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Independent System Operator

2022 Long Term Forecast – End Use Modeling & Electrification Assumptions

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Joint Electric System Planning Working Group & Load Forecasting Task Force Meeting

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Primary Topics

1. Residential End Use Model
2. Data Development of Heating & Cooling Usage in Residential Sector
3. Long Term Forecast Assumptions

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New York Residential End Use Model

Key Terminology

- Unit Energy Consumption (UEC or UPC) – The annual energy usage of an appliance averaged across only those homes with the appliance.
- Saturation – The percentage of all homes with a given appliance. May be greater than or less than 100%. (Some homes have multiple computers, TVs, refrigerators, etc.)
- Intensity (I) – The annual energy usage of an appliance averaged across all homes, with or without the appliance.

$$Intensity = UEC * Saturation$$

- Total Usage = Intensity * Number of Residential Households

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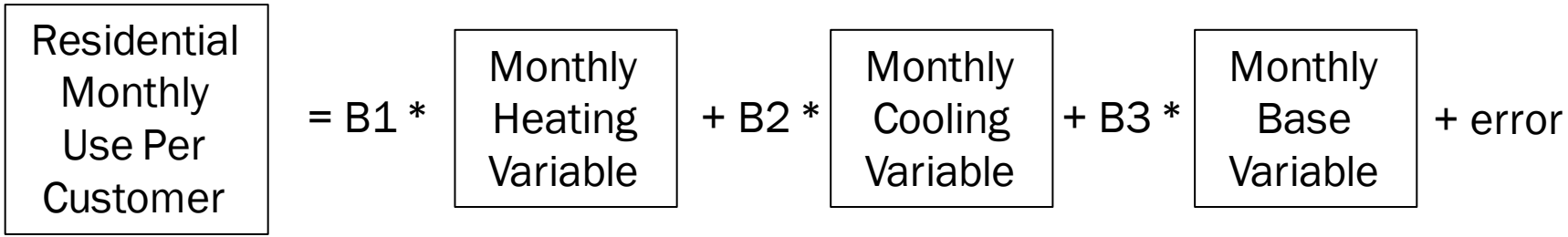
Simplified End Use Model Equation of Monthly Residential Use Per Customer



Monthly and annual energy forecasts are obtained by multiplying use per customer by households

In practice, trends in the economy, demographics, weather, and efficiency are introduced into these variables to provide a much richer structure for producing a forecast.

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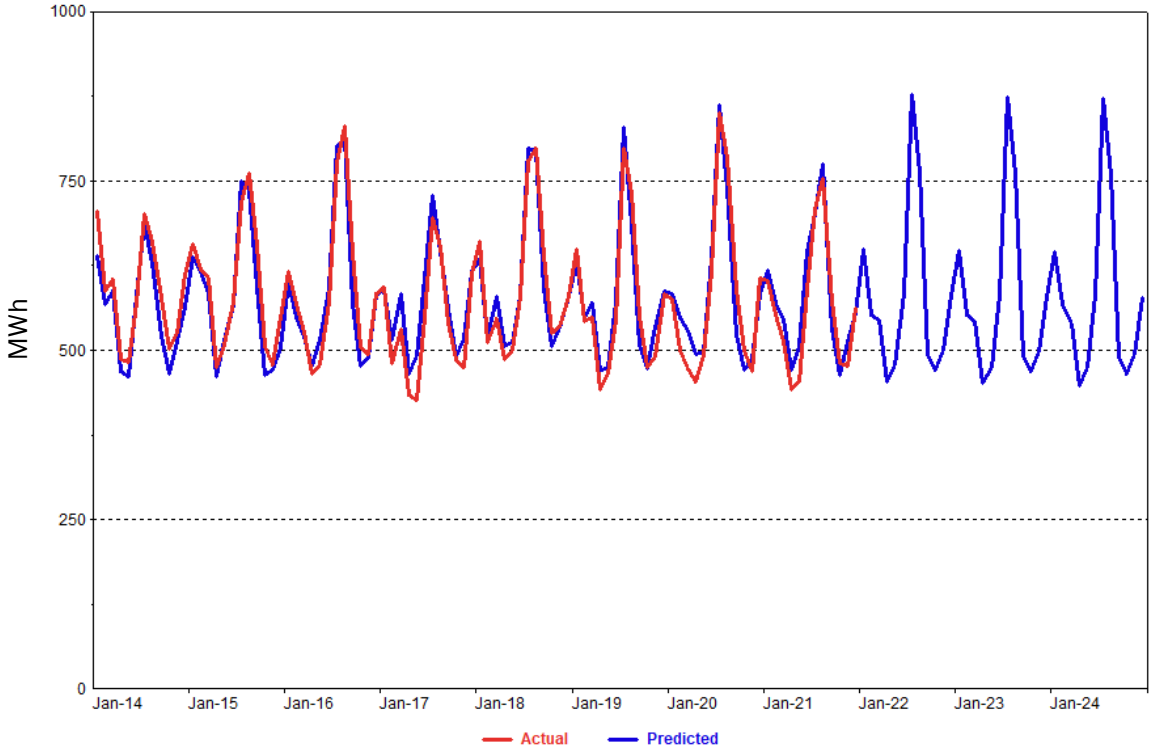
Historical Data is Used to Fit the Model & Then Produce a Forecast Based on Economic and Technology Trends



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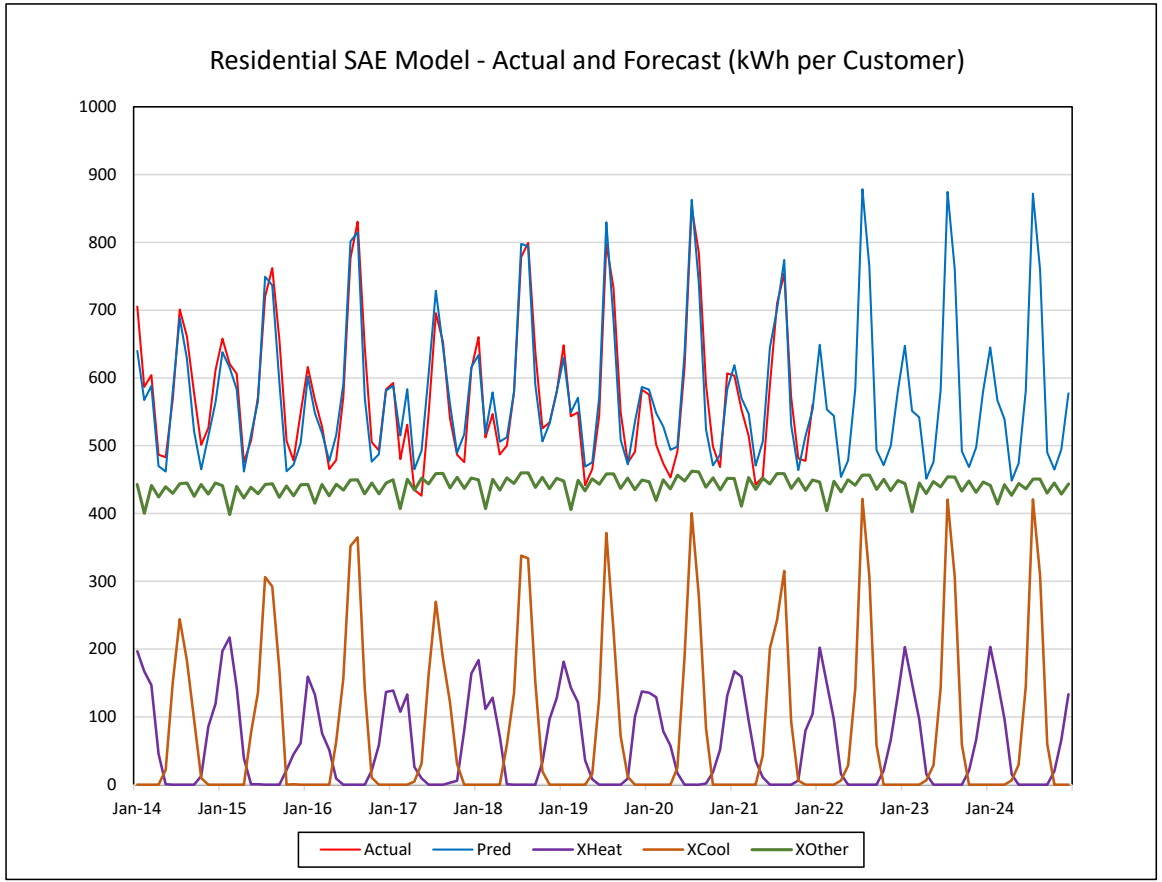

Monthly components of heating, cooling and base energy usage sum to the total residential use per customer. Technology trends can be specific to each of these components.

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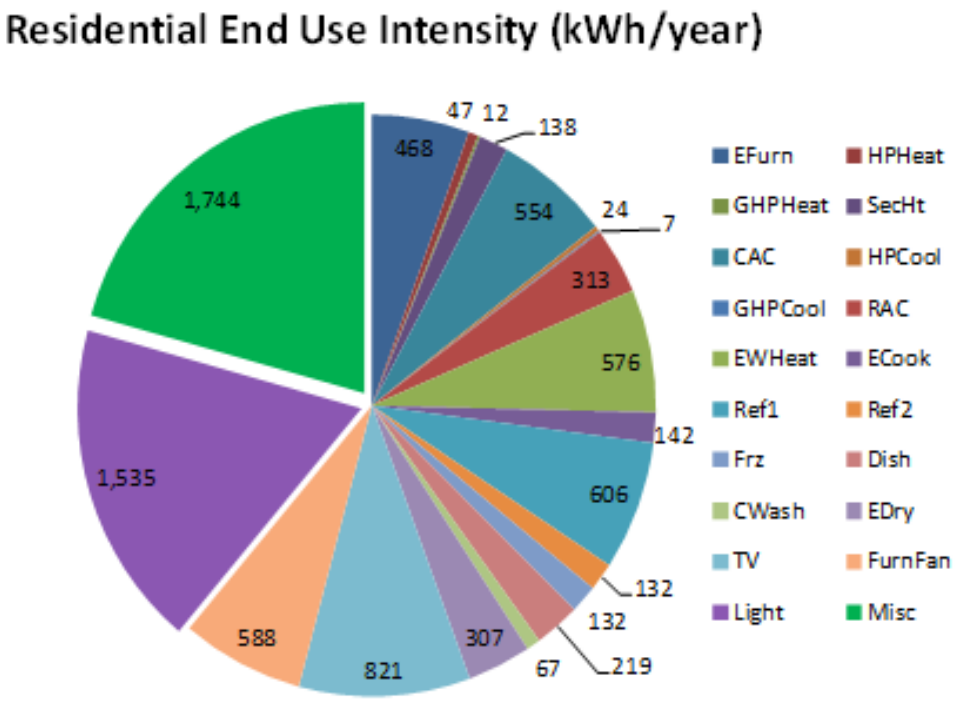
Residential End Uses



End Use & Equipment Definitions	
EFurn	Electric furnace and resistant room space heaters
HPHeat	Heat pump: space heating
GHPHeat	Ground-source heat pump space: heating
SecHt	Secondary heating
CAC	Central air conditioning
HPCool	Heat pump: space cooling
GHPCool	Ground-source heat pump: space cooling
RAC	Room air conditioners
EWHeat	Electric water heating
ECook	Electric cooking
Ref1	Refrigerator
Ref2	Second refrigerator
Frz	Freezer
Dish	Dishwasher
CWash	Electric clothes washer
EDry	Electric clothes dryer
TV	TV sets
FurnFan	Furnace fans
Light	Lighting
Misc	Miscellaneous electric appliances

Reference year for intensity is 2009. Current models are benchmarked to data from 2018.

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End Uses & Technologies are Categorized By Weather Response

Heating Technologies

End Use	UEC - KWh	Saturation (%)	Intensity - KWh
EFurn	6,529	3.06%	200
HPHeat	4,130	1.46%	60
GHPHeat	4,348	1.06%	46
SecHt	875	25.33%	222
FurnFan	318	47.31%	150
Heating	16,200	4.18%	678

Cooling Technologies

End Use	UEC - KWh	Saturation (%)	Intensity - KWh
CAC	1,080	46.78%	505
HPCool	1,009	1.46%	15
GHPCool	913	1.06%	10
RAC	327	128.15%	419
Cooling	3,330	28.50%	949

Other End Uses & Appliances

End Use	UEC - KWh	Saturation (%)	Intensity - KWh
EWHeat	1,582	11.56%	183
ECook	117	34.67%	40
Ref1	1,126	100.00%	1,126
Ref2	987	41.69%	412
Frz	215	29.09%	62
Dish	52	81.45%	43
CWash	42	95.40%	40
EDry	459	39.60%	182
TV	208	100.00%	208
Light	623	100.00%	623
Misc	2,076	100.00%	2,076
Other	3,366	148.40%	4,995

Model Variables	Intensity kWh	Percentage
Heating	678	10.2%
Cooling	949	14.3%
Other	4,995	75.4%
Total	6,622	100.0%

Total Intensity is equal to average annual use per customer.

Heating and cooling variables are indexed to a reference year and conditioned by monthly heating and cooling degree days.

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New York Residential Space Heating and Cooling Energy Usage Characteristics

Data Sources

1. NYSERDA 2019 Residential Building Stock Assessment
2. National Renewable Energy Laboratory ResStock Model of Building & Energy Usage Characteristics
3. Energy Information Administration – Monthly Natural Gas Usage Data for New York Residential Class
4. NYISO review of heat pump performance characteristics
5. ITRON Electric Forecasting Group data

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NYSERDA 2019 Residential Building Stock Assessment

On-Site Sample Sizes by Heating System & Climate Zone

Technology	Climate Zone 4	Climate Zone 5	Climate Zone 6	Total
Heat Pumps - AS	11	20	7	38
Heat Pumps - GS	0	14	3	17
Other Electric	3	29	16	48
Natural Gas	64	204	36	304
Oil, Prop, Ker	26	44	45	115
Other Fossil	0	18	13	31
Total Households	90	274	92	456

Note: Due to small sample sizes, a given technology was not sampled at every utility. This doesn't mean none are to be found in the service territory.

On-Site Sample Sizes by Heating System & Utility

Technology	Cen Hudson	Con Ed	LIPA	National Grid	NYSEG	O&R	RG&E	Total
Heat Pumps - AS	5	7	4	4	6	0	5	38
Heat Pumps - GS	3	0	0	6	6	0	2	17
Other Electric	3	2	1	22	12	1	7	48
Natural Gas	8	49	15	136	51	4	41	304
Oil, Prop, Ker	9	7	19	45	25	5	5	115
Other Fossil	2	0	0	16	10	0	3	31
Total Households	22	56	34	192	91	9	52	456

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NYSERDA 2019 Residential Building Stock Assessment

Number of Households by Heating System & Utility

Technology	Cen Hudson	Con Ed	LIPA	National Grid	NYSEG	O&R	RG&E	Total
Heat Pumps - AS	1,357	207,250	118,429	40,459	82,734	0	38,046	488,275
Heat Pumps - GS	9,986	0	0	22,060	10,909	0	543	43,498
Other Electric	271	0	29,607	56,437	9,444	0	19,158	114,917
Natural Gas	20,570	1,396,381	389,736	1,133,406	389,800	28,602	304,365	3,662,860
Oil, Prop, Ker	75,820	207,250	535,351	333,693	201,056	19,701	49,305	1,422,177
Other Fossil	9,715	0	0	33,103	46,776	0	9,444	99,038
Total Households	97,746	1,603,631	925,087	1,490,299	632,510	48,303	373,371	5,170,948

Average Installed Capacity by Heating System & Utility - BTU per Hour

Technology	Cen Hudson	Con Ed	LIPA	National Grid	NYSEG	O&R	RG&E	Total
Heat Pumps - AS	45,600	53,843	24,900	28,834	37,457	0	29,305	40,039
Heat Pumps - GS	77,350	0	0	44,067	33,723	0	48,800	49,173
Other Electric	34,800	0	11,200	18,543	51,180	0	8,499	17,697
Natural Gas	88,570	146,522	137,180	98,626	95,632	138,110	74,513	118,917
Oil, Prop, Ker	130,070	144,714	148,395	110,778	109,528	127,664	85,746	130,101
Other Fossil	126,227	0	0	57,996	60,014	0	72,300	67,006
Total Households	140,709	153,247	147,216	103,237	104,434	133,850	77,386	125,889

Note: Due to small sample sizes, a given technology was not sampled at every utility. This doesn't mean none are in the service territory.

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NYSERDA 2019 Residential Building Stock Assessment

Number of Households by Cooling System & Utility

Technology	CenHud	ConEd	LIPA	NGrid	NYSEG	O&R	RG&E	Total
Room AC	66,105	710,573	236,858	305,177	328,565	18,887	37,774	1,703,939
Central AC	11,126	508,165	596,986	663,506	187,294	38,588	200,486	2,206,150
Heat Pumps (AS)	1,357	207,250	118,429	40,459	82,734	0	38,046	488,275
Heat Pumps (GS)	9,986	0	0	1,085	10,909	0	271	22,252
Total Households	78,859	1,218,738	804,237	1,000,457	538,896	48,032	267,133	3,956,352

Average Unit Installed Capacity by Cooling System & Utility - BTU per Hour

Technology	CenHud	ConEd	LIPA	NGrid	NYSEG	O&R	RG&E	Total
Room AC	8,863	8,111	7,931	7,913	7,240	9,250	9,511	8,968
Central AC	35,079	44,097	33,896	32,029	28,520	33,748	28,338	37,967
Heat Pumps (AS)	20,300	19,144	20,920	15,462	22,142	0	27,766	21,757
Heat Pumps (GS)	50,469	0	0	50,875	37,852	0	57,600	53,227
Avg Unit Capacity	17,124	16,567	21,856	20,706	15,407	26,153	23,699	22,092

Note: Due to small sample sizes, a given technology was not sampled at every utility. This doesn't mean none are in the service territory.

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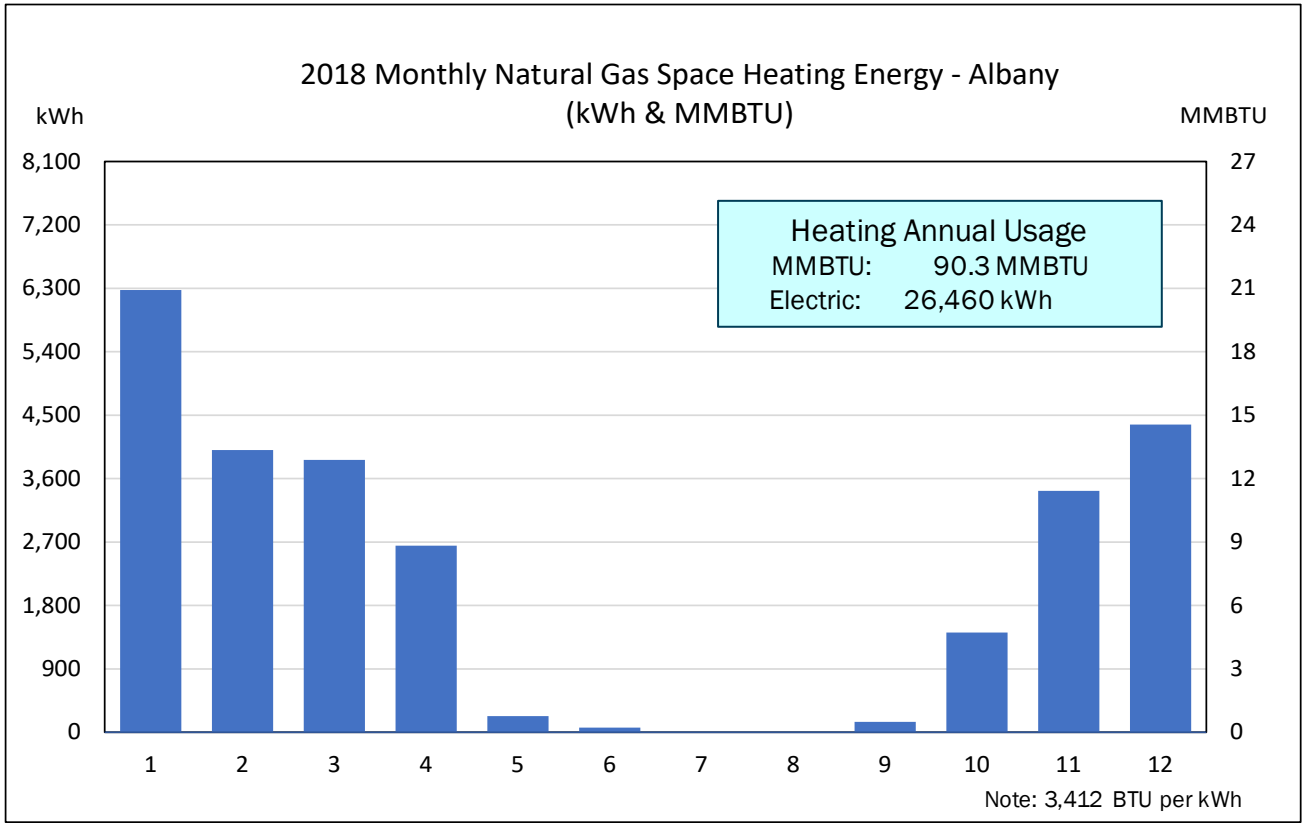
NREL ResStock Database – Monthly Peak Heating Load



Source: NREL ResStock database

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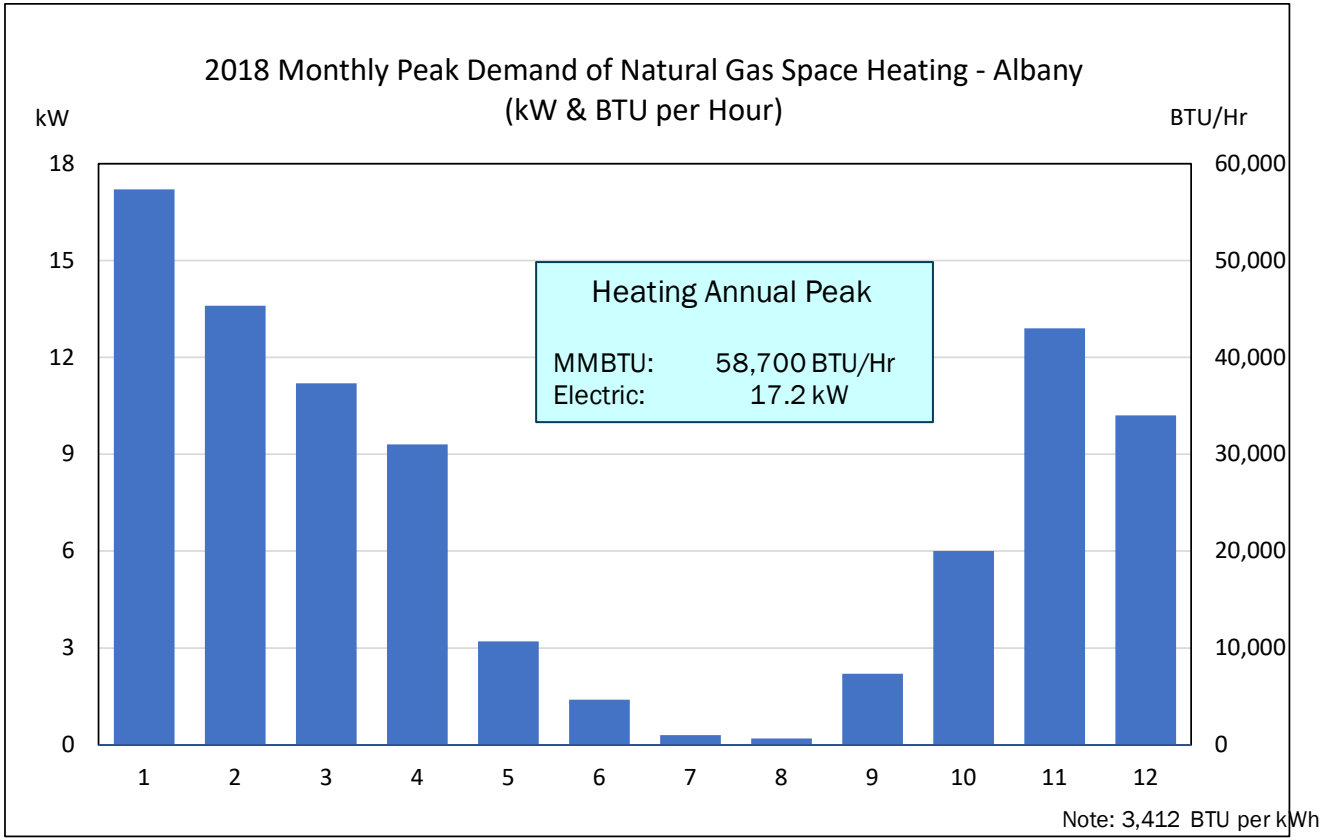
NREL ResStock Database – Natural Gas Monthly Energy Usage



Source: NREL ResStock database

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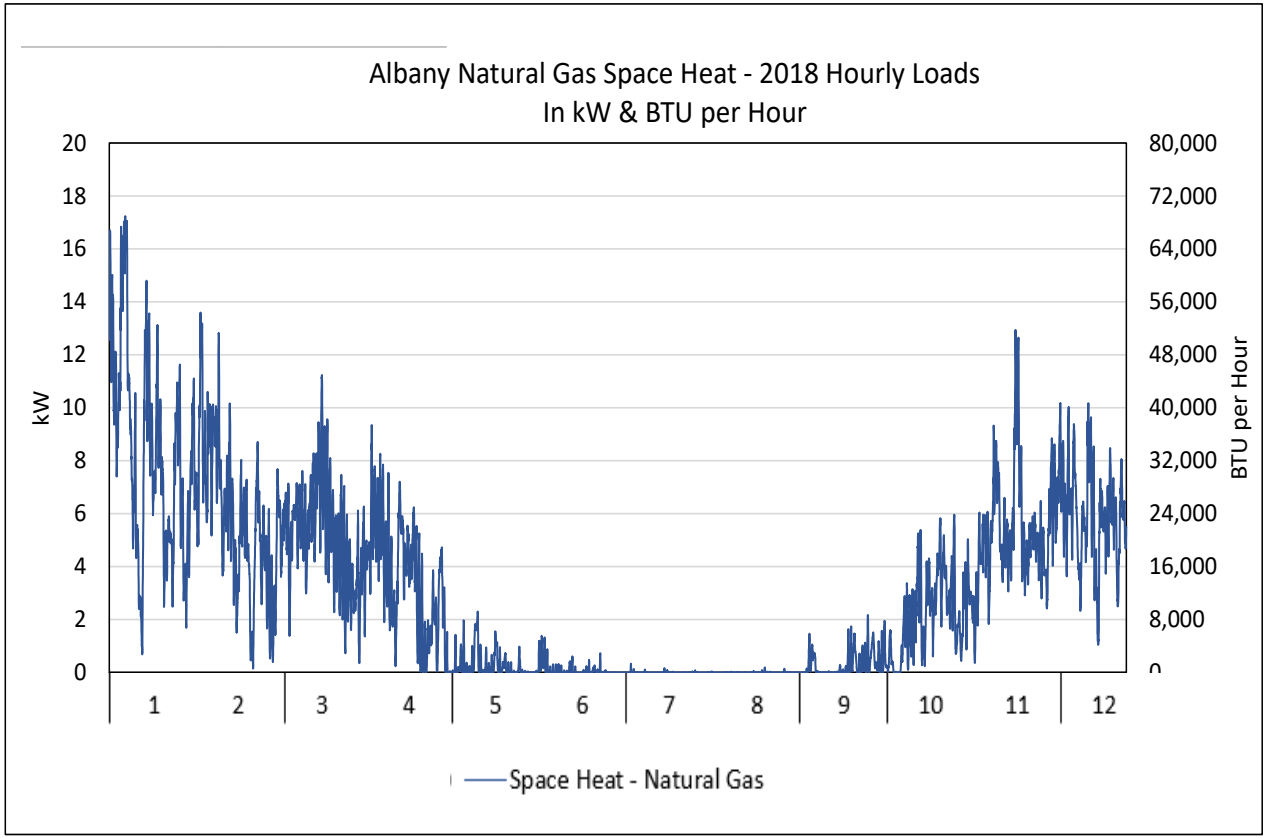
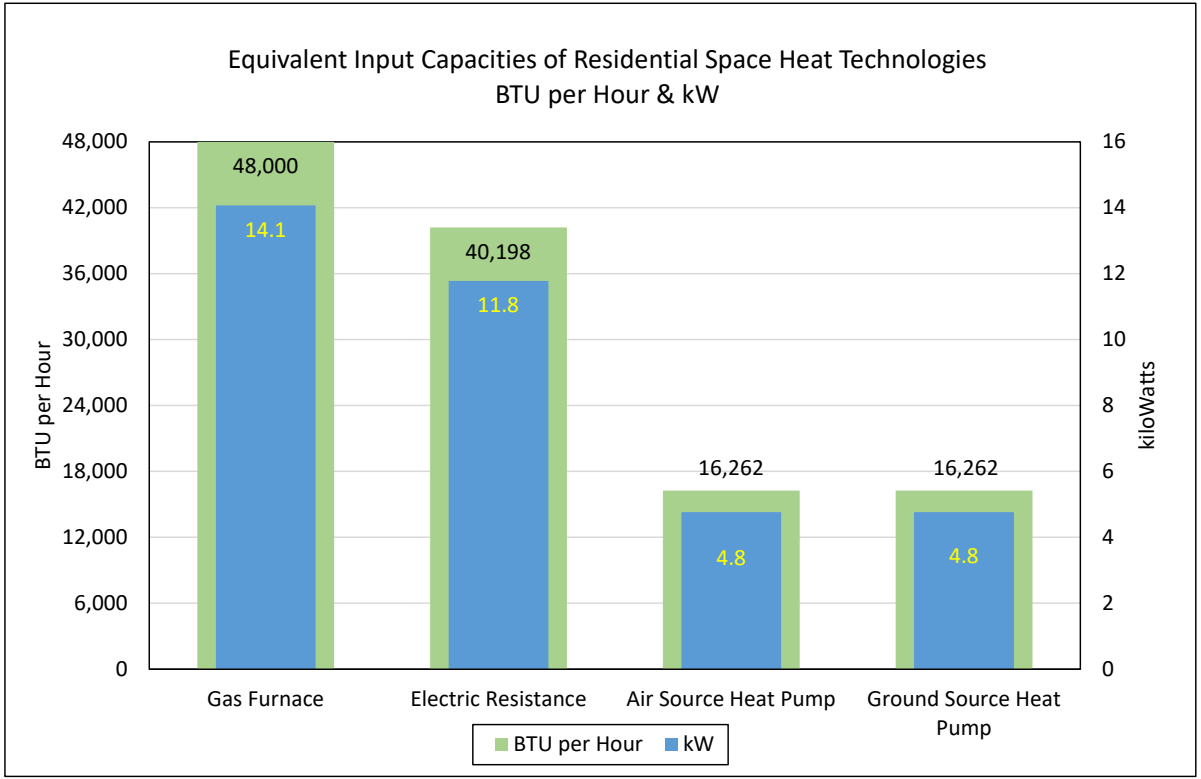
NREL ResStock Database – Hourly Loads for Natural Gas Spaced Heating



Source: NREL ResStock database

Equivalent Peak Loads for Space Heating Technologies



This chart indicates that the replacement size of a 48,000 BTUH gas furnace is on the order of 12 kW for electric resistance heating, or 4.8 kW for a heat pump, in order to provide the equivalent amount of home heating capacity.

Source: NREL ResStock database

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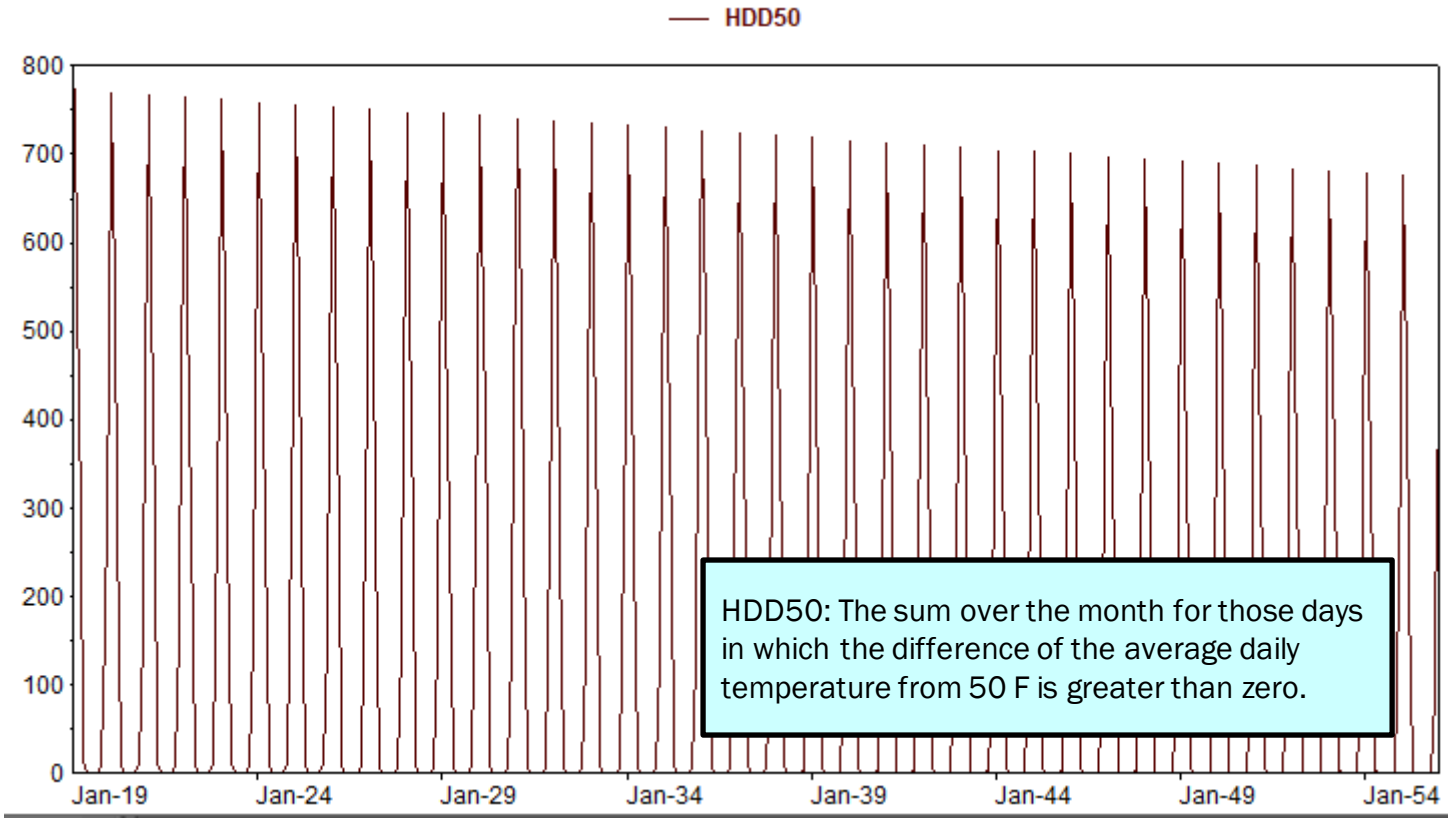
New York Residential Energy Forecasting Assumptions – Weather & Economic Trends

Downward Trend in Heating Degree Days Will Reduce Winter Energy and Winter Peaks



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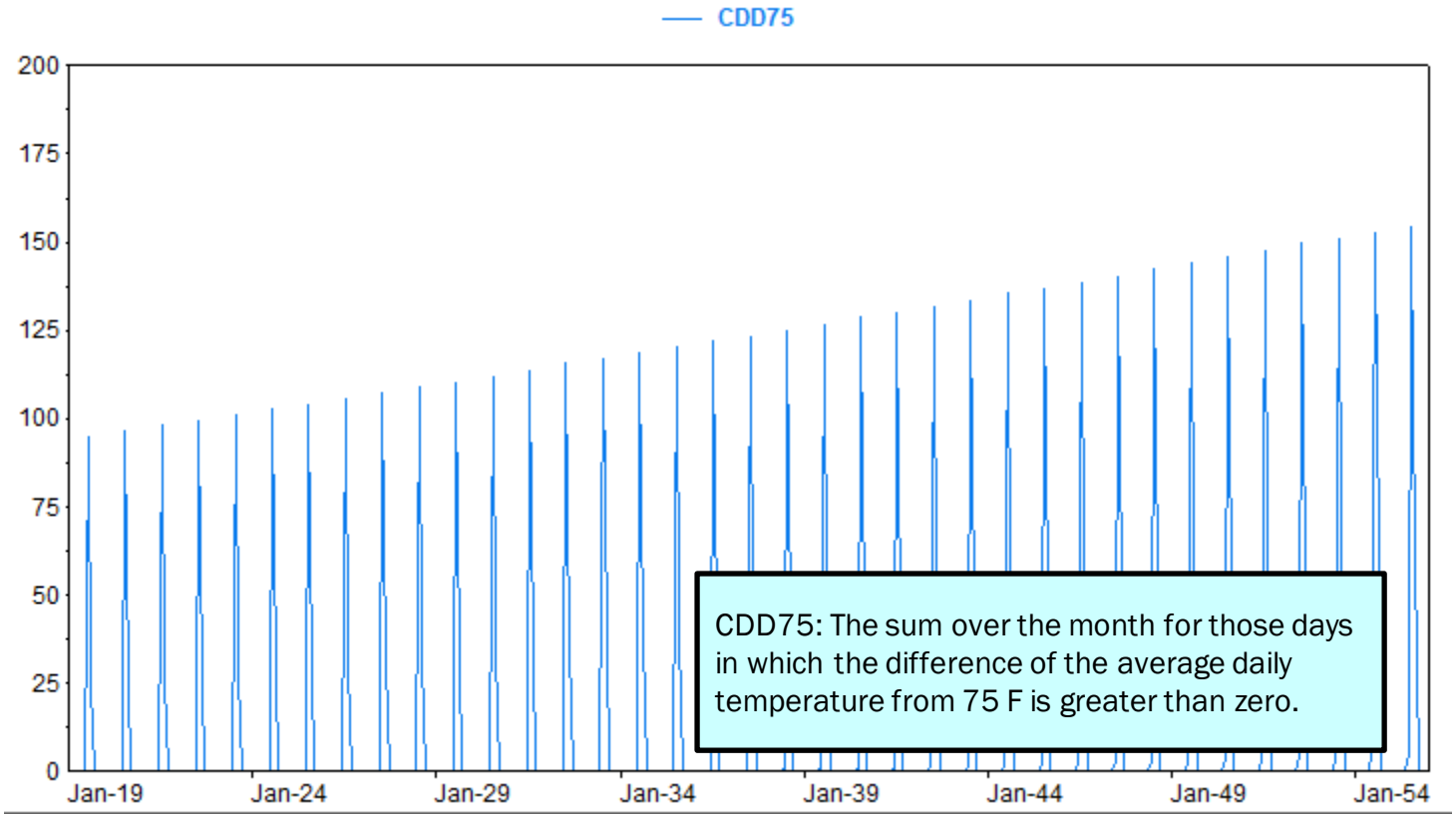
Upward Trend in Cooling Degree Days Will Increase Summer Energy and Summer Peaks



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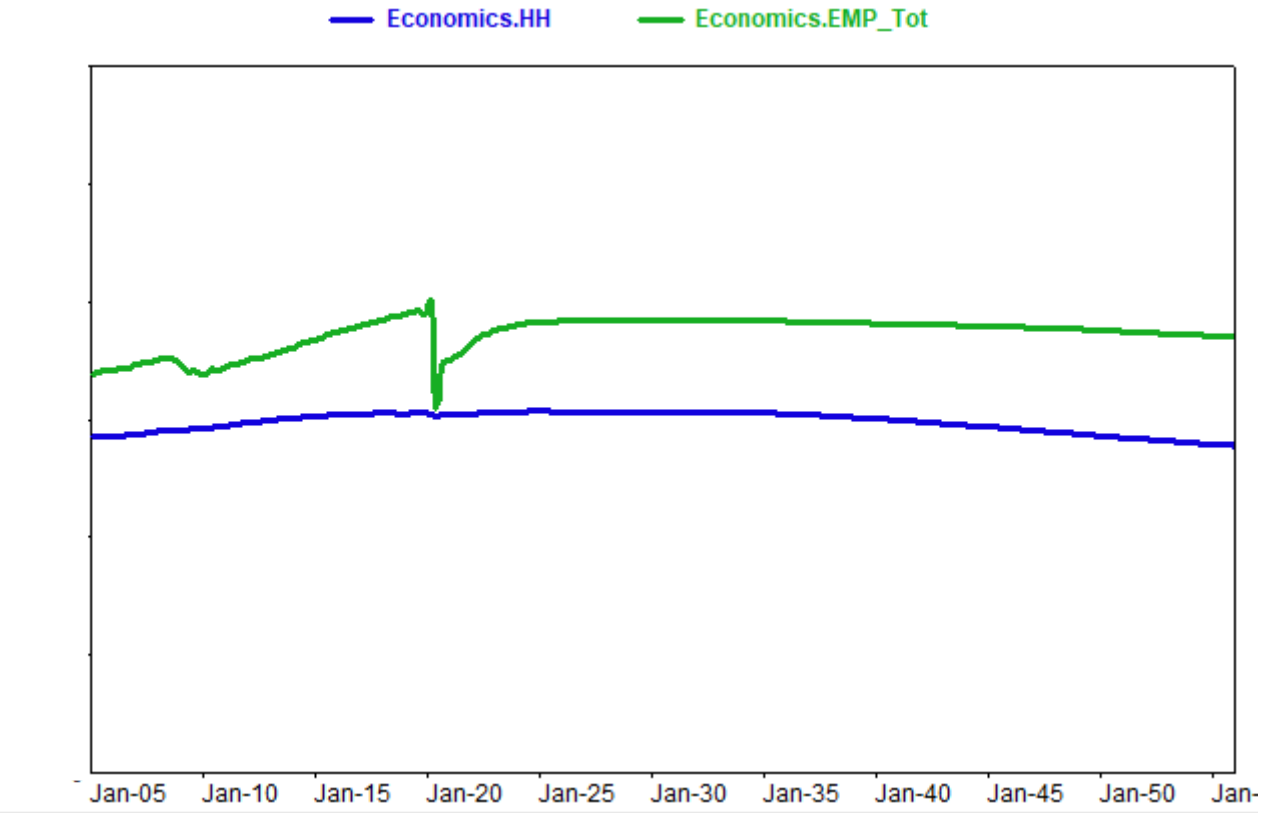
Employment and Household Growth Is Essentially Flat Until 2035 and Then Gradually Declines



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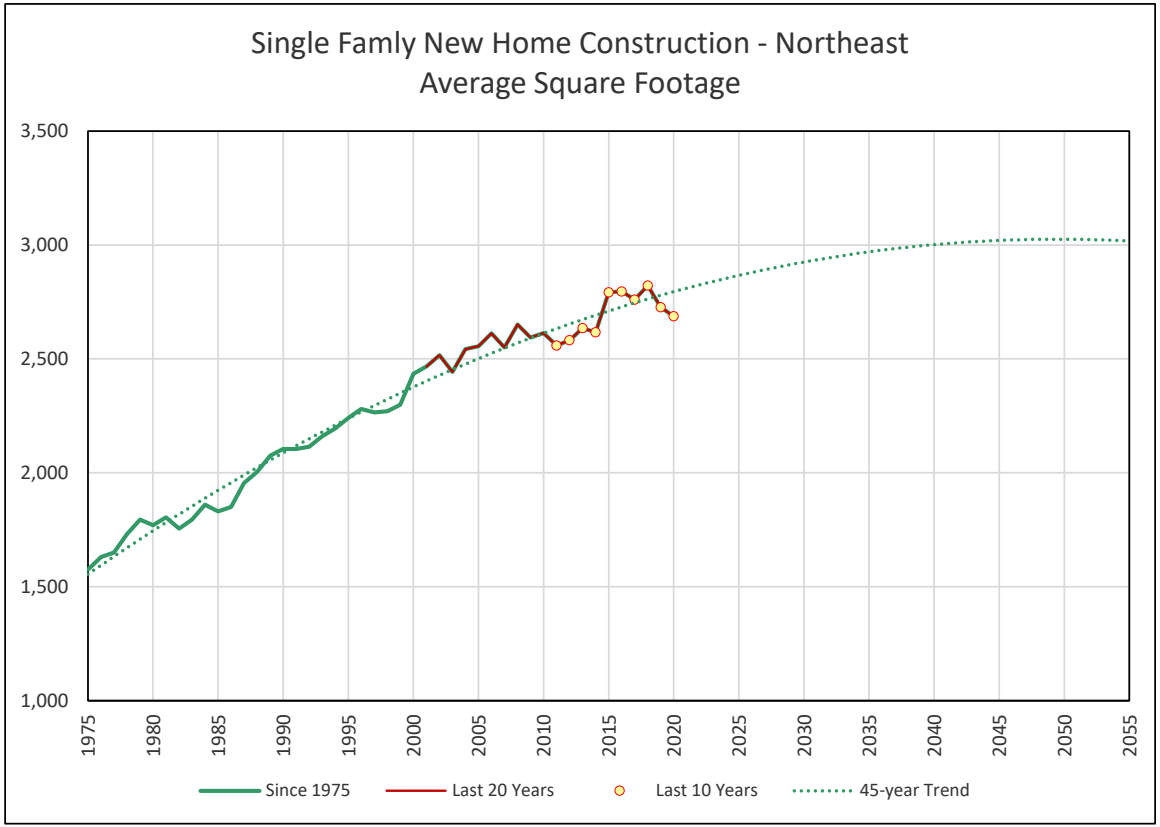
New York Residential Energy Forecasting Assumptions – Building & Appliance Efficiency Trends

Average Home Size Increases at a Diminishing Rate of Growth



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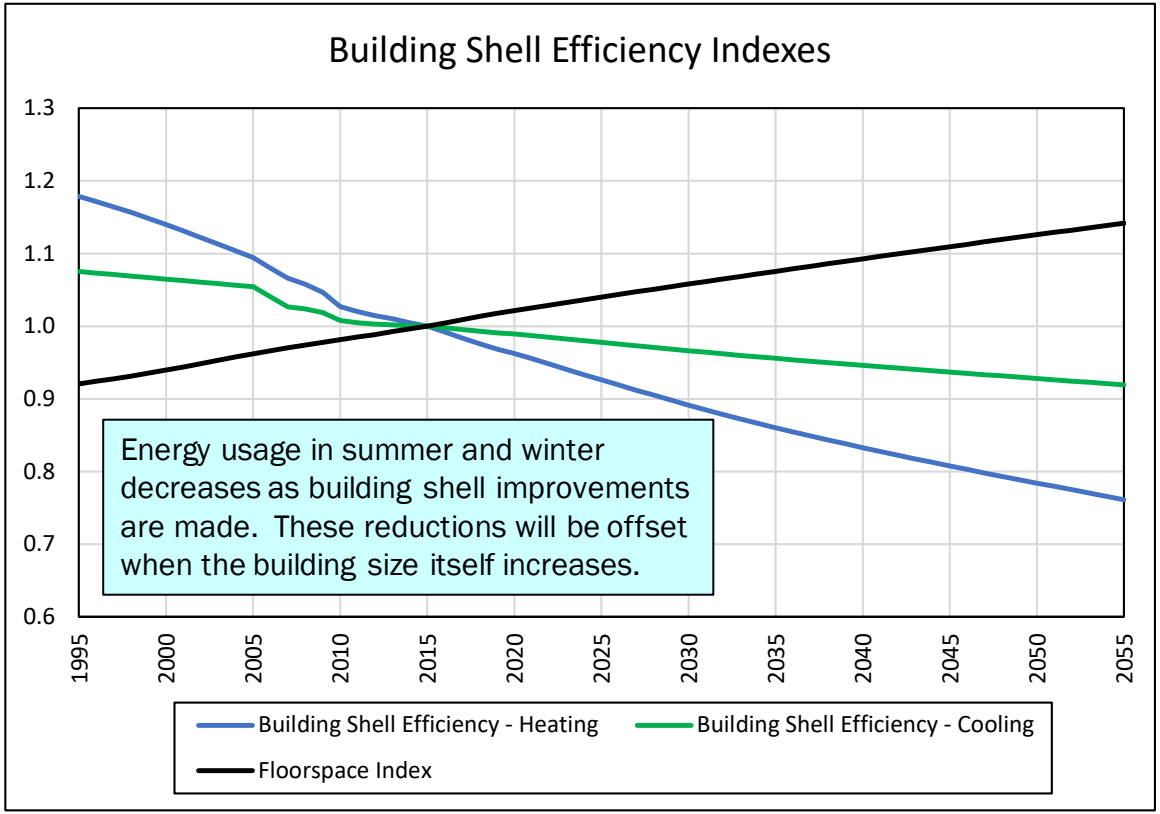
Building Shell Efficiency Reduces Heating & Cooling Energy Use
Indexes are Relative to 2015



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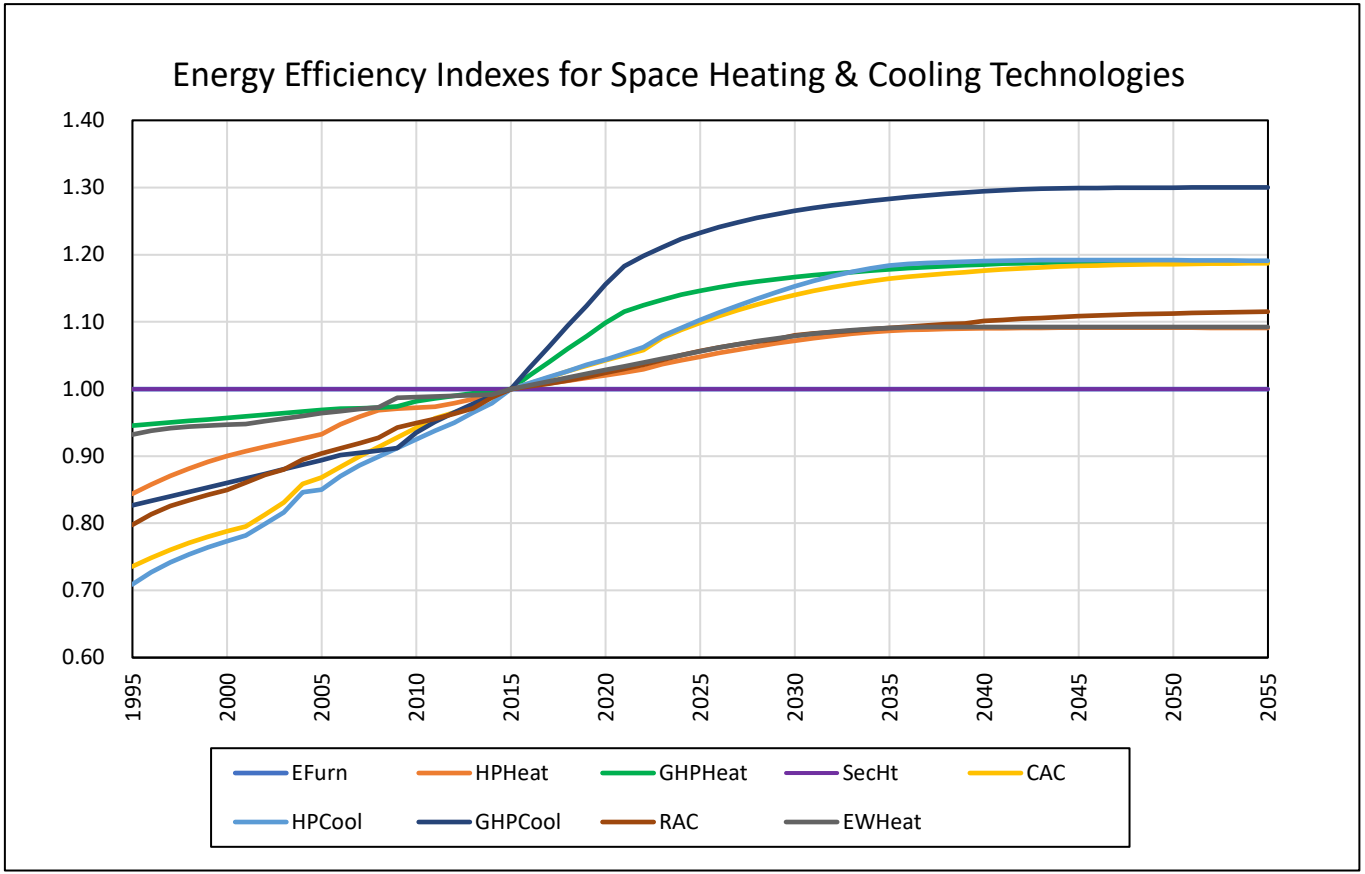

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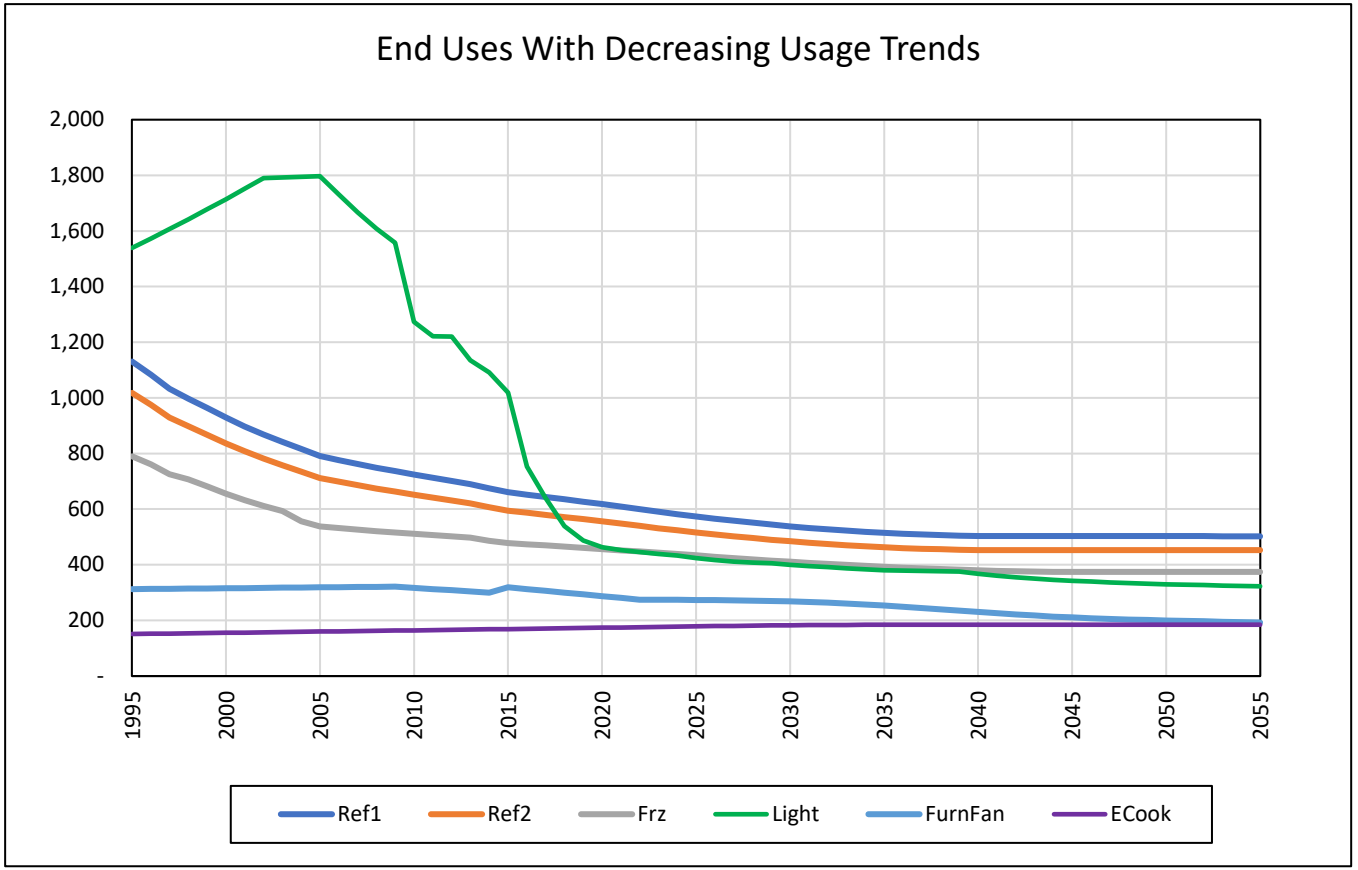

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New York City – Local Law 97

- Under this groundbreaking law, most buildings over 25,000 square feet will be required to meet new energy efficiency and greenhouse gas emissions limits by 2024, with stricter limits coming into effect in 2030
- The goal is to reduce the emissions produced by the city's largest buildings 40 percent by 2030 and 80 percent by 2050
- Owners of noncompliant buildings face the prospect of multimillion-dollar annual fines beginning in 2024
- Reducing emissions from a building can take years, especially for properties in the top 20% of emitters
- Most measures that reduce emissions also improve energy efficiency, reducing the operating cost of a building

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Local Law 97 & Forecasting Impact in Zone J

1. Increase the rate at which energy reductions occur due to
   - LED lighting,
   - air conditioning and
   - building shell efficiency improvements
2. Increase the rate of adoption of air source heat pumps for space heating
3. Net impact will be to reduce usage more quickly than would otherwise be the case
4. Continue monitoring the actual and weather-adjusted energy usage in Zone J. As compliance with LL 97 proceeds over the next several years, energy usage should decrease in the commercial sector at a faster rate than in other Zones

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New York Residential Energy Forecasting Assumptions – Electrification Trends

Approach to Electrification Forecast (1)

1. Identify monthly & hourly usage characteristics of natural gas & other fossil-fueled appliances
2. Determine the equivalent electric usage characteristics after accounting for the differences in energy conversion efficiency
3. Starting from the current saturation of electric appliances, gradually convert fossil-fueled appliances to electric
4. Apply the same types of building and appliance efficiency trends to these new electric appliances

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Approach to Electrification Forecast (2)

5. Overall energy forecast is determined by the product of appliance usage, number of households, and the percent of homes (saturation) with that appliance
6. Saturation is typically less than 100%. However, if there are more than one refrigerator, room AC, or a primary and a secondary heat source, then the saturation for all these appliances could exceed 100%

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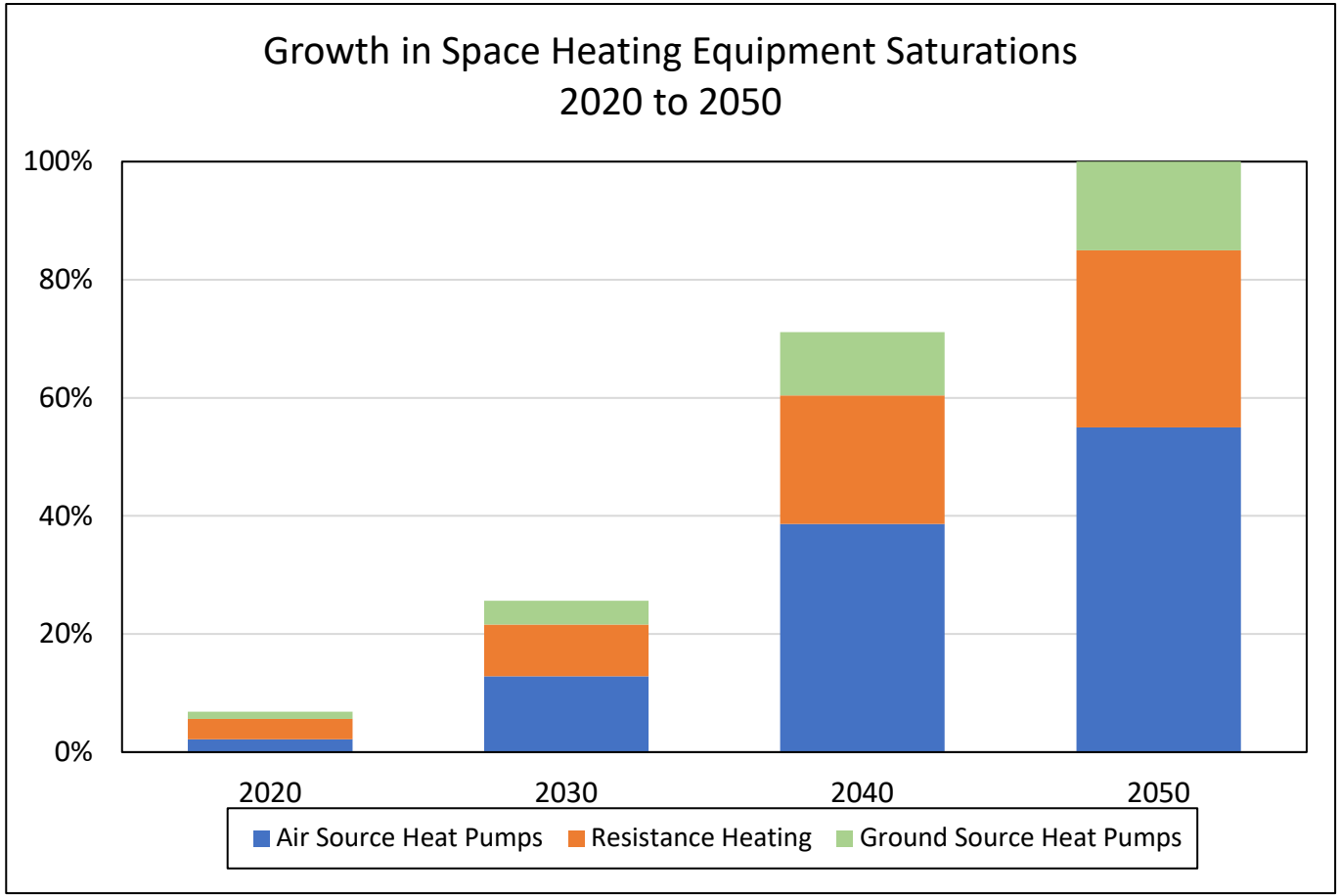

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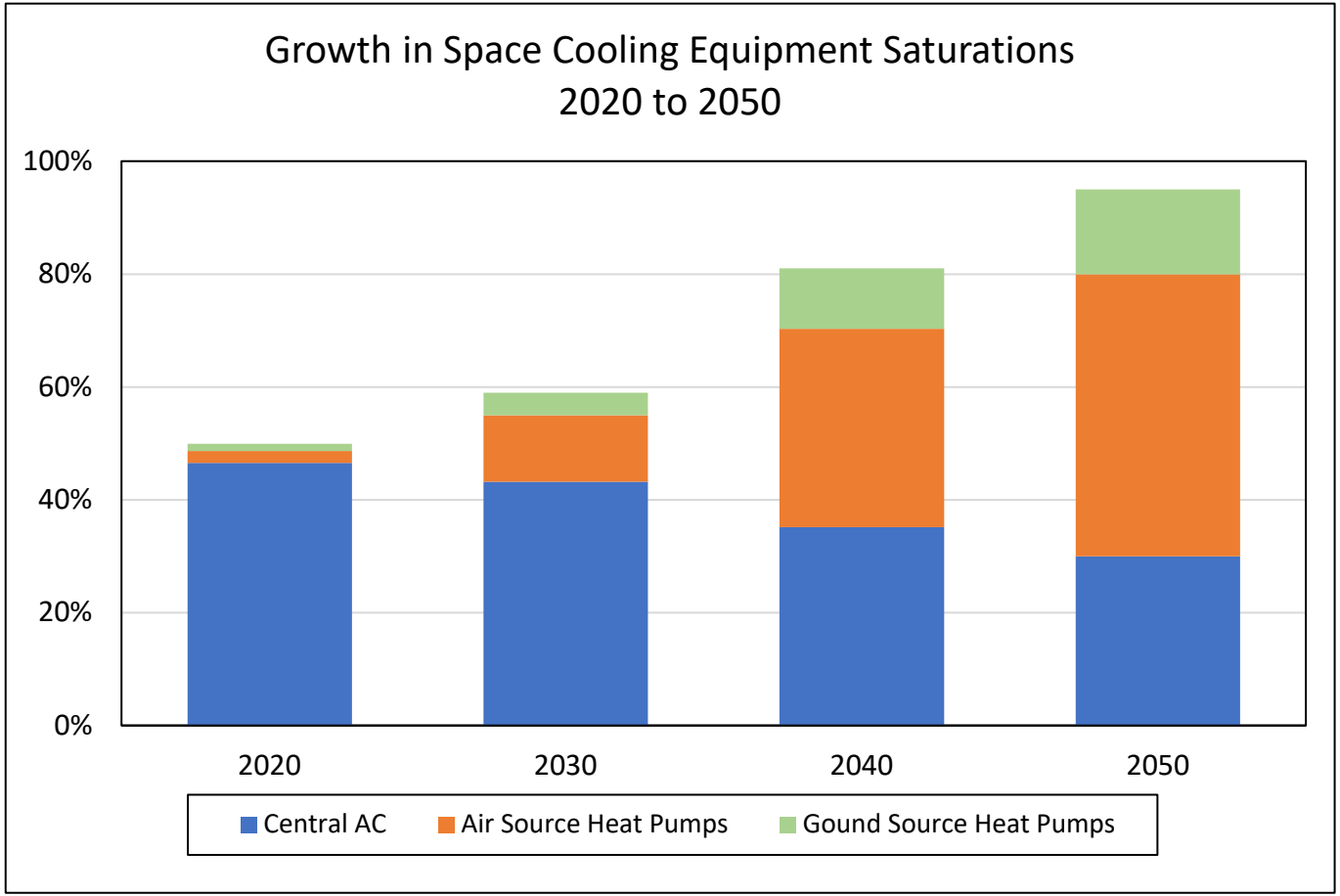

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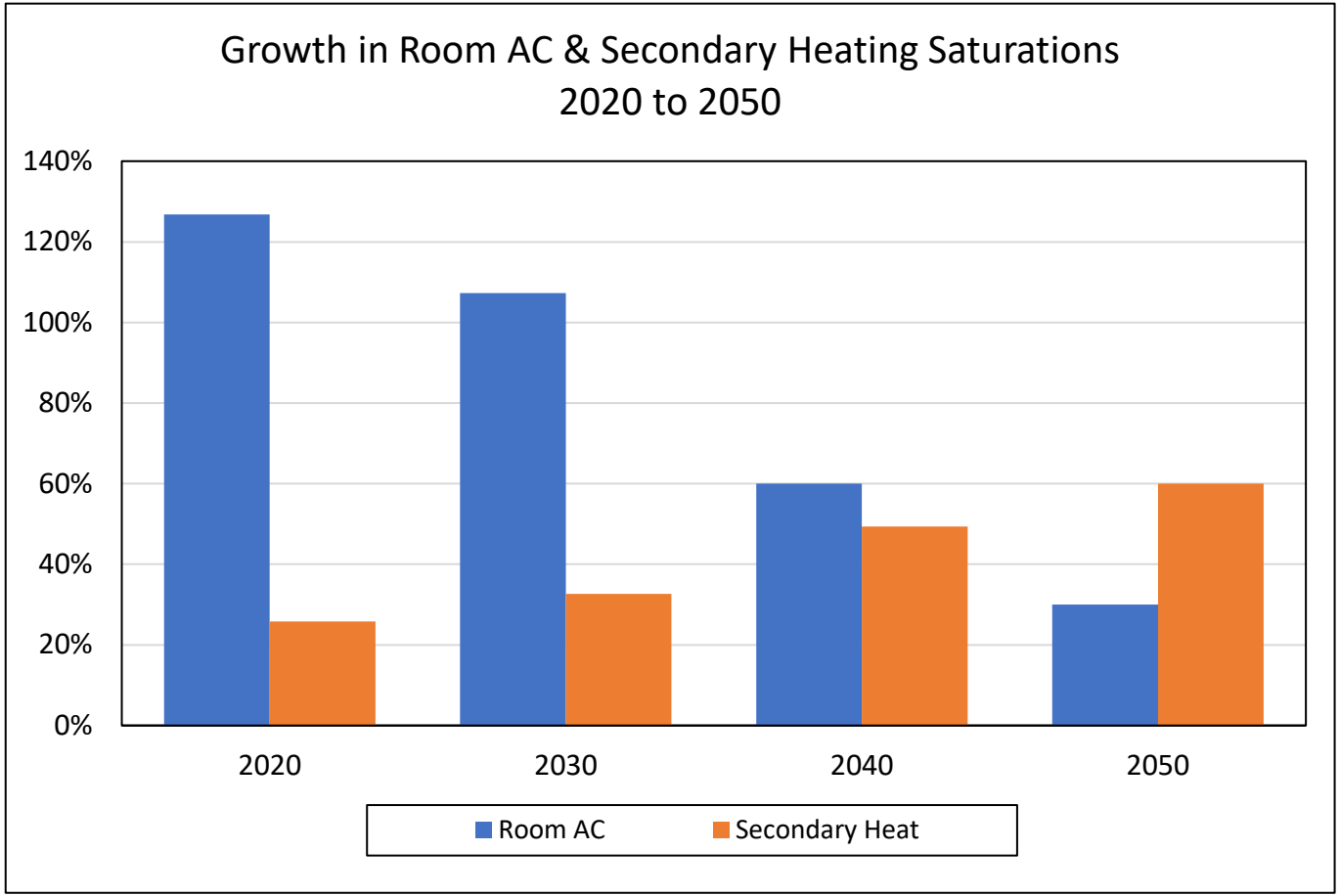

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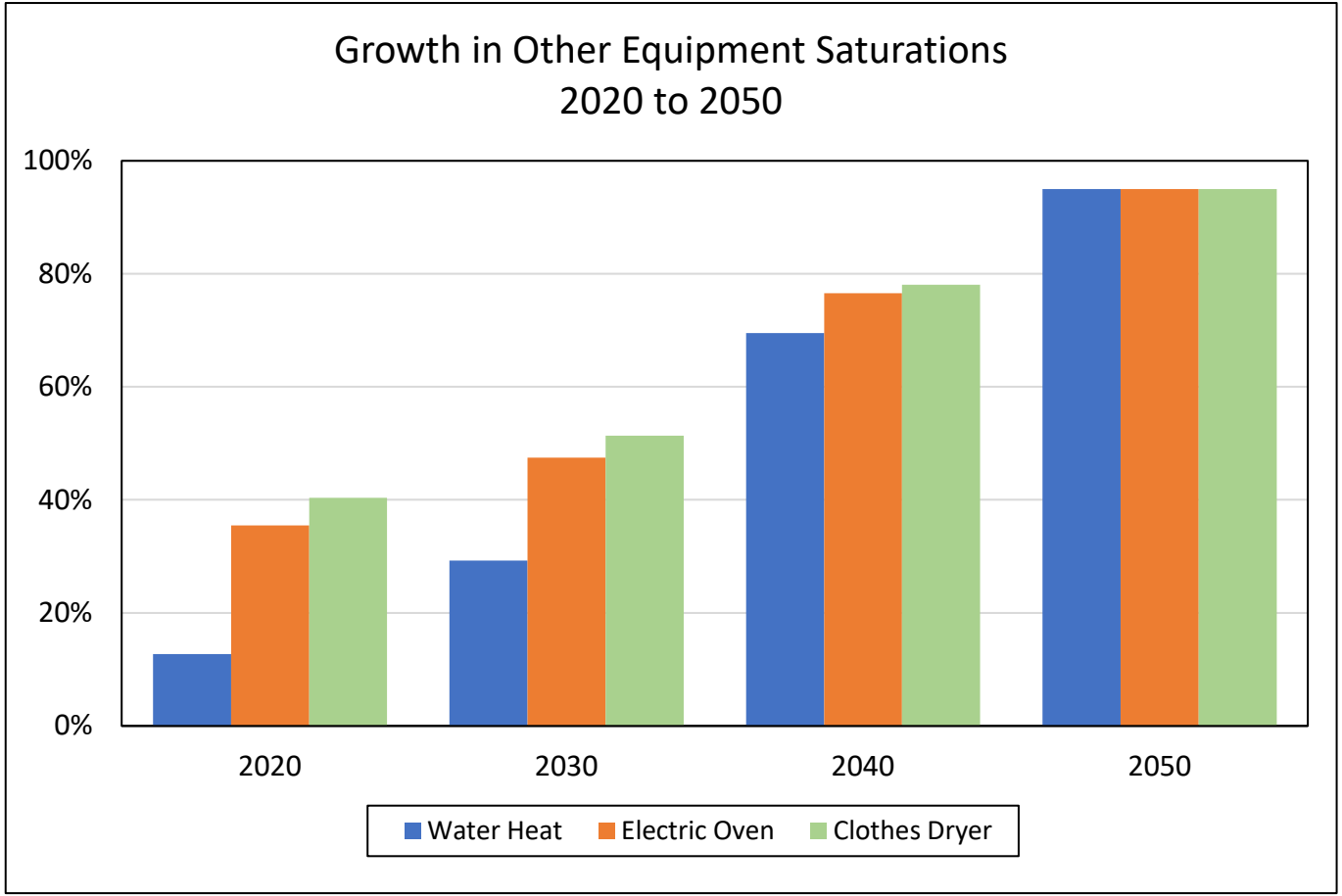

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Questions?

“Everything that rises must converge”

- Teilhard de Chardin

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

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