



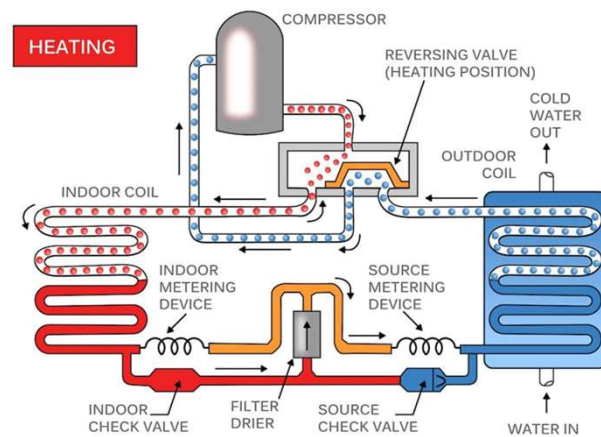
Heat Pump Space Heating Proposal

Energy Code TAG

July 2021

What's in the (original) Heat Pump Space Heating Proposal?

Summary: Provide heat pump space heating, rather than fossil fuel or electric space heating, for all buildings. Exceptions are provided to allow electric resistance heating for small loads and as well as supplemental electric resistance heat for very cold weather.



Heat pumps squeeze warmth out of cold air

Key Changes to the Proposal We Will Walk Through Today

C403 New Construction & Additions:

- Exception 2: Addition of more dwelling unit wattage for areas with a design outdoor condition of less than 4F
- Exception 6: Consolidation of air-to-water heat pump exceptions into one exception with broader allowances. Allowance of gas-fired back-up for air-to-water heat pumps in Climate Zone 5
- Exception 10: Allowance for gas-fired kitchen make-up units for Climate Zone 5
- Exception 16: Removed language
- Exception 15: Addition of a freeze protection exception

C503 Alterations

- List of project types that require heat pumps (instead of list of exceptions)
- Allowance for gas for boiler replacements in all Climate zones

Exception 2

- Addition of more dwelling unit wattage for areas with a design outdoor condition of less than 4F

2. Dwelling and sleeping units. Dwelling or sleeping units having an installed HVAC heating capacity no greater than 750 watts in Climate Zone 4, and 1000 watts in Climate Zone 5, in any separate habitable room with exterior fenestration are permitted to be heated using electric resistance appliances. For buildings in locations with exterior design conditions below 4°F, an additional 250 watts above that allowed for Climate Zone 5 is permitted.

2a. Corner rooms. A room within a dwelling or sleeping unit that has two primary walls facing different cardinal directions, each with exterior fenestration, is permitted to have an installed HVAC heating capacity no greater than 1000 watts in Climate Zone 4, and 1300 watts in Climate Zone 5. Bay windows and other minor offsets are not considered primary walls. For buildings in locations with exterior design conditions below 4°F, an additional 250 watts above that allowed for Climate Zone 5 is permitted.



Exception 6

- Exception 6: Consolidation of air-to-water heat pump exceptions into one exception with broader allowances

6. Air-to-water heat pumps, up to 2,000 MBH. Buildings are permitted to utilize electric resistance (for climate Zone 4 or 5) or fossil fuel-fired (for climate Zone 5) auxiliary heating to supplement heat pump heating for hydronic heating systems ~~that have air-to-water heat pump heating capacity no greater than 2000 kBTU/hr at 47°F, and~~ that meet all of the following conditions:

- Controls for the auxiliary electric resistance or fossil fuel-fired heating are configured to lock out the supplemental heat when the outside air temperature is above 362°F, unless the hot water supply temperature setpoint to the building heat coils cannot be maintained for 20 minutes.
- The heat pump controls are configured to use the compressor as the first stage of heating down to the lowest exterior design temperature for which the equipment is rated an outdoor air temperature of 17°F or lower except during startup or defrost operation.
- The heat pump rated heating capacity at 47°F is no less than 7580% of the design heating load at 29°F.



Exception 10

- Exception 10: Allowance for gas-fired kitchen make-up units for Climate Zone 5

102. Kitchen exhaust. Make-up air for commercial kitchen exhaust systems required to be tempered by Section 508.1.1 of the International Mechanical Code is permitted to be heated ~~by using fossil fuel (if Climate Zone 5) or using~~ electric resistance ~~appliances (if Climate Zone 4 or 5).~~



Exception 16

- Exception 16: Removed

~~16. **Emergency generators.** Emergency generators are permitted to use fossil fuels.~~

Exception 15

- Exception 15: Addition of a freeze protection exception

157. **Freeze Protection.** Spaces sized for indoor design conditions of 45°F or lower, intended for freeze protection, and insulated as conditioned are permitted to use electric resistance heating.

C503: Alterations

C503.4.6 New and Replacement HVAC heating system equipment. Where building HVAC mechanical heating equipment is added or replaced, the new equipment shall comply with Section C403.1.4 if one or more of the following project conditions exist:

- An existing heat pump is replaced, or new heating capacity is added to an existing system.
- An existing fossil fuel-fired or electric resistance unit with DX cooling is replaced, or new heating capacity is added to an existing system.
- A fossil fuel-fired furnace or electric resistance unit is replaced, and cooling is added to the same previously uncooled space
- A fossil fuel-fired or electric resistance boiler is replaced. If exception 6, ~~7, 8, or 9~~ of C403.1.4 is used and an electric service upgrade would be required, gas auxiliary heat in lieu of electric resistance auxiliary heat is permissible for any climate zone. The auxiliary heat can be used at the outdoor air temperature required by the load.



C503: Alterations, cont'd

Exceptions:

- Where only one heating appliance is failing and is replaced by another having the same or lesser heating capacity and the same or higher efficiency, C403.1.4 does not apply. This exception cannot be used within the same building more than once in a 24-month period.
- Code officials have discretion to grant additional exceptions based on space impracticality.

-If the alteration does not meet one of the above conditions yet opts to comply with C403.1.4, the project is exempt from all requirements of C406.

C503.4.6.1 Added or Replaced Heating Hydronic Equipment. Any added or replaced heating hydronic equipment shall be designed with a supply water temperature of 120F or less.



Economic Model Assumptions

Economic models were run for two different building types, each in both the western (coastal) climate zone and eastern (mountain) climate zone.

A 54,000 sq. ft. medium office:

- Baseline for the small retail store was a single zone packaged DX + VAV with HW reheat from central gas boilers.
- Alternative 1 was single zone packaged heat pumps

A 25,000 sq. ft. small retail store:

- Baseline for the small retail store was a packaged DX units with gas furnaces boilers.
- Alternative 1 was single zone packaged heat pumps

Economic Model Results - Medium Office

Mountain Region

Life Cycle Cost Analysis

Alternative	Baseline	Alt. 1
Energy Use Intensity (kBtu/sq.ft)	37.3	31.6
1st Construction Costs	\$ 1,314,715	\$ 1,306,248
PV of Capital Costs	\$ 2,552,850	\$ 2,554,398
PV of Utility Costs	\$ 1,334,726	\$ 1,378,140
Total Life Cycle Cost (LCC)	\$ 3,887,575	\$ 3,932,539
Present Social Cost of Carbon (SCC)	\$ 211,583	\$ 131,407
Total LCC with SCC	\$ 4,099,159	\$ 4,063,946

Single zone packaged DX + VAV with HW reheat from central gas boilers

Single zone packaged heat pump

Coastal Region

Life Cycle Cost Analysis

Alternative	Baseline	Alt. 1
Energy Use Intensity (kBtu/sq.ft)	32.1	26.2
1st Construction Costs	\$ 1,221,487	\$ 1,177,500
PV of Capital Costs	\$ 2,370,540	\$ 2,302,629
PV of Utility Costs	\$ 1,163,517	\$ 1,143,812
Total Life Cycle Cost (LCC)	\$ 3,534,057	\$ 3,446,441
Present Social Cost of Carbon (SCC)	\$ 178,654	\$ 108,985
Total LCC with SCC	\$ 3,712,711	\$ 3,555,426

Single zone packaged DX + VAV with HW reheat from central gas boilers

Single zone packaged heat pump

Source: OFM Cost Analysis Tool



Economic Model Results - Small Retail

Mountain Region

Life Cycle Cost Analysis	Single zone packaged DX + VAV with HW reheat from central gas boilers	Single zone packaged heat pump
Alternative	Baseline	Alt 1
Energy Use Intensity (kBtu/sq.ft)	46.8	34.2
1st Construction Costs	\$ 429,919	\$ 431,021
PV of Capital Costs	\$ 813,936	\$ 842,872
PV of Utility Costs	\$ 734,913	\$ 687,382
Total Life Cycle Cost (LCC)	\$ 1,548,849	\$ 1,530,253
Present Social Cost of Carbon (SCC)	\$ 128,748	\$ 65,542
Total LCC with SCC	\$ 1,677,597	\$ 1,595,796

Coastal Region

Life Cycle Cost Analysis	Single zone packaged DX + VAV with HW reheat from central gas boilers	Single zone packaged heat pump
Alternative	Baseline	Alt 1
Energy Use Intensity (kBtu/sq.ft)	41.2	29.1
1st Construction Costs	\$ 356,339	\$ 355,752
PV of Capital Costs	\$ 670,049	\$ 695,681
PV of Utility Costs	\$ 643,332	\$ 584,433
Total Life Cycle Cost (LCC)	\$ 1,313,381	\$ 1,280,114
Present Social Cost of Carbon (SCC)	\$ 114,413	\$ 55,726
Total LCC with SCC	\$ 1,427,794	\$ 1,335,841

Source: OFM Cost Analysis Tool



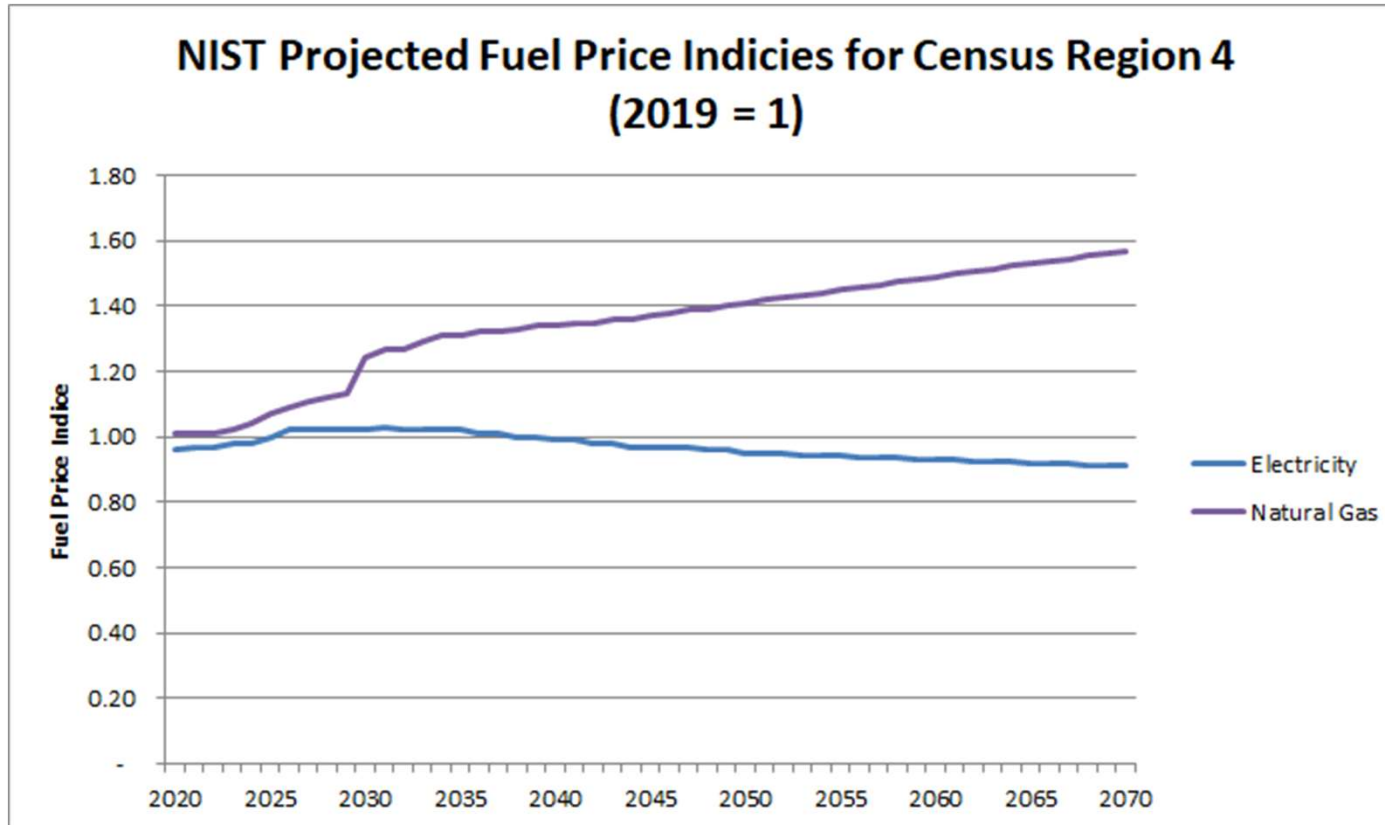
Economic Model Energy Results

Prototype	Code Edition	Case	4C		5B	
			EUI, kBtu/sf	% EUI Savings	EUI, kBtu/sf	% EUI Savings
Medium Office	2006	Base	42.23		47.14	
	2018	WSHP	26.22	38%	26.96	43%
	2030	WSHP	9.35	78%	10.77	77%
	2030	Radiant Floor	8.33	80%	9.28	80%
Standalone Retail	2006	Base	58.03		69.45	
	2018	PSZ HP	29.60	49%	32.73	53%
	2018	PSZ DX AC/Gas Furnace	29.45	49%	34.97	50%
	2030	PSZ HP	21.44	63%	23.88	66%
	2030	PSZ DX AC/Gas Furnace	21.59	63%	23.91	66%

- Modeled Energy Savings
 - 6 EUI for Medium Office Building for both 4C and 5B
 - 12 EUI for Small Retail Store for both 4C and 5B



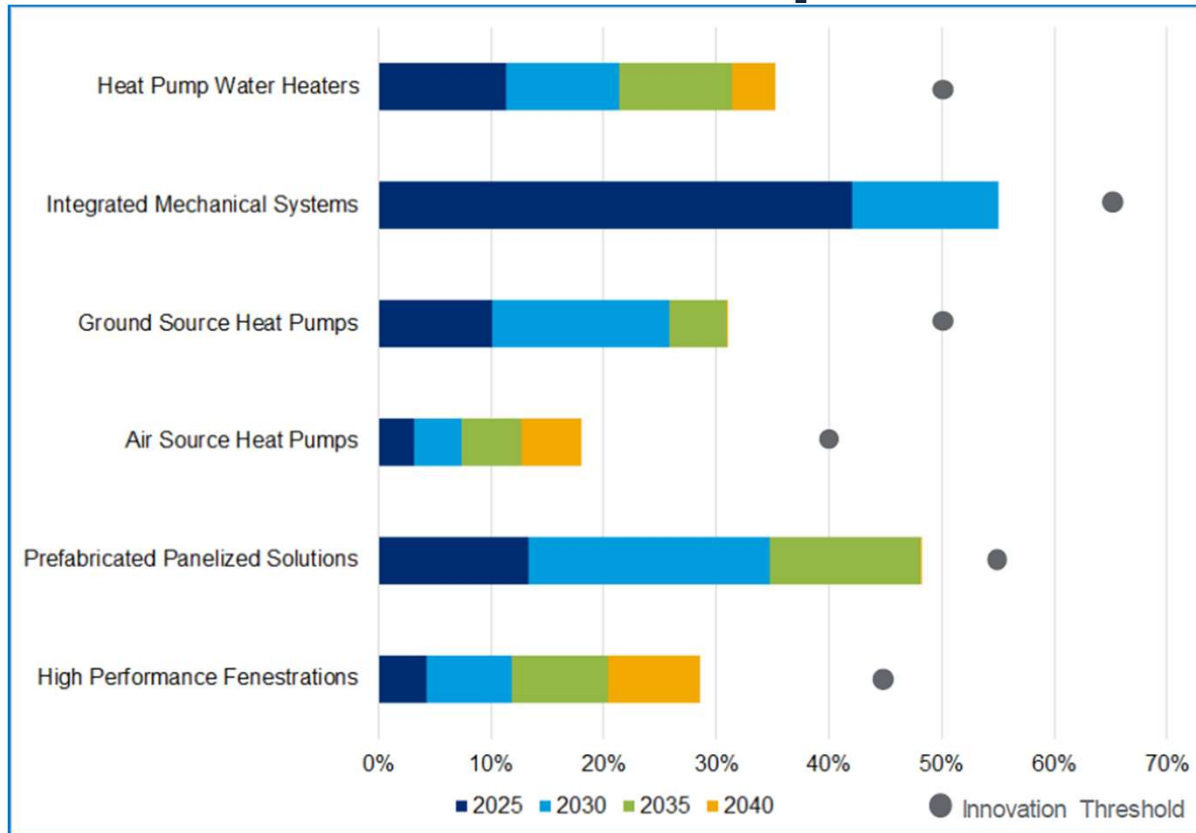
FAQ: What about Operating Cost?



Source: OFM Cost Analysis Tool



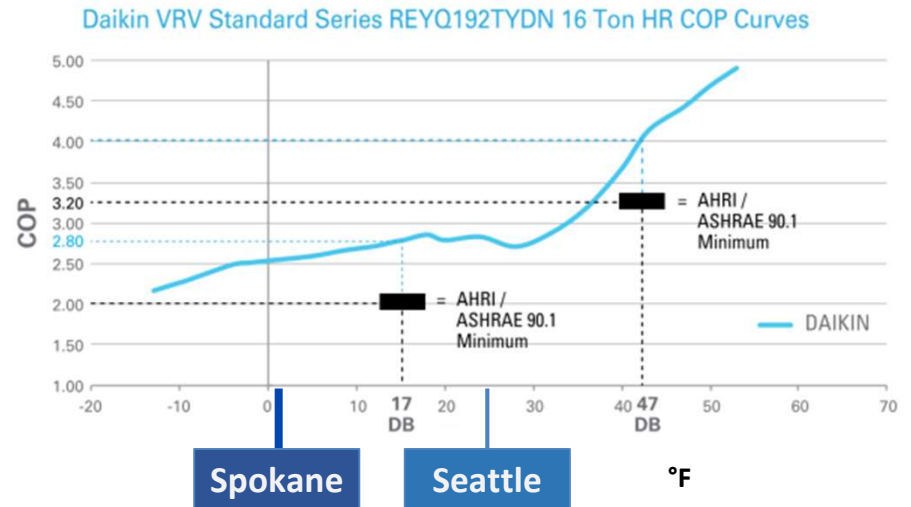
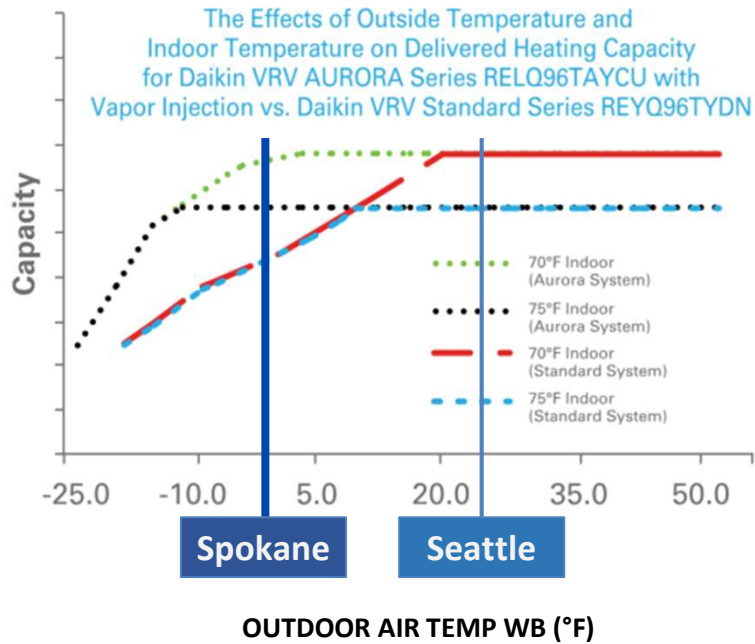
FAQ: What about Capital Cost?



Source: NYSERDA, Carbon Free Buildings Roadmap, Day 1, <https://www.nysERDA.ny.gov/-/media/Files/Programs/Carbon-Neutral-Buildings/Day-1-Carbon-Neutral-Roadmap-Presentation.pdf>



FAQ Cold Climate Heat Pumps

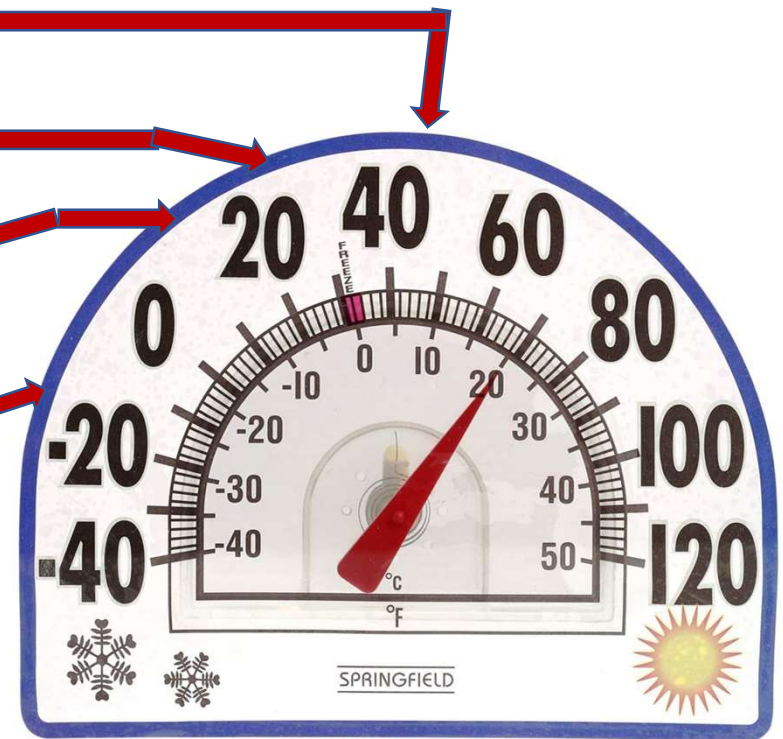


Source: Daikin



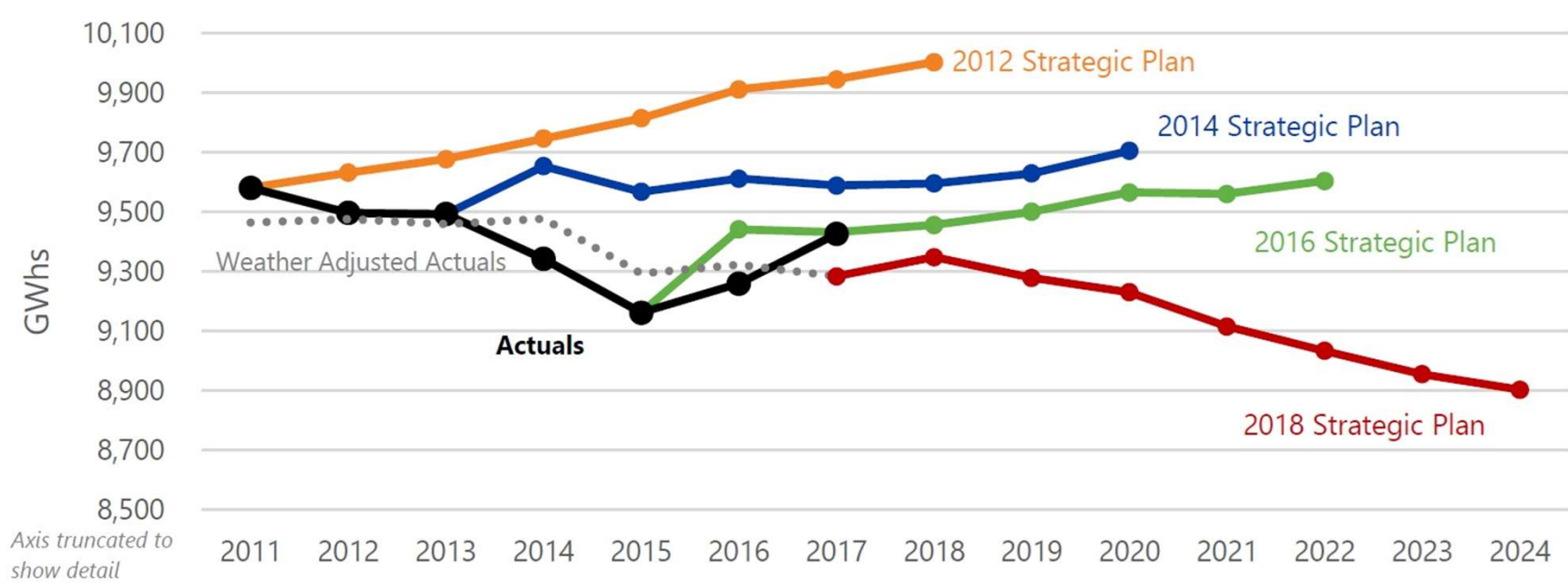
FAQ Cold Climate Heat Pumps

- **40° - 45°** PTHP/VTHP
- **20° - 25°** Single speed compressors
 - Before steep drop in capacity & COP
- **5° - 15°** Modern variable speed compressors
 - Before steep drop in capacity & COP
- **-10° to -15°** Some variable speed compressors
 - Before needing backup electric heat



FAQ What about Grid Capacity?

Grid loads in WA are declining
Even with record-breaking construction volume



Source: Seattle City Light 2018 Strategic Plan

