



Beneficial Electrification of Maine Buildings - Plans and Progress

Emerging Trends in Home Electrification

Annual Event - June 16, 2022

Session Description

What's next in residential electrification? A high percentage of new homes in Maine are all electric, and more heat pump installations are “whole-home” heating solutions. This session will discuss Efficiency Maine's recent findings on the performance of whole-home heat pumps, best practices for whole-home heat pump use and installation, and recent successes of using heat pumps as the sole source of heating mobile homes in Maine.

Session Outline

1. Maine's Heat Pump Goals and Progress
2. New Construction Baseline Study
3. New Construction HVAC Cost Assessment
4. Whole-Home Heat Pump Case Studies
5. Whole-Home Heat Pump Retrofits Pilot Study
6. What's Next?

Maine Climate Council's Climate Action Plan (Maine Won't Wait)

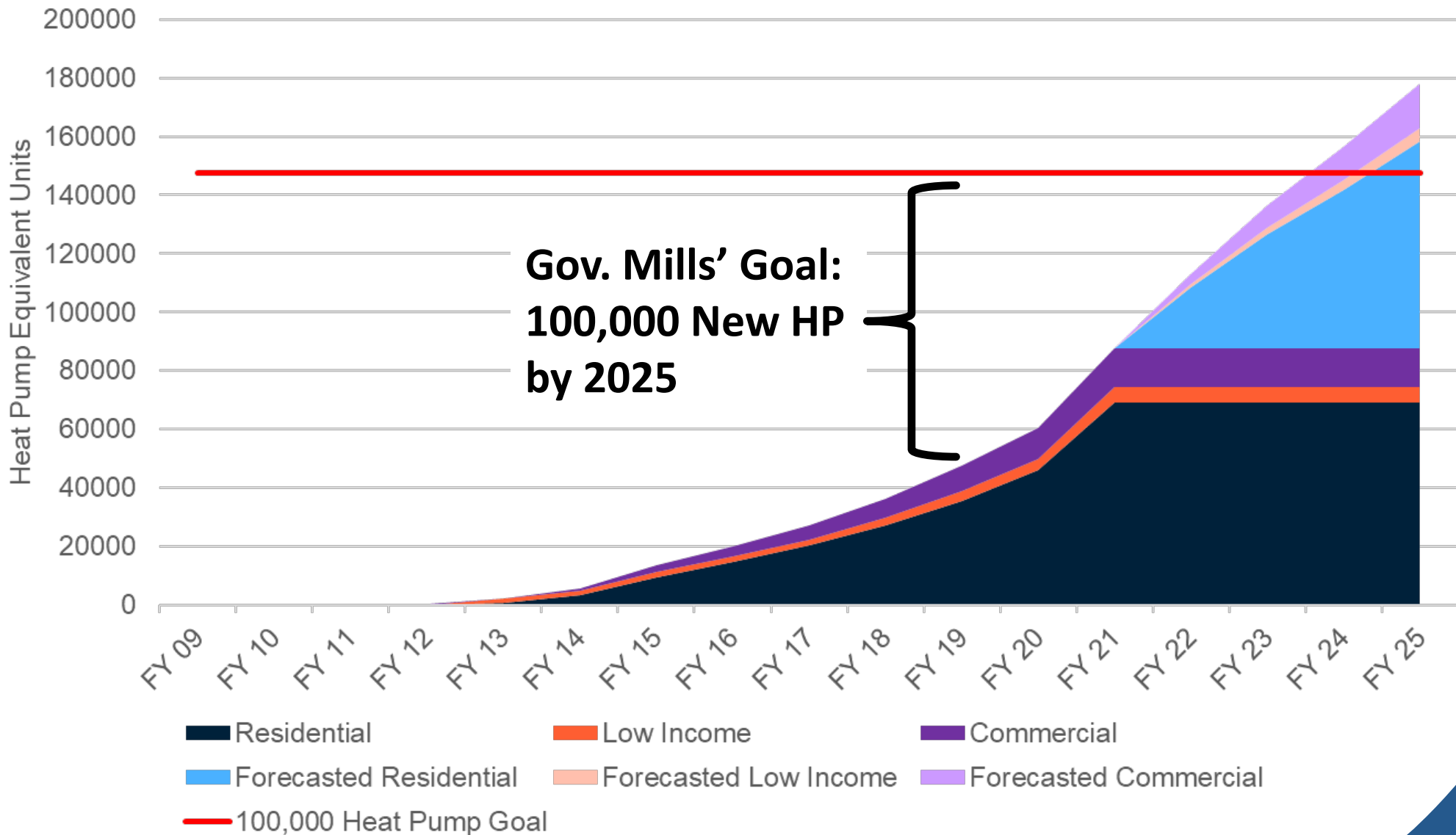
By 2025, starting in 2020:

1. 100,000 new heat pumps in homes & businesses (LD1766)
2. 15,000 new heat pumps in income-eligible households

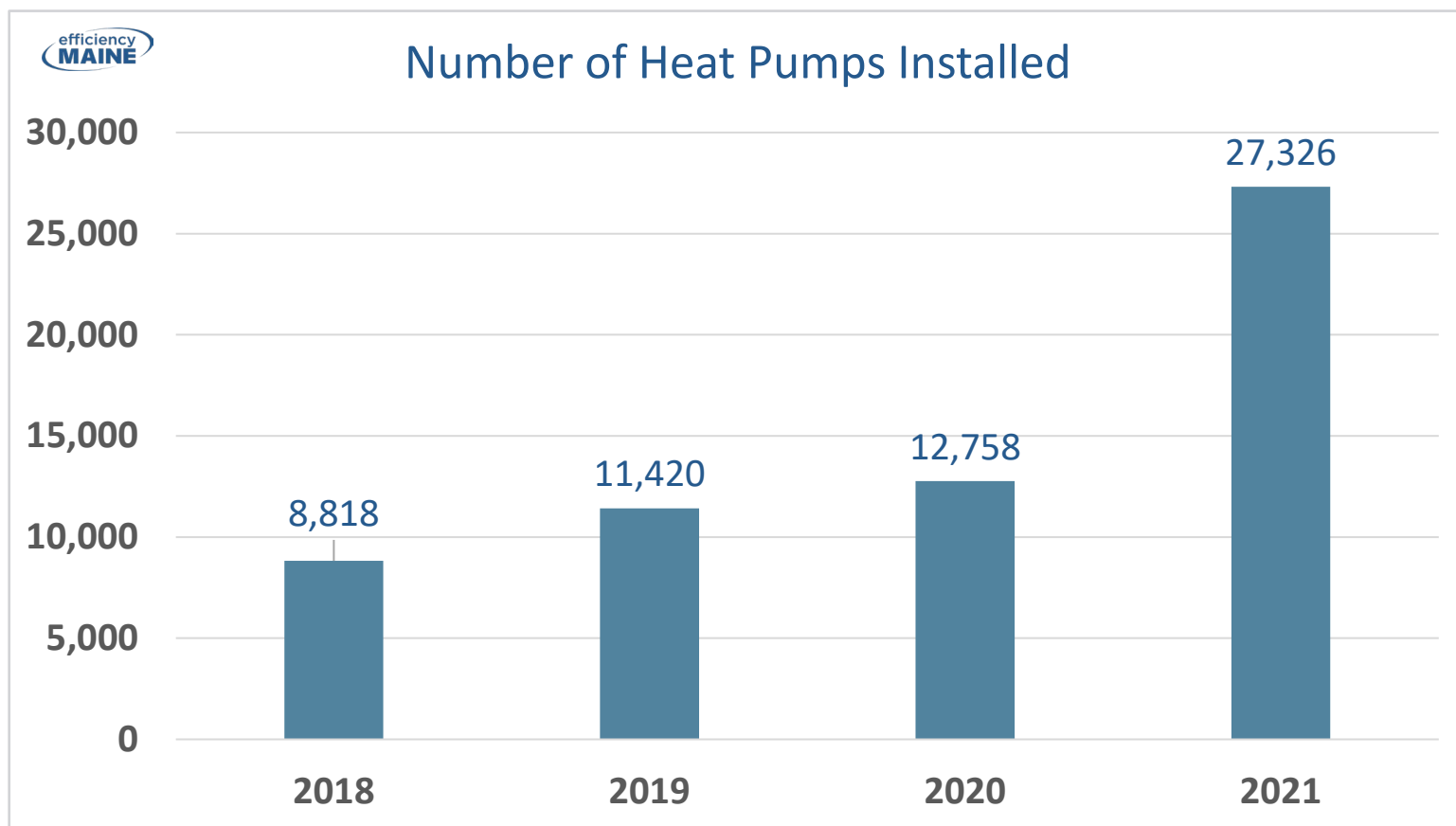
By 2030, cumulative:

1. 130,000 homes using between 1-2 heat pumps and
2. additional 115,000 homes using whole-home heat pump systems
3. ~100,000 units in businesses

Progress - Transitioning to Clean Heating & Cooling



Scaling up Heat Pump Systems



One (1) unit is equivalent to an efficient single-zone, mini-split heat pump that would typically displace 25.1 million Btu per year (equivalent to 180 gal. of heating oil). Larger heat pump systems are counted as more than one unit based on the delivered heating Btu of the systems installed.

- Nationally recognized heat pump program
 - AESP, 2022 “Groundbreaking Program Design & Implementation Award”
 - Alliance to Save Energy, 2020 “Star of Energy Efficiency”

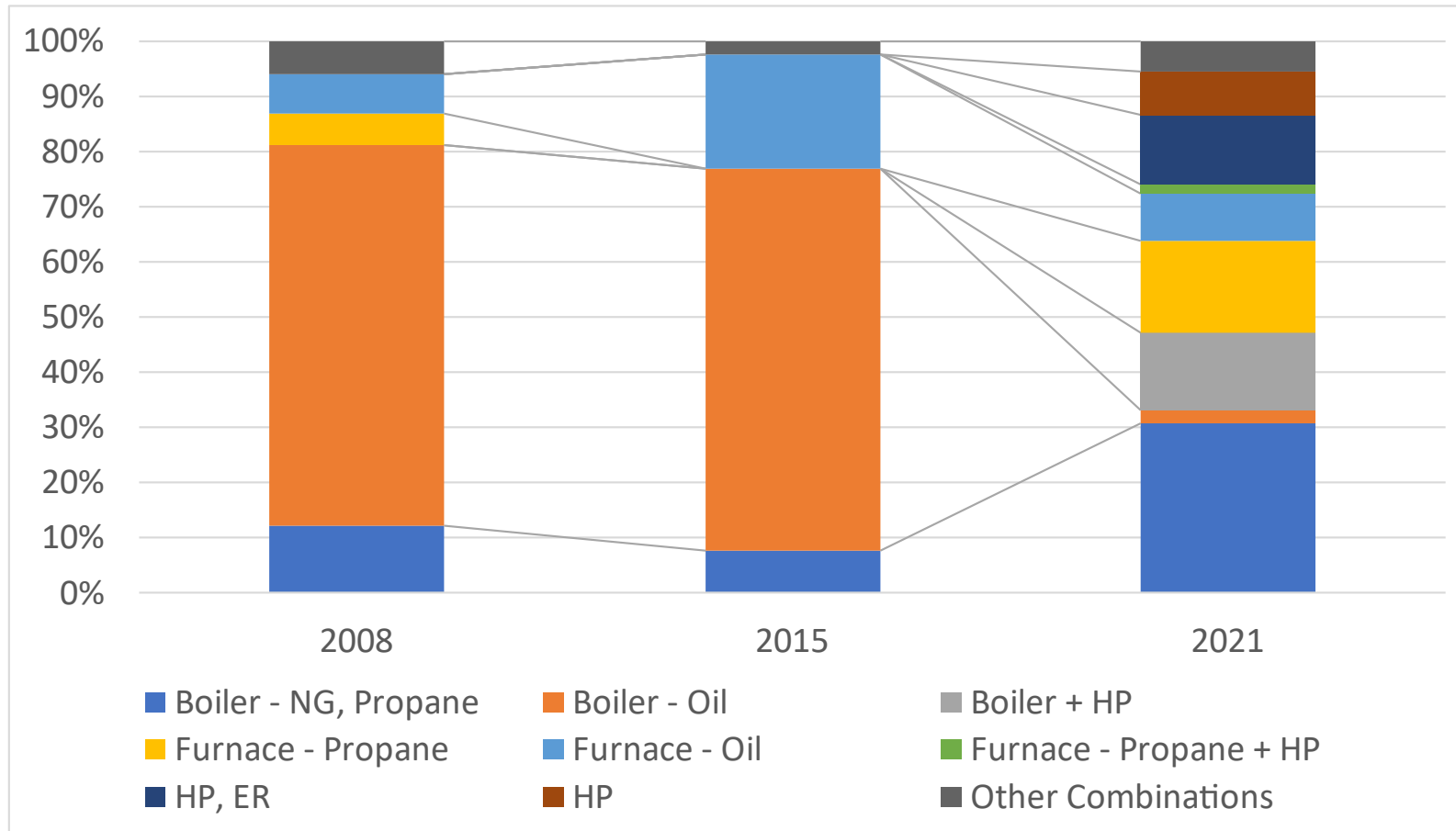


New Construction Baseline Study

Heating System Trends in New Construction

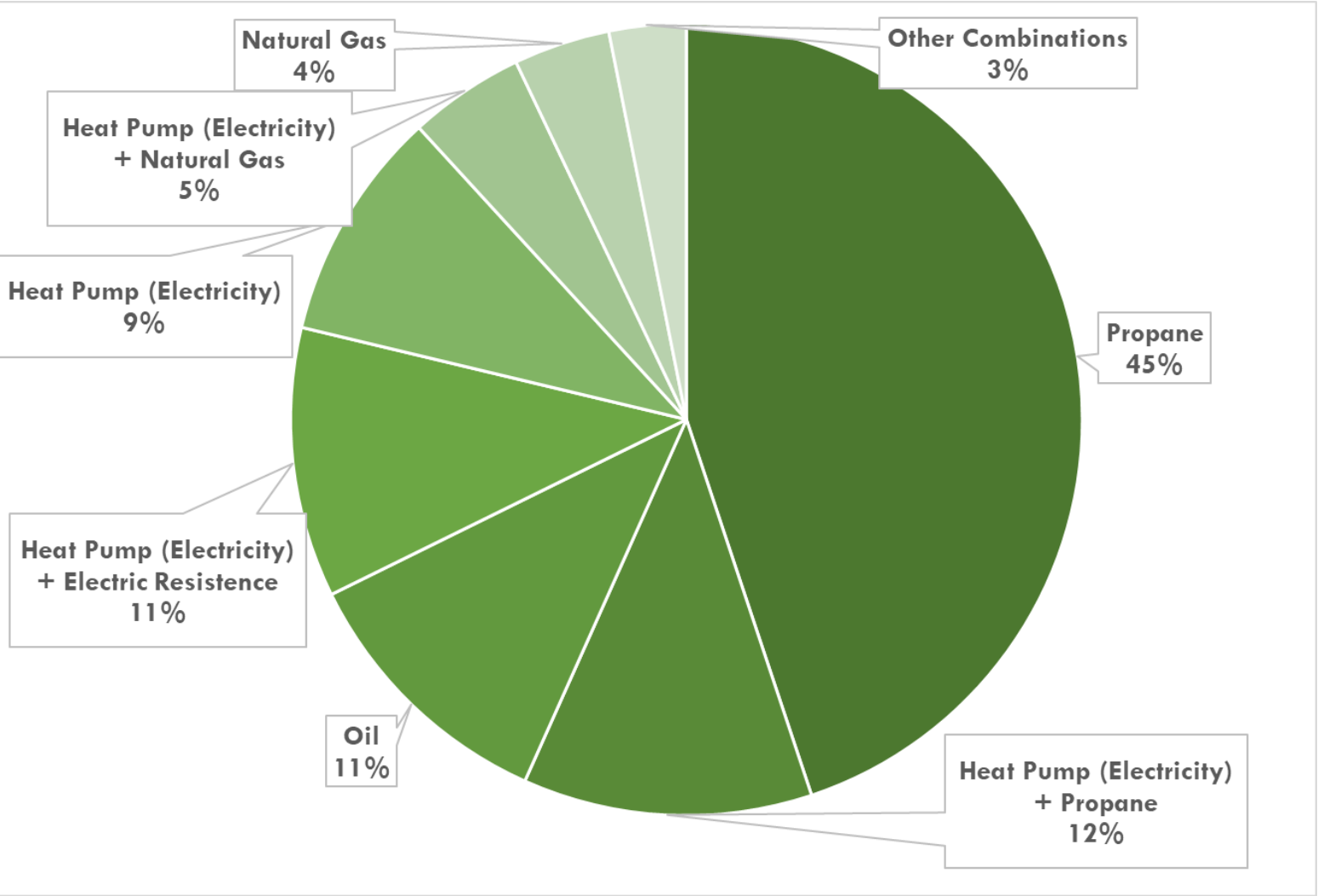
- **2021 New Construction Baseline Study conducted by Ridgeline Energy Analytics**
 - 127 Home built between 2017 and 2020
 - 57 single homes
 - 41 multifamily homes
 - 29 manufactured homes
 - 13/16 counties
 - 60 single-family and multifamily homes in municipalities with >4,000 population
 - 38 single-family and multifamily homes in municipalities with <4,000 population

Oil Use is Fading, Heat Pump Use is Growing



20% of homes are all electric heat, meaning they heat with a heat pump or heat pump w/electric resistance

20% of Homes Heat with Heat Pumps or Heat Pumps with Electric Resistance; Oil Use is Minor



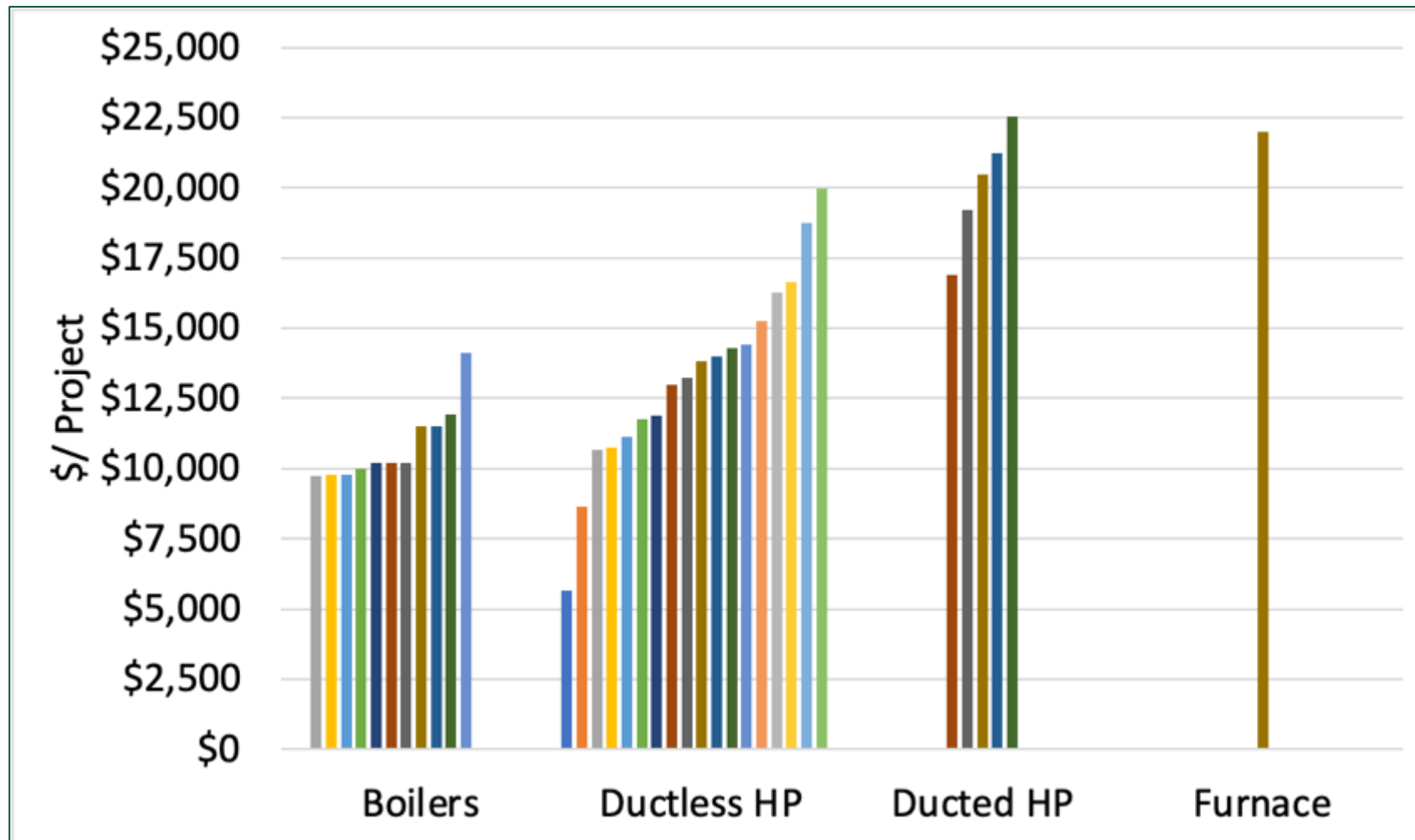


New Construction HVAC Cost Assessment

Residential Heating System Costs Assessment

- 2021 Residential New Construction Heating System Installation Cost Assessment
 - Gathered 35 recent project bids from five Maine builders

Boiler and Heat Pump Costs (\$/project)



Boiler/Heat Pump Cost Comparison

System	Lower 80% Confidence Interval	Mean	Upper 80% Confidence Interval
Boiler	\$10,296	\$10,817	\$11,337
Ductless	\$12,692	\$13,361	\$14,030
Difference	\$2,396	\$2,545	\$2,693

- Boiler costs include cost of distribution systems (piping, radiators, pumps, etc.)
- Boiler costs do not include an allowance for cooling



Whole-Home Heat Pump Case Studies

Whole-Home Heat Pump Metering Study

- Study conducted in winter 2021 by DNV
 - 10 homes with preexisting heat pump installations as their primary heat source
 - Most houses retained preexisting heating systems or included an electric coil in the air handler to provide backup/supplementary heat
 - Metered from February-June 2021
 - All homeowners were satisfied or very satisfied with their heat pump systems and the comfort of their homes
 - 7 out of 10 homes did not use supplementary heating to any significant degree in addition to the heat pumps

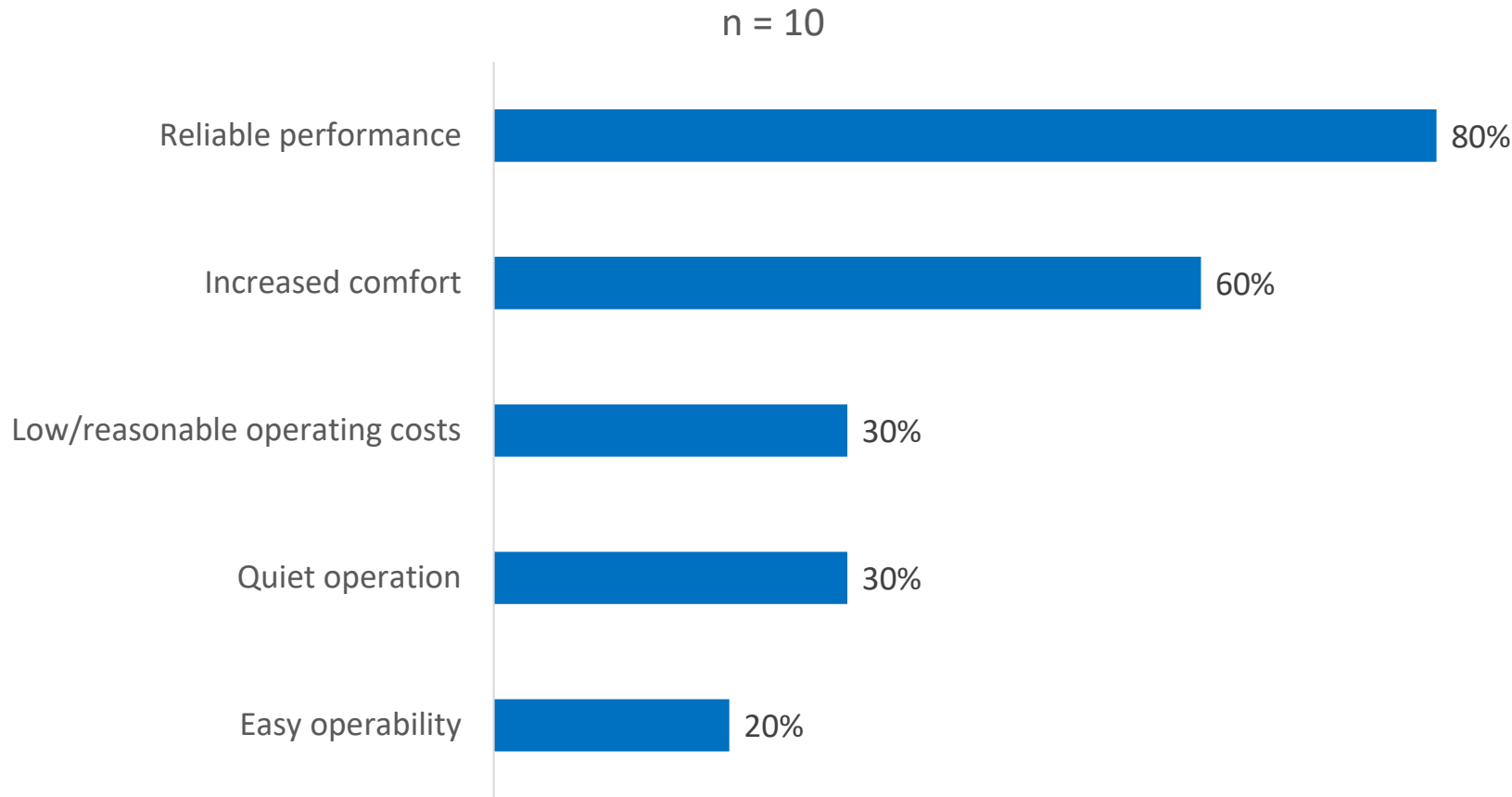
10 Unique Homes and Systems

Site ID	Location	Home Description	Conditioned Space	Air Leakage CFM50	Heat Pump System Description	Other Heating Systems
01	MDI	1770 Single Family	1,850	2,897	Air-to-water with 10 zones	Electric coil and Wood Stove
02	Sanford	2000 Single Family	4,000	1,879	Ducted air-to-air Single zone	Space heater in basement and Hot water coil (oil)
03	Gardiner	1803 Single Family	2,300	5,696	2 Ducted air-to-air 2+1 zones	Wood fireplace
04	GDI	1935 Single Family	1,200	4,938	Ducted air-to-air (1 zone) Ductless air-to-air (3 zones)	Wood fireplace
05	GDI	1993 Single Family	1,700	7,330	Ducted air-to-air (1 zone) Ductless air-to-air (2 zones)	Kerosene heater and Wood stove
06	GDI	2003 Single Family	2,400	3,731	Ducted air-to-air 3 zones (2 on 1st, 1 on 2nd)	Electric heater in bathroom and Wood stove
07	GDI	1904 Condo	1,370	5,428	Ducted/Ductless air-to-air 2 zones (ductless on 1st, ducted on 2nd)	Oil boiler
08	Cumberland	1900 Single Family	1,500	4,294	Ducted air-to-air 1 zone	Two wood stoves
09	Greene	2013 Single Family	1,760	608	Ducted air-to-air 1 zone	Electric coil
10	Arundel	2000 Single Family	1,846	720	Ducted air-to-air 2 zones (1 for bedroom, 1 for rest of home)	Electric coil and Propane fireplace

MDI – Mount Desert Island

GDI – Great Diamond Island

Reasons for Satisfaction with HP Performance

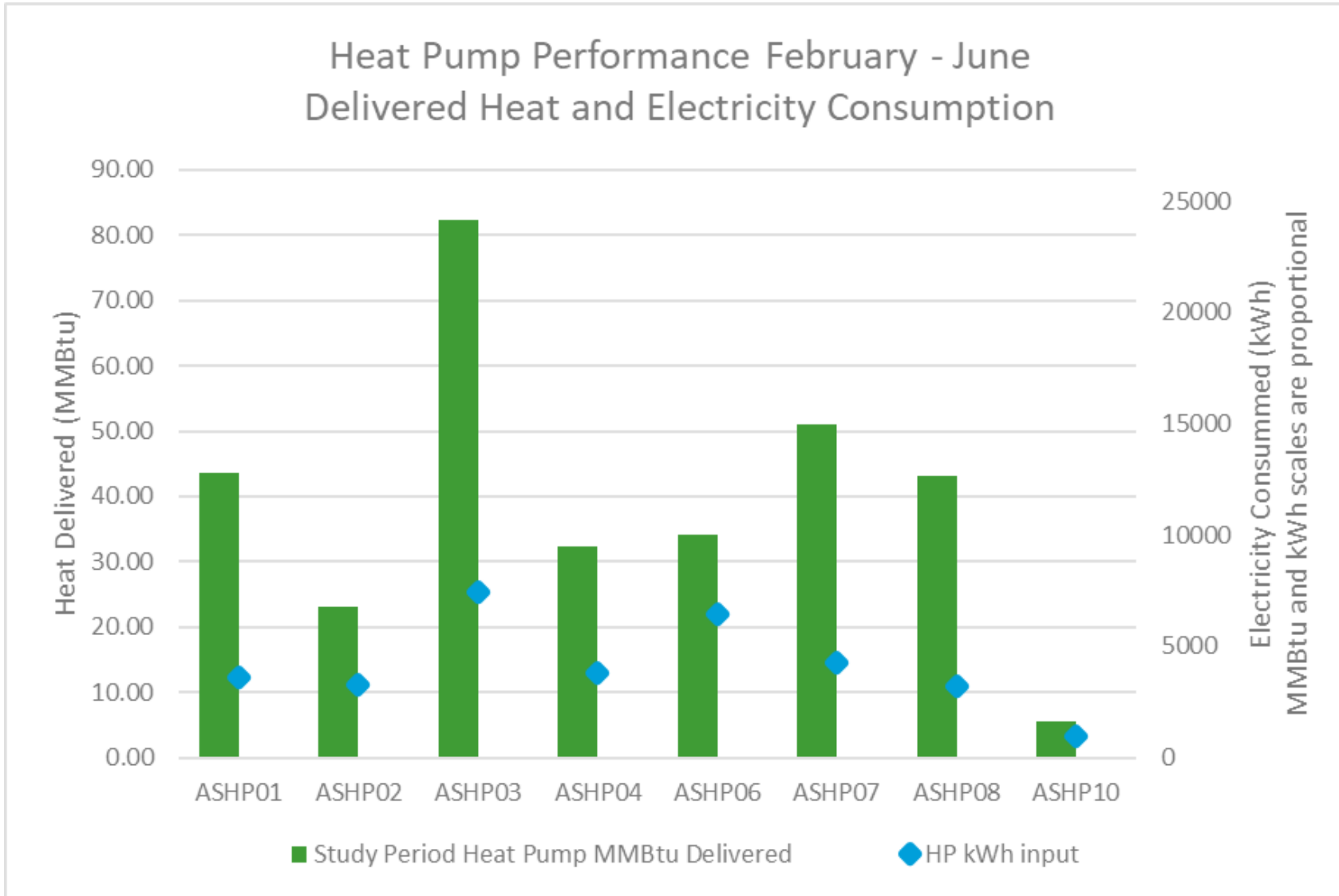


% of Participants Citing Factor as Reason for HP Performance Satisfaction

All surveyed participants were satisfied or very satisfied with their heat pump's performance

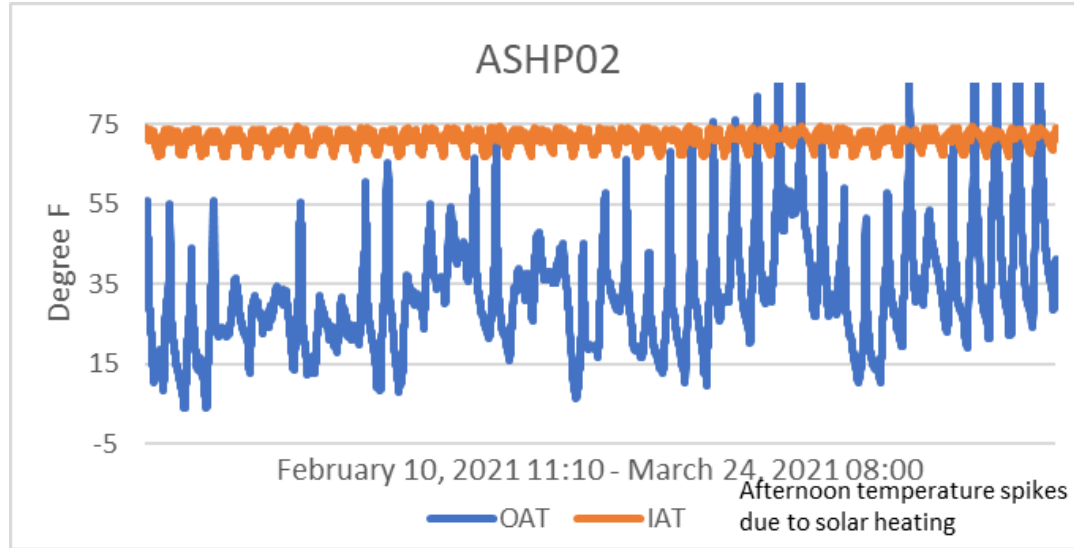
- “In terms of performance, [the heat pumps] are great. They've actually worked really well.”
- “[The heat pump is] really quiet, and it's been quite dependable.”
- “[The heat pump is] working beautifully.”
- “Nothing but really positive experiences; can't think of one negative thing.”

Measured Heat Pump Performance



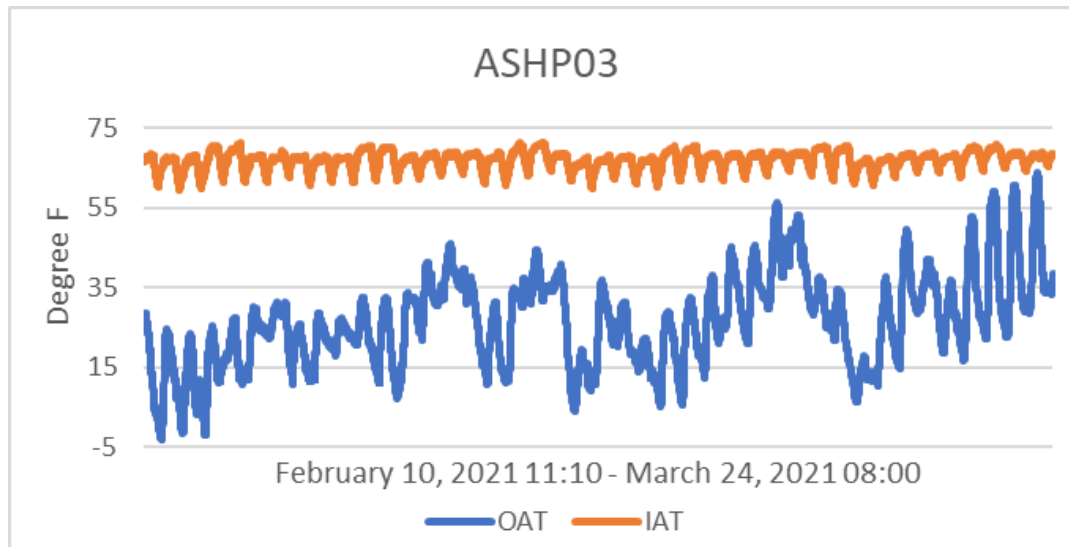
- Coefficient of Performance (Energy Output/Energy Input) for the heat pumps ranged from 1.7 to 3.9 for the performance measured over the study period.
- Energy output was calculated from the difference in heat content of the supply air and return air and the flow rate of the supply air.
- Energy input was calculated from the metered power use of the heat pump.

Indoor versus Outdoor Air Temperature

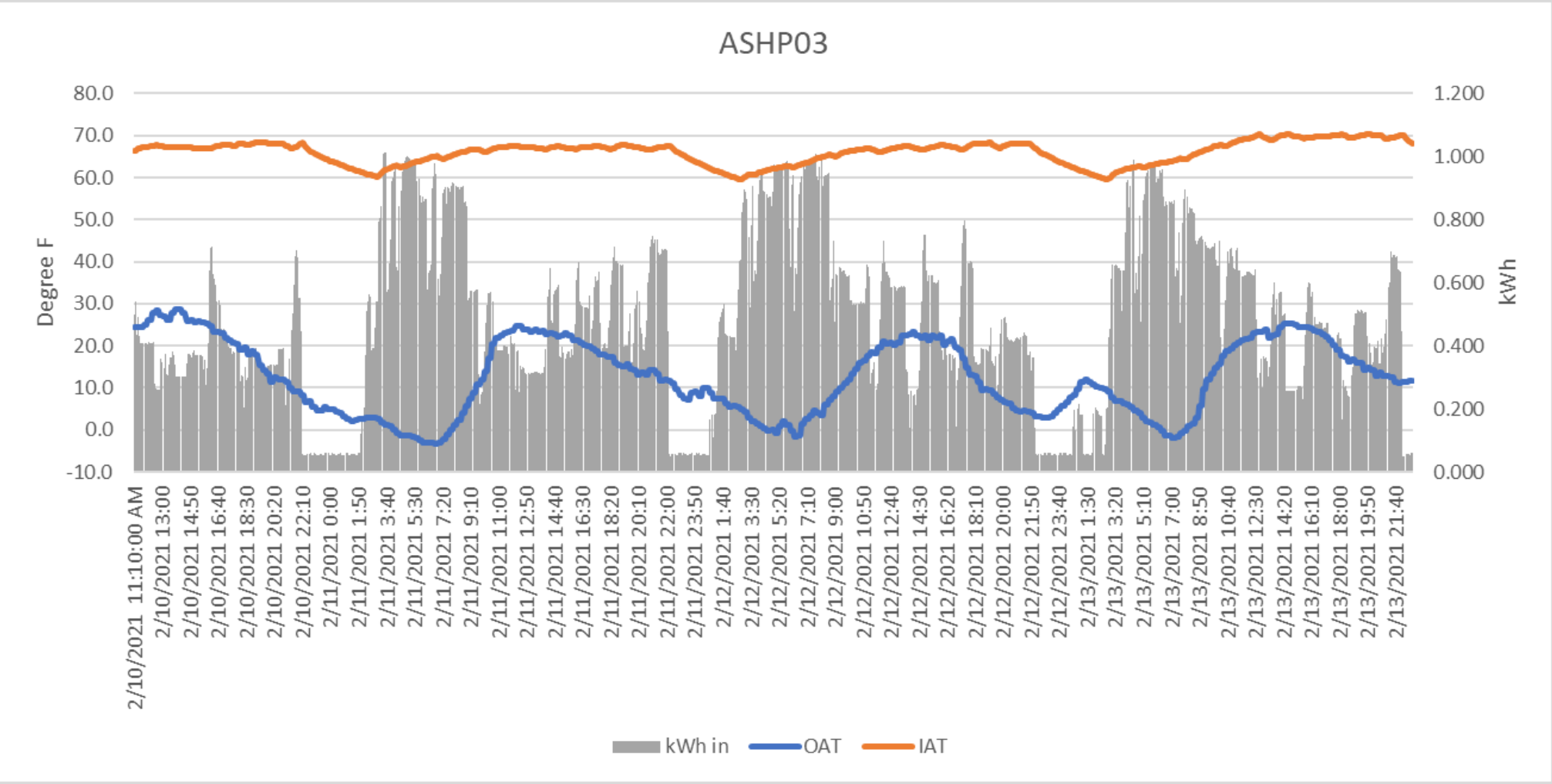


Site 3 (Gardiner) used the Outdoor Air Temperature (OAT) measured at site 9 (Greene) due to a meter issue.

IAT is Indoor Air Temperature



Site 3 Usage and Temperature Detail



Whole-Home Heat Pump Pilot

Whole-Home Heat Pump Pilot

We know heat pumps work in Maine. This pilot seeks to determine if they can work as the sole heating source in Maine.

To test this, existing fossil fuel furnaces were removed or disabled and replaced with heat pump units.

- Some, but not all, homes received a small amount of electric resistance for backup heat

19 homes are participating throughout the state

- 10 mobile homes
 - No other study has retrofitted mobile homes entirely to heat pumps
- 9 stick-built homes

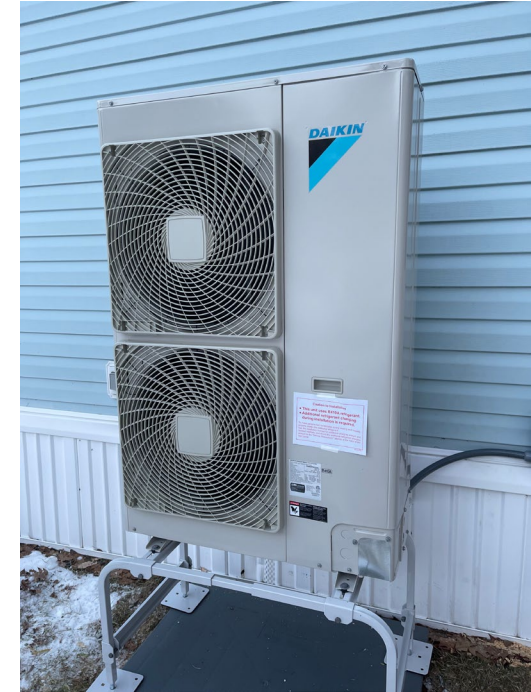
Found eligible equipment across 4 different manufacturers

Ducted Mobile Home Solution



Indoor Unit

- Heat pumps replace the Miller furnace and use the existing ductwork
- Manufacturer claims this heat pump maintains full capacity down to -5°F and it has been seen to still produce heat at temperatures lower than that.
 - Temperatures have hit as low as -10°F outside homes this year, with the heat pump able to maintain interior temperature without supplemental heat
- First known instances of retrofitting an existing mobile home's heating entirely with heat pumps.



Outdoor Unit

Stick-built Mobile Home Solution



Ducted Indoor Unit

- Homes with preexisting ductwork were fitted with a ducted heat pump to directly replace their furnace
- Homes without ductwork were fit with mini-split heat pumps as needed throughout their homes
 - All fossil fuel systems were still disabled
- Temperatures have reportedly hit as low as -20 F outside homes this year, with the heat pump able to maintain interior temperature



Outdoor Unit & Meter

Participant Quotes

- “The heat seems more even with the HP.”
- “We are very happy. The heat pumps worked so well we didn’t turn on the furnace at 0 F. Our pipes [under the home] did not freeze.”
- “At -9F we had no idea it was so cold outside. With the oil furnace we had large variation [in temperatures]. This is a much more even heat. We had no issues at –20 F.”

What's Next?

- On track to meet goals from the state Climate Action Plan
- Triennial Plan V has ample budgets for heat pumps
- Trends:
 - Improved efficiency
 - Improved cold-temperature performance
 - Whole-home solutions
 - Adoption beyond wall units



Questions?