New York ISO
Independent System Operator

NYISO's Building Electrification Forecast for New York State

Arthur Maniaci

Principal Forecaster

Energy Systems Integration Group (ESIG)
Session 5 – Building Electrification

June 14, 2023

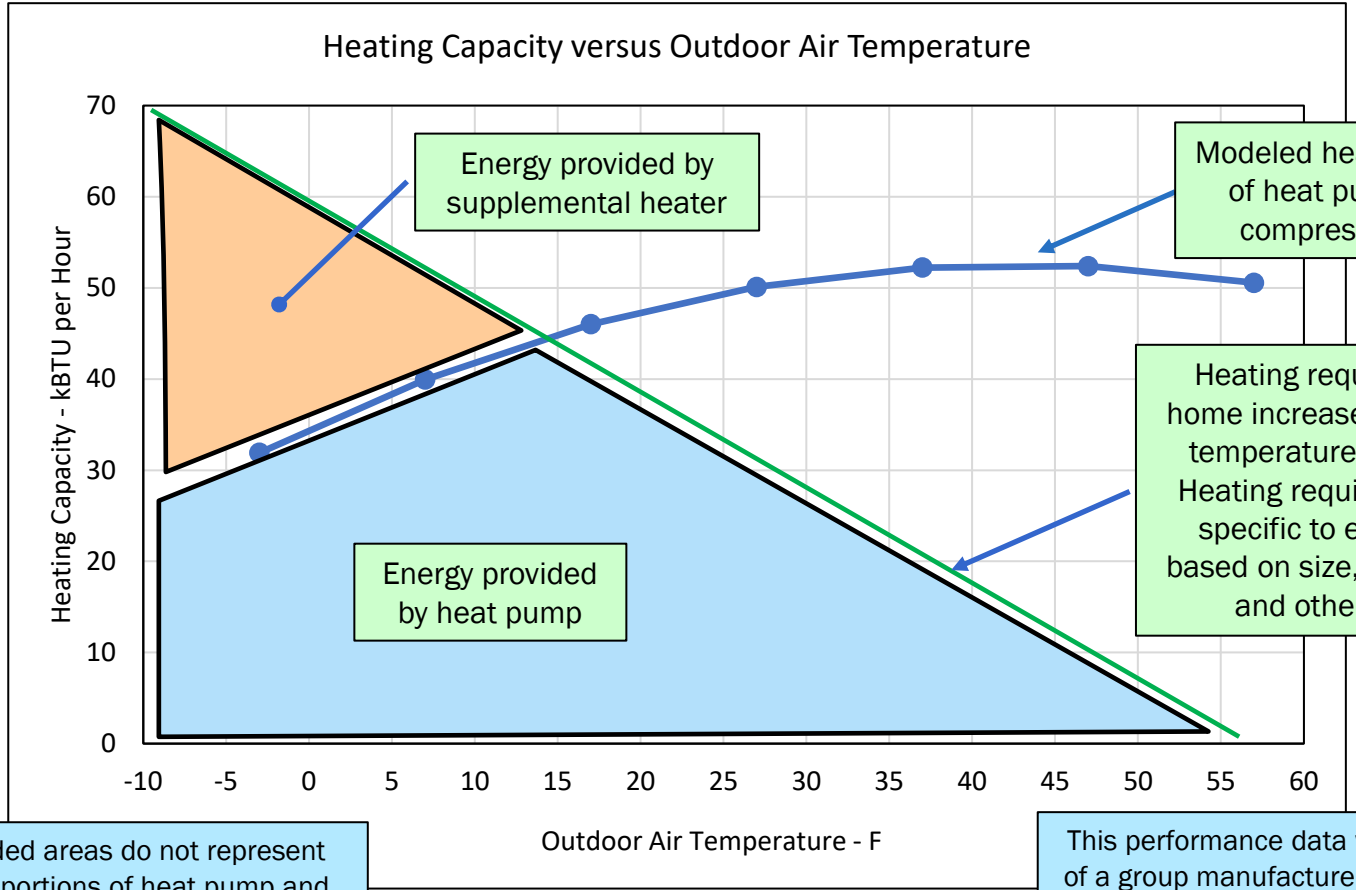
Part 1: Construction of Base Year Heat Pump Usage Characteristics

New York ISO

Air Source Heat Pump Characteristics

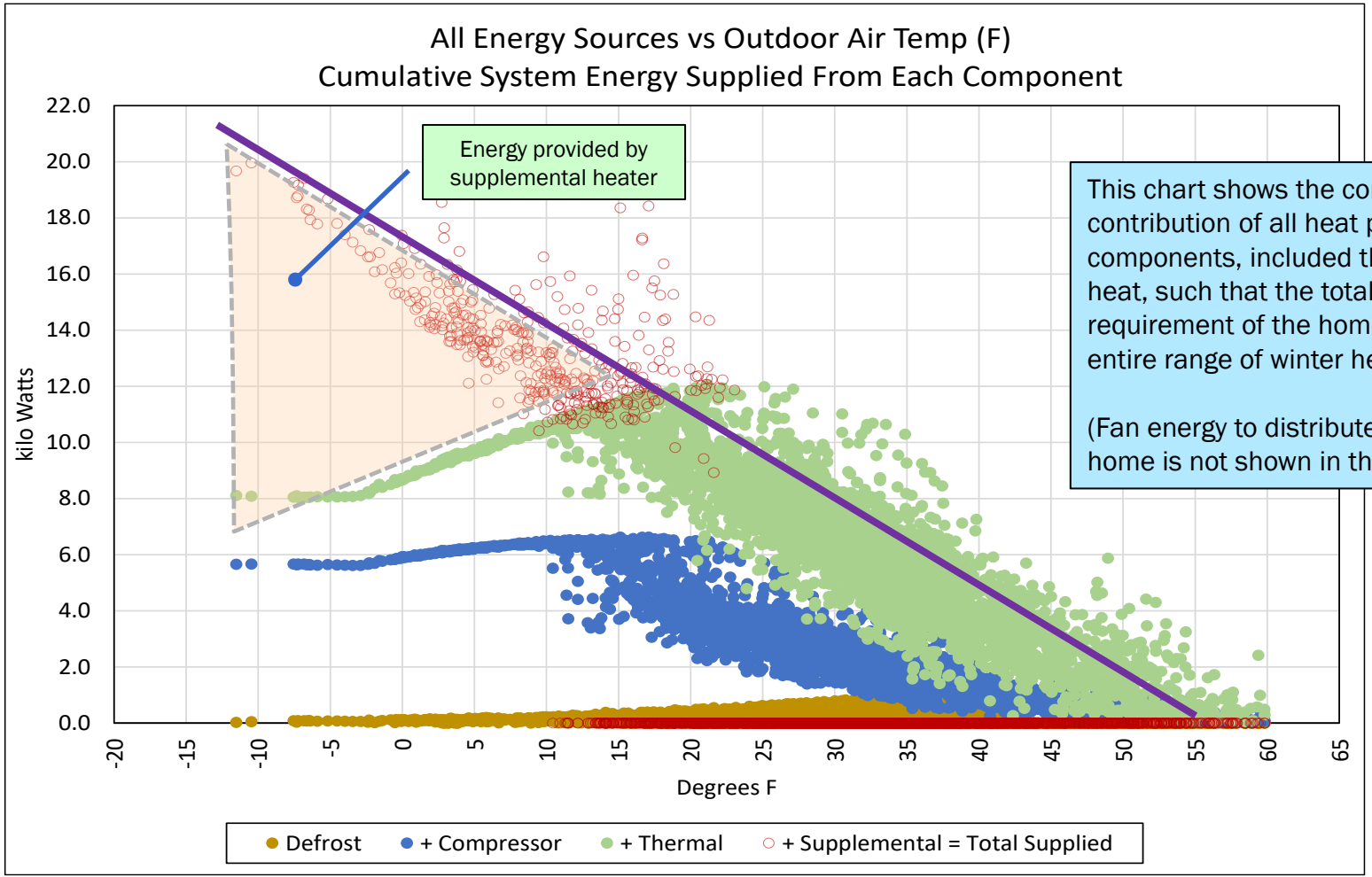
- Cold climate Air Source Heat Pumps (ASHP) with sufficient supplemental heating capacity can deliver heating energy to a home at a much higher efficiency than an electric resistance or gas furnace.
- The performance of an air source heat pump for cooling use in summer weather conditions is very similar to that of central air conditioning systems.
- ASHP delivers lower temperature heat (92° F) at higher airflow rate to the space than a gas furnace or an electric furnace (135° F). Consequently, the fan energy needed to circulate air in a home is about three times as great as the other furnaces, which deliver air at much higher temperatures.
- At temperatures 20° F and below, supplemental heating is required to maintain the home's interior temperature at 70° F. At winter design conditions of -3° F for Albany NY, the heat pump provides 6 kW of heating capacity while the supplemental heat provides 12 kW of heating capacity. An additional 2 kW of heating capacity was obtained from the outdoor environment.
- The systems studied all meet forthcoming Energy Star requirements for heating capacity at 5° F.

New York ISO



Note: The shaded areas do not represent the relative proportions of heat pump and supplemental energy used annually.

This performance data was taken from one of a group manufacturers' data, all of which had similar performance characteristics.

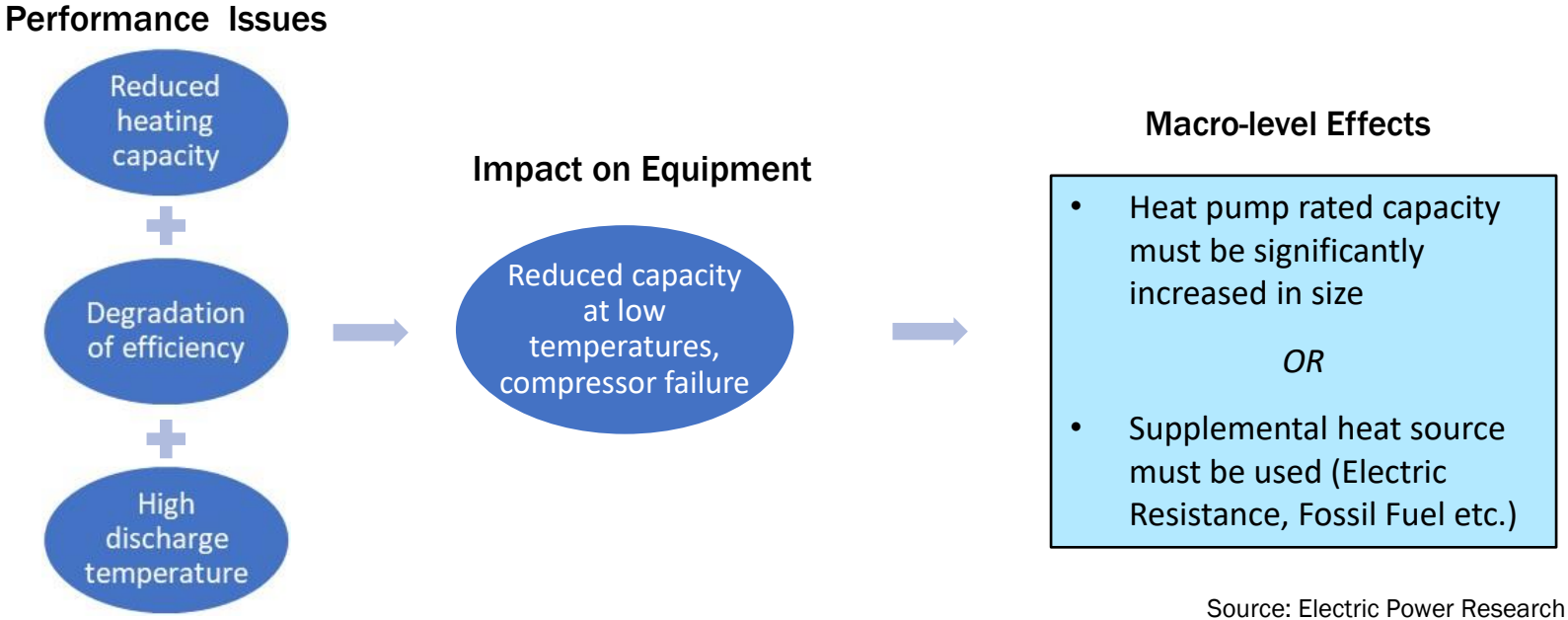


This chart shows the combined contribution of all heat pump components, included the supplemental heat, such that the total heating requirement of the home is met over the entire range of winter heating conditions.

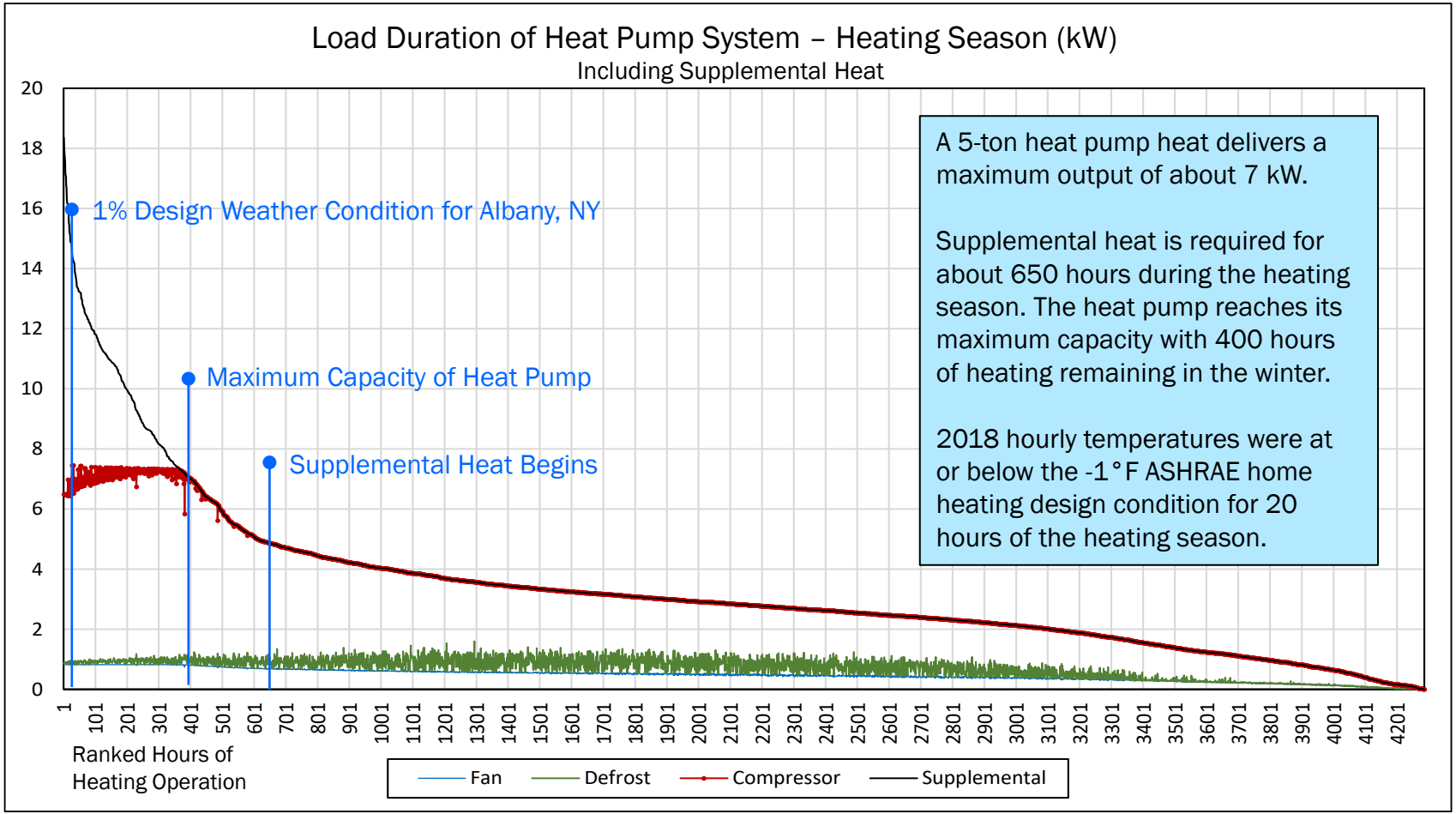
(Fan energy to distribute the air within the home is not shown in this chart.)

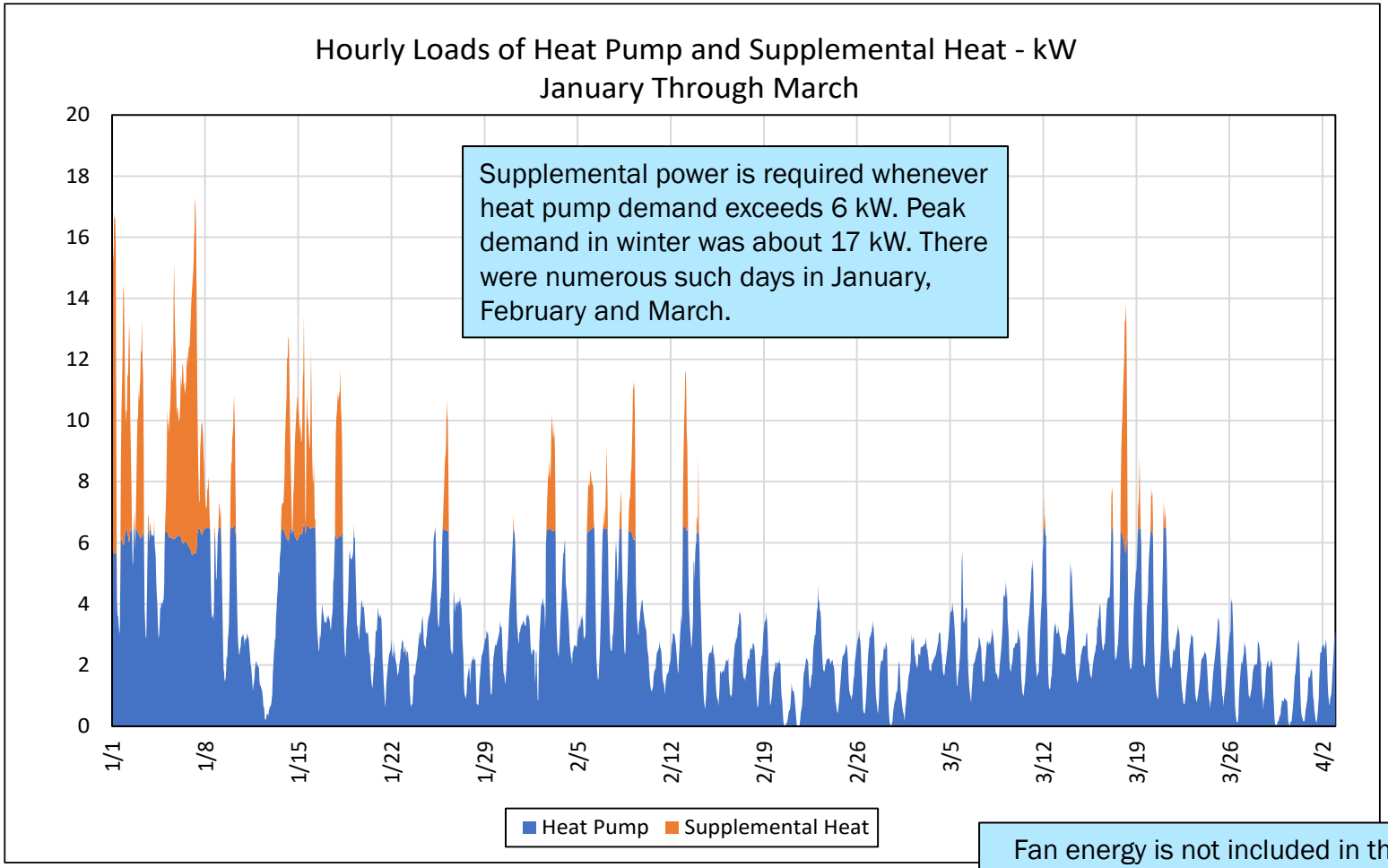
The Challenge of Low-Temperature Operation with Current Air Source Heat Pumps

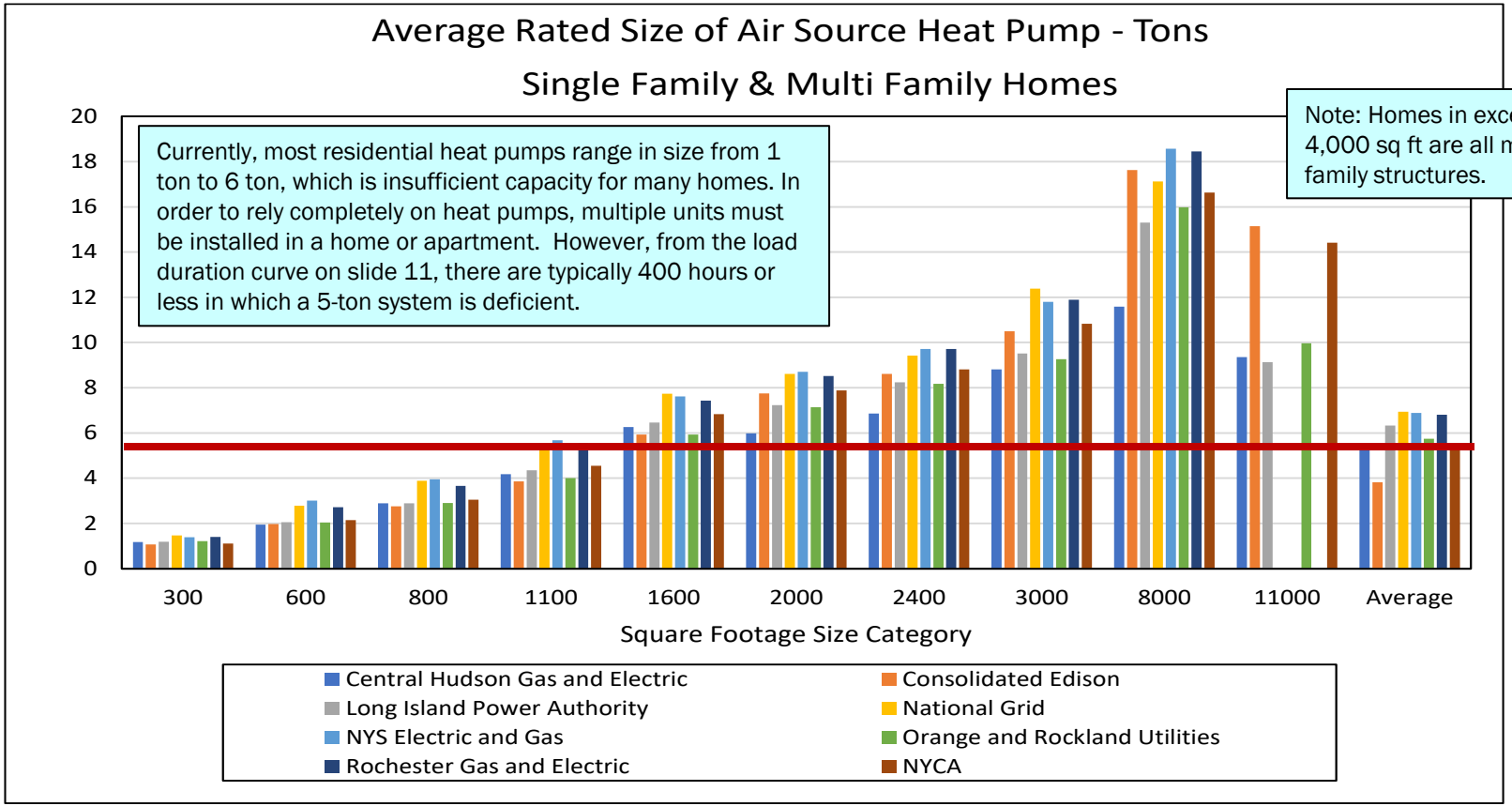
Current air-source heat pumps face three major technical issues when operating at the coldest outside air temperatures (5º F and below), such that they produce only 40% to 80% of heating capacity as compared to heating capacity at their rated temperature (45º F to 50º F).



Source: Electric Power Research Institute







Note: This analysis excludes electric T&D losses, so that the required capacity is that of the home or apartment.

Source: NREL 2018 ResStock Database for New York

New York ISO

NREL ResStock Database for 2018

- NREL ResStock database contains a representative baseline of housing stock and energy usage characteristics for electric, gas, oil, propane and other fuels. Building vintages are representative of 2018 housing stocks. All results are reported in kWh and kW, regardless of fuel type.
- The energy characteristics were obtained from the DOE EnergyPlus building simulation tool which accounts for weather, building size, construction type, building shell, window type and all other information needed to perform heat transfer calculations at 15-minute intervals.
- The sample for New York was about 33,700 individual building simulations, with sample weights for each site provided to expand to the population of the state.
- Annual natural gas results can be compared to EIA NY residential energy usage as a calibration benchmark of the sample expansion.

New York ISO

Number of Homes Heated by Fossil Fuel, by Size - Sq Ft

Size of Home or Apartment - Sq	Central Hudson Gas and Electric	Consolidated Edison	Long Island Power	National Grid	NYS Electric and Gas	Orange and Rockland	Rochester Gas and Electric	NYCA
300	6,295	351,332	29,540	23,729	17,433	10,170	4,116	442,615
600	13,317	645,037	48,910	76,513	67,797	17,918	24,697	894,190
800	21,308	811,865	86,199	141,889	128,329	26,392	49,153	1,265,135
1100	40,678	783,294	196,853	269,008	223,245	44,794	96,368	1,654,239
1600	34,383	289,589	195,158	222,761	178,935	34,625	81,840	1,037,289
2000	34,867	163,923	190,799	140,194	121,308	32,446	53,753	737,289
2400	19,855	88,136	106,053	81,356	67,555	28,329	29,056	420,339
3000	16,949	138,257	119,371	90,557	66,586	23,729	25,424	480,872
Total	**187,652**	**3,271,432**	**972,882**	**1,046,006**	**871,187**	**218,402**	**364,407**	**6,931,969**

Source: NREL 2018 ResStock Database for New York

Space Heating Requirements, Fossil Fuels - Average Annual kBTU

Size of Home or Apartment - Sq Ft	Central Hudson	Consolidated Edison	LIPA	National Grid	NYS Electric & Gas	Orange & Rockland	Rochester Gas & Electric	NYCA
300	17,900	16,298	18,123	22,432	21,163	18,653	21,402	17,065
600	29,700	30,154	31,362	42,443	46,010	31,054	41,566	32,800
800	44,258	42,062	44,232	59,375	60,271	44,293	55,835	46,618
1,100	63,733	58,918	66,471	84,763	86,794	61,248	84,949	69,480
1,600	95,699	90,560	98,817	118,299	116,274	90,618	113,569	104,494
2,000	91,482	118,327	110,421	131,524	132,998	109,047	130,152	120,388
2,400	104,873	131,697	125,878	143,955	148,420	124,961	148,503	134,730
3,000	150,327	201,594	179,867	213,395	213,037	180,989	206,543	197,445
Total	**80,756**	**58,255**	**96,765**	**105,959**	**105,316**	**87,770**	**104,010**	**80,717**

Space Heating Requirements, Fossil Fuels - Peak Capacity, BTU per Hour

Based on average of 10 coldest days of heating season. Maximum hourly capacity will be higher

Size of Home or Apartment - Sq Ft	Central Hudson	Consolidated Edison	LIPA	National Grid	NYS Electric and Gas	Orange & Rockland	Rochester Gas & Electric	NYCA
300	30,624	30,857	45,149	47,079	37,763	39,104	32,843	33,293
600	40,730	29,668	38,154	43,530	50,307	32,034	44,526	33,922
800	32,004	30,988	33,996	49,074	55,953	33,254	52,558	37,149
1100	46,606	33,736	39,310	58,296	58,007	30,752	63,434	43,886
1600	54,521	41,518	44,079	67,446	66,240	48,351	62,135	54,455
2000	58,130	43,713	50,124	62,596	67,027	48,791	70,053	56,006
2400	55,031	46,257	50,232	71,866	68,113	47,429	65,685	57,862
3000	63,156	58,260	58,889	76,508	71,497	73,019	75,851	65,998
Total	**47,738**	**34,730**	**44,771**	**60,325**	**61,017**	**43,139**	**61,996**	**45,506**

Source: NREL 2018 ResStock Database for New York

Space Heating Requirements - Air Source Heat Pump - Average Annual kWh

COP - Coefficient of Performance. HSPF is Heating Season Performance Factor. Each measures the ration energy provided to energy consumed over the heating season.

Based on Seasonal COP of 2.5, or HSPF of 8.5

Size of Home or Apartment - Sq Ft	Central Hudson	Consolidated Edison	LIPA	National Grid	NYS Electric and Gas	Orange & Rockland	Rochester Gas & Electric	NYCA
300	1,679	1,529	1,700	2,104	1,985	1,749	2,007	1,600
600	2,785	2,828	2,941	3,981	4,315	2,912	3,898	3,076
800	4,151	3,945	4,148	5,569	5,653	4,154	5,237	4,372
1,100	5,977	5,526	6,234	7,950	8,140	5,744	7,967	6,516
1,600	8,975	8,493	9,268	11,095	10,905	8,499	10,651	9,800
2,000	8,580	11,098	10,356	12,335	12,473	10,227	12,206	11,291
2,400	9,836	12,351	11,806	13,501	13,920	11,720	13,928	12,636
3,000	14,099	18,907	16,869	20,014	19,980	16,974	19,371	18,518
Total	**7,574**	**5,464**	**9,075**	**9,938**	**9,877**	**8,232**	**9,755**	**7,570**

Space Heating Requirements, Air Source Heat Pump - Peak Capacity, kW

Based on average of 10 coldest days of heating season. Maximum hourly capacity will be higher. Peak COP is 1.65

Size of Home or Apartment - Sq Ft	Central Hudson	Consolidated Edison	LIPA	National Grid	NYS Electric and Gas	Orange & Rockland	Rochester Gas & Electric	NYCA
300	4.35	4.38	6.42	6.69	5.37	5.56	4.67	4.73
600	5.79	4.22	5.42	6.19	7.15	4.55	6.33	4.82
800	4.55	4.40	4.83	6.97	7.95	4.73	7.47	5.28
1100	6.62	4.79	5.59	8.28	8.24	4.37	9.01	6.24
1600	7.75	5.90	6.26	9.58	9.41	6.87	8.83	7.74
2000	8.26	6.21	7.12	8.89	9.52	6.93	9.95	7.96
2400	7.82	6.57	7.14	10.21	9.68	6.74	9.33	8.22
3000	8.97	8.28	8.37	10.87	10.16	10.38	10.78	9.38
Total	**6.78**	**4.94**	**6.36**	**8.57**	**8.67**	**6.13**	**8.81**	**6.47**

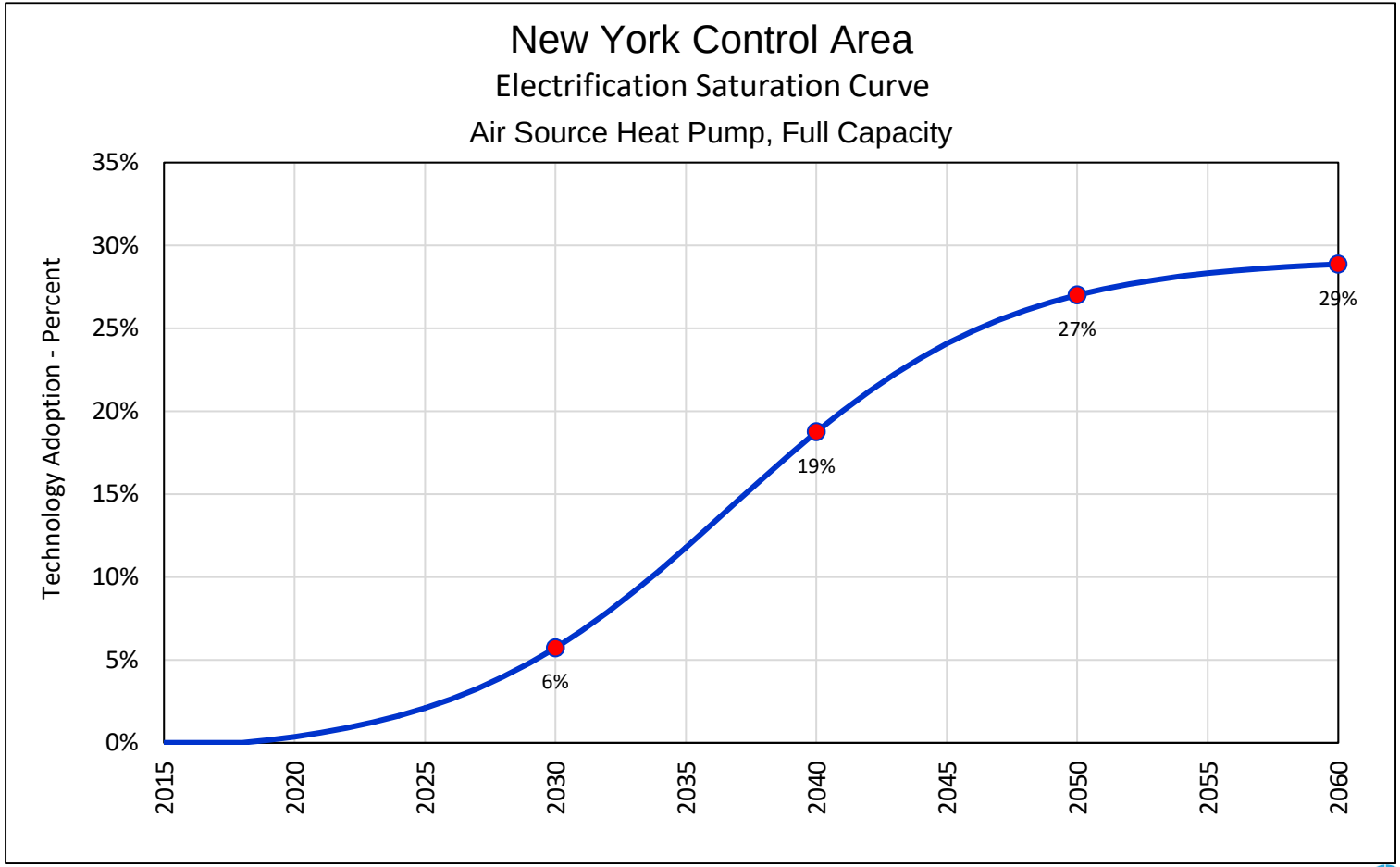
Source: NREL 2018 ResStock Database for New York

2050 Space Heating Technology Parameters

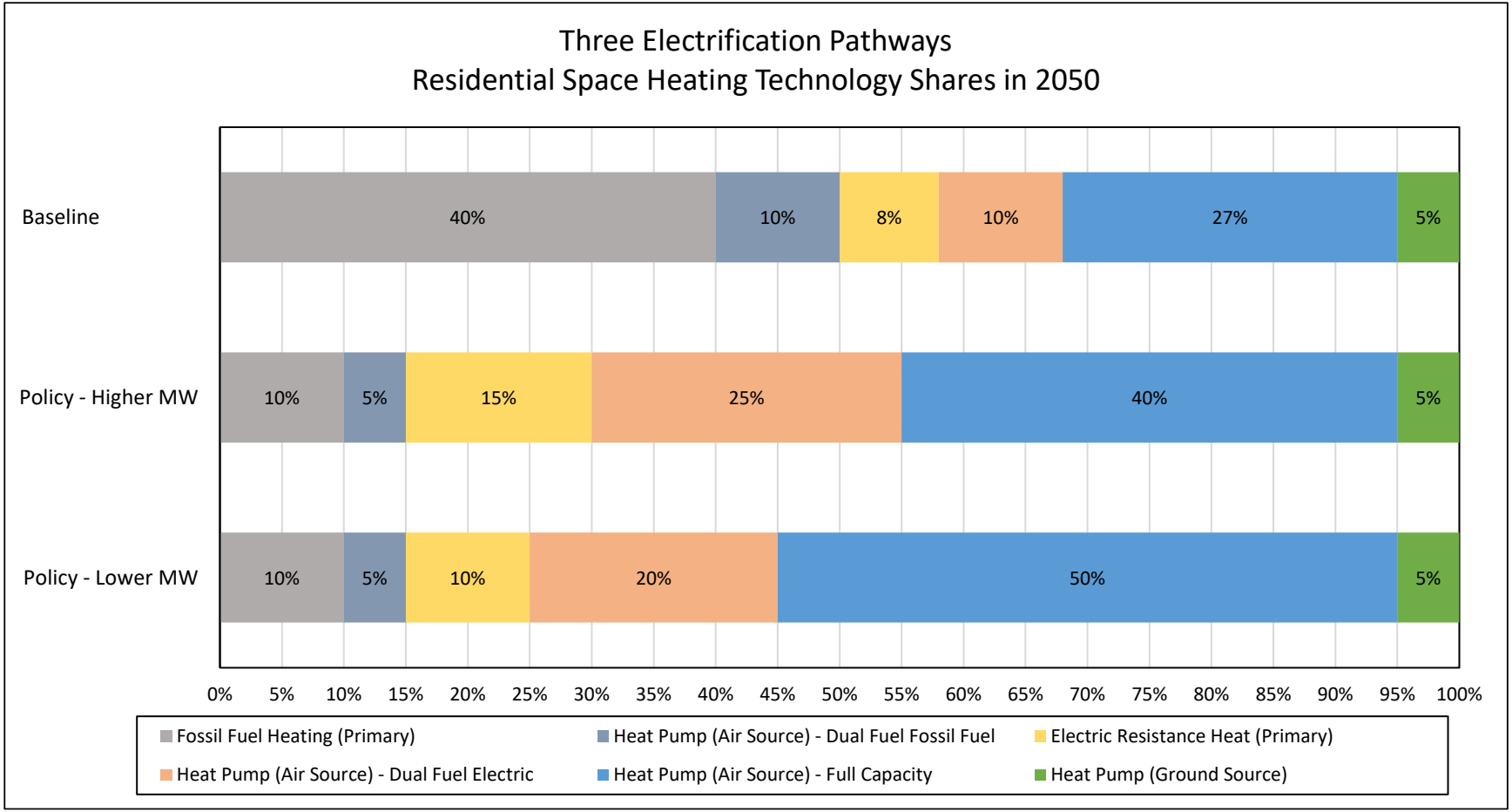
Tech Forecast	HH	ASHP Full	ASHP Dual Fuel	Elec Res	GSHP	Supplemental	Total
Units	6,806,416	1,837,732	1,361,283	544,513	339,313	680,642	4,763,483
Percent		27.0%	20.0%	8.0%	5.0%	10.0%	70.0%
MW		8,016	4,259	5,417	867	1,888	20,448
GWh		12,216	6,508	9,491	1,519	3,308	33,042
kW/Unit		4.36	3.13	9.95	2.55	2.77	4.29
kWh/Unit		6.65	4.78	17.43	4.48	4.86	6.94
Load Factor		17.4%	17.4%	20.0%	20.0%	20.0%	18.4%
kW @1600 SqFt		6.999	5.599	12.807	2.135	2.561	
kWh @1600 SqFt		10,429	8,343	22,438	3,740	4,488	
LF @1600 SqFt		17%	17%	20%	20%	20%	
kw/ERes		1.83	2.29	1.00	6.00	0.20	
kWh/ERes		2.15	2.69	1.00	6.00	0.20	

Source: NREL 2018 ResStock Database for New York

New York ISO



New York ISO



New York ISO

Part 2: Summary of 2023 Long-Term Forecast

New York ISO

Current Forecast Features

- Thirty Year Forecast Horizon
- Baseline & Two State Energy Policy Scenarios
- Annual Energy by System & Zone
- Seasonal Peaks by System & Zone
- 90^{th} - 10^{th} and 99^{th} - 1^{st} Percentile Bandwidths on Seasonal Peaks
- Hourly Load Forecasts

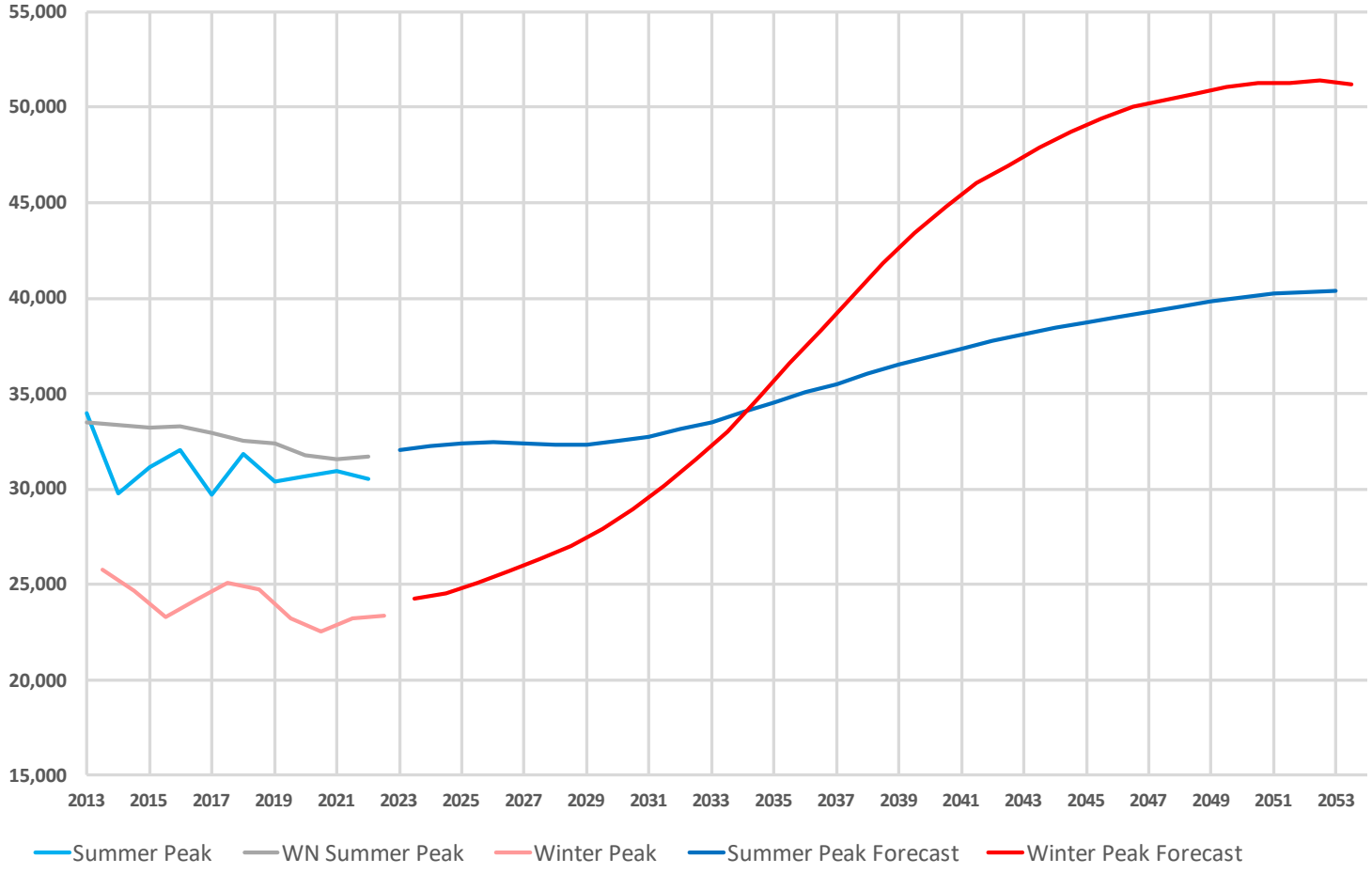
New York ISO

Load & Usage Categories

- Baseline of End Uses
  - Heating, Cooling, Lighting, Refrigeration & Others
- Energy Efficiency Impacts
- Electric Vehicles
- Solar PV (Behind-the-Meter)
- Building Electrification
- Large Loads
- Energy Storage
- Distributed Generation, Other Than Solar

New York ISO

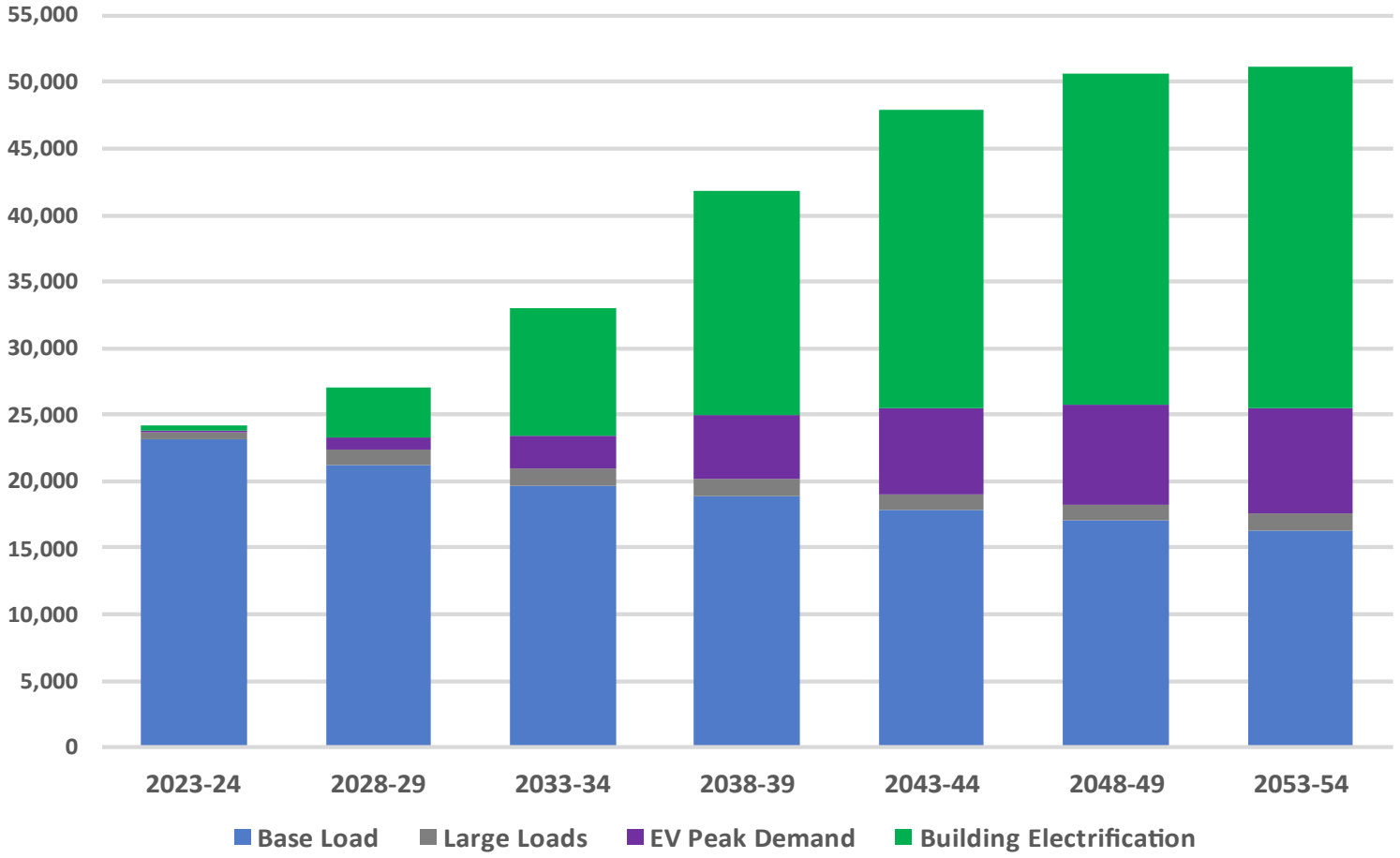
NYCA Coincident Peak - MW



- Actual historical values reflect metered load.
- Weather normalized summer peak values from ICAP forecast process include demand response added back onto the load and reflect the adjusted load at design weather conditions. The NYCA aggregate design condition is the 57th percentile.
- Forecast values assume no reductions due to demand response and assume trended weather.

New York ISO

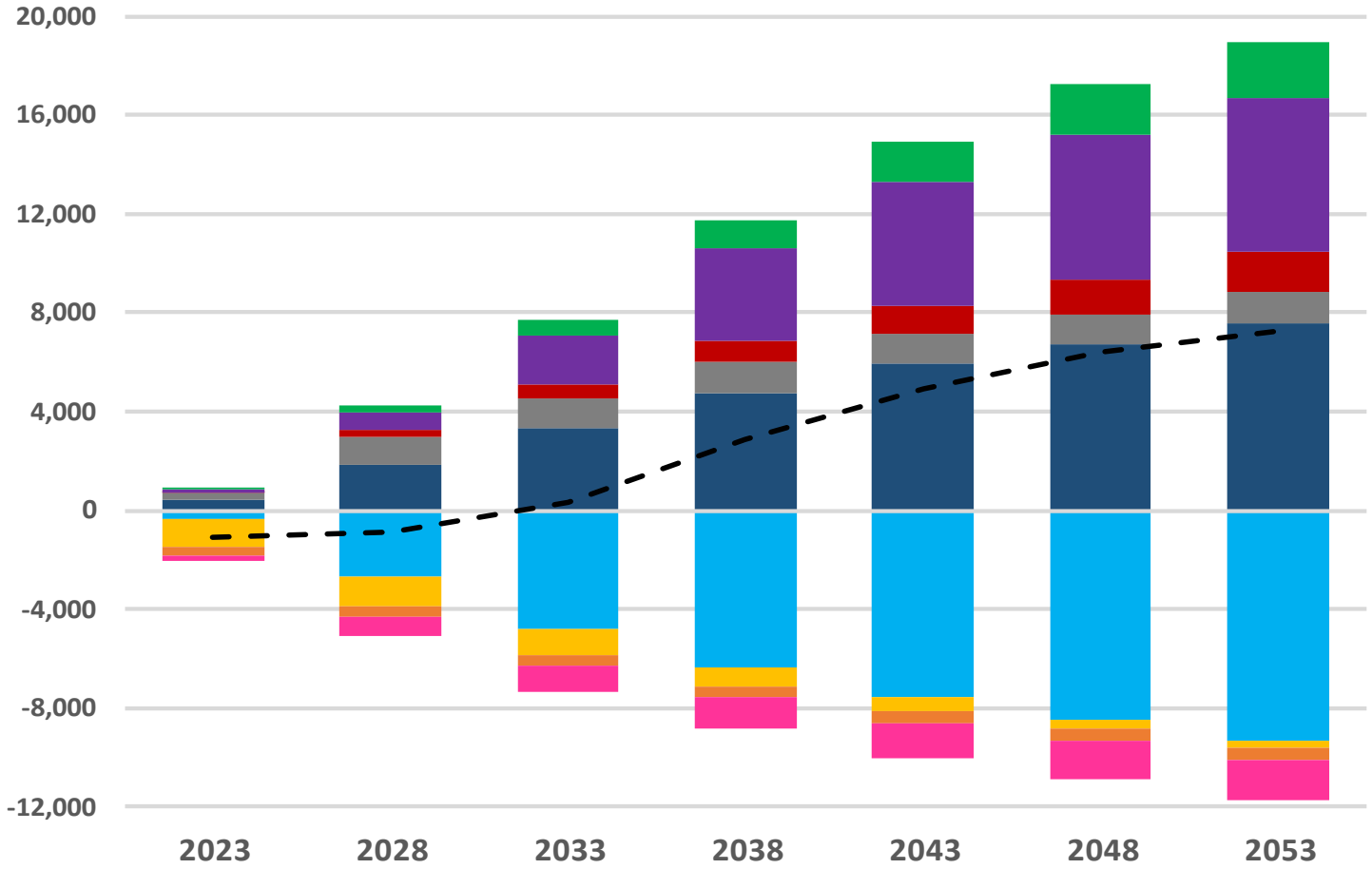
NYCA Winter Peak Demand Estimated Forecast Components (MW)



- Base load growth includes reductions due to BTM distributed generation, BTM energy storage, energy efficiency, and temperature trends.

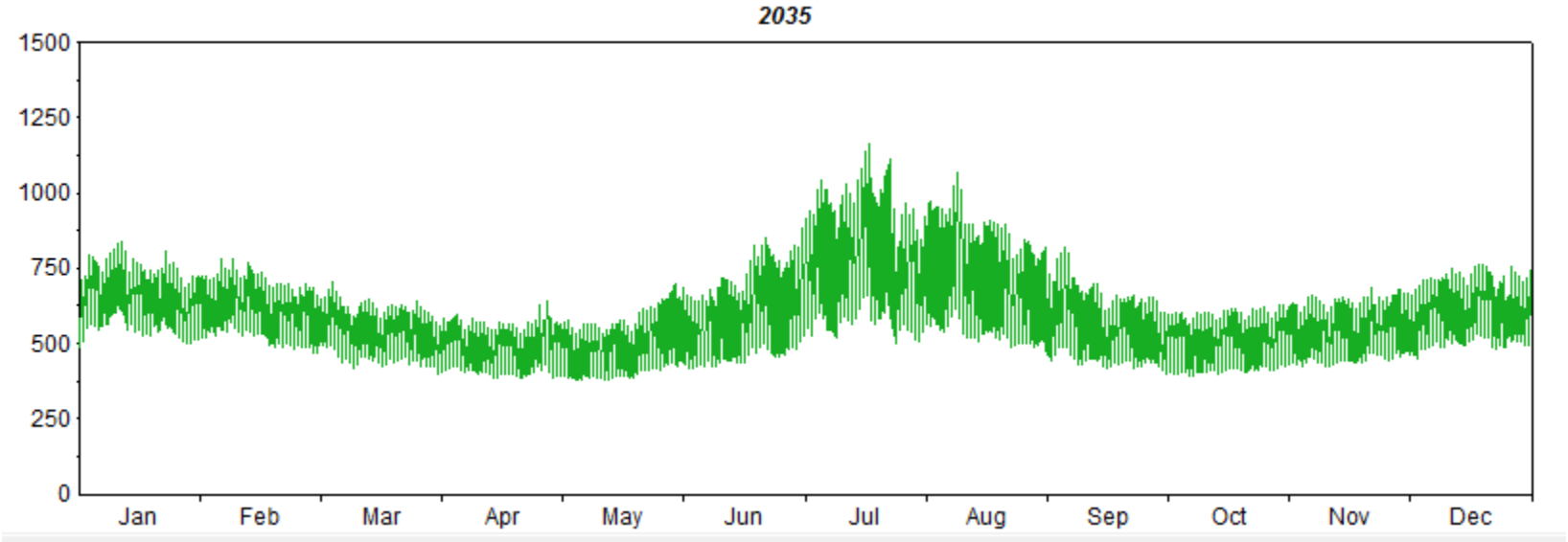
New York ISO

NYCA Summer Peak Estimated Forecast Impacts, MW



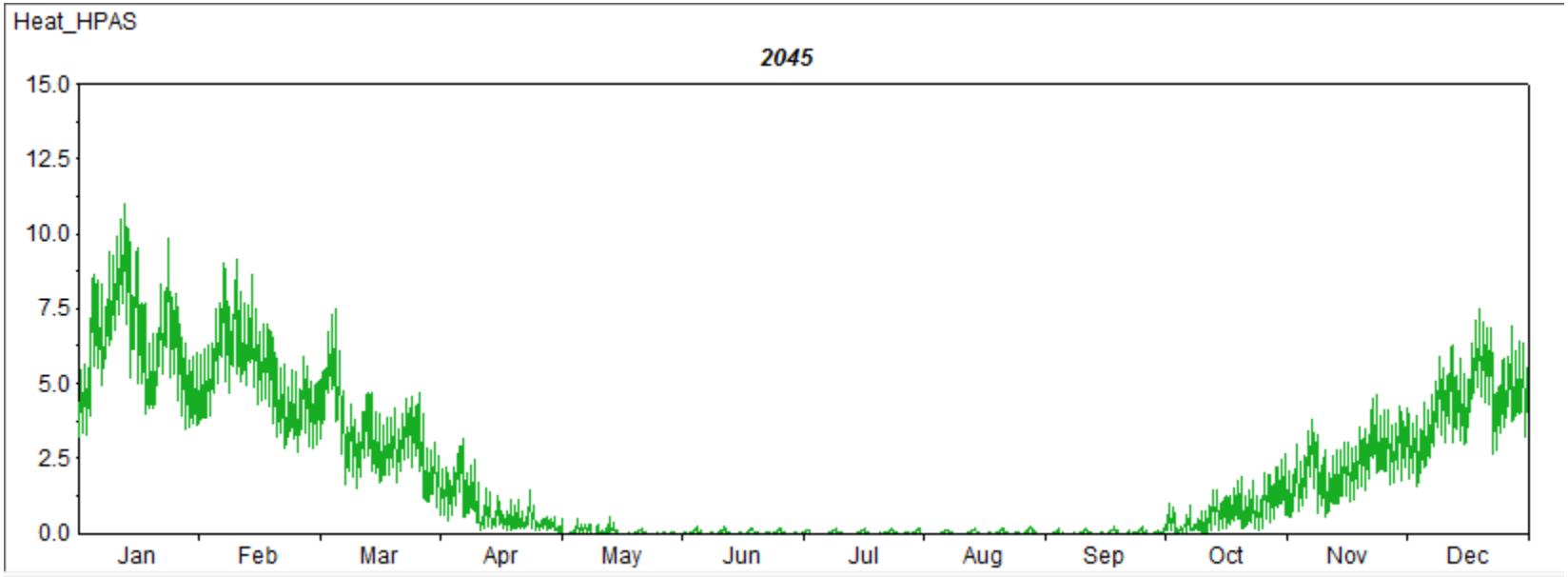
- Energy efficiency and economic growth impacts are generally endogenous to the end-use models, and reflect impacts relative to 2022

Hourly Load Forecast of Base Load for a Single Year (MW)



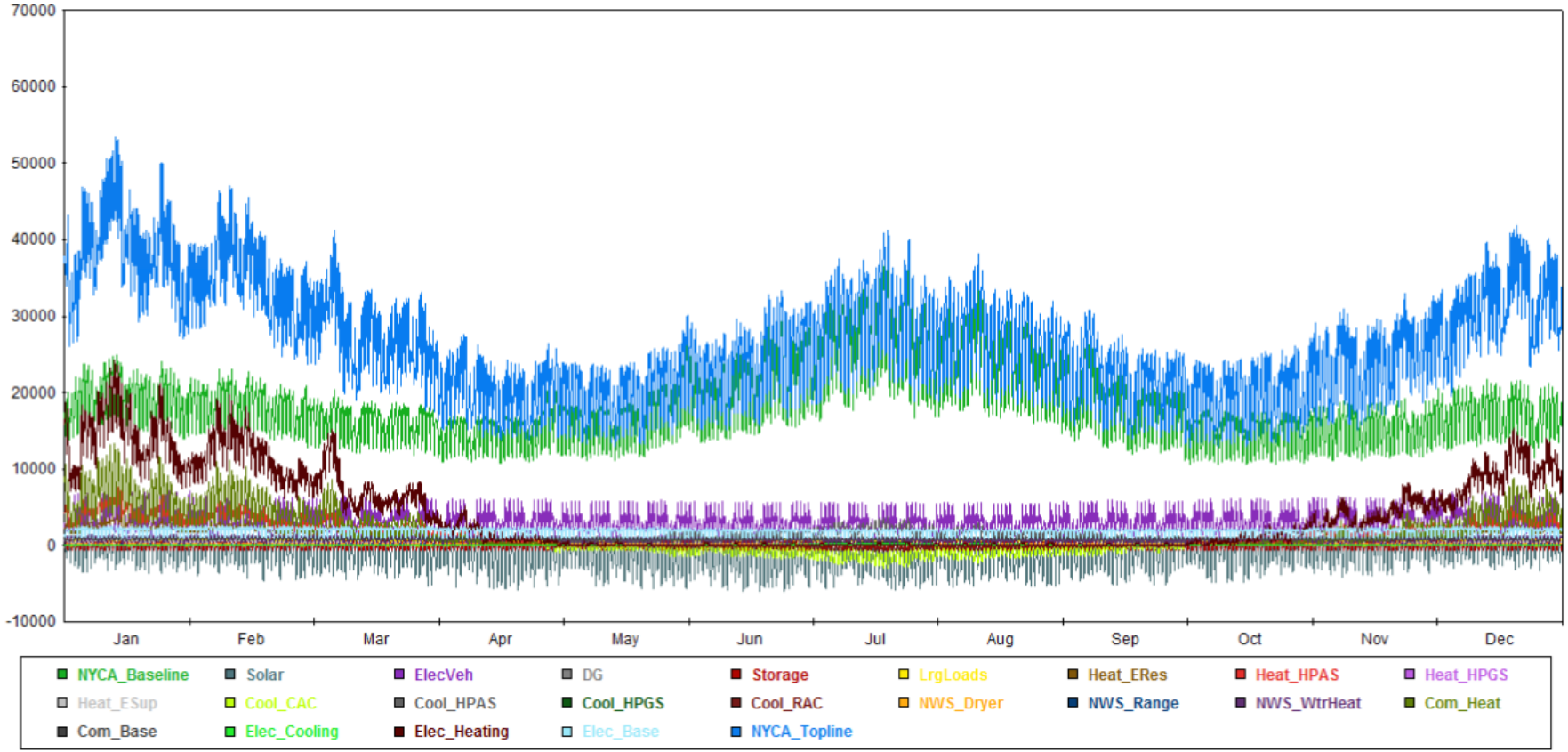
New York ISO

Hourly Load Forecast of Heat Pumps for a Single Year (kW)



New York ISO

System Forecast & Build-up of All Load Components in 2050 (MW)



Questions?

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

New York ISO