MI POWER GRID

Making the Most of Michigan's Energy Future

New Technologies and Business Models

Stakeholder Meeting 3:
Heat Pumps for Space & Water Heating

The meeting will begin promptly at 1:00 pm.

February 24, 2021

1PM – 5 PM

MPSC

Michigan Public Service Commission

MI POWER GRID

Making the Most of Michigan's Energy Future

New Technologies and Business Models: Welcome and Overview

Joy Wang

WangJ3@Michigan.gov

Smart Grid Section

Michigan Public Service Commission

MPSC

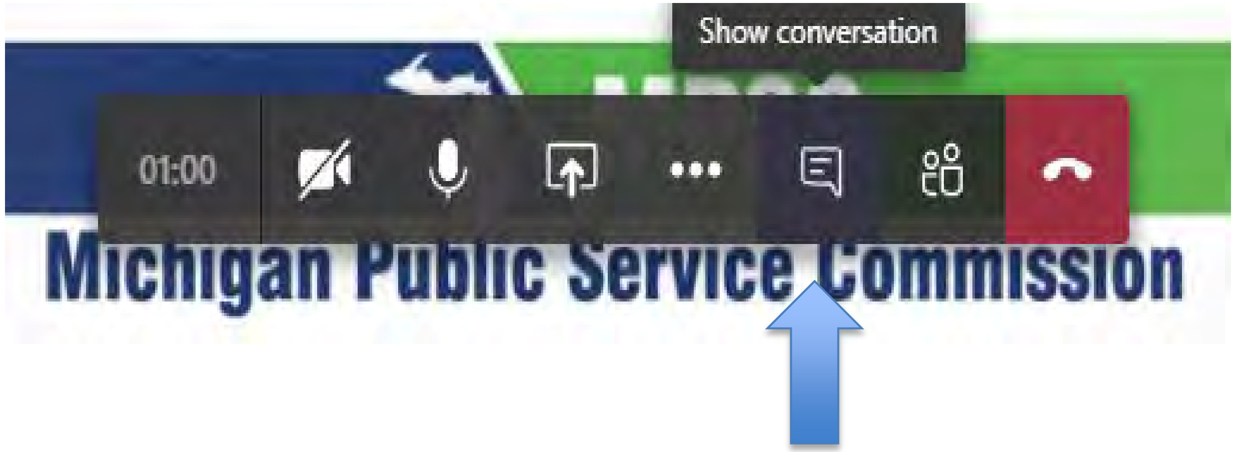
Michigan Public Service Commission

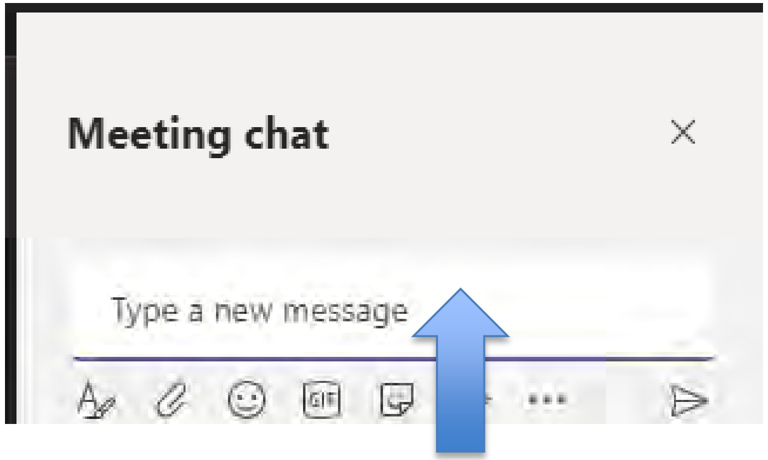
Agenda

1:00 pm	Welcome and Opening Remarks	Joy Wang, MPSC Staff, and Karen Gould, Energy Waste Reduction Section Manager, MPSC
1:05 pm	Heat Pumps, in Michigan?	John (Jack) Mayernik, National Renewable Energy Laboratory
1:40 pm	Regulatory Solutions for Heat Pump Deployment	Sherri Billimoria, RMI
2:15 pm	Break	
2:25 pm	*Panel: Heat Pumps for Space & Water Heating – Learnings, Opportunities, and Barriers* Jose Goncalves, DTE Energy Gregg Holladay, Bradford White Karen Jackson, Ontonagon Village Housing Andrew McNeally, Upper Peninsula Power Company Chris Neme, Energy Futures Group	Moderator: David Walker, MPSC Staff
3:20 pm	Break	
3:25 pm	Heat Pumps: Promising Use Cases, Policy Options, and Michigan Context	Rachel Gold, Marty Kushler, Christopher Perry, American Council for an Energy-Efficient Economy
4:00 pm	Beneficial Electrification of Space and Water Heating: A Perspective from Maine	Ian Burnes, Efficiency Maine
4:20 pm	Cold Climate Air-Source Heat Pumps: Hurry Up, Slowly	David Lis, Northeast Energy Efficiency Partnerships
4:40 pm	Ground Source Heat Pumps: New Opportunities and Barriers to Expansion in the Residential Market	Sinye Tang and Rona Banai, Dandelion Ian Rinehart, the AdHoc Group
4:55 pm	Closing Statements	Joy Wang, MPSC Staff
5:00 pm	Adjourn	

Housekeeping

- This meeting is being recorded
- Recording and slides posted on workgroup website in about a week
- All audience members will be muted
- Please type questions into the chat box
    - To access chat box:





- Staff will ask chat box questions during Q&A

Housekeeping, cont.

- During the meeting, if clarification of your question is needed, we will ask you to unmute.
  - To unmute:
    - Phone: Press *6
    - Teams: Click mic button
  - Please mute yourself again after your clarification.

- Chat box may note when audience members enter/exit.
  - These notices are automatic:

- If you are not a session speaker, please turn off your video.

- If Teams via web browser is not working, try a different web browser.
  - All work except Safari

- Please share your thoughts on the meeting with us by filling out the survey.

MI POWER GRID

Making the Most of Michigan's Energy Future

Opening Remarks

Karen Gould
Manager, Energy Waste Reduction Section
Michigan Public Service Commission

Stakeholder Meeting 3: Space and Water Heating
February 24, 2021

MPSC
Michigan Public Service Commission

Heat Pumps, in Michigan?

John (Jack) Mayernik

Project Manager

Strategic Energy Analysis Center

National Renewable Energy Laboratory

NATIONAL RENEWABLE ENERGY LABORATORY

Heat Pumps, In Michigan?

Jack Mayernik

2/24/2021

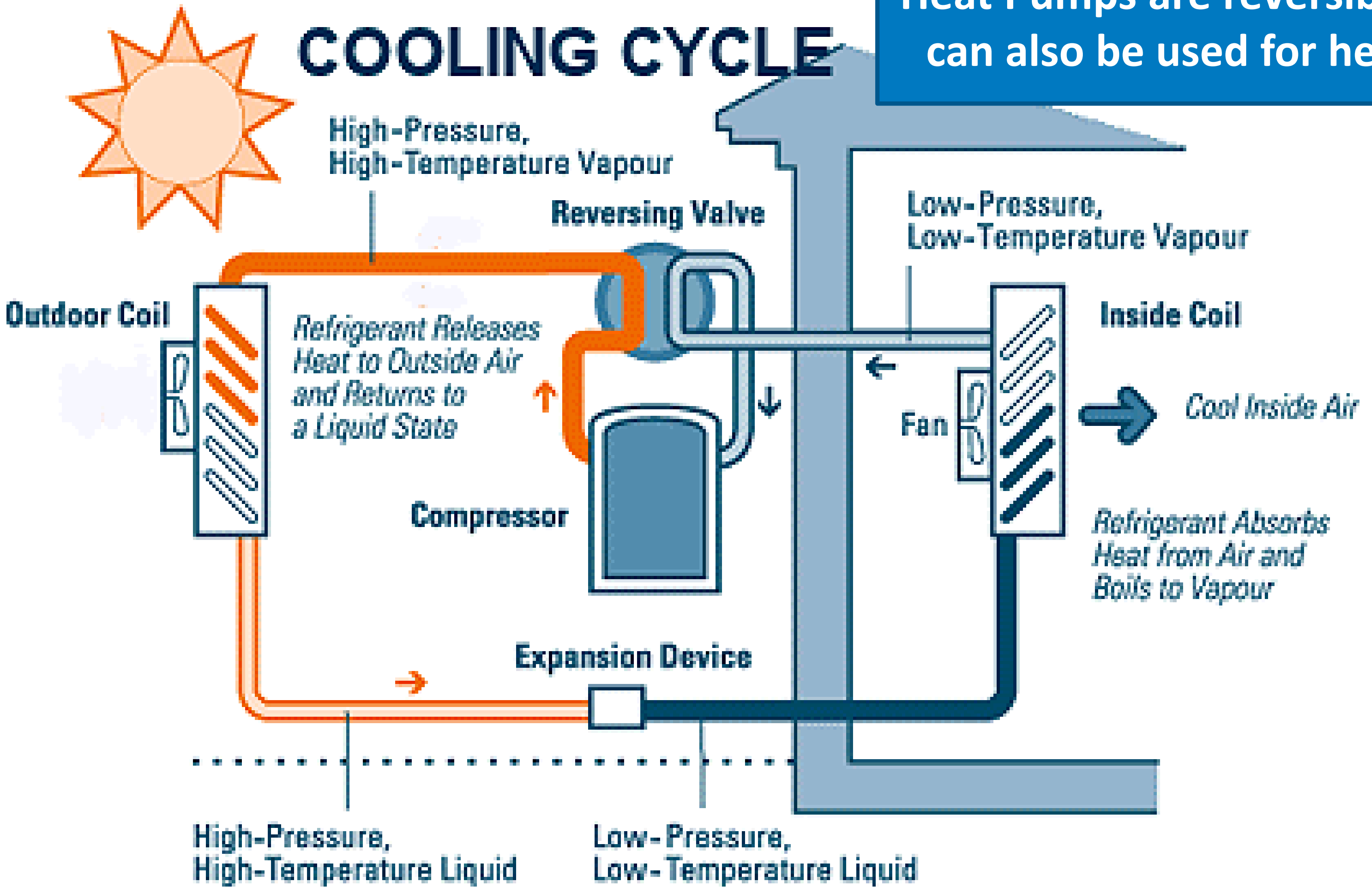
NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Opportunity for Heat-Pumps in Michigan

- What is a Heat-Pump and How Does it Work?
- Just How Efficient are Heat-Pumps?
- Are Heat-Pumps a Good Solution for Michigan?

What is a Heat-Pump?

Heat Pumps are reversible and can also be used for heating



Efficiency

Furnace Efficiencies

	Federal Minimum Standard	Energy Star Specification
Gas Furnace	80% AFUE	90% AFUE
Electric Furnace	78% AFUE	N/A

US DOE: *https://www.ecfr.gov/cgi-bin/text-idx?SID=a9921a66f2b4f66a32ec851916b7b9d9&mc=true&node=se10.3.430_132&rgn=div8*
US EPA: *https://www.energystar.gov/sites/default/files/Furnaces%20Version%204.1_Program%20Requirements.pdf*

Electric Heat Pump Efficiencies

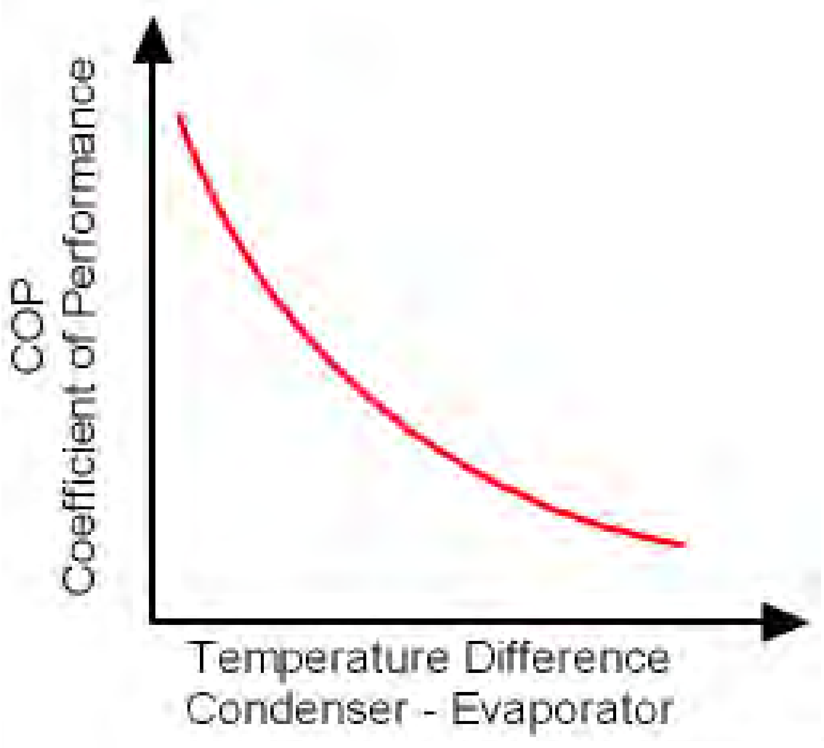
	Basic	Mid-Tier	Top of the Line
Air-Source	~2 SCOP	~3 SCOP	~4 SCOP
Ground-Source	~4 SCOP	~5 SCOP	~6 SCOP

NREL: *https://www.nrel.gov/docs/fy13osti/56393.pdf*
IEA Heat Pump Technologies TCP: *https://heatpumpingtechnologies.org/annex41/*

Direct comparisons require additional analysis about how various pieces of equipment compare to one-another

Performance in Cold Climates

Illustrative Performance Curve



As the temperature difference between interior and exterior temperatures grows the efficiency of heat-pumps declines

Climate

- Regional climatic variations impact performance
- All else equal - greater HDD means that more efficient heating systems will be more cost effective

Michigan – Water ***Winter*** Wonderland

Location	HDD	CDD	Record Low
Detroit	6729	566	-13 deg.
Traverse City	7794	458	-33 deg.
US Average	4126	1459	N/A

US EPA: https://portfoliomanager.energystar.gov/pm/degreeDaysCalculator

Heating Degree Days (HDD) are a measure of how cold a location is over a period of time relative to a base temperature, most commonly specified as 65 degrees Fahrenheit. The measure is computed for each day by subtracting the average of the day's high and low temperatures from the base temperature (65 degrees), with negative values set equal to zero. Each day's heating degree days are summed to create a heating degree day measure for a specified reference period. Heating degree days are used in energy analysis as an indicator of space heating energy requirements or use.
(*US DOE, Energy Information Administration*)

Cold Climate Heat-Pumps

- Equipment is commercially available that meets the needs of specific climates (e.g. cold-climates)
- Cold-Climate Heat Pumps experience lower levels of efficiency degradation at low outdoor temperatures
- Many heat-pumps have secondary heat sources that turn on when the heat-pump can't maintain a constant indoor air temperature.

The efficiency of the building envelope cannot be ignored – especially in cold climates

Three Resources to Better Understand CCHP:

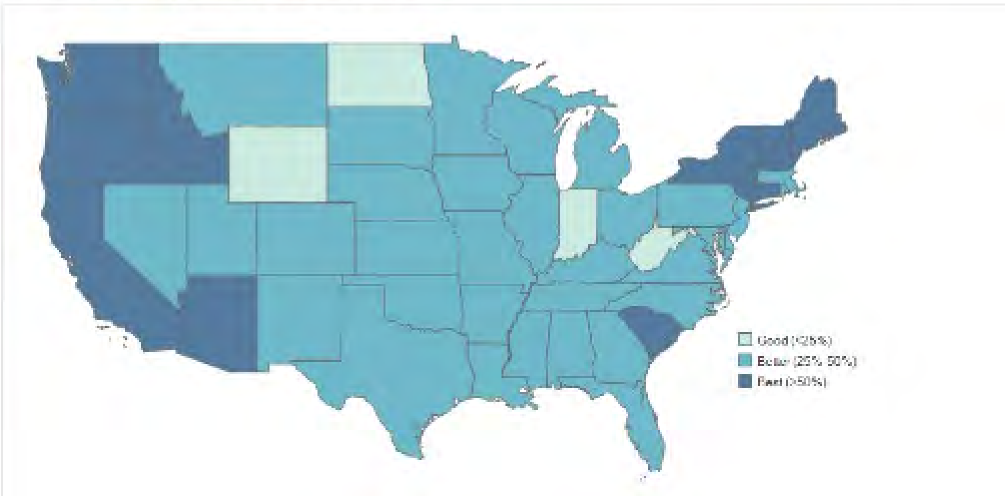
US DOE: *Cold-Climate Heat Pumps Using Tandem Compressors*

IEA: *Cold Climate Heat Pumps: US Country Report*

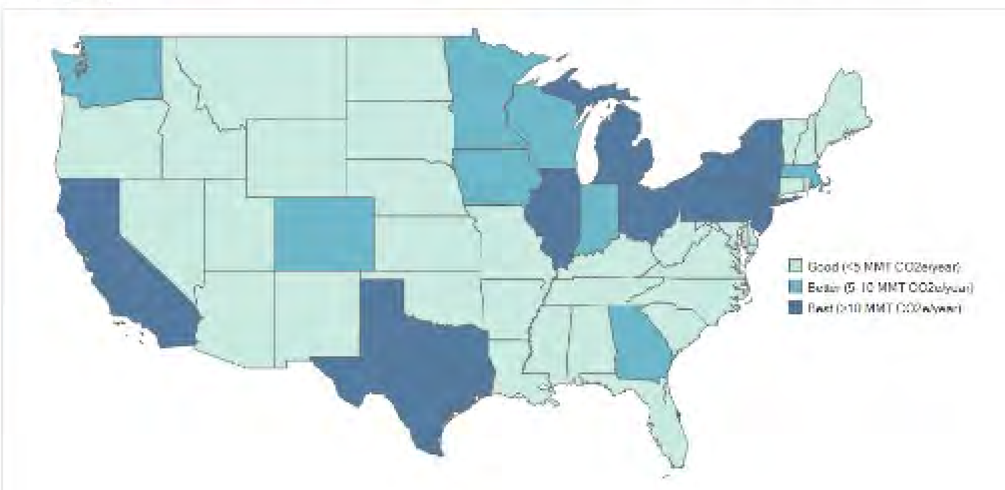
NREL: *Field Performance of Inverter-Drive Heat Pumps in Cold Climates*

Emissions

Average Household Reduction in GHG Emissions From Replacing Gas Water and Space Heating with Electric Heat Pumps Over the Life of the Appliance



Annual Statewide Emissions Reductions from Electrifying Gas Water and Space Heating in 2030 (MMT CO2e/year)



The typical household would be able to reduce emissions from heating and water-heating by 25-50%

Michigan shows great state-wide potential for emission reductions from transitioning to electric heat-pumps

Sierra Club: https://www.sierraclub.org/articles/2020/04/new-analysis-heat-pumps-slow-climate-change-every-corner-country

Energy Costs

Electricity Prices - 2019

	Commercial (cents/kWh)	**Residential** (cents/kWh)
Michigan Average	11.39	15.74
US Average	10.68	13.01

US DOE: https://www.eia.gov/electricity/sales_revenue_price/pdf/table4.pdf

Higher electricity costs in Michigan mean that consumers will *benefit more* from energy efficient options

When comparing electric heat-pumps to natural gas furnaces differences in fuel cost also need to be accounted for.

Cost Effectiveness in Cold Climates

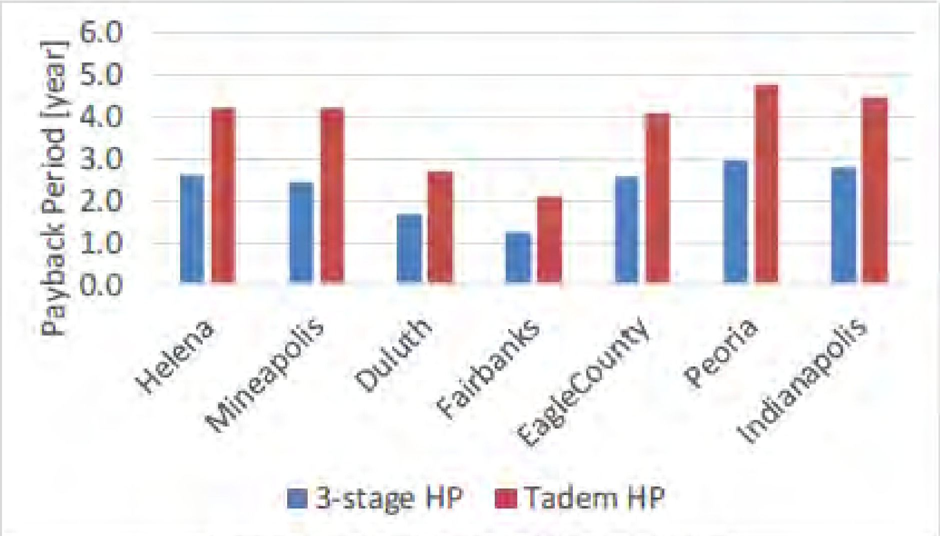


Figure 2: Payback periods of the two CCHPs

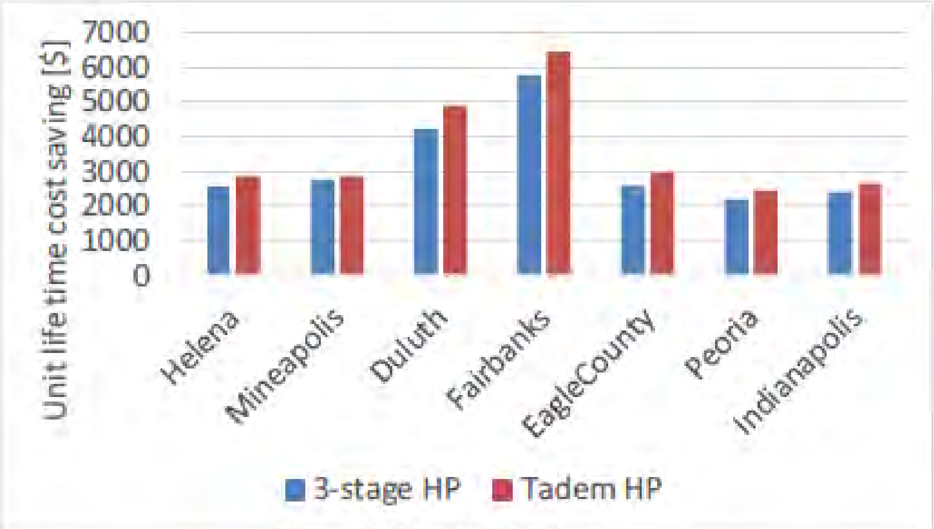


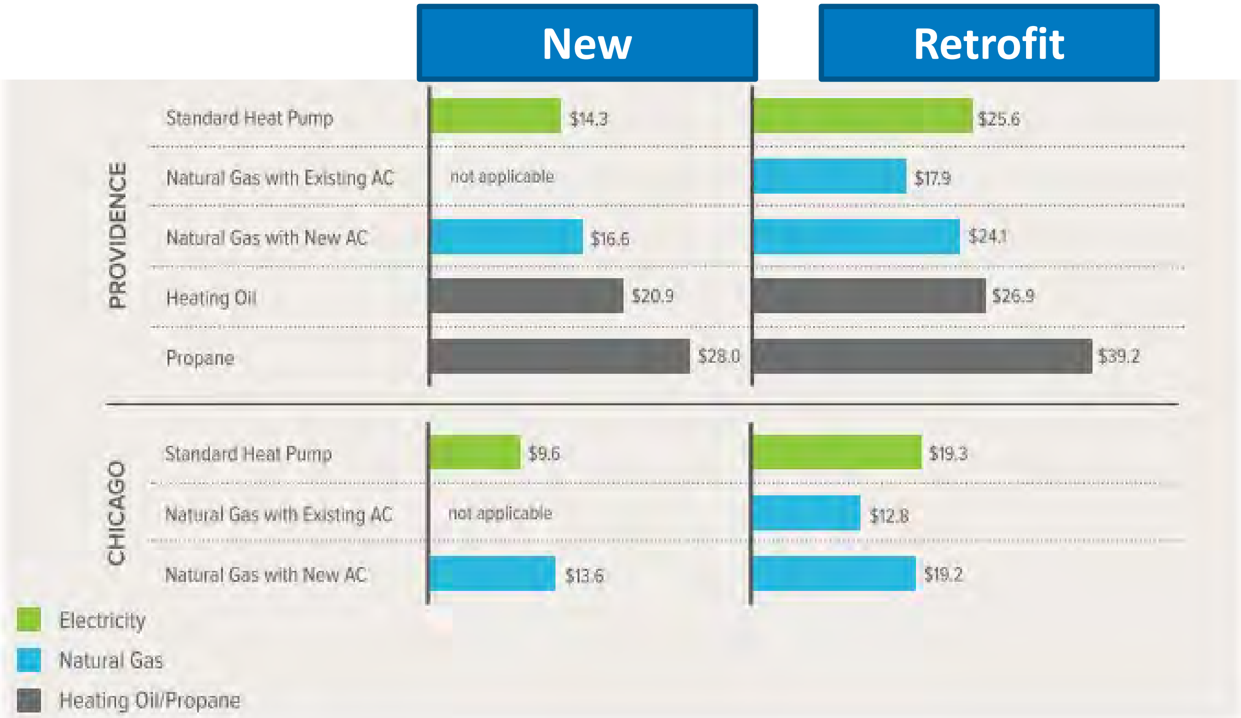
Figure 3: Life cycle cost savings

Assuming average utility rates (13-cents per kWh), these two approaches pay for themselves in under 5-years in analyzed locations

Compared to a typical heat-pump these two approaches offer significant cost savings

ORNL: https://info.ornl.gov/sites/publications/Files/Pub125738.pdf

Cost Effectiveness - New vs. Existing



RMI: https://rmi.org/wp-content/uploads/2018/06/RMI_Economics_of_Electrifying_Buildings_2018.pdf

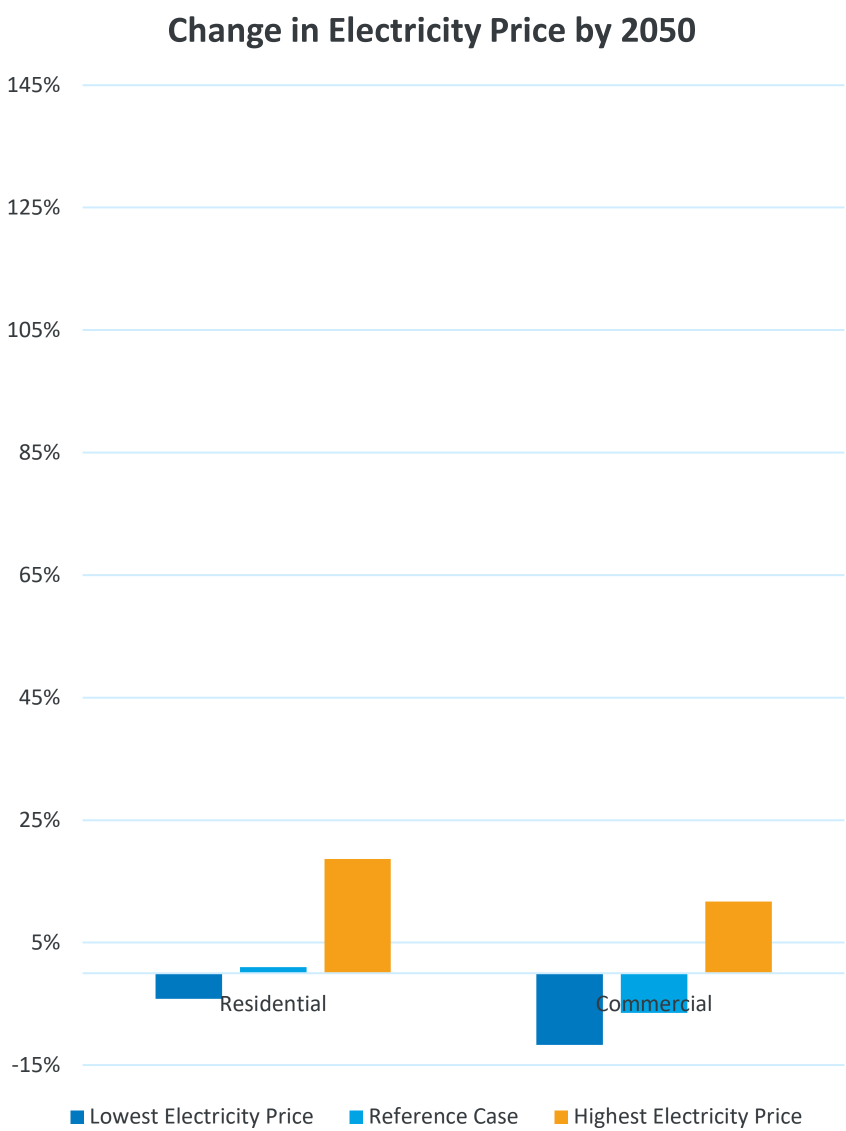
Climate Comparison

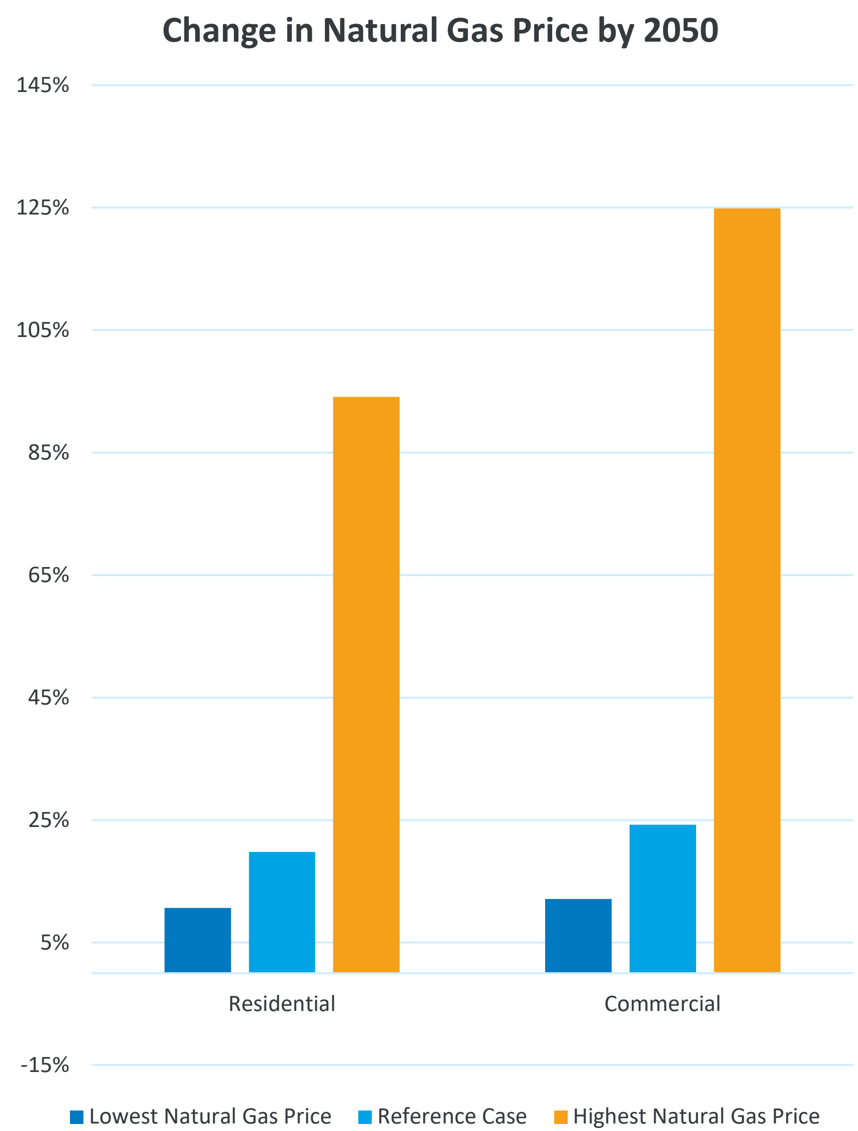
Location	HDD	CDD
Detroit	6729	566
Traverse City	7794	458
Providence	**5427**	**795**
Chicago	**6198**	**909**
US Average	4126	1459

US EPA: https://portfoliomanager.energystar.gov/pm/degreeDaysCalculator

All electric systems are likely to be cost effective in new construction and may be cost effective for select retrofits, because of the capital cost savings of having to only install one system.

Future Cost of Energy





US DOE: https://www.eia.gov/outlooks/aeo/data/browser/

Thank You

Contact Information:
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www.nrel.gov

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Regulatory Solutions for Heat Pump Deployment

Sherri Billimoria

Manager, Carbon-Free Buildings

RMI

ENERGY. TRANSFORMED.

Regulatory Solutions for Heat Pump Deployment

Sherri Billimoria

February 25, 2021

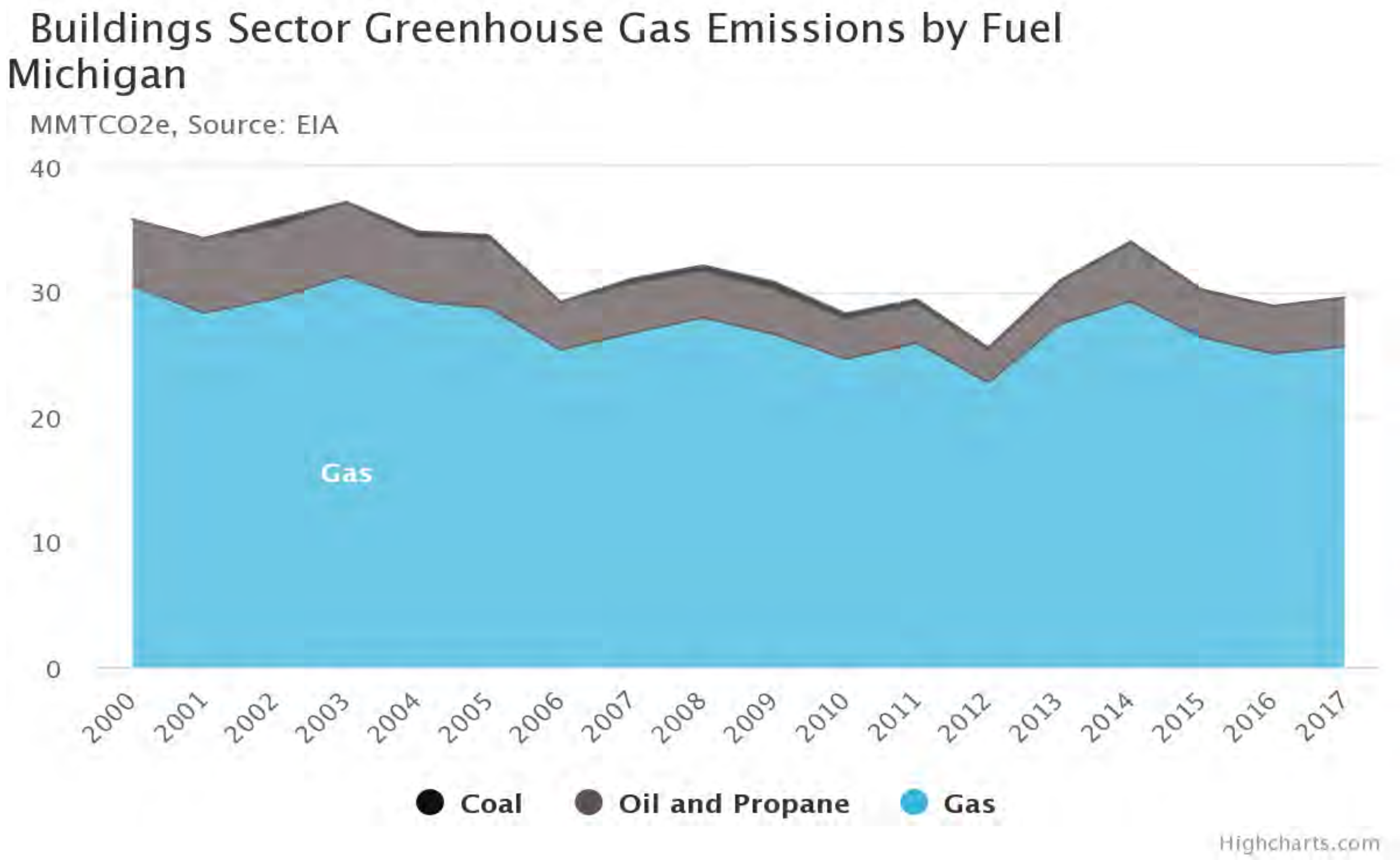
Contents

Contents

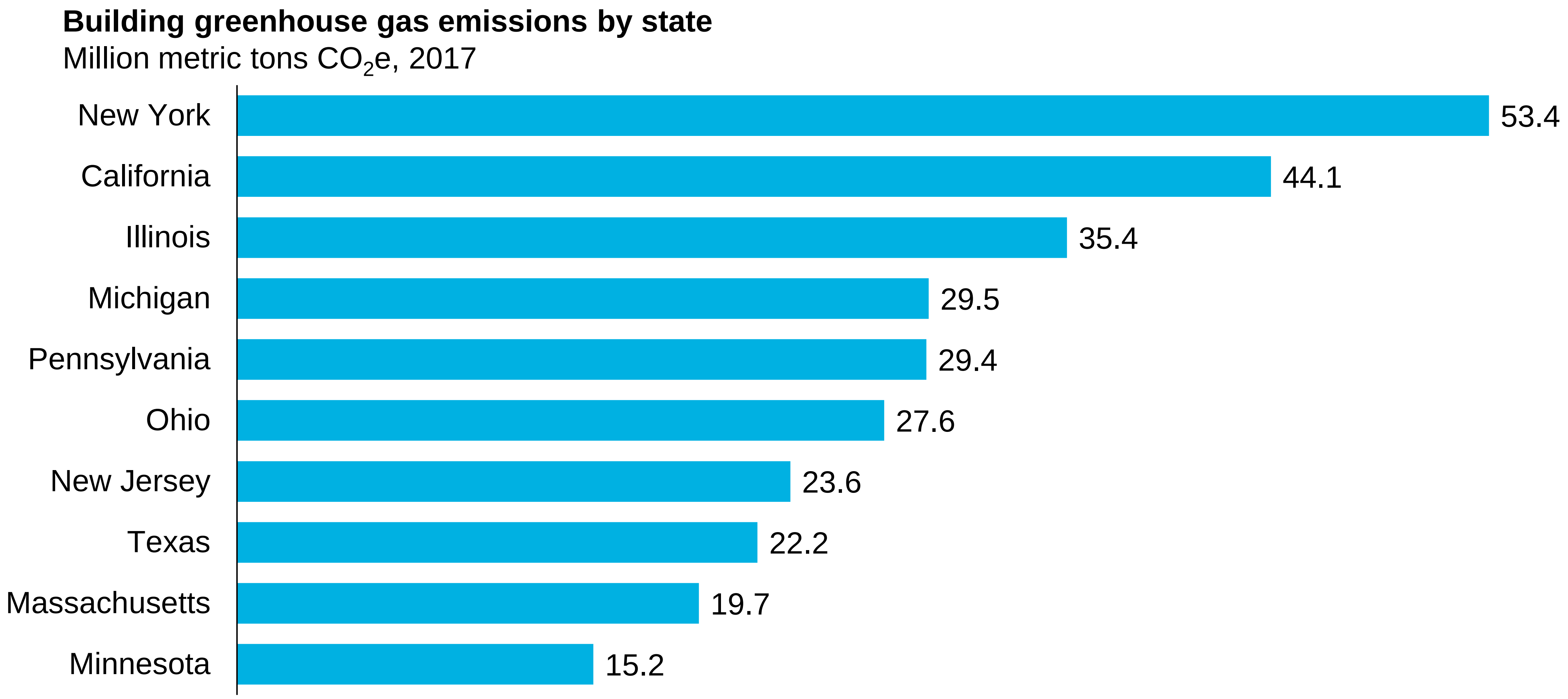
- Need to decarbonize buildings
- Overview of heat pumps
- How regulation can help

Direct fossil fuel combustion in buildings account for almost 20% of Michigan's energy emissions

In Michigan, most of these emissions come from burning gas

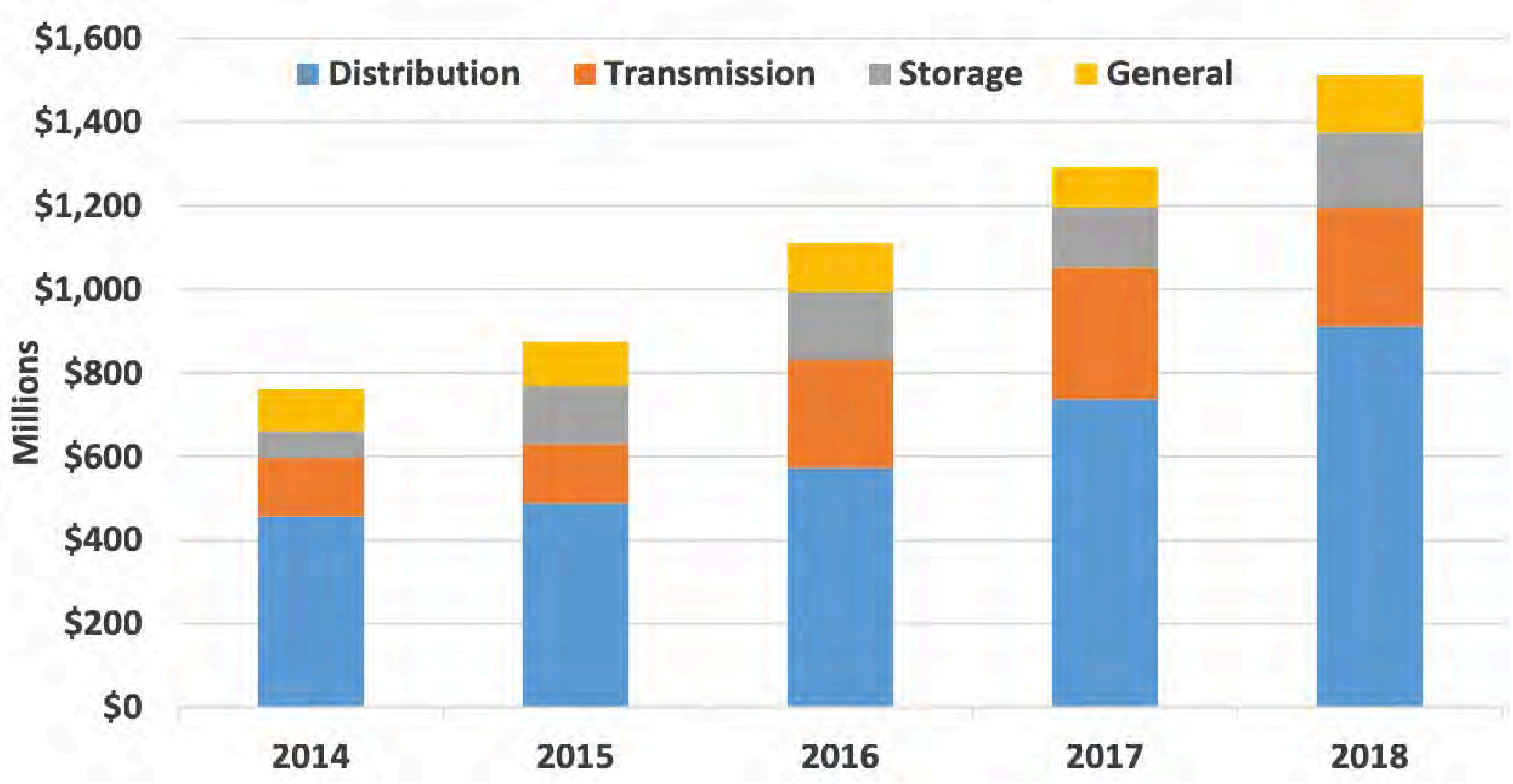


10 states are responsible for 56% of US direct building emissions; Michigan is the 4th largest contributor



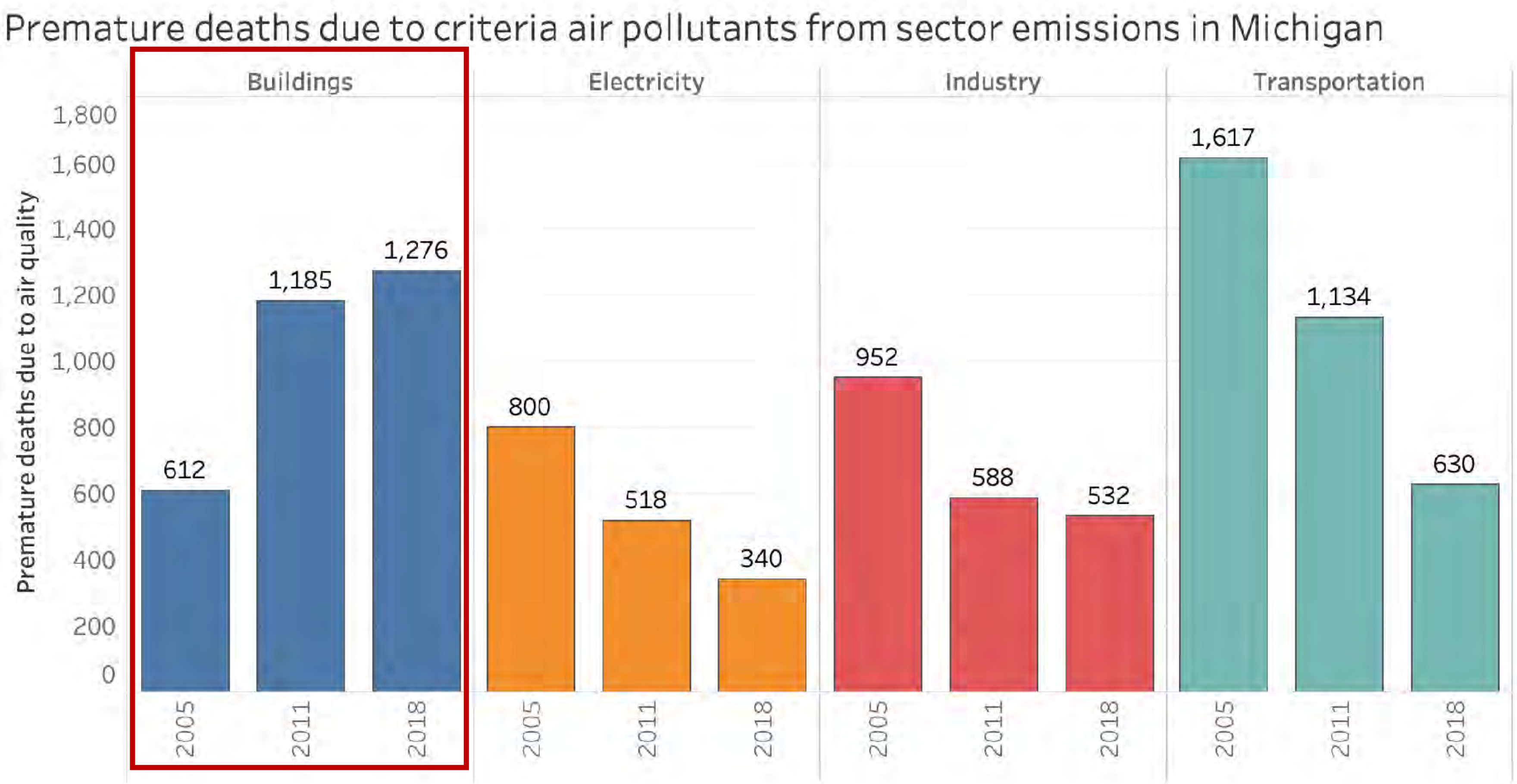
Capital expenditures in gas infrastructure have increased over time

Michigan Historic Gas Infrastructure Capital Expenditures



Fossil fuels infrastructure with a **50+ year payback** is financed by customers.

Buildings are the highest contributor of Michigan's premature deaths due to outdoor air pollution



Data source: State and sector-level premature mortality data from Dedoussi, I.C., Eastham, S.D., Monier, E. et al. Premature mortality related to United States cross-state airpollution. Nature 578, 261–265 (2020).https://doi.org/10.1038/s41586-020-1983-8

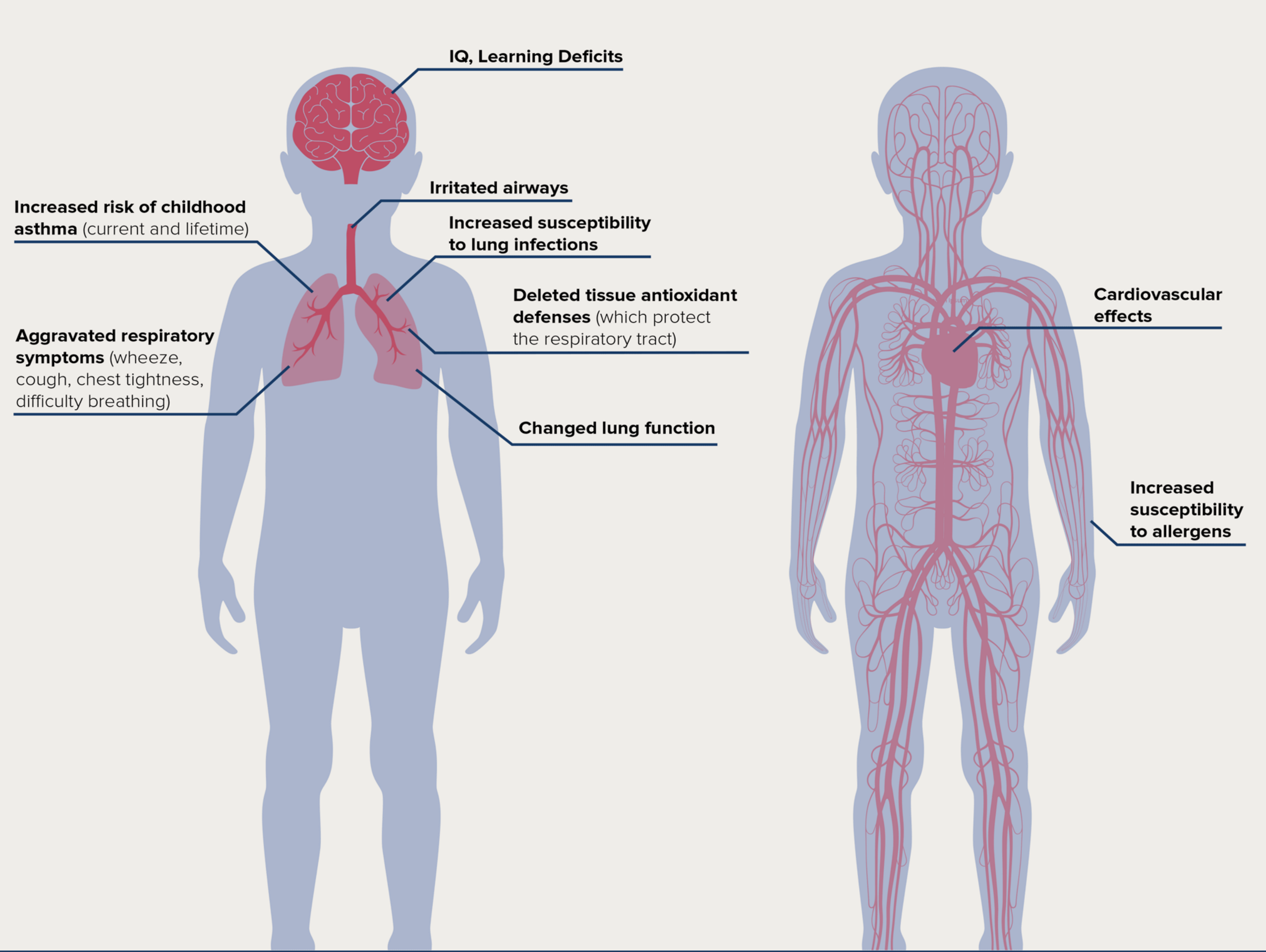
NO_2 Health Impact

Homes with gas stoves have **50 - 400% higher NO_2 emissions** than homes with electric stoves. People with lower income and people of color often face higher exposure

In 2016, the EPA found a causal relationship between exposure to NO_2 and respiratory health effects, such as **asthma**

Residents living in counties with higher levels of long-term NO_2 were **more likely to die from COVID-19**

Health Effects of NO_2 in Children



rmi.org/gas-stoves-pollution-health

Contents

- Need to decarbonize buildings
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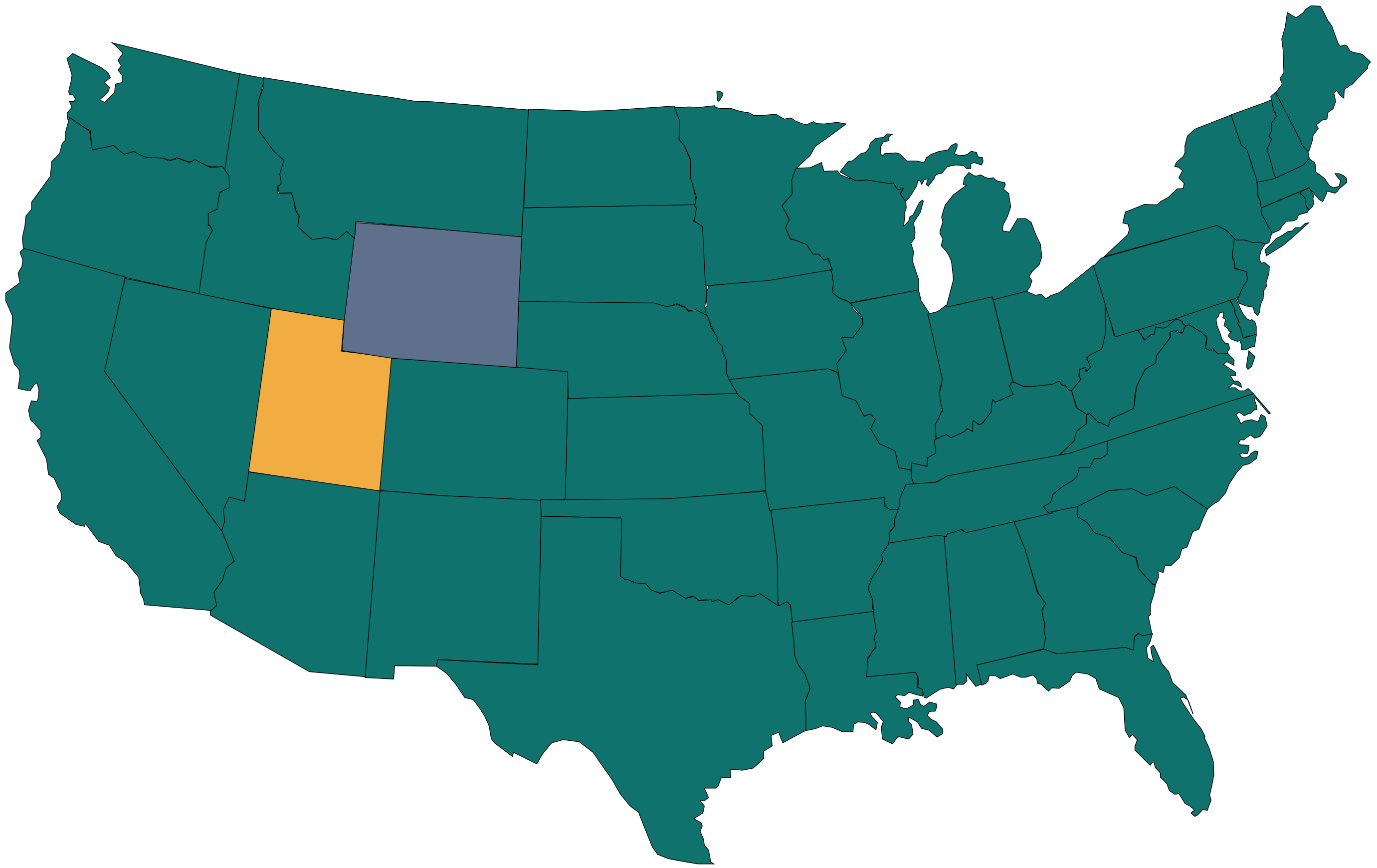
For 99% of US households, heat pumps will save emissions compared to gas alternative over its lifetime

- Heat pumps deliver two to four times more heating energy than the electricity they consume
- When compared to fuel oil, there is no question that heat pumps are cleaner source of heat

Emissions Impact by State: Heat Pumps vs. Gas Furnace



- New heat pumps reduce carbon emissions vs. gas furnace
- Pending policy may change outcome
- New heat pump doesn't currently reduce emissions vs. gas

Source: https://rmi.org/its-time-to-incentivize-residential-heat-pumps/

Yes, heat pumps work in cold climates.

- **Ground and water source heat pumps** function well without much reduction in efficiency in extreme temperatures
- Today modern air-source heat pumps work without back up to **-15F**
- Electric resistance or existing fossil fuel infrastructure can be used for backup heating – some heat pump programs leave existing **fossil fuel infrastructure** as back up source of heating, but **electric resistance** heating is also effective.
- Maine has a goal of installing 100,000 heat pumps, and many of these are being used for **whole-home heating.**
- There is concern over winter peaking – in a highly electrified future, the electric grid could be strained during the coldest days of the year. Although not an immediate concern, key mitigating strategies include **weatherization and demand response programs.**

Yes, heat pumps can be cost-effective.

Heat pumps can be cost-effective for new construction and in some retrofit cases.

- New construction
- Electric resistance
- Delivered fuels
- Avoided gas infrastructure
- Avoided costs of health and emission impacts

Contents

- Need to decarbonize buildings
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Utility regulation – both gas and electric – can either support or hinder building decarbonization.

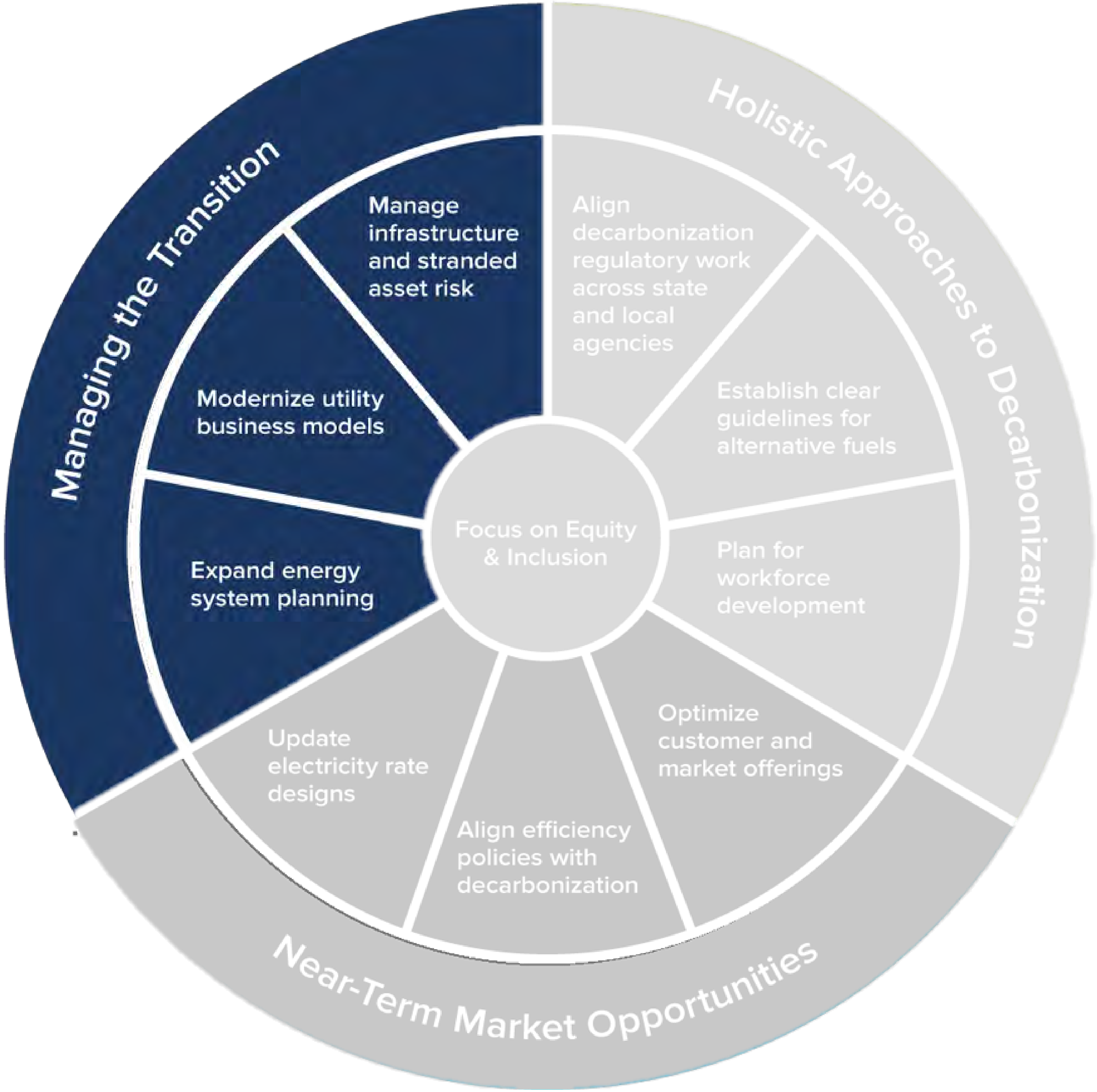
Framing what's needed

Focus on Equity & Inclusion

Holistic Approaches to Decarbonization

Near-Term Market Opportunities

Managing the Transition



Modernize utility business models

Pathways for Gas Utilities in a Carbon-Free Future

PATH 1 TRANSFORMATION

Gas utilities transform their business models to thrive in a carbon-free future with new offerings.

PATH 2 MANAGED TRANSITION

Gas system winds down as energy shifts to electricity; new earnings opportunities for gas utilities to manage an effective transition; workers supported with transition plan and secure benefits.

DEAD-END PATHS

PATH 3 Failure to mitigate climate change. Failure to mitigate climate change. Continued widespread gas use contributes to unsustainable emissions and climate change well in excess of manageable levels.

PATH 4 Gas utility death spiral. Gas utility death spiral. Customers defect from the gas system, raising prices, straining the utility business, challenging customer affordability, and leaving employees unsupported.

PATH 5 Overreliance on RNG. Utilities pursue RNG to maintain today's business model, leading to either path 3 (because available RNG is insufficient to eliminate emissions) or path 4 (because high-cost RNG spurs more electrification).

Thank you!

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Making the Most of Michigan's Energy Future

New Technologies and Business Models

Break: 2:15 – 2:25 PM

Stakeholder Meeting 3: Heat Pumps for Space and Water Heating

February 24, 2021

MPSC

Michigan Public Service Commission

Panel: Heat Pumps for Space & Water Heating – Learnings, Opportunities, and Barriers

Moderator

David Walker
EWR Staff
MPSC

Jose Goncalves
EWR Program Principal
Marketing Supervisor, DTE Energy

Gregg Holladay
Business Development Manager
Bradford White Water Heaters

Karen Jackson
Executive Director
Ontonagon Village Housing

Andrew McNeally
Energy Efficiency Program Administrator
Upper Peninsula Power Company

Chris Neme
Co-founder and Principal
Energy Futures Group

MI POWER GRID

Making the Most of Michigan's Energy Future

New Technologies and Business Models

Break: 3:20 – 3:25 PM

Stakeholder Meeting 3: Heat Pumps for Space and Water Heating

February 24, 2021

Heat Pumps: Promising Use Cases, Policy Options, and Michigan Context

Christopher Perry
Research Manager, Buildings Program
ACEEE

Rachel Gold
Director, Utilities Program
ACEEE

Martin Kushler
Senior Fellow
ACEEE

Heat Pumps:

Promising Use Cases, Policy Options, and Michigan Context

American Council for an Energy-Efficient Economy

Chris Perry, Buildings Research Manager

Rachel Gold, Utilities Director

Marty Kushler, Senior Fellow

February 24, 2021

ACEEE American Council for an Energy-Efficient Economy

Agenda

Electrification Use Cases

Policy Options to Scale Electrification Alongside Energy Efficiency

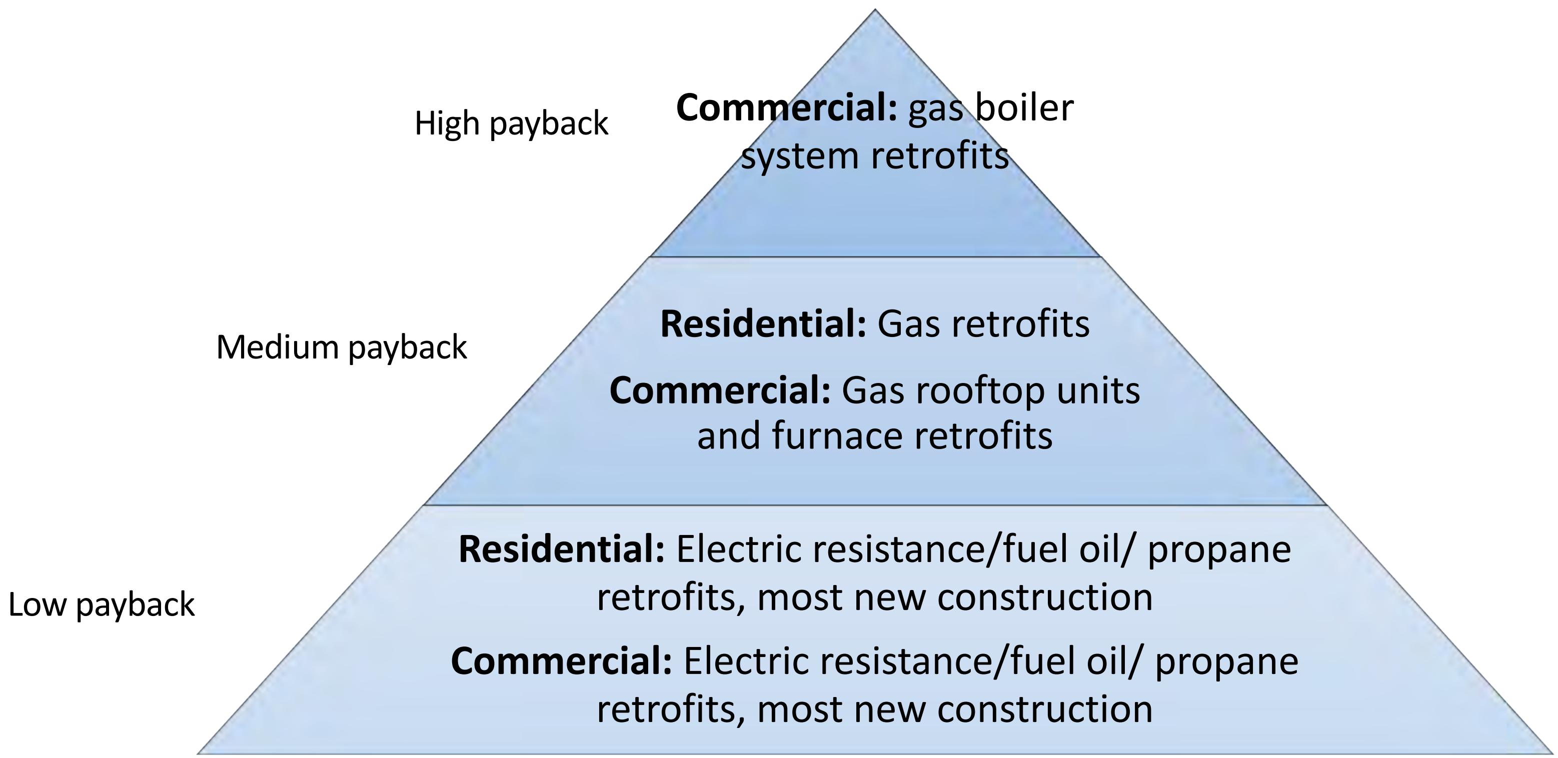
Application to Michigan's Policy Context

Electrifcation Use Cases

Chris Perry, Research Manager

ACEEE
American Council for an Energy-Efficient Economy

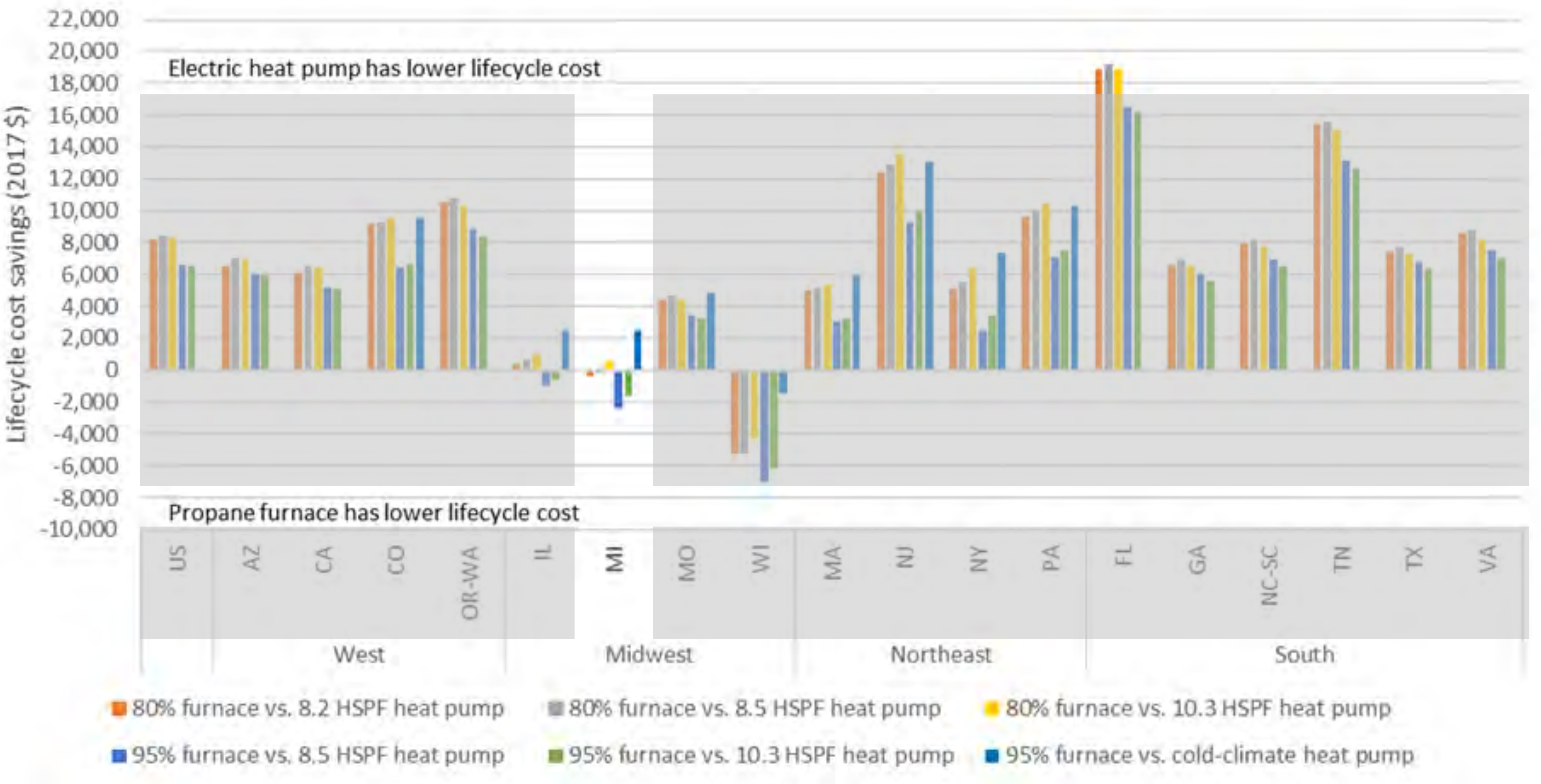
ACEEE's rough space heating electrification cost-effectiveness hierarchy*



**Each building is unique.* *This hierarchy represents a generalization of cost-effectiveness findings for electrifying building space heating systems, and does not account for unique variables including climate, operating hours, rates, incentives, and others.*

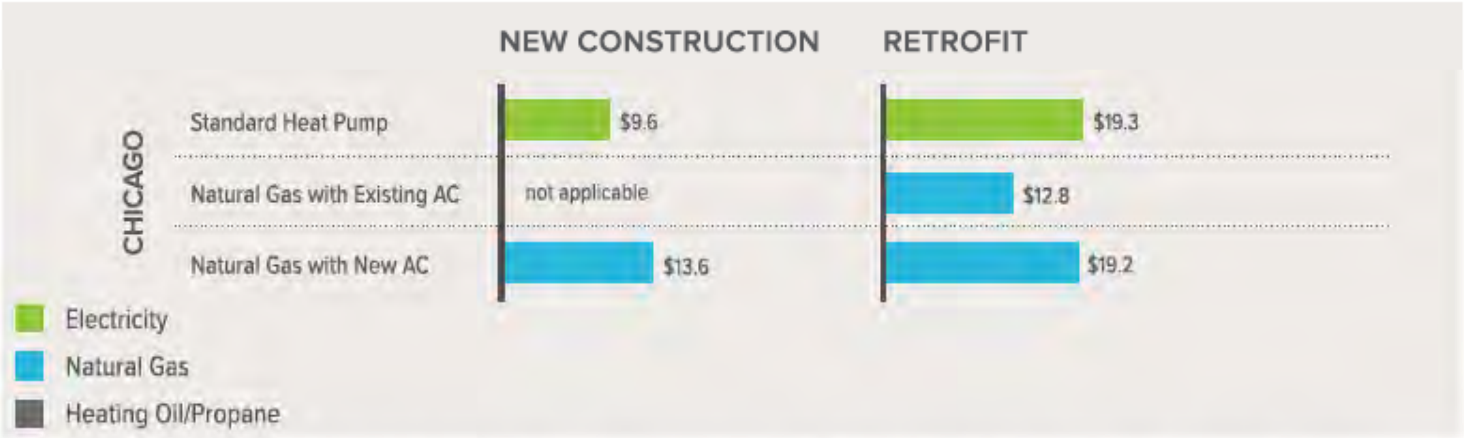
ACEEE American Council for an Energy-Efficient Economy

Without incentives, we found **residential** propane to heat pump retrofits to be cost effective in some cases.



Lifecycle Cost Savings from Converting a Propane Furnace to a Heat Pump

RMI found that **residential** gas to heat pump retrofits were cost effective in new construction and roughly equal in retrofits.



COMPARISONS OF 15-YEAR NET PRESENT COSTS OF WATER HEATING AND SPACE CONDITIONING (THOUSAND $)

Note: *Chicago was the city evaluated in the report closest to Michigan's climate*

rmi.org/insight/the-economics-of-electrifying-buildings/

The right policies can greatly improve the economics of **commercial** space heating electrification, even in cold climates.

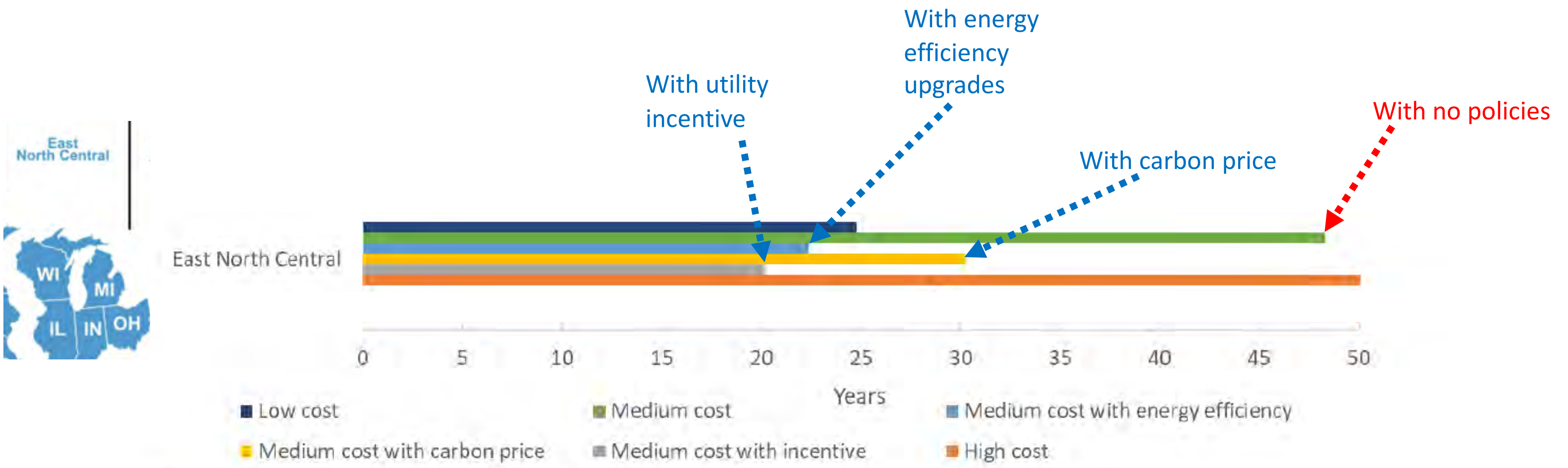
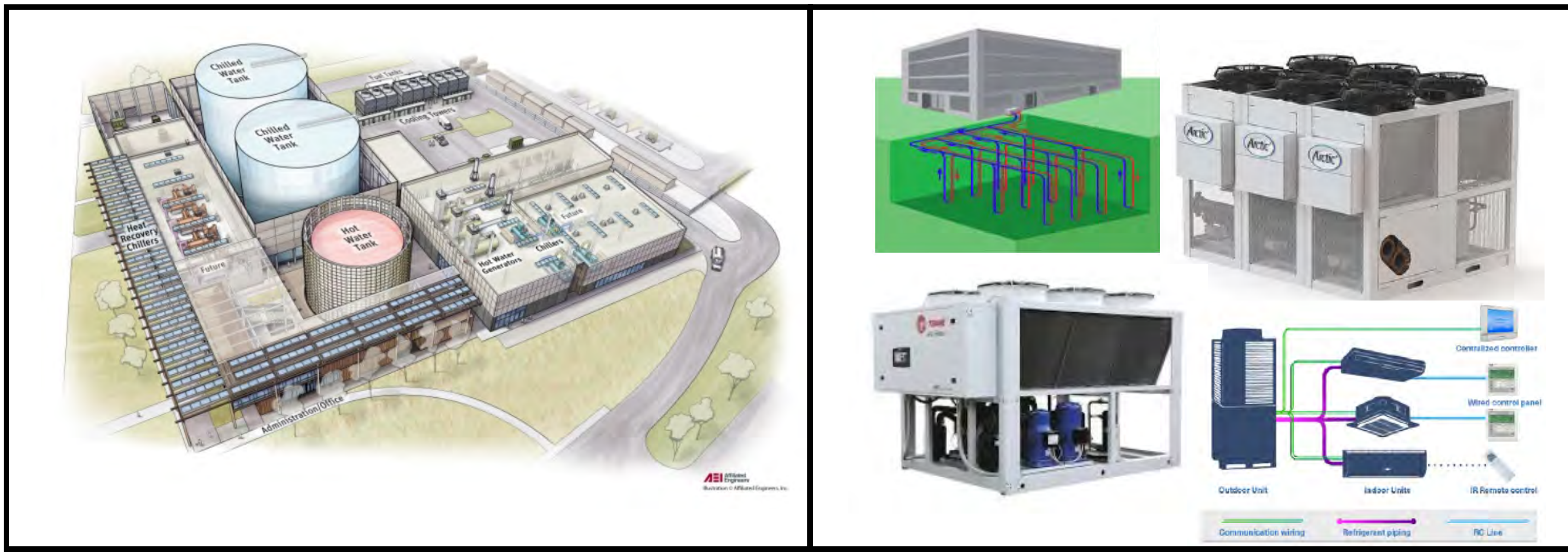


Figure 21. Median simple payback period by region for different scenarios for RTUs

ACEEE American Council for an Energy-Efficient Economy

www.aceee.org/research-report/b2004

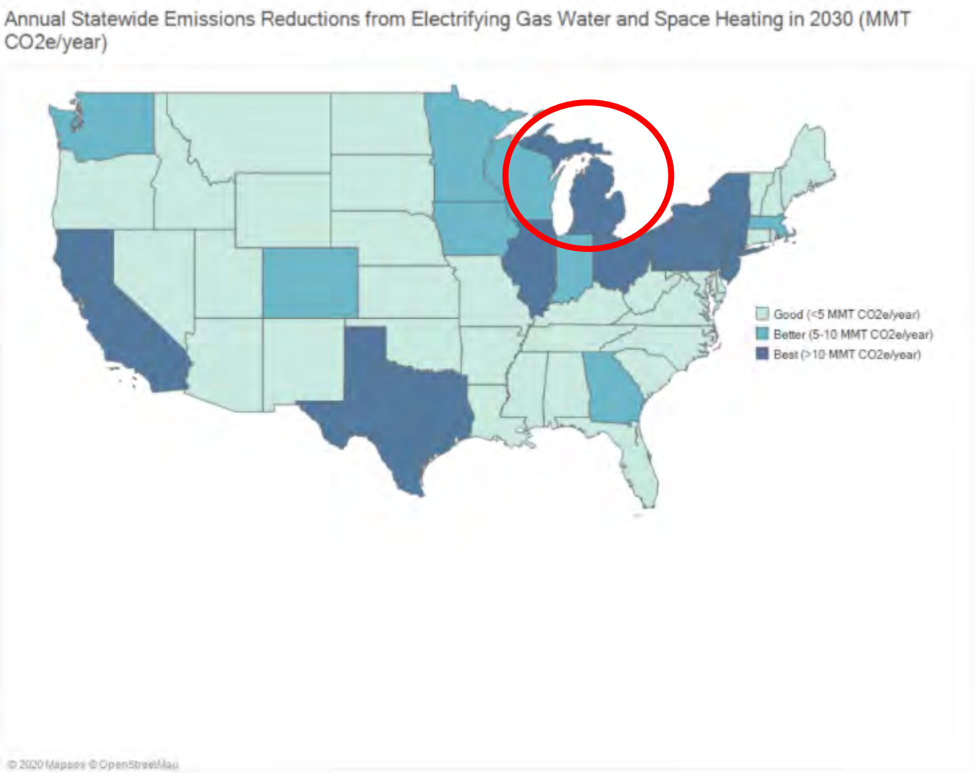
The biggest challenge in space heating is retrofitting large, complex commercial buildings.



Stanford electrified part of its campus using a combination of heat recovery chillers and large-scale thermal storage (**left**), many technologies may be used to electrify space heating including ground-source heat pumps, modular chillers, multi-pipe heat pumps, and variable refrigerant flow (VRF) systems (**right**).

sustainable.stanford.edu/sites/default/files/documents/Stanford_SESI_General_Information_Brochure.pdf, www.aceee.org/research-report/b2004

Heat pump water heaters use about half as much energy as electric resistance water heaters. Carbon reduction and grid connectivity are the main drivers for switching from gas to HPWHs.



Heat pump water heaters can also shift and shed load for utilities, which benefit the grid and consumers' energy bills.

ACEEE American Council for an Energy-Efficient Economy

www.sierraclub.org/articles/2020/04/new-analysis-heat-pumps-slow-climate-change-every-corner-country

Policy Options to Scale Electrification Alongside Energy Efficiency

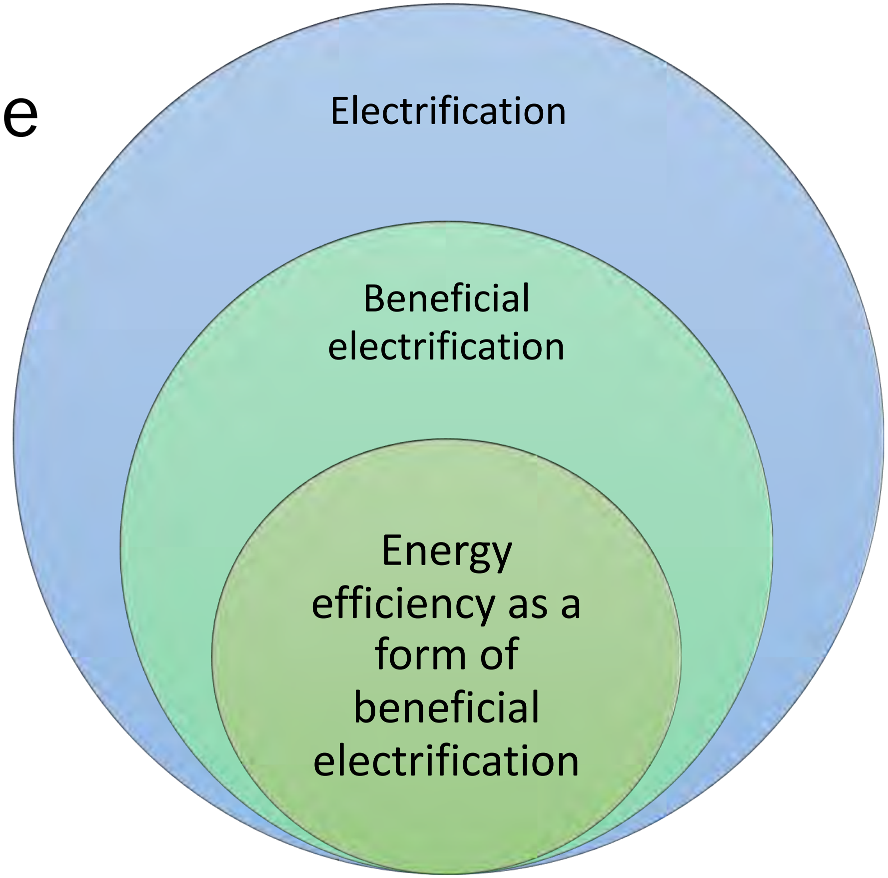
Rachel Gold, Utilities Director

ACEEE
American Council for an Energy-Efficient Economy

ACEEE's perspective: beneficial electrification (BE) is a form of energy efficiency when it meets three criteria:

1. Saves total energy in source Btu's
2. Saves consumers money
3. Reduces emissions

BE often means shifting to energy-efficient technologies, e.g. electric vehicles (EVs) and high-efficiency heat pumps



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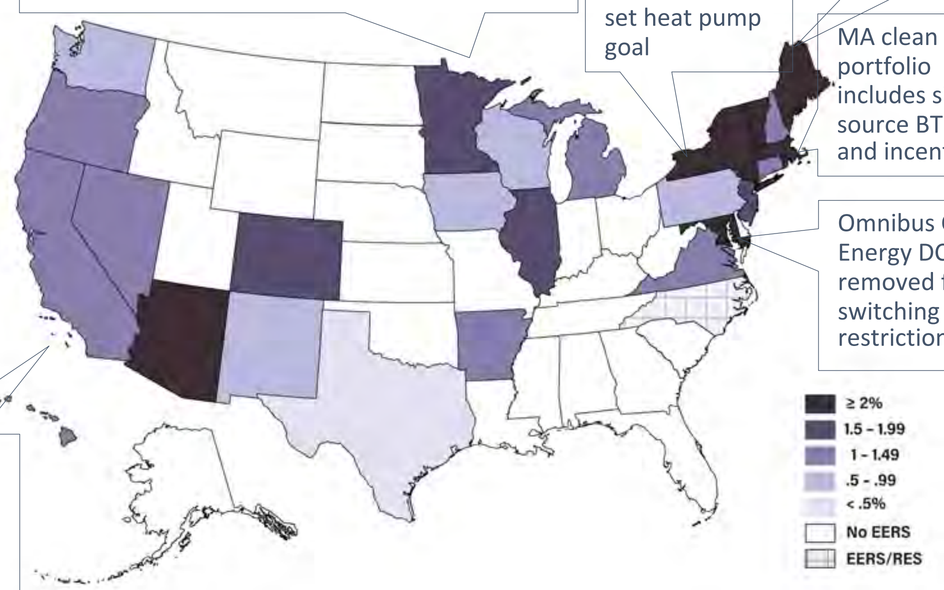
Emerging state policy tools for bringing beneficial electrification into energy efficiency programs

EERS have begun to evolve to enable both energy efficiency and electrification to scale

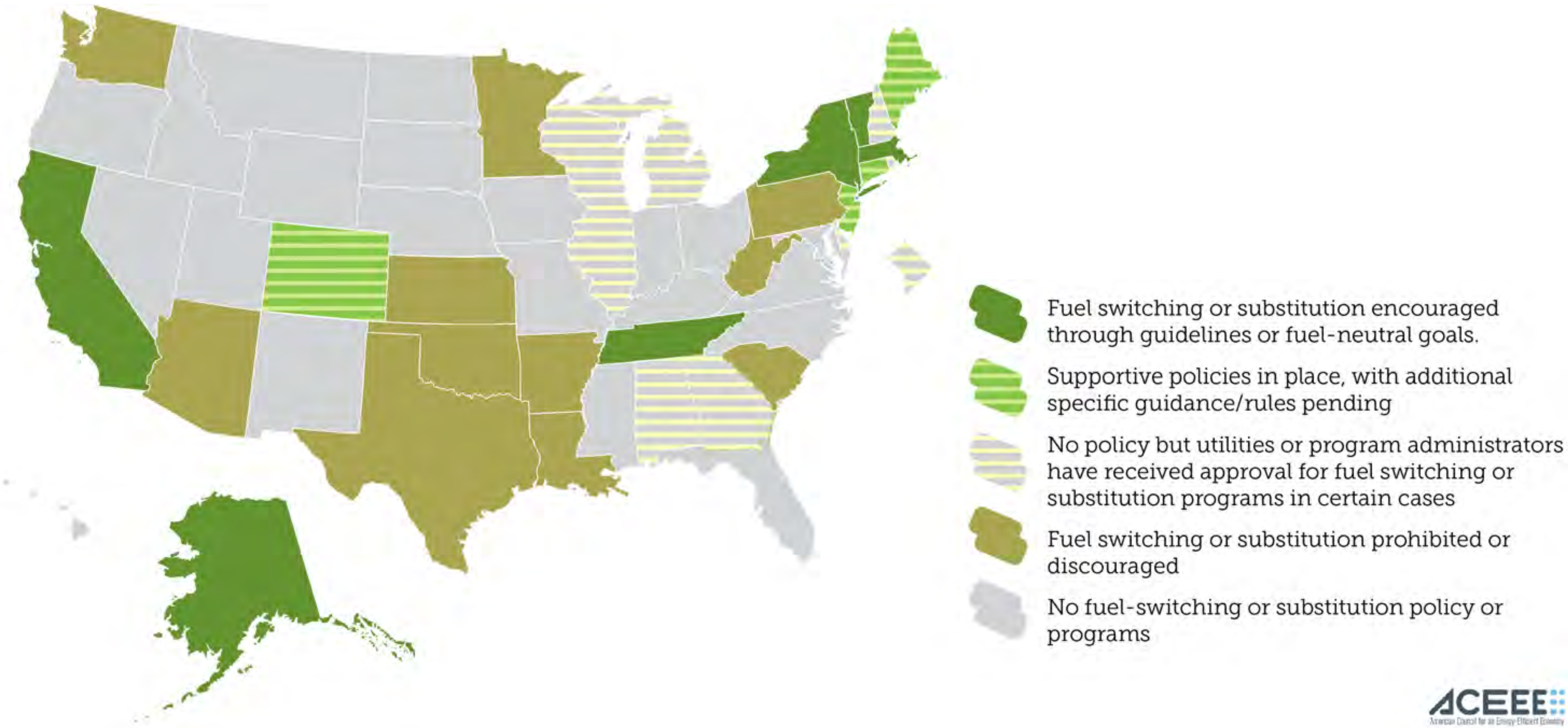
- Fuel-neutral “BTU” goals in NY and MA
  - both include sub-targets or multiple targets in portfolio to ensure electricity efficiency
  - NY: overarching target, based on site BTUs
  - MA: multiple goals, using ”adjusted” Btus based on site and source (CHP) savings
- Avoided carbon emissions targets at SMUD
- Heat pump deployment targets – ME and NY



Source: ACEEE 2020 State Scorecard, Next-Generation EERS, 2019

ACEEE American Council for an Energy-Efficient Economy

Fuel switching rules also have begun to evolve



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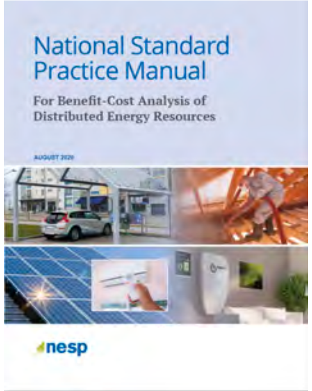
States adjusting cost-effectiveness testing to better value electrification



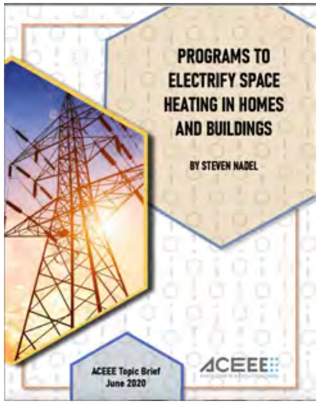
- National Standard Practice Manual now includes guidelines for electrification
- Electrification will require increased generation, and increase net electric utility system costs
  - how much will depend on when and how they are used rate design, demand response, direct load control, are all important)
  - with vehicle-to-grid, could potentially reduce net electric system costs
- But, will also reduce costs from the other fuels (gas, oil, propane) they replace, so important to include those impacts
- Important to include net GHG, air emissions impacts
- Typically lead to increased electric utility revenues; may lead to reduced electricity rates

States are modernizing utility business models to align incentives with building decarbonization

- Revisiting or newly establishing decoupling
  - helps **keep a utility's spending in check** while it pursues electrification
  - can help **make state carbon goals more achievable,** because decarb requires both EE and electrification
  - helps **ensure that customers benefit** from the extra revenue utilities receive from electrification
- Shifts in performance incentive mechanisms
  - rewards utilities for desired outcomes from electrification or heat pumps – e.g., summer or winter peak demand savings, GHG reduction, low income electrification
  - including or considering lifetime savings to pursue HVAC and envelope measures

Source: 2020 ACEEE State Scorecard; ACEEE and RAP blog post, 2020

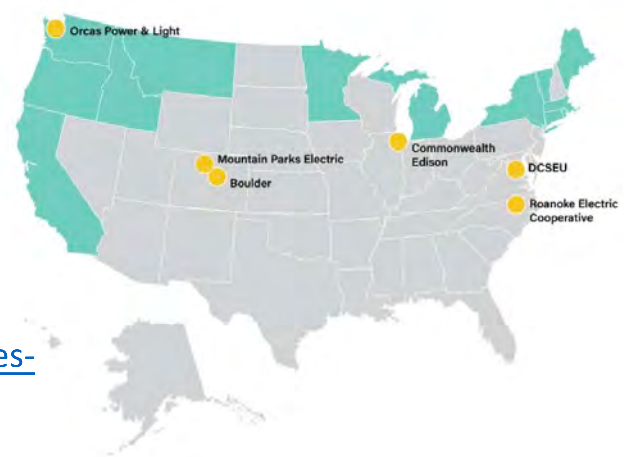
States are updating program designs to scale EE + electrification



Space heating electrification programs are rapidly growing – as of 2020, budgets of $110M, up 70% from prior year.

Program design trends:

- Encouraging weatherization to reduce loads alongside new heat pumps
    - Offering ‘pre-electrification’ or ‘heat pump ready’ programs (e.g, weatherization, envelope programs)
    - 1/3 of programs require weatherization
- Targeting upstream incentives to contractors or distributions
- Updating program materials, incentives to align with reducing total energy use across fuels
    - Contractor training in cold climate heat pump performance, maintenance, etc
    - Offering higher incentives, enabled by all fuel savings and value on GHG reductions



Nadel 2020. https://www.aceee.org/topic-brief/2020/06/programs-electrify-space-heating-homes-and-buildings

ACEEE
American Council for an Energy-Efficient Economy

Application to Michigan's Policy Context

American Council for an Energy-Efficient Economy

Michigan Utility EE Statute (PA 342 OF 2016) essentially precludes electrification/heat pumps

- Defines EE as "decrease in customer consumption of electricity or natural gas, achieved through measures or programs…" [Sec. 5(d)]
- The cost-effectiveness definition focuses on "avoided supply-side costs" to electric and gas utilities [Sec..13(d)]
- The "overall goal" of EWR is to "…reduce the future costs of [utility] service to customers"…"**In particular**, an electric provider's energy waste reduction plan shall be designed **to delay the need for constructing new electric generating faciltiies** and thereby protect consumers from incurring the costs of such construction: [Sec. 71(3)]
- The "energy waste reduction standard" is specifically designed as a % of electric sales for electric utilities, and a % of gas sales for gas utilities [Sec. 77(1)(3)]
- The utility performance incentives are specifically tied to MWh savings for electric utilities and dekatherm savings for gas utilities [Sec. 75]

➢ **Under current statute, the only heat pumps that could qualify as a measure under EWR would be electric heat pumps replacing inefficient electric heat (or possibly gas heat pumps replacing inefficient gas heat)**

- (& no mention of 'climate', greenhouse gas, or carbon anywhere in EWR)

ACEEE American Council for an Energy-Efficient Economy

MPSC in 2020 did approve a couple of heat pump pilots

- The Commission has recognized those statutory constraints, while still approving heat pump pilot programs for DTE and Consumers Energy (CE)
- For DTE (U-20373) approved a pilot to install heat pumps in <u>low-income homes</u> with <u>existing electric heat</u> (and emphasized that limitation in its approval)
- For CE (U-20372) approved a pilot to install heat pumps for <u>low-income homes</u> with <u>existing heating from "non-commission regulated fuels such as propane</u>", to gather information about heat pump performance and costs. However, the order included an explicit caveat:
    - "Notwithstanding, the **Commission cautions that measures that increase overall electricity consumption–regardless of a reduction in total million British thermal units energy usage or other benefits–are not suitable for full-scale electric EWR program implementation.** The Commission stresses the importance of maintaining the integrity of electric EWR programs with respect to the clear statutory charge in 2008 PA 295 as amended–that is, to save kilowatt-hours and defer investment in new power plants. See, e.g., December 4, 2008 order in Case No. U-15800, p. 13 ("The overall goal of an [EWR] plan is to reduce the future costs of provid[ing] service to customers.") (p.2) [emphasis added]

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Two other important Commission statements
(from Order U-20372, March 5, 2020)

Caveat on costs

- "Moreover, the Commission is concerned, particularly for low-income customers, that heat pump applications may increase overall energy costs relative to propane or other fuel sources, at least based on current prices." (p.2)

Call for further consideration

- "The Commission also expects to explore with stakeholders electrification issues more broadly as part of the "New Technologies and Business Models" discussions under subsequent phases of the MI Power Grid Initiative; the Commission will provide further guidance through the MI Power Grid Initiative." (p.3)

Conclusions

– Lack of explicit statutory authority to pursue electrification (or for that matter, any specific statute calling for climate action)

+ The Governor has been outspoken about her interest in pursuing actions to combat climate change

∴ For heat pump electrification, likely need to focus on things that can be done administratively and/or within current regulatory authority

- -Renewable sources accounted for only ~ 8% of electricity generation in Michigan (2019 data). Natural gas generation is the marginal dispatch source. A thorough analysis of cost and carbon impacts will require a consideration of lifetime projected emissions given an evolving electric grid.

➢ Current priority should be maximizing building energy efficiency (which will save energy, money and carbon, regardless of heating fuel source), with research and pilot projects to prepare for future larger scale heat pump electrification

Thank you!

ACEEE Resources

- *Comparative Energy Use of Residential Furnaces and Heat Pumps*, May 2016
- *Opportunities for Energy and Economic Savings by Replacing Electric Resistance Heat with Higher Efficiency Heat Pumps*, May 2016
- *Energy Savings, Consumer Economics, and Greenhouse Gas Emissions Reductions from Replacing Oil and Propane Furnaces, Boilers, and Water Heaters with Air-Source Heat Pumps*, July 2018
- Next-Generation EERS, August 2019
- State Policies and Rules to Enable Beneficial Electrification in Buildings through Fuel Switching, April 2020
- Programs to Electrify Space Heating in Homes and Buildings, June 2020
- *Electrifying Space Heating In Existing Commercial Buildings: Opportunities and Challenges*, October 2020

Contact Information

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ACEEE American Council for an Energy-Efficient Economy

Beneficial Electrification of Space and Water Heating: A Perspective from Maine

Ian Burnes

Director, Strategic Initiatives

Efficiency Maine

Efficiency Maine Trust

- Independent, quasi-state agency
- Runs programs to promote energy conservation and clean energy for all customer groups, all energy types, in all areas of Maine
- Provides rebates, financing, technical information and registry of vendors
- Funded by
  - Electric and natural gas utility ratepayers
  - Regional Greenhouse Gas Initiative (RGGI)
  - ISO New England grid operator (Forward Capacity Market)
  - Grants and contracts

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Cut to the chase:

Scalable, market-based electrification is essential, and requires:

1. Extreme customer satisfaction
2. Attractive business opportunity for vendors and installers
3. Supportive public policies

Efficiency Maine Heat Pump Programs

1. Extreme Customer Satisfaction

Promoting a Positive Consumer Experience

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866-376-2463 | Contact

AT HOME AT WORK ENERGY INFORMATION RESOURCES ABOUT

Heat Pump User Tips

Download Print Version of Tips

DOWNLOAD

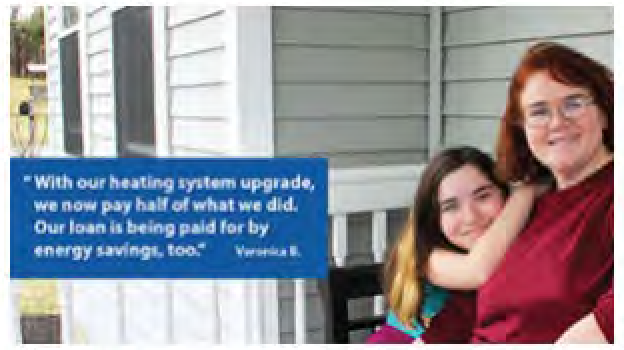
Heat Pumps FAQ

Heat Pumps – Frequently Asked Questions

+ Will a heat pump reduce my annual heating costs?
+ How do I find a heat pump installer near me?
+ Do heat pumps work in cold weather?

Case Studies

Residential



Veronica
Veronica says she's saving over 50% a month now that she's installed a high-efficiency heating system and added insulation in the basement.
PDF

Bill
Bill installed a heat pump with the help of an incentive and low-interest loan from Efficiency Maine. Read about Bill's heating project.
PDF

Nancy & Jim
See how one Presque Isle couple is saving an estimated 50 percent on their heating costs after installing a high-efficiency heat pump.
VIDEO

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Consumer Education: (Efficiency Maine webpage topics)

Indoor unit location

1. *Heat rises*
2. *Consider air flow*
3. *Simplify connections*
4. *Coordinating thermostats*

Indoor unit types

1. *Wall units*
2. *Floor units*
3. *Ceiling cassettes*
4. *"Mini-Ducts,"* or *"Compact Ducts,"*

Other Considerations:

1. *Cold temperature performance*
2. *Air movement*
3. *Heat distribution*
4. *Interactions with the primary heating system*
5. *Aesthetics*

Outdoor unit location

1. *Aesthetics*
2. *Unobstructed airflow*
3. *Door, window, and walkway interference*
4. *Roof runoff*
5. *Serviceability*

Outdoor unit type & size

1. *Multi-zone versus Single-zone*
2. *Sizing*

Other considerations

1. *Line sets*
2. *Condensate drain line*

Online Tools

Compare Home Heating Costs

Decrease | Increase | Reset | CALCULATE

Fuel Type (Units)	Cost per Unit Delivered	Heating System	Show Details	Annual Cost
1. Firewood (cord)	$275	wood stove	☐	$ 1,263
2. Electric (kWh)	$0.17	ENERGY STAR® geothermal heat pump	☐	$ 1,341
3. Natural Gas (ccf)	$1.37	parlor stove	☐	$ 1,393
4. Electric (kWh)	$0.17	ductless heat pump	☐	$ 1,464
5. Natural Gas (ccf)	$1.37	ENERGY STAR® boiler	☐	$ 1,606
6. Oil (gallon)	$1.93	ENERGY STAR® boiler	☐	$ 1,718
7. Natural Gas (ccf)	$1.37	ENERGY STAR® furnace	☐	$ 1,739
8. Oil (gallon)	$1.93	ENERGY STAR® furnace	☐	$ 1,798
9. Kerosene (gallon)	$2.52	space heater	☐	$ 1,847
10. Wood pellets (ton)	$268	pellet stove	☐	$ 1,849
11. Wood pellets (ton)	$268	pellet boiler	☐	$ 2,121
12. Propane (LP) (gallon)	$2.38	parlor stove	☐	$ 2,698
13. Propane (LP) (gallon)	$2.38	ENERGY STAR® boiler	☐	$ 3,110
14. Propane (LP) (gallon)	$2.38	ENERGY STAR® furnace	☐	$ 3,368

Find a Residential Registered Vendor

Use this tool to find a residential energy efficiency contractor near you. Efficiency Maine recommends getting estimates from at least three contractors.

QUESTIONS TO ASK A REGISTERED VENDOR

What services do you need? Heat Pumps × | **ZIP Code:** 04401 | **Distance:** 25 Miles | **Sort by:** Number Of EM Rebates* | SEARCH

Vendor:	Energy Assessment & Air Sealing	Insulation	Heat Pumps	Natural Gas/Propane/LP Heating	Oil/Kerosene Heating	Pellet Boilers	Pellet/Wood Stoves	Geothermal	Heat Pump Water Heater	Solar	Phone:	Web/Email:	
1. **Valley Home Services** 2477 Rt 2, Hermon, ME - 04401			●								800-316-7815	Visit Website Send an Email	0 Miles
2. **MAC Heat Pumps** 87 Hillside Ave, Suite 3, Bangor, ME - 04401			●								207-947-3851	Visit Website Send an Email	0 Miles
3. **Dave's Mechanical Maintenance Inc** 25 Grove St, Milford, ME - 04461			●	●	●						207-951-6274	Visit Website Send an Email	15 Miles
4. **New England Heat Pumps** 507 N Main St, Brewer, ME - 04412			●								207-745-3489	Visit Website Send an Email	7 Miles
5. **Holden Energy and Alternative Technology** 43 Mt View Ln, Holden, ME - 04429			●								207-852-6612	Visit Website Send an Email	14 Miles

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Quality Assurance – Registration, Training & Inspections

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Residential Registered Vendors

Residential Registered Vendor Agreement Form

Section 2: Basic Requirements. Please include the following documentation when submitting agreement form

✔	Required Documentation
☐	Code of Conduct: http://www.efficiencymaine.com/docs/Code-of-Conduct.pdf
☐	Certificate of Comprehensive General Liability Insurance* (minimum coverage: $500,000/occurrence)
☐	Efficiency Maine Trust added as Additional Insured and Certificate Holder of General Liability Insurance policy (See address at bottom of page 3)
☐	Workers' Compensation Insurance* (**Exceptions:** Sole Proprietors or Limited Liability Corporations without employees)

Section 3: Service Offerings and Qualifications.

Heat Pumps

- ☐ One employee must have Environmental Protection Agency (EPA) Section 608, Type II or Universal Refrigerant Handling Certification.
- ☐ One employee must have ductless heat pump installation training provided by a manufacturer of ENERGY STAR heat pumps, or an Efficiency Maine Registered Trainer.
- ☐ One member of each installation crew must have Efficiency Maine Annual Heat Pump Basics training certificate.

Efficiency Maine Heat Pump Programs

2. Attractive Business Opportunity

Air Source Heat Pump Measure

RESIDENTIAL

Rebate Amount

- 1st indoor unit: **$500** if Tier 1 or **$1,000** if Tier 2
- 2nd indoor unit: **$250** if Tier 1 or **$500** if Tier 2

Criteria

- Tier 1 heat pumps:
  - AHRI-rated HSPF 12.0 or greater for systems w/ 1 indoor unit
  - AHRI-rated HSPF 10.0 or greater for systems w/ multiple indoor units
- Tier 2 heat pumps:
  - AHRI-rated HSPF 12.5 or greater
  - Each system is single-zone
  - Wall-mounted indoor unit
  - Installed on or after 1/1/2020
  - Home not served by natural gas
- Minimal Hassle
  - No weatherization prerequisite
  - No energy audit prerequisite

COMMERCIAL

Rebate Amounts

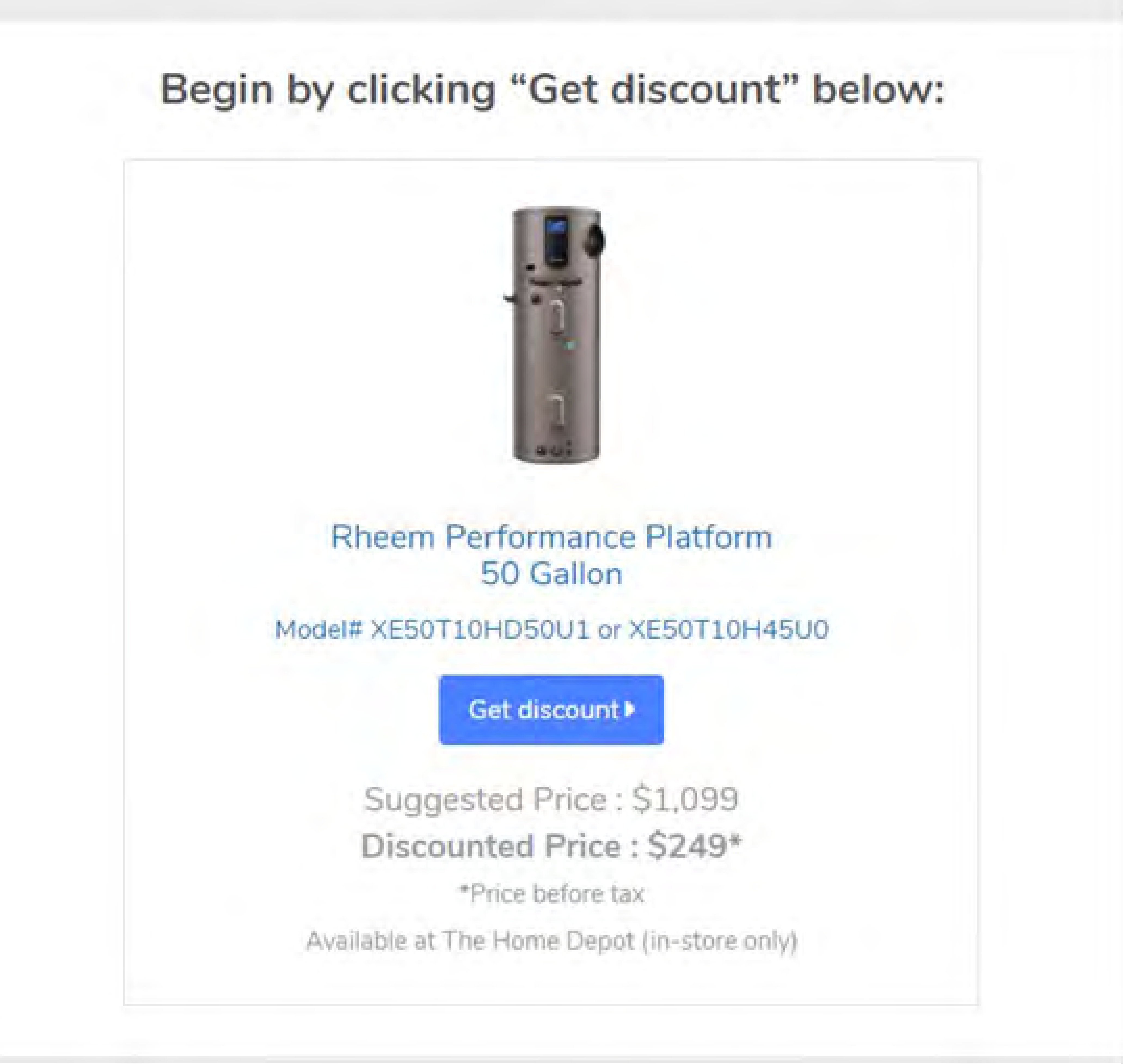
Zones	Minimum HSPF	Incentive
1	12	$500
2	10	$750
3	10	$1000
4+	10	$1250

Heat Pump Water Heater

Distributor Channel

- If Participating Distributor (supply house) will mark-down and then Efficiency Maine reimburses Distributor $850
- Plumbers must provide Maine address of installation
  - subject to inspection

Retail & Mfr. Channel



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Trade Allies have access to:

- **Rebates**
- **Home energy financing**
- **Heat pump co-op marketing funds**
- **Heat pump training scholarships**
- Listing on Efficiency Maine's Residential **Registered Vendor Locator**
- **E-Newsletters**
  - Program updates
  - Best practices tips that our Quality Assurance Inspectors have observed in the field
  - Notice of upcoming exhibiting opportunities
  - **Click here** for archives
  - **Click here** to subscribe
- **Sales tools**
  - **Brochures**
  - **Case studies**
  - Residential Registered Vendor logo

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Marketing Materials, Program Materials, Sharing Ad Costs

Heating Systems

1. Heat Pump Rebate Claim Form (PDF)
2. List of Most Commonly Rebated Heat Pump Models (PDF)
3. Heat Pump Installation Checklist (PDF)
4. Heat Pump User Tips (PDF)
5. Heat Pump Rebate Brochure (PDF)
6. Introduction to Heat Pumps (PDF)
7. Heating and Water Heating Instant Discounts Brochure (PDF)
8. Biomass Heating System Rebate Eligibility Criteria and List (PDF)
9. Biomass Heating System Rebate Claim Form (PDF)
10. Quick Guide to Home Heating (PDF)
11. Heating Cost Comparison Chart (PDF)
12. Introduction to ECM Circulator Pumps Brochure (PDF)
13. Geothermal Heat Pump Rebate Claim Form (PDF)

Water Heating

1. Heat Pump Water Heater Rebate Claim Form (PDF)
2. Water Heating Cost Comparison Chart (PDF)
3. Guide to Water Heating (PDF)
4. Heat Pump Water Heater User Tips (PDF)
5. Heat Pump Water Heater Myths & Facts (PDF)
6. Heat Pump Water Heater Testimonials from Maine Plumbers (PDF)
7. Heating and Water Heating Instant Discounts Brochure (PDF)

Low Income Initiatives

1. AHI Weatherization Claim Form
2. AHI Weatherization Reservation Request Form
3. RRV Addendum for AHI
4. AHI Heat Pump Claim Form
5. AHI Heat Pump Reservation Request Form

Home Energy Loans

1. Home Energy Loan Brochure (PDF)
2. Home Energy Loan Work Scope Form (PDF)
3. Home Energy Loan Comparison Chart (PDF)
4. List of PACE Towns (PDF)

Marketing Co-Op Program

Marketing Co-Op Program Offer

Efficiency Maine will reimburse Heat Pump Residential Registered Vendors 50% of pre-approved marketing expenses up to a maximum reimbursement of $5,000.

Marketing and Reimbursement Requirements

- ☐ 1. Marketing eligible for reimbursement must
  - ☐ a. Be submitted by a Residential Registered Vendor (RRV)
  - ☐ b. Be targeted to Maine audiences
  - ☐ c. Mention heat pumps
  - ☐ d. Mention Efficiency Maine rebates
- ☐ 2. Expenses must be incurred between July 1, 2020 and June 30, 2021.
- ☐ 3. Reimbursement requests must be submitted to Efficiency Maine by July 31, 2021.

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Efficiency Maine Heat Pump Programs

3. Supportive Public Policies

Related Maine Policy

- Maine law:
    - Requires Efficiency Maine to harvest, and utilities to pay from rates, "all cost-effective" electric efficiency
    - Requires Efficiency Maine to direct revenues from the Forward Capacity Market to advance the **goal of installing 100,000** high-efficiency **heat pumps in the next 5 years**. Public Law Ch. 306, LD 1766 (2019)
    - Directs RGGI to Efficiency Maine to save electricity or reduce GHG
- Other policies creating unlevel playing field, perverse price signals:
    - Carbon emissions from electricity generation plans is regulated under RGGI and costs are passed through to electricity customers
    - For petroleum products such as oil, propane, and kerosene, there is no comparable cost of carbon nor is there any energy conservation charge being assessed .

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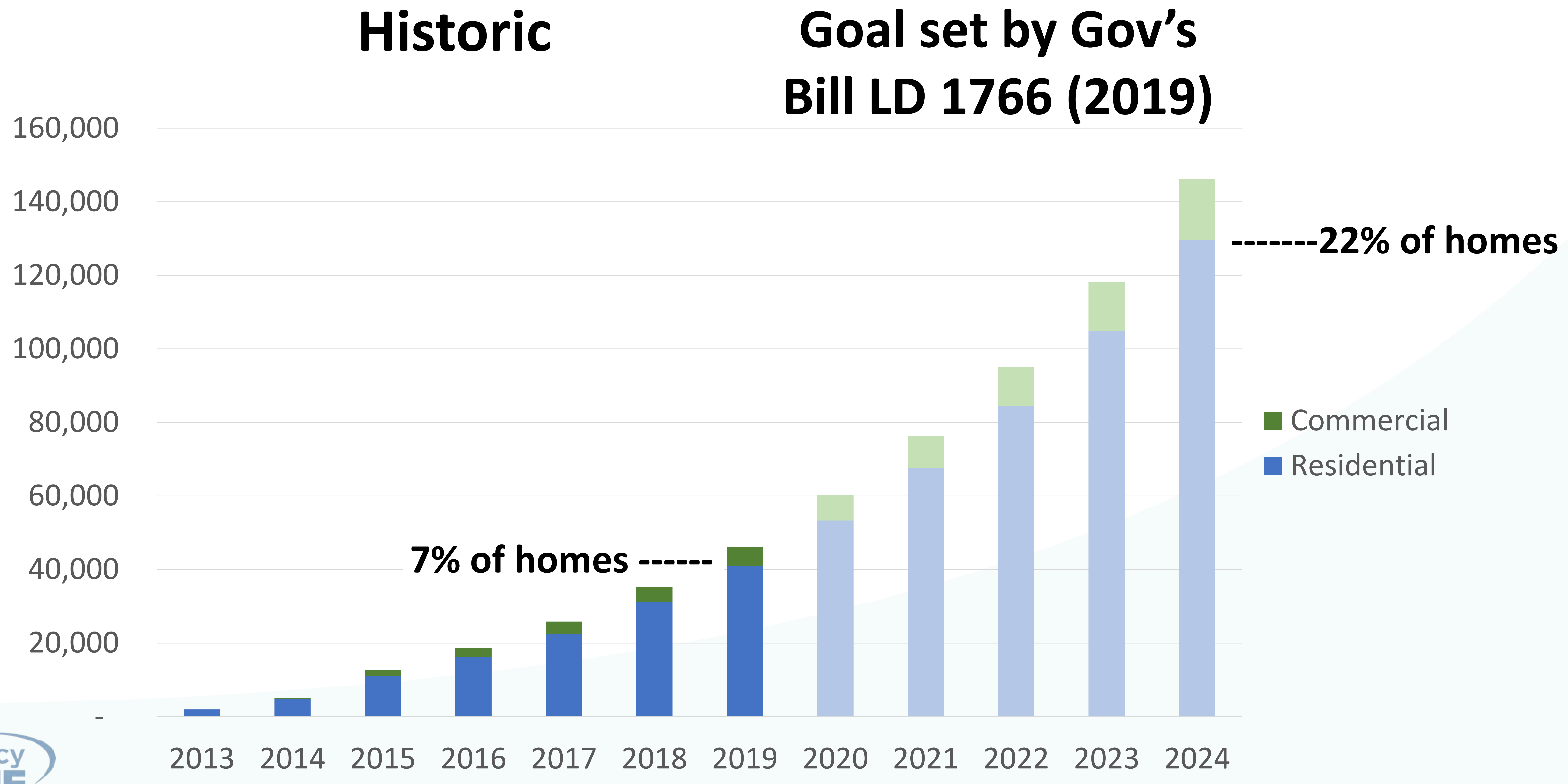
Getting Results

Keeping Customers Happy and Vendors Motivated

Maine's High-Performance ASHP Installations (Cumulative)



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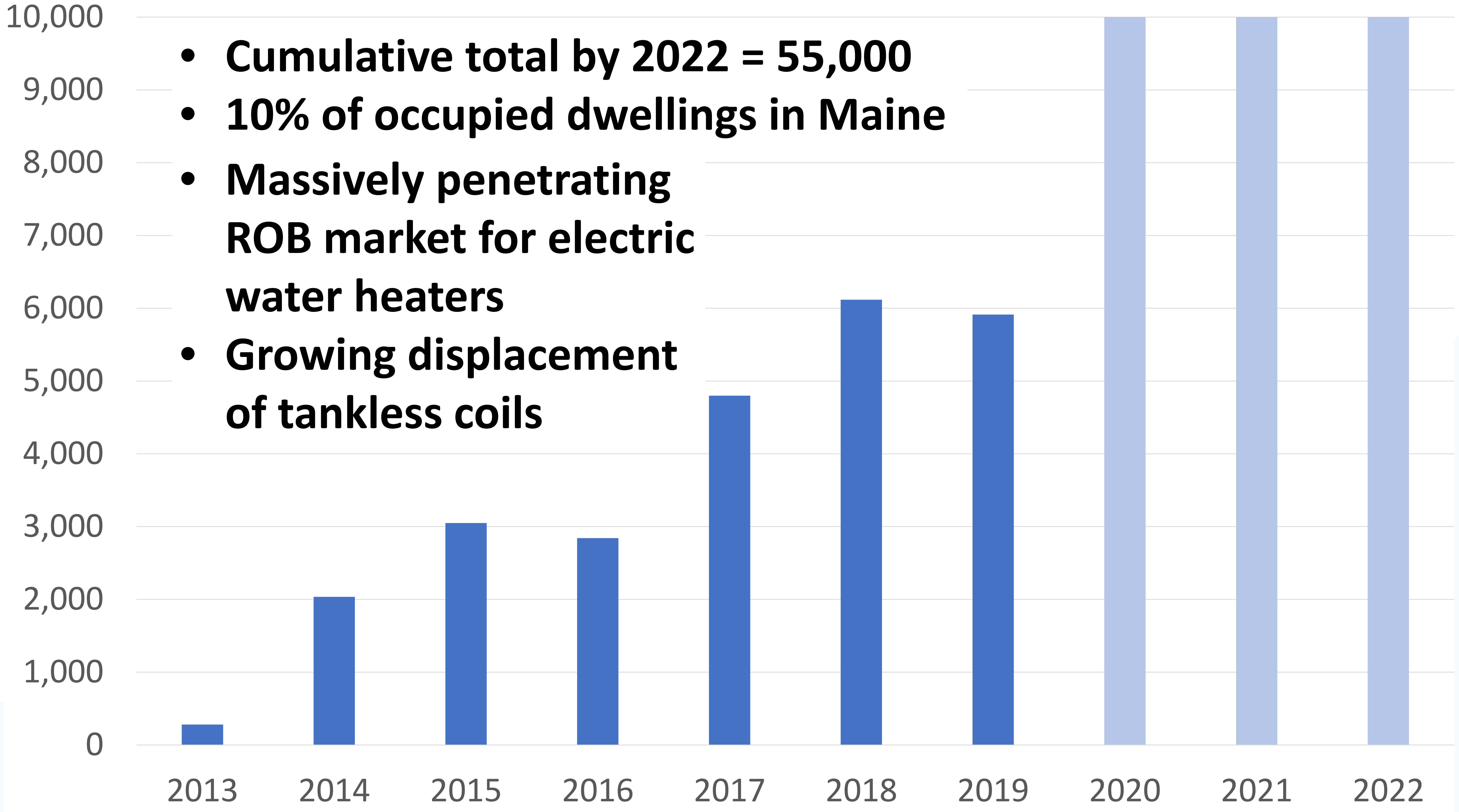
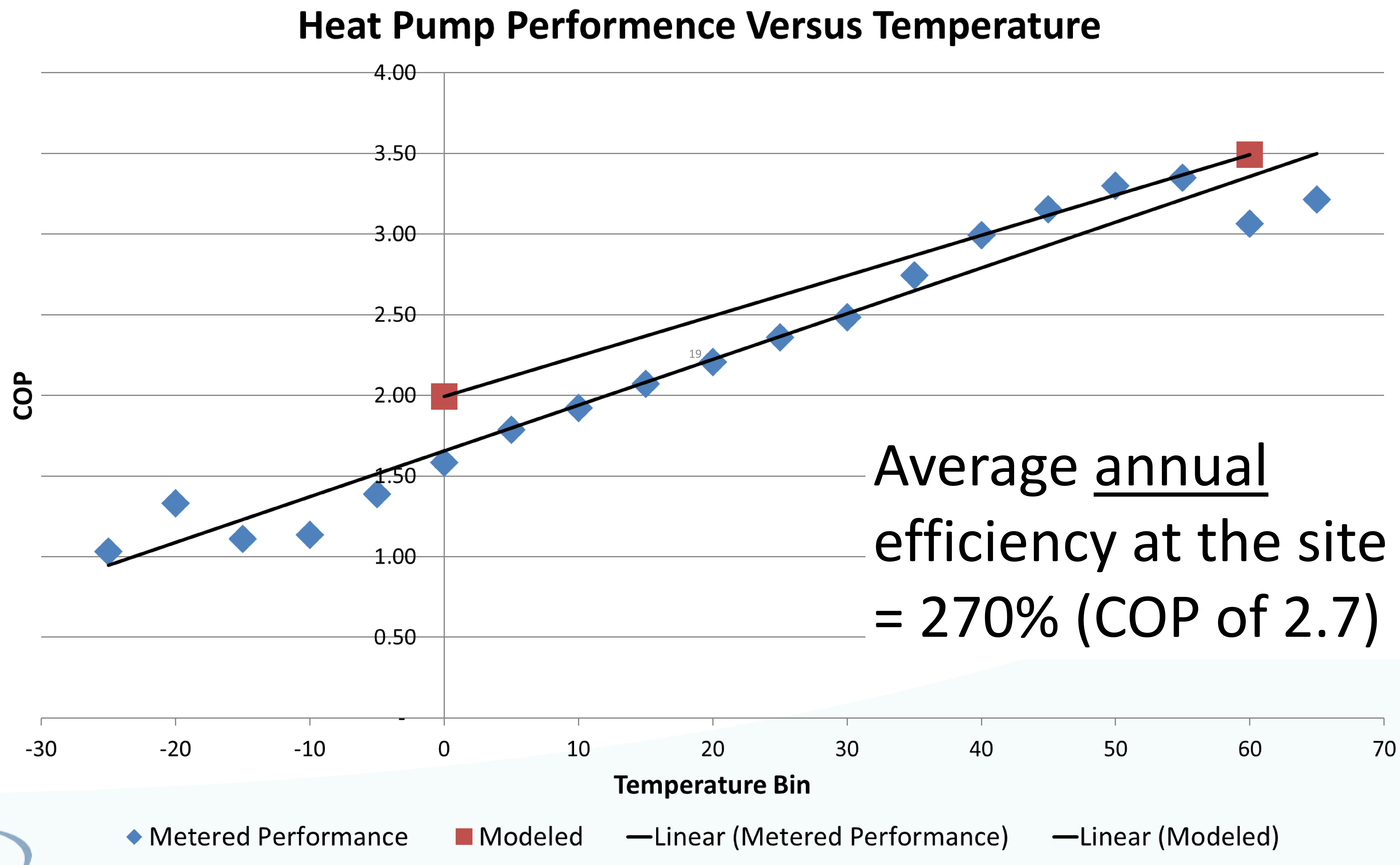
Maine Sales of Heat Pump Water Heaters (Annual # of Units)



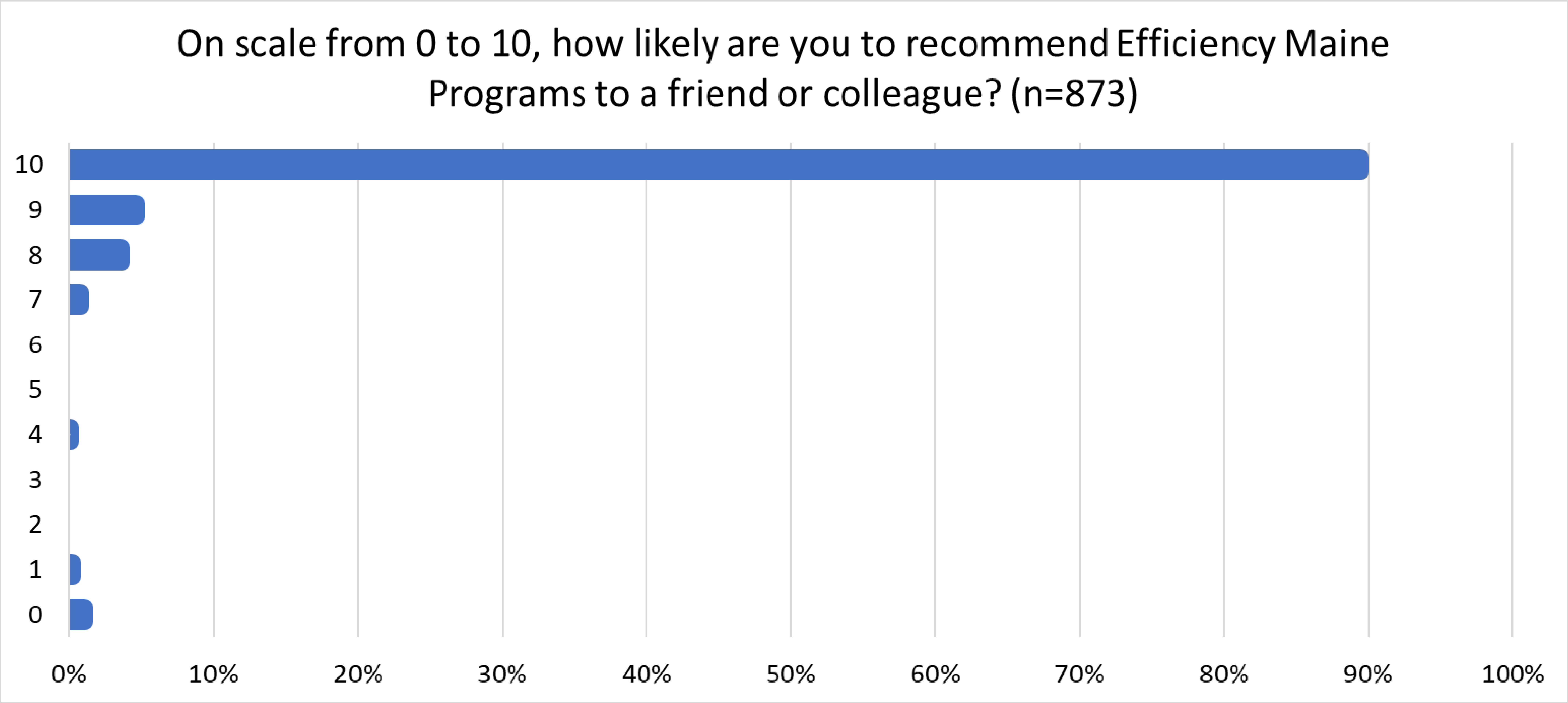
Maine's Evaluated Performance of High-HSPF Heat Pumps



Average annual efficiency at the site = 270% (COP of 2.7)

Customer Satisfaction with Contractor

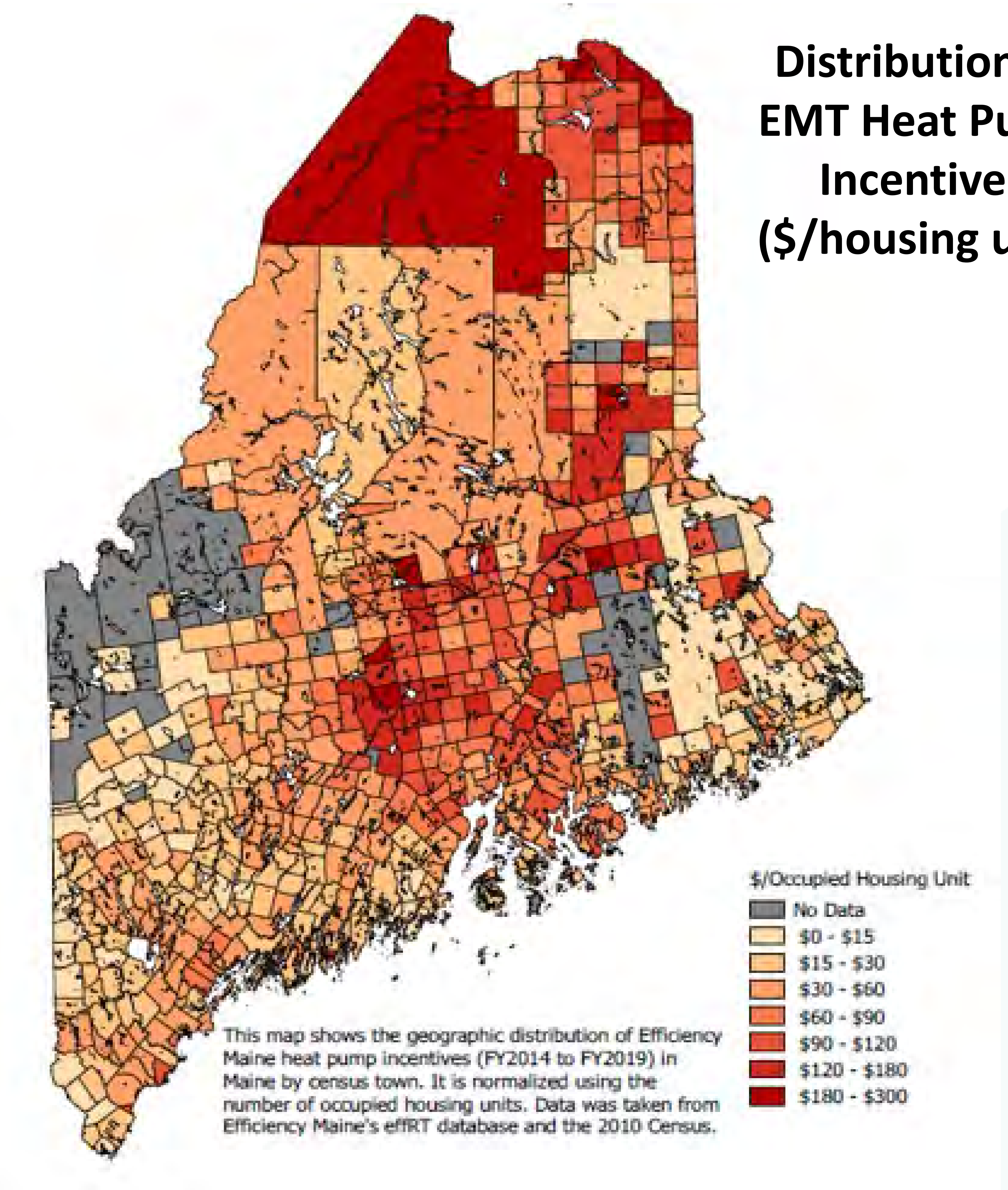
Customer Satisfaction with Heat Pump Program



Disadvantaged Communities

- **Rural, remote, and island communities**
  - EMT project incentives achieving good geographic diversity (see, e.g., Heat Pump map)
  - Increased grid utilization can decrease rates in short term
- **Fossil-fuel economy and supply chain entities**
  - Of 183 EMT registered vendors supplying fossil-fuel equipment services, 144 also qualified to install heat pumps

Distribution of EMT Heat Pump Incentives ($/housing unit)



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Maine's Lessons Learned (So Far)

Opportunities

Economics – strong when using highest HSPF models vs. predominantly oil & propane baseline
- and vs. electric resistance
- and vs. tankless coil domestic water heating
- also may suppress electric rates in declining rural utilities

Emissions – reductions are significant

Marketing – word-of-mouth, very high customer satisfaction

Competition – robust range of products, vendors, installers keeps prices low

Training – among dedicated HP manufacturers, vendors, installers promotes good customer experience

Equity – can be well served by ASHP and HPWH; good fit with enhanced incentives and direct-install programs

Support – from policymakers and regulators helps significantly

Barriers

Misinformation – from incumbent supply chain installers and fuel dealers

Misunderstanding – about how to optimize ASHP performance when retrofitting as partial heating solution in existing homes

Perverse price signals and **unlevel playing fields**

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Cold Climate Air-Source Heat Pumps: Hurry Up, Slowly

David Lis

Director, Technology & Market Solutions

Northeast Energy Efficiency Partnerships

Cold climate Air-source heat pumps; Hurry up, slowly

- Dave Lis, Director, Technology and Market Solutions
- MI Power Grid: New Technologies and Business Models Workgroup Meeting #3: Space & Water Heating with Heat Pumps

Northeast Energy Efficiency Partnerships

Mission

We seek to accelerate regional collaboration to promote advanced energy efficiency and related solutions in homes, buildings, industry, and communities.

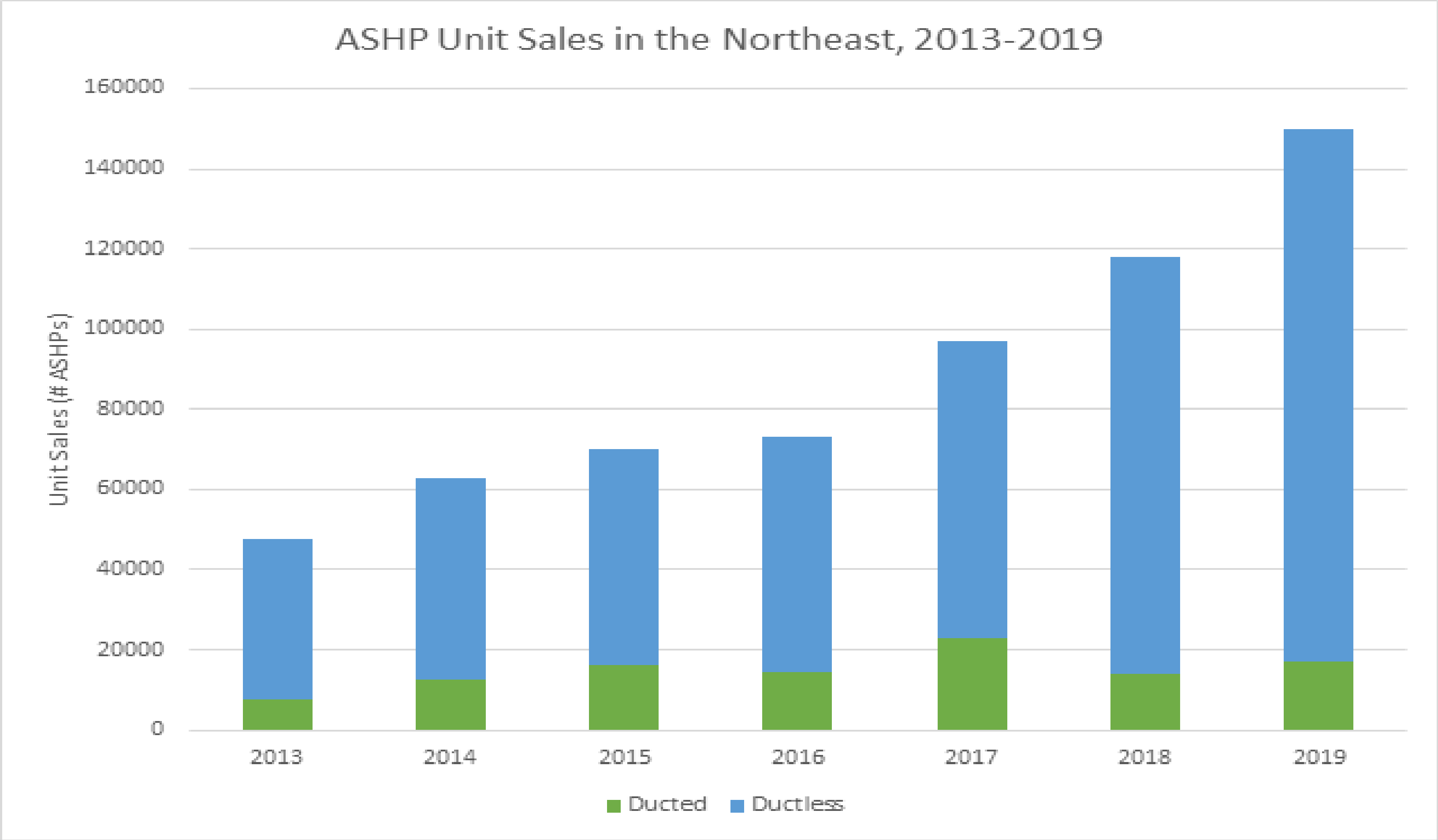
Approach

Drive market transformation regionally by fostering collaboration and innovation, developing tools, and disseminating knowledge

Air-Source Heat Pump Technology (R)Evolution

- Not your grandparents ASHP
  - Variable capacity compressors (inverter driven)
  - Sophisticated controls
  - Flash injection
- Delivering capacity and efficiency at low outdoor temperatures
- Air-to-Air- ducted, ductless and everything in between
- Air-to-Water – Variety of distribution options

Market Momentum Building



Sales in context

- Furnaces (235k)
- Boilers (160k)
- Central AC (220k)

NYSERDA data. Provided by D+R International. Reuse is prohibited without permission

Contributing Factors to Growth

Regional ASHP Market Transformation Initiative

POLICYMAKERS

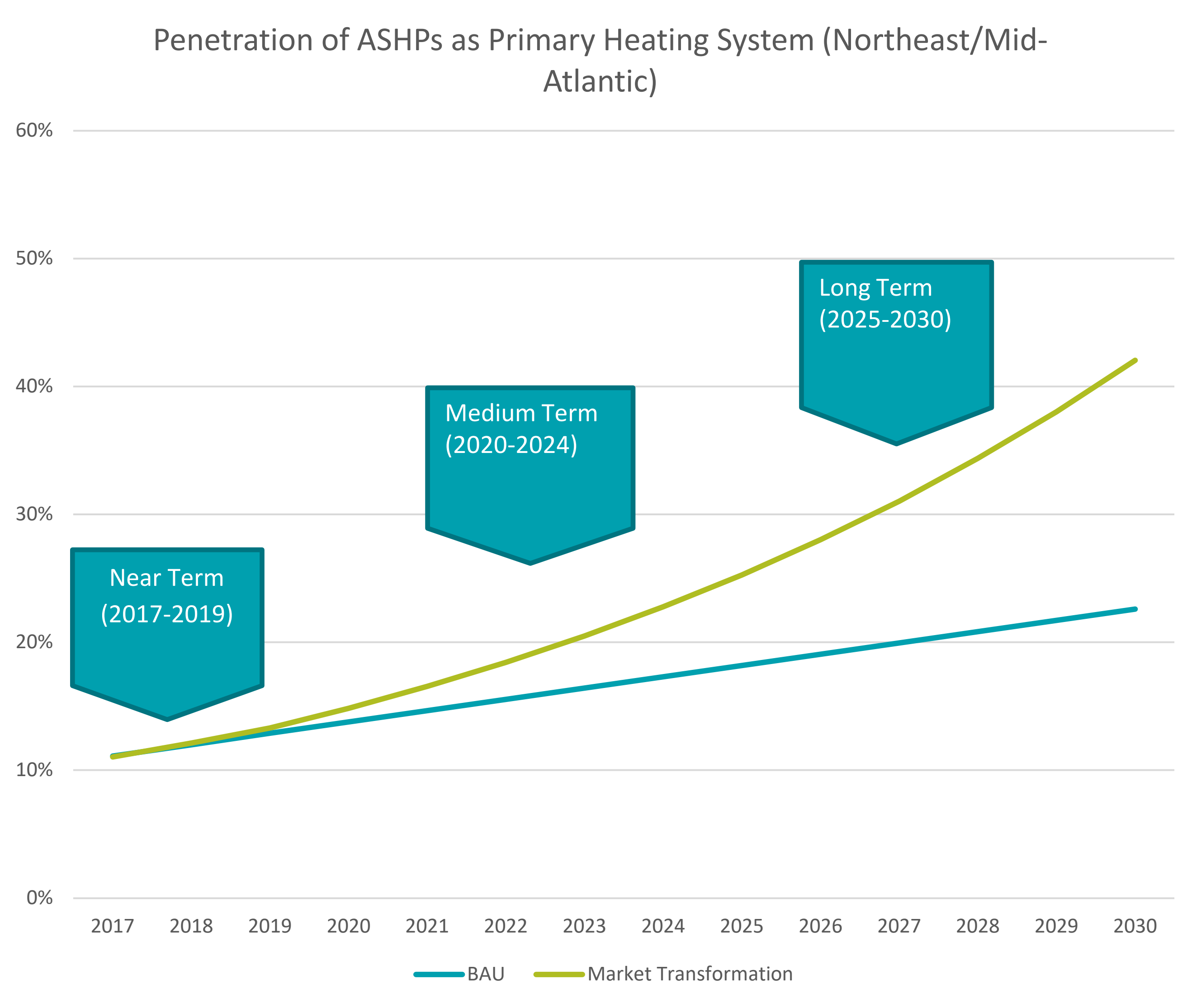
PROGRAM ADMINISTRATORS

INDUSTRY PLAYERS & BUSINESS INTERESTS

Current Market Transformation Strategies

1. Increase Consumer Education and Awareness
2. Increase Installer/Builder Awareness of, and Confidence in, ASHP through expanded training and education
3. Reduce Upfront Costs of installed systems through robust and aligned promotional programs and the support of alternative business models
4. Mobilize State and Local Policymakers to expand support for ASHPs
5. Promote Advanced Control technologies to allow automated coordination among multiple heating systems
6. Enable the promotion of climate-appropriate ASHPs through Improved Performance Metrics
7. Develop more accurate tools to predict energy, cost and GHG savings associated with ASHP installation through collection and analysis of Real World Performance Data

Long-term Adoption Target- 40% Primary Heating Systems by 2030



Hurry up….Slowly

Finding the right balance between urgency and quality

Tale of Two ASHP Projects

Cold-climate Air Source Heat Pumps Specification

Cold Climate Air-Source Heat Pump Specification (Version 3.0)

As facilitated by Northeast Energy Efficiency Partnerships (NEEP)

EFFECTIVE JANUARY 1, 2019

The following specification defines a set of performance requirements and reporting requirements to meet the voluntary "Cold-climate Air-Source Heat Pump Specification" (ccASHP Specification). The specification was designed to identify air-source heat pumps that are best suited to heat efficiently in cold climates (IECC climate zone 4 and higher). The specification is intended as a model equipment specification to be used broadly by energy efficiency program administrators in cold climates as a minimum requirement for program qualification. It also is intended for engineers, contractors, and other practitioners who need assurance that the equipment they select will have the required heating capacity at design temperature without unnecessary oversizing, and will serve the load efficiently throughout the ambient temperature range.

Stakeholders should be aware that simply meeting the performance requirements does not necessarily mean a product is appropriate for all cold climate applications. Consumers, contractors, and designers should review building loads, equipment capacities at design temperatures, and other important factors before selecting equipment.

Scope

- Air-to-air, split system heat pumps
- Indoor and outdoor units must be part of an AHRI matched system, defined by federal regulation 10CFR §430.2 as a *central air conditioning heat pump*
- Compressor must be variable capacity (three or more distinct operating speeds, or continuously variable)
- Non-ducted ASHP systems[1]
    - Single-zone ASHP systems with non-ducted indoor units (i.e. wall, ceiling, floor, etc.)
    - Multi-zone systems rated with non-ducted indoor units
- Ducted ASHP systems[1]
    - Centrally ducted
    - Single-zone systems with compact-ducted indoor unit
    - Multi-zone systems rated with all ducted or mixed (ducted and non-ducted) indoor units
- Does NOT include ground-source, water-source, or air-to-water heat pump systems

---

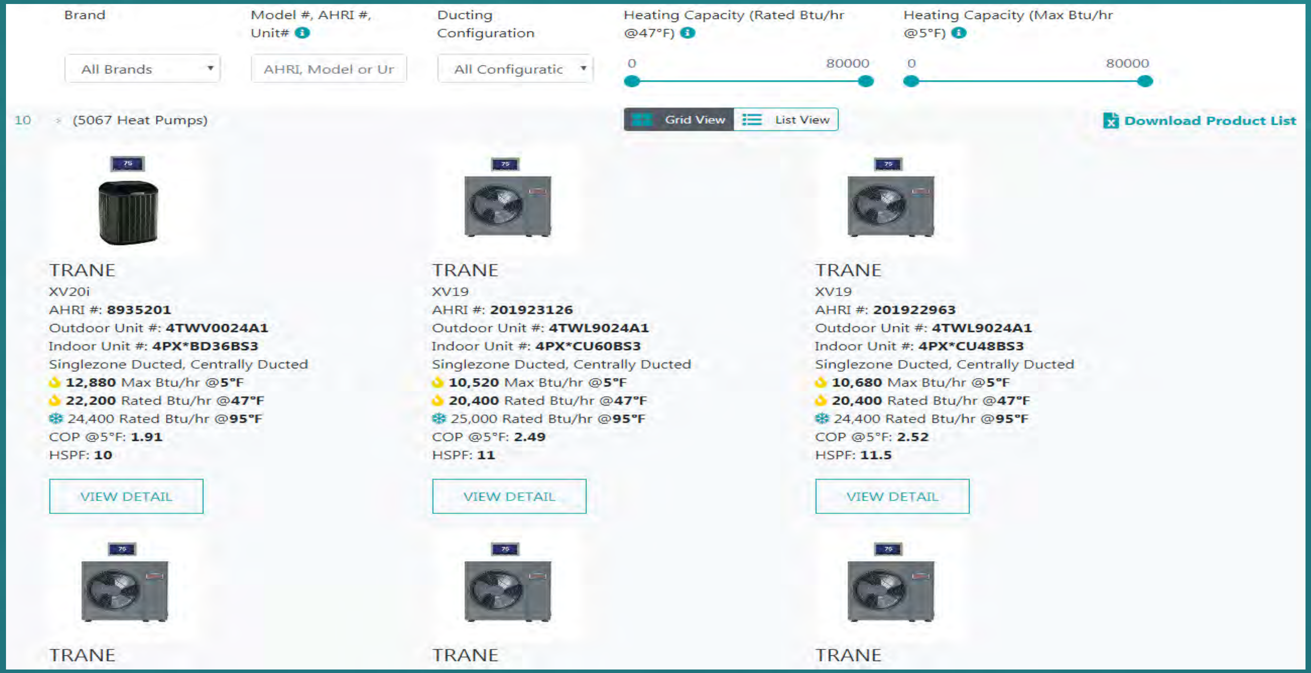
- Antiquated test procedure/performance metrics for latest generation of ASHPs
- Created difficulty in differentiating high performing systems, particularly for cold climate applications

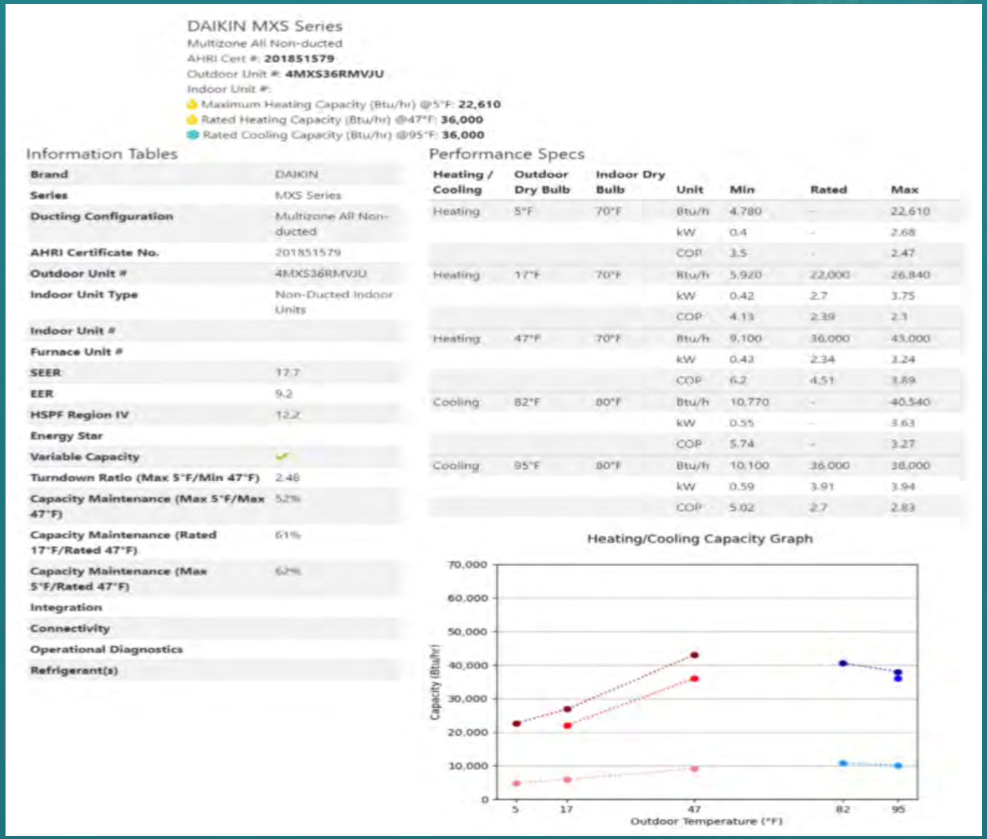
https://neep.org/ASHP-Specification

NEEP’s Cold-Climate ASHP Product List

ashp.neep.org

One-stop-shop for cold-climate qualified air source heat pumps





Now 10,000+ systems from over 80 major brands

Design and Installation Resources

neep.org/ASHPInstallerResources

Consumer Resources –
NEEP Air Source Heat Pump Buying Guide

- Good resource for all audiences
- Especially for consumers who are looking to learn more about heat pumps
- Check out the O&M guide and Case Studies too

THANK YOU!

Dave Lis

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www.neep.org

Ground Source Heat Pumps: New Opportunities and Barriers to Expansion in the Residential Market

Sinye Tang

Vice Present, Finance & Strategy

Dandelion

Rona Banai

Utilities and Rebates Manager

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Ian Rinehart

Principal

The AdHoc Group

DANDELION

Ground Source Heat Pumps: New Opportunities and Barriers to Expansion in the Residential Market

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MI Power Grid - PSC
February 24, 2021

About Dandelion

#1 U.S. Residential Geothermal Installer after 3 years of operation

- Mission to democratize access to geothermal and make it affordable to any homeowner
- 2017 spun out of X, Alphabet's Innovation Lab
- Backed by leading investors like Breakthrough Energy Ventures, Google Ventures, and Lennar
- 4 warehouses based in NY and CT with more to come

Impact to date:

- >100,000 gallons/year of reduced heating oil consumption
- $2,250/ year in average homeowner savings
- >100 Clean Energy jobs added to our communities

What we do

Providing a Clean Energy Alternative to Fossil Heating

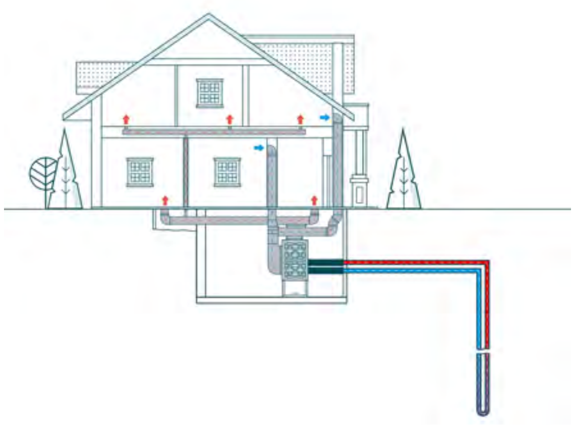
Heating Fuel	# of Households in Michigan
Propane	336k
Fuel Oil	42k
Natural Gas	3.0m

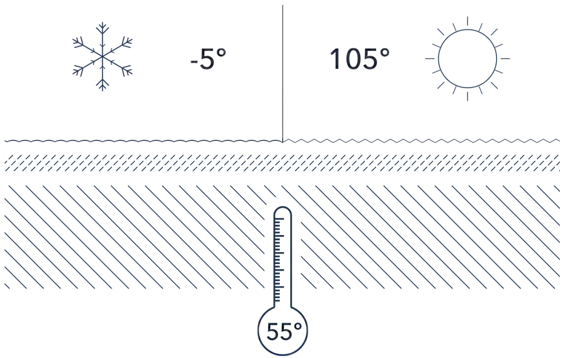
Drivers for alternative home heating solutions:

HOMES WITH FUEL OIL

- Fuel oil is expensive
- Fuel delivery is inconvenient
- Not eco-friendly

Ground Source Heat Pumps - Benefits and Traditional Barriers





Benefits

Efficiency

Temperature and outside air relative humidity do not affect underground heat rejection/absorption

Comfort

100% of space heating & cooling, domestic hot water

Maintenance

No outside exposure = longer service life. 25 years for heat pump, 50+ years for loop

Home Equity

Significant increases possible

Traditional Barriers

Site Feasibility

Site footprint may not be accessible to traditional rig suites

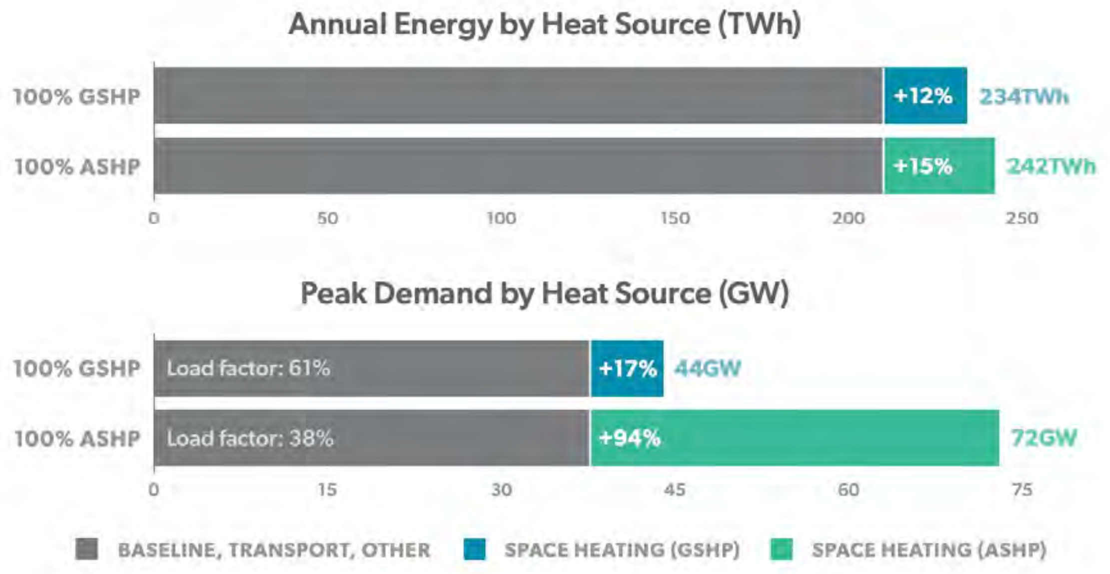
Cost

~$30k cost before federal, state and utility incentives

Product innovation and financing to increase access and decrease costs is critical for widespread GSHP adoption

Ground Source Heat Pumps play a Key Role in Sustainable Electrification

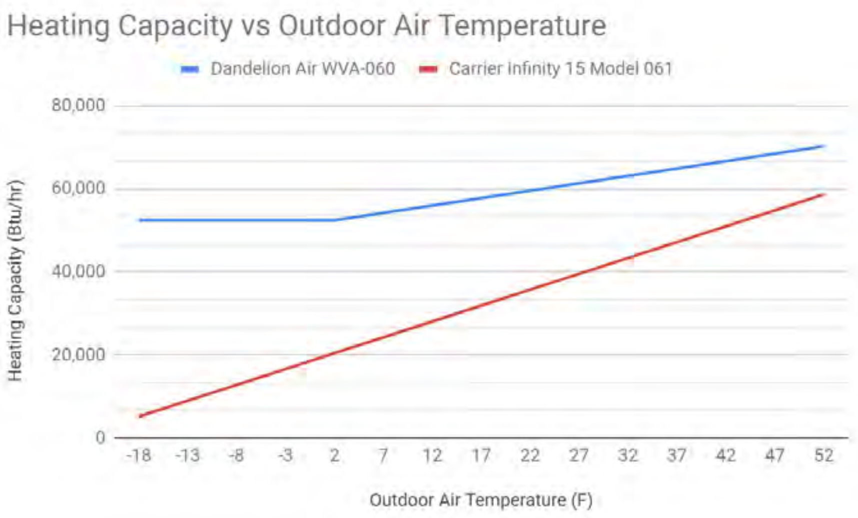
Case study: Electrifying New England heating through 100% ASHPs would increase peak by 94%
GSHPs would only result in a slight increase in peak demand (17%)

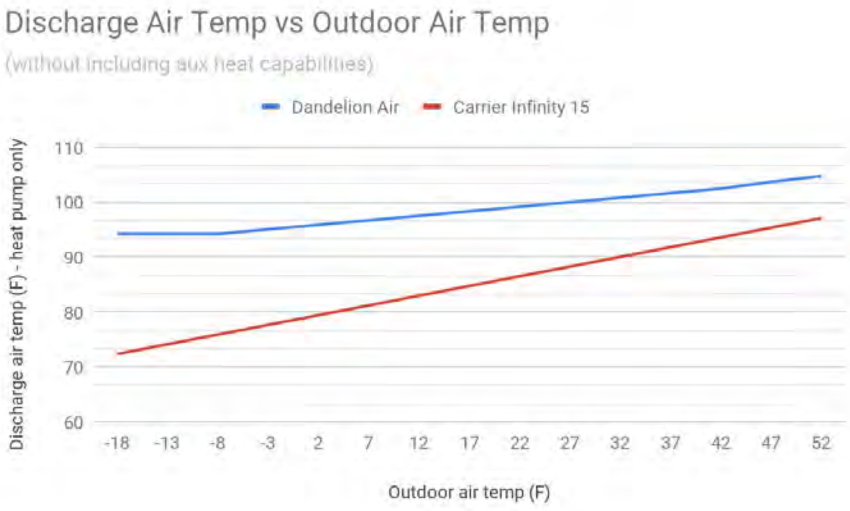


Source: Heating Sector Transformation in Rhode Island: Pathways to Decarbonization by 2050

Ground Source Heat Pumps - Designed for Cold Climates

Greater capacity and discharge temps at cold temperatures compared to Air Source Heat Pumps





Heating capacity is highly sensitive to outdoor temperatures for air source units. Because of this, they often need to be paired with a backup heating source in cold climates.

Another impact of lower capacity at lower temperatures is ASHPs have lower discharge air temperatures when it's cold. Anything below 90F will feel uncomfortable in the house.

Geothermal Heat Pump Advances

DANDELION'S APPROACH

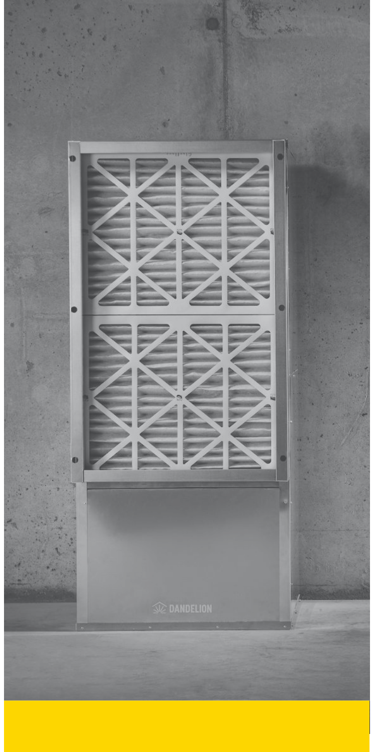
Ground source heat pumps have been around since the 1940s

Dandelion is using product innovation to standardize installation and drive down costs

Our goal is to make geothermal accessible to every home

"Suburban" rig suites

Smaller rig suites allow us to access homes with smaller footprints



Software-driven precision

Integrated software and hardware allows us to reduce costs

Focus on Service

Our goal is to make home improvement stress free

MI Opportunity and Market Barriers

Key Initial Residential Segments in Michigan

Heating Fuel	# of HHs in MI	Potential Annual Geo Heating Savings	Potential Annual Geo Carbon Savings
Propane	336k	$1,500+	Up to 65%
Fuel Oil	42k	$1,500+	Up to 80%

Other segments:

- Customers with electric resistance heating
- New homes

Standardized Per Ton Incentives are Missing in Michigan

Incentives from leading states offer meaningful per-ton incentives.
Average residential systems are 4-5 Tons.

NY Utility Incentives:

Utility Incentive	$ per ton	Total for 5T system
Central Hudson	$2,000	$10,000
ConEd	$2,850	$14,250
National Grid	$1,500	$7,500
NYSEG/RGE	$1,500	$7,500
O&R	$2,000	$10,000

CT Utility Incentives:

Utility Incentive	$ per ton for fuel oil	Total for 5T system
All IOUs	$1,500	$7,500

MA State Incentive:

State Incentive	$ per ton	Total for 5T system
MassCEC Rebate	$2,000	$10,000

MI POWER GRID
Making the Most of Michigan's Energy Future

New Technologies and Business Models

Closing Comments

Stakeholder Meeting 3: Heat Pumps for Space & Water Heating

February 24, 2021

MPSC
Michigan Public Service Commission

Thank You and Please Stay Engaged!

- Thank you for your participation
  - Share your thoughts through:
    - Meeting survey
    - Meeting chat
      - Remains open for comments or discussions after meeting.
      - Easier to access with the Teams App
    - Stakeholder comment section of workgroup website
      - Send a document to be posted to the comment section via email to Joy Wang at WangJ3@Michigan.gov
- Please stay engaged
  - Sign up for the listserv if you have not already
    - Go to MI Power Grid New Technologies and Business Models workgroup page
    - Scroll to bottom to add email
  - Attend future meetings
    - Next meeting on March 10 from 1 – 5 PM
    - Topic: Behind the Meter and Community Solar
  - Speak at a future meeting
    - Limited slots available for stakeholder input/experiences
    - If interested, email: Joy Wang at WangJ3@Michigan.gov

Thank you!