



Making the Switch:

The Imperative to Convert the Whole Home (or Whole Building) to Heat Pumps

Annual Event – September 14, 2023

Panel Participants

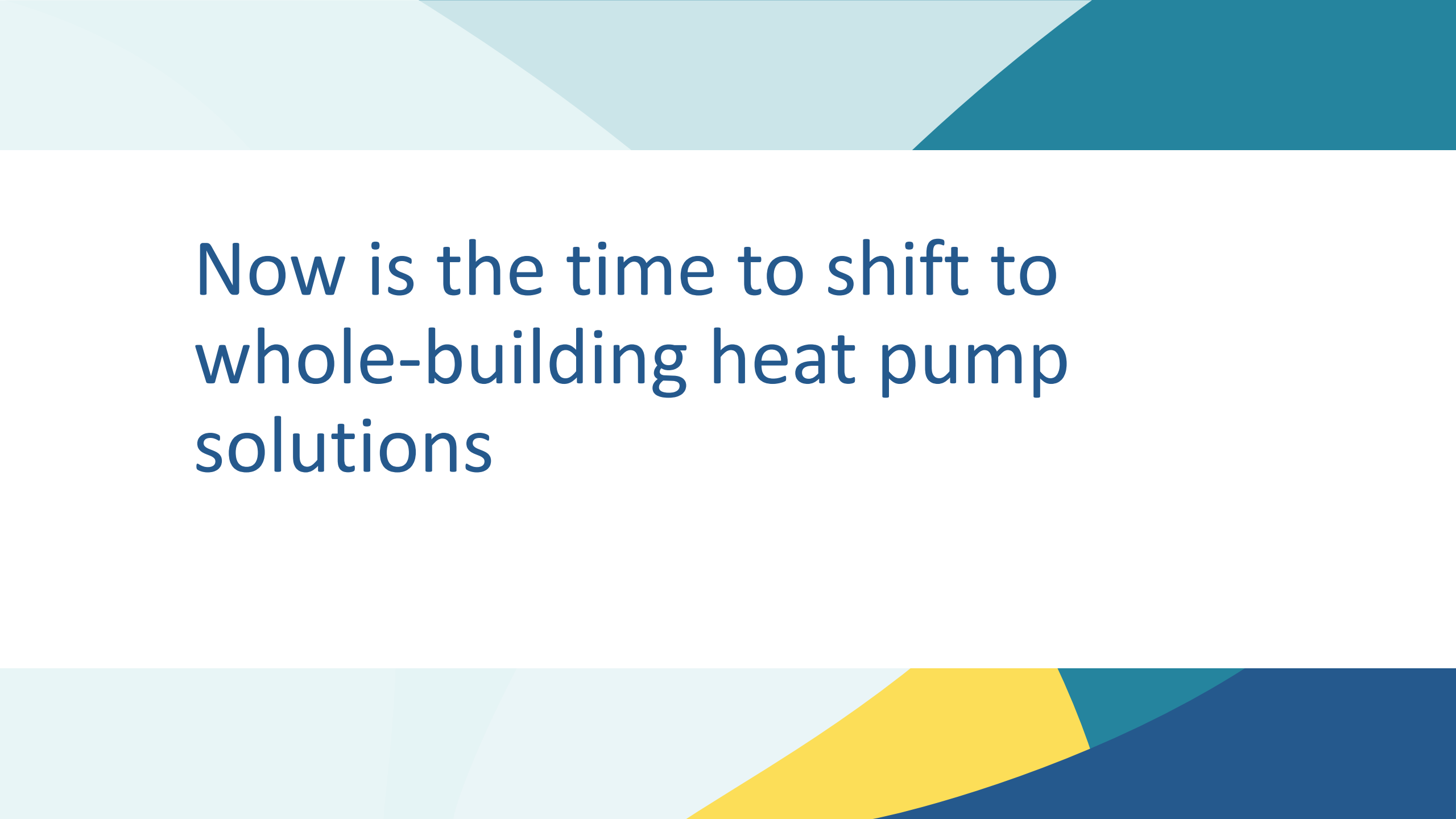
Moderator: Peter Eglinton, Deputy Director, Efficiency Maine

Panelists:

- Laura Martel, Research & Evaluation Manager, Efficiency Maine
- Dave Korn, Senior Engineer, Ridgeline Energy Analytics, Inc.
- Philip Chaney, Architect, SMRT Architects and Engineers
- Kerry Dineen, Mechanical Engineering Discipline Leader, SMRT Architects and Engineers

Session Outline

- Now is the time to shift to whole-building heat pump solutions
- Program evaluations demonstrate need for whole-building approach
- Whole-building solutions work
 - Residential examples
 - Commercial examples
- Q&A



Now is the time to shift to
whole-building heat pump
solutions

New federal tax credits offset need for Efficiency Maine's residential rebates for "room heaters"

	Current Efficiency Maine Rebates	New Federal Tax Credit (as of January 2023)
Incentive	Any Income: \$800 for 1 st unit \$400 for 2 nd unit Low-Income: \$2,000 for 1 st unit \$400 for 2 nd unit	30% up to \$2,000 (+ \$600 for panel upgrade, if needed)
Frequency	Once	Per year

Maine has aggressive whole-home heat pump targets

- Maine Climate Action Plan (“Maine Won’t Wait”)
 - Electrify the heating & cooling of Maine buildings using heat pumps so that 115,000 homes are using a whole-home heat-pump systems by 2030
 - Goal was codified by the Maine Legislature in the Efficiency Maine Trust Act (35-A MRS Sec 10104)
- Federal requirements for Inflation Reduction Act electrification rebates for low- and moderate-income households:
 - Heat pumps must be installed as a primary source of heating/cooling.
 - Systems may be installed:
 - As a replacement for fossil systems
 - For heat pumps added to households with electric heating systems, heat pumps must be installed to provide the primary heating and cooling for the household... Heat pump may not be a supplemental-only unit to another electric system. Existing electric system may be used to provide back-up and/or secondary heating/cooling

Focus of panel: other drivers of the heat pump imperative

- Program evaluations demonstrate imperative for whole-building approach
- Whole-building solutions work for both residential and commercial settings



Program evaluations demonstrate
need for whole-building approach

Program Impact Evaluations

Estimate the achieved energy savings (kWh), summer and winter demand reduction (kW), and fossil fuel impacts (MMBTU) of program rebated heat pumps.

- C&I Heat Pump Impact Evaluation
 - Projects installed July 2016 – June 2019
 - On-site metering of 103 heat pump systems
- Residential Heat Pump Impact Evaluation
 - Projects installed December 2019 – June 2021
 - On-site metering of 124 heat pump systems

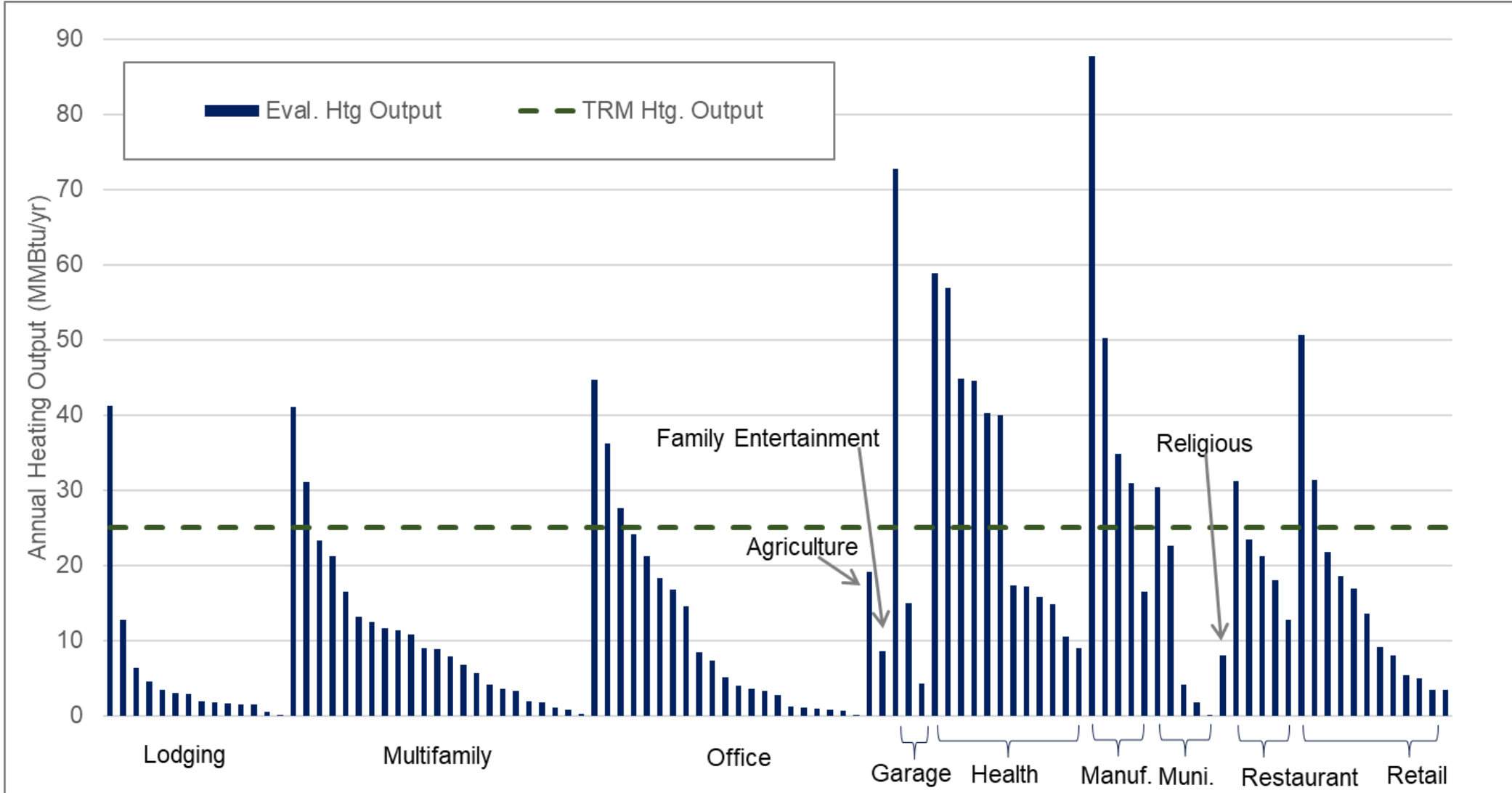
Customers report using the heat pumps for heating, but still rely on other heating systems

- C&I Customer Survey:
 - Over half (54%) reported using their heat pumps on all heating season days, and an additional 31% said they used their heat pumps on most cool and all cold days.
 - 29% reported still using their pre-existing heating system frequently, 40% reported infrequent use.
- Residential Customer Survey:
 - Four out of five participants report using their new heat pump(s) as their primary heating system.
 - About two-thirds of participants switch to their alternative source on very cold days.

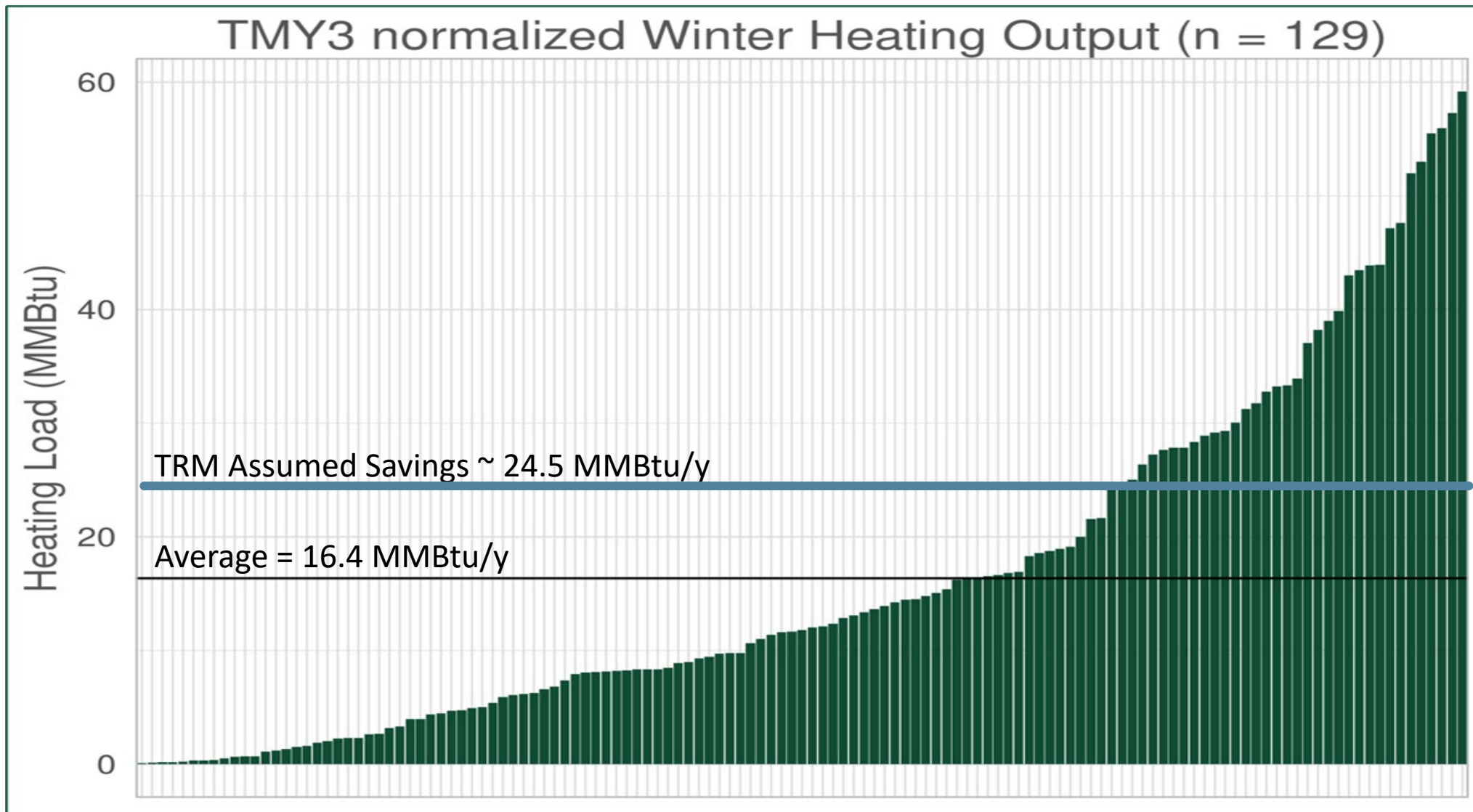
Metering results indicate that heat pumps are not being used to their full heating potential

- The C&I Evaluation found heat pumps had an average annual heating load of 39% of what was expected by the program based on the Technical Reference Manual.
- The Residential Evaluation found heat pumps produced approximately 67% on average of what was expected per the Technical Reference Manual.
- Usage of individual heat pumps varied significantly.

C&I Heat Pump Usage - Heating



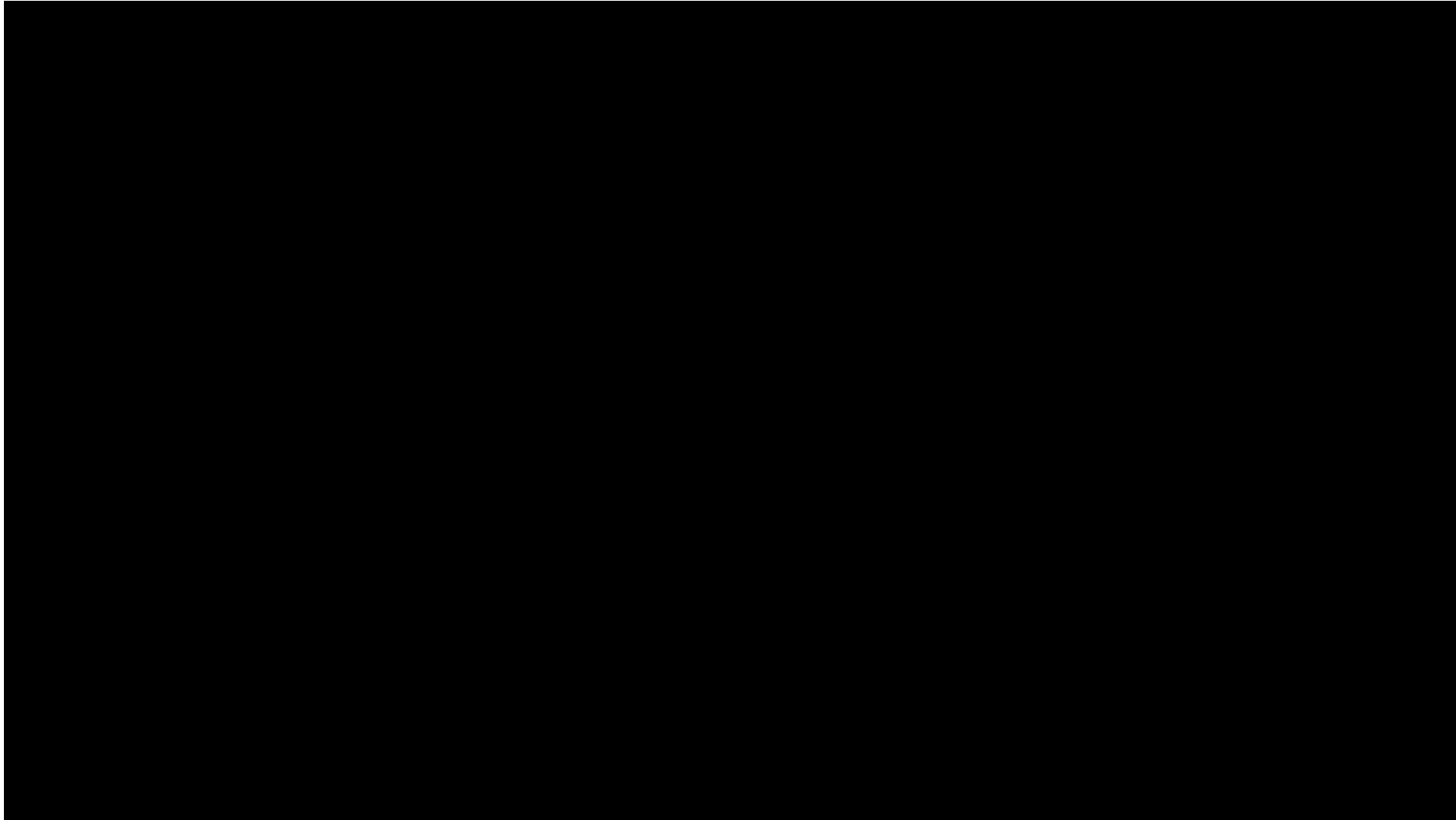
Residential Heat Pump Usage - Heating





Whole-building solutions work: residential examples

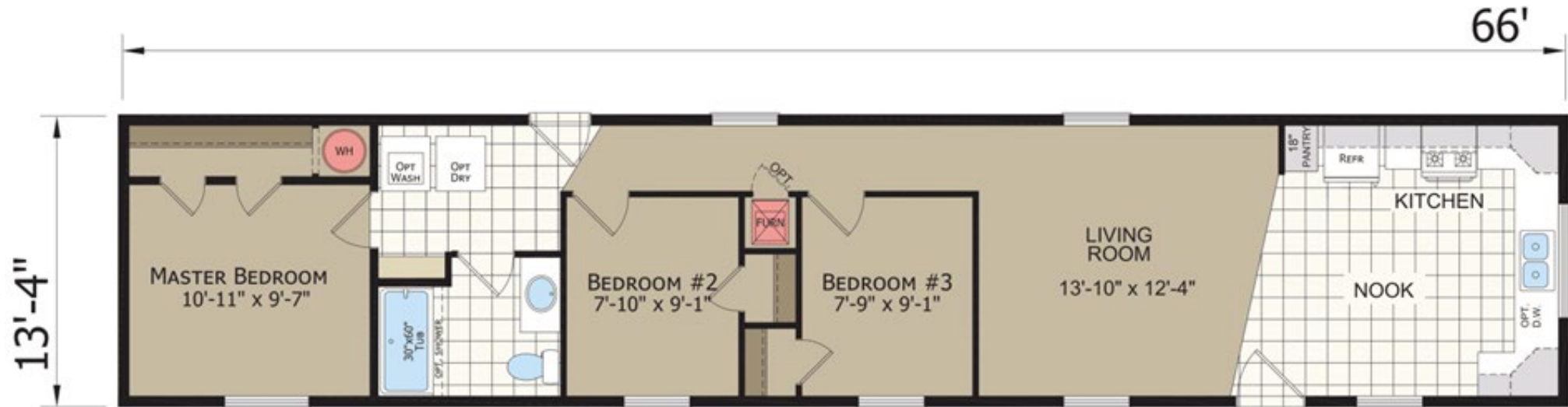
Whole-Home Heat Pump Case Study



Manufactured Home Heat Pump Pilot

- Manufactured homes in Maine
 - Over 62,000 homes in the state, or roughly 8% of the housing stock
 - Primarily use low to moderate efficiency kerosene, oil, and propane furnaces for heating
 - Coefficient of Performance (COP) of existing units are roughly 0.8, or 80% efficient
 - Include economically stressed occupants
- Electrification of manufactured homes is a challenge due to:
 - Lack of industry experience
 - Water lines run under homes and are kept warm by air in the ducts
 - Small HVAC closets
 - 100A panel capacities

Target Homes to Date



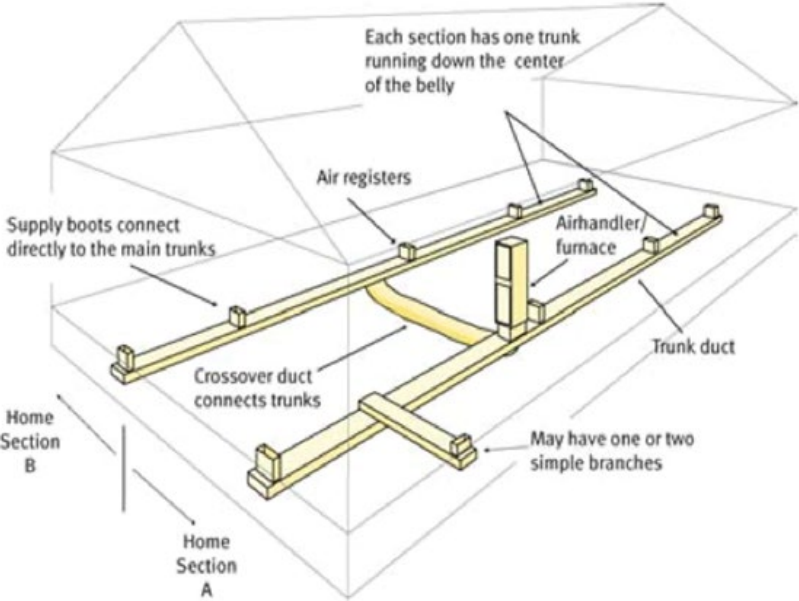
Example “Single-Wide” Layout

- “Single-wide” manufactured homes
- Climate Zones 6a, 5b, and 5a
 - Kittery, ME, to Bangor, ME
- Previously heated with kerosene, oil, or propane
- Underbelly insulation and ductwork fully intact
- Owner Occupied
- Meet income screening requirements
- Ability to fit appropriately sized heat pump and any necessary supplemental electric resistance in both closet and electric panel

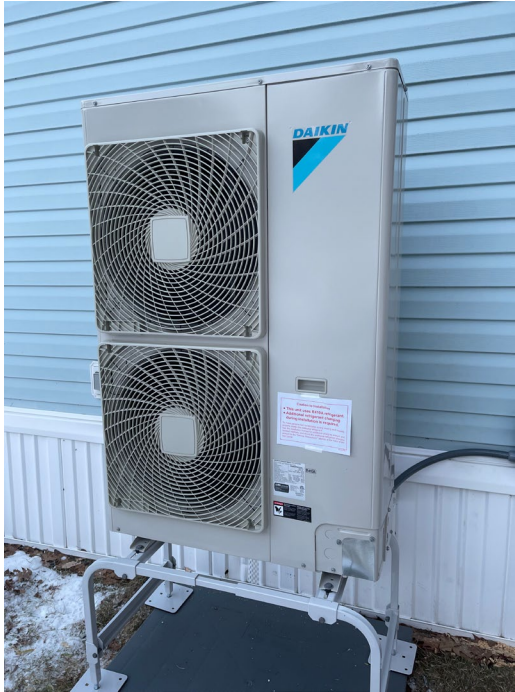
Ducted Mobile Home Solution



Indoor Unit



Duct Work Layout

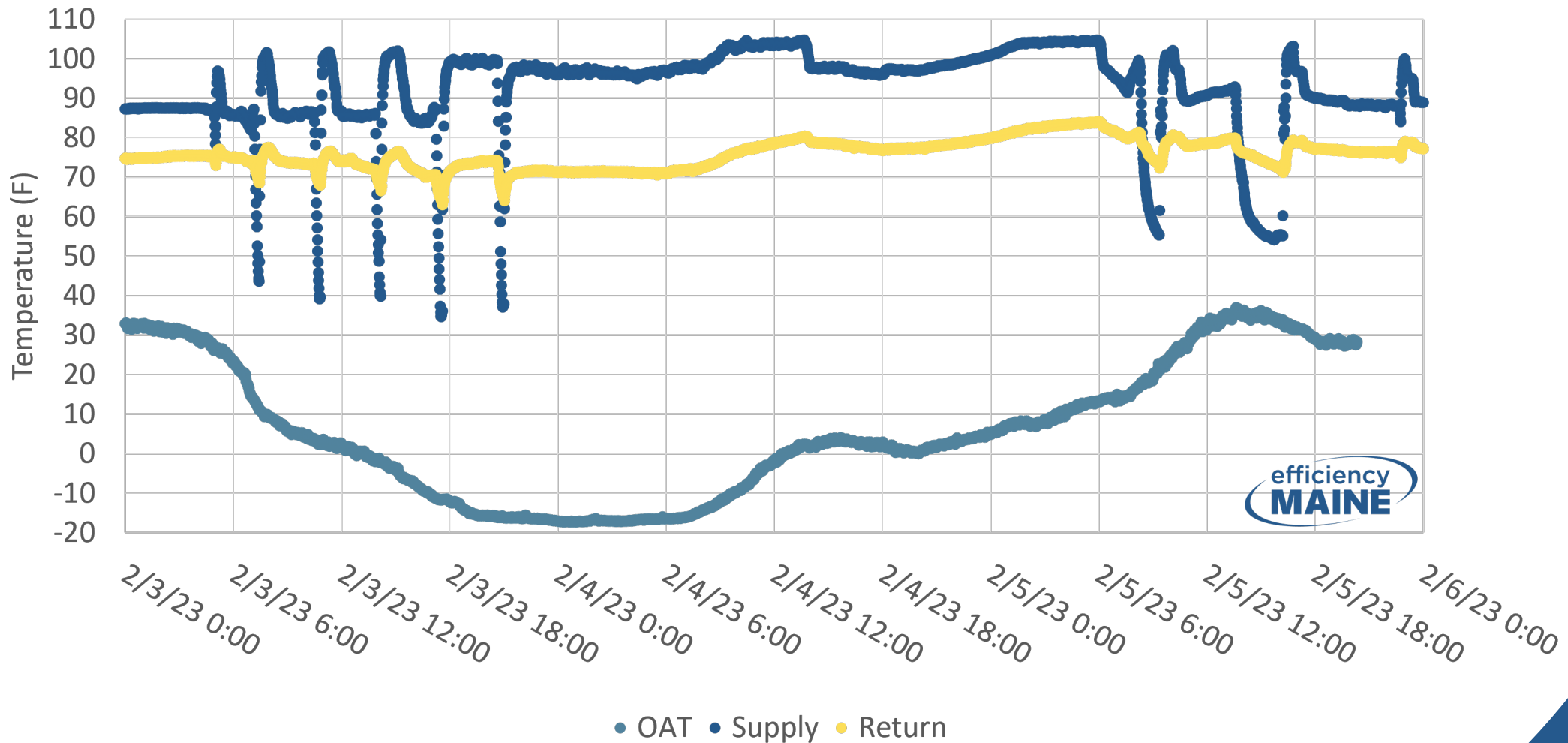


Outdoor Unit

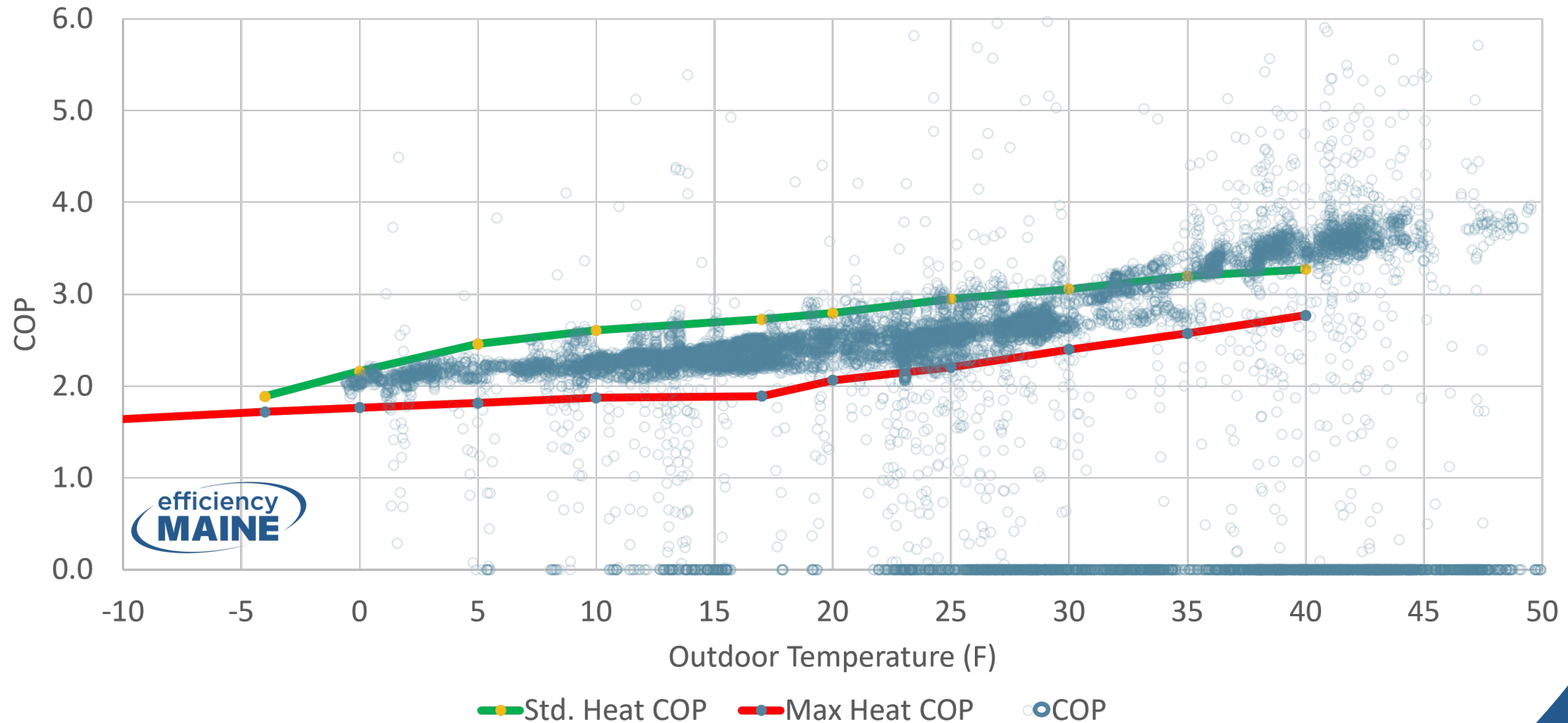
Pilot Progress

- **Phase 1: Winter 2021 – 2022 in Collaboration with Ridgeline Energy Analytics**
 - 10 manufactured homes participated in first year
 - No participant co-pay for initial pilot testing
 - Allowed us to meter their homes throughout the winter
 - Offering included an opt-out clause after 1 year to go back to previous heating system (no participants took this offering)
- **Phase 2: Winter 2022 – 2023 in Collaboration with Ridgeline Energy Analytics**
 - 19 additional manufactured homes participated in second year
 - Received unit for no money down, but participants agreed to a co-pay of \$50 / month for 50 months
 - Includes full 5-year labor warranty through the installers, in addition to manufacturer parts warranty
 - Allowed us to meter their homes throughout the winter
- **Phase 3: Winter 2023 – 2024 in Collaboration with Ridgeline Energy Analytics and CLEAResult**
 - Planning to mirror Phase 2 offering and test additional home sizes and climate zones

Very Cold Temperature Performance: Hancock, Maine, Down to -16F



Efficiency of 36,000 Btu/hr Ducted HP in Hancock (2/14/23 - 3/10/23)



Winter Observations

- Heat pumps successfully heated homes, with no back up, down to -16F OAT with few issues.
- One outdoor heat pump unit was encased in ice due to ice sliding off metal roof. The heat pump did not provide capacity until ice was cleared, then returned to normal.
- Heat pumps appeared to operate at or near rated efficiency (COP) and provided heat near capacity.
- Actual heat loss appeared to be lower than heat loss modeled using Cool Calc, a Manual J-based vended software.

Resources

- Beneficial Electrification of Maine Buildings - Plans and Progress Emerging Trends in Home Electrification Annual Event (2022) - https://www.energycymaine.com/docs/Beneficial-Electrification-Residential-2022_06_13_FINAL.pdf
- Whole Home Heat Pump Study (2021)-
https://www.energycymaine.com/docs/DNV_Whole_Home_Heat_Pump_Study_2021.pdf
- Maine New Construction Baseline Assessment (2021) -
<https://www.energycymaine.com/docs/Maine-New-Construction-Baseline-Assessment-08262021.pdf>
- Memorandum on New Construction HVAC Pricing (2021) -
https://www.energycymaine.com/docs/Memorandum_on_New_Construction_HVAC_Pricing.pdf



Whole-building solutions work: commercial examples



September 14, 2023

Portland Commons & Efficiency Maine

SUBMITTED BY:

SMRT Architects and Engineers

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SMRT 

Architecture • Engineering • Planning

Project at a glance

Size: 216,915 square feet

Stories: 8

Residential Units: 385

Beds: 580

Construction: Cold formed bearing wall with precast concrete plank

P3 Project Delivery

Efficiency Maine Support:
\$480,000



Systems at a glance

Heating And Cooling:

- VRF change over system
- 38 outdoor units
- 657 indoor units

Ventilation:

- Rooftop ERV's
- 3 Units serving entire building

Hotwater:

- Whole building system
- fully recirculating
- *gas powered

Equipment

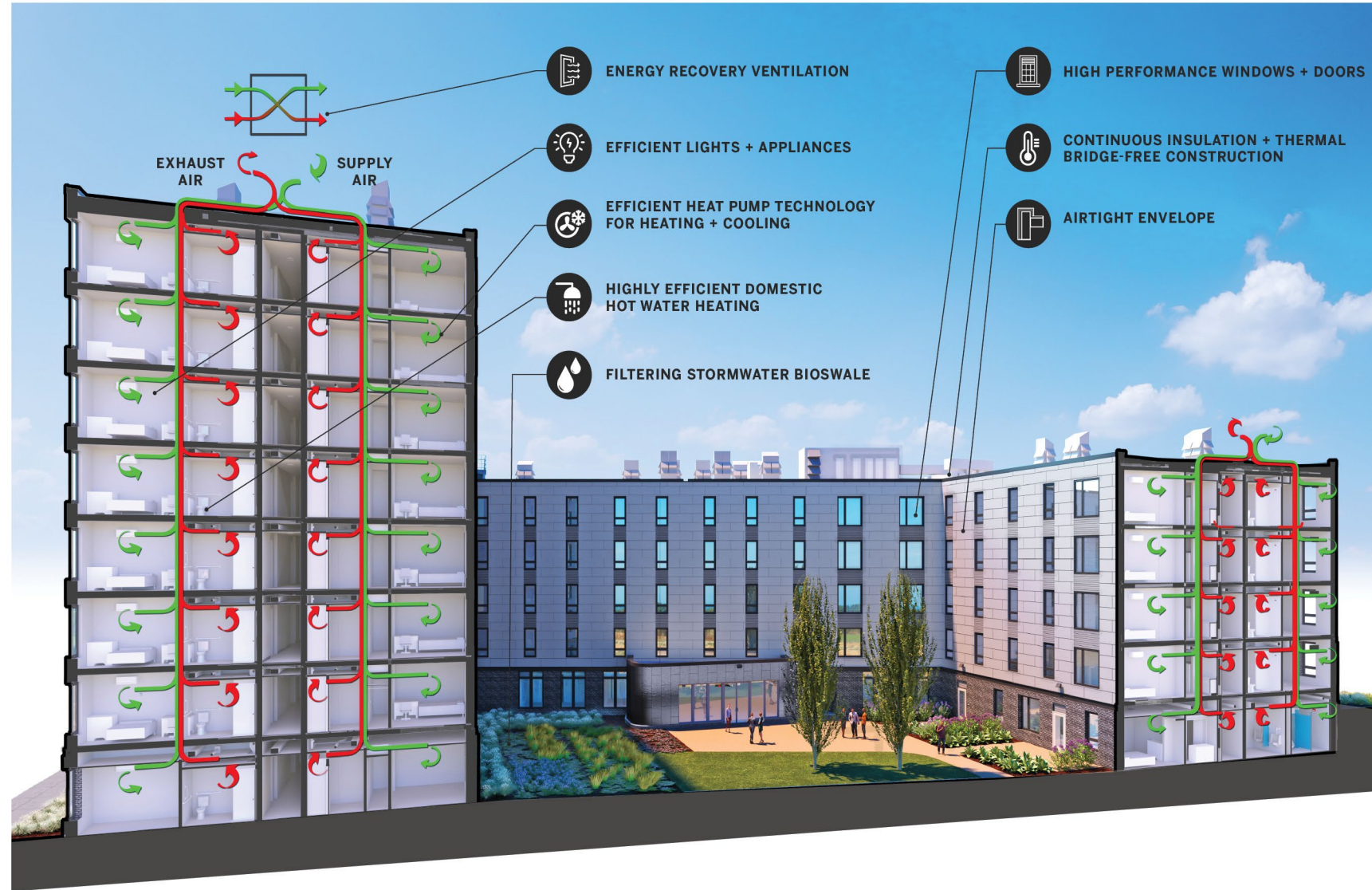
- Electric stoves
- Washing machines
- Heat pump dryers



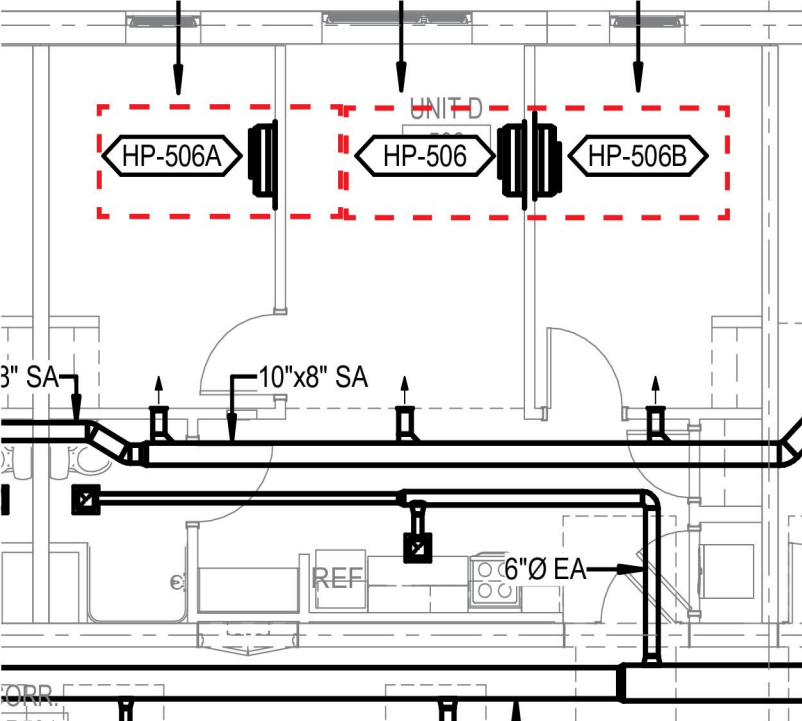
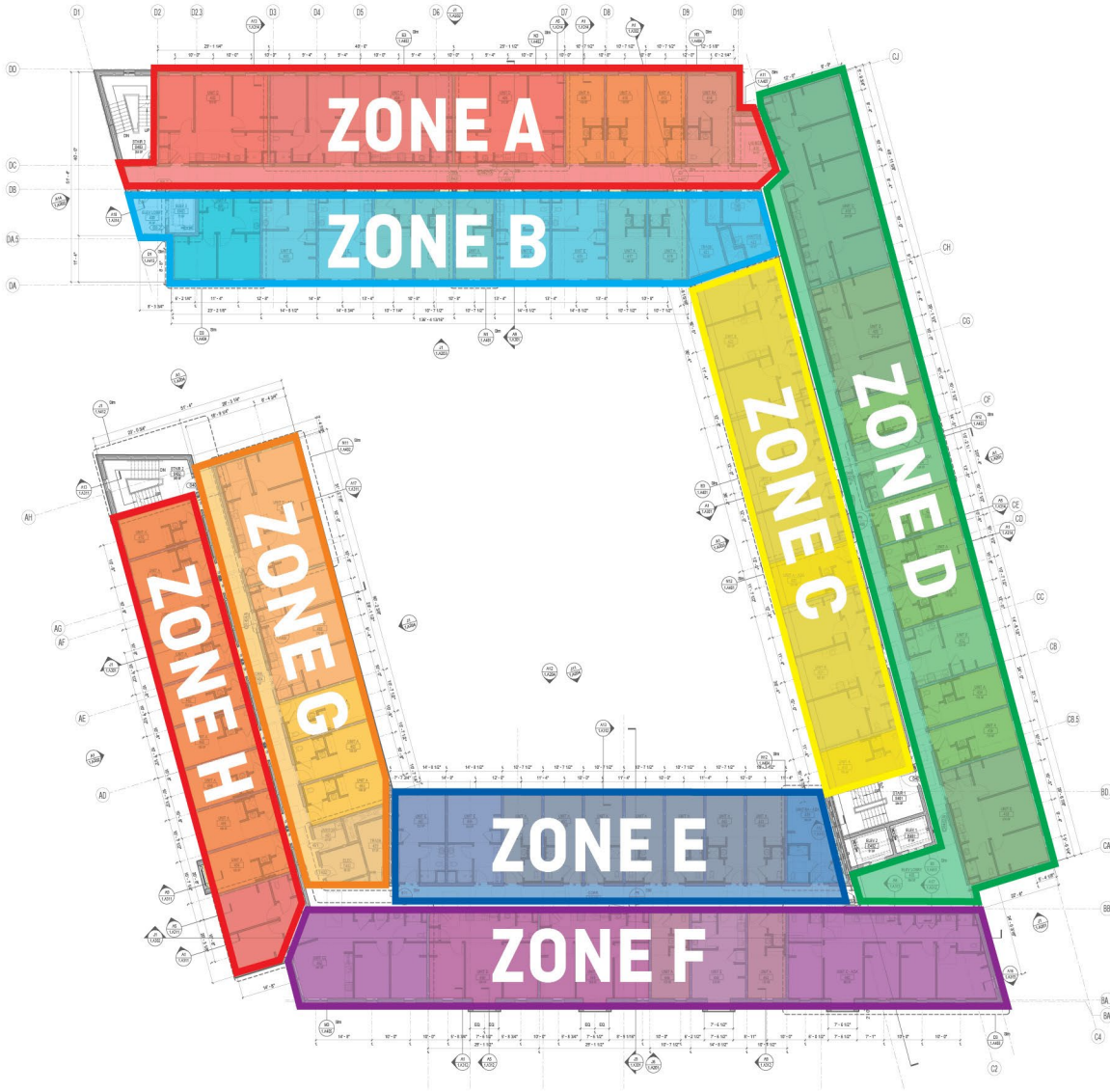
System Challenges

Heating And Cooling:

- VRF heat recovery vs change over
- Ducted vs non-ducted
- Refrigerant line length
- System zoning
- Urban location
- Construction type
- High rise construction



System Zoning



Passive House Certification

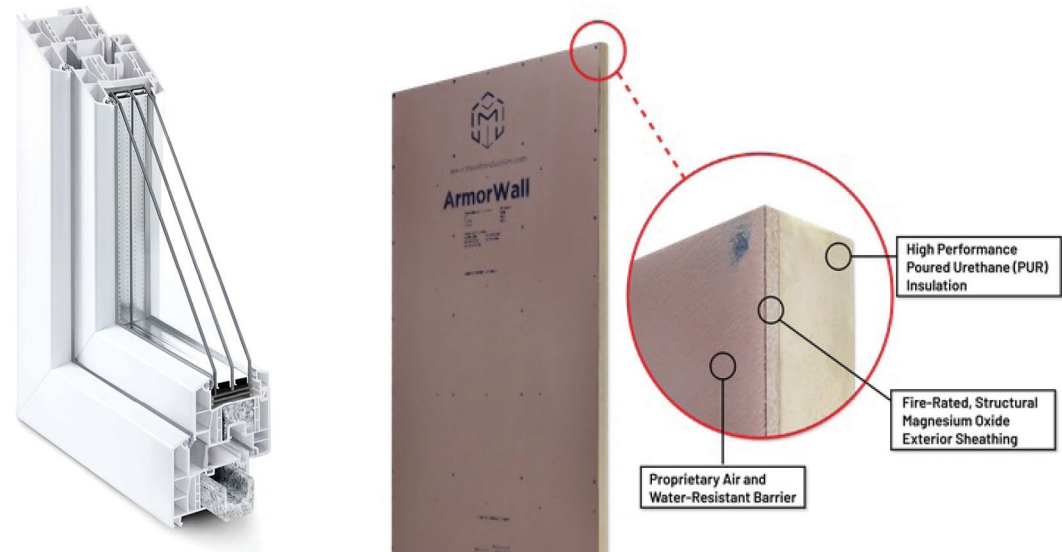
Performance based Standard

Energy modeling provides real-time analysis of design considerations and decisions that relate to building performance and operation.

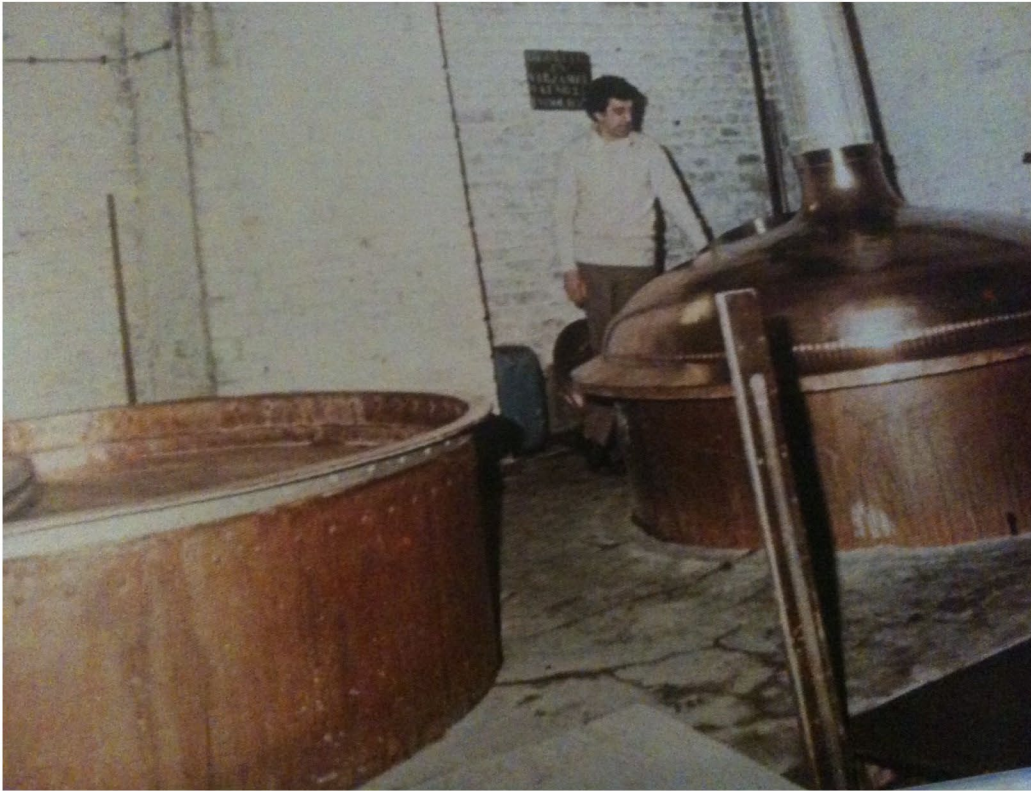
User Comfort

User Comfort is Embedded in performance and additional criteria are built into the modeling that analyze user comfort.

Second Largest Passive House Dormitory in the United States



Allagash Tasting Room



Questions?

Please use notecards available on your table.

How to Participate in the Triennial Plan VI Process

- The Trust seeks preliminary comments from interested parties on Triennial Plan VI implementation strategies, budgets, and metrics.
- See our Request for Information at <https://www.energymaine.com/triennial-plan-vi/>.
- Comments accepted through December 12, 2023.