

End Use Forecasting Tools & Data: Itron MetrixLT & NREL ResStock

Arthur Maniaci

Principal Forecaster

Load Forecasting Task Force
May 26, 2022

(1) Hourly Load Forecasting Tool

Need for a comprehensive hourly load forecasting tool

- New electric technologies have ‘non-conforming’ hourly profiles – they are significantly different than the current hourly profiles of zonal and system loads and are evolving over time.
- Net demand must account for power withdrawals as well as power injections.
 - Injections: Behind-the-meter solar, energy storage discharge
 - Withdrawals: electric vehicle charging, energy storage charging, large data centers
- **Electrification trends will modify the hourly loads in residential and commercial buildings**
 - Replacement of heating technologies from fossil to electric with significant adoption of heat pumps
 - Replacement of cooling technologies from central and room AC with heat pumps
 - Replacement of fossil fueled water heating, cooking and clothes drying equipment with electric
- Over time, the typical hourly profile of net load, the hour of the coincident peak, and the relative sizes of winter and summer peaks will gradually change.
- The final system and zonal peaks can be best determined by applying monthly or annual energy to per unit hourly profiles for all contributors to the forecast, and only then finding the date, hour and magnitude of the peak loads.

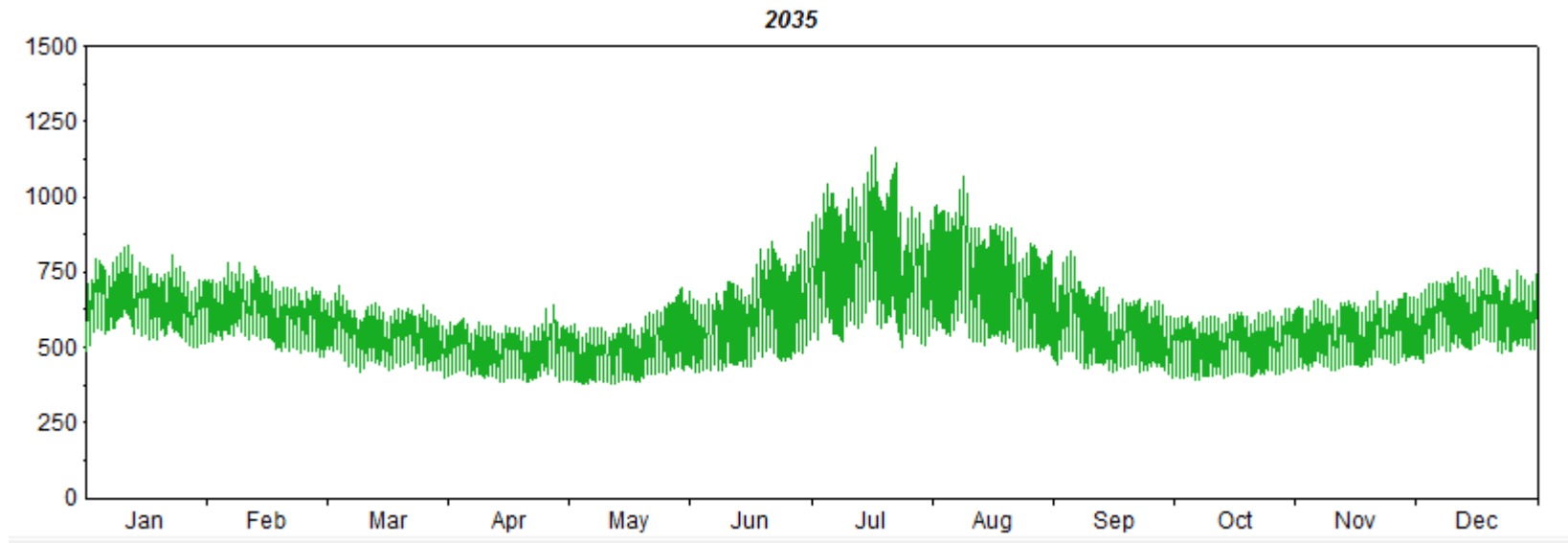
MetrixLT Features

- **Hourly load forecasts**
 - Imports daily, monthly or annual class or end use energy forecasts and per-unit hourly load profiles for class or end uses
 - Scales hourly loads in future years consistent with energy forecasts
 - In conjunction with MetrixND (or other software), produces weather-sensitive hourly load forecasts
- **Trended weather and weather-sensitive forecasts for climate impact studies**
 - Imports daily weather pattern of temperature – dry bulb, wet bulb, heat indexes, etc.
 - Using trend parameters, produces future daily temperature with increasing or decreasing trends and trended heating and cooling degree days.
- **Produce aggregate hourly loads at system level and find the resulting coincident peak hour**
- **Data reporting and visualization tools**

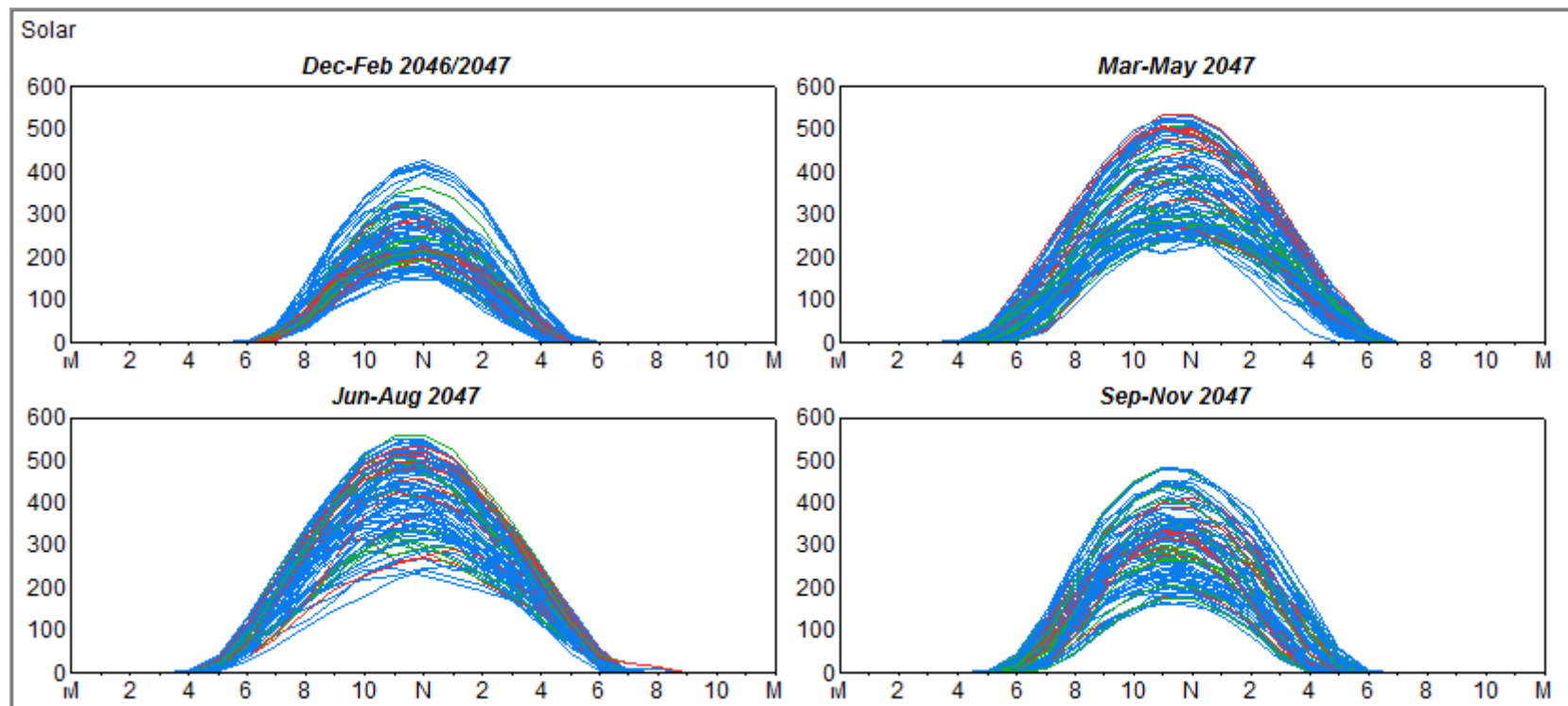
Monthly Energy & Peak Forecasts for Base Load



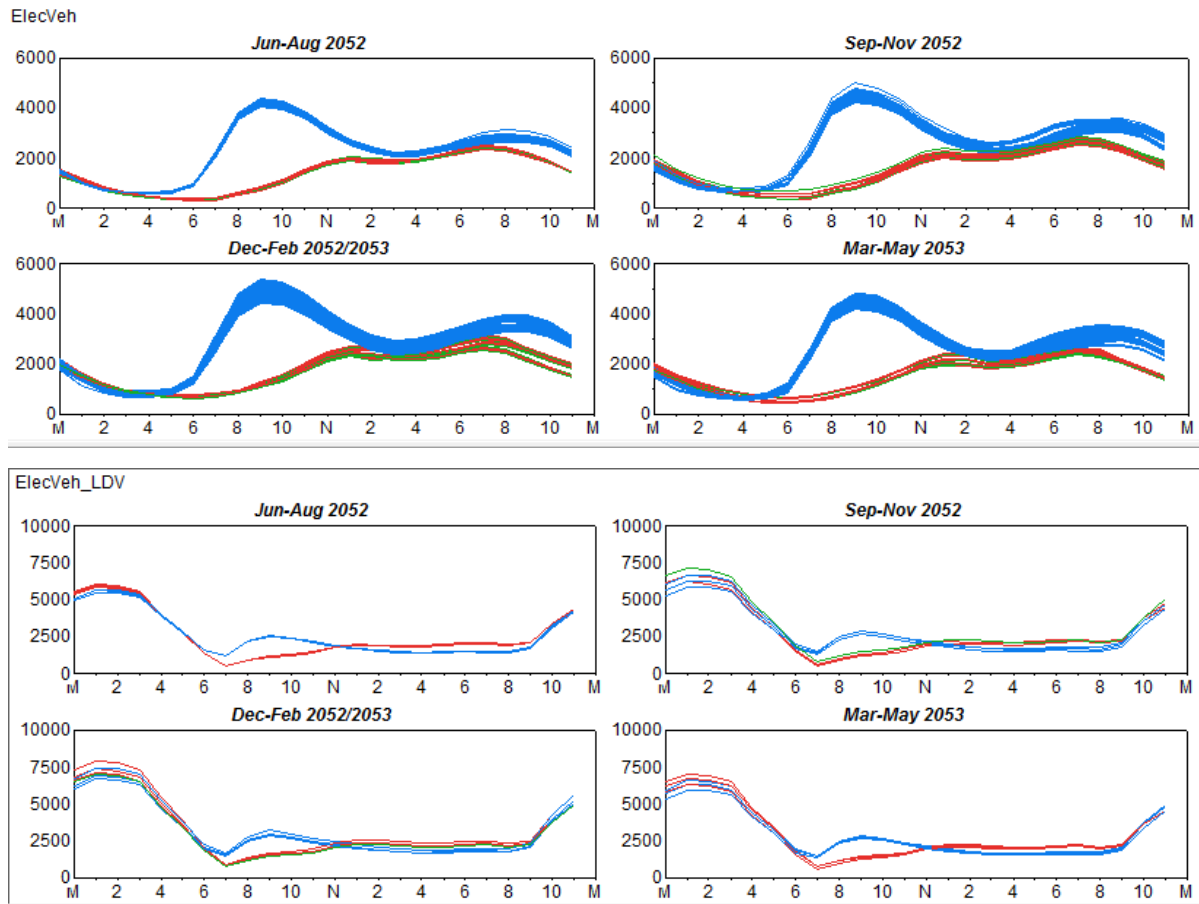
Hourly Load Forecast of Base Load for a Single Year



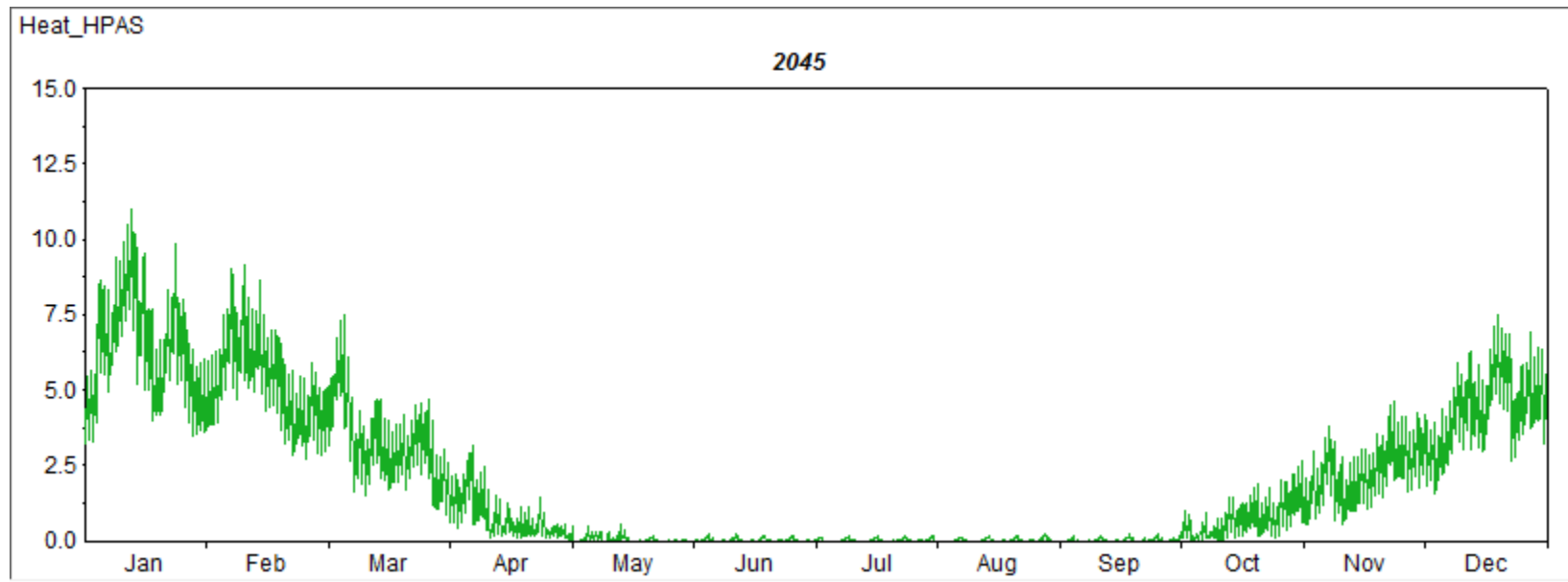
Hourly Load Forecast of BTM Solar for a Single Year



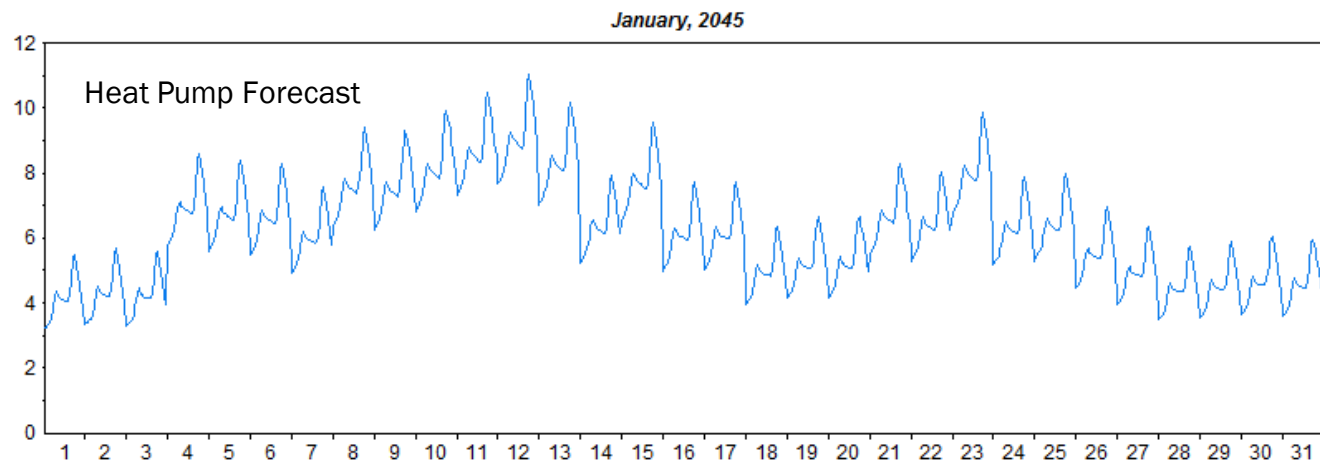
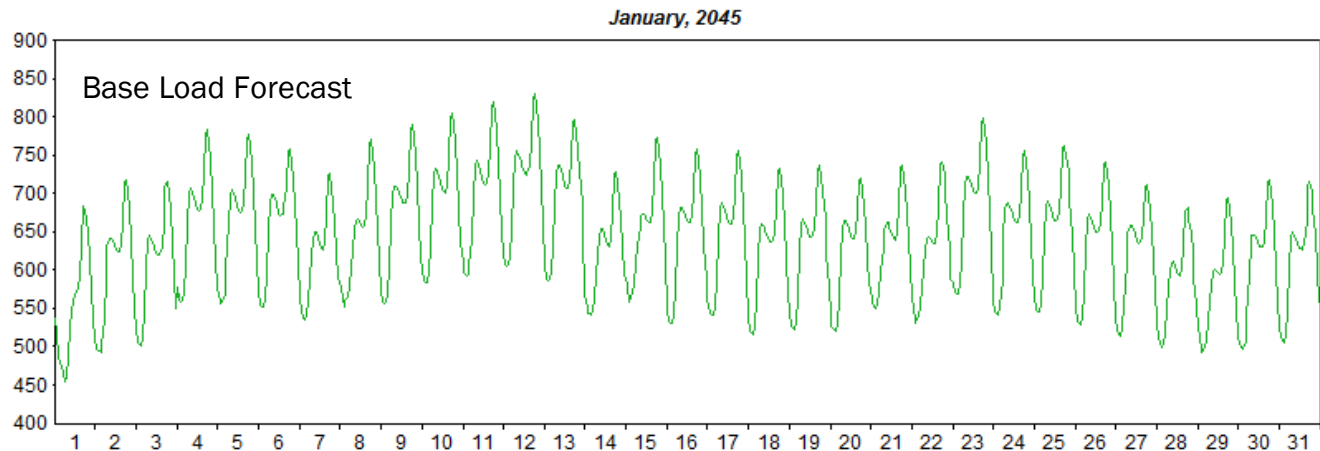
Hourly Loads for EVs – Managed & Unmanaged - for a Single Year



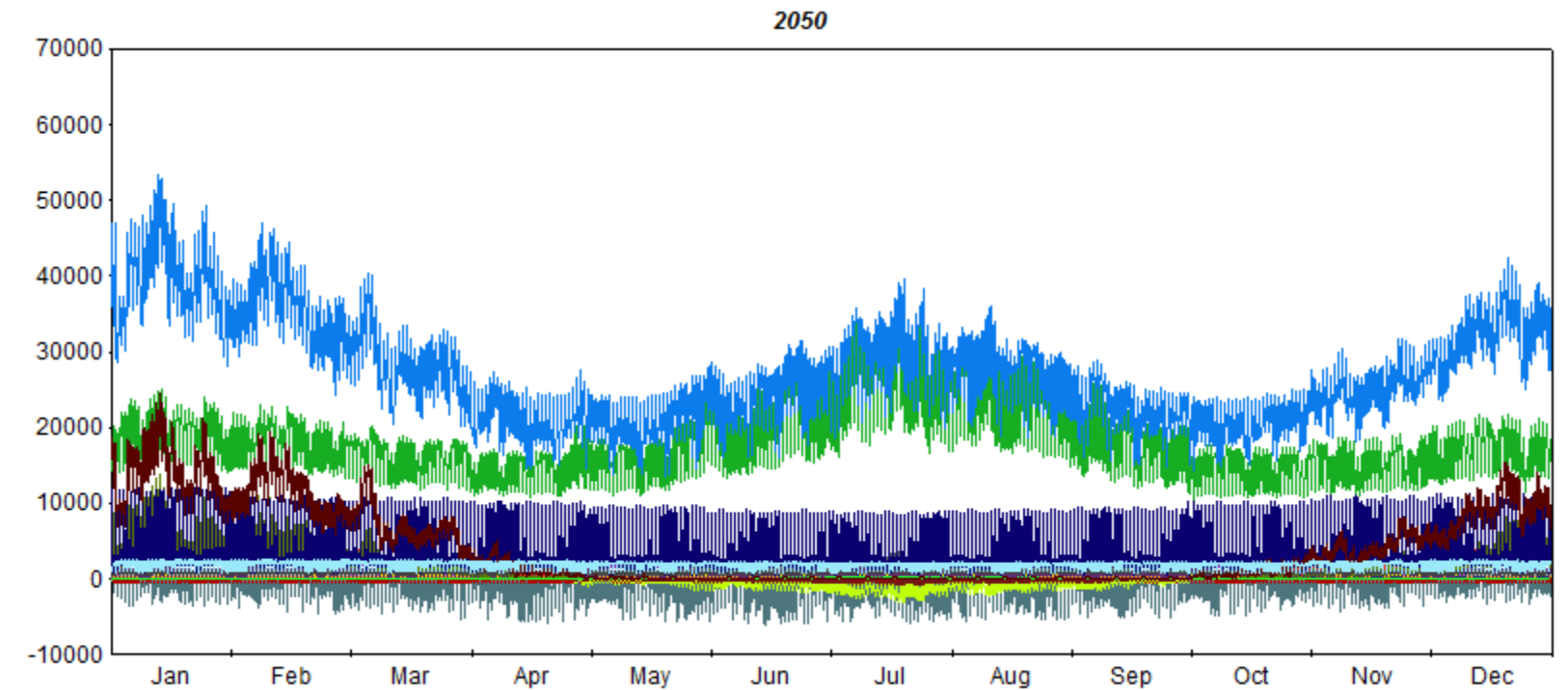
Hourly Load Forecast of Heat Pumps for a Single Year



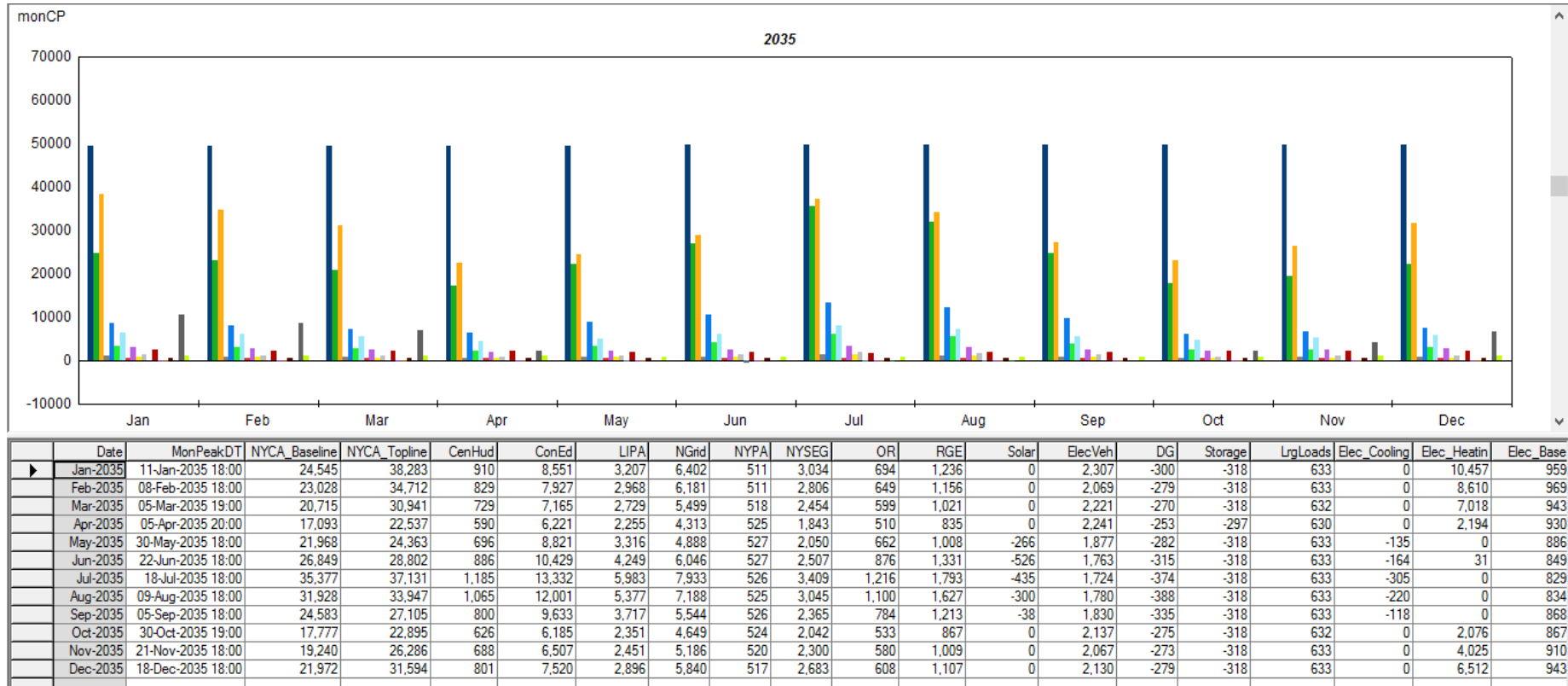
Proper Daily Alignment of Weather-Sensitive Load Forecasts



System Forecast & Build-up of All Components for a Single Year



Report of Monthly System Coincident Peaks & Each Component



Current & Future Uses of Hourly Load Model

- Hourly forecasts in development this year to gain experience and compare results to alternative methods
- Need more insight into evolution of EV patterns and storage charging & discharging patterns.
- Load Diversity across areas is one topic for further work.
- Expect to be used as primary tool for future long term forecasts

(2) NREL ResStock & ComStock 'Data Lakes'

NYISO's Interest in ResStock & ComStock

- 1. Supports continued development of SAE models for long term energy forecasts**
- 2. Provides hourly end use data for use in MetrixLT**
- 3. Supports development of Building Electrification forecasts for heat pumps & other technologies**
- 4. More consistent, timely and detailed than RECS and CBECS**

Primary Topics

- 1. Metadata: 2018 Building & Equipment Characteristics by PUMA₁ Region, End Use & Fuel Type**
- 2. Load Data: End Use Load Data at 15 MPI by PUMA & Fuel Type, Choice of 2018 Weather or TMY**
- 3. Downloading Results for Individual Sites & Geographic Regions, Including PUMA, County, State & ISO/RTO Region, From the AWS Data Lake**

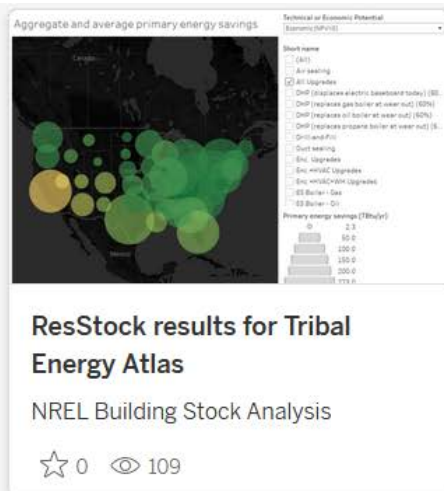
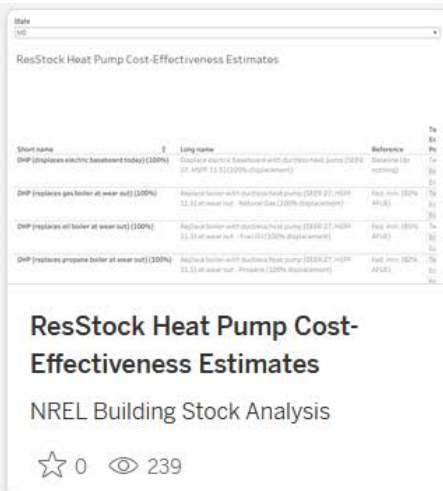
1. PUMA stands for Public Use Microdata Area. They are non-overlapping areas that partition each state into areas of no fewer than 100,000 people. NY has 62 counties and 145 PUMAs.

American Community & Housing Surveys + *Energy Plus Building Simulation Program* + *Terra-Bytes of Data & Fast Computers* = *Residential Energy, Peak & Hourly Load Data Representative of Every County in US*

1. Data Viewer
2. Building Characteristics
3. State Fact Sheets
4. Datasets
5. FAQ
6. Publications
7. Typology

<https://resstock.nrel.gov/>

Ongoing building energy research program at NREL has already resulted in numerous studies & published papers, with many more to come.



(2a) Metadata: 2018 Building & Equipment Characteristics by PUMA Region, End Use & Fuel Type

Public Datasets

(1) *Select Datasets, Weather Year, then Metadata*

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

This dataset describes the timeseries energy consumption of the U.S. residential building stock at the end-use level. For details on how it was created and validated, please see the [project's final report](#). For instructions on how to access pre-created aggregate data files, please visit the [End Use Load Profiles for the U.S. Building Stock project website](#). For commercial building stock data, please see the [ComStock data viewer](#). Two versions of this dataset have been created: one with actual weather data from 2018, and another with typical (TMY3) weather data. The TMY3 15-min energy data should not be used for larger geographies because weather events are not regionally aligned. Multiple geographic views of the dataset have been created, one by state, and one for each Census region by PUMA.

Releases

Select a Data Viewer link below to go to the Data Viewer or Building Characteristics Viewer.

Publication date	Release #	Building stock represented	Upgrades applied	Weather year	Data Viewer Links - Annual and Timeseries Energy	Data Viewer Links - Building Characteristics	Data Table with Characteristics and Annual Energy Use (metadata.tsv)	Supplemental Data and Dictionaries	Input building characteristics
October 2021	1	U.S. residential sector circa 2018	None	amy2018	by_state , by_puma_northeast , by_puma_midwest , by_puma_south , by_puma_west	by_state , by_puma_northeast , by_puma_midwest , by_puma_south , by_puma_west	metadata	suppl_data_dict	github
October 2021	1	U.S. residential sector circa 2018	None	tmy3	by_state , by_puma_northeast , by_puma_midwest , by_puma_south , by_puma_west	by_state , by_puma_northeast , by_puma_midwest , by_puma_south , by_puma_west	metadata	suppl_data_dict	github

(2) We are now at a Data Portal of Amazon Web Service Data Lake.....

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 / resstock_amy2018_release_1 / timeseries_aggregates_metadata

Show 50 entries

Object	Timestamp	Size
metadata.tsv	2022-02-02 13:37:10	1.4 GB

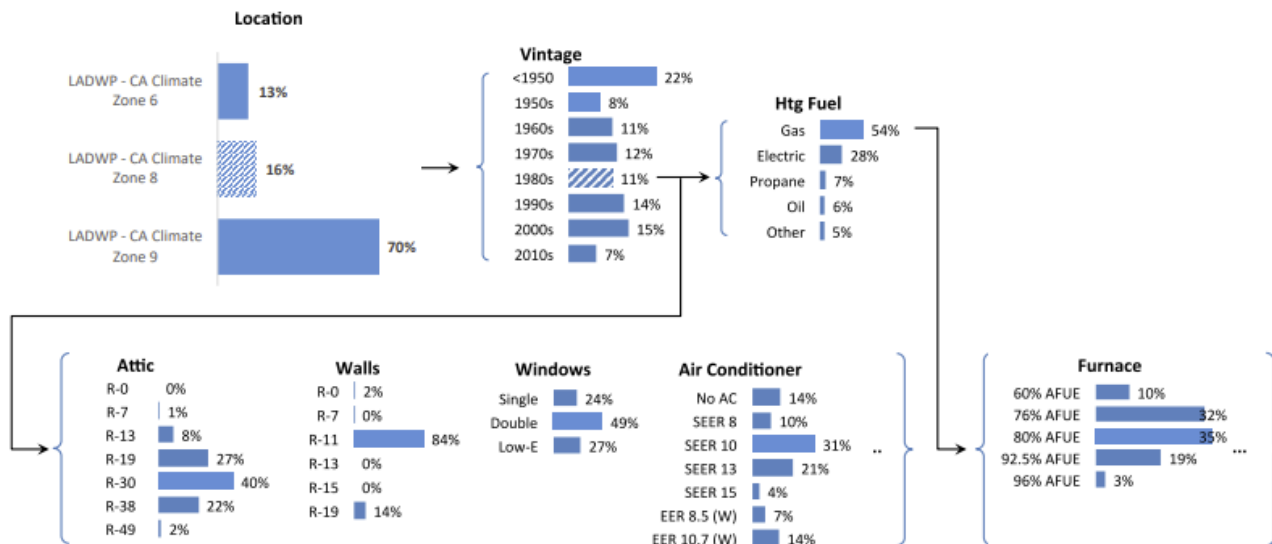
Showing 1 to 1 of 1 entries

Copyright 2020 Open Energy Data Initiative
Copyright 2014-2018 Amazon.com, Inc. or its affiliates. All Rights Reserved.
Licensed under the Apache License, Version 2.0 (the "License"); you may not use this file except in compliance with the License.
You may obtain a copy of the License at <http://www.apache.org/licenses/LICENSE-2.0>
This file has been modified by the Open Energy Data Initiative to add links to the OEDI data catalog and add the OEDI logo to provide context, and allow a URL parameter for the bucket name.

Download the Metadata.tsv file (tab separated variables). It will take awhile as it contains PUMA records for the entire US. There are 33,711 records just for NY, distributed across 140 PUMAs.

Building Characteristics Assigned Randomly, with Means Based on ACS & Other Data

Conditional Probability Distributions



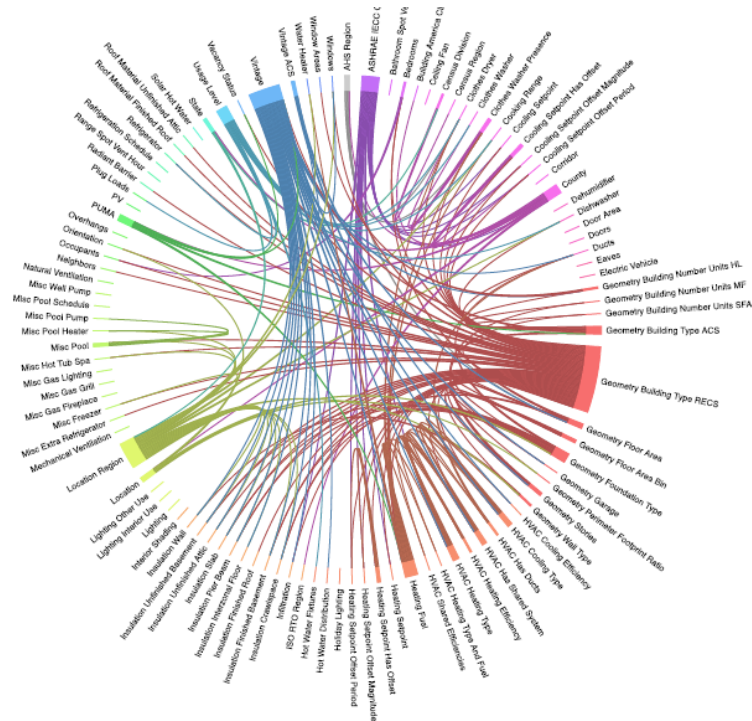
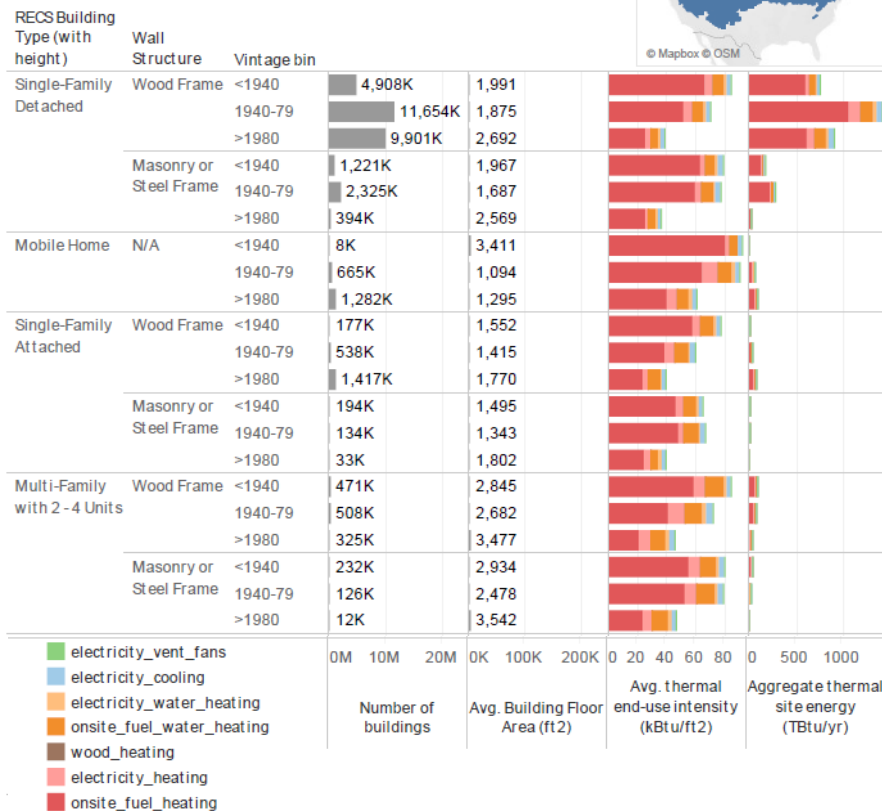
- Conditional probabilities for all building types, structures, and HVAC saturations are obtained from ACS, AHS, RECS, and other similar national databases.
- This ensures that any given PUMA contains buildings, equipment and energy characteristics consistent with actual structures & energy metrics.

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

Elaina Present, NREL

April 15, 2022

ResStock sample selection is a very elaborate process in order to represent several hundred different attributes



Heating Fuel Type & Technology

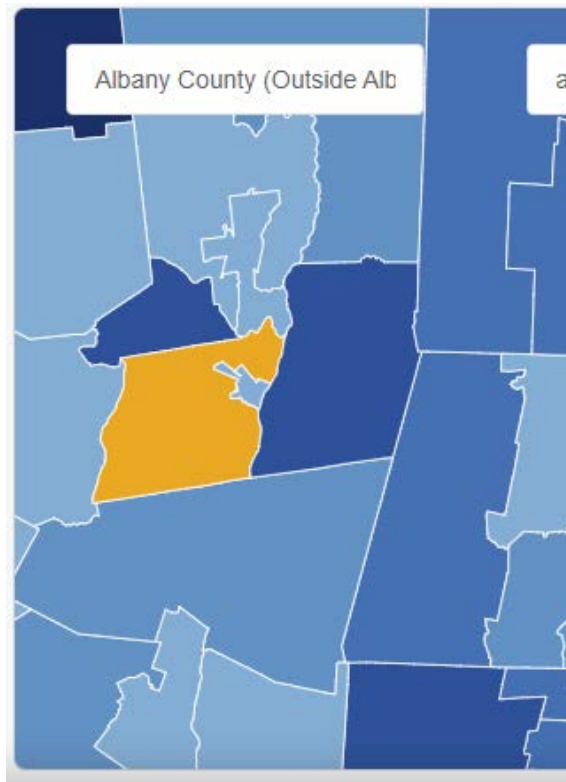
Row Labels	Sum of 8_weight
Electricity ASHP	192,978
Electricity Baseboard	275,061
Electricity Electric Boiler	4,358
Electricity Electric Furnace	212,349
Electricity Electric Wall Furnace	4,116
Electricity Shared Heating	230,993
Fuel Oil Fuel Boiler	502,906
Fuel Oil Fuel Furnace	922,277
Fuel Oil Fuel Wall/Floor Furnace	51,090
Fuel Oil Shared Heating	399,758
Natural Gas Fuel Boiler	656,417
Natural Gas Fuel Furnace	2,508,235
Natural Gas Fuel Wall/Floor Furnace	710,170
Natural Gas Shared Heating	900,969
None	283,293
Other Fuel Shared Heating	27,361
Propane Fuel Boiler	15,012
Propane Fuel Furnace	181,356
Propane Fuel Wall/Floor Furnace	60,048
Propane Shared Heating	23,729
Grand Total	8,162,479

Cooling Technology

Row Labels	Sum of 8_weight
Central AC	3,473,612
Heat Pump	227,603
None	1,340,922
Room AC	3,120,342
Grand Total	8,162,479

ResStock metadata provides a rich collection of structure types, building construction types and HVAC equipment that is representative of the ACS, AHS, & RECS frequencies for those characteristics. Also modeled are equipment efficiency, insulation levels, home size and other end uses and equipment.

Building & Equipment Characteristics in Each PUMA Are Consistent With ACS Data



Albany County (Outside Albany City) PUMA
Fuel Type: All Fuels **Upgrade:** Baseline

Vintage	Households
1940s	4,116
1950s	6,053
1960s	5,327
1970s	6,295
1980s	3,148
1990s	1,937
2000s	726
2010s	484
<1940	23,487
Total	51,573

Space Heating Fuel	Households	Saturation
Electricity	12,349	23.94%
Fuel Oil	2,421	4.69%
Natural Gas	36,320	70.42%
Other Fuel	242	0.47%
Propane	242	0.47%
Total	51,574	100.00%

Water Heating Fuel	Households	Saturation
Electricity	11,380	22.07%
Fuel Oil	2,179	4.23%
Natural Gas	37,772	73.24%
Propane	242	0.47%
Total	51,573	100.00%

The National sampling proportion is about 1 : 242. This PUMA is represented by about 213 individual samples, with the saturations as indicated. The energy data in metadata has *not* been expanded from sample to the entire population.

Comparison of NY Electric Space Heat Saturations – ACS vs ResStock

American Community Survey – About 220,000 sampled homes in NY

Utility	10 to 19 Unit	2 Unit	20 to 49 Unit	3 or 4 Unit	5 to 9 Unit	50 or more Un	Mobile Home	SF Attached	SF Detached	Total
Central Hudson Gas and Electric	48.06%	19.18%	42.39%	25.97%	27.61%	45.66%	0.82%	19.10%	6.64%	13.66%
Consolidated Edison	13.32%	5.39%	11.01%	6.61%	12.16%	17.25%	5.77%	4.74%	3.78%	10.74%
Long Island Power Authority	21.16%	8.58%	19.66%	22.06%	24.88%	30.46%	2.63%	23.33%	2.47%	6.36%
National Grid	48.61%	10.64%	43.49%	27.95%	36.45%	42.79%	4.90%	18.04%	5.90%	12.58%
NYS Electric and Gas	33.49%	7.42%	37.87%	22.95%	31.70%	45.71%	4.27%	18.03%	5.99%	10.40%
Orange and Rockland Utilities	19.53%	16.95%	22.25%	15.65%	24.04%	19.88%	0.00%	12.53%	4.63%	9.66%
Rochester Gas and Electric	37.54%	14.70%	43.13%	27.57%	32.38%	46.06%	3.32%	13.96%	7.18%	13.76%
Total	20.21%	7.34%	14.15%	13.69%	20.48%	19.69%	4.21%	9.89%	4.90%	10.63%

ResStock – About 33,700 sampled homes in NY

Average Residential Electric Usage - kWh

Utility	10 to 19 Unit	2 Unit	20 to 49 Unit	3 or 4 Unit	5 to 9 Unit	50 or more Un	Mobile Home	SF Attached	SF Detached	Grand Total
Central Hudson Gas and Electric	25.00%	19.67%	38.10%	20.69%	44.23%	57.89%	2.27%	22.22%	6.21%	12.62%
Consolidated Edison	16.02%	5.08%	13.26%	6.29%	13.83%	18.29%	0.00%	4.33%	3.36%	11.42%
Long Island Power Authority	28.71%	6.02%	24.39%	9.09%	19.57%	21.79%	0.00%	17.06%	2.54%	5.52%
National Grid	51.43%	19.85%	47.71%	28.75%	52.67%	55.03%	1.52%	10.30%	6.42%	14.25%
NYS Electric and Gas	37.63%	13.13%	58.33%	20.80%	42.53%	41.07%	4.36%	14.81%	6.14%	11.62%
Orange and Rockland Utilities	24.39%	19.67%	30.43%	14.29%	25.37%	14.71%	5.00%	5.41%	3.76%	8.93%
Rochester Gas and Electric	40.43%	20.00%	51.22%	21.21%	38.68%	35.14%	5.66%	9.09%	8.11%	14.16%
Grand Total	23.00%	9.52%	16.94%	12.14%	25.35%	20.40%	2.84%	7.47%	5.04%	11.27%

This initial review shows that ACS & ResStock saturations are similar. Confidence margins not yet available for either sample.

Tips for Working With Metadata

- Metadata is comprised of individual sites with a unique building ID. Each site has a weight of 242.131. Multiply site energy data by weight to expand usage to population.
- Metadata reports annual energy by end use & fuel type but no hourly loads. All energy data is in kWh, even Gas, Oil, & other fuel types.
- Append numbers to field names & make a data dictionary for easier selection of fields to summarize or tabulate.
- Geo fields allow you to select State, County, PUMA, ISO/RTO & other areas.
- Since end use energy by fuel type is available for each site, we can directly calculate UEC, Saturations, Intensity and Total Usage. Square Footage data is also available.
- Heating & cooling end uses include several distinct technologies – furnaces, heat pumps, RAC, CAC, etc.
- Utility service territories are not provided. However, you can assign these yourself using County or PUMA lists.

Number of All Sample Sites

69_in.hvac_heating_type_and_fuel (All)

Sample vs Population Households

Count of 8_weight

Column Lat

Row Labels	10 to 19 Unit	2 Unit	20 to 49 Unit	3 or 4 Unit	5 to 9 Unit	50 or more Un Mobile Home	Single-Family	Single-Family	Grand Total
Central Hudson Gas and Electric	24	61	21	58	52	19	44	36	644
Consolidated Edison	980	1,969	2,473	1,446	998	4,740	31	1,085	15,717
Long Island Power Authority	101	216	82	88	92	156	24	170	4,279
National Grid	140	519	109	313	243	169	329	165	5,521
NYS Electric and Gas	93	495	72	226	174	112	275	108	4,405
Orange and Rockland Utilities	41	61	23	77	67	34	20	74	1,008
Rochester Gas and Electric	47	105	41	99	106	74	53	88	1,822
Grand Total	1,426	3,426	2,821	2,307	1,732	5,304	776	1,726	33,711

Number of Households in Population

69_in.hvac_heating_type_and_fuel (All)

Counties were assigned to Utilities by NYISO

Sum of 8_weight

Column Lat

Row Labels	10 to 19 Unit	2 Unit	20 to 49 Unit	3 or 4 Unit	5 to 9 Unit	50 or more Un Mobile Home	Single-Family	Single-Family	Grand Total
Central Hudson Gas and Electric	5,811	14,770	5,085	14,044	12,591	4,600	10,654	8,717	155,932
Consolidated Edison	237,288	476,756	598,790	350,121	241,647	1,147,701	7,506	262,712	483,051
Long Island Power Authority	24,455	52,300	19,855	21,308	22,276	37,772	5,811	41,162	811,139
National Grid	33,898	125,666	26,392	75,787	58,838	40,920	79,661	39,952	855,691
NYS Electric and Gas	22,518	119,855	17,433	54,722	42,131	27,119	66,586	26,150	690,073
Orange and Rockland Utilities	9,927	14,770	5,569	18,644	16,223	8,232	4,843	17,918	147,942
Rochester Gas and Electric	11,380	25,424	9,927	23,971	25,666	17,918	12,833	21,308	292,736
Grand Total	345,279	829,541	683,052	558,596	419,371	1,284,263	187,894	417,918	3,436,565

Number of Sample Sites - Electric Heating Systems

69_in.hvac_heating_type_and_fuel (Multiple It

Sampled Households with Gas or Electric Heating Systems

Count of 8_weight

Column Lat

Row Labels	10 to 19 Unit	2 Unit	20 to 49 Unit	3 or 4 Unit	5 to 9 Unit	50 or more Un Mobile Home	Single-Family	Single-Family	Grand Total
Central Hudson Gas and Electric	6	12	8	12	23	11	1	8	40
Consolidated Edison	157	100	328	91	138	867		47	67
Long Island Power Authority	29	13	20	8	18	34		29	85
National Grid	72	103	52	90	128	93	5	17	227
NYS Electric and Gas	35	65	42	47	74	46	12	16	175
Orange and Rockland Utilities	10	12	7	11	17	5	1	4	23
Rochester Gas and Electric	19	21	21	21	41	26	3	8	98
Grand Total	328	326	478	280	439	1,082	22	129	715

Number of Sample Sites - Nat Gas Heating Systems

69_in.hvac_heating_type_and_fuel (Multiple It

Note: structure types include Single Family Attached & Single Family Detached.

Count of 8_weight

Column Lat

Row Labels	10 to 19 Unit	2 Unit	20 to 49 Unit	3 or 4 Unit	5 to 9 Unit	50 or more Un Mobile Home	Single-Family	Single-Family	Grand Total
Central Hudson Gas and Electric	14	23	7	24	18	6	2	21	100
Consolidated Edison	504	1,636	1,187	1,126	606	2,284	18	955	1,455
Long Island Power Authority	58	154	51	58	62	85	2	131	1,451
National Grid	64	380	54	200	103	69	53	144	1,971
NYS Electric and Gas	51	405	25	157	91	62	66	88	1,675
Orange and Rockland Utilities	30	44	12	63	46	26	2	67	388
Rochester Gas and Electric	25	81	16	77	63	45	18	80	945
Grand Total	746	2,723	1,352	1,705	989	2,577	161	1,486	7,985

69_in.hvac_heating_type_and_fuel	(Multiple	ms)	Number of Households in Population With Electric Heating Systems									
Sum of 8_weight		Column La										
Row Labels	10 to 19 Unit	2 Unit	20 to 49 Unit	3 or 4 Unit	5 to 9 Unit	50 or more Unit	Mobile Home	Single-Family Attached	Single-Family Detached	Grand Total		
Central Hudson Gas and Electric	1,453	2,906	1,937	2,906	5,569	2,663	242	1,937	9,685	29,298		
Consolidated Edison	38,015	24,213	79,419	22,034	33,414	209,928		11,380	16,223	434,625		
Long Island Power Authority	7,022	3,148	4,843	1,937	4,358	8,232		7,022	20,581	57,143		
National Grid	17,433	24,939	12,591	21,792	30,993	22,518	1,211	4,116	54,964	190,557		
NYS Electric and Gas	8,475	15,739	10,170	11,380	17,918	11,138	2,906	3,874	42,373	123,971		
Orange and Rockland Utilities	2,421	2,906	1,695	2,663	4,116	1,211	242	969	5,569	21,792		
Rochester Gas and Electric	4,600	5,085	5,085	5,085	9,927	6,295	726	1,937	23,729	62,470		
Grand Total	79,419	78,935	115,739	67,797	106,296	261,986	5,327	31,235	173,124	919,856		

69_in.hvac_heating_type_and_fuel	(Multiple	ms)	Number of Households in Population With Nat Gas Heating Systems									
Sum of 8_weight		Column La										
Row Labels	10 to 19 Unit	2 Unit	20 to 49 Unit	3 or 4 Unit	5 to 9 Unit	50 or more Unit	Mobile Home	Single-Family Attached	Single-Family Detached	Grand Total		
Central Hudson Gas and Electric	3,390	5,569	1,695	5,811	4,358	1,453	484	5,085	24,213	52,058		
Consolidated Edison	122,034	396,126	287,410	272,640	146,731	553,027	4,358	231,235	352,301	2,365,862		
Long Island Power Authority	14,044	37,288	12,349	14,044	15,012	20,581	484	31,719	351,332	496,853		
National Grid	15,496	92,010	13,075	48,426	24,939	16,707	12,833	34,867	477,240	735,594		
NYS Electric and Gas	12,349	98,063	6,053	38,015	22,034	15,012	15,981	21,308	405,569	634,383		
Orange and Rockland Utilities	7,264	10,654	2,906	15,254	11,138	6,295	484	16,223	93,947	164,165		
Rochester Gas and Electric	6,053	19,613	3,874	18,644	15,254	10,896	4,358	19,370	228,814	326,877		
Grand Total	180,630	659,323	327,361	412,833	239,468	623,972	38,983	359,807	1,933,416	4,775,792		

69_in.hvac_heating_type_and_fuel (Multiple)ms)		Electricity - Average Heating Usage per Household - kWh								
Average of 168_out.electricity.heat Column La										
Row Labels	10 to 19 Unit	2 Unit	20 to 49 Unit	3 or 4 Unit	5 to 9 Unit	50 or more Unit	Mobile Home	Single-Family Attached	Single-Family Detached	Grand Total
Central Hudson Gas and Electric	7,421	12,646	2,822	10,022	7,526	3,094	3,911	10,115	15,224	10,248
Consolidated Edison	6,788	11,747	6,053	9,109	8,096	4,519		9,728	20,689	6,648
Long Island Power Authority	2,835	6,950	6,396	7,927	3,591	3,382		8,897	16,459	9,324
National Grid	7,191	12,407	5,914	11,507	9,009	5,269	15,483	12,094	22,433	12,906
NYS Electric and Gas	6,192	13,075	5,024	12,142	9,132	4,320	10,250	9,962	20,320	12,815
Orange and Rockland Utilities	6,728	13,056	3,439	7,304	7,371	2,919	5,513	6,614	20,483	10,793
Rochester Gas and Electric	7,138	13,471	11,252	11,213	7,600	7,777	14,736	11,257	20,481	13,742
Grand Total	6,493	12,222	6,098	10,481	8,248	4,596	11,548	9,904	20,309	9,637

69_in.hvac_heating_type_and_fuel (Multiple)ms)		Natural Gas - Average Heating Usage per Household - kWh								
Average of 216_out.natural_gas.heat Column La										
Row Labels	10 to 19 Unit	2 Unit	20 to 49 Unit	3 or 4 Unit	5 to 9 Unit	50 or more Unit	Mobile Home	Single-Family Attached	Single-Family Detached	Grand Total
Central Hudson Gas and Electric	7,366	16,950	4,902	14,237	10,045	7,482	5,314	16,538	30,272	20,836
Consolidated Edison	11,663	16,803	10,708	16,769	12,824	9,455	55,497	21,918	37,853	17,535
Long Island Power Authority	7,656	13,945	8,315	14,437	11,800	9,228	6,152	14,640	33,156	27,002
National Grid	10,472	19,230	8,517	16,367	11,467	8,552	18,739	21,286	38,822	30,961
NYS Electric and Gas	11,257	20,494	10,271	17,197	12,617	10,590	21,441	21,276	39,226	31,537
Orange and Rockland Utilities	9,819	15,084	12,522	12,382	8,776	7,859	24,962	14,833	34,593	25,018
Rochester Gas and Electric	11,993	19,836	10,718	15,762	12,401	11,142	19,389	19,766	36,383	30,286
Grand Total	11,078	17,592	10,508	16,439	12,334	9,459	23,783	20,666	37,099	23,614
Estimated Heat Delivered @ 85% Eff	9,416	14,954	8,932	13,973	10,484	8,041	20,216	17,566	31,534	20,072

Number of Households in Population With Electric Heating Systems

69_in.hvac_heating_type_and_fuel (Multiple It-ns)

Calculating Electric Space Heating Saturations

Sum of 8_weight	Column Labels									
Row Labels	10 to 19 Unit	2 Unit	20 to 49 Unit	3 or 4 Unit	5 to 9 Unit	50 or more Un Mobile Home	Single-Family	Single-Family	Grand Total	
Central Hudson Gas and Electric	1,453	2,906	1,937	2,906	5,569	2,663	242	1,937	9,685	29,298
Consolidated Edison	38,015	24,213	79,419	22,034	33,414	209,928		11,380	16,223	434,625
Long Island Power Authority	7,022	3,148	4,843	1,937	4,358	8,232		7,022	20,581	57,143
National Grid	17,433	24,939	12,591	21,792	30,993	22,518	1,211	4,116	54,964	190,557
NYS Electric and Gas	8,475	15,739	10,170	11,380	17,918	11,138	2,906	3,874	42,373	123,971
Orange and Rockland Utilities	2,421	2,906	1,695	2,663	4,116	1,211	242	969	5,569	21,792
Rochester Gas and Electric	4,600	5,085	5,085	5,085	9,927	6,295	726	1,937	23,729	62,470
Grand Total	79,419	78,935	115,739	67,797	106,296	261,986	5,327	31,235	173,124	919,856
Total Units in State	345,279	829,541	683,052	558,596	419,371	1,284,263	187,894	417,918	3,436,565	8,162,479

Electric Avg Heating Saturation (Calculated)

Average Residential Electric Usage - kWh

Row Labels	10 to 19 Unit	2 Unit	20 to 49 Unit	3 or 4 Unit	5 to 9 Unit	50 or more Un Mobile Home	Single-Family	Single-Family	Grand Total	
Central Hudson Gas and Electric	25.0%	19.7%	38.1%	20.7%	44.2%	57.9%	2.3%	22.2%	6.2%	12.6%
Consolidated Edison	16.0%	5.1%	13.3%	6.3%	13.8%	18.3%	0.0%	4.3%	3.4%	11.4%
Long Island Power Authority	28.7%	6.0%	24.4%	9.1%	19.6%	21.8%	0.0%	17.1%	2.5%	5.5%
National Grid	51.4%	19.8%	47.7%	28.8%	52.7%	55.0%	1.5%	10.3%	6.4%	14.3%
NYS Electric and Gas	37.6%	13.1%	58.3%	20.8%	42.5%	41.1%	4.4%	14.8%	6.1%	11.6%
Orange and Rockland Utilities	24.4%	19.7%	30.4%	14.3%	25.4%	14.7%	5.0%	5.4%	3.8%	8.9%
Rochester Gas and Electric	40.4%	20.0%	51.2%	21.2%	38.7%	35.1%	5.7%	9.1%	8.1%	14.2%
Electric Saturation	23.0%	9.5%	16.9%	12.1%	25.3%	20.4%	2.8%	7.5%	5.0%	11.3%

Divide (units of a cell with a given structure type & electric heating) by (Total units of that structure type).

Electric Avg HH Square Footage - Sample

Average Square Footage

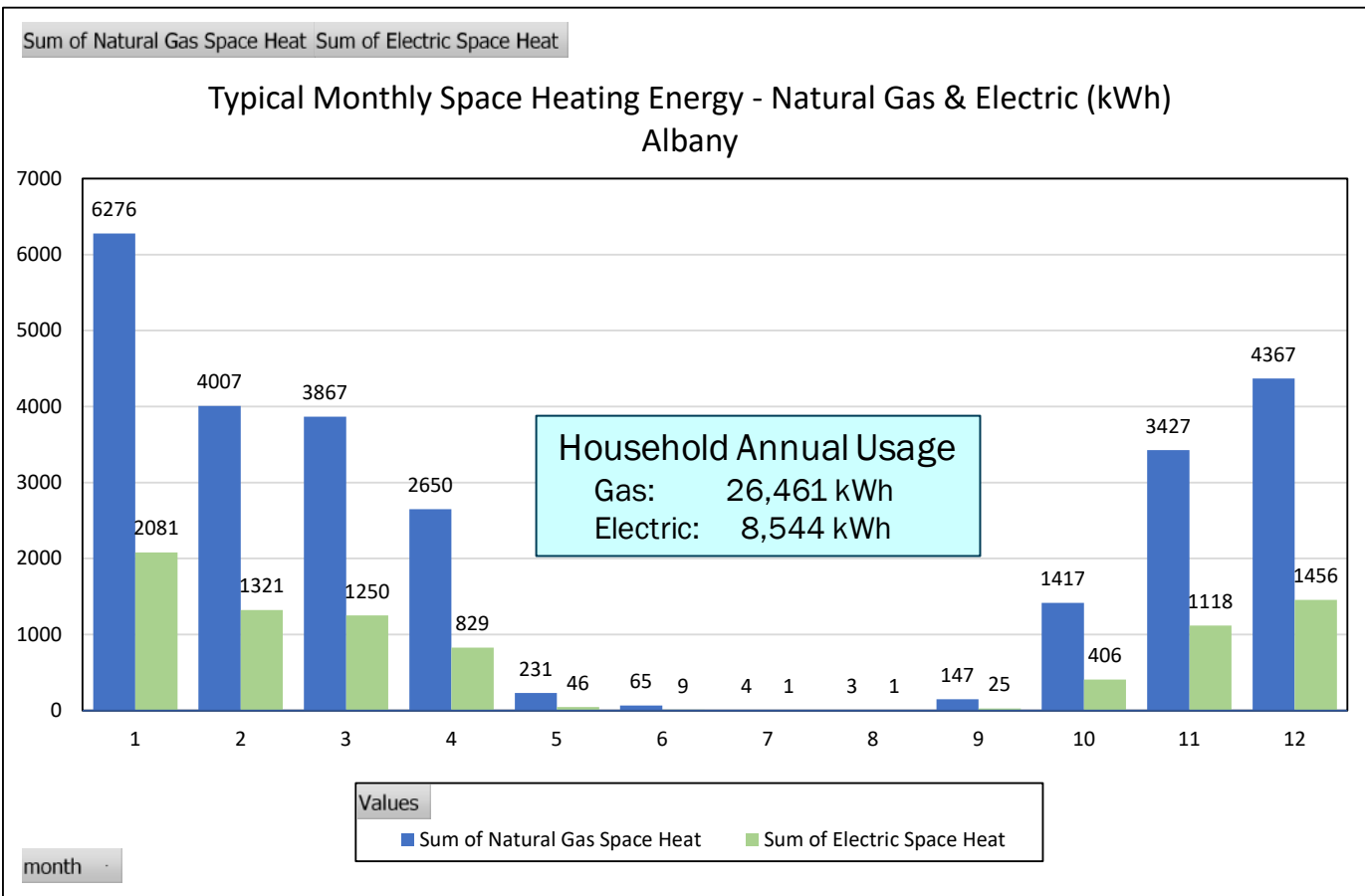
69_in.hvac_heating_type_and_fuel (Multiple It...ns)

Average of 9_in.sqft

Column Labels

Row Labels	10 to 19 Unit	2 Unit	20 to 49 Unit	3 or 4 Unit	5 to 9 Unit	50 or more Un Mobile Home	Single-Family	Single-Family	Grand Total	
Central Hudson Gas and Electric	649	1,096	952	1,215	838	865	885	1,736	2,121	1,385
Consolidated Edison	827	1,116	877	1,050	918	949		1,744	2,185	1,004
Long Island Power Authority	836	2,127	892	991	842	824		2,241	2,353	1,635
National Grid	923	941	873	960	872	812	1,086	1,537	2,180	1,282
NYS Electric and Gas	829	913	869	877	872	814	1,197	1,667	2,048	1,304
Orange and Rockland Utilities	1,955	969	1,007	970	863	967	1,220	1,864	2,078	1,387
Rochester Gas and Electric	804	949	1,063	878	771	755	885	1,771	2,087	1,351
Grand Total	879	1,044	888	981	874	922	1,116	1,824	2,149	1,186

Distributions of square footage of homes is obtained from American Housing Survey. It is a smaller sample and not as geographically comprehensive as the American Community Survey.



Source: NREL ResStock database

Space Heating UEC & Other Energy Metrics for Albany County

Metric	Elec Heat	Oil Heat	Gas Heat	Propane Heat
N Pop.	12,591	9,685	59,322	1,937
Sum MWh	148,238	320,066	1,598,123	35,724
UEC: Avg kWh	11,773	33,048	26,940	18,443
Avg MMBTU	40.17	112.76	91.92	62.93
Max Pop kW	99,883	201,789	1,078,679	26,447
Max Avg kW	7.93	20.84	18.18	13.65
Avg BTUH	27,067	71,090	62,042	46,587

Why are Gas & Oil UECs & Capacities twice that of Electric UEC? All SF homes have similar sizes. A similar pattern was observed in MidAtlantic Electric Space Heat end use. Finally, our own SAE models return a Beta of 1.0 when the electric space heat UEC is set to about 8,000 kWh.

Heating UEC by Fuel & Structure Type

After accounting for structure type, square footage, furnace efficiency & relative share of building types, gas & electric space heat UEC are indeed very similar within SF & MF structures, without introducing behavioral or utilization differences.

Electric Avg Heating kWh - Population (Calculated)

Average Residential Electric Usage - kWh

Row Labels	10 to 19 Unit	2 Unit	20 to 49 Unit	3 or 4 Unit	5 to 9 Unit	50+ Units	Mobile Home	SF Attached	SF Detached	Grand Total
Central Hudson Gas and Electric	7,421	12,646	2,822	10,022	7,526	3,094	3,911	10,115	15,224	10,248
Consolidated Edison	6,788	11,747	6,053	9,109	8,096	4,519		9,728	20,689	6,648
Long Island Power Authority	2,835	6,950	6,396	7,927	3,591	3,382		8,897	16,459	9,324
National Grid	7,191	12,407	5,914	11,507	9,009	5,269	15,483	12,094	22,433	12,906
NYS Electric and Gas	6,192	13,075	5,024	12,142	9,132	4,320	10,250	9,962	20,320	12,815
Orange and Rockland Utilities	6,728	13,056	3,439	7,304	7,371	2,919	5,513	6,614	20,483	10,793
Rochester Gas and Electric	7,138	13,471	11,252	11,213	7,600	7,777	14,736	11,257	20,481	13,742
Grand Total	6,493	12,222	6,098	10,481	8,248	4,596	11,548	9,904	20,309	9,637
Electric Saturation	23.0%	9.5%	16.9%	12.1%	25.3%	20.4%	2.8%	7.5%	5.0%	11.3%
Avg Square Footage	879	1,044	888	981	874	922	1,116	1,824	2,149	1,186

Nat Gas Avg Heating kWh - Population (Calculated)

Average Residential Electric Usage - kWh

Row Labels	10 to 19 Unit	2 Unit	20 to 49 Unit	3 or 4 Unit	5 to 9 Unit	50+ Units	Mobile Home	SF Attached	SF Detached	Grand Total
Central Hudson Gas and Electric	7,366	16,950	4,902	14,237	10,045	7,482	5,314	16,538	30,272	20,836
Consolidated Edison	11,663	16,803	10,708	16,769	12,824	9,455	55,497	21,918	37,853	17,535
Long Island Power Authority	7,656	13,945	8,315	14,437	11,800	9,228	6,152	14,640	33,156	27,002
National Grid	10,472	19,230	8,517	16,367	11,467	8,552	18,739	21,286	38,822	30,961
NYS Electric and Gas	11,257	20,494	10,271	17,197	12,617	10,590	21,441	21,276	39,226	31,537
Orange and Rockland Utilities	9,819	15,084	12,522	12,382	8,776	7,859	24,962	14,833	34,593	25,018
Rochester Gas and Electric	11,993	19,836	10,718	15,762	12,401	11,142	19,389	19,766	36,383	30,286
Grand Total	11,078	17,592	10,508	16,439	12,334	9,459	23,783	20,666	37,099	23,614
Nat Gas Saturation	52.3%	79.5%	47.9%	73.9%	57.1%	48.6%	20.7%	86.1%	56.3%	58.5%
Avg Square Footage	921	1,097	903	1,153	913	925	1,244	1,737	2,155	1,528

NYISO is verifying the 2018 ACS saturation data and may need to update SF/MF shares in its SAE models.

ISO

(2b) 2018 Aggregate Hourly Load Data by PUMA, Fuel Type & End Use

Select Data Viewer, then region of interest

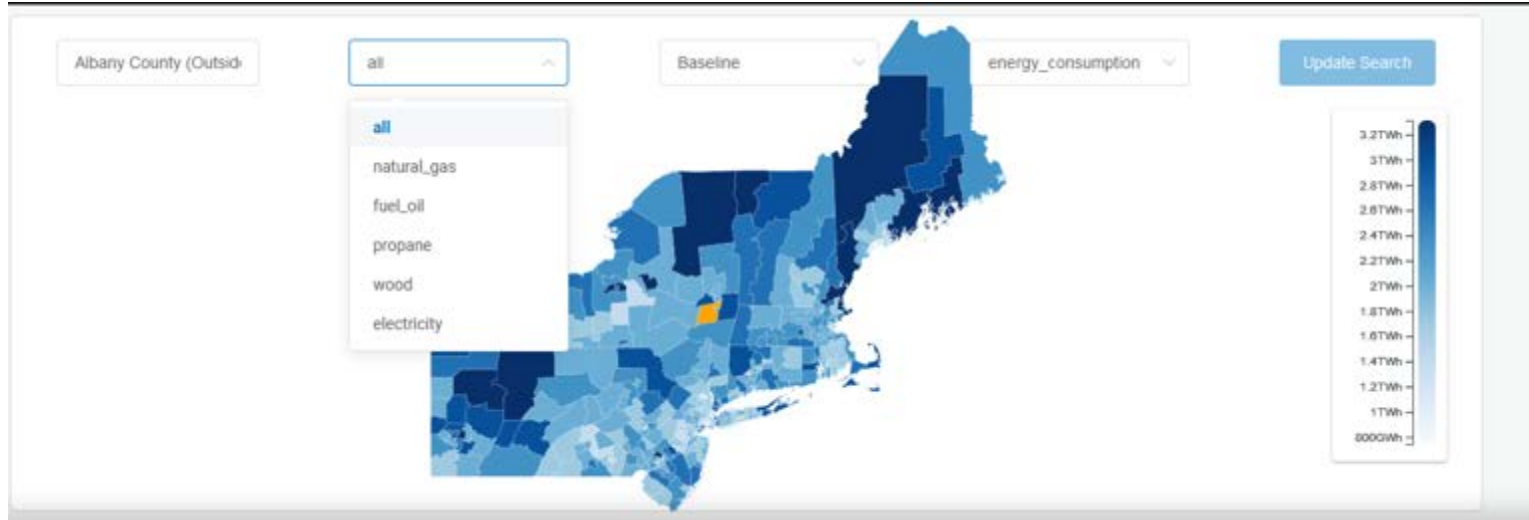
This method navigates directly within the ResStock web site.

Datasets

The screenshot displays a grid of six dataset cards. The card for 'ResStock National Load Profiles by PUMA Northeast 2018' is highlighted with a blue border, and its 'Go' button is highlighted with a red border. Each card includes a title, subtitle, a 'public' status indicator, and a 'Go' button with a right-pointing arrow.

- ResStock National Load Profiles by State 2018**
ResStock National Load Profiles by State 2018
• public
Go →
- ResStock National Load Profiles by PUMA Northeast 2018**
ResStock National Load Profiles by PUMA Northeast 2018
• public
Go →
- ResStock National Load Profiles by PUMA Midwest 2018**
ResStock National Load Profiles by PUMA Midwest 2018
• public
Go →
- ResStock National Load Profiles by PUMA South 2018**
ResStock National Load Profiles by PUMA South 2018
• public
Go →
- ResStock National Load Profiles by PUMA West 2018**
ResStock National Load Profiles by PUMA West 2018
• public
- ResStock National Load Profiles by PUMA Northeast TMY**
ResStock National Load Profiles by PUMA Northeast TMY
• public

Select a 'PUMA' using mouse;
Select a Fuel Type;

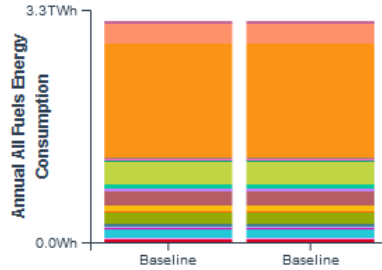


Scroll lower in window.....

Select 'Explore Time Series'

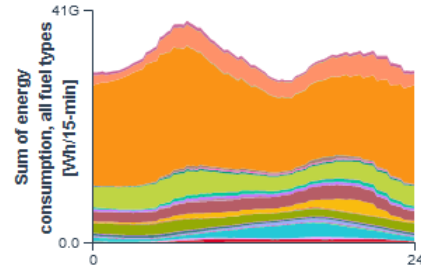
Legend:

- Electricity: Bath Fan
- Electricity: Ceiling Fan
- Electricity: Clothes Dryer
- Electricity: Clothes Washer
- Electricity: Cooking Range
- Electricity: Cooling
- Electricity: Dishwasher



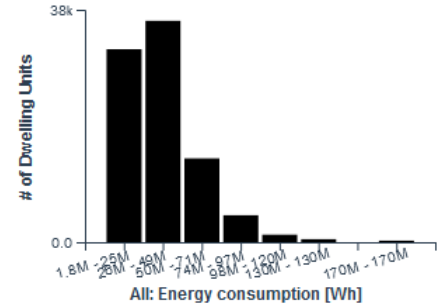
Baseline vs Baseline

Explore Bar Charts



Hour of Day [EST]

Explore Timeseries



Explore Histograms

Select Fuel, Aggregation Type, Timeseries Range, Months & then..... follow the White Rabbit

ResStock National Load Profiles by PUMA Northeast 2018 > Albany County (Outside Albany City) PUMA > Timeseries Data

Print This Report

Export CSV

Fuel Type:

Upgrade:

Output:

all

Baseline

energy_consumption

Aggregation Type:

Timeseries Range:

Month Constraints:

sum

year

Start: ☐

End: ☐

Chosen Search Parameters:

Location: Albany County (Outside Albany City) PUMA

Fuel Type: all

Upgrade: Baseline

Output: energy_consumption

Aggregation Type: sum

Timeseries Range: year

Month Constraints: Jan to Dec

Filters

+ Add Filters

Update Search

Currently Viewing:

Albany County (Outside Albany City) PUMA

+ More Locations

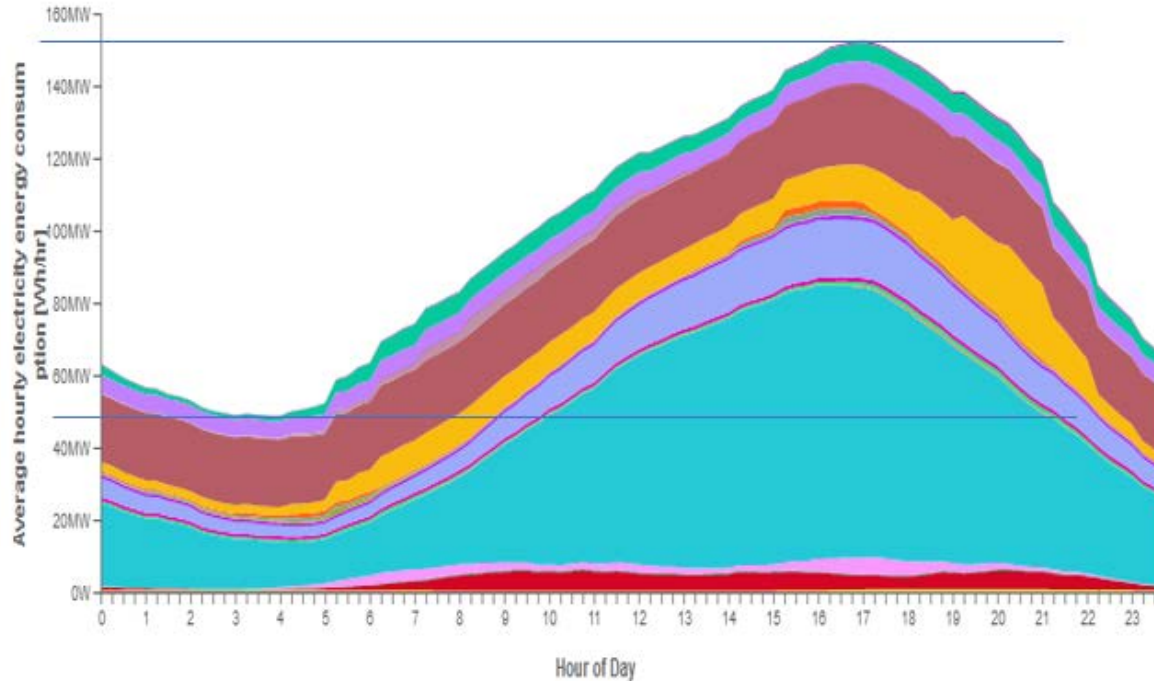
Legend:

- Electricity: Bath Fan
- Electricity: Ceiling Fan
- Electricity: Clothes Dryer
- Electricity: Clothes Washer
- Electricity: Cooking Range
- Electricity: Cooling
- Electricity: Dishwasher
- Electricity: Ext Holiday Light
- Electricity: Exterior Lighting
- Electricity: Extra Refrigerator
- Electricity: Fans Cooling
- Electricity: Fans Heating
- Electricity: Freezer
- Electricity: Garage Lighting
- Electricity: Heating
- Electricity: Heating Supplement
- Electricity: Hot Tub Heater
- Electricity: Hot Tub Pump
- Electricity: House Fan
- Electricity: Interior Lighting
- Electricity: Plug Loads
- Electricity: Pool Heater
- Electricity: Pool Pump
- Electricity: Pumps Cooling
- Electricity: Pumps Heating
- Electricity: Pv
- Electricity: Range Fan
- Electricity: Recirc Pump
- Electricity: Refrigerator
- Electricity: Vehicle
- Electricity: Water Systems
- Electricity: Well Pump
- Fuel Oil: Heating
- Fuel Oil: Water Systems
- Natural Gas: Clothes Dryer
- Natural Gas: Cooking Range
- Natural Gas: Fireplace
- Natural Gas: Grill
- Natural Gas: Heating
- Natural Gas: Hot Tub Heater
- Natural Gas: Lighting
- Natural Gas: Pool Heater
- Natural Gas: Water Systems
- Propane: Clothes Dryer
- Propane: Cooking Range
- Propane: Heating
- Propane: Water Systems
- Wood: Heating

.... Update Search

Energy Use Is Calculated at 15 MPI For A Wide Range of End Uses

Average hourly electricity consumption in Jun - Aug by hour of day



Chosen Search Parameters:

Location: Albany County (Outside Albany City) P
UMA

Fuel Type: electricity

Upgrade: Baseline

Output: energy_consumption

Aggregation Type: average

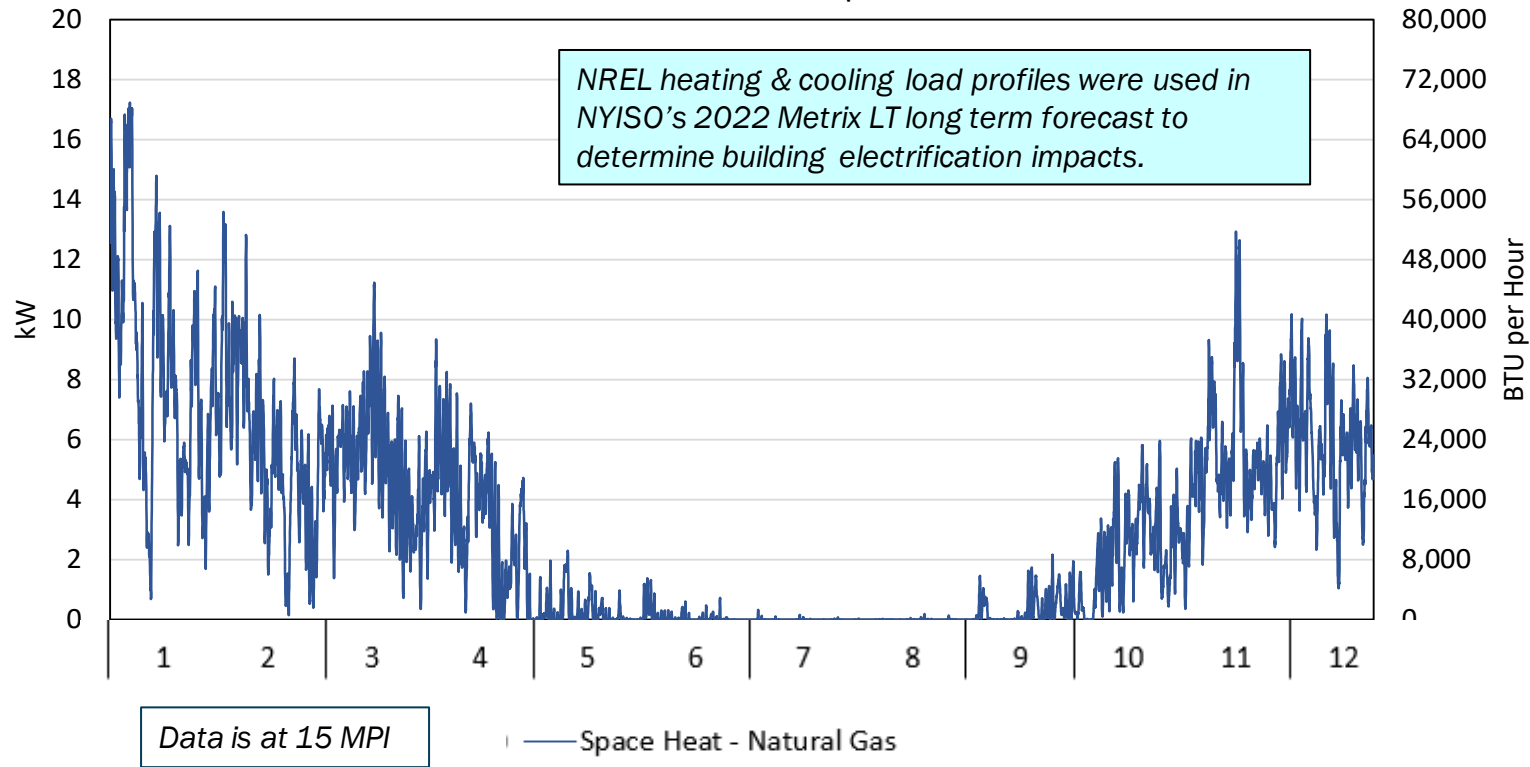
Timeseries Range: day

Month Constraints: Jun to Aug

Close

k ISO

Albany Natural Gas Space Heat - 2018 Hourly Loads In kW & BTU per Hour



Source: NREL ResStock database

New York ISO

Our Mission & Vision



Mission

Ensure power system reliability
and competitive markets for New
York in a clean energy future



Vision

Working together with stakeholders
to build the cleanest, most reliable
electric system in the nation