BUREAU OF ENERGY AND
TECHNOLOGY POLICY

Slides for the morning and afternoon sessions are in separate decks. This is the **morning** deck.

September 22, 2022

Heat Pump Barriers & Market Strategies

Technical Session 2

CT 2022 Comprehensive Energy Strategy

Session is being recorded

Logistics & Housekeeping

- **This session is being recorded**
- **Please include your name and affiliation (if any) in your Zoom icon**
- **Please turn off your audio and video except when speaking**
- **To enter the queue to provide verbal comment, use Zoom's *raise hand* feature (more details will be provided later)**
- **Use the chat function to ask questions about presentations or procedures.**

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Today's Agenda – Morning

Click on agenda section heading to jump to corresponding slides

General Introduction	9:00-9:30 am
Public Comment	9:30-9:45 am
Heat Pump Market Overview	9:45-10:40 am
Q&A	10:40-10:55 am
Barriers to Adoption	10:55 am -12:15 pm
Q&A	12:15-12:30 pm
------------------------------LUNCH--------------------------------	12:30-1:00 pm

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Today's Agenda – Afternoon

Slides for the morning and afternoon sessions are in separate decks. This is the **morning** deck.

Market Transformation 1	1:00-1:50 pm
Q&A	1:50-2:00 pm
Market Transformation 2	2:00-2:50 pm
Q&A	2:50-3:05 pm
Deployment in Affordable Housing	3:05-4:20 pm
Q&A	4:20-4:35 pm
Public Comment	4:35-4:50 pm
Wrap Up	4:50-5:00 pm

Tomorrow's Agenda – Morning

Slides for tomorrow's session are in a separate deck.

General Introduction & Recap	9:00-9:20 am
Public Comment	9:20-9:35 am
Co-Delivery of Heat Pumps with Other Measures	9:35-10:30 am
Q&A	10:30-10:45 am
Incentives and Measure Delivery	10:45 -11:30 am
Q&A	11:30-11:45 pm
Wrap Up	11:45-11:55 pm
--------------------------------LUNCH----------------------------------	12:00-1:00 pm

Technical Session 3: Building Thermal Decarbonization Support Strategies – Starts at 1 pm

UPCOMING TECHNICAL SESSIONS

Session 2 Continued: Building thermal decarbonization, Part B – Heat pump barriers & market strategies

Part B: Friday, Sept. 23, 2022, from 9 a.m. to noon ET

Session 3: Building thermal decarbonization – Support strategies

Friday, Sept. 23, 2022, from 1 p.m. to 5 p.m. ET

Session 4: Building thermal decarbonization – Economic potential & technology targets

Thursday, Oct. 6, 2022, from 9 a.m. to 5 p.m. ET

Other sessions on Electric Demand Response and Alternative Fuels to be announced for October

More information on the CES webpage: https://portal.ct.gov/DEEP/Energy/Comprehensive-Energy-Plan/Comprehensive-Energy-Strategy

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Technical Session	Meeting Date(s)	Deadline for Written Comments
2	Sept. 22, 2022 9 a.m. - 5 p.m. ET Sept. 23, 2022 9 a.m. - noon ET	Oct. 7, 2022, at 5:00 p.m. ET
3	Sept. 23, 2022 1 p.m. - 5 p.m. ET	Oct. 7, 2022, at 5:00 p.m. ET
4	Oct. 6, 2022 9 a.m. - 5 p.m. ET	Oct. 21, 2022, at 5:00 p.m. ET

Written Comment Opportunities

- **After each technical session DEEP is accepting written comments – deadlines vary**
- **Please see the August 18th notice for submission instructions and specific questions for which DEEP is seeking responses**
- **More information on the CES web page: https://portal.ct.gov/DEEP/Energy/Comprehensive-Energy-Plan/Comprehensive-Energy-Strategy**

WELCOME & INTRODUCTIONS

Thanks for joining our technical session today!

Comprehensive Energy Strategy Scope & Objectives

- **Scope**: electricity, thermal energy, and fuels for transportation

- **Objectives:**
  - Examine future energy needs in the state and identify opportunities to reduce costs, ensure reliable energy availability, and mitigate public health and environmental impacts of CT's energy use
  - Provide recommendations for legislative and administrative actions to aid in achievement of interrelated environmental, economic, security, and reliability goals

BETP Mission: to manage energy, telecommunication, and broadband policy issues and program deployment with the goal of establishing a clean, economical, equitable, resilient, and reliable energy future for all residents.

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DEEP's Approach to the 2022 CES

5 Key Lenses

- **Climate** – meeting greenhouse gas reduction obligations under Global Warming Solutions Act
- **Equity** – energy decisions that produce equitable outcomes
- **Affordability** – energy decisions that produce affordable outcomes
- **Economic development** – workforce development; economic competitiveness
- **Reliability & Resilience** – energy system improvements and load balancing

Key Strategies

- Build on and/or modify findings and recommendations of 2013 and 2018 CESs
- Consider emerging issues not addressed in a prior CES
- Rely on results from recent, major quantitative studies where appropriate rather than duplicate efforts

3 Factors to Consider in all CES Technical Sessions

1. **The carbon intensity of the electric grid**
   - Impacts the speed at which electrification can support decarbonization
2. **Fuel price volatility**
   - Impacts technology affordability and access, as well as growth of the clean energy economy
3. **Need for emission-reduction solutions that facilitate climate change adaptation, resilience, and energy security**
   - Impacts solution selection strategies and requires solutions to optimize a variety of needs

Tentative CES Development Timeline

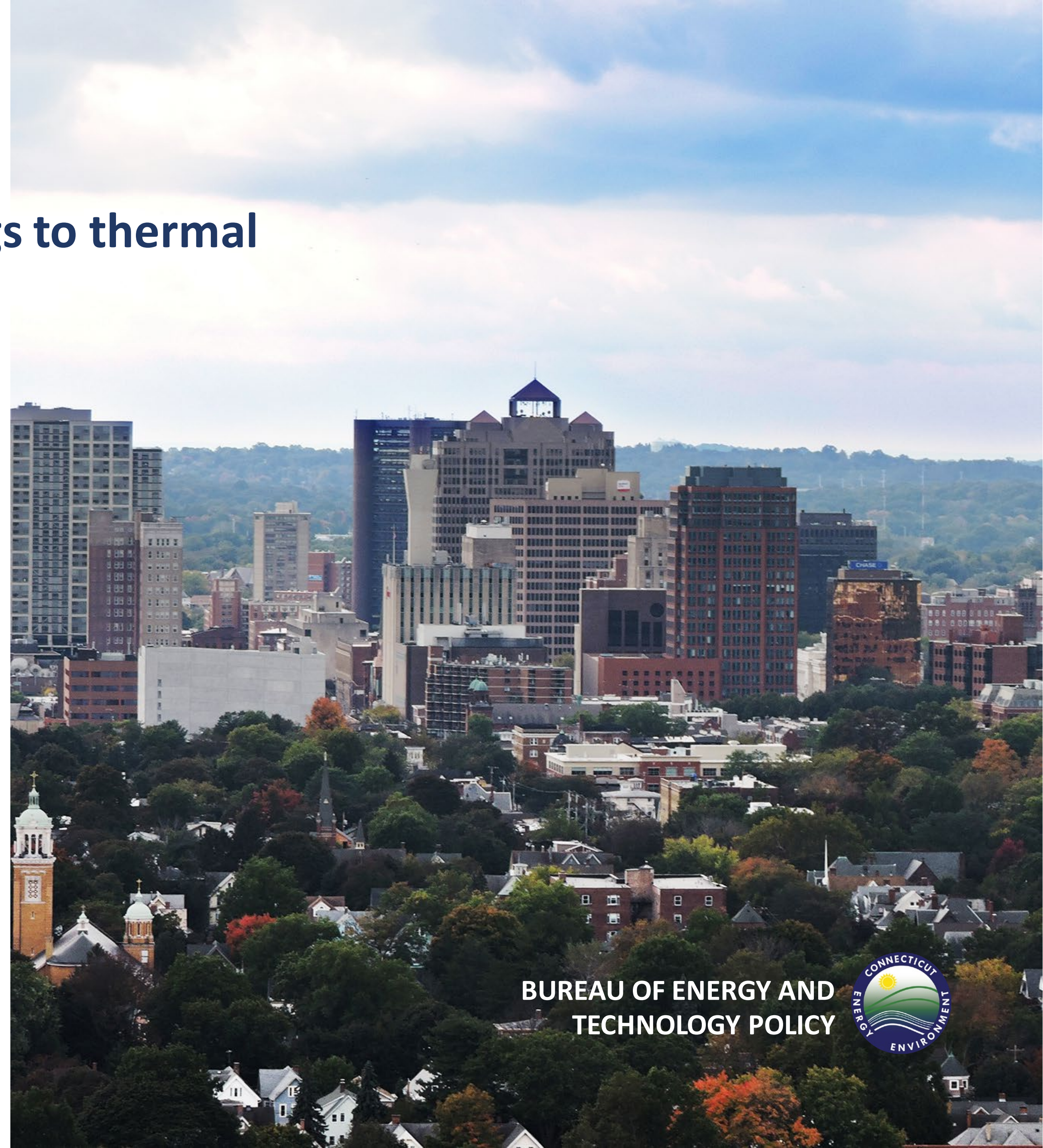
- **September 2022** – Technical Sessions 1-3
- **October 2022** – Technical Sessions 4-6
- **November 2022** – Technical Sessions 7 & 8
- **October 2022 – January 2023** – Drafting & Public Comment Periods for at least 3 White Papers
    - White papers to be based on topics covered in technical sessions
- **Q1 & Q2 of 2023** – CES Drafting, Public Comment Opportunities, & Listening Sessions

Technical Session Topics

1. **Hard-to-Decarbonize End Uses**
2. **Heat Pump Market Barriers & Strategies**
3. **Building Thermal Decarbonization Support Strategies**
4. **Building Thermal Decarbonization – Economic Potential & Technology Targets**
5. **Electric Demand Response**
6. **Alternative Fuels**
7. **Natural Gas Planning & Policies**
8. **Carbon Pricing & Low-Carbon Incentives**

Why devote several CES technical meetings to thermal decarbonization of buildings?

- Integrated Resources Plan issued in 2020 (and updated 2022) addressed electricity grid decarbonization
- EV Roadmap issued in 2020 addressed transportation decarbonization
- Combustion of fossil fuels in residential and commercial buildings accounts for nearly one-third of statewide greenhouse gas emissions
- CES will provide overarching strategy for building decarbonization



Deep reductions in use of thermal fossil fuels are needed for CT to satisfy the Global Warming Solutions Act (GWSA)

*Between 2001 and 2018, **residential** thermal emissions from combustion of fossil fuels fell 10.6% -- far less than the 26.4% reduction the GWSA's 2030 economy-wide target implies was needed.*

- *To bring emissions in line with the 2030 target will require reducing them 3.6 times faster between 2018 and 2030.*

*Between 2001 and 2018, **commercial** emissions from combustion of fossil fuels were essentially unchanged.*

- *This means that the full 45% reduction the GWSA's 2030 economy-wide target implies will need to be accomplished between 2018 and 2030.*

*In **both sectors**, fossil fuel emissions will need to continue decreasing sharply between 2030 and 2050.*

Non-climate benefits of thermal decarbonization

Long-term energy affordability

Health and safety improvements

Enhanced comfort

Regional workforce development

A number of renewable thermal technologies can significantly reduce building GHG emissions

Heat pumps for space and water heating

Biodiesel and renewable diesel for space heating

Solar water heating

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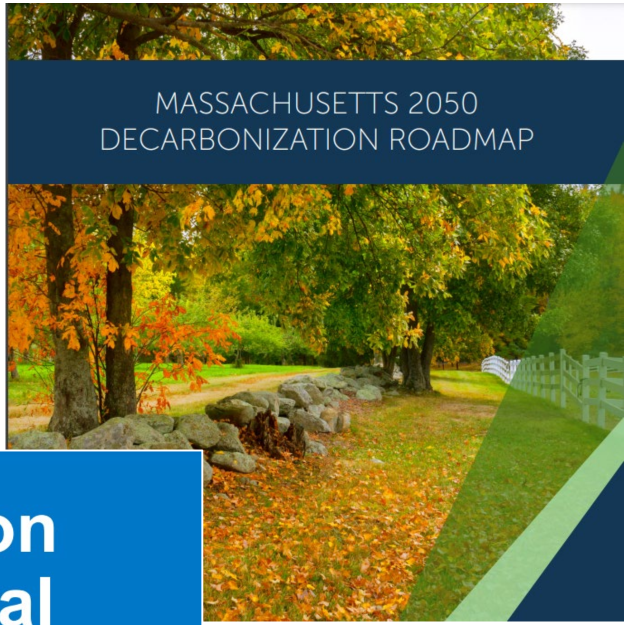
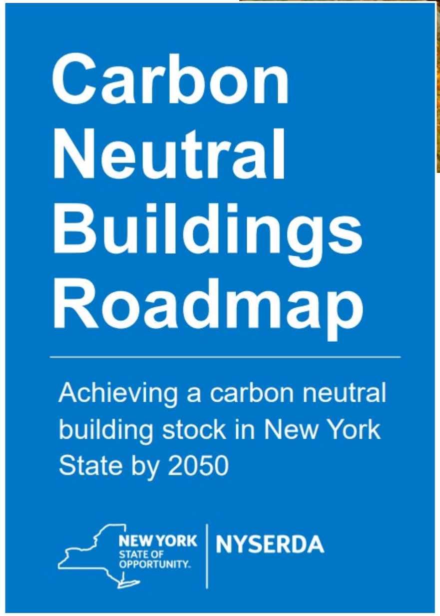
Thermal electrification via heat pumps is a key decarbonization strategy across U.S. and Northeast

Advantages of heat pumps

- High efficiency
- Investment in a single appliance provides both heating and cooling
- As electricity grid is decarbonized:
  - Heating is decarbonized
  - Decreased reliance on imported thermal fuels
  - Improved resilience





What is a heat pump?

Traditional examples: refrigerators, freezers, air conditioners

Employs mechanical engineering principles to move heat from one place to another

In heating mode, harvests renewable heat from atmosphere, ground, or water body

In space-conditioning applications, provides both heating and cooling

Types:

- Air source (as above)
- Ground source
- Heat pump water heater

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Heat pumps in current CT policies and programs

Conservation & Load Management Program

- Heat pump incentives
- Heat Pump Consultation Service
- Heat Pump Installer Network
- Increased emphasis on heat pumps on Energize CT

Weatherization Assistance Program

- Proposed heat pump pilot
- Accelerated deployment of heat pumps expected with new federal funding

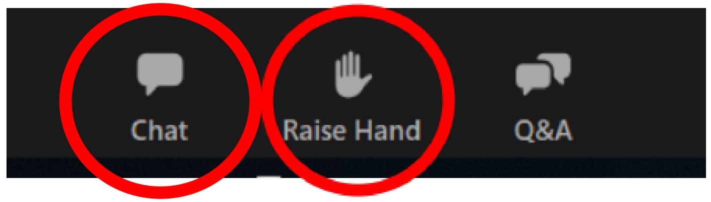
Heat pumps in state-owned group homes

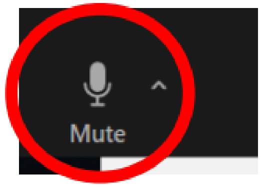
- Pilot installation in 2 facilities, one paired with solar PV
- More homes are scheduled for evaluation for HPs

Executive Order 21-3 requires development of plans to:

- retrofit existing fossil fuel-based heating and cooling systems at state buildings to systems capable of being operated without carbon emitting fuels
- achieve zero-GHG emissions for all new construction and major renovations funded by the state or in facilities owned/operated by the Executive Branch

Questions and Comments





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At the conclusion of each panel DEEP will hold a brief question and answer period.

If you have a question for a presenter, please drop it into the chat to Jeff Howard. DEEP will pose as many questions as time allows to the speakers. Clarifying questions will be prioritized. Leading questions will not be accepted.

If you would like to make a comment during the public comment periods:

- Please use the “Raise Hand” feature if you would like to speak
- After any interested elected officials have provided their comments, you will be invited to provide your comment in the order the hands were raised
- Please unmute yourself, state your name and affiliation
- Given time limitations, please limit your comment to 2 minutes.
- After your comments, please remember to click the “Mute” button

General Public Comment

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Heat Pump Market Overview

Lisa Skumatz, Robert Wirtshafter, Jared Powell, & Sam Manning – CT Energy Efficiency Evaluation Team & NMR Group, Inc.

Griffith Keating & George Lawrence – CT Energy Efficiency Board Consultants

Kate Donatelli & Rebecca Dube – CT DEEP, Bureau of Energy & Technology Policy

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(speaker order may vary)

CT Energy Efficiency Evaluation Team & NMR Group, Inc.

High Level Findings on CT's Residential HP Market Characterization

Extracted from results from HP MarketsR1965 HP/HPWH Baseline and Market Characterization & R2027 HP/HPWH Reliability Study by Jared Powell and Tom Ledyard, NMR for CT EEB

Presenters:
Lisa Skumatz and Robert Wirtshafter, Evaluation Administrator Team, CTEEB
Slides prepared by NMR Group

Key Outputs from the HP Study

- Describe the size of the heat pump market
- Describe market actor roles and perspectives
- Describe likely system configurations and applications
- Assess end user satisfaction and product reliability
- Review customer cost-effectiveness by system configuration

Main Takeaways

The CT market is poised to take off with continued program intervention.

Market actors are generally interested in and comfortable with heat pump technologies, with some gaps that can be overcome.

Heat pump end users reported high levels of reliability and satisfaction with the technology.

CT has underperformed in terms of sales volume compared to neighboring states.

There are opportunities in CT to boost heat pump usage and installation rates.

Heat Pump Definitions and Acronyms

MSHP: Mini or Multi-split heat pump

- Can serve a single or multiple zones
- Often ductless, but can be ducted
- Inverter driven

ASHP: Air-source heat pumps

- Air-to-air and air-to-water; most residential systems are air-to-air
- Centrally ducted heat pump systems

GSHP: Ground-source heat pumps

- Sometimes called geothermal
- Exchanges heat with underground loops, either in soil or water, to provide heat to a space

HPWH: Heat pump water heater

- Tank-style water heater that heats water using the surrounding air (via the heat pump)

MARKET CHARACTERIZATION – HP & HPWH

What's the story with MSHPs in CT?

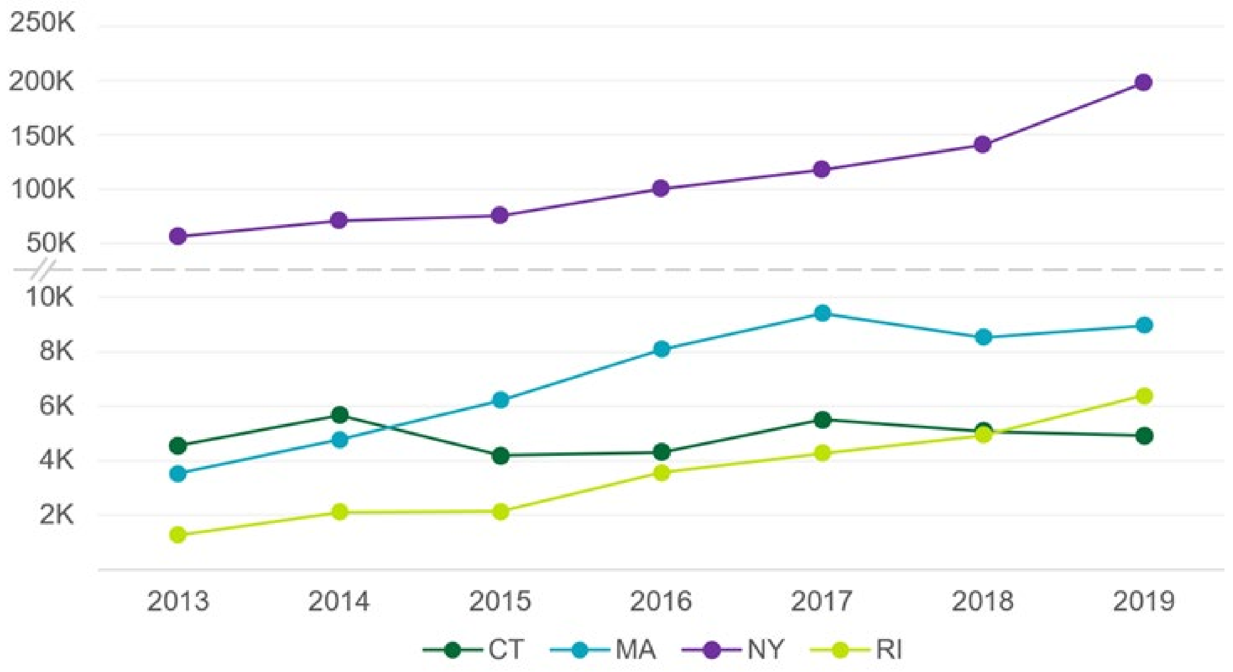
What did the CT MSHP market look like compared to neighboring states from 2013 to 2019?

Market flat in CT – but growing in MA, RI, NY

Average SEER and HSPF for CT MSHPs increased but was lowest in the region in 2019

CT lowest in region for proportion of higher efficiency MSHPs in market but had highest growth in the region (59% in 2013 to 84% in 2019) (catching up)

Regional Estimated Annual Equipment Unit Sales for MSHPs (2013-2019), HARDI



RW

What's the story with MSHPs in CT?

What did distributors and installers say about MSHP Market Trends in CT?

Heat Pump Installations (All Kinds):	~29% of HVAC installations in existing homes
	~38% of HVAC installations in new homes
Cold Climate MSHPs:	Installers: 74% are ccMSHPs Distributors: 48% are ccMSHPs
	Incremental cost for cold climate equipment (excluding labor): Installers: ~19% Distributors: ~21%

- MSHPs were well stocked and consumer demand was high
- Ductless MSHPs most common configuration being sold and installed in CT
- Ducted and partially ducted MSHPs becoming increasingly popular; ~48% of new construction MSHP installations

RW

What's the story with MSHPs in CT?

What are the common MSHP installation scenarios?

Installers

MSHPs most commonly installed as supplemental system rather than whole-home heating system

MSHPs were being installed in homes with oil and electric resistance heat

Installers frequently recommended MSHPs to customers; most customers (63%) accepted their recommendations indicating the market is ready to accept HPs, subject to installer confidence

Most often recommended heat pumps to homeowners looking for additional heating or cooling and homeowners in existing homes

End Users

Existing system before install:

- 57% working with no need of repair
- 34% in need of major or minor repair
- 4% no longer working

Heating installation characteristics:

- 55% heat spaces also served by other systems
- 25% heat all or most of home
- 9% home's only heating system

Primary heat pre/post install:

- Oil: Pre – 48% / Post – 42%
- Electric: Pre – 22% / Post – 33%
- Natural Gas: Pre – 15% / Post – 13%

What's the story with ASHPs in CT?

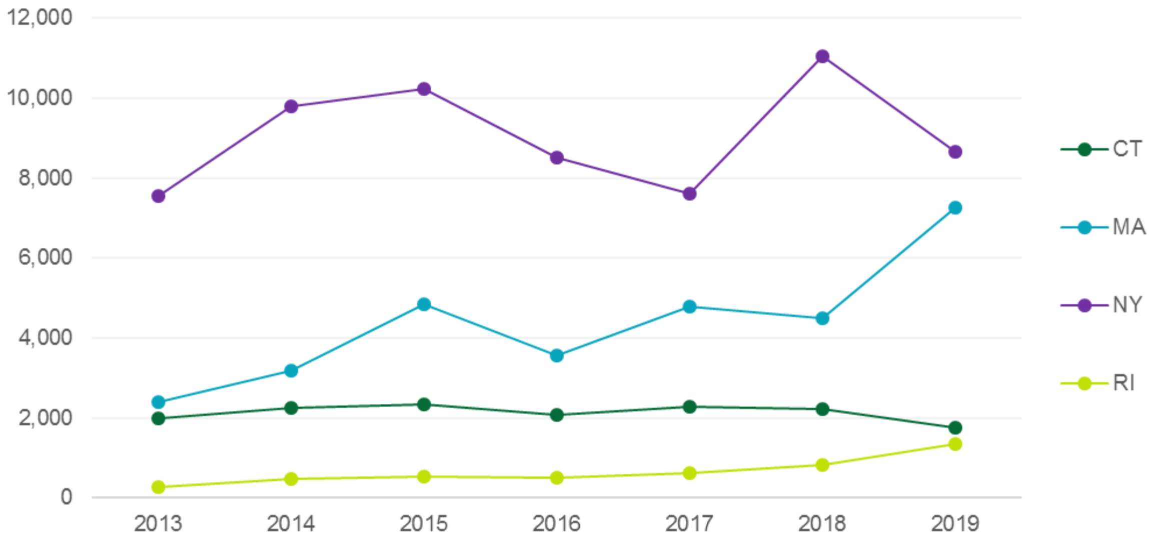
WHAT DID THE CT ASHP MARKET LOOK LIKE COMPARED TO NEIGHBORING STATES FROM 2013 TO 2019?

CT ASHP market size relatively flat from 2013 to 2018, dropped by 21% in 2019

2019 drop contrasted with regional market where periods of growth were higher than in CT

Estimated average SEER and HSPF for CT ASHPs increased but was lowest in the region in 2019, showing room for shift to inverter-driven systems

Regional Estimated Annual Equipment Unit Sales for ASHPs (2013-2019), HARDI



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What's the story with ASHPs in CT?

What did the CT ASHP market look like compared to neighboring states from 2013 to 2019?

The proportion of high-efficiency equipment in Connecticut was less than the proportion in surrounding states from 2013 to 2019, but ASHPs inherently less efficient than ductless

2020 Program Incentives	**ASHP split system:** $500 SEER: 16.0 / HSPF: 10.0 (2021 – HSPF: 9.5)
	ASHP displacing ER heat: $1,000 SEER: 16.0 / HSPF: 10.0
Distributor and Installer Feedback	ASHPs were a small portion of HP sales; ducted, inverter driven models replacing traditional non-inverter systems

Proportion of Annual ASHP Units Sold by Efficiency (SEER and HSPF)

What's the story with GSHPs in CT?

What did the CT GSHP market look like from 2017 to 2019?

Small, niche market

- <200 installs each year
- Over one-half in new homes
- High savings, high upfront costs

Interviewees report no significant changes

Estimated program market share down, but small market denominator

- Ranges: 46-69% in 2017 to 29%-51% in 2019

Expensive, with limited program funding

- Program Incentives: $750 - $1,500/ton, downstream, $15k max
- Inconsistent funding outside program (CEFIA and federal tax credits)

GSHP Market Size
(Ranges based on different data sources)

Year	High: Based on CT, MA, and RI Data	Middle (Average)	Low: CT Data Only
Residential retrofit			
2017	78	66	59
2018	42	29	22
2019	49	36	29
New construction			
2017	85	68	52
2018	92	72	53
2019	95	73	52
Total GSHP market			
2017	164	135	111
2018	133	102	75
2019	144	110	81

What's the story with HPWHs in CT?

What did the CT HPWH market look like from 2016 to 2019?

Growing market with potential:

- RASS confirmed over half of SF homes could readily accommodate them
- Large portion of market with oil, electric, and propane

Market actors report highly incentive dependent (90+% incentivized)

- Incentives for large tanks temporarily went away
- Sales of large tanks dropped

Program incentives: Require HPWHs for

- 2019: $750, < 55 gallons
- 2020-2021: $750, <55 gallons; $400 for 55+ (2015 federal mins require HPWH for 55+)

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RELIABILITY & MARKET BARRIERS – HP & HPWH

What's the story with Heat Pumps and HPWHs in CT?

WHAT DO END USERS IN CT THINK ABOUT HP AND HPWH RELIABILITY?

End Users

Service: regular preventative maintenance or tune-up

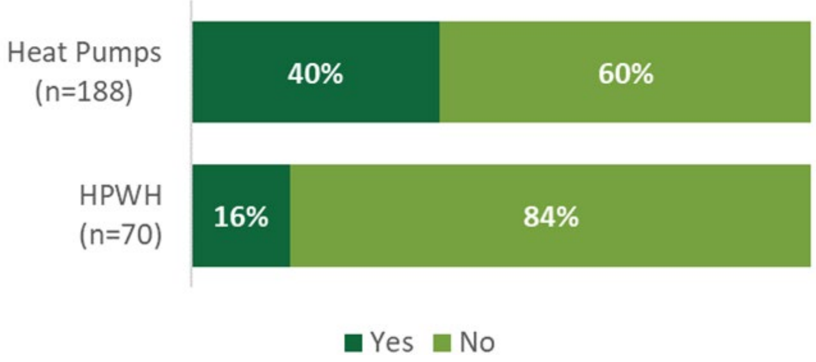
Repair: fixing a problem

40% of HVAC heat pump users and 16% of HPWH users reported having service or repair since install

HP Repair visits: HVAC HP average ~0.5 visits per year across all customers; for those with a visit, average 1-2 visit/year since installation. Service visits 35% ($248)

HPWH Repair visits: 0.1 visits per year across all customers; <1 visit per year for those receiving visits. (Service visits 13%, $205)

Heat Pump and HPWH Service or Repair Needed

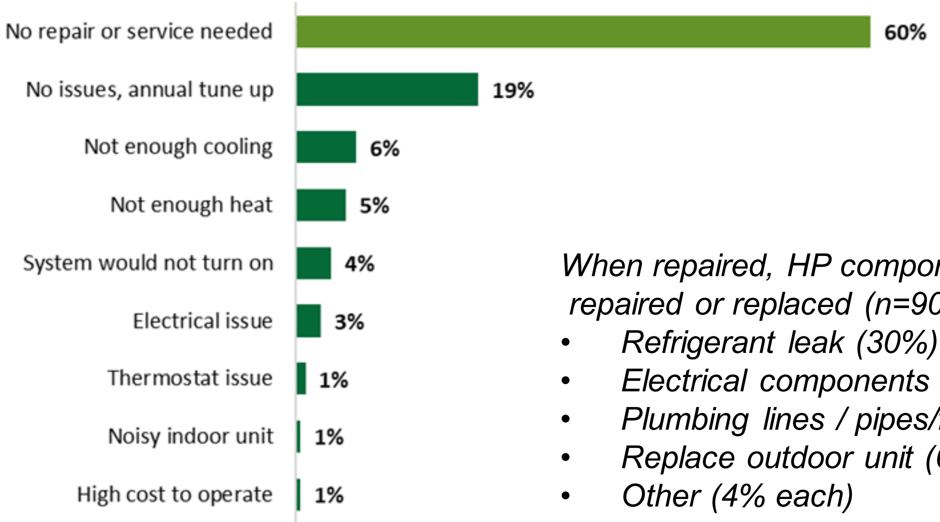


Among those reporting repair or service, over one-half were annual tune ups with no actual problem reported

Nearly half of MSHP end users needing repairs (47%) reported paying nothing out of pocket

The <u>most common issues</u> were not enough cooling or not enough heat; for 4% of end users the system would not turn on (for various reasons)

Reason for HVAC Heat Pump Service or Repair (n=188)



When repaired, HP components repaired or replaced (n=90):

- *Refrigerant leak (30%)*
- *Electrical components (28%)*
- *Plumbing lines / pipes/fittings (10%)*
- *Replace outdoor unit (6%)*
- *Other (4% each)*

LS

What's the story with Heat Pumps in CT?

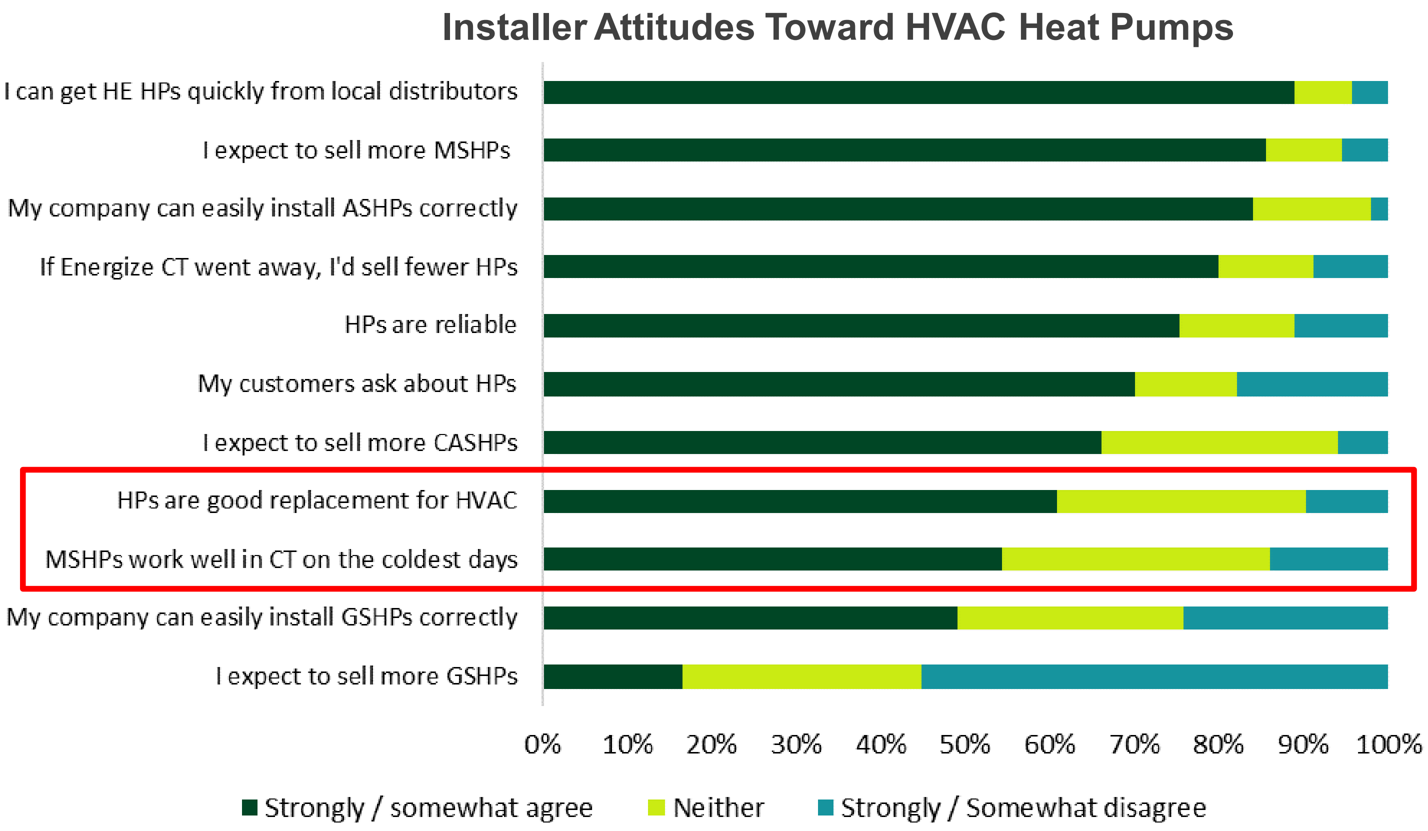
What are Heat Pump barriers to adoption in CT?

Installers and Distributors

Most contractors with HP experience report they are **available**, **reliable**, and increasingly **popular**

Some installers still skeptical about whole home / cold weather performance

Lower marks for GSHPs (not often installed by surveyed contractors)

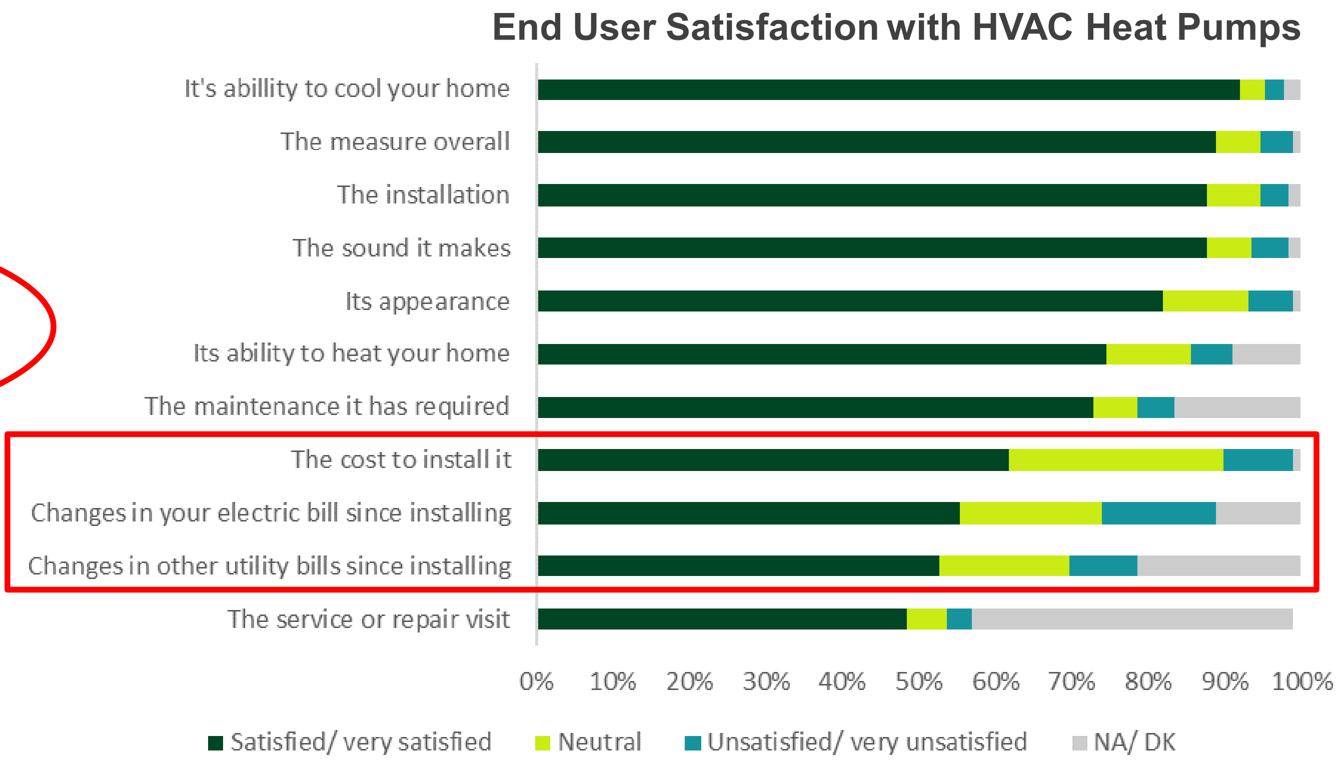


What's the story with Heat Pumps in CT?

What are Heat Pump barriers to adoption in CT?

End Users

- Overwhelmingly positive satisfaction metrics, overall (89%) and for potential problem areas
- Largest issue is cost and electric and utility bill savings not meeting expectations
- 40% of heat pumps end users reported having a repair or service visit. Almost half of these were annual tune-ups with no issue reported
- Most common issues reported were not enough cooling (6%) or heat (5%)



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What's the story with HPWHs in CT?

What are HPWH barriers to adoption in CT?

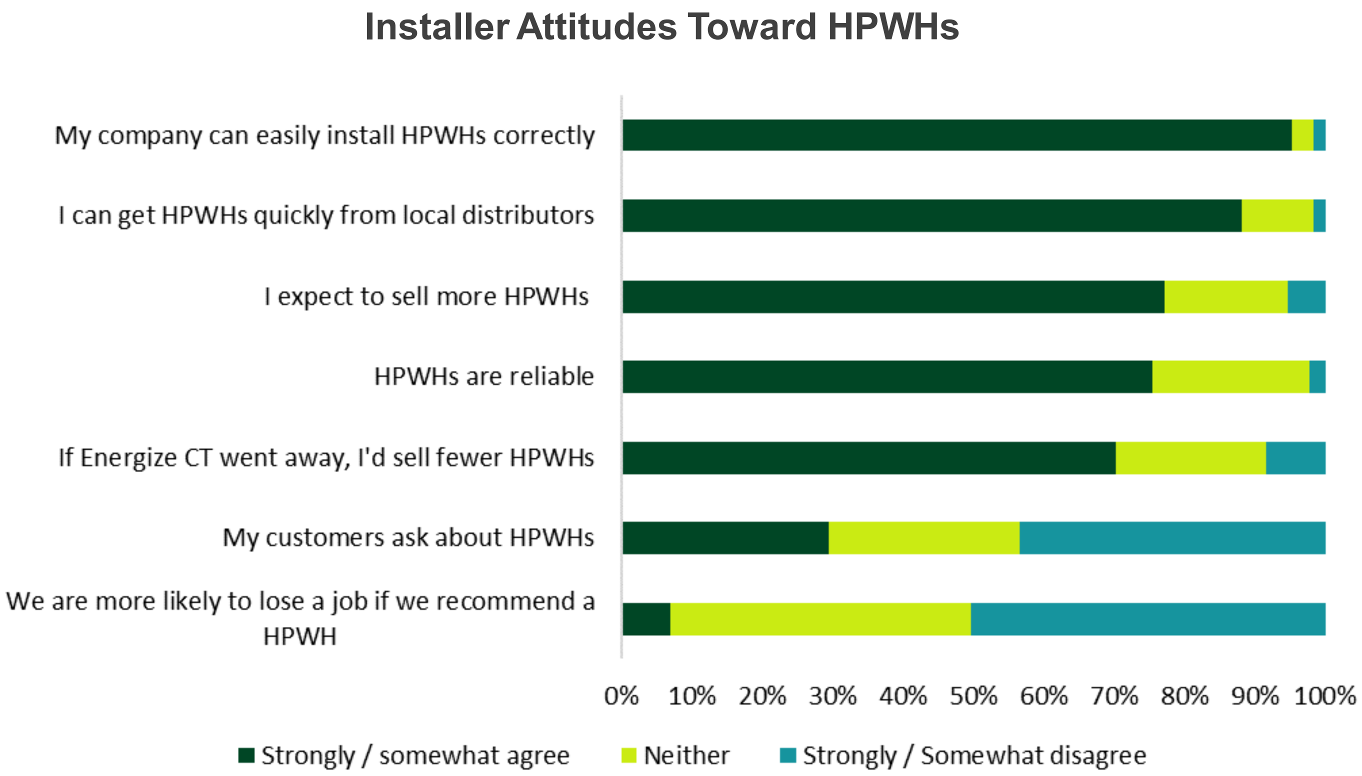
Installers and Distributors

Low customer awareness: 30% of installers said customers ask for them

Like-for-like is the easy recommendation

More install barriers than resistance: noise, condensate, makeup air, etc.

Clear opportunity: installers can install them easily and they are readily available; only 7% agreed that HPWH recs cause them to lose a job



What's the story with HPWHs in CT?

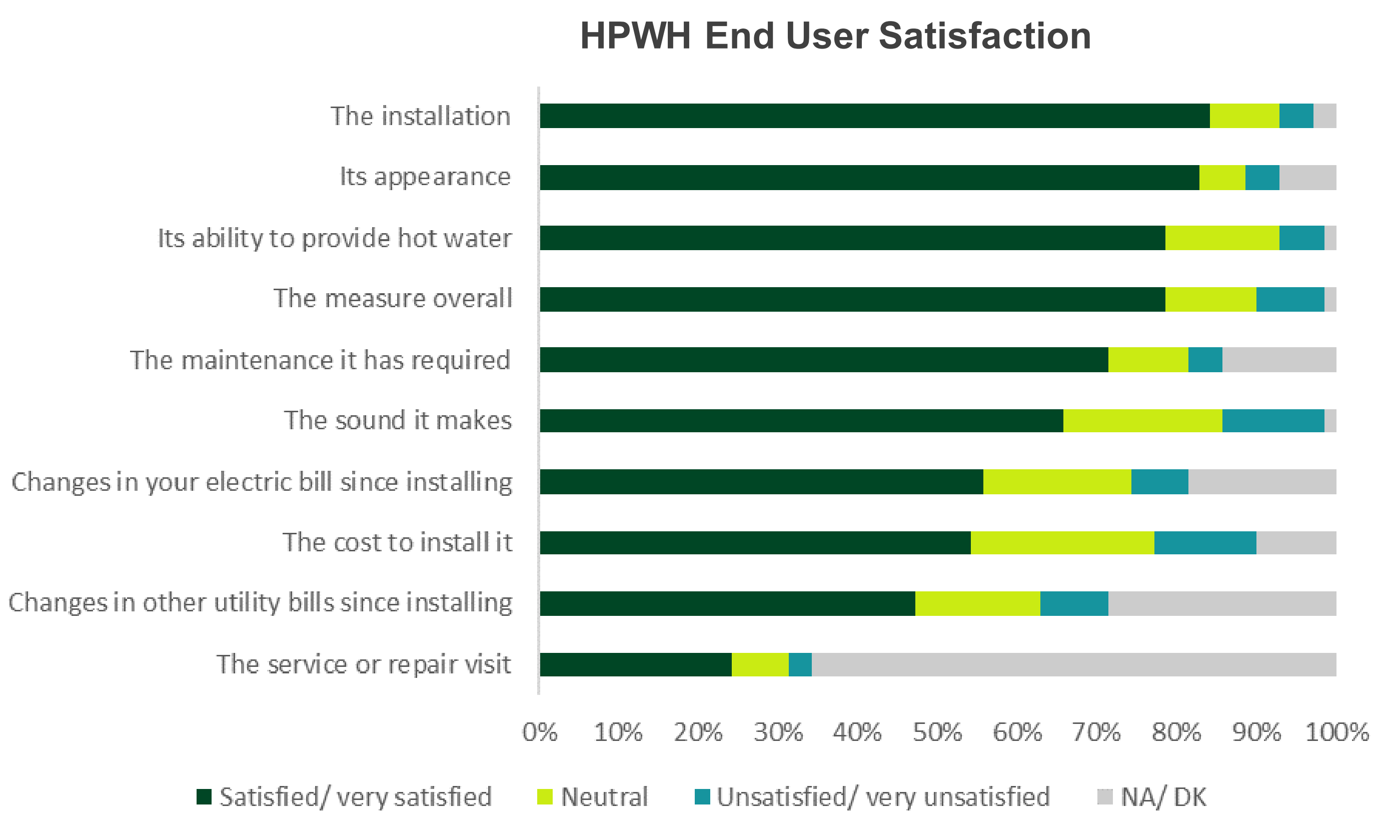
WHAT ARE HPWH BARRIERS TO ADOPTION IN CT?

End Users

Overwhelmingly positive satisfaction metrics, overall (79%) and for potential problem areas

Noise and cost the largest negative ratings, but minor issues overall

Very low rates of repair. 16% reported having a service or repair visit, half of those were annual tune-ups



Summary of Program Recommendations

- Change program design to focus on both sales and usage of heat pumps
- Include delivered fuels in baseline scenarios
- Increase technical and sales expertise of installers and distributors
- Increase program support and resources to participating distributors
- Work with distributors and retailers to stock HPWHs for same day replacement
- Improve program tracking data quality
- Further investigate opportunities to refine the program(s) and track market progress

RW

Questions / Discussion?

CT Energy Efficiency Board Consultants

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Empowering you to make smart energy choices

Heat Pump Customer Costs

For the DEEP CES Technical Session #2

Energy Efficiency Board Technical Consultants

September 22, 2022

Key Assumptions

- Energy Costs
  - Oil price is from the most recent CT state fuel price survey
  - Propane price is from the most recent EIA CT price survey
  - Natural Gas price is EIA CT residential average
  - Electric price is EIA CT residential average
- Projections
  - All energy prices were projected to change proportionally with AESC projections. Initial years were tweaked to give a more realistic ramp from current prices
- Loan rates
  - Financing analysis was run at a 0.99% APR for a 10-year term as per the Heating Loan Program

Scenarios Analyzed

- Full Displacement
  - Full displacement measures were assumed to provide the entire heating needs of the building, with an electric resistance backup that could be used in sub-zero temperatures.
- Partial Displacement
  - Partial displacement values were assumed to provide heating down to 24 degrees for Residential and 30 degrees for C&I, below which existing fossil fuel equipment would provide heat.
- AC blend for Residential, AC for C&I
- Replace on Burnout assumes the project is triggered by the failure of the existing air conditioning system

Residential Ductless Mini Split

Ductless Mini Split Heat Pump	Natural Gas		Oil		Propane	
Customer Savings or (Costs)	First Year	Life Cycle	First Year	Life Cycle	First Year	Life Cycle
Full Displacement	$ (287)	$ (22,202)	$ 415	$ 1,598	$ 1,718	$ 26,512
Partial Displacement down to 24°F Switchover	$ (575)	$ (23,065)	$ (47)	$ (3,443)	$ 1,169	$ 19,293

- Baseline Technology: Boiler and AC Blend
- Replace on Burnout (ROB)

Residential Ducted Heat Pumps

Ducted Heat Pump	Natural Gas		Oil		Propane	
Customer Savings or (Costs)	First Year	Life Cycle	First Year	Life Cycle	First Year	Life Cycle
Full Displacement	$ (1,140)	$ (26,265)	$ (334)	$ (4,919)	$ 528	$ 11,972
Partial Displacement down to 24°F Switchover	$ (724)	$ (20,398)	$ (56)	$ (2,462)	$ 697	$ 12,151

- Baseline Technology: Furnace and AC Blend
- Replace on Burnout (ROB)

Residential Ground Source Heat Pumps

Ground Source Heat Pump	Natural Gas		Oil		Propane	
Customer Savings or (Costs)	First Year	Life Cycle	First Year	Life Cycle	First Year	Life Cycle
Full Displacement	$ (2,093)	$(39,616)	$ (1,286)	$ (1,089)	$ (424)	$ 27,429

- Baseline Technology: Furnace and AC Blend
- Replace on Burnout (ROB)

Commercial Ductless Mini Split

Ductless Mini Split	Natural Gas		Oil		Propane	
Customer Savings or (Costs)	First Year	Life Cycle	First Year	Life Cycle	First Year	Life Cycle
Full Displacement	$ (180)	$ (26,162)	$ 968	$ 7,729	$ 2,412	$ 36,795
Partial Displacement down to 30°F Switchover	$ (600)	$ (20,410)	$ (3)	$ (2,813)	$ 746	$ 12,278

- Baseline Technology: Boiler and Air Conditioning
- Replace on Burnout (ROB)

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Commercial Ducted Heat Pump

Ducted Heat Pump	Natural Gas		Oil		Propane	
Customer Savings or (Costs)	First Year	Life Cycle	First Year	Life Cycle	First Year	Life Cycle
Full Displacement	$ (1,106)	$(35,877)	$ 56	$ (3,617)	$ 1,517	$ 24,233
Partial Displacement down to 30°F Switchover	$ (840)	$(23,630)	$ (202)	$ (5,932)	$ 599	$ 9,347

- Baseline Technology: Furnace and AC
- Replace on Burnout (ROB)

C&I VRF and Dedicated Outdoor Air Sys.

VRF and DOAS	Natural Gas		Oil		Propane	
Customer Savings or (Costs)	First Year	Life Cycle	First Year	Life Cycle	First Year	Life Cycle
Full Displacement	$ (1,122)	$(57,327)	NA	NA	NA	NA
Partial Displacement down to 30°F Switchover	NA	NA	NA	NA	NA	NA

- Variable Refrigerant Flow heat pump system combined with a Dedicated Outdoor Air System
- 4000 Square Feet Coverage
- Baseline Technology: Roof Top Unit
- Replace on Burnout (ROB)

energize CONNECTICUT CT℠

C&I Ground Source Heat Pump

Ground Source Heat Pump	Natural Gas		Oil		Propane	
Customer Savings or (Costs)	First Year	Life Cycle	First Year	Life Cycle	First Year	Life Cycle
Full Displacement - Boiler	$ (201)	$ (21,597)	$ 871	$ 23,068	$ 2,218	$ 59,903
Full Displacement - Furnace	$ (1,139)	$ (29,194)	$ (67)	$ 15,471	$ 1,280	$ 52,306

- Baseline Technology: Boiler / Furnace and AC
- Replace on Burnout (ROB)

Ground Source Heat Pump	Electricity	
Customer Savings or (Costs)	First Year	Life Cycle
New Construction	$ 297	$ 26,257

- Baseline Technology: Variable Refrigerant Flow
- New Construction

Questions?

CT DEEP, Bureau of Energy & Technology Policy

BUREAU OF ENERGY AND TECHNOLOGY POLICY

September 22, 2022

Inflation Reduction Act Heat Pump Opportunities

Rebecca Dube
CT DEEP

What is the IRA?

The recently passed Inflation Reduction Act is a bill that includes billions in funding to bring down consumer energy costs and increase American energy security.

These programs will help Connecticut meet the state goal of a 45% reduction in carbon emissions by 2030 and assist in climate change resiliency and adaption efforts.

This bill will fight high energy costs for residents, particularly low-income residents, through rebates, tax credits, and grants.

Rebates

Home Energy Performance-Based, Whole-House Rebates (HOMES)

Awards grants to state energy offices to establish a rebate program for homeowners for whole-house energy efficiency retrofits where the amount of rebate is based on modeled or measured energy savings and are higher for low to moderate income households. Rebates are available for both single-family and multifamily homes.

Expected Funds: ~$59 million

Rebates

Single Family

- Modeled energy system savings of 20 – 35%
  - $2,000; or 50 percent of the project cost
- Modeled energy system savings of 35% and up
  - $4,000; or 50 percent of the project cost
- Measured energy system savings of 15%+
  - a payment rate per kilowatt hour saved, or kilowatt hour-equivalent saved, equal to $2,000 for a 20 percent reduction of energy use for the average home in the State; or 50 percent of the project cost.

Multi-Family

- Modeled energy system savings of 20 – 35%
  - $2,000; Max of $200,000
- Modeled energy system savings of 35% and up
  - $4,000; Max of $400,000
- Measured energy system savings of 15%+
  - a payment rate per kilowatt hour saved, or kilowatt hour-equivalent saved, equal to $2,000 for a 20 percent reduction of energy use for the average home in the State; or 50 percent of the project cost.

Rebates

Low- to Moderate-income Households

- Modeled energy system savings of 20 – 35%
  - $4,000 per unit/home; or 80 percent of the project cost
- Modeled energy system savings of 35% and up
  - $8,000 per unit/home; or 80 percent of the project cost
- Measured energy system savings of 15% and up:
  - A payment rate per kilowatt hour saved, or kilowatt hour-equivalent saved, equal to $4,000 for a 20 percent reduction of energy use per single-family home or dwelling unit, or 80% of the project cost.

Low- to Moderate-Income Definition:

An individual or family the total annual income of which is less than 80 percent of the median income of the area in which the individual or family resides.

Rebates

High-Efficiency Electric Home Rebate Program

Awards grants to state energy offices and Indian Tribes to establish a program for low- and moderate-income homeowners for high-efficiency appliance and non-appliance upgrades where the amount of rebate is defined by appliance or upgrade. Rebates are available for both single-family and multifamily homes.

Expected Funds: ~$59 million

Rebates

Heat pump rebates:

- Up to $1,750 for a heat pump water heater
- Up to $8,000 for a heat pump for space heating or cooling

Rebates that support installation/function:

- Up to $4,000 for an electric load service center upgrade;
- Up to $1,600 for insulation, air sealing, and ventilation; and
- Up to $2,500 for electric wiring.

Maximum per home: $14,000

Low- to Moderate-Income Definition:

An individual or family the total annual income of which is less than 80 percent of the median income of the area in which the individual or family resides.

Tax Credits

Extension, Increase, and Modifications of Nonbusiness Energy Property Credit

Extends and triples (30%) the Nonbusiness Energy Property Credit, making it more affordable for homeowners to invest in energy-efficient home improvements, as well as encouraging home energy audits.

Residential Clean Energy Credit

Extends the Energy Efficiency Property Credit and renames it the Residential Clean Energy Credit, making it more affordable for homeowners to install clean energy such as solar (+storage), wind, or geothermal.

30% credit through Dec. 31, 2032, 26% through Dec. 31, 2033, 22% credit through Dec. 31, 2034.

Extension, Increase, and Modifications of New Energy Efficient Home Credit

Extends and increases the credit amounts for energy efficient new construction of Energy Star single family homes, manufactured home, and multifamily buildings.

Single Family: $2,500 for a home eligible to participate in the Energy Star Residential New Construction Program, or $5,000 if it meets the ZERH requirements.

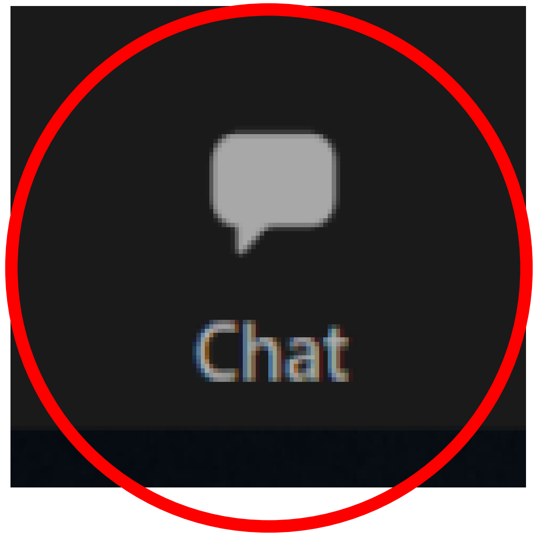
Please Note:

Federal program guidance has not yet been released.

What we do know:

- *Funds for rebate programs will go to State Energy Offices.*
- *SEOs have two years to create and implement programs before funds are redistributed.*
- *An individual cannot benefit from both the HOMES program and high-efficiency electric homes rebate program.*

Questions



At the conclusion of each panel DEEP will hold a brief question and answer period.

If you have a question for a presenter, please drop it into the chat to **Jeff Howard**. DEEP will pose as many questions as time allows to the speakers. Clarifying questions will be prioritized. Leading questions will not be accepted.

Barriers to Adoption

Jeff Howard– CT DEEP, Bureau of Energy & Technology Policy

Joe Uglietto, Charlie Uglietto & Ray Albrecht – Diversified Energy, Chubby Oil, & Clean Fuels Alliance America

Natalia Sudyka & Larry Rush – Eversource & Avangrid

Stephen Pantano – Rewiring America

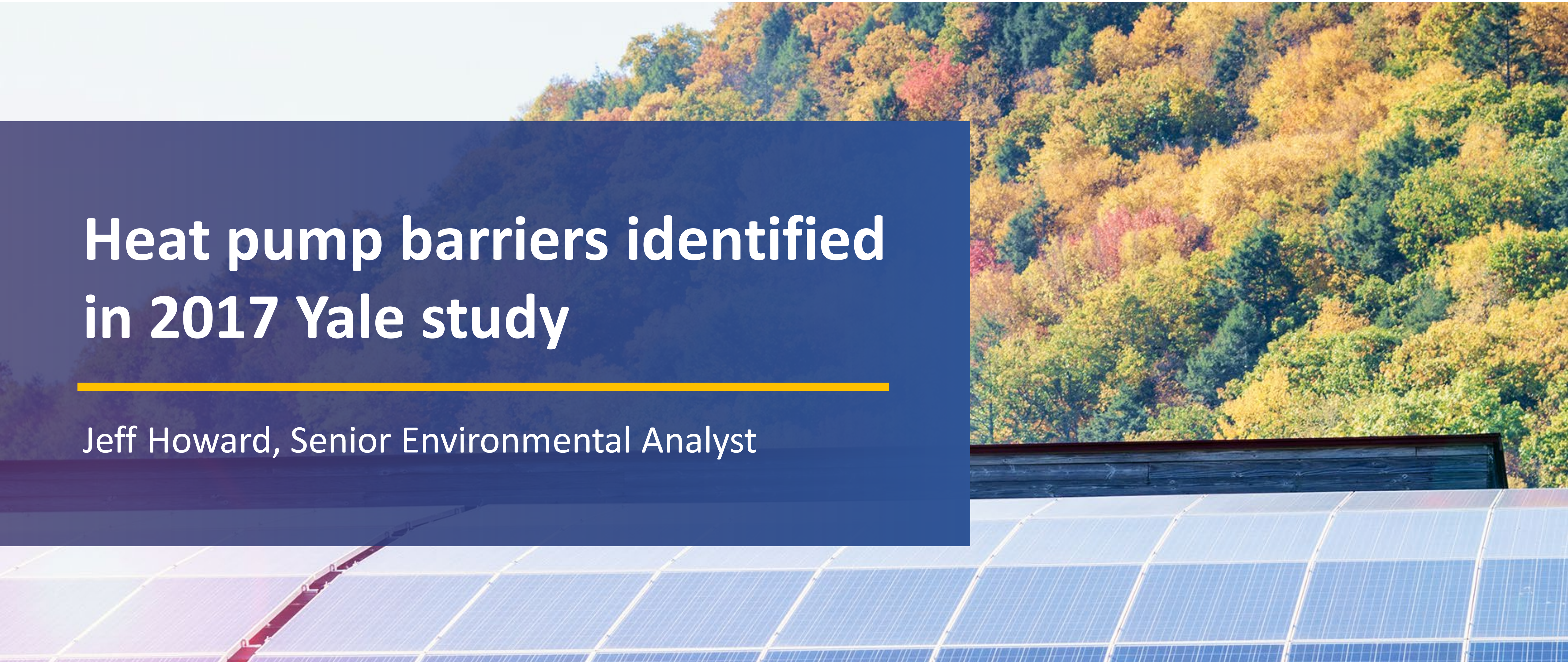
(speaker order may vary)

BUREAU OF ENERGY AND TECHNOLOGY POLICY

CT DEEP, Bureau of Energy & Technology Policy

BUREAU OF ENERGY AND
TECHNOLOGY POLICY

Sept. 22, 2022



Heat pump barriers identified in 2017 Yale study

Jeff Howard, Senior Environmental Analyst

Feasibility of Renewable Thermal Technologies in Connecticut

A FIELD STUDY ON BARRIERS AND DRIVERS

2017 Yale University analysis conducted for CT Green Bank

BUREAU OF ENERGY AND TECHNOLOGY POLICY

CONNECTICUT ENERGY ENVIRONMENT

2017

Barrier: Advantages of renewable thermal technologies (RTTs) not recognized by customers and installers

- Lack of familiarity with:
  - the technologies
  - financial advantages
- RTT is perceived as untested and high risk
- Conventional replacement of equipment one-for-one means overlooking opportunity for package solutions

2017

Barrier: Cost to entry is high

- Some RTTs are expensive, long-term investments
- Customers expect short payback periods
- District energy systems involve high infrastructure costs

2017

Barrier: Installer business models

- Familiarity with RTTs not widespread among installers, who tend to specialize in particular technology/set of technologies
- Thermal technologies often replaced on emergency basis
- Installers tend to use RTT incentives to bolster profit, rather than lower customer cost

2017

Barrier: Split incentives

- Traditional owner/tenant meter split creates disincentive for both parties
- RTT installation
  - can shift energy costs from landlord to tenant, or vice versa
  - may shift responsibility for maintenance

Diversified Energy, Chubby Oil, & Clean Fuels Alliance America

Connecticut 2022 Comprehensive Energy Strategy

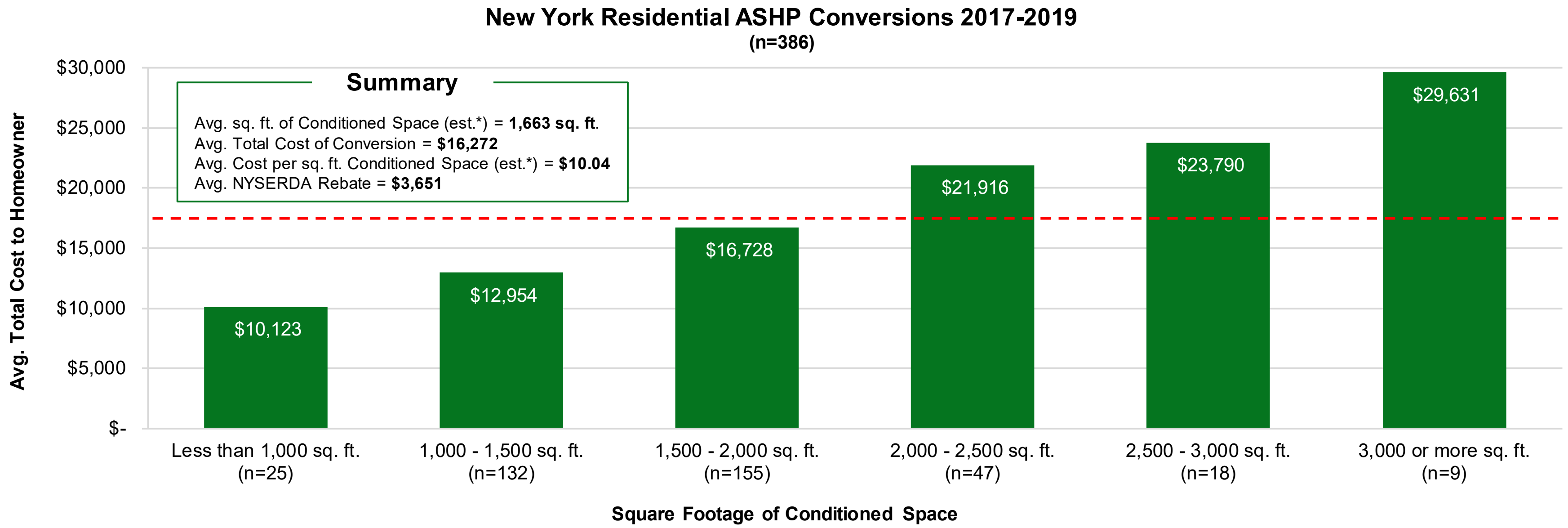
Building Thermal Decarbonization – Heat Pump Barriers and Market Strategies

Report Prepared For:

The materials contained in this document are intended for public distribution.

September 22, 2022

NYSERDA Whole-Home ASHP Conversions: 2017-2019



Median Size of Residence in New York = **1,764 sq. ft.**
Median Residence Conversion Cost (est.*) = **$17,286**

Assumptions

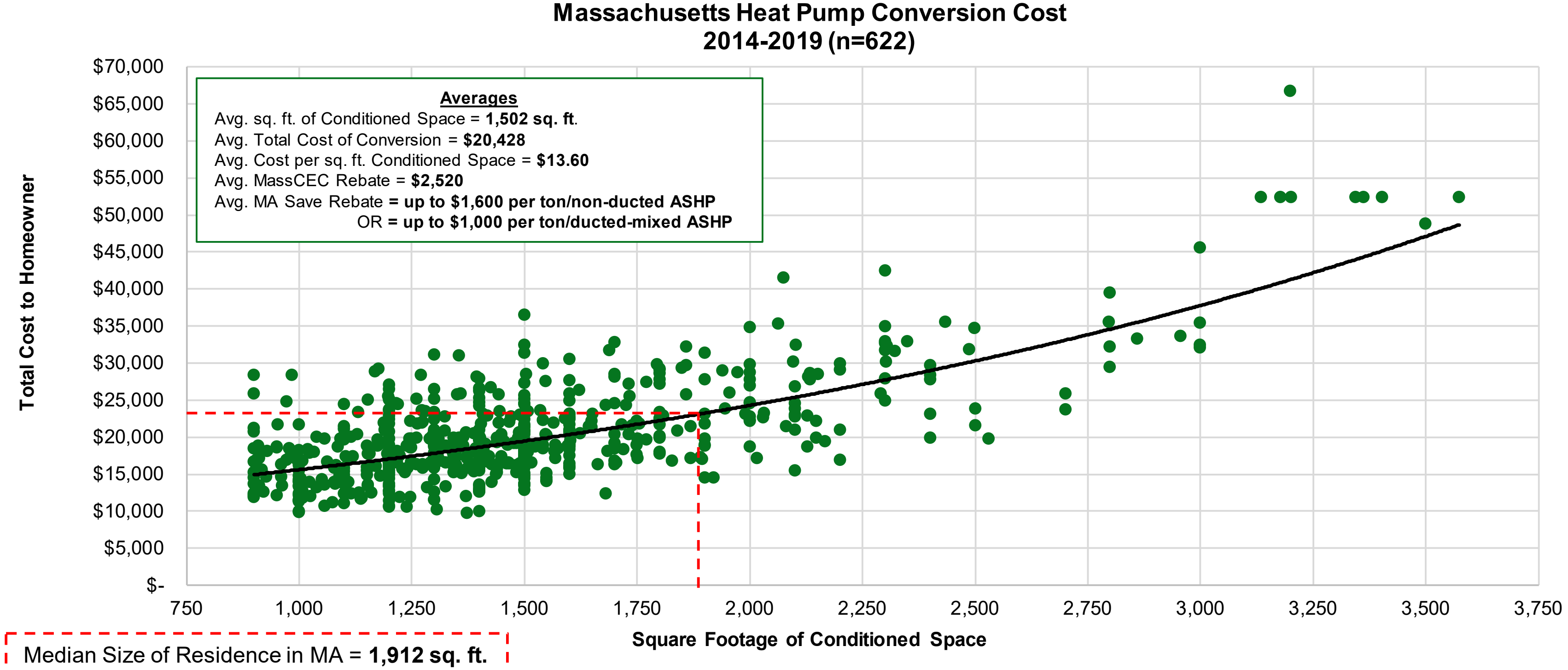
- ✓ Applications that NYSERDA reported giving an incentive less than a full load incentive were excluded. Full load incentive qualified as:
  - ✓ Less than 1,000 sq. ft. ≥ $1,500
  - ✓ 1,000 – 1,500 sq. ft. ≥ $1,500
  - ✓ 1,500 – 2,000 sq. ft. ≥ $2,500
  - ✓ 2,000 – 2,500 sq. ft. ≥ $3,500
  - ✓ 2,500 – 3,000 sq. ft. ≥ $4,500
  - ✓ 3,000+ sq. ft. ≥ $5,000
- ✓ Applications that NYSERDA reported as being a whole-home solution were included if they received a full load incentive.
- ✓ Applications that self reported being a whole-home solution were included if they received a full load incentive.
- ✓ Applications listing ground-source heat pumps as their primary heating system were excluded.

*Estimated cost per sq. ft. was assumed to be 750 sq. ft. for residences reported under 1,000 sq. ft. and 3,500 sq. ft. for residences reported over 3,000 sq. ft. The remaining buckets were assumed to be the median (e.g. 1,000-1,500 sq. ft. was assumed to be 1,250 sq. ft.)

Source: Diversified Energy Specialists Research & Analysis; NYSERDA, U.S. Census Bureau

MassCEC ASHP Rebate Program: 2014-2019

The cost of converting to an electric air-source heat pump system in Massachusetts is substantial and isn't affordable for most low- and middle-class residents



Median Size of Residence in MA = **1,912 sq. ft.**
Median Residence Conversion Cost = **$21,572**

Assumptions

- ✓ Applications that reported a contained space under 900 square feet were excluded
- ✓ Applications that reported the installed heat pump capacity at 5° F (Btu) could not sufficiently provide heat for a minimum of 80% of the residences heat load were excluded. This calculation was based on a 40 Btu per square foot requirement
- ✓ Applications that reported the project as new-build construction or an addition were excluded. Only reports of "existing home" or "retrofit" were included
- ✓ Applications that reported heat pumps as a supplemental heat source were excluded
- ✓ Only applications within 2 standard deviations of the mean were included
- ✓ Any application that did not report square footage of conditioned space, any cost metric, installed capacity at 5° F (Btu), or number of heat pumps were excluded

Source: Diversified Energy Specialists Research & Analysis; MassCEC; MA DOER

MassCEC Whole-Home Heat Pump Pilot: 2019-2021

The Massachusetts Clean Energy Center whole-home pilot program provided validation into previous cost studies on the installation of residential air-source heat pumps

Program Requirements

- ✓ May 2019 to June 2021
- ✓ The pilot program required that the air-source heat pump system must be capable of heating the entire home and be in use throughout the heating season
- ✓ For existing homes, the program only served installations displacing natural gas.
- ✓ For new construction, the homes could not include any fossil fuel appliances for other uses like hot water and cooking.

Project Type	Number of Projects in Pilot	Average Conditioned Sq. Ft. of Home	Median Project Cost
Existing Building	126	1,674	$20,000
New Construction	31	1,468	$14,000
Gut Rehab	11	1,173	$12,700
Total	**168**	**1,603**	**$18,400**

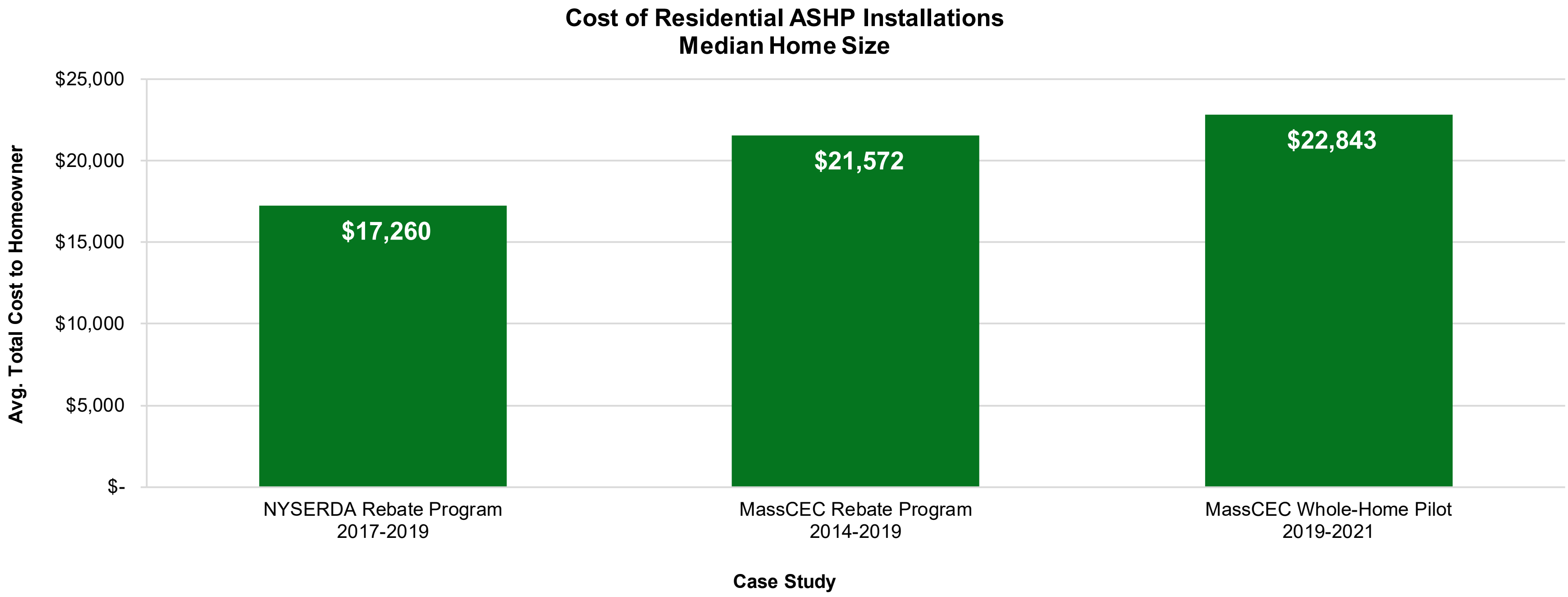
Program Conclusions

- ✓ The program director, Meg Howard, concluded:
  - ✓ **"Costs were higher than we hoped."**
  - ✓ "Of the retrofit projects in our pilot, **25% required an electric service upgrade**, while **38% reported that their natural gas heating system also provided their domestic hot water, which meant that homeowners either had to leave their natural gas boiler in place just to heat their hot water** or else buy a new hot water heater as part of the project."

Source: Diversified Energy Specialists Research & Analysis; MassCEC

Summary: Three Case Studies

The average cost of installing a residential air-source heat pump in all three case studies indicates that the electrification movement will face substantial challenges in the residential thermal sector



Median Size of Residence in MA = **1,912 sq. ft.**
Median Size of Residence in NY = **1,764 sq. ft.**

Source: Diversified Energy Specialists Research & Analysis

New York Median Household Income by County

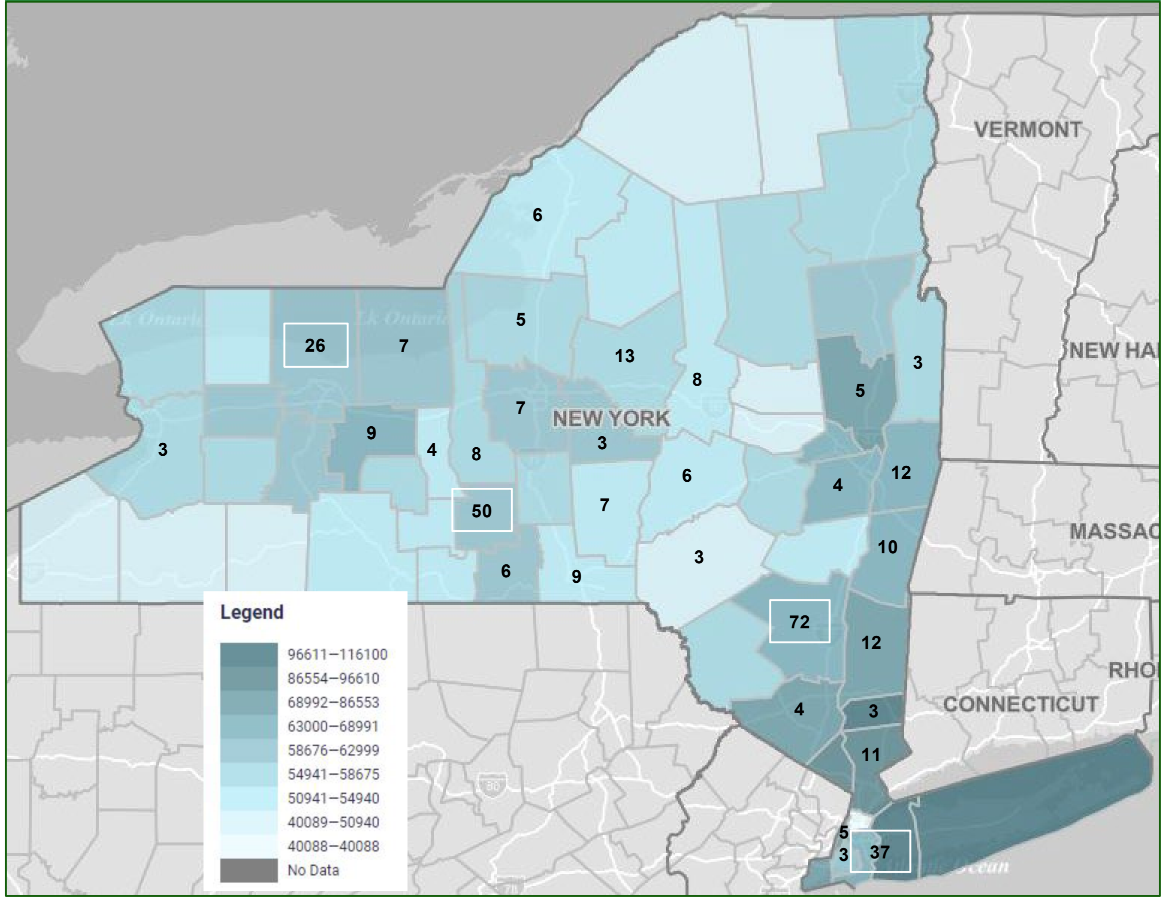
Most conversions appear to occur in higher income counties in New York

Analysis

The map displays numbered labels for counties with 3 or more whole-home ASHP installations and white borders for counties with 20 or more installations

- ✓ The high cost of installing a whole-home ASHP system is a barrier to entry for environmental justice populations
- ✓ The consolidation of whole-home ASHP installations in high-income counties has a considerable impact on low-income counties:
  - ✓ ASHP installations increase the cost of electricity for all ratepayers
  - ✓ Widens the greenhouse gas emissions gap between high-income and EJ communities
  - ✓ Improves air-quality in high-income communities, while EJ communities air-quality is unchanged
- ✓ ASHP installations increase the grid load
  - ✓ Increasing the cost of electricity
  - ✓ Increasing the greenhouse gas emissions from electricity
  - ✓ Increasing the amount of renewable electricity generation needed to meet the state's net-zero carbon electricity goal
- ✓ The rebate comes from the system benefit charge, which all ratepayers in the state of New York pay, but only the high-income households can capitalize on these rebates
- ✓ Assumed that the highest income households in each county are the households installing whole-home ASHP systems

Median Household Income by County 2015-2019 (2019 $)

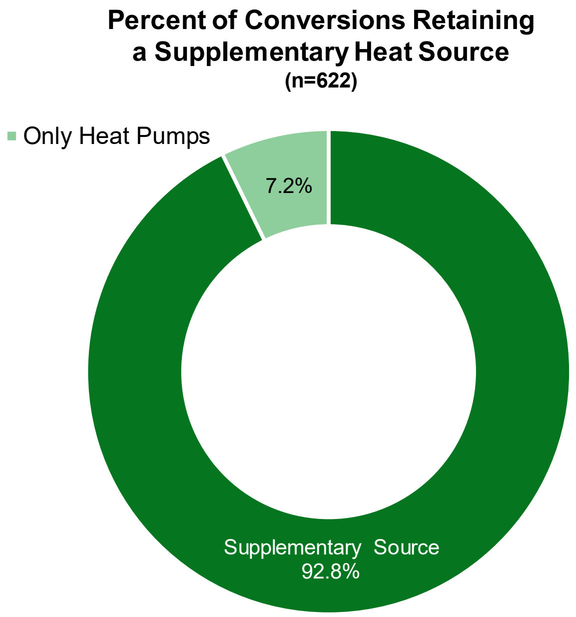


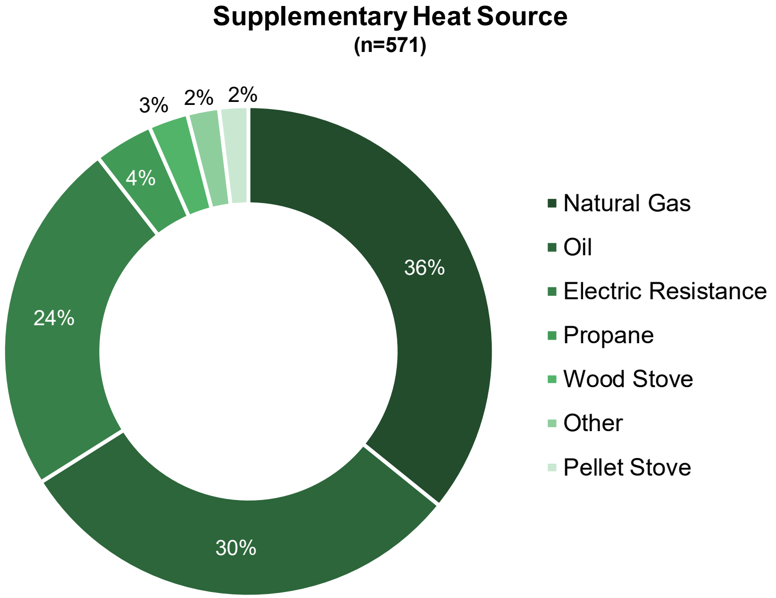
Source: U.S. Census Bureau, 2019 ACS 5-Year Estimates, New York, County, Median Household Income

DIVERSIFIED ENERGY SPECIALISTS

Conversion: Supplementary Heat Source

In addition to the high cost of conversion to air-source heat pumps, most installers recommend retaining a supplementary source of heat due to the heat pump systems inability to sufficiently heat residences in the cold Massachusetts winters





Assumptions

- ✓ Applications that self-reported whether a backup source of home heating would be used were included
- ✓ For applications that failed to report whether a backup source of home heating was used, DES used their self-reported installed capacity at 5° F (Btu) to determine if the heat pump system could sufficiently provide heat for greater than 90% of the residence's heat load. The determination was made based on a 40 Btu per square foot requirement. If the system could not provide sufficient heat for 90% or more of the residences heat load, DES assumed that a supplementary heat source was used

Source: Diversified Energy Specialists Research & Analysis; MassCEC; MA DOER

Consumer Behavior

Homeowners in the northeast are not choosing to install air-source heat pump systems, despite the financial rebates available

Thermal Electrification Scalability

States in the northeast have set lofty residential electrification goals:

- ✓ Massachusetts set a goal of one million households using high-efficiency electric heating systems by 2030, converting at a rate of 100,000 households per year.
    - ✓ In an August 2021 article, the Boston Globe estimated that only 461 homes were converted to electric heat in 2020, missing the state goal by 99,539 conversions.
- ✓ The NYSERDA Residential Air-Source Heat Pump Rebate Program resulted in 386 whole-home air-source heat pump installations over a 3-year period, averaging just over 100 conversions per year.

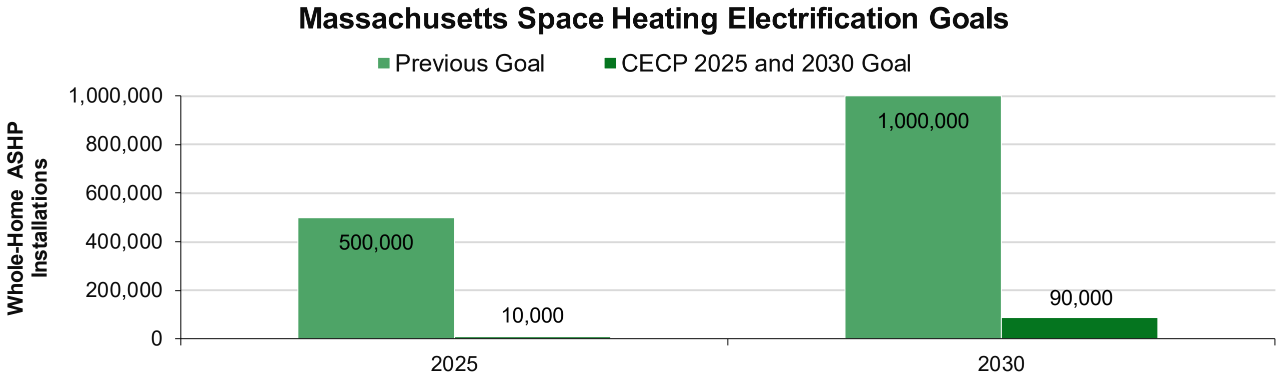
ISO-NE 2020 Heating Electrification Study

- ✓ The 2020 ISO-NE 2020 Heating Electrification report projected winter peak load and annual grid load increases through 2030 based on 1 million residential ASHP installations from 2021-2030
- ✓ Their data was based on Sagewells' AMI metering of 18 residences in MA
    - ✓ They measured the electric output from the winter from 18 heating oil & natural gas heated homes in the 2017-2018 winter
    - ✓ They then installed an ASHP system in the 18 homes during the summer
    - ✓ Measuring the hourly electrical output from the homes in the winter of 2018-2019, they predicted the grid load and winter peak load that would be added per residential ASHP conversion
- ✓ They used that data to project the increase in grid load and increase in winter peak load through 2030
- ✓ Despite no mention of it in their report, they conceded by email that the ASHP system in all 18 homes provided heat for less than 50% of the annual heat load
- ✓ They also conceded that the legacy heating system was not removed and that they had no data on water heating

Source: Diversified Energy Specialists Research & Analysis, ISO-NE 2020 Heating Electrification Report, Boston Globe: https://www.bostonglobe.com/2021/08/21/science/massachusetts-should-be-converting-100000-homes-year-electric-heat-actual-number-461/?p1=StaffPage&p1=Article_Inline_Related_Link

States' Failure to Meet Thermal Electrification Goals

The Massachusetts Clean Energy and Climate Plan for 2025 and 2030 was released on June 30, 2022. In the "Appendices to the Clean Energy and Climate Plan for 2025 and 2030", the electrification goals for buildings were changed



Original 2020 Goal

- One million households using high-efficiency electric heating systems by 2030, converting at a rate of 100,000 households per year.

New MA CECP Goal

- Homes with whole-home air source heat pump space heating:
  - 2020 Historical: 40,000 homes installed by 2020
  - 2025 Target: 50,000 (10,000 installations from 2020-2025)
  - 2030 Target: 140,000 (90,000 installations from 2025-2030)
- Homes with partial-home* heat pump space heating:
  - 2020 Historical: 220,000 homes installed by 2020
  - 2025 Target: 320,000 (100,000 installations from 2020-2025)
  - 2030 Target: 610,000 (290,000 installations from 2025-2030)

*Partial-home heat pump space heating is defined as "half of the buildings' heating systems would be served by fuel and the other half with electricity"

Source: Diversified Energy Specialists Research & Analysis, https://www.mass.gov/doc/clean-energy-and-climate-plan-for-2025-and-2030/download

Background & Contact Information

DIVERSIFIED ENERGY SPECIALISTS

- Thermal Portfolio Standards
- Renewable Portfolio Standards
- Carbon Offsets
- Renewable Energy Consulting

Diversified Energy Specialists

- ✓ Renewable energy consulting
  - ✓ Thermal technologies
  - ✓ Greenhouse gas emissions reduction
  - ✓ Cap-and-trade programs
  - ✓ Rebate programs
- ✓ Environmental markets trading
  - ✓ Renewable portfolio standards
  - ✓ Thermal portfolio standards
  - ✓ Low-carbon fuel standards
- ✓ Carbon offsets
  - ✓ Purchasing
    - ✓ Procurement
    - ✓ Aggregation

Contact Information

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Charlie Uglietto - Chubby Oil

Environmental and Economic Characteristics

Biodiesel-fired Heating Technologies and Electrically-driven Cold Climate Heat Pumps

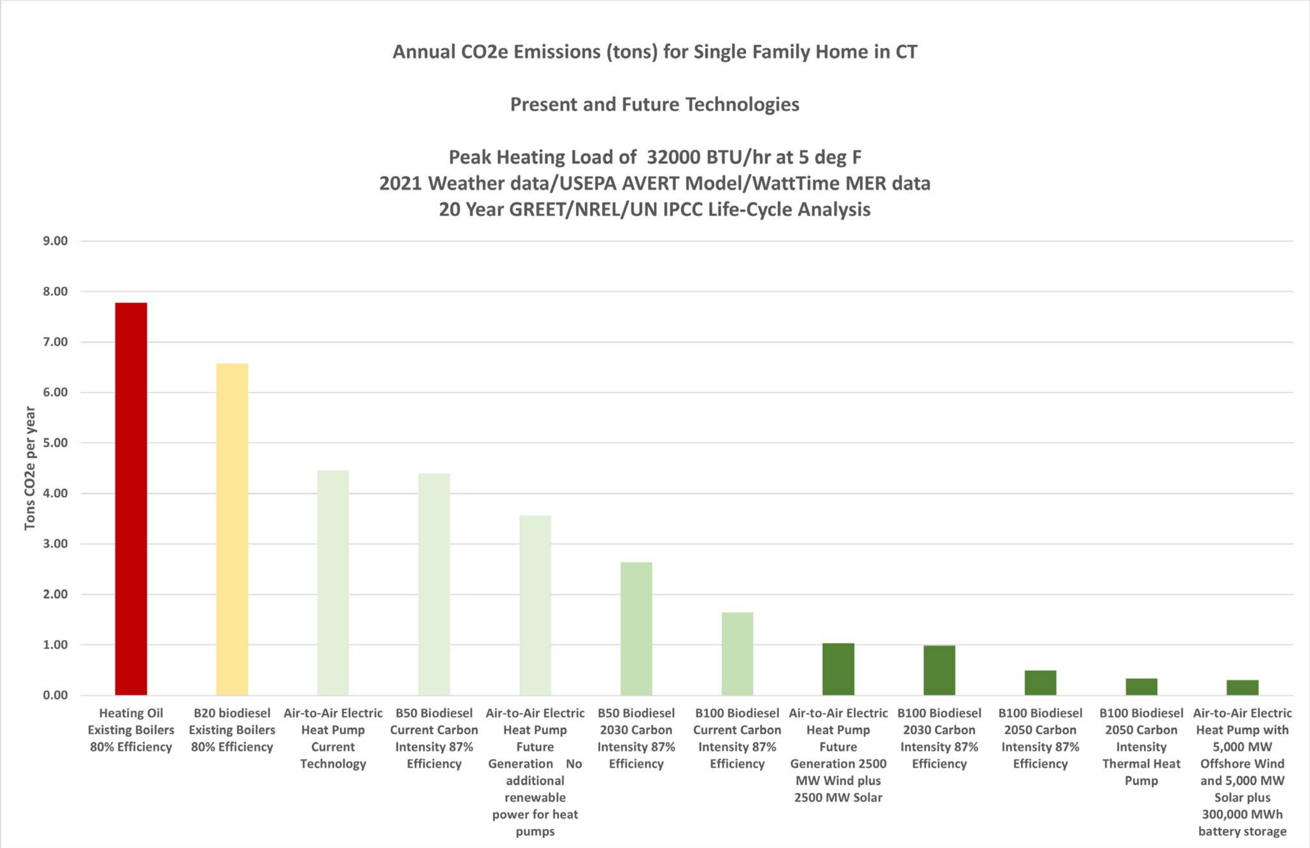
BIOHEAT

Ray Albrecht, P.E.
Raymond J Albrecht LLC

Technical Representative
Clean Fuels Alliance America

Member of ISO New England
Planning Advisory Committee
ISO New England Load Forecast Committee

Annual CO2e Emissions for Single Family Home in CT with Biodiesel and Heat Pump Systems



Hourly heat load and generation analysis using actual weather data, USEPA AVERT model, GREET LCA data, and AVERT/WattTime marginal emissions rate data.

Horse race between biodiesel heating technologies and electrically-driven heat pumps

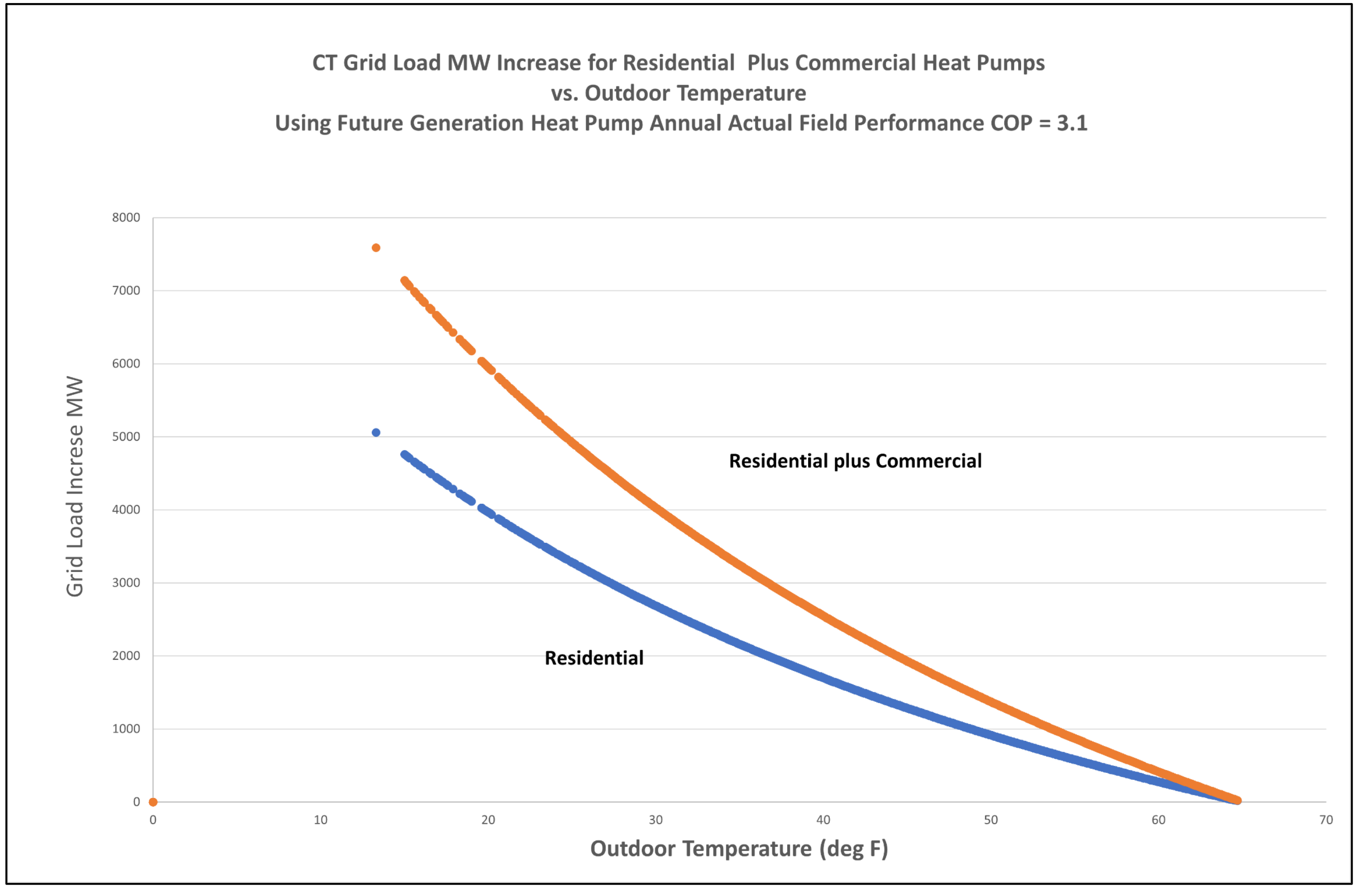
B50 and existing heat pump technology each achieve about 40% GHG savings (LCA-based) compared to traditional heating oil

Biodiesel carbon intensity decreasing with improved feedstocks and more efficient/renewable processing

Heat pump COP performance improving by approximately 25% in near term but further GHG savings over long term dependent on increased wind/solar marginal generation

Steady progress by both technologies to same end goals of 90+ percent GHG savings by 2050. Achieved via biodiesel-fired thermal heat pumps and wind/solar-driven cold-climate heat pumps

Grid Load Increase in CT From Heat Pumps in Residential and Commercial Buildings



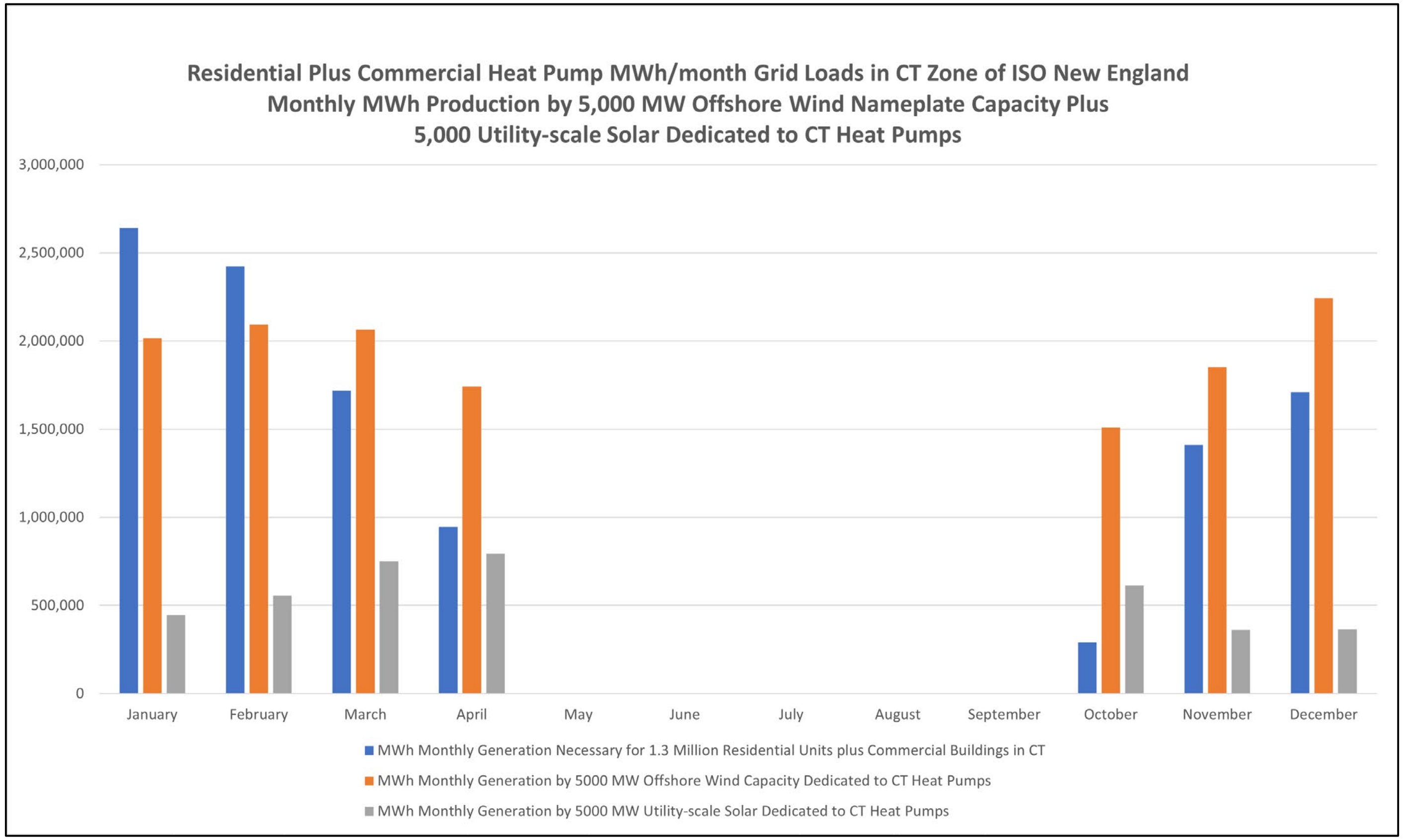
7500 MW peak grid load increase at design outdoor temperature in Connecticut with full implementation of cold-climate heat pumps in 1.3 million residential units plus commercial building sector plus moderate building efficiency improvements. Approximately 4 kW per residential unit peak demand increase.

Would more than double the existing CT winter peak load of about 5000 MW.

Based on the use of future generation heat pump technologies that achieve 25% higher real-world efficiency than current cold-climate heat pump technologies.

Efficiency increase aligns with the goals of the US Department of Energy Cold Climate Heat Pump Technology Challenge and Northeast Energy Efficiency Partnership (NEEP) programs.

Monthly Heat Pump Grid Loads plus Offshore Wind and Solar PV Production



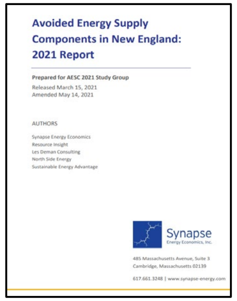
Installed nameplate capacity of 5,000 MW of offshore wind plus 5,000 MW of solar PV could approximately meet the needs of residential and commercial heat pumps in CT during the coldest months of the heating season.

Blue bars represent monthly MWh consumption by heat pumps. Orange bars represent monthly MWh production by 5,000 MW of offshore wind power. Gray bars represent MWh production by 5,000 MW of solar PV.

Monthly MWh production figures are provided by the USEPA AVERT model based on historical weather data for the New England region.

7500 MW peak load X 48 hrs at low wind/solar output = 360,000 MWh load thus approximately 300,000 MWh battery storage requirement.

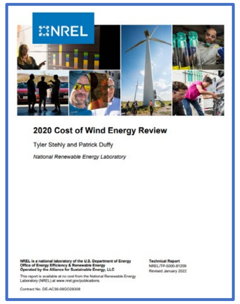
Capital Cost Estimates for Power Generation/Transmission/Distribution for Heat Pumps in CT


Avoided Energy Supply Components in New England: 2021 Report

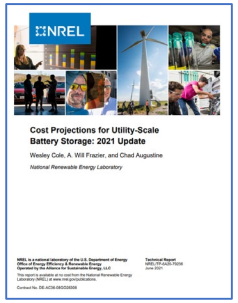
Prepared for AESC 2021 Study Group
Released March 15, 2021
Amended May 14, 2021

AUTHORS

Synapse



2020 Cost of Wind Energy Review
Tyler Stehly and Patrick Duffy
National Renewable Energy Laboratory



Cost Projections for Utility-Scale Battery Storage: 2021 Update
Wesley Cole, A. Will Frazier, and Chad Augustine
National Renewable Energy Laboratory

5,000 MW of offshore wind capacity at $5 million per MW and 5,000 MW of solar PV capacity at a cost of $3 million per MW, as estimated by NREL, would yield a total CapEx of approximately $40 billion for generation capacity. Since floating-type offshore wind platforms will be required for much of the New England coast, due to water depths of greater than 180 feet, an upward revision to CapEx could be necessary. Service life of 30 years used for analysis.

NREL mid-range CapEx forecast for year 2030 for utility-scale battery storage at $200,000 per MWh capacity would yield a total CapEx approximately $60 billion, to cover diurnal supply/load gaps plus a 48 hour storage discharge needed during wind/solar drought conditions. Subject to adjustment, however, based on material price increases or decreases which might occur as the wind and solar industries grow. Increased production volumes may contribute to economies of scale, which might provide downward pressure on costs. Increased volumes of mining and extraction of materials for batteries, on the other hand, could trigger higher prices due to supply shortages. Lithium and cobalt commodity prices have recently increased multi-fold with corresponding upward pressure on battery storage prices. Service life of 10 years used for analysis but dependent on depth of discharge (DOD) cycling practices.

Increased grid transmission capacity in Connecticut would also be necessary. Transmission upgrade costs vary widely on a local basis depending on existing capacity and load characteristics, this analysis uses the average annual cost figure of $94 per kw-yr for New England, as developed in the 2021 Avoided Energy Supply Component Update report by Synapse Energy Economics for electric utilities and state regulatory agencies located in the ISO New England grid. The $94 figure represents a combination of construction and also operating cost, e.g., labor, administration, insurance, and taxes. The CapEx portion would be on the order of $2000 per kW though highly dependent on specific circumstances. $2000 per kW for 7500 MW of transmission upgrades in Connecticut would yield a total CapEx of approximately $15 billion. Transmission costs may also be affected by NIMBY opposition thus forcing underground burial or suboptimal routing of rights-of-way through densely populated regions. Service life of 30 years used for analysis though actual values can be longer.

Increased local electricity distribution capacity would also be necessary for implementation of residential and commercial heat pumps in Connecticut. Synapse Energy Economics has identified a wide range of accounting practices used by electric utilities in New England, with corresponding cost figures that range from *de minimis* to over $200 per kW-yr. More consistent accounting practices used in other states, such as New York, have indicated distribution upgrade costs ranging from $50 to $250 per kW-yr representing variations in cost and difficulty of distribution network construction which occur in rural through dense urban environments. A CapEx figure of $3000 per kW is used for this analysis. The corresponding cost for 7500 MW of distribution upgrades would be approximately $22 billion. Service life of 30 years used for analysis.

Recent capital cost analyses for residential heat pumps have centered on an approximate figure of $20,000 per onsite installation. The corresponding capital cost for installation of 1.3 million residential heat pumps in Connecticut would be approximately $26 billion. The total capital cost for installation of residential and commercial heat pumps in CT would thus be approximately $40 billion. This analysis uses an initial service life of 10 years for full-capacity heat pumps with major component (e.g., compressor/control) replacement at the 10 and 20 year milestones.

Capital Expense Summary for Power Generation/Transmission/Distribution plus Heat Pump Installation in CT

Time Horizon	10 yrs	20 yrs	30 yrs
Wind and Solar PV Generation	$ 40 billion	$ 40 billion	$ 40 billion
Battery Storage + Refurbishment	$ 60 billion	$ 120 billion	$ 180 billion
Transmission	$ 15 billion	$ 15 billion	$ 15 billion
Distribution	$ 22 billion	$ 22 billion	$ 22 billion
Onsite Heat Pump + Refurbishment	$ 40 billion	$ 50 billion	$ 60 billion
Total	$ 177 billion	$ 247 billion	$ 317 billion

Approximately 11.1 million MWh of electricity would be generated per heating season by the described combination offshore wind plus solar PV. Approximately 330 million MWh would be produced over the course of 30 years. A high fraction of the potential output of the described wind/solar generation capacity would be curtailed during the summer, due to the high ratio of winter-to-summer peak grid load that will occur with electrification of heating, unless multi-month seasonal storage (e.g., hydrogen for synthetic fuel production) can be implemented.

The total 30 year capital cost of the generation/transmission/distribution cost components would be $257 billion. The corresponding levelized capital cost of electricity produced by the described wind/solar generation system can be calculated as the $257 billion total capital cost divided by 330 million MWh of generation over the 30 year time horizon. The resulting infrastructure cost of electricity generation/transmission/distribution would thus be approximately $780 per MWh or 78 cents per kWh. Electric utility operations and administrative costs would be additional.

Biodiesel - protecting our environment for future generations

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Eversource & Avangrid

DEEP Technical Session: Comprehensive Energy Strategy

September 22, 2022

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Barriers to Heat Pump Adoption

Customer Awareness and Perceptions

Overall Familiarity with Heat Pumps

Very familiar	13%
Somewhat familiar	28%
Not too familiar	30%
Not at all familiar	29%
Not too/Not at all familiar	59%

Primary Benefits and Drawbacks

Primary Benefits

- Better/more efficient heating and cooling
- Lower cost heating and cooling
- Environmental benefits

•Perceived Drawbacks

- High initial cost
- Need for professional installation
- Ineffective at extreme temperatures

Barriers: Single Family Heat Pump Adoption

Single-Family Barriers	Core Strategies to Address
Lack of general awareness	• Increased community engagement, including upcoming Heat Pump 101 webinar series
Upfront installation expenses	• Targeted marketing, identifying customers who stand to see lowest upfront costs: existing ductwork • Equipment discounts provided by participating distributors • Fuel optimization rebates, available to customers using heat pumps as the primary source of heat
Misconceptions about performance in cold climates	• No cost, virtual heat pump consultations to provide education for customers considering installations • Operational guidance to maximize system performance • Heat Pump Installer Network to ensure quality installation

Barriers: Multifamily

Multifamily Barriers	Core Strategies to Address
Limited options for PTAC replacements	• Working with industry to identify PTHP equipment solutions • Introduce new marketing and resources to help customers explore options for replacement
Lack of owner motivation to upgrade	• Marketing and messaging additional benefits (aside from operational savings) including central cooling
Risk of tenant misconceptions	• Integrated control requirement ensures units are easy to manage by tenants and can provide additional peace of mind

Barriers: Commercial & Small Business

C&I Barriers	Core Strategies to Address
Equipment availability and lead times	• Maintaining relationships with manufacturers and distribution partners to understand supply chain delays • Introduce energy optimization rebates to clearly message equipment use and capability expectations, ensure qualified equipment is shipped to region
Building challenges	• Differentiated energy optimization incentives to account for additional soft costs associated with installing in large facilities
Lack of motivation to upgrade	• Marketing and messaging additional benefits (aside from operational savings) and selling points, including central cooling

Additional Support Services

Educational Resources

Heat Pump Consultations

Operational Guidance

EnergizeCT.com/HeatPump

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ADVANTAGES

COST
Compared to heating with oil, propane, or electric resistance (baseboard), heat pumps can allow you to save money on energy expenses.

CONVENIENCE
Heat pumps provide all-in-one comfort: heating, cooling, and dehumidification in one unit.

EFFICIENCY
Heat pumps can be up to 400% efficient—for every 1 unit of energy used to power a heat pump, up to 4 units of heat energy are supplied.

ENVIRONMENTAL IMPACT
Heat pumps help reduce your carbon footprint by emitting less greenhouse gases.

NEXT STEPS

If you're looking for some assistance, the Sponsors of Energize Connecticut℠ can help provide technical guidance and support. Schedule a no-cost virtual consultation with a Heat Pump Specialist.

Our Heat Pump Specialists have been trained to help you make informed decisions specific to your goals and the unique needs of your home and can connect you with contractors participating in the Energize CT Heat Pump Installer Network.

For more information, visit EnergizeCT.com/HeatPump.

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EnergizeCT.com 1-877-WISE-USE

EVERSOURCE

Energize Connecticut – programs funded by a charge on customer energy bills.

Introduction to heat pumps

Heat pumps can efficiently heat your home in the winter and double as a cooling system in the summer—while lowering greenhouse gas emissions.

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HOW HEAT PUMPS WORK

Heat pumps move heat inside in the winter and draw heat outside in the summer. Instead of burning fossil fuels, like oil or propane, they use a refrigerant cycle, powered by electricity, to move heat and keep your home at a comfortable temperature year-round.

These systems are environmentally friendly, affordable to operate, and can last longer than other heating and cooling systems.

There are two main types of heat pumps, air source and ground source (geothermal). Both air and ground source heat pumps offer highly efficient heating and cooling in one system.

AIR SOURCE HEAT PUMPS

Air source heat pumps extract heat from the air outside and distribute it inside in the winter. During warmer months, this process is reversed to provide cooling. These systems can be installed either with or without ductwork and can heat and cool either an individual room or your whole home.

- Ductless heat pumps, also known as mini-splits, are an efficient alternative for heating and cooling areas where ductwork doesn't exist or can't be installed.
- If your home has ductwork for heating and cooling, a centrally-ducted heat pump can use it to heat and cool your home more efficiently than propane, electric, and oil heating systems.

GROUND SOURCE HEAT PUMPS

Ground source heat pumps use the earth's constant temperature to provide heating and cooling. In the winter, fluid circulating in underground pipes carries the earth's heat to your home, and in the summer, the process is reversed so heat from your home is carried back to the earth to provide cooling. Ground source heat pumps are the most efficient type of heat pump and are a great option for properties with sufficient outdoor space.

CONSIDERATIONS

EFFICIENCY FIRST: Before upgrading your heating system, consider preliminary measures, such as sealing and insulating your ductwork or completing weatherization work.

ELECTRICAL USAGE: A heat pump is an electrical system, so running one will add to your electrical use. In many cases, that additional electrical use is offset by savings elsewhere, such as a propane or oil heating fuel bill.

QUALITY INSTALLATION: Heat pumps work best when correctly sized and designed for your home. Working closely with a qualified contractor will help ensure your system is designed to meet your heating and cooling needs.

Marketing Resources

Thank you

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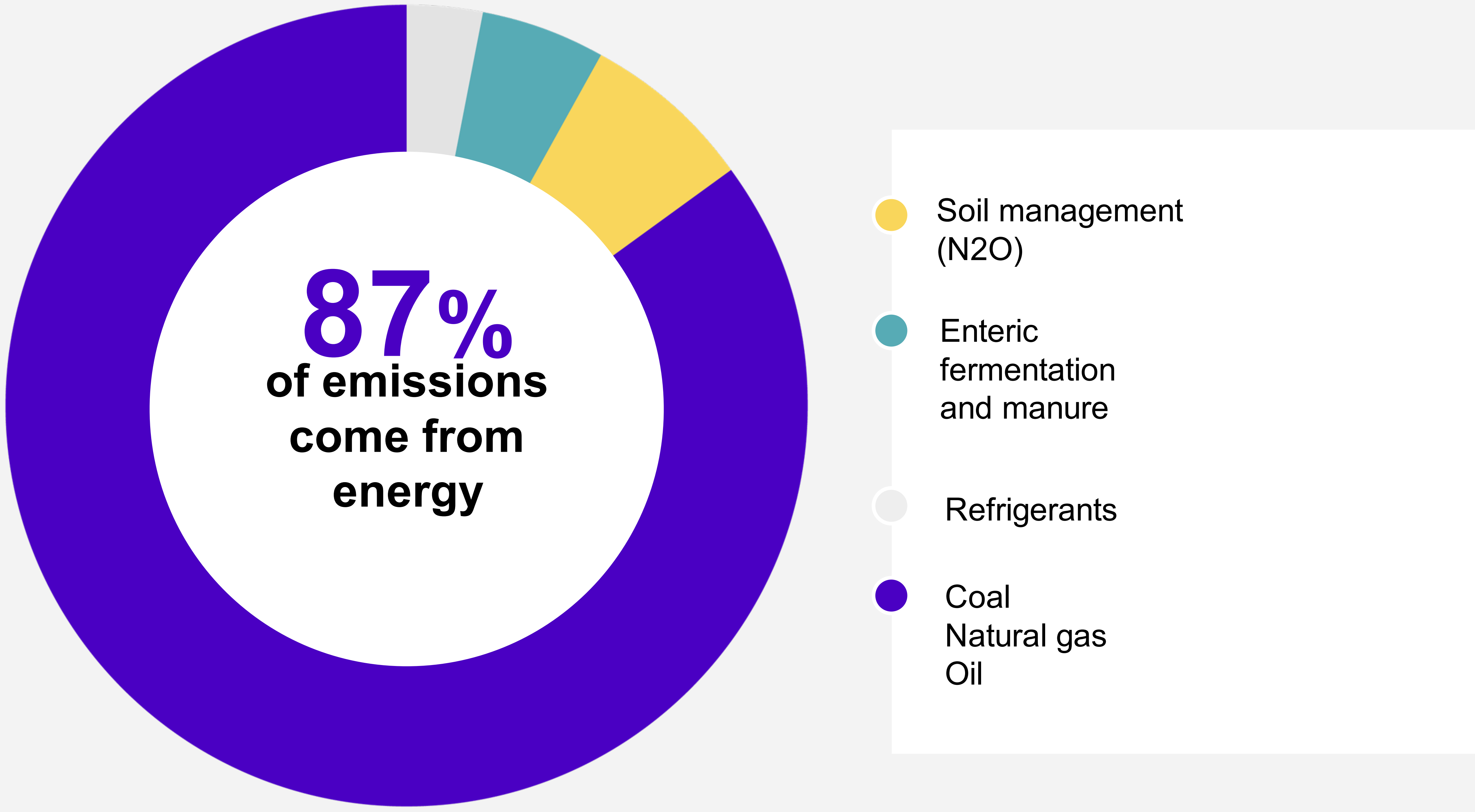
Rewiring America

Electrification Barriers & Strategies

Stephen Pantano

Head of Research, Rewiring America

Why electrify?


87%
of emissions
come from
energy
Soil management (N2O)
Enteric fermentation and manure
Refrigerants
Coal
Natural gas
Oil

42%

of our energy-related emissions come from decisions made around the kitchen table.

Electrification barriers and opportunities

What are the barriers?

- Higher upfront costs for newer, more efficient electric technologies
- Older housing stock requires simultaneous weatherization
- Competing incentives for new gas hookups and efficient fossil fuel appliances
- Shortage of contractors with sufficient heat pump experience
- Renter/owner divide

The Inflation Reduction Act: Consumer Incentives

CONSUMER REBATES: HEEHRA

$4.5B in direct rebates, up to $14,000 per household*

Designed for lower/moderate income households:
→ 100% of cost of electrification for households <80% AMI
→ 50% of cost of electrification for households 80–150% AMI

Rebates of up to $1,750 for a heat pump water heater, $2,500 for rewiring, $1,600 for basic weatherization

CONSUMER TAX CREDITS: 25C

Tax credit of up to 30% of the cost of upgrades

Designed for households who have to pay taxes (middle/high income)

Tax credit cap of $1200 per year, with the exception of heat pumps & heat pump water heaters – tax credits capped at $2,000 per year

* HOMES Rebates also available: +$4.5B for whole-home upgrades

The Inflation Reduction Act: Affordable Housing Incentives

CONSUMER TAX CREDITS: 45L

Tax credits for single- and multi-family homes that meet energy efficiency criteria and meet prevailing wage requirements

AFFORDABLE HOUSING RETROFITS

Direct grants and loans for energy and water efficiency retrofits and the installation of zero emissions technologies

GHG REDUCTION FUND

$27 billion in grants and loans enabling disadvantaged communities to benefit from zero emissions technologies

The Inflation Reduction Act: Workforce Incentives

ENVIRONMENTAL JUSTICE GRANTS

$3B for partnerships that include local nonprofits for environmental and climate justice projects

Air and pollution monitoring, low- and zero-emissions technologies, community engagement, climate resilience and adaptation

CLIMATE POLLUTION REDUCTION GRANTS

$5B for states and municipalities

Planning and implementation of programs, policies, measures, and projects that reduce GHG emissions, particularly in disadvantaged communities

Statewide IRA Benefits for CT

If Connecticut successfully ramps up to 100% electric adoption by the end of the IRA, **$10 billion in residential electrification benefits** will have been invested across every community, generating **16,580 direct and 57,700 total new jobs**

Connecticut

The IRA will deliver huge savings

If we maximize its electric potential for our communities and households

The Inflation Reduction Act (IRA) provides every American household — all 121 million of them — with an electric bank account, good for ten years. It empowers American families to save thousands of dollars on the upfront costs of electric machines (how we power our cars, heat our air and water, cook our food, dry our clothes and get our energy). In turn, those machines will save families save an average of $1,800 per year on their energy bills.

By utilizing the IRA's incentives, Americans will bring billions of dollars in benefits to their communities, saving money at the household level, creating local jobs and fighting the climate crisis with every heat pump installed. Since 42 percent of energy-related emissions come from the machines we rely on daily, our mandate is clear: within ten years, every new machine installed must be electric.

The good news is that the Inflation Reduction Act is designed to help us ramp to that future. It scales with our ambition. If we hit our climate targets, the IRA will deliver $858 billion in support for residential electrification to our communities, unlocking more than one trillion dollars of cumulative economic benefits. 80 million homes will participate, each receiving $10,600 on average in IRA incentives.

Our maps demonstrate this electric potential for the country and for our communities. Electrification is today's Victory Garden. It's up to us to achieve our potential and meet the moment.

Monthly utility bills will be lower for at least 120.1 million out of 121 million households, in every U.S. county, as a result of more efficient heat pump space heating and water heating units.

Millions of new jobs will be created, across every zip code — jobs that cannot be automated or offshored — as electricians, plumbers, and solar installers, as well as jobs in manufacturing, finance, and other indirect sectors.

The savings are particularly meaningful for low- and moderate-income (LMI) households. LMI households have 3x the energy burden (the portion of their income spent on home energy) as other households.

Cleaner air indoors and out; studies show children in homes with gas stoves are 42% more likely to experience asthma symptoms than children in homes with electric stoves, and outdoor air pollution from residential buildings is now responsible for ~15,500 premature deaths annually.

REWIRING AMERICA

map.rewiringamerica.org

REWIRING AMERICA

Average Household IRA Benefits in CT

One-time IRA benefits

The 591,000 low- and moderate-income (LMI) households in Connecticut would be eligible for an average of **$11,607 in upfront discounts** through the IRA.

All 1.4 million households in Connecticut would be eligible for an average of **$5,596 in IRA tax credits**.

Ongoing energy bill savings

	# of Furnaces	**Avg. savings if electrified**	# of Water Heaters	**Avg. savings if electrified**
Electric Resistance	200K	**$349 / yr**	379K	**$435 / yr**
Fuel Oil	556K	**$1,088 / yr**	355K	**$308 / yr**
Propane	58,705	**$892 / yr**	84,846	**$460 / yr**
Natural Gas	488K	**$212 / yr**	542K	**$119 / yr**

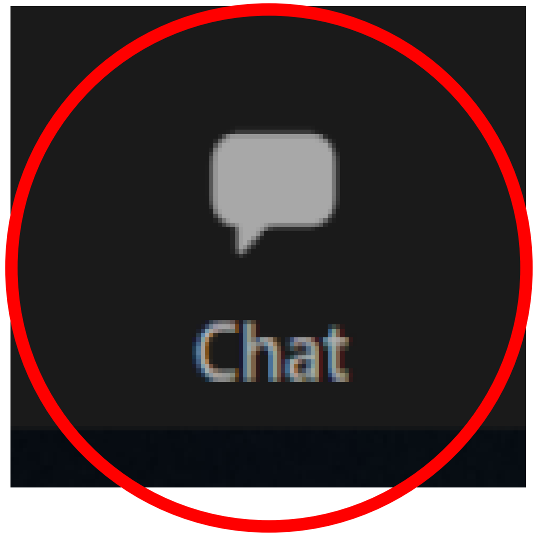
What can State and Local Governments do?

- Evaluate ‘electrification readiness’ within the building stock & educate consumers
- Deploy electrification incentives:
  - Plan now for IRA implementation
  - Bundle & streamline additional incentives like in California, New York, Massachusetts, and more
  - Target households with the greatest needs
- Establish workforce development and training programs like New York City and DC
- Establish favorable policy, including building emissions standards, all-electric new construction, energy and housing affordability targets.
- Discontinue gas line extension & gas appliance incentives; repair (don’t replace) gas infrastructure.

REWIRING AMERICA

hello@rewiringamerica.org

Questions



At the conclusion of each panel DEEP will hold a brief question and answer period.

If you have a question for a presenter, please drop it into the chat to **Jeff Howard**. DEEP will pose as many questions as time allows to the speakers. Clarifying questions will be prioritized. Leading questions will not be accepted.

Lunch Break

(we'll restart at 1:00 p.m. ET)

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