



BUREAU OF ENERGY AND  
TECHNOLOGY POLICY

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

September 22, 2022

# Heat Pump Barriers & Market Strategies

Technical Session 2  
CT 2022 Comprehensive Energy Strategy

Session is being  
recorded

# Today's Agenda – Afternoon

Click on agenda section heading to  
jump to corresponding slides

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

# Market Transformation

David Lis – Northeast Energy Efficiency Partnerships

Rob Aldrich – Steven Winter Associates

Natalia Sudyka & Larry Rush – Eversource & Avangrid

(speaker order may vary)

Click on agenda section heading to  
jump to corresponding slides

BUREAU OF ENERGY AND  
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# Northeast Energy Efficiency Partnerships



# Heat Pump Market Strategies

- Dave Lis, Director, Technology and Market Solutions
- Connecticut Technical Session- Building Thermal Decarbonization – Heat Pump Barriers and Market Strategies
- September 22, 2022



# Northeast Energy Efficiency Partnerships

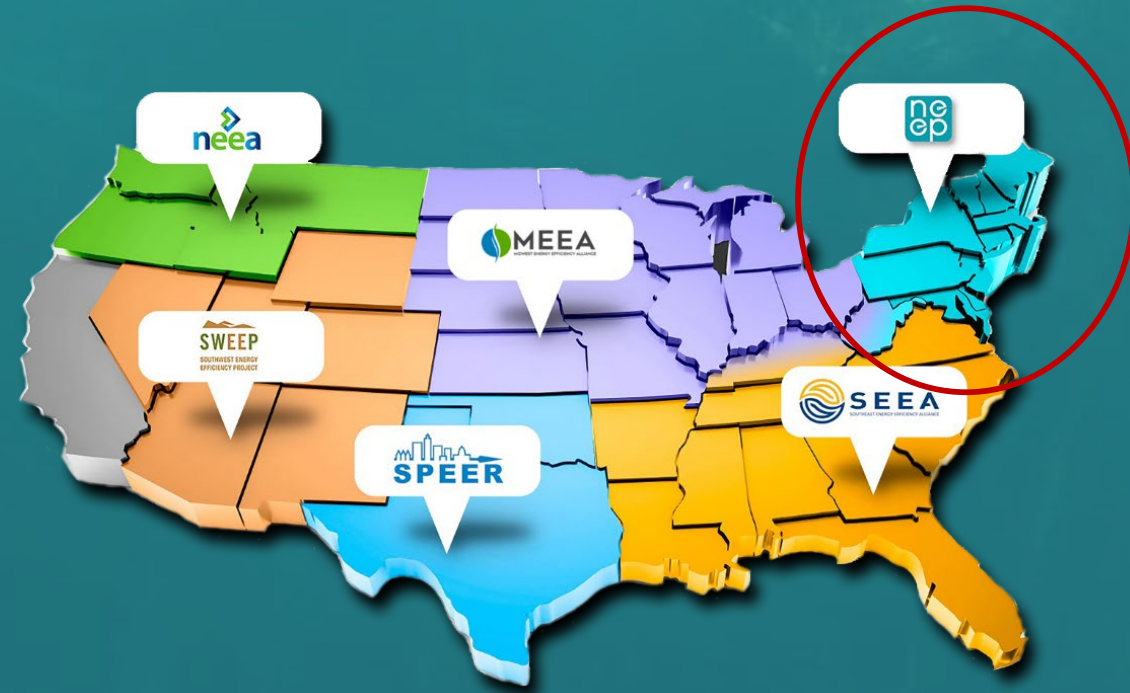


## Mission

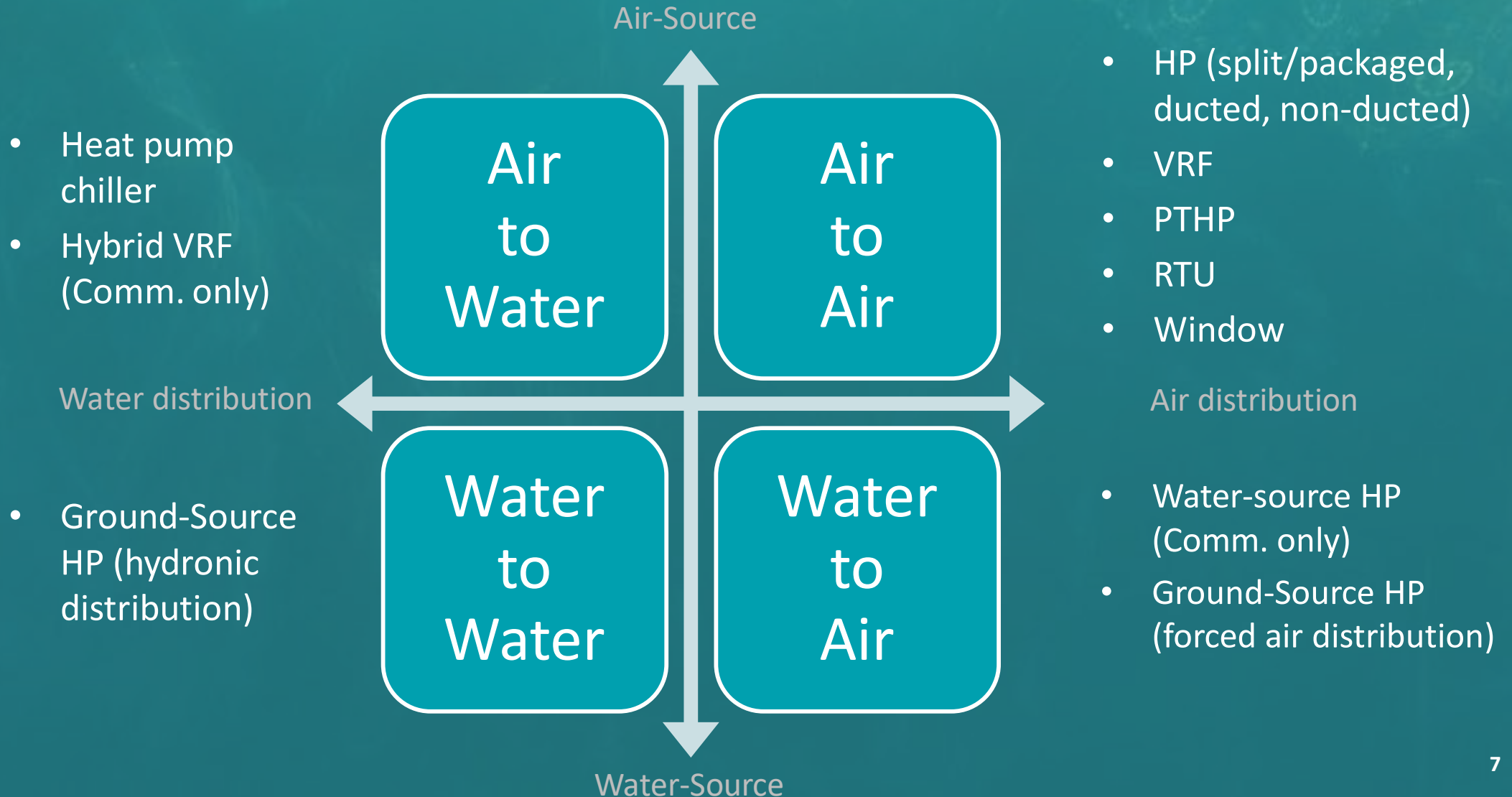
We seek to accelerate regional collaboration to promote advanced energy efficiency and related solutions in homes, buildings, industry, and communities.

## Approach

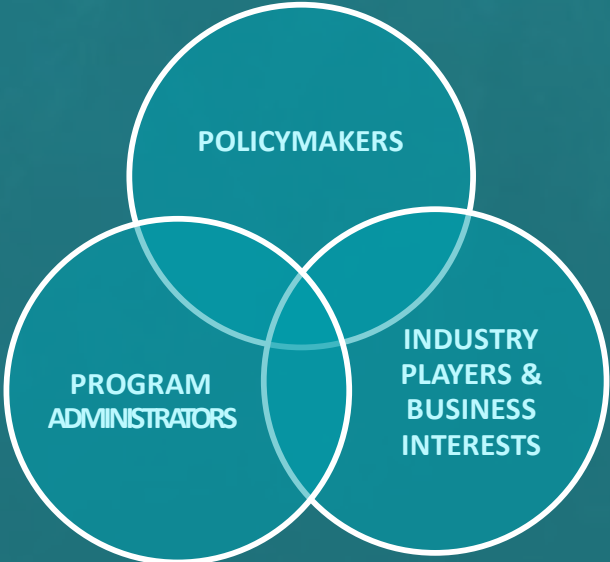
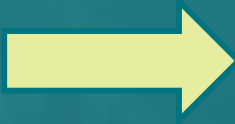
Drive market transformation regionally by fostering collaboration and innovation, developing tools, and disseminating knowledge



# Categorizing Heat pump technologies



# Regional Heating Electrification Initiative



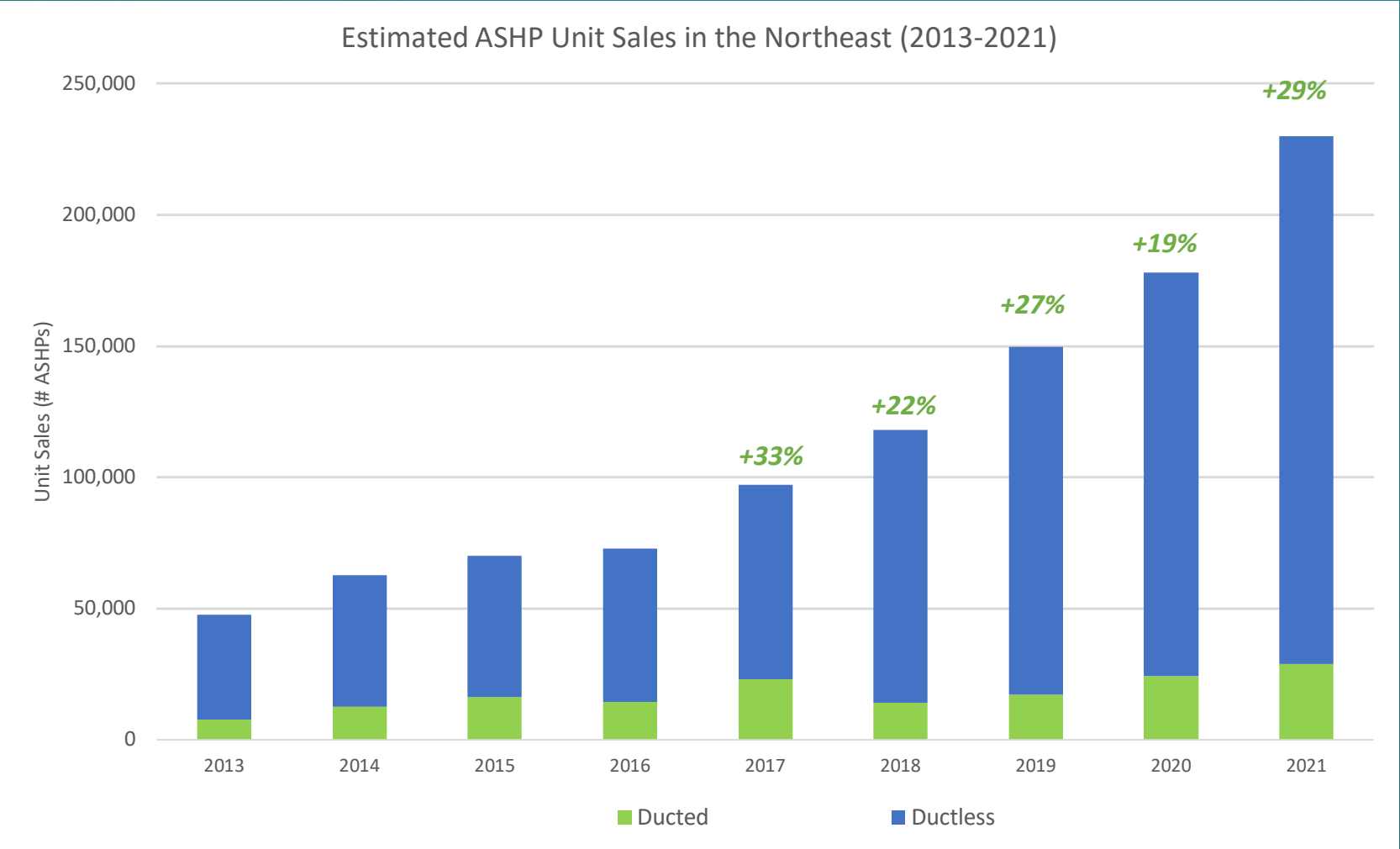


# Current Market Transformation Strategies



- 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**

# Market Momentum Building



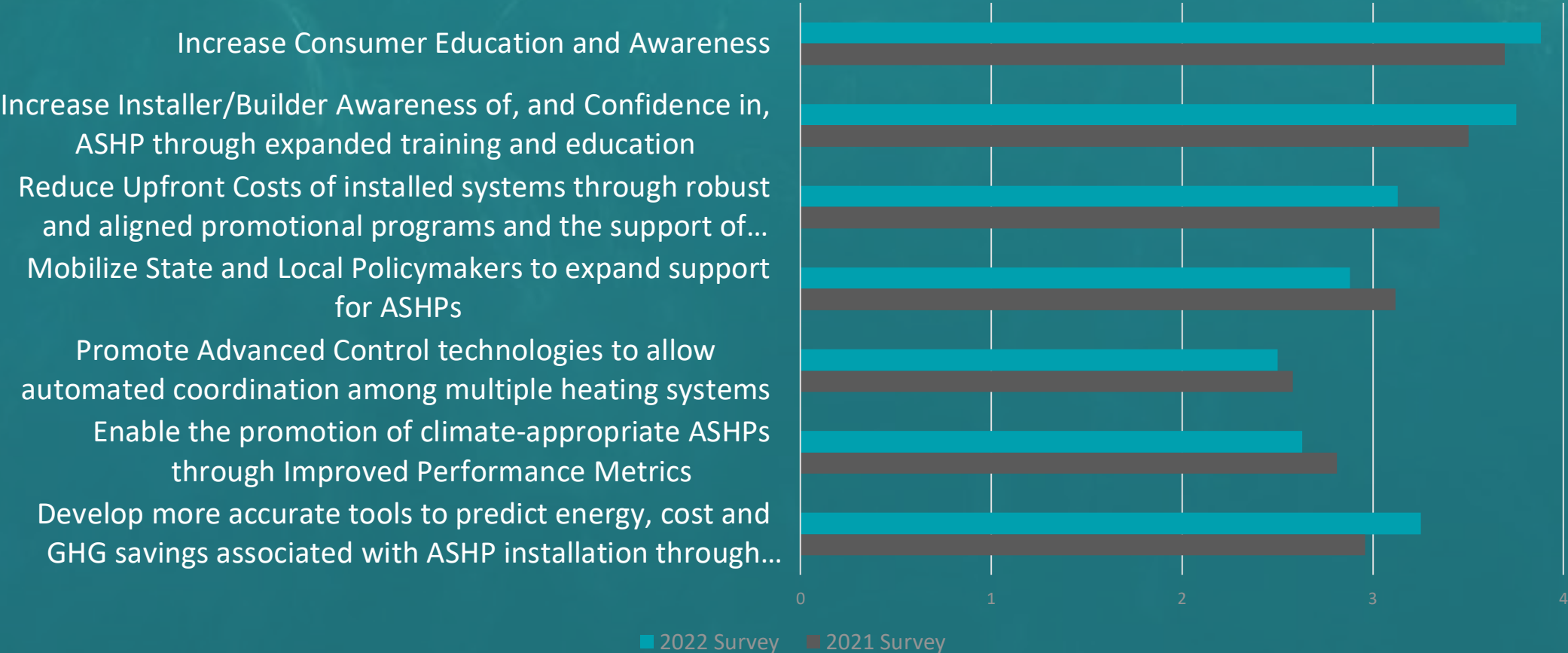
## Sales in context

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

# Residential Market Strategies- Forward looking Priorities



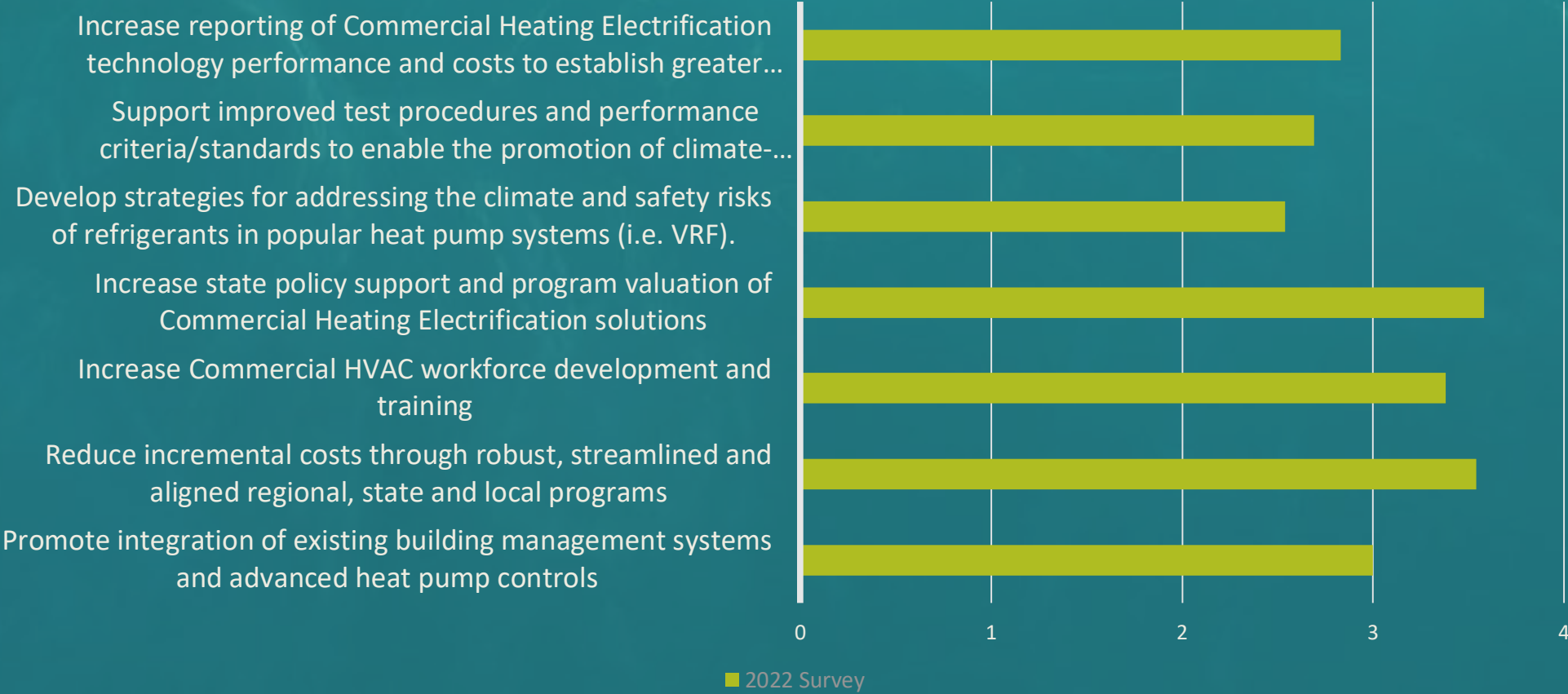
## Priority of Regional Action over the Next 2-3 Years (Residential)



# Commercial Market Strategies- Forward looking Priorities



## Priority of Regional Action over the Next 2-3 Years (Commercial)



# Model Program elements



- Robust Downstream and Midstream incentives
- Consumer Education
- Workforce Education/Support
- Quality Assurance elements
- Equity
- Evaluation



# Supporting Policies



- State Targets
- Shifting Decarb/Fuel switching policies for EE programs
- Alternative Portfolio Standards
- Building Performance Standards
- New Construction codes/standards
- Workforce funding
- Financing

# Policies and Programs on the cusp/horizon



- Equity in market shift
- Clean Heat standards
- Emission-based appliance standards
- Financing+ program implementer+ incentives+ BPS (Ithaca model)
- Supporting refrigerant transition
- Utility rate redesign
- Leveraging Federal funding

# NEEP's Cold-Climate ASHP Specification and Product List



ashp.neep.org

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

Brand: All Brands | Model #, AHRI #, Unit #: AHRI, Model or Ur | Ducting Configuration: All Configuratic

Heating Capacity (Rated Btu/hr @47°F): 0 to 80000 | Heating Capacity (Max Btu/hr @5°F): 0 to 80000

10 > (5067 Heat Pumps) | Grid View | List View | Download Product List

**TRANE**  
XV20i  
AHRI #: **8935201**  
Outdoor Unit #: **4TWV0024A1**  
Indoor Unit #: **4PX\*BD36BS3**  
Singlezone Ducted, Centrally Ducted  
🔥 **12,880** Max Btu/hr @5°F  
🔥 **22,200** Rated Btu/hr @47°F  
❄️ 24,400 Rated Btu/hr @95°F  
COP @5°F: **1.91**  
HSPF: **10**

[VIEW DETAIL](#)

**TRANE**  
XV19  
AHRI #: **201923126**  
Outdoor Unit #: **4TWL9024A1**  
Indoor Unit #: **4PX\*CU60BS3**  
Singlezone Ducted, Centrally Ducted  
🔥 **10,520** Max Btu/hr @5°F  
🔥 **20,400** Rated Btu/hr @47°F  
❄️ 25,000 Rated Btu/hr @95°F  
COP @5°F: **2.49**  
HSPF: **11**

[VIEW DETAIL](#)

**TRANE**  
XV19  
AHRI #: **201922963**  
Outdoor Unit #: **4TWL9024A1**  
Indoor Unit #: **4PX\*CU48BS3**  
Singlezone Ducted, Centrally Ducted  
🔥 **10,680** Max Btu/hr @5°F  
🔥 **20,400** Rated Btu/hr @47°F  
❄️ 24,400 Rated Btu/hr @95°F  
COP @5°F: **2.52**  
HSPF: **11.5**

[VIEW DETAIL](#)

Now 40,000+ systems from over 100 major brands

**DAIKIN MXS Series**  
Multizone All Non-ducted  
AHRI Cert #: **201851579**  
Outdoor Unit #: **4MXS36RMVJU**  
Indoor Unit #:

🔥 Maximum Heating Capacity (Btu/hr) @5°F: **22,610**  
🔥 Rated Heating Capacity (Btu/hr) @47°F: **36,000**  
❄️ Rated Cooling Capacity (Btu/hr) @95°F: **36,000**

Information Tables		Performance Specs						
Brand	DAIKIN	Heating / Cooling	Outdoor Dry Bulb	Indoor Dry Bulb	Unit	Min	Rated	Max
Series	MXS Series	Heating	5°F	70°F	Btu/h	4,780	-	22,610
Ducting Configuration	Multizone All Non-ducted				kW	0.4	-	2.68
AHRI Certificate No.	201851579				COP	3.5	-	2.47
Outdoor Unit #	4MXS36RMVJU	Heating	17°F	70°F	Btu/h	5,920	22,000	26,840
Indoor Unit Type	Non-Ducted Indoor Units				kW	0.42	2.7	3.75
Indoor Unit #					COP	4.13	2.39	2.1
Furnace Unit #		Heating	47°F	70°F	Btu/h	9,100	36,000	43,000
SEER	17.7				kW	0.43	2.34	3.24
EER	9.2				COP	6.2	4.51	3.89
HSPF Region IV	12.2	Cooling	82°F	80°F	Btu/h	10,770	-	40,540
Energy Star					kW	0.55	-	3.63
Variable Capacity	✓				COP	5.74	-	3.27
Turndown Ratio (Max 5°F/Min 47°F)	2.48	Cooling	95°F	80°F	Btu/h	10,100	36,000	38,000
Capacity Maintenance (Max 5°F/Max 47°F)	52%				kW	0.59	3.91	3.94
Capacity Maintenance (Rated 17°F/Rated 47°F)	61%				COP	5.02	2.7	2.83
Capacity Maintenance (Max 5°F/Rated 47°F)	62%							
Integration								
Connectivity								
Operational Diagnostics								
Refrigerant(s)								

**Heating/Cooling Capacity Graph**

Outdoor Temperature (°F)	Heating Capacity (Btu/hr)	Cooling Capacity (Btu/hr)
5	~22,610	~36,000
17	~22,000	~36,000
47	~10,770	~36,000
82	~10,100	~36,000
95	~10,100	~36,000



# Take-aways

- A few key heat pump technologies are gaining traction in the region...ready for primetime
- Other emerging heat pump techs are at earlier stages of market adoption
- Key strategy areas- Consumer, Installer, affordability
- Important roles for incentive and regulation to transform the heating sector at scale and pace
- Exciting regional Collaboration opportunities



# THANK YOU!

Dave Lis  
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P: 781.860.9177 X127  
[www.neep.org](http://www.neep.org)

# Steven Winter Associates



# Air-Source Heat Pumps: Metrics and Tools for Cold Climate Programs



Robb Aldrich, [raldrich@swinter.com](mailto:raldrich@swinter.com)

Steven Winter Associates, Inc.

# Background



NYSERDA Initiative



**NYS Clean Heat**

ACEEE Paper

[https://aceee2022.conferencespot.org/event-data/pdf/catalyst\\_activity\\_32344/catalyst\\_activity\\_paper\\_20220810190439169\\_85747746\\_6874\\_4fb6\\_962f\\_4a9d2f51ec4d](https://aceee2022.conferencespot.org/event-data/pdf/catalyst_activity_32344/catalyst_activity_paper_20220810190439169_85747746_6874_4fb6_962f_4a9d2f51ec4d)



# HSPF, HSPF2



## Variable-speed ASHPs:

- Five steady-state tests (17°F – 62°F ODB)
- Manufacturers specify compressor speeds
  - sometimes fan speeds
  - may/may not happen in normal operation

# NEEP Specification



Ask manufacturers:

- What's the **Maximum** capacity at **5°F** ODB?
- What's the power consumption & COP here?

To qualify:

- COP  $\geq$  **1.75** (Max@5)
- **Variable** speed (at least three distinct speeds)
- (several other criteria)



<https://neep.org/heating-electrification/ccashp-specification-product-list>

# NEEP Specification



- Mfrs must provide performance info at specific conditions
  - Capacity range (min – rated – max)
  - Power consumption at capacities
  - COP

Info available in a **DATABASE**  
(free for end-users)



<https://neep.org/heating-electrification/ccashp-specification-product-list>

			Capacity Level		
Outdoor Dry Bulb (°F)	Indoor Dry Bulb (°F)		Minimum	Rated	Maximum
47	70	Btu/h			
		kW			
		COP			
17	70	Btu/h			
		kW			
		COP			
5	70	Btu/h		Optional	
		kW		Optional	
		COP		Optional	
Lowest Cataloged ODB	70	Btu/h			
		kW			
		COP			



# ENERGY STAR v6: Cold Climates



Several requirements...

## Controls Verification Protocol: CVP

- Test at 5°F ODB with **Native Controls**
- **NOT** specified compressor and fan speeds
- COP  $\geq$  **1.75** using CVP



[https://www.energystar.gov/products/spec/central\\_air\\_conditioner\\_and\\_air\\_source\\_heat\\_pump\\_specification\\_version\\_6\\_0\\_pd](https://www.energystar.gov/products/spec/central_air_conditioner_and_air_source_heat_pump_specification_version_6_0_pd)

# CSA EXP07:19



## Features

- ALL about **Native Controls**
- Load based: Apply a load, see how the HP meets the load
- Seasonal COP

## Concerns

- Early days
- Time and cost to perform tests

Heating	Outdoor Conditions
Continental	6 Temperatures from -10°F to 54°F
Marine	4 Temperatures from 17°F to 54°F
Cooling	Outdoor Conditions
Dry	5 Temperatures from 77°F to 113°F
Humid	4 Temperatures from 77°F to 104°F

<https://neea.org/img/documents/CSA-EXP07-Plain-Language-Guide.pdf>

# Capacity Ratios



1. Turndown
  - Assess modulation capabilities
2. Capacity Maintenance
  - cold temperatures



# Max@5 / Rated@47

Where do these numbers come from?

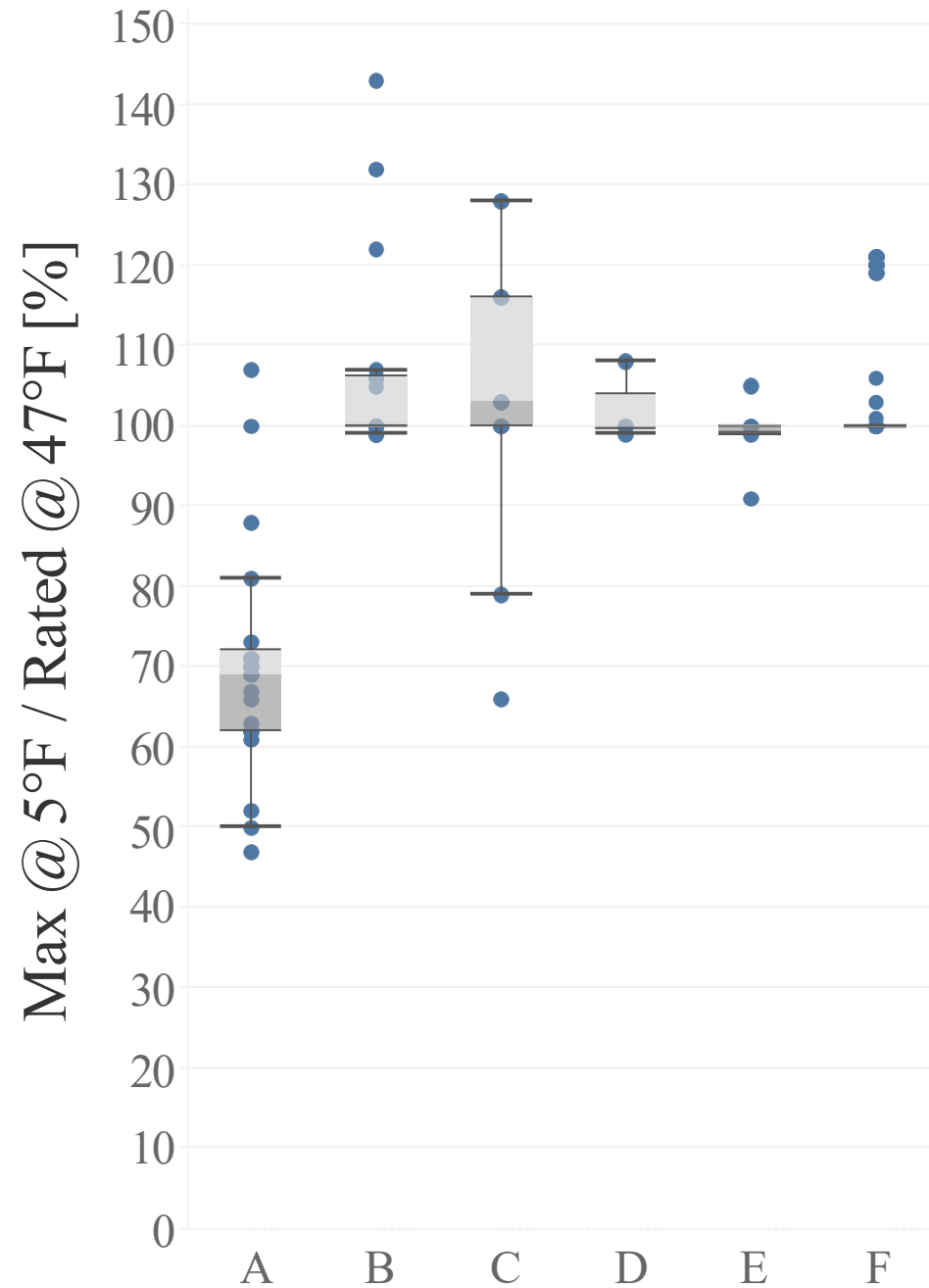
Max@5°F

- Manufacturer specified (e.g. NEEP)
- Perhaps CVP in the future

Rated@47°F

- AHRI 210/240 ( $H_{1,Nom}$ )

# Best Cold-Climate Equipment



- Single-zone
- Ductless

# Rated@17 / Rated@47



Where do these numbers come from?

## Certificate of Product Ratings

High Heat (47F) : 19700

AHRI 210/240:  $H_{1,Nom}$

Low Heat (17F) : 12900

AHRI 210/240:  $H_{1,Full}$

HSPF : 11.60

Sold in? : USA, Canada

AHRI CERTIFIED®

# Preliminary ENERGY STAR v6 Data



Heating Capacity at 47°F (Btu/h)	Heating Capacity at 17°F (Btu/h)	
14000	14500	$\frac{\text{Rated@17}}{\text{Rated@47}} = 104\%$
10000	5500	$\frac{\text{Rated@17}}{\text{Rated@47}} = 55\%$

[https://www.energystar.gov/productfinder/downloads/ENERGY\\_STAR\\_CAC\\_HP\\_V6.xlsx](https://www.energystar.gov/productfinder/downloads/ENERGY_STAR_CAC_HP_V6.xlsx)

# What's a program administrator to do?



- NEEP Spec – still a good start...
- Keep tabs on better metrics (CVP, EXP07)
- Don't mandate arbitrary, unproven metrics
- Help contractors design, select, and install the right equipment in the right application

**Quality Design & Installation:  
more important than any metric!**



# Support Contractors



- Practical resources
- Practical training
- Practical load calc tools
- Practical case studies
- Practical program QC tools



Thanks to DEEP, NYSERDA,  
Stakeholders who contributed!

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# Eversource & Avangrid

# DEEP Technical Session: Comprehensive Energy Strategy

September 22, 2022

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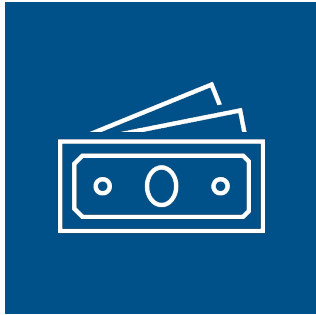
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# Heat Pump Installer Network



Rebates and  
financing



Leads and  
referrals



Marketing  
support



Technical  
resources

[EnergizeCT.com/HPIN](https://www.energizect.com/HPIN)

# Find A Contractor Look-up Tool

The screenshot shows the top navigation bar with the Energize Connecticut logo and a dropdown menu for "Explore Solutions". Below this is a large dark blue banner with a home icon and the text "Find a Participating Contractor". To the right is a search filter section titled "Narrow Your Search:" with a help icon. It includes checkboxes for "Project Type" (Commercial and Residential), a search box for "Enter your zip code", a dropdown for "Services Needed", a dropdown for "Specialty", and another search box for "Included Keywords".

energize CONNECTICUT **CT** Explore Solutions ▾

🏠

## Find a Participating Contractor

**Narrow Your Search:** ⓘ

**Project Type**

Commercial

Residential

**Enter your zip code**

Enter your zip code 🔍

**Services Needed**

Services Needed ▾

**Specialty**

Specialty ▾

**Included Keywords**

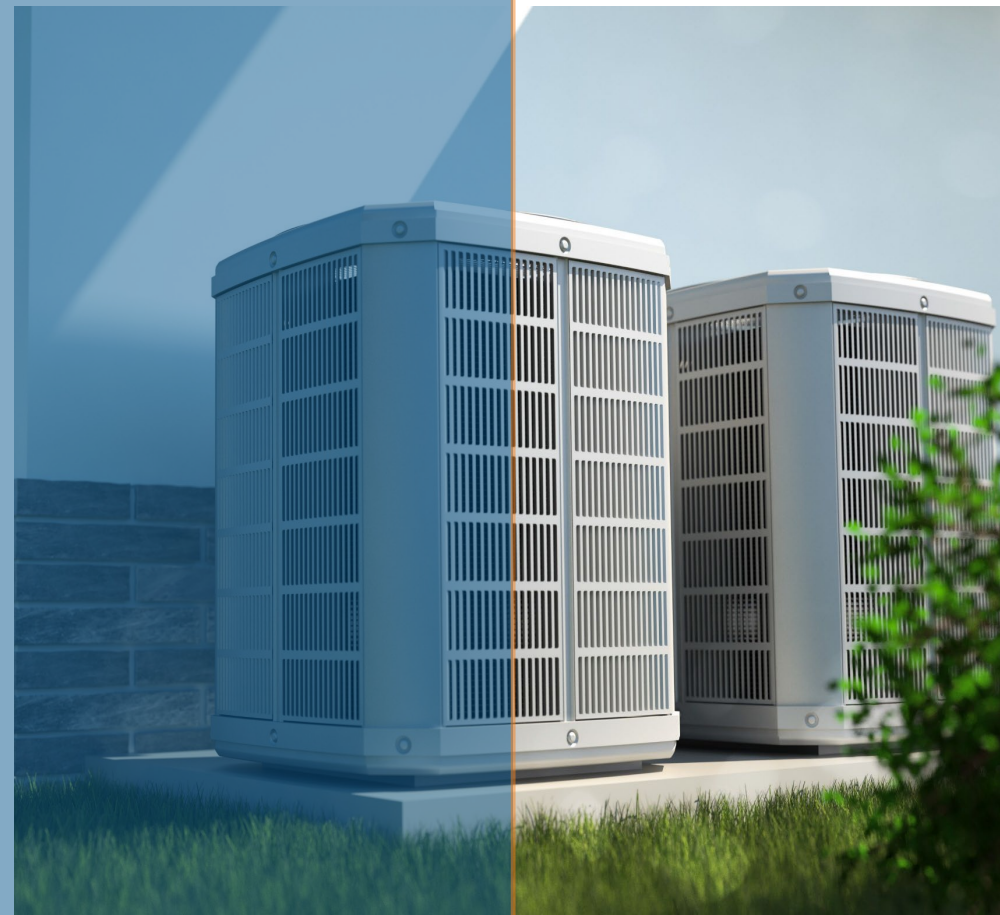
Keywords to include 🔍

# Requirements to Join

Signed copy of the Energize CT Heat Pump Installer Participation Agreement

Relevant licenses, insurance, and proof of training:

- **Air Source Heat Pump Installers:**
  - **EPA Section 608 Certification**
  - Certificate of heat pump installation training provided by a manufacturer
- **Ground Source Heat Pump Installers:** International Ground-Source Heat Pump Association (IGSHPA) accredited installer or GeoExchange Designer (CGD) certificate







Straightforward  
enrollment



Easy access to  
support and  
resources



Clear offers and  
program  
expectations

# Heat Pump eLearning Center Training Courses

## Residential Heat Pump Program Overview

- Program equipment eligibility
- Heat Pump rebates and financing
- Heat Pump Installer Network participation
- Available resources

## Air Source Heat Pump Sizing and Design

- Basic heat pump operation
- Using load calculations
- System sizing and specifications
- Design options and considerations
- Controls and thermostats
- Recommended practices

## Mini-Split Heat Pump Installation Best Practices

- Common air source heat pump myths and facts
- Best practice tips for heat pump placement, installation, operation
- System placement and installation fundamentals
- Review of heat pump user tips

# Thank you

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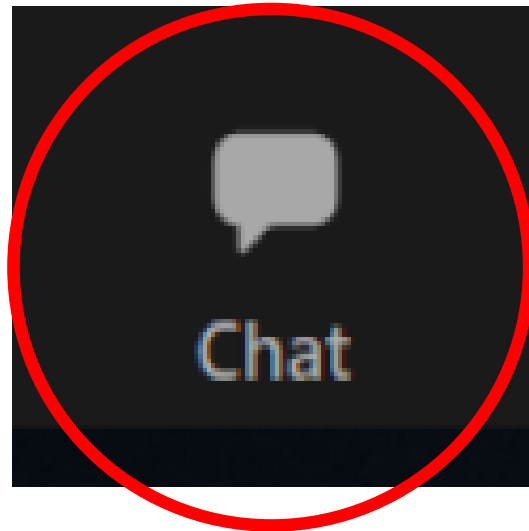


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**energize**  **CT**<sup>SM</sup>  
CONNECTICUT

# 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.

# Market Transformation Continued

Melissa Kops, Laura Bozzi, & Alicia Dolce – CT Green Building Council  
& Yale School of Public Health

Jason Masters – Buro Happold

Bernie Pelletier & Deborah Roe – People's Action for Clean Energy

Click on agenda section heading to  
jump to corresponding slides

(speaker order may vary)

BUREAU OF ENERGY AND  
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# CT Green Building Council & Yale School of Public Health

## Marketing and Health Impacts of Heat Pumps and Electrification

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September 22, 2022

**Melissa Kops** AIA, LEED AP BD+C, LFA

*Board Advisor*

CT Green Building Council

**Laura Bozzi**

*Director of Programs*

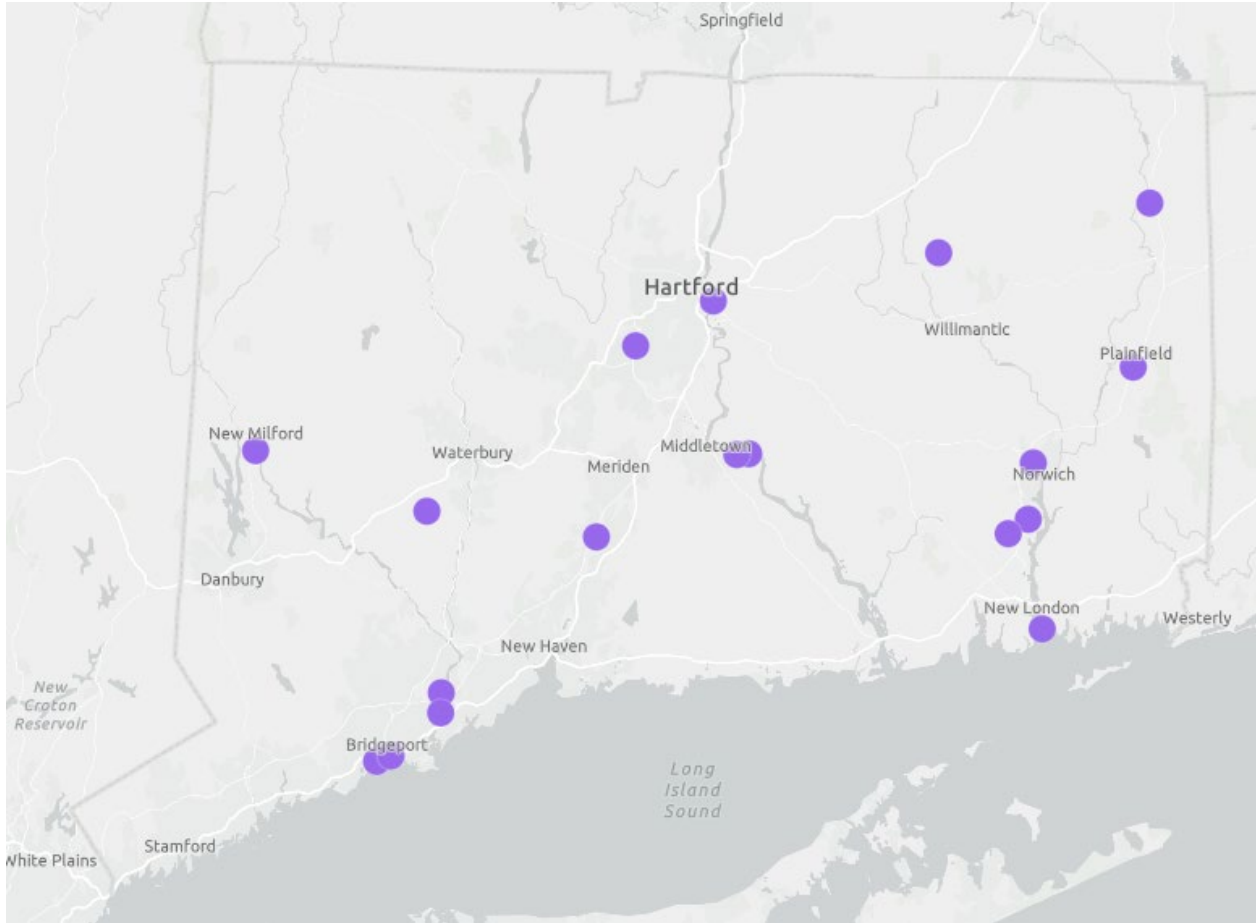
Yale Center on Climate Change and Health

**Alicia Dolce**

*Executive Director*

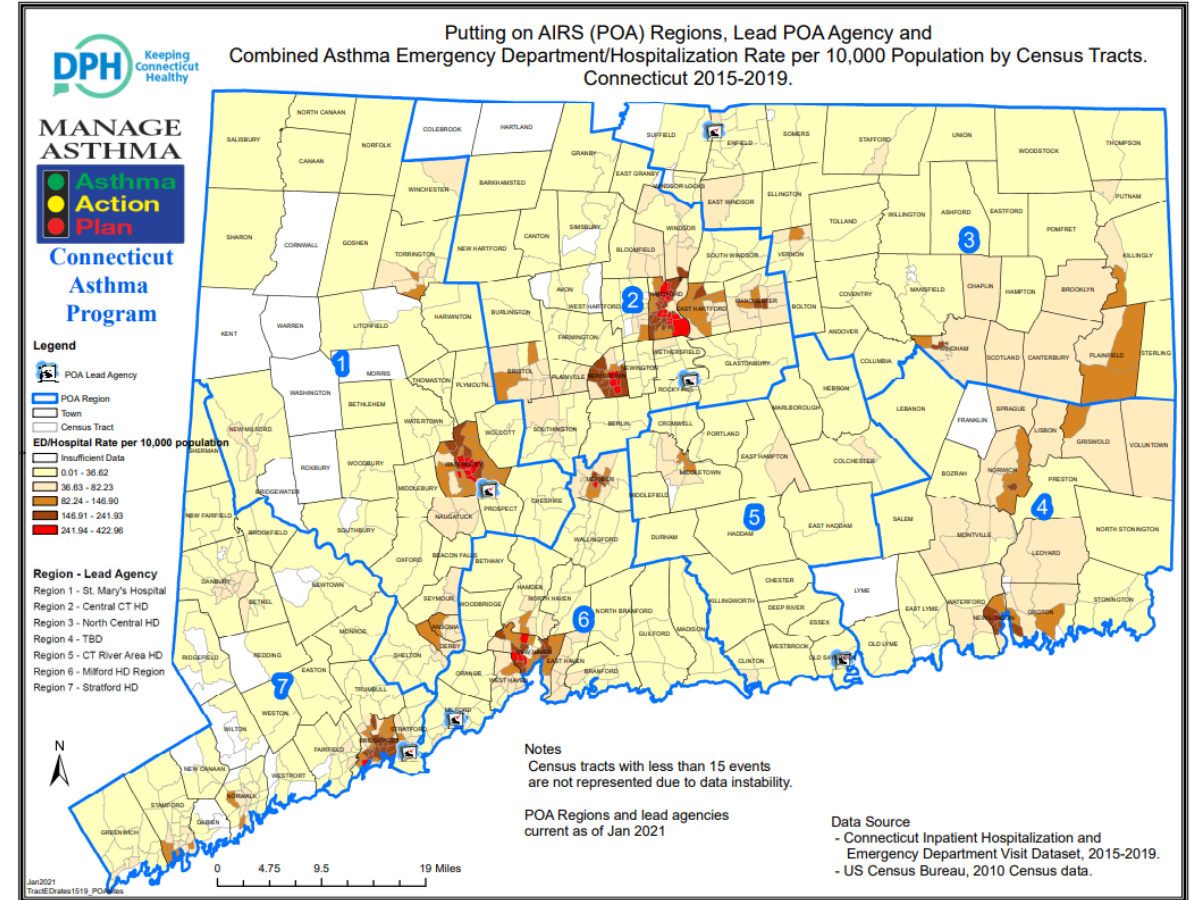
CT Green Building Council

# Air Pollution and Asthma



## Pollution-emitting Power Plants in CT

[EPA Power Plants and Neighboring Communities Mapping Tool](#)



## Asthma Emergency Visits and Hospitalizations

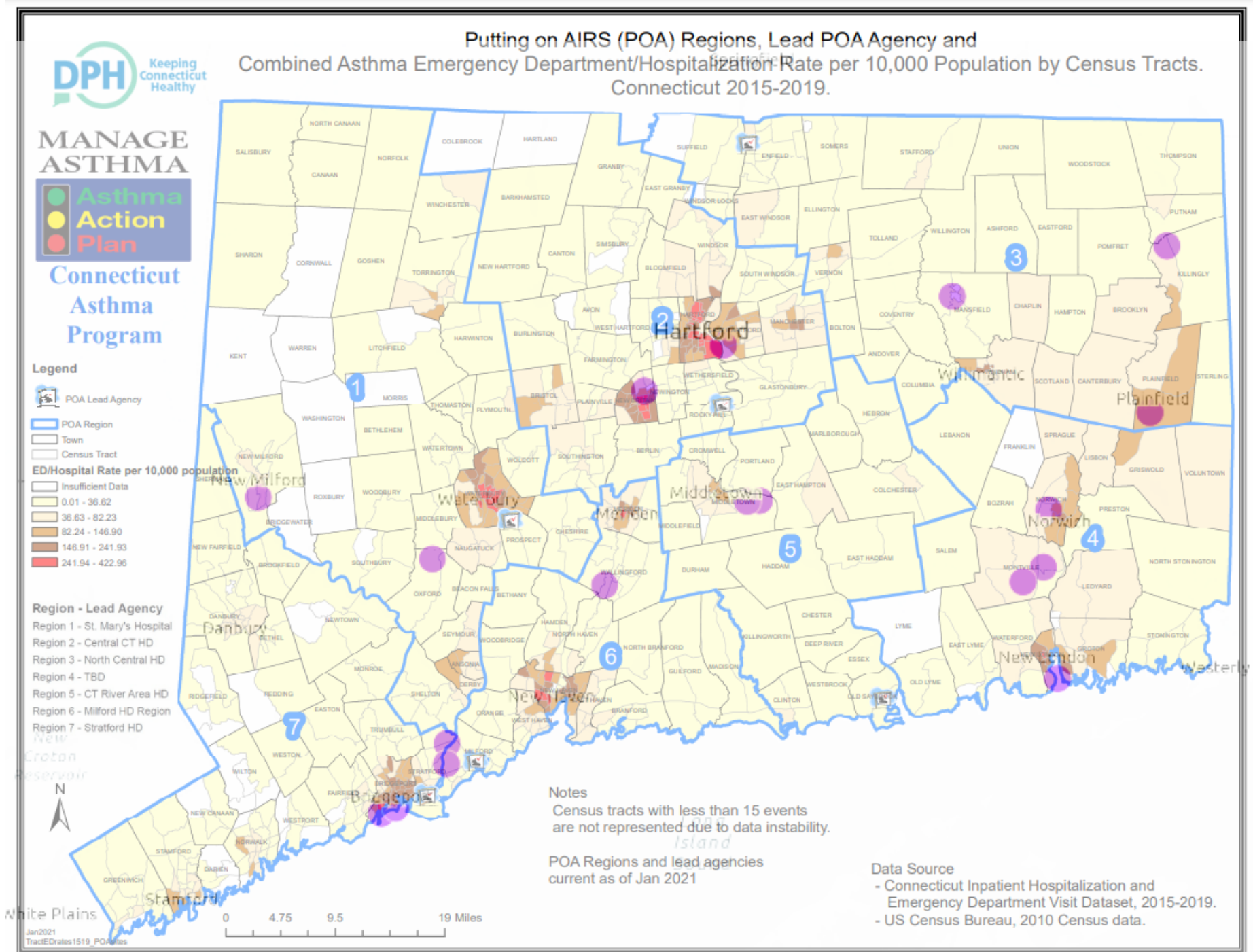
Estimates based on the [2014-2018 Connecticut Inpatient Hospitalization and Emergency Department Visit dataset](#) and the 2010 Census population data at the census tract level, per 10,000 population.



## Pollution-emitting power plants in purple overlaid with asthma incidence rates

While there is some apparent correlation between power plants and asthma rates, it doesn't tell the whole story.

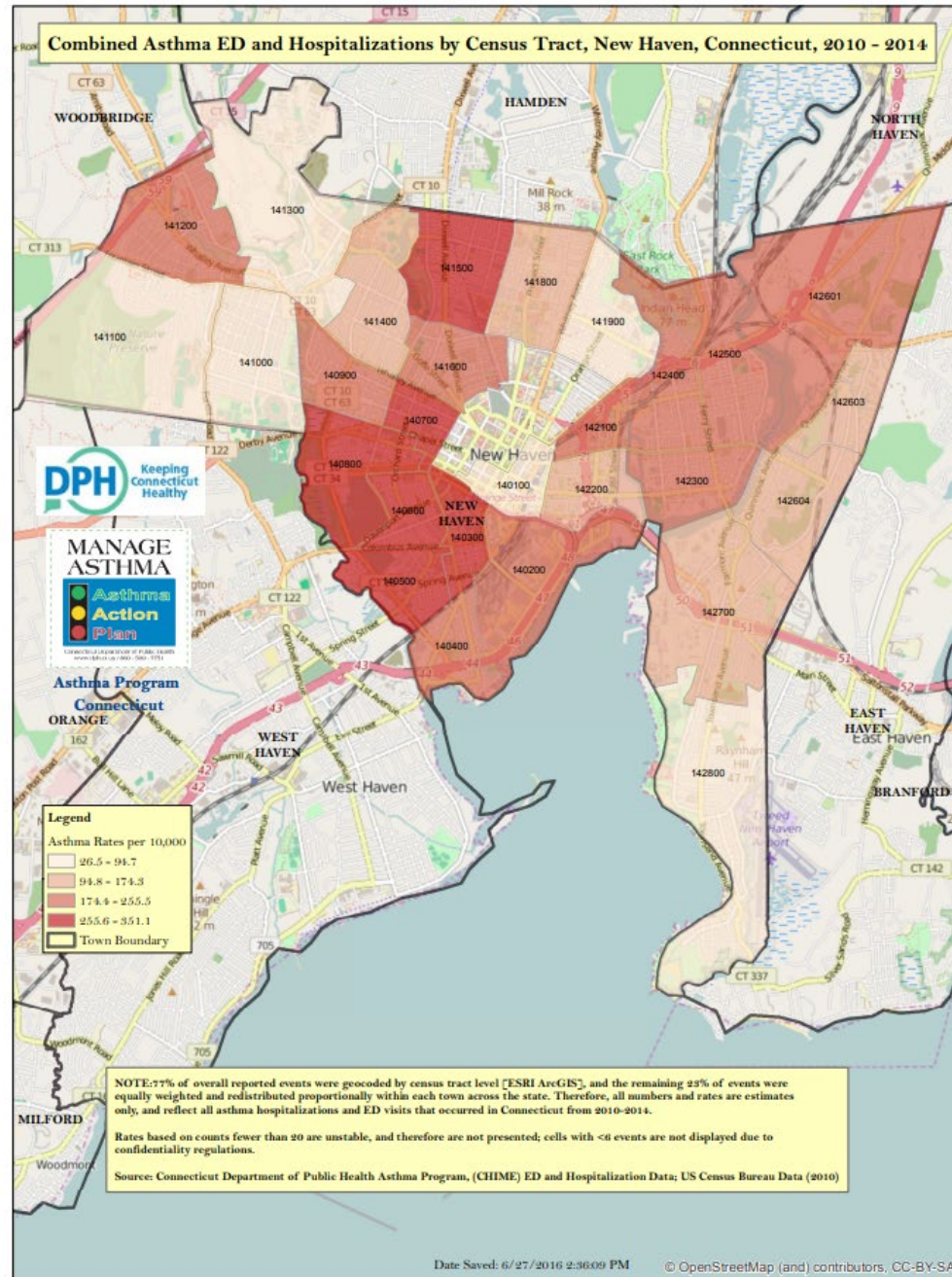
For instance, in Waterbury and New Haven there is a high asthma incidence rate but there are no adjacent high-emitting power plants.



## City of New Haven Asthma Incidence per 10,000 people from 2010-2014

Here you can see elevated incidents of asthma along highway corridors, but the highest prevalence of asthma incidents seems to occur in communities of color where housing is dense. This is most likely related to the housing conditions.

- How are the homes in these neighborhoods heated?
- What is their energy-efficiency?
- Electrification and weatherization measures that improve housing conditions can also improve asthma.



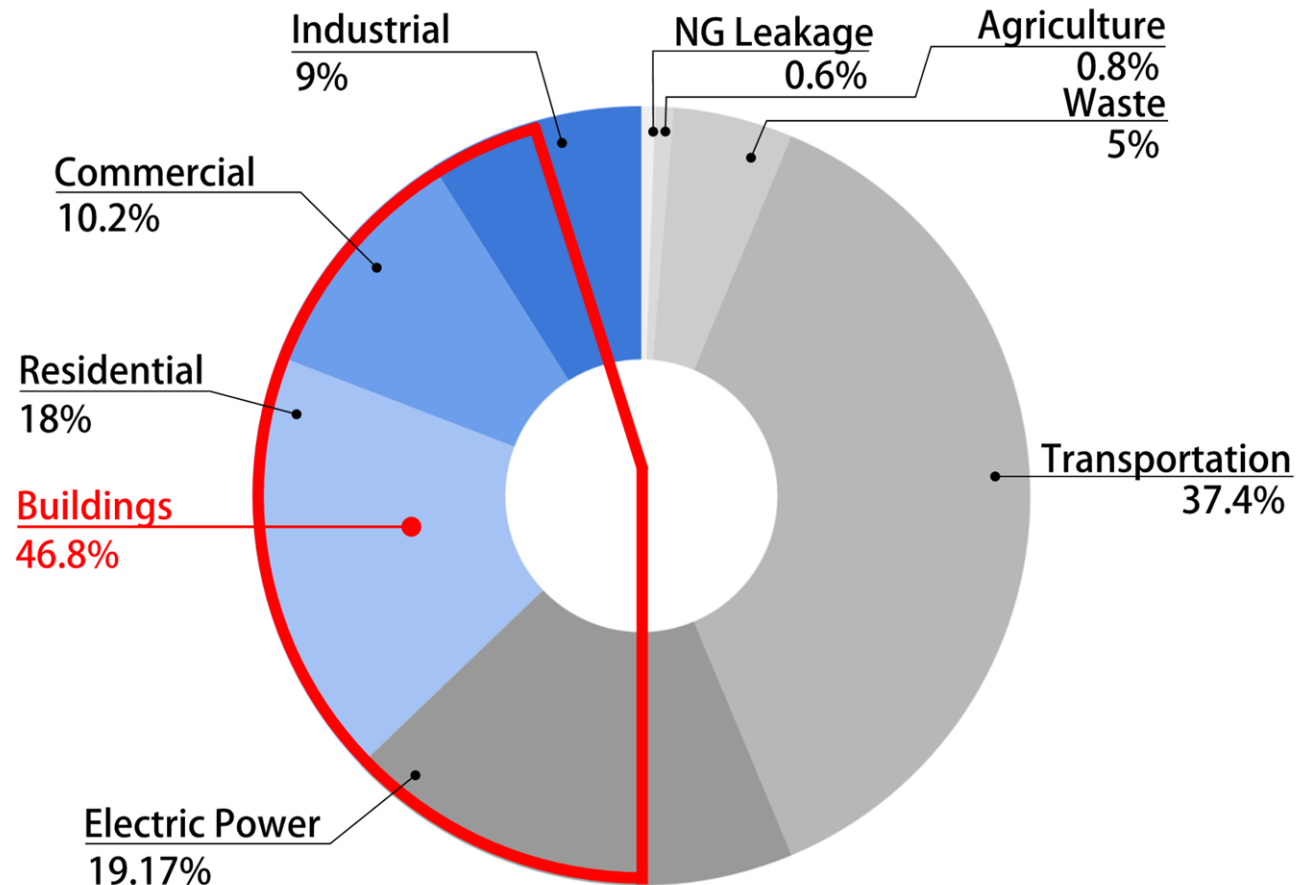
## The Building Sector is the largest contributor to climate change (Greenhouse Gas Emissions) in Connecticut

The Building Sector should be evaluated as a whole, including its electrical consumption.

Electrical consumption includes demand directly related to the performance of a building such as lighting, air-conditioning, heating, ventilation, appliances, etc.

- Greenhouse Gas Emissions are related to the creation of air pollution.

# Why Buildings Matter So Much



## Estimated greenhouse gas emissions in Connecticut from buildings

Graphic by the Connecticut Green Building Council | [Build Better CT - Biggest Potential to Reduce Carbon Emission](#)

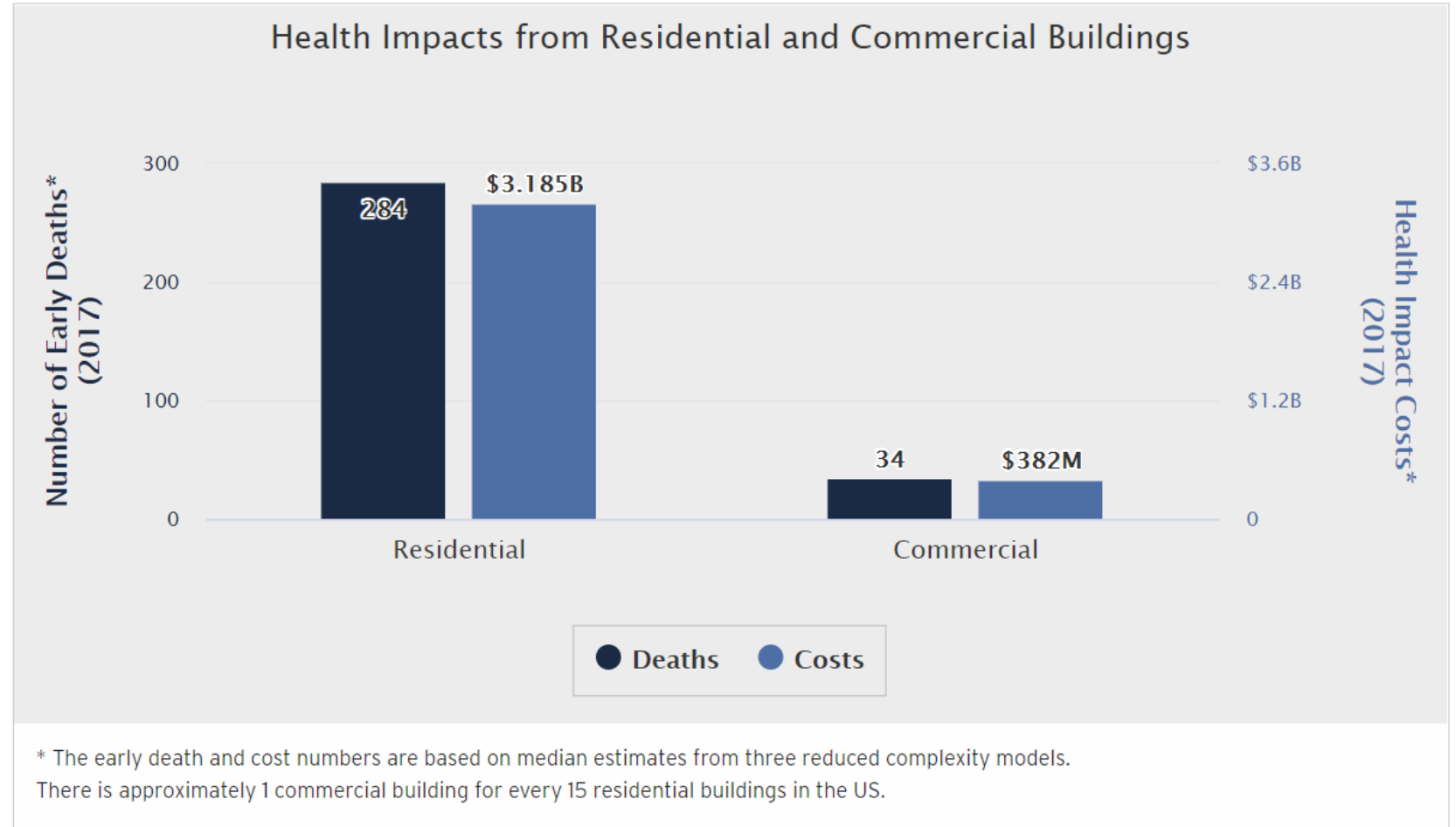
Sources: [2018 Connecticut Greenhouse Gas Inventory](#), DEEP Office of Climate Change, Technology and Research, 2019, [Energy Consumption by Sector](#), Energy Information Administration

*In Connecticut, air pollution from burning fuels in buildings led to an estimated 318 early deaths and \$3.567 billion in health impact costs in 2017.*

High health impacts (including but not limited to asthma) related to onsite fossil fuel combustion can be reduced by converting to heat pumps.

- Fund studies to be able to quantify health-related savings of energy-efficiency and fuel-switching, in order to be able to find increased sources of funding.
- Prioritize fuel-switching in areas of high asthma incidence.
- Work at the neighborhood scale instead of house-by-house.

# Health Impacts of Building Emissions (Onsite Fossil Fuel Combustion) in Connecticut



Source: RMI, [What is the health impact of buildings in your state?](#)

*(The data portrays the impacts of building pollution originating in the state but not impacts from cross-state pollution. Furthermore, these figures are underestimates and do not account for health impacts from exposure to indoor air pollution, direct exposure to other outdoor pollutants such as ozone or NO<sub>x</sub>, or other health burdens like asthma or emergency room visits.)*

# Time Spent Inside Buildings Dramatically Impacts Our Health

*“The average life expectancy of a  
American is 79 years old.  
Remarkably, **we spend 70 of those  
79 years inside of buildings, a  
greater percentage of time than a  
whale spends submerged below the  
surface of the ocean.”***

**Dr. Richard Corsi** PHD, PE  
*Dean of the College of Engineering  
University of California, Davis*



# Time Spent Inside Buildings Dramatically Impacts Our Health

Our greatest exposure to outdoor air pollution is indoors.

This exposure is compounded by direct exposures to unaccounted for indoor air pollutants.

**TABLE 3.1 The dirty secret of outdoor air pollution.**

	Outdoor Air Pollution	Breathing Rate	Time Spent Indoors	Total <i>Outdoor</i> Air Pollution Breathed per Day
<b>Outdoors</b>	20 µg / m <sup>3</sup>	0.625 m <sup>3</sup> / hour	2.4 hours (10% of 24 hours)	<b>30 µg / day</b>
<b>Indoors</b>	10 µg / m <sup>3</sup>	0.625 m <sup>3</sup> / hour	21.6 hours (90% of 24 hours)	<b>135 µg / day</b>

*Source: 2020, Healthy Buildings : How Indoor Spaces Drive Performance and Productivity / Joseph G. Allen, John D. Macomber.*

# Potential Health Impacts of Heat Pumps & Building Electrification

Laura Bozzi, PhD

Yale Center on Climate Change and Health

# There is growing evidence of the health harms of combustion in the home

- Most existing research has focused on gas stoves
- Gas appliances emit air pollutants including CO, NO<sub>x</sub>, particulate matter, and formaldehyde, as well as leaked (non-combusted) methane
- These pollutants have been linked to acute and chronic health effects, including exacerbated asthma and other respiratory illness, cardiovascular disease, and premature death
  - Children are especially susceptible



# Research findings, continued

- Indoor air quality is worse in housing with old and unmaintained appliances, and in smaller residences (like apartments)
- Renters face particular challenges in controlling appliance choices or affording maintenance
- To maximize health, climate, and economic benefits, weatherization, ventilation, and electrification should be coupled
  - Weatherization alone may create unintended consequence of increased indoor air pollution from fossil fuel appliances

# What about space & water heating appliances?

- Water heaters and home heating appliances (e.g., furnaces) emit a larger proportion of combustion pollutants than gas kitchen appliances
- Venting reduces their impact on indoor air quality
- However, this depends on appliance maintenance and effective venting
- There are research gaps in the literature on IAQ impacts of appliances
  - Heating appliances have been less well studied than stoves
  - Most research is on gas; other fossil fuels (heating oil, kerosene, propane) are less studied

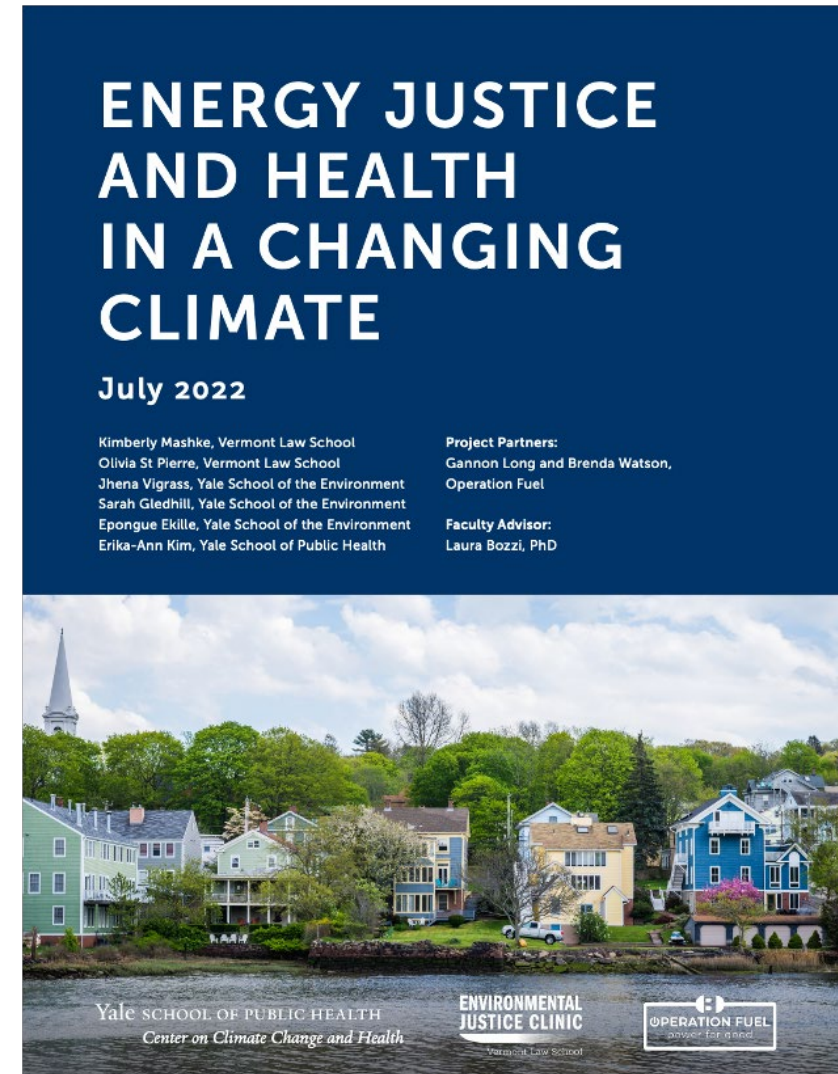
# Other health benefits of heat pumps

## Provides efficient cooling

- A/C is the most effective strategy to protect against the health harms of extreme heat, but it can be too costly and produces GHG and other pollution
- Efficient cooling is increasingly important as climate change worsens (e.g., August 2022 was the hottest month on record in Connecticut)

## May help address energy insecurity, which causes adverse physical and mental health impacts

- Requires equitable policies to support conversion, particularly for rental units and low-income households



# Combustion-based water & space heaters impact outdoor air quality

*A lesson from California:*

- Gas water heaters and home heating appliances (like furnaces) are responsible for the bulk of outdoor air pollution from gas appliances
- Buildings (largely from water and space heating) emit about 4x NO<sub>x</sub> emissions from electric utilities and nearly 2/3 emissions from light-duty vehicles statewide
- Because of this contribution to ozone pollution, the California Air Resources Board is expected to vote this month to adopt a zero-emission standards for space and water heating, to go into effect in 2030

# The Potential of a Healthy Home: Marketing Implications

Market research suggests that protecting personal and family health are much stronger drivers instead of the value proposition of cost savings (Saving Money!) when marketing energy efficiency upgrades and programs.

- Shelton Group\* - Pre-pandemic: *2019 Energy Pulse™*
- Health was emerging as a primary driver for energy efficiency home improvements
  - 72% of Americans believed their homes had a moderate to strong impact on their health
  - 60% were at least somewhat concerned about indoor air quality (IAQ)

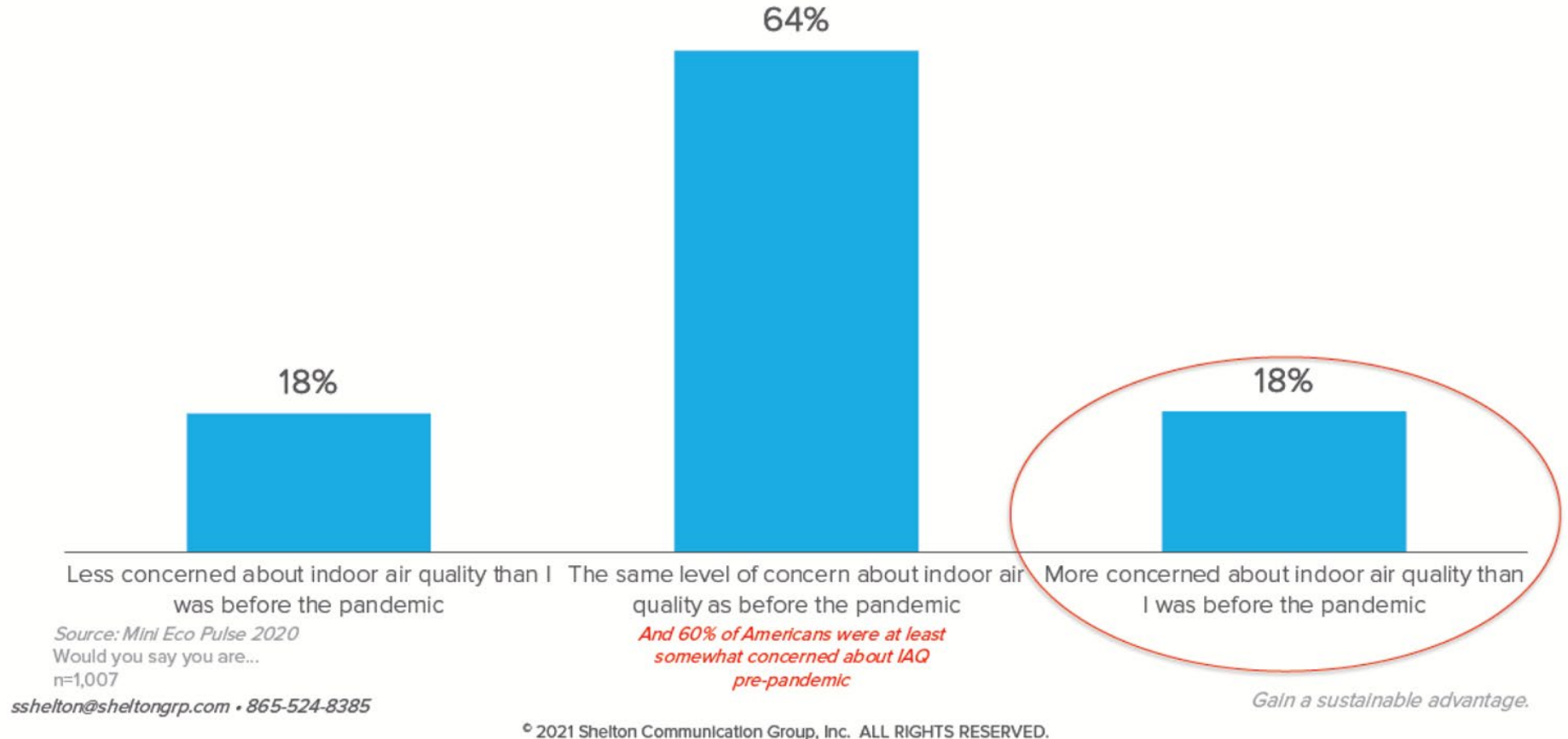
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\*[Shelton Group](#), a national marketing firm studying energy, the environment and sustainability trends

Today, amidst COVID we see even more concern about IAQ

A Shelton Research poll taken May 2020 revealed approx the same levels, 64%, remain somewhat concern about IAQ

- 18% of respondents expressed more concern about IAQ than before the pandemic
- "...You could draw a solid conclusion that now three quarters of Americans are at least somewhat concerned about the air they're breathing in their homes"



Source: Suzanne Shelton: IAQ Is the Next Big Deal: Aug. 5, 2020

# Recommendations Summary

- Prioritize fuel-switching in areas of high asthma incidence.
- Fund studies in order to quantify health-related savings of energy-efficiency and fuel-switching to help identify increased sources of funding.
- Emphasize the health benefits of heat pumps on the EnergizeCT website
- Fund additional education and outreach programs that focus on health benefits of heat pumps over fossil fuel heating & cooling choices targeted to Environmental Justice communities and key stakeholders; i.e. affordable housing/multifamily property owners and developers.
- Encourage work at the neighborhood scale in addition to house-by-house.
  - Organize a working group to brainstorm and collaborate on innovative solutions to scale up heat pump adoption in Environmental Justice communities.
  - “Connect the Dots” with the various actors and programs already in place to amplify impact:
    - CT Equity & Environmental Justice Advisory Council (CEEJAC)
    - Non-profits & quasi-public state agencies that focus on CT’s built environment: PACE, CTGBC, CT Green Bank, CHFA, etc.
    - Energize CT & Community Partnership Initiative
    - Yale Center on Climate Change & Health
    - Healthy Homes Program

# Buro Happold



**Buro Happold**  
NORTH AMERICA

# Heat Pump Market Transformation



# WHO WE ARE

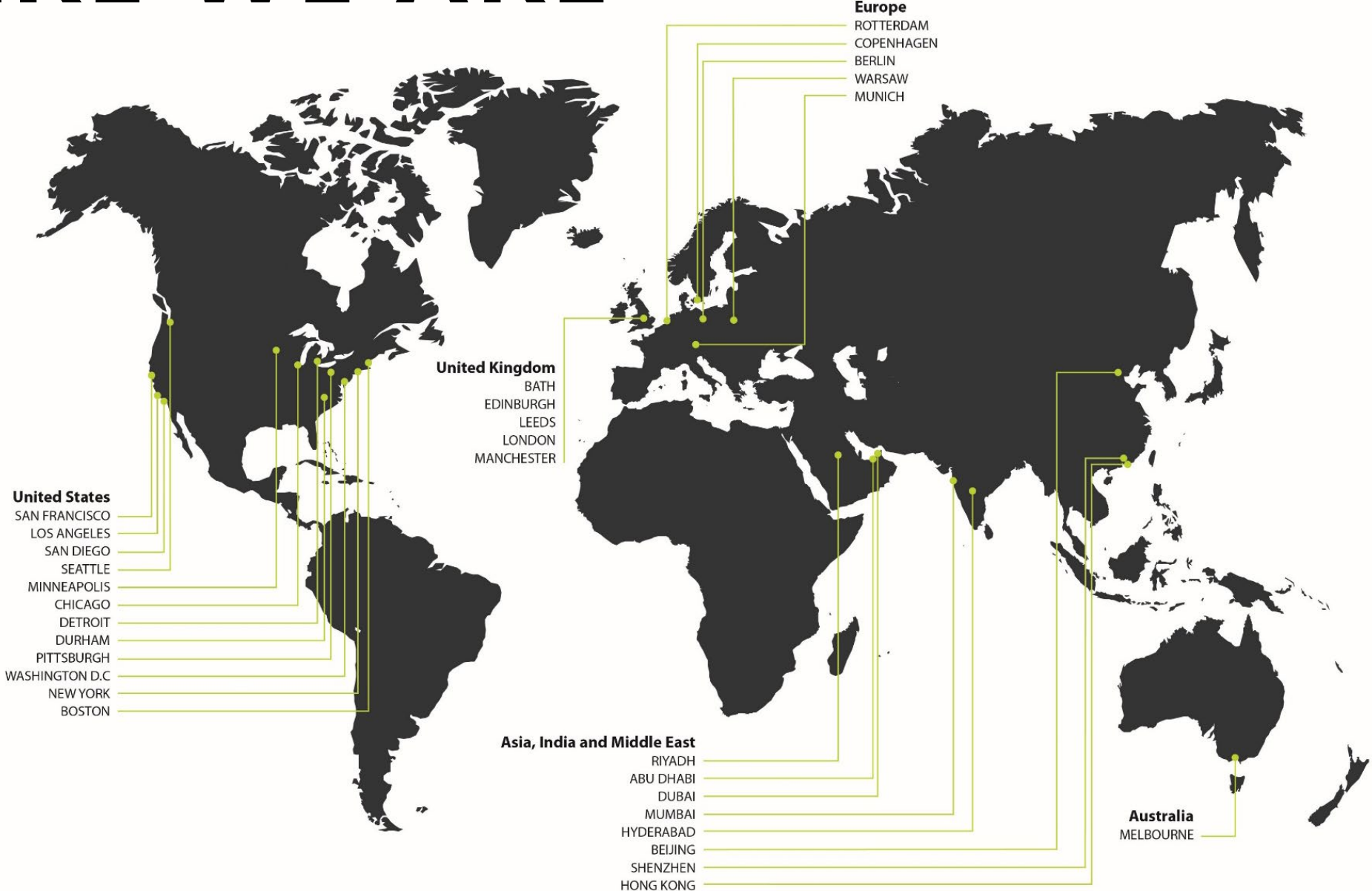
An independent, global practice of over 2,300 engineering and consulting professionals working in the built environment.

We are an international, integrated consultancy of engineers, consultants and advisers, with a presence in 31 locations worldwide, over 70 partners and 2,300 employees.

For over 45 years, we have built a world-class reputation for delivering creative, value-led solutions for an ever-challenging world.

As a truly inter-connected community of experts, we value human wellbeing, curiosity, embrace mutual responsibility and genuinely care about the impact and legacy of our work.

# WHERE WE ARE



# BURO HAPPOLD



12 offices in the US

**2300**  
Staff  
Globally

**1976**  
Year  
Founded

**100+**  
LEED  
Certified  
Projects

# OUR SERVICES

## ENGINEERING

STRUCTURAL

MECHANICAL

ELECTRICAL

ACOUSTIC

FAÇADE

LIGHTING

ENGINEERING

## CONSULTING

ENERGY

ENVIRONMENTAL

SUSTAINABILITY

STRATEGIC PLANNING

TRANSPORTATION & MOBILITY

WATER & WASTE

# Heat Pump Markets

Base Year 2021 → Market Size \$55 70 85 billion

Forecast Period → 8 Years 2030

Compound Annual Growth Rate

5%

7%

9.5%

2030 Value Projection (Billions USD)

\$84 to 132

\$95 to \$156

\$122 to \$192

# Heat Pump Market Drivers

**Public  
Policy**

**Competent  
Installers**

**Technology  
Advancement**

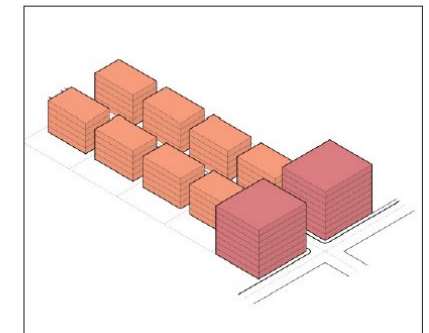
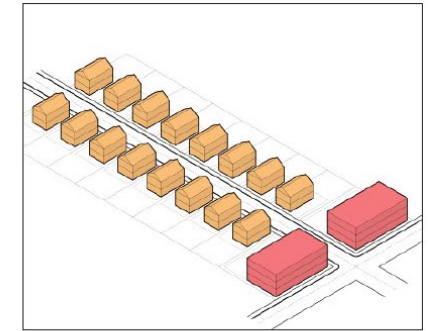
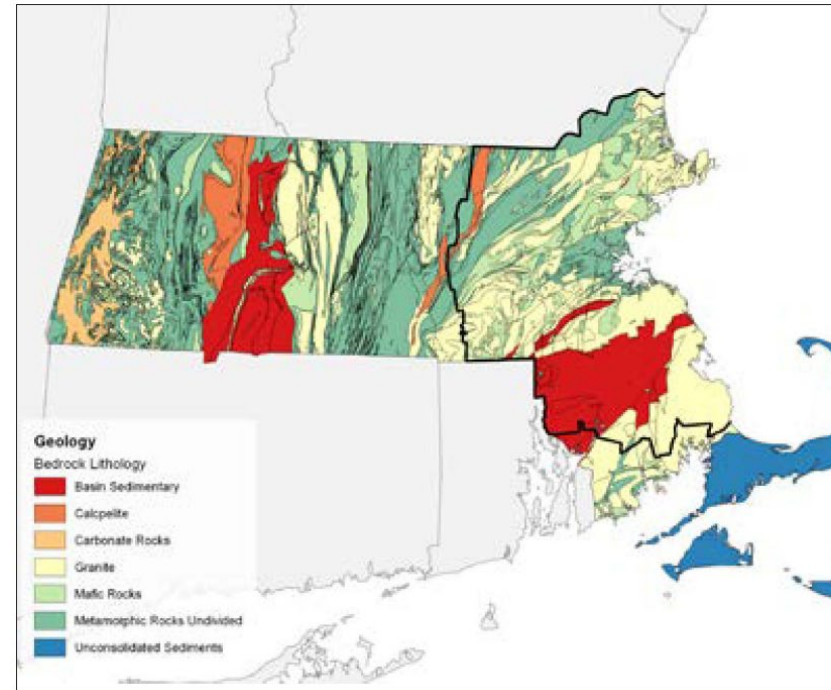
**In-Situ  
Site  
Complexity**

**Access to  
Capital**

**Participant  
Cooperation**

# GeoMicroDistrict Feasibility Study

- BH selected by Home Energy Efficiency Team (HEET), a Boston-based nonprofit, to lead the development of an innovative GeoMicroDistrict Feasibility Study
- explored the potential of replacing natural gas infrastructure with a network of neighborhood-scale district heating systems or “GeoMicroDistricts.”
- assess the feasibility of designing, developing, implementing, and scaling up these systems in the Greater Boston area
- focused on the use of ground-source heat pump technology

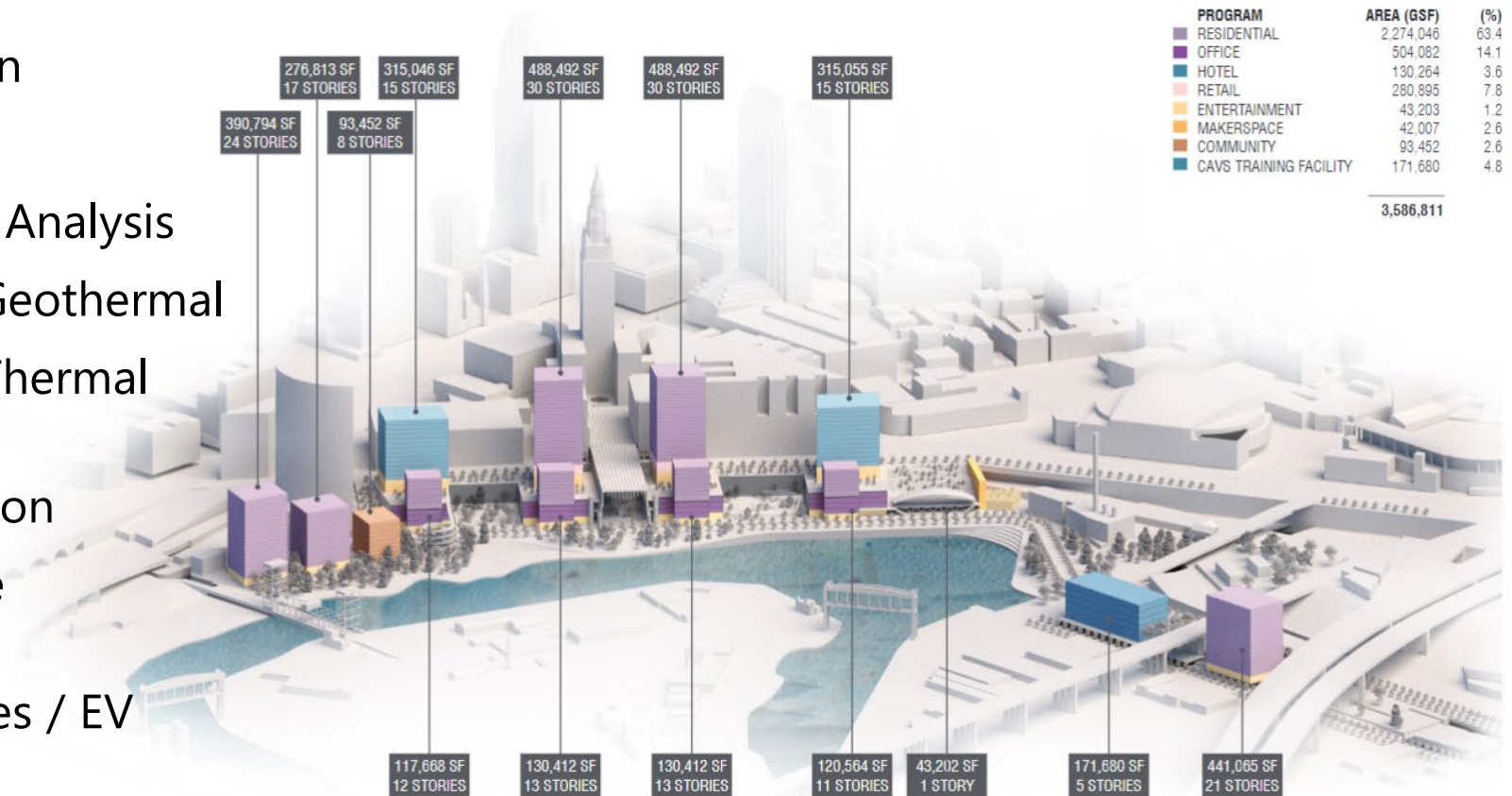


Worked with network of stakeholders, tech advisors, local utilities and universities to assess the potential impacts of implementing GeoMicroDistrict systems based on a range of sustainability, health and safety, and social and economic indicators



# Cleveland Client

- 3.5 million square feet
- 100% new construction
- LEED Silver or better
- Full Techno-Economic Analysis
- District Heating with Geothermal
- Potential River water Thermal Exchange
- Downtown Revitalization
- Renewable and Offsite Generation
- Smart Grid / Appliances / EV Charging



# Detroit Client

- 13.6 million square feet
- 90% new construction
- LEED Silver or better
- Full Techno-Economic Analysis
- District Heating with Geothermal
- Potential River water Thermal Exchange
- Downtown Revitalization
- Smart Grid / Appliances / EV Charging
- Renewable and Offsite Generation

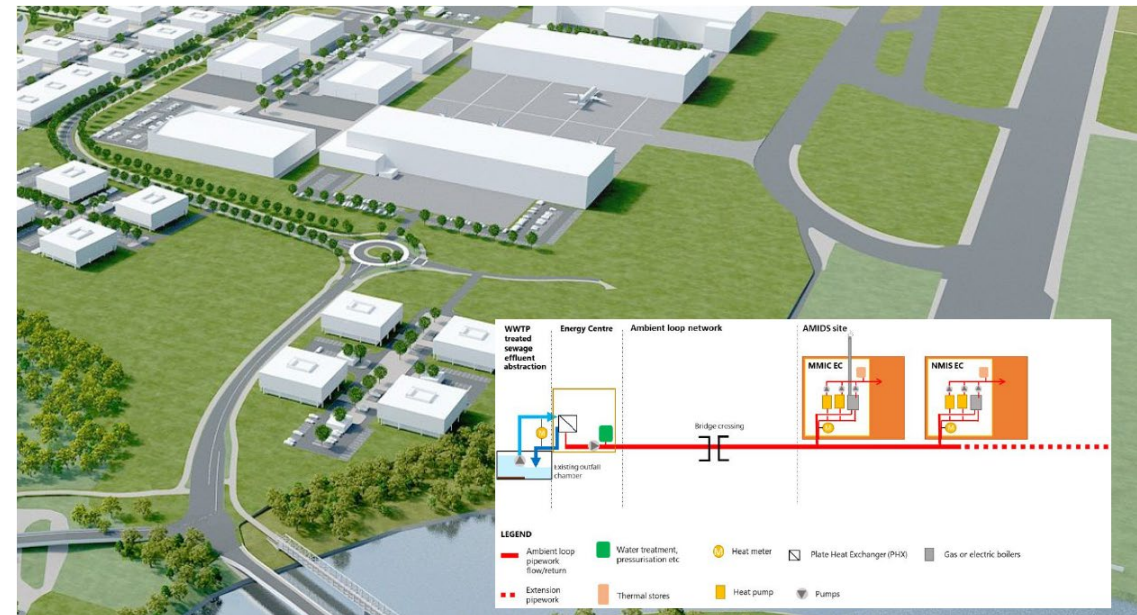


# AMIDS – Scotland’s First ‘5G’ District Energy Network and Net Zero Carbon Campus

Renfrewshire, Scotland

- 150-acre site next to Glasgow Airport
- Advanced Manufacturing Innovation District Scotland (AMIDS)
- initially commissioned to complete an energy strategy for the site
- Buro Happold contracted to design, structure finance, outline business case
- District Heat with Geothermal Exchange
- The very low operating temperatures (10-20°C)

Completed in 2018

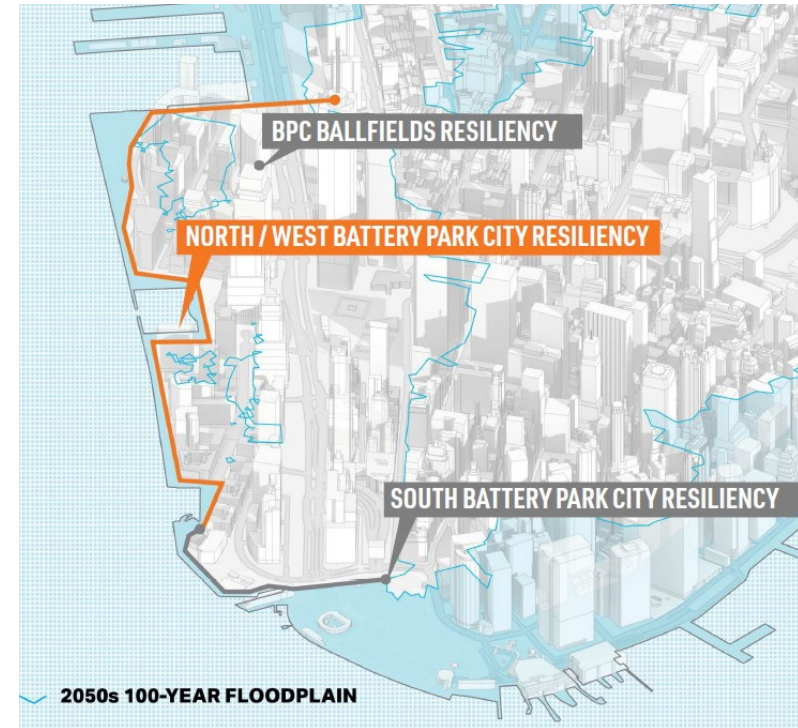


SERVICES PROVIDED BY BURO HAPPOLD  
Energy engineering; water engineering

# Battery Park City Authority

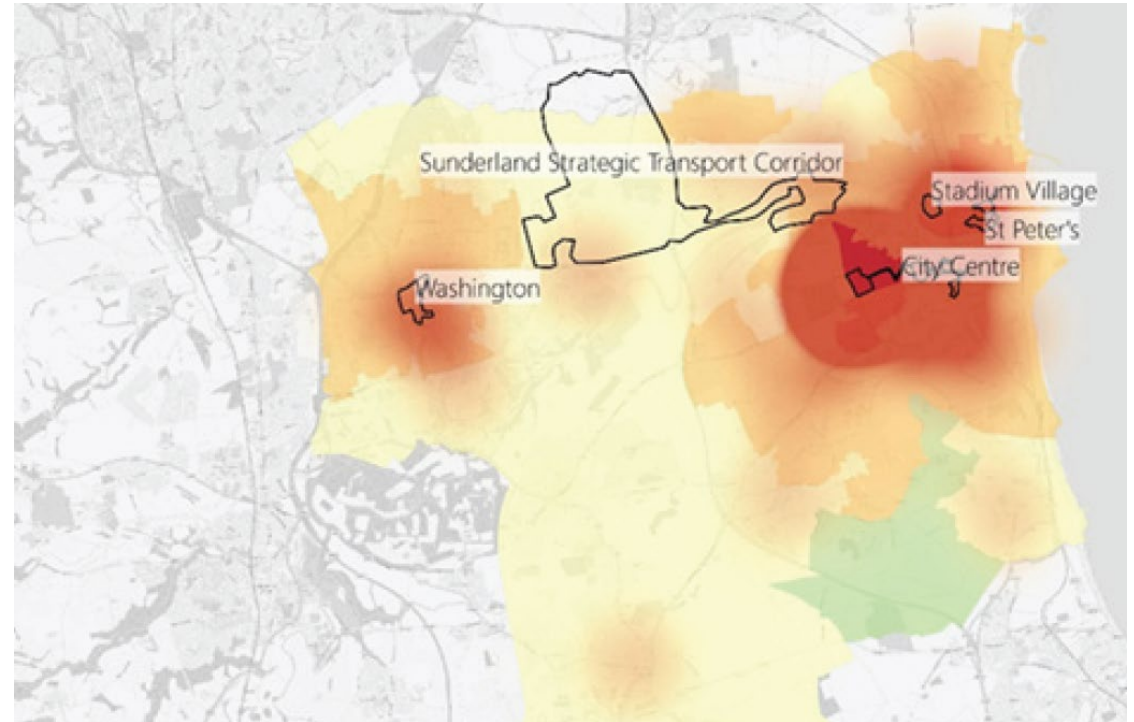
- 33 buildings
- 92 acres on the SW end of Manhattan
- 36 acres of parks
- 240 slip marina
- 10.7 million square feet
- 8,275 residential unit
- 15 LEED certified bldgs.
- Full T/E analysis for District Heat with Geothermal & Riverwater exchange

NY, NY



# Sunderland City Centre heat network

- Energy Masterplanning and Technical and Financial Feasibility to develop district heating in Sunderland.
- Technoeconomic modelling indicated 5 clusters with Heat Network potential
- 3 within 1km of the city center
- key aim of the study was to explore the potential of district heat networks in Sunderland, including the provision of a city-wide Heat Map and Energy Masterplan
- Open-Loop ground source heat pump serving municipal, university, commercial and residential customers



SERVICES PROVIDED BY BURO HAPPOLD  
Energy consulting      risk and resilience  
Sustainability      strategic planning

# INFLATION REDUCTION ACT

Section 45

Section 48

Section 6417

Section 25

Section 179D

Section 6418

Section 30c

Section 48

Section 40



\$4.3 billion Whole House Rebates

\$4.275 State Energy offices to implement electric homes

\$1 billion Improve latest building energy codes

\$ 5 billion Energy infrastructure financing

\$760 million Interstate Electricity Transmission lines / \$ 2 billion in loans

\$15 million DOI – Insular Affairs

# Inflation Reduction Act Incentive Highlights

- Section 45 – Electricity produced from certain Renewable Resources (PTC) 2.6 c/kWh  
45(v) clean hydrogen \$0.60/kg, Solar/Wind/**Geothermal**/Marine  
45(L) new energy efficient home credit \$5k
- Section 48 – Energy Credit (Investment Tax Credit = 30% total cost)
- Section 6417 – Direct Pay option of PTC for public & non-profits
- Section 6418 – Direct Transfer of ITC from public/non-profits to private/taxed
- Section 179D – commercial bldg. energy efficiency (\$1.88 to \$5/sf max)
- Section 30c – Alternative fuel vehicle refueling property credit (30% tax credit)
- Section 30d – clean vehicle credit (up to \$7,500 tax credit/vehicle)
- Section 40a - biodiesel & renewable diesel \$1/gallon credit, 2<sup>nd</sup> gen biofuel @ \$1.01/gallon  
\$1.25/gallon SAFs (sustainable aviation fuel)
- Section 25c - Non-business Energy Property Credit (30% tax credit)  
25(d) residential clean energy credit (30% on ee upgrades. Batteries/panels)

# THANK YOU !

We'd love to hear from you

**JASON MASTERS**

**[Jason.masters@burohappold.com](mailto:Jason.masters@burohappold.com)**

**BUROHAPPOLD**  
**ENGINEERING**



# People's Action for Clean Energy

# Overcoming Barriers to Building Sector Decarbonization:

Data Informed Pathways and Community Outreach

September 22, 2022

CT Comprehensive Energy Strategy – Session 2

Bernie Pelletier, People's Action for Clean Energy

Deborah Roe, People's Action for Clean Energy



# Goals for this presentation

- Introduce the PACE building database:
  - What it is
  - Using it to create and evaluate strategy
  - Example: Replace Central AC with Ducted Heat
  - Ask: Incorporating approach in CES
  - Ask: DEEP to improve data and collect additional data
- Share HeatSmart observations:
  - Barriers encountered/ approach to overcoming
  - Recent progress by EnergizeCT!
  - Suggestions for building on that progress

# PACE Building Database (aka the “Matrix”)

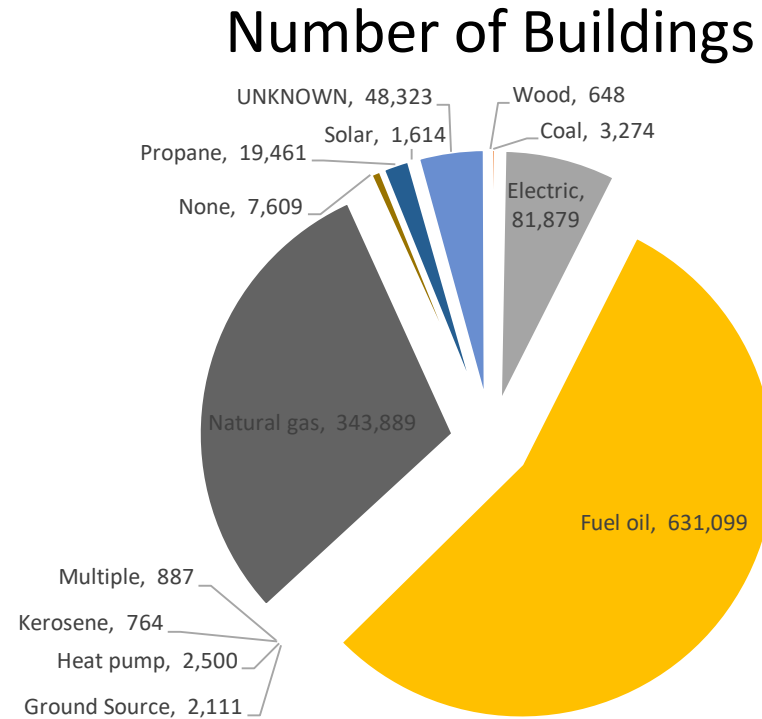
- Source: property list from Connecticut towns and cities
- Status: PACE has 131 towns in a database and estimation process for 38 towns
- Green Bank is also working on this (discussing tomorrow)
- Building level data (every building in Connecticut!):
  - Town/City: Address – Owner (in a connectable file)
  - Building use (coming soon – energy profile by building use)
  - Heating System
  - Heating Fuel
  - Air Conditioning (Central yes or no)
  - Basement (Yes or No – Area)
  - Finished area/living area
  - Year Built
  - Roof Material
  - Framing type
  - Number of stories



# Total State Building Inventory : Number

(Commercial and Residential)

Fuel	Number
Coal	3,274
Electric	81,879
Fuel oil	631,099
Ground Source	2,111
Heat pump	2,500
Kerosene	764
Multiple	887
Natural gas	343,889
None	7,609
Propane	19,461
Solar	1,614
UNKNOWN	48,323
Wood	648
Total	1,144,060



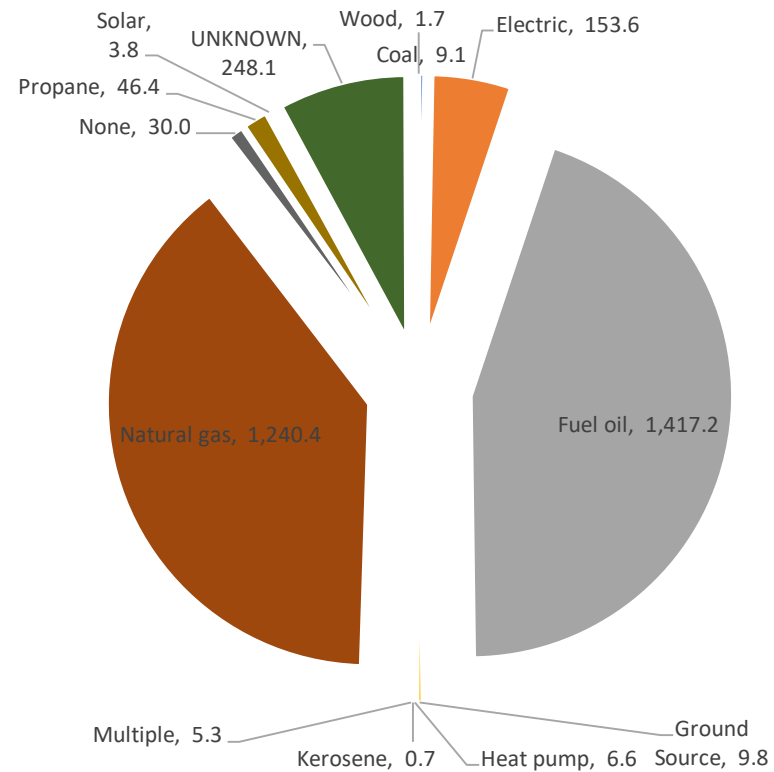
### Observations:

- This data provides deep insight into building stock
- Heat Pumps are coded inconsistently
- Oil heat is primary heating fuel
- Some gaps

# State Building Inventory: Area

## Square Feet (Millions)

Fuel	Square Feet (Millions)
Coal	9.1
Electric	153.6
Fuel oil	1,417.2
Ground Source	9.8
Heat pump	6.6
Kerosene	0.7
Multiple	5.3
Natural gas	1,240.4
None	30.0
Propane	46.4
Solar	3.8
UNKNOWN	248.1
Wood	1.7
Total	3,172.7



### Observations:

- Oil and Natural Gas predominate

# State Building Inventory: Volume

- Living area (square feet): 3,172,720,895 square feet
- Volume of conditioned space : 25,381,159,086 cubic feet
- A cube about 3,000 feet on each side!



# Sample Decarbonization Pathway: Hybrid Heating

1. Replace Central AC with ducted heat pumps in single family homes
2. Dual Fuel Thermostat – switch to legacy system at 32F

- Well established idea (see reference)
  - Small incremental cost i.e. replacing the AC anyway
  - Improves AC efficiency from average 13 SEER to 18 SEER >>28% summer savings
  - 57% of annual heating load is handled by heat pump assuming 32F switch to legacy system:
    - No grid impact on winter peak demand
    - Increased homeowner resiliency
- For homes with legacy heating systems reduced fuel consumption in the hybrid model allows residents to keep their existing system
- This is the “plug in hybrid” analog to home electrification

## References:

- CLASP-RAP-Hybrid-Heat-Swap.pdf <https://www.clasp.ngo/wp-content/uploads/2022/06/ACtoHeatPumpSwap.pdf>
- Electricity Load Implications of Space Heating Decarbonization Pathways : <https://www.sciencedirect.com/science/article/pii/S2542435119305781>



# Scenario: Quantification

## Single family homes with AC

Step 1: – Identify number and square feet of single family homes with Central AC

	Number	Square Feet (Millions)
CT Total Buildings (Commercial and Residential)	1,144,060	3,172
Single Family (Total number)	948,047	1,900
Single Family with Central AC	370,915	899

# Heating Load Covered by Heat Pump

Step 2: Calculate the heating load attributable to time when temperature is greater than 32F.

Bradley Airport	<a href="https://www.degreedays.net/#generate">https://www.degreedays.net/#generate</a>
HDD at 65 F	5508
HDD not covered < 32	2371
HDD covered $\geq$ 32	3137
Heat Load Covered	57%

Degree day represents the average number of degrees between the target – 65F and the actual outdoor temperature over the day. This is measured at various points in CT.

# Current Fuel Consumption and GHG (Source PACE Energy Model)

Fuel	Unit	SQ FT (Millions)	Fuel /Sq Ft	Annual Consumption	GHG Factor	GHG Tons
Electric	MWH	17	.013	226,000	0.00029	66
Oil	Gallons	514	.394	202,590,000	0.01120	2,269,019
Gas	CCF	309	.500	154,617,000	0.00586	905,288
Other (propane, wood, coal)	Gallons	50	.394	19,658,000	0.01120	220,179
No Impact(Heat pumps, solar, no heat)	MWH	8	.004	31,000	0.00029	8,461
Total		899				3,468,038

# Impact of Ducted Heat Pump Strategy on GHG

Current GHG (single family homes with AC)	3,468,038
Heat load/GHG shift to ducted heat pump	1,976,782
Remaining legacy load GHG	1,491,256
New Heat Pump GHG	544,794
New GHG	2,036,051
Percent Reduction	41%
With Carbon free grid (2040)	57%

# Weatherization – shrink the heating cube

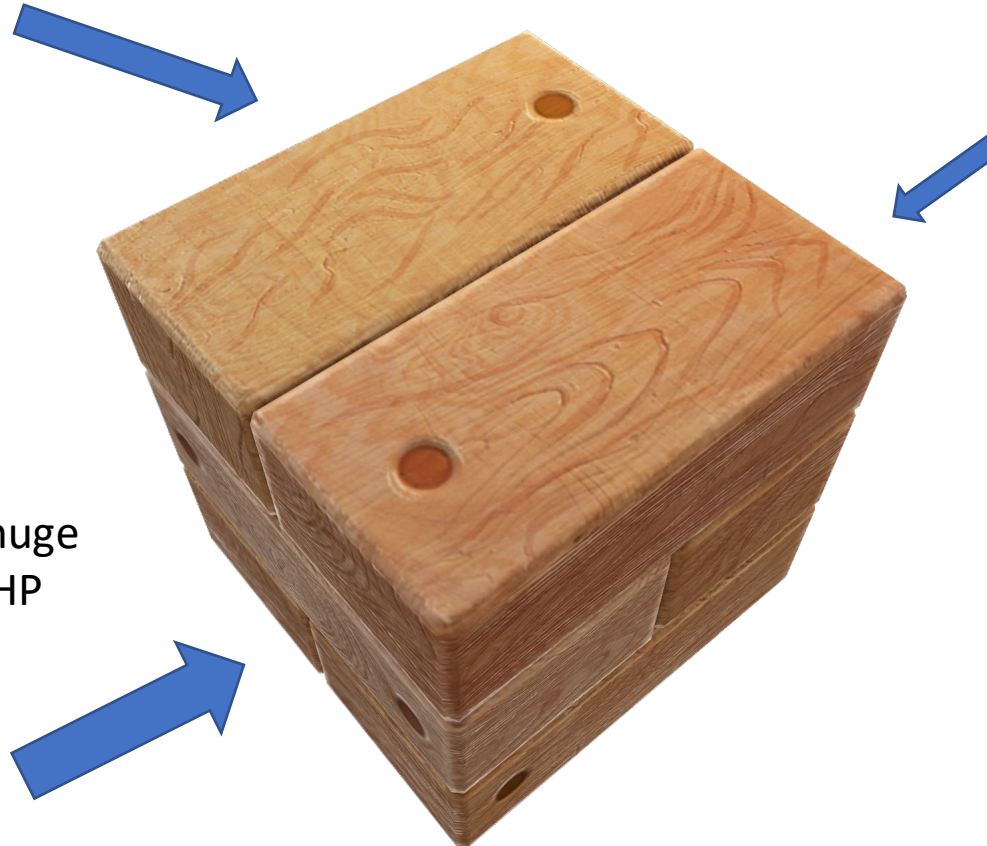
Today's heating produces 14 Million tons of CO<sub>2</sub> (PACE Energy Model) annually – a 10% building shell improvement statewide is 1.4 million tons of improvement !



# Additional Decarbonization examples

Ductless heat pumps can offer splendid AC and reduce GHG in virtually any building. Important to quantify the expected reduction in heat load

Buildings with ducts of any sort (AC/ Heating) are 52% of building stock – huge opportunity for geothermal – and ASHP heat pumps



Electric heated buildings produce 542,000 tons of CO<sub>2</sub> - heat pumps reduce that by 70% - favorable grid impact

# Recommendations and Next Steps

- Incorporate building data analysis into the CES
  - Develop pathways
  - Evaluate GHG impacts
  - Enhanced analytics to ISO New England and utilities
- Develop simple metrics to track progress
  - Number and what type of Heat Pump installed each year
  - HARDI (Heating, Air-conditioning and Refrigeration Distributors International) data – HVAC equipment sold each year
- Work with Installers and Manufacturers to develop pathways, spur technical development, and do situation based marketing.
- Customize outreach- match solutions to need

# HeatSmart: Overcome Barriers to Heat Pump Adoption Through Education and Outreach





# Final 2021 ASHP Adoption Forecast

*Includes Assumed Legacy Electric Heat Replacement*

Year	Annual ASHP Installs (Thousands)						ISO-NE
	CT	MA	ME	NH	RI	VT	
2021	3.0	18.4	17.8	2.9	1.9	6.0	50.0
2022	3.5	21.1	22.2	3.9	2.3	6.2	59.2
2023	4.0	24.3	22.9	5.1	2.7	6.9	65.9
2024	4.6	42.0	23.5	5.6	3.3	7.5	86.5
2025	5.2	59.6	24.3	6.2	3.9	8.0	107.2
2026	6.1	75.5	25.0	6.8	4.7	8.5	126.5
2027	7.0	89.4	25.7	7.5	5.7	9.0	144.2
2028	8.0	103.6	26.5	8.2	6.8	9.5	162.6
2029	9.2	114.3	27.3	9.1	8.2	10.0	178.0
2030	10.6	121.9	28.1	10.0	9.8	10.5	190.8
<b>Cumulative Total</b>	<b>61.0</b>	<b>669.9</b>	<b>243.3</b>	<b>65.4</b>	<b>49.4</b>	<b>82.2</b>	<b>1171.1</b>
<b>Approx. Share of Households with ASHP in 2030 (%) *</b>	<b>4.2%</b>	<b>23.4%</b>	<b>40.2%</b>	<b>10.9%</b>	<b>11.0%</b>	<b>29.5%</b>	<b>18.8%</b>

# Barriers to Heat Pump Adoption

Technology	Installers	Housing Stock	Consumers
Variety of technologies and machine configurations	Attitudes vary greatly	Technology more compatible with some homes than others	Lack of consumer awareness/ prevalence of misinformation
Supply chain issues	Varied quoting methods	Homes in different degrees of thermal barrier readiness	Initial cost of units
Better options needed for some homes like those that heat hydronically	Different degrees of installer knowledge and training	Split incentives in rental situations	Wait for emergency before replace
Lack of understanding of grid scale impacts	Not enough installers trained; long wait times	Town policies vary in terms of encouraging green technology	Cost of electricity and upgrading electrical panel
	Not enough connection between HES and heat pumps		Don't want to deal with inconvenience, don't like the look of units, etc.

# What is HeatSmart?

HeatSmart is a community-based outreach and education program designed to promote energy efficiency and adoption of clean heating and cooling technologies.

## Strategy

- 1) Gather a committed community team along with a town commitment
- 2) Public outreach (press release, info sessions, event tabling, neighbor-to-neighbor marketing, and tailored mailings)
- 3) Connect participant with HES partners and heat pump concierge service

[Our Towns](#)

[FAQs](#)

[Bethel](#)

[Branford](#)

[East Hampton](#)

[Guilford](#)

[Middletown](#)

[Stonington](#)

[West Hartford](#)

# Challenges Along the Way

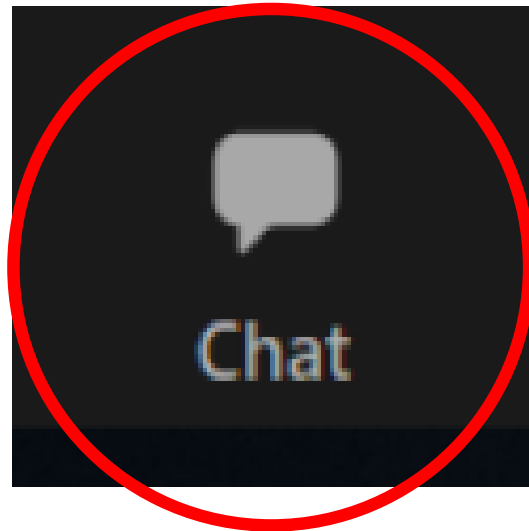


- Connecting with interested installers
- Interest in energy education
- Scheduling delays
- Consistency in procedures, quoting, etc.
- Availability of data

# Recommendations and Next Steps

- Continue and Enhance
  - Heat pump installer network (HPIN)
  - Heat Specialist consulting
  - Community Partnership support
- Expand Concierge Function to be a “whole house approach”
  - Addressing the paperwork barrier
  - Help overcome home efficiency barriers (mold, K&T, asbestos...)
  - Home efficiency over the long term
  - Integrating the IRA benefits
- Provide Heat Pump adoption data
  - Current public facing data “lumps” heat pumps of all types with furnaces, boilers, AC, and circulator pumps
- Engage municipalities as allies in the CES
  - Community Partnership Initiative, Sustainable CT, and other funding opportunities
  - Community Best Practices: Energy planning, Lead by Example, data standardization
  - Education Opportunities for Municipalities e.g., town building departments

# 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.

# Deployment in Affordable Housing

Kyle Ellsworth – CT DEEP, Bureau of Energy & Technology Policy

Frank Stellato – Millennium Real Estate Services

Penny Fisher – CT Housing Finance Authority

Tim Fabuien – CMC Energy Services

Click on agenda section heading to  
jump to corresponding slides

(speaker order may vary)

BUREAU OF ENERGY AND  
TECHNOLOGY POLICY



# CT DEEP, Bureau of Energy & Technology Policy





**BUREAU OF ENERGY AND  
TECHNOLOGY POLICY**

# Connecticut Weatherization Assistance Program, Bipartisan Infrastructure Law (BIL)

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Kyle Ellsworth  
Associate Research Analyst  
CT DEEP



# Intro

- The U.S. Department of Energy (DOE) **Weatherization Assistance Program (WAP)** reduces energy costs for low-income households by increasing the energy efficiency of their homes, while ensuring their health and safety.
- WAP is guided by federal regulations [10 CFR 440](#) (programmatic) and [2 CFR 200](#) (financial). Specific CT WAP program guidance can be found in our [CT WAP Operations Manual](#), found on [our website](#).

# WAP Formula Funds

- CT WAP applies annually to DOE for *Formula* funds, which are congressionally appropriated and average \$3.5 million per year.
- CT WAP currently contracts with two subgrantee service providers to implement the Formula funds: Community Renewal Team (CRT) and New Opportunities, Inc (NOI). Both are Community Action Agencies.
- CRT and NOI have in-house staff for energy audits, coordination, and inspections. They both use subcontractors for the installation of weatherization measures.
- CT is divided into five regions for the Formula WAP program. CRT has responsibility for Region 1 and 2. NOI has responsibility for Region 3, 4, and 5.



# Weatherization Measures

## **Mechanical/Shell Measures**

- Duct sealing
- Air sealing
- Clean/Repair/Replace heating and/or cooling systems
- Repair/Replace water heaters
- Insulation
- Windows/Door replacement

## **Health and Safety Measures**

- Testing of heating systems and combustion appliances
- Install mechanical ventilation to promote IAQ
- Install smoke and CO alarms
- Evaluate mold/moisture issues
- Perform incidental safety repairs where needed



# Benefits

- Participants save an average of \$372 dollars per year on energy costs.
- For every \$1.00 of investment, the WAP returns \$2.78 in nonenergy benefits. Total lifetime health and household-related benefits average \$14,148 per unit served.
- Last year, CT WAP completed 208 units, investing \$5,833 on average per unit on weatherization measures and \$2,144 on health and safety measures.



# WAP - BIL

- The Bipartisan Infrastructure Law (BIL) provides \$3.5 Billion nationally to the WAP
- 5-year period of performance
  - PY22 – PY26 (July 1, 2022 – June 30, 2027)
- CT WAP Total Available Award
  - \$46,215,781
    - Dispersed in 3 tranches
- BIL funding is in addition to CT's annual Formula WAP award, and DEEP will administer the program separately, with a slightly different focus.

# BIL - Financials

## Tranche 1

- Application due 7/1/22
- \$6,932,367
- Received

## Tranche 2

- Application due 10/1/22
- \$16,175,523

## Tranche 3

- Performance-based
- Must hit 30% of unit goal
- \$23,107,890



# BIL - Draft budget

Category	Grantee (DEEP)	Subgrantee(s)
Administration	\$3,466,184	\$3,466,184
Training and Technical Assistance*	\$5,677,314	\$1,000,000
Program Operations	-	\$27,722,694
Health and Safety	-	\$4,158,405
Vehicles and Equipment	-	\$500,000
Insurance	-	\$150,000
Financial Audits	-	\$75,000
<b>Total</b>	<b>\$9,143,498</b>	<b>\$37,072,283</b>

\* T&TA funds are used to hire technical consultant(s), Quality Control Inspector(s), purchase data management software, and provide training for all personnel within the WAP network (Grantee, Subgrantees, and Subcontractors)



# BIL - Production Goals

	Year 1	Year 2	Year 3	Year 4	Year 5
Unit Completions	0 – (ramp-up)	884	884	884	884

- Unit production goal: 3,536
- Program Operations Spending: \$27,722,694
- Health and Safety Spending: \$4,158,405
- Average Spending Per Unit: \$7,982

# WAP & Heat Pumps

## Past

- CT WAP has only installed one ASHP – customer with unique circumstance.
- Although allowable in WAP, RTT has been cost prohibitive in most situations.
- Braided funding is usually required to achieve Savings-To-Investment Ratio (SIR) and Average Cost Per Unit (ACPU).

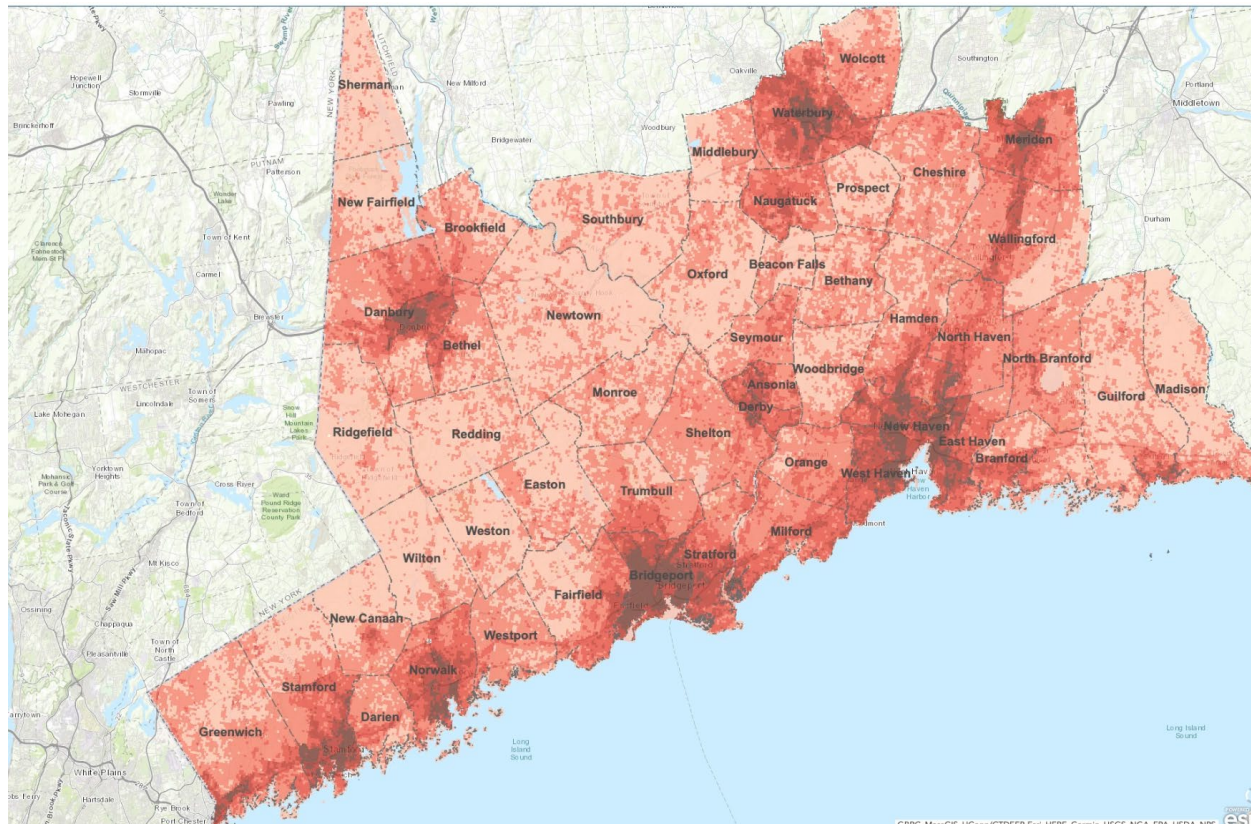
## Future

- CT WAP is requesting from DOE the use of a portion of the WAP-BIL Training and Technical Assistance budget to fund a pilot program to install RTT in multifamily housing.
- The pilot would demonstrate to customers the cost-effectiveness of RTT when considering the cooling functionality and allow for the installation of RTT within ACPU guidelines.
- CT WAP is currently working with DOE to identify eligible RTT technologies.

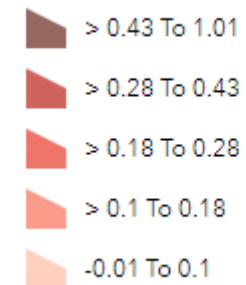


# Heat Pump Pilot Program

- Heat vulnerabilities exist in cities, especially multifamily buildings, and heat pumps can be used to cool as well as heat.



Heat Vulnerability (Normalized)



Most vulnerable to extreme heat and negative side effects of heat.

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TECHNOLOGY POLICY



# Methodology of Pilot

- Work with CT Utilities and other stakeholders to identify incentives and potential projects.
- Subgrantee to RFP to find reputable and dependable contractor(s) to work with.
- Focus on projects with the greatest opportunity to benefit from weatherization and RTT, i.e. properties with electric resistance or delivered fuel heating systems.
- Target projects where the greatest benefits flow down to the tenants.
- Prioritize customer engagement and education.

# Barriers to RTT

- RTT is expensive; a study of single-family ASHP installations in CO found costs to average \$11.18/square foot, or \$16,770 for a 1,500 s.f. home. Costs to upgrade electrical service can add another \$1,150 on average.
- Increase in electric utility costs for the low-income customer.
  - However, there is an active docket at PURA considering a Low-Income Discount Rate for customers who qualify.
- Customer/landlord apprehension of new technology.
  - Perceptions of ccASHP effectiveness

# Inflation Reduction Act (IRA)

Program	Description	Rebate Amount	Who Qualifies	Notes
Home Energy Performance-Based, Whole-House Rebates (HOMES)	Rebates for modeled or measured energy savings on whole-house retrofits	<ul style="list-style-type: none"> <li>- Up to \$4,000 or 80% cost of project for 20-35% modeled energy savings</li> <li>- Up to \$8,000 or 80% cost of project for greater than 35% modeled energy savings</li> <li>- \$4,000 or 80% cost of project per KWh saved for 20% reduction for at least 15% measured energy savings</li> </ul>	<p>Single family homes or multifamily buildings with at least 50% of units occupied by LMI households</p> <p>LMI = less than 80% AMI</p>	Rebates for LMI households can be increased by SEOs
High-Efficiency Electric Home Rebate Program	Point-of-sale rebates on electric appliances and non-appliance upgrades	<ul style="list-style-type: none"> <li>- HP water heater = \$1,750</li> <li>- HP for space heating and cooling = \$8,000</li> <li>- Electric stove, cooktop, range, or oven = \$850</li> <li>- Electric HP clothes dryer = \$850</li> <li>- Electric load service center upgrade = \$4,000</li> <li>- Insulation, air sealing, ventilation = \$1,600</li> <li>- Electric wiring = \$2,500</li> </ul> <p><b>MAX = \$14,000</b></p> <ul style="list-style-type: none"> <li>- If income 80-150% AMI = 50% project cost</li> <li>- If income less than 80% AMI = 100% project cost</li> </ul>	<p>Single family homes or multifamily buildings with at least 50% of units occupied by LMI households</p> <p>LMI = less than 150% AMI</p> <p>Governmental, commercial, or nonprofit entity carrying out electrification project</p>	<p>Must be Energy Star certified</p> <p>Additional \$500 for installation by governmental, commercial, or nonprofit entity</p>

# Inflation Reduction Act (IRA)

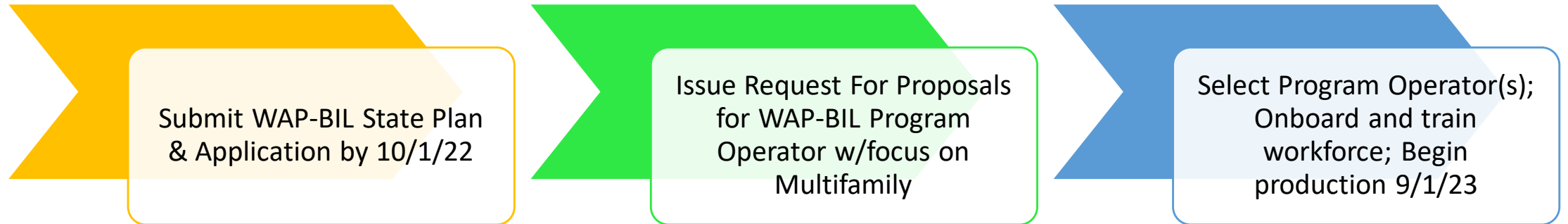
- Both rebate programs state that rebates cannot be combined with another Federal grant or rebate for the same single upgrade or electrification project → possible barrier to co-implementation.
- DEEP is working with DOE and the C&LM HES-IE program to ensure we leverage to maximum effect as much of the federal funding as possible based on anticipated DOE guidance for the WAP and IRA.

# Training

- DEEP plans to hire 3 additional staff to help manage the WAP-BIL program.
- The selected subgrantee(s) will need to dedicate an estimated 6-8 staff and management positions to administer the funds and meet program goals.
- In addition, an estimated 45 skilled persons will be needed to audit units, install measures, and inspect completed work.
- All training will be paid for with WAP-BIL funding.
- Recruitment efforts will be focused on underserved communities.



# Timeline



# Public Hearings

- CT WAP will be conducting two public hearings to describe the WAP-BIL State Plan and field questions and comments from participants.
- Wednesday, September 28<sup>th</sup>, 2022
  - 10:00AM
    - <https://ctdeep.zoom.us/j/86027011045>
  - 6:00PM
    - <https://ctdeep.zoom.us/j/82784100270>
- Comments can be submitted to DEEP through 9/29/22 @ 4:00PM
  - Email [Kyle.Ellsworth@ct.gov](mailto:Kyle.Ellsworth@ct.gov)

# Questions?

**Kyle Ellsworth**

**Associate Research Analyst**

**Office of Affordable Housing Energy Retrofits**

**Bureau of Energy and Technology Policy**

**Department of Energy and Environmental Protection**

**[Kyle.Ellsworth@ct.gov](mailto:Kyle.Ellsworth@ct.gov)**

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TECHNOLOGY POLICY**



# Millennium Real Estate Services

# Frank Stellato

**Associate Director of Real Estate  
Millennium Group**

Millennium Real Estate Services, LLC

Millennium Construction Services, LLC

Millennium Development & Consulting Services, LLC



• DEVELOPMENT CONSULTING • CONSTRUCTION • PROPERTY MANAGEMENT •

# Background/Training:



## **BPI - Multifamily Building Operator Training**

- sponsored by HUD and Department of Energy
- Focus on building science operators and maintenance
- Occupant health, safety and comfort (IAQ)
  
- Energy auditing
- Evaluation of alternative approaches
- “Translator” between the stakeholders

# HUD Green Retrofit Program:



- Funded by American Recovery & Reinvestment Act of 2009 (ARRA)
- Energy and green retrofits in the multifamily housing stock (HUD)
- Targeted “Green” job creation
- Investment-grade energy audit (third-party pre and post)
- \$15k per unit max
- Lead to changes in the MAP underwriting guidelines
  
- Involved in Five (5) projects – One (1) heat pump retrofit

# Sayebrook Village East – Case Study

## **Existing Conditions**

- 36 units garden-style, 1 and 2 story wood frame, circa early 80's construction
- Elderly occupants
- Owner paid electric, individually metered by unit
- Existing in-ceiling resistive electric heating, through wall AC (tenant provided)
- Poor temperature control
- Weak thermal envelope performance

## **Project Scope – Operating cost reduction phase (step 1 of 3):**

- Bathroom exhaust fans (Energy Star, occupant sensor)
- Additional insulation (from r-36 to r-60)
- Exterior doors
- Heat Pumps – 2 ton multi-head Daikin (12.6 EER/16.6 SEER) \$8k/unit\*
- Owner desire for back-up heat



# SVE Case Study .....continued

## **Outcomes:**

- 24% reduction in average electric consumption
- Improved resident comfort (drafts, temp control)
- Utility Incentives - \$114k (39% of cost)
- Increased NOI leveraged new mortgage and additional cap ex work:
  - Windows
  - Siding and wall insulation
  - Lighting, appliances, etc.

# Design & Construction Delivery Considerations

- Funding tail wags the dog
- Procurement requirements of funder, program or agency
- MEP Design – full plans/specs vs outline performance specs
- Bidding, contracts and the change order game
- Post Construction considerations:
  - Training of staff and residents
  - Develop operating and maintenance procedures
  - Warranty and extended warranty

# Contact Information

**Frank Stellato**

Associate Director of Real Estate  
Millennium Group

203-804-1985

[fstellato@millennium-realty.com](mailto:fstellato@millennium-realty.com)

# CT Housing Finance Authority



CONNECTICUT  
HOUSING FINANCE  
AUTHORITY

# Mini Splits / Heat Pump HVAC Systems from an Asset Management Perspective



Penny Fisher  
Asset Manager 3 - Multifamily, CHFA

## Setting the stage.....

### Building Styles:

- One story garden style apartments
- Two-story low-rise style apartments

### Population Served:

- Elderly
- Family

### Range of years installed:

- 2008 – 2020 with majority installed 2009-2012
- Units age from 2 – 14 years.... The average age is 10-13 years old

### Three brands installed:

- Mitsubishi
- LG
- Daikin



# General Consensus

- Happy to provide air conditioning to residents who otherwise wouldn't have it.
- Eliminates unsightly window unit air conditioners
- Units are energy efficient
- Saves resident money
- More expensive for management to maintain





# Maintenance

- Filter change
  - ✓ annually or bi-annually
  - ✓ Cleaned/replaced by maintenance staff
- Regular Maintenance
  - ✓ Annually
  - ✓ By maintenance staff or third party
- Deep cleanings
  - ✓ Annually
  - ✓ At turnover
  - ✓ As needed
  - ✓ Majority by a third party



# Costs to Maintain

## Filter Cleaning and Regular Maintenance

- ✓ by maintenance staff, \$20 - \$500/unit, average of \$325/unit
- ✓ by third party, \$80 - \$350/unit, average of \$214/unit

## Deep Cleaning

- ✓ by third party, average \$438/unit

Thoroughness vs. qualifications of the servicer?



## Maintenance Calls

Of the Owners polled, 27% of residents submitted work orders over the course of the year.

Reasons:

- Use of remote control
  - ✓ Symbol recognition
  - ✓ Confusion of use
  - ✓ Small print
- Operating mode
  - ✓ Settings are confusing
  - ✓ Switching between a/c and heat modes during the change in seasons
  - ✓ Multiple heat pump units within an apartment need to be set to same mode to work properly



## Additional info....

- Rebuilding heat pump units
  - ✓ \$3,000 - \$5,500/unit
  - ✓ Parts are no longer available – need to be fabricated
- New heat pump units
  - ✓ \$4,500 - \$8,000/unit



# From an Asset Management Perspective

Pros:

- ✓ Able to offer residents an energy efficient, cost saving method of heating and cooling.
- ✓ Especially for the elderly population



# From an Asset Management Perspective

## Cons:

- ✓ Maintenance costs as well as replacement are excessive and is burdensome to the Owner. In some cases, prohibitive.
  - ✓ Owners are deferring these costs; hence causing more expensive repairs or even replacement sooner than expected.
- ✓ Owners may have not been educated when the system was proposed to be installed, giving them an idea of:
  - ✓ Frequency of Maintenance
  - ✓ Cost of Maintenance
  - ✓ Expected Useful Life
  - ✓ Cost of Replacement



## Other items to note....

When units are maintained on a regular basis, they last longer and continue to be efficient. Owners who put off maintenance due to cost are finding that the units are reaching the end of their useful life sooner.

In order to get buy-in from Owners for future energy efficiency programs, along with the benefits, they need to be educated on the realistic long-term costs.



# CMC Energy Services





Founded in 1977 by Doris Iklé, continues to be woman owned and operated

35+ Utility and Government Clients, operations in 10 states

Mission Driven and Customer Focused

400+ Employees  
400+ BPI certifications

Proven Processes and Deep Technical Expertise throughout all market segments

50,000 Energy Assessments and 25,000 QA Inspections Annually

Decades of successful program design, outreach, customer engagement and delivery

1,200 GWh Saved for C&I Customers



Heating, Ventilation, Air Conditioning, and Refrigeration technologies keep evolving and becoming more complex, especially as the emphasis on energy efficiency grows. Connecticut is known as a forerunner in the campaign for energy efficiency in HVAC/R systems. Learning this trade can mean not only job security in Connecticut but a healthy paycheck, too. The Constitution State is one of the top-paying states for HVAC Mechanics and installers in the United States. That's according to the U.S. Bureau of Labor Statistics, which also reports that there are over 380,400 Heating, Air Conditioning, and Refrigeration Mechanics and Installers nationwide and 4,360 work in Connecticut.

There are several institutions and programs available in Connecticut offering training in HVAC . There is a minimum requirement of 720 hours with some programs extending over a year to complete. A selection of the options are listed below:

- Connecticut Technical High School System (CT State Dept. of Education)
- Penn Foster (online)
- Entech Advanced Energy Training
- Porter & Chester Institute
- Industrial Management & Training Institute
- Lincoln Technical Institute
- Connecticut State College

The For-profit schools can cost as much as \$35,000 too complete.



Finding an apprenticeship after completion of training, is one of the biggest challenges faced by newcomers to the industry. This isn't do too job openings. almost every contractor would love to hire more but the Department of Labor has a strict mandate of a 3/1 ratio. You must have 3 licensed technicians to every one apprentice. As many in the industry start to age out and retire this makes it almost impossible to refill those positions.

Another major problem is in the matter that apprentices can be utilized . No apprentice shall at any time engage in any of the work for which a license is required without direct supervision. Direct supervision shall mean under the guidance of a licensed contractor or journeyman and within the sight and/or hearing of said licensed person.

# Apprenticeship

- **D-2 LIMITED WARM AIR, AIR CONDITIONING AND REFRIGERATION JOURNEYPERSON**

- The holder of this license may perform the installation, repair, replacement, maintenance or alteration of any warm air, air conditioning and refrigeration system, including necessary piping for the conveyance of heating or cooling media and associated pumping equipment, and only while in the employ of a contractor licensed for such work. This license does not include the installation or servicing of oil burners of any size. **(4,000 hours 2 years)**

- **S-10 LIMITED HEATING COOLING JOURNEYPERSON**

The holder of this license may perform work only while in the employ of a licensed contractor and only limited to hot water or steam heating systems for buildings not over three stories high with total heating load not exceeding 500,000 BTU's, steam pressure not exceeding fifteen pounds, and/or cooling installations up to 35 tons per systems. This license also covers the installation or servicing of oil burners handling up to five gallons per hour as well as LP gas supplied by gas containers and/or natural gas piping for work covered by this limited license. The requirements to qualify for this license examination shall be the completion of a registered apprenticeship program or equivalent experience and training. **(6,000 Hours 3 years)**

- **S-2 UNLIMITED HEATING, PIPING, AND COOLING JOURNEYPERSON**

The holder of this license may do all heating, piping and cooling work as so defined only while in the employ of a licensed contractor. The requirements to qualify for this license examination shall be the completion of a registered apprenticeship program or equivalent experience and training. **(8,000 hrs. 4 years)**

## **Types of Refrigeration Certification**

EPA has developed four types of certification:

1. For servicing small appliances (Type I).
2. For servicing or disposing of high- or very high-pressure appliances, except small appliances and MVACs (Type II).
3. For servicing or disposing of low-pressure appliances (Type III).
4. For servicing all types of equipment (Universal)

Journey person, must attach the original copy of the Letter of Apprenticeship Completion Certificate from the Department of Labor, Must pay for and pass PSI test for same license.



Installing electric heat pumps and heat-pump water heaters (HPWHs) in homes is one of the most promising strategies for residential building electrification. Low- and moderate-income (LMI) customers stand to benefit the most from the nonenergy benefits and efficiency savings from heat pumps. But heat pumps have high up-front costs that create a barrier to adoption, especially for LMI customers.

Reducing the labor constraints on our contractors will lower the install cost. This will help lessen the barrier to adoption for our LMI community. With the added benefit of more availability of high paying jobs that are easier to obtain.

We are at a unique time where an older industry (HVAC) is beginning to merge with a newer one (Green Jobs). If we can find a way to be collaborative, we should be able to solve many of these issues. As well as taking care of our social responsibilities and ensuring underserved communities get the help and respect they deserve.

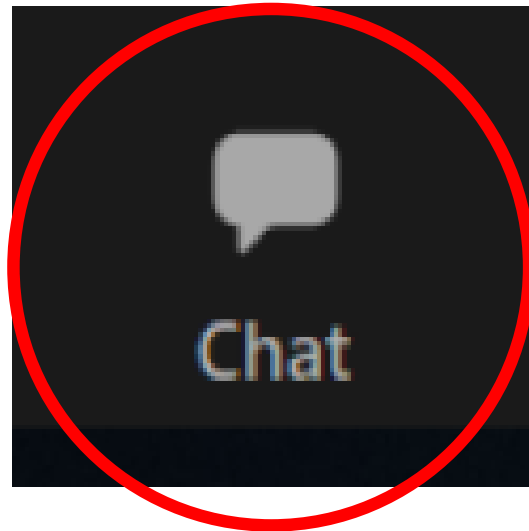




**Thank You**

**Tim Fabuien**  
**CMC Energy Services**  
**Tfabuien@cmcenergy.com**

# Questions



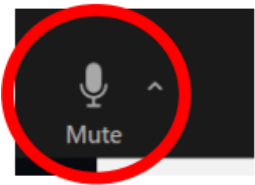
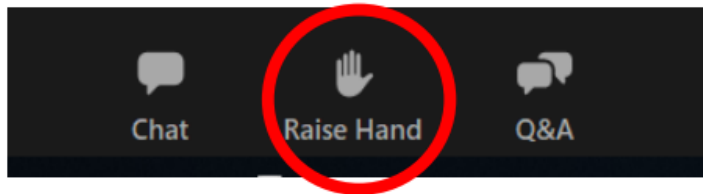
At the conclusion of each panel DEEP will hold a brief question and answer period.

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.

# Public Comments

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



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of the  
screen**

# General Public Comment

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# WRAP UP

Thanks for joining our technical session today!

**REMINDER: this session continues tomorrow morning at 9am ET.**

**Written comments** related to this session, or the general Comprehensive Energy Strategy can be submitted to:

1. [this](#) web page – or –
2. Via email to [ces@energy.ct.gov](mailto:ces@energy.ct.gov)

**All information on upcoming Comprehensive Energy Strategy technical sessions and written comment opportunities can be found on the** [CES website](#)

This slide deck and a recording of this session will be posted on the CES webpage

Written Comments related to this technical session are due  
**Friday, October 7, 2022, at 5:00 p.m. ET**

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# Thank you for joining!

Questions? [DEEP.EnergyBureau@ct.gov](mailto:DEEP.EnergyBureau@ct.gov)

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