HVAC system type fields is CBECS. So, the dataset is probably not excellent at anything finer than census division, while CoStar is the source for fields: building type, size (sq ft), vintage, number of stories and is likely good as long as the geography selected has more than 350 building IDs.

ComStock Reference Documentation
https://www.nrel.gov/docs/fy23osti/83819.pdf

ComStock Data in Action

Next, we are going to discuss the types of analyses that ComStock data can be used for and highlight a handful of projects. Before we get into them, it’s important to note that these projects were custom analyses, but they provide examples of the types of questions that can be answered with ComStock data.



The ComStock dataset can be used for a variety of applications, from high-level analysis like climate action plans, to more specific analysis such as energy codes. In the following slides, we'll go through an example use case for each of these applications.

Climate Action Plans use the standard dataset to identify high impact segments of the stock to target.

Grant or incentive programs typically use ComStock for identifying technology potential and/or scenarios. For anything greater than a state geography, the standard dataset is a great option. For county or city geographies, dataset users should ensure selected geography includes more than 350 buildings IDs or samples.

For electrification planning, you can use the standard dataset to characterize the existing building stock, quantify building loads, and identify pathways for electrification. ComStock data also is often an input into other analytic tools or frameworks.

Codes and standards use ComStock data to understand the impacts of requirement setting that align with local policy goals.

Climate Action Plans

- LA100 Study informs the City of Los Angeles, the Los Angeles Department of Water and Power, and other stakeholders of possible pathways to 100% renewable energy.
- To develop a climate action plan, ComStock can characterize your commercial building stock and identify addressable segments.

LA100
The Los Angeles 100% Renewable Energy Study

First up is climate action plans. The LA100 study was completed by NREL in 2021. Many of you are probably familiar with climate action plans (CAP) – but for those that are not, a CAP includes emissions reduction targets and actions that the city or state can take to meet those targets.

In general, CAP development starts with the emissions target. Then, an advisory or technical working group is created for each sector (buildings, transportation, etc.) to understand the gap between where the city/state currently is and the emissions target, and to identify actions to reduce the gap.

This is where ComStock comes in – for the buildings sector, ComStock can characterize the existing commercial building stock and identify high-impact segments of the stock that can be targeted to reduce emissions. Oftentimes, cities/states will consider multiple scenarios for how to reach the emissions targets.

The LA100 study is the Los Angeles climate action plan. It identified possible pathways to achieving 100% renewable energy. ComStock was used to characterize the stock, and to analyze electrification and energy efficiency measures and their impact on emissions and grid stability.

Climate Action Plan:

1. City emissions goal/target
2. Create advisory or technical working groups for each sector (buildings, transportation, etc.)
3. Understand the gap
    - For buildings, start with a stock characterization (know what buildings are in your city
    - Break down the building stock into smaller chunks
4. Target high-impact segments of the stock
5. Consider multiple scenarios for how to reach goals

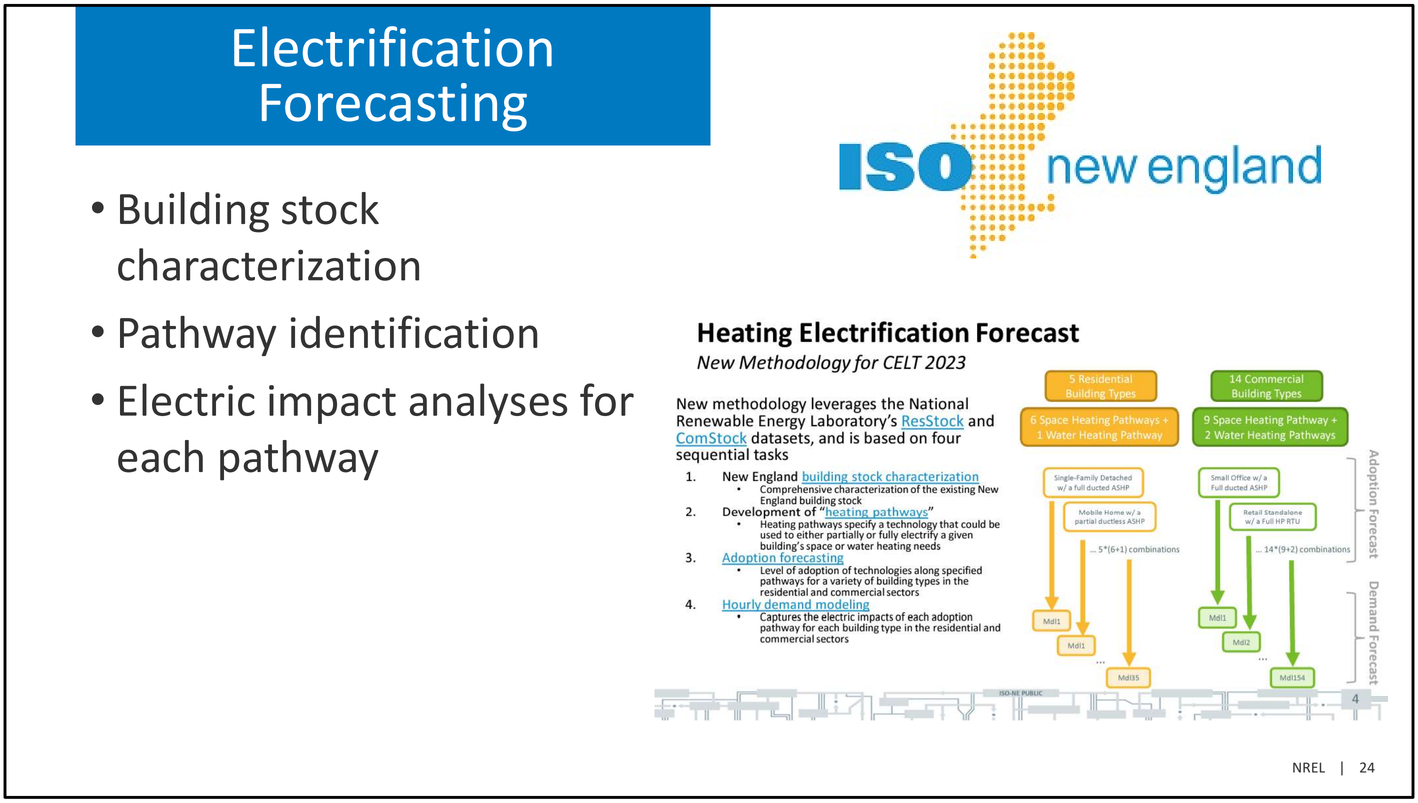
Grant, Rebates, or Incentive Programs

- Design of grants, rebates and incentive programs for
  - HVAC
  - Lighting
  - Envelope
- Reduce the burden of applying
  - Minnesota's Solar for Schools Program: Readiness Assessment

(Photo by Dennis Schroeder / NREL)

The ComStock dataset is frequently used by states, utilities and municipalities to understand the impact a grant, rebate, or incentive program may have on their region. It can also be used to design more effective programs. Analysis may be performed for traditional energy efficiency measures such as LED lighting retrofits or newer interventions needed for electrification such as heat pump boilers.

Data can also be useful when applying for programs. Building loads can be quantified without custom simulation or using generic building models. For example, ComStock data includes energy efficiency and upgrade measures results to see if improvements reduce the load significantly enough to lower the size requirements of a PV system. This is useful for initial assessments such as a school's solar readiness assessment, evaluation of Go/No-Go scenarios, or as an input to more comprehensive analysis.



Utilities use ComStock and ResStock data to inform electrification pathways and the impacts they may have on the grid. NREL's partner, ISO New England, used ComStock to forecast impacts of heating electrification on state and regional electric energy and demand was included as part of the 2023 Capacity, Energy, Loads, and Transmission (CELT) forecast.

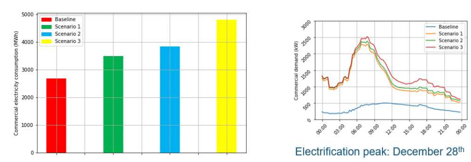
For more information, please see ISO New England's Report "Final 2023 Heating Electrification Forecast" https://www.iso-ne.com/static-assets/documents/2023/04/heatFx2023_final.pdf

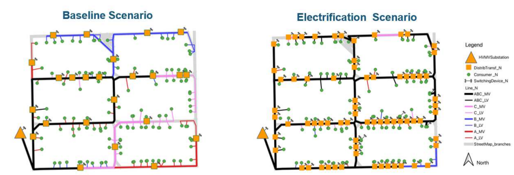
Detailed Electrification Planning

CITY OF ITHACA
GREEN NEW DEAL
AN EQUITABLE TRANSITION TO CARBON NEUTRALITY BY 2030

BLOC POWER

- New financing business model for electrification
- Multiple scenarios run to understand impact on
  - Building loads
  - Electric distribution network





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Ithaca, New York adopted the Green New Deal resolution in mid 2019. About 40% of Ithaca homes are more than 100 years old, and the full retrofit of every building was estimated to cost \$600 million. For a city with about 30,000 residents and projected revenues of around \$80 million, financing such an ambitious project needed new ideas.

Installing heat pumps and making other efficiency improvements makes financial sense for some buildings: the energy savings will pay for the improvements. Other projects may be close, or simply not pencil out. Either way, the savings accrue slowly. So, in order to get all buildings decarbonized, the city aggregated blocks of buildings to manage project risk, and then securitized the project to attract private capital.

The numbers work for some collections of buildings, they don’t work for others. But in the end, as a whole, it works for the investor. The program is essentially a way of covering the upfront costs of building improvements and turning it into “electrification as a service,” resulting in long-term leasing or long-term lending at a low interest rate.

Investors in Ithaca's decarbonization plan are a Brooklyn-based climate tech company called BlocPower, and Boston-based private equity firm Alturus. The two have combined to commit about $105 million to make low- and zero-interest loans for heat pumps and other electrification technologies available to residents and businesses, with BlocPower acting as program administrator and also lending its expertise in building energy use analysis.

NREL and BlocPower have worked together for several years. The startup was included in the NREL-Wells Fargo Foundation inaugural Innovation Incubator (IN2) cohort. This incubator program focuses on demonstration projects relating to building decarbonization technology. More recently, the company has been using stock energy data and NREL's tool chain to rapidly evaluate electrification projects. The snapshots here show examples of a multi-scenario analysis for building loads and electric grid where heat pumps are evaluated for space heating, domestic water, and electrification of commercial cooking equipment.

Source: "Inside Ithaca's plan to electrify 6,000 buildings and grow a regional green workforce using private equity funds" Robert Walton June 2, 2022

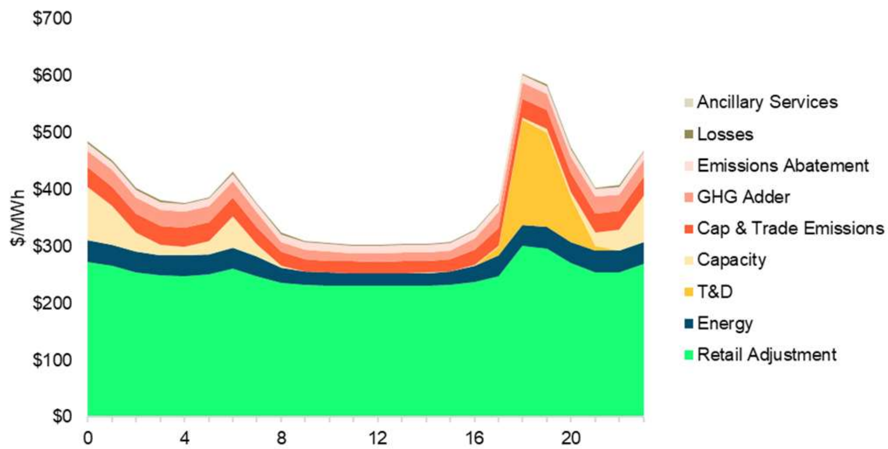
Notes:

- Baseline Scenario: No electrification measures implemented
- Electrification Scenario 1: Heat pumps (ASHPs) for space heating only
- Electrification Scenario 2: Heat pumps (ASHPs) for space heating and domestic water heating
- Electrification Scenario 3: Heat pumps (ASHPs) for space heating and domestic water heating and electrification of commercial cooking equipment

Codes and Standards

- ComStock load shapes were used to determine impacts of future California Title 24 measures on building owners.

Sample Hourly Average Electric Life-Cycle Cost Hourly Factors



Now for the final use case in this presentation: codes and standards. In this example, ComStock load shapes were used to analyze future California Title 24 energy codes. The California Energy Commission updates the Title 24 Building Energy Efficiency standards every three years by working with stakeholders in a public and transparent process. In the most recent code cycle, ComStock load shapes were used to understand how various code changes may impact building owners.

Outside of this example, stock characterization using ComStock could also be used to inform building performance standards for cities.

Additional Use Cases

- Identify energy savings for building portfolio owners
- Hourly load profiles integrated into 3rd party software tools
- Use in lab experimentation of physical equipment to represent the whole building load
- Training data for test beds
- To inform market potential of a new technology
- Academic research - extreme weather scenarios, novel thermodynamic cycles, integrated assessment models

Please tell us how you are using the data at comstock@nrel.gov!

In an attempt to keep this presentation brief, we have only mentioned a few of the possible use cases for the ComStock dataset.

Accessing the Dataset

This next section will provide an overview of how you can access ComStock datasets.

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-min intervals	15-min intervals	Customizable	Annual or 15-min intervals
Grouped by	Individual Building ID	Individual Building ID	Geograhies: climate zone, ISO/RTO region, state	Customizable	Customizable
Fields by	Building Input Charateristics	-	-	-	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	OpenEI Data Lake	OpenEI Data Lake	Open EI Data Lake	ComStock.nrel.gov	Scripting Languages

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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 been formatted to be accessible in four main ways to meet the needs of many different users and use cases.

1. files of individual model characteristics together with annual results, commonly referred to as the “metadata” file
2. timeseries load profiles (individual building and pre-aggregated) in downloadable spreadsheets,
3. a web-based data viewer, customizable time scales and aggregations
4. a detailed format that can be queried with big data tools

Please note, there are separate public datasets available for residential and commercial building stocks.

Field Naming Convention

Prefix or Name	Count	Description	Example
in.	64	Inputs of building characteristics and geospatial codes	in.window_type
out.	352	Simulation outputs	out.electricity.refrigeration.energy_consumption
calc.	159	Calculated values such as totals and % savings	calc.weighted.electricity.cooling.energy_consumption..tbtu
weight	1	Value for scaling single model results to national scale	4.8960474
bldg_id	1	Unique id of the building model	3324
upgrade	1	Unique id number for upgrade	5
model_count	1	Number of models aggregated (timeseries files)	5334
applicability	12	Upgrade names	FALSE
Second Level			
out.[fuel type]	6	Fuel type - electricity, natural gas, etc.	out.natural_gas.water_systems.energy_consumption
out.emissions	20	Emission values	out.emissions.electricity.egrid..co2e_kg
out.params	197	Model parameters and summary statistics	out.params.dx_cooling_average_cop..cop
out.qoi	15	Quantities of interest such as peak demand	out.qoi.maximum_daily_use_summer_kw..kw
out.site_energy	4	total of all end uses, site energy	out.site_energy.total.energy_consumption
Third Level			
out.[fuel type].[end use]	136	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 OpenEI Data Lake

The field naming convention is fairly simple. At the highest level there is –

- .in for inputs,
- .out for outputs,
- calc. for calculated fields,

then a handful of columns that provide simulation information.

There are 64 input columns, 352 output columns, and 159 calculated columns.

For .out there is a second level that includes fuel type, emissions, model parameter and statistic fields, and site energy.

.in does not have a second level.

The third level of .out is where you'll find the end uses.

Finally, units are denoted by a ".." with the unit following, i.e "..kw" is kilowatt

Example Metadata File

Building ID | County | Building Type | Building Area (unweighted) | Annual Electricity Peak (kW) (unweighted) | Annual Natural Gas Consumption (unweighted)

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

This slide shows a snapshot of a metadata file download.

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

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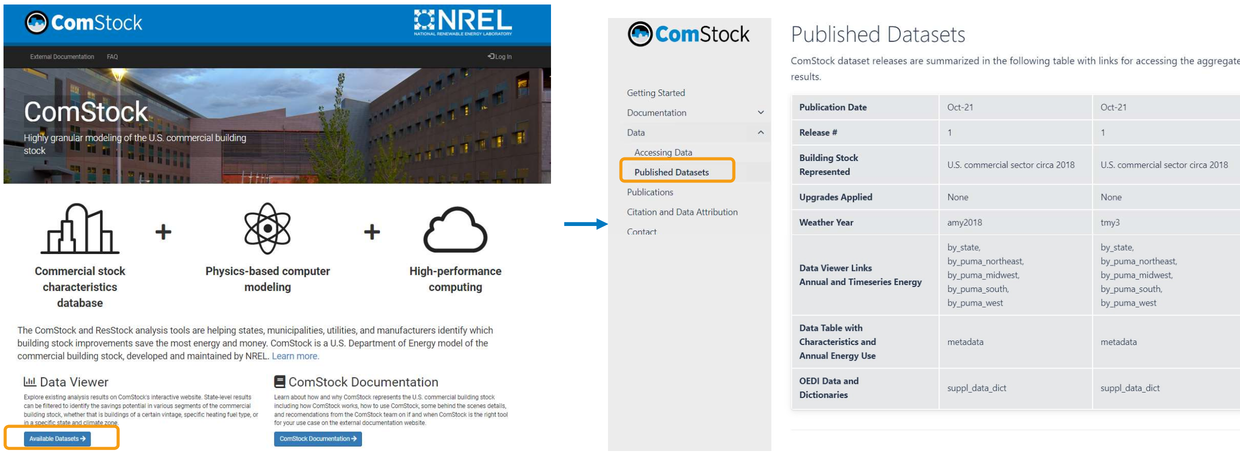
This slide shows a snapshot of a timeseries file download.

Summary of Dataset Links



Access at: ComStock.nrel.gov and ComStock Documentation Site

This page provides a set of links to easily navigate the different ways to access the dataset

First, notice the metadata file links. The building ID in the metadata file can be used as a key across the different files and exports.

Second, there are links to the Annual and Timeseries Data Viewer. There are two main geographies supported – by state and by PUMA. PUMA stands for Public Use Microdata Areas. They are non-overlapping, statistical geographic areas that the Census bureau created. They contain about 100,000 people each. Census tracts combine to create PUMAs. It’s currently the smallest geographic unit that the dataset supports.

Third is a link to the data dictionary, which has definitions for all the fields in the dataset.

Finally, for those familiar with building energy models, there is a link to our public GitHub repo.

Open Energy Data Initiative Folder Structure

OEDI AWS S3 Explorer for the Open Energy Data Initiative

oedi-data-lake / nrel-pds-building-stock / end-use-load-profiles-for-us-building-stock / 2021 / comstock_amy2018_release_1

Show 50 entries

Object	Timestamp	Size
building_energy_models/		
geographic_information/		
metadata/		
timeseries_aggregates/		
timeseries_aggregates_metadata/		
timeseries_individual_buildings/		
weather/		
citation.txt	2022-03-30 06:00:45	5.4 kB
data_dictionary.tsv	2022-03-07 13:30:36	30.9 kB
enumeration_dictionary.tsv	2021-10-21 16:09:34	12.5 kB
upgrade_dictionary.tsv	2021-10-21 16:34:24	90 B
upgrades_lookup.json	2023-03-29 13:31:05	21 B

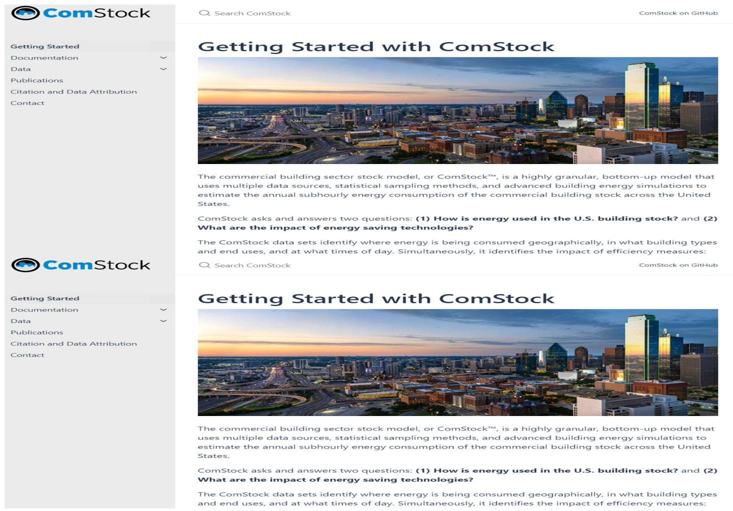
Showing 1 to 12 of 12 entries

Folder structure: year/comstock_weather file_release_#/[metadata, timeseries - aggregate, indv, etc]

Access at: Open EI Data Lake

Both the residential and commercial datasets are hosted on Open EI Data Lake with a similar file structure.

ComStock Documentation Website



Access at: https://nrel.github.io/ComStock.github.io/

Keep an eye out for new material on our website where we post documentation, publications and guidance on how to use the dataset in your analysis.

Where to find it…

ComStock Documentation Website
https://nrel.github.io/ComStock.github.io/
Getting started • Publications • Technical documentation

AWS OEDI Repository
https://data.openei.org/submissions/4520
Metadata and annual results • Aggregate load profile results • Individual model results and input files including weather
Data dictionary and enumeration dictionary • Geospatial information

Web Data Viewer
https://comstock.nrel.gov
Graphical in-browser data visualizations • Custom aggregation tool
Requires free account

There are 3 key places you may need to access the data, the documentation, and the model files.

Please reach out to us at comstock@nrel.gov with questions, requests or to share how you've used our data in your work!