Overview

Theme of the day: **strategic electrification**

Discussion:
- CT’s heat pump market
- Technical perspective
- Regional overview
- Financing & engagement opportunities
Heat Pump Trends & Consumer Engagement
Deep Decarbonization

Public Act 08-98 – An Act Concerning Global Warming Solutions
Reduce statewide GHG emissions by 80% below 2001 levels by 2050
Home Energy Consumption: A Primer

Average Northeast Household Energy Consumption by End-Use

- Space Heating, 57%
- Water Heating, 18%
- Air Conditioning, 4%
- Refrigerators, 2%
- Other, 21%

Primary Energy Source for Space Heating by % of Total Households

- Fuel Oil, 43%
- Natural Gas, 34%
- Electricity, 16%
- Propane, 4%
- Other, 3%

Source (1): 2015 RECS Survey Data, EIA, Northeast Average Site Energy Consumption (MMBTU/Household)
Source (2): 2018 CT Comprehensive Energy Strategy, Figure B4, p. 68
## Three Key Strategies for Strategic Electrification

<table>
<thead>
<tr>
<th><strong>Advanced Electric Technologies</strong></th>
<th><strong>Deep Energy Efficiency</strong></th>
<th><strong>Grid Integration</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Electric Vehicles (EV)</td>
<td>• Passive Design principles</td>
<td>• Control strategies to allow for demand response and load shifting capabilities</td>
</tr>
<tr>
<td>• Air-Source Heat Pumps (Ducted &amp; Ductless)</td>
<td>• Air-tight thermal envelope</td>
<td>• Grid-responsive building design to maintain thermal comfort while shifting operational loads and run-times</td>
</tr>
<tr>
<td>• Ground-Source Heat Pumps (GSHP)</td>
<td>• Well-insulated/Minimal thermal bridging</td>
<td></td>
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</table>
Regional Efforts:
Strategic Electrification & Heat Pumps

2016
VT integrates strategic electrification into statewide Comprehensive Energy Plan

2017
MA Energy Efficiency Advisory Council presentation Residential Strategic Electrification & Heat Pumps

2018
CT DEEP publishes Comprehensive Energy Strategy (CES) with plans to transition to cleaner thermal fuels and technologies through strategic electrification
To continue the state’s progress toward meeting Global Warming Solutions Act goals and improve air quality, decarbonization of thermal systems is necessary.

DEEP recommends encouragement of renewable thermal technologies (RTT), and in particular heat pumps, that in the summer can provide efficient cooling and in the winter can cost-effectively displace conventional heating fuels/sources.
Strategic Electrification of Homes

Key Concepts
- Decarbonization
- Strategic Electrification

Key Strategies
- Fuel switching to displace or replace fossil fuel heating
- Low heating loads make heat pumps more advantageous
- Enhanced incentives for “all-electric” EE homes

Key Technologies
- Heat Pumps (Air-Source, Ground-Source, Water Heaters)
- High Performance Building Envelope
- Balanced Mechanical Ventilation (HRV/ERV) Systems
CT Ductless Heat Pump Program

- In 2017, Energize CT transitioned to offering instant discount rebates to qualifying DSHPs through participating HVAC Distributors.
- In 2018, the program has 57 active Memorandums of Understanding:
  - Equipment installation information required.
- Field support reps “circuit riders” provide training to sales associates and store managers about program guidelines.
- Energize CT has partnered with manufacturers and Distributors to promote the installation of ductless heat pump systems via training to installation contractors.

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Qualification Criteria</th>
<th>Incentive Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ductless Heat Pump</td>
<td>ENERGY STAR certified Single Indoor Unit: 20 SEER, 12.5 EER, 10 HSPF</td>
<td>A $300 instant discount to licensed contractors at participating distributor locations</td>
</tr>
<tr>
<td>Ductless Heat Pump</td>
<td>ENERGY STAR certified Multi-Indoor Unit: 18 SEER, 12.5 EER, 9 HSPF</td>
<td>A $500 instant discount to licensed contractors at participating distributor locations</td>
</tr>
<tr>
<td>Central Air Source Heat Pump System</td>
<td>16 SEER, 12.5 EER, 10 HSPF ENERGY STAR and AHRI certified</td>
<td>$500 mail-in rebate per system</td>
</tr>
</tbody>
</table>
Distributor Participation

51 Distributors
134 Branches
Ductless Heat Pump Results

Ductless Heat Pump Rebates

- 2016 (mail-in): 1,029
- 2017 (midstream): 2,882
- 2018 YTD (midstream): 3,008

180% Lift
HEAT PUMP TRENDS & HOW TO EDUCATE CUSTOMERS
**Bordering CT**

**Energize CT**
- $300/home – 20/12.5/10 - single
- $500/home – 18/12.5/9 – multi
- *$700 bonus for electric heat*
- **Upstream starting 1/17**

**Smart E-Loan**
- 4.99% for 5/7 or 10 year term

**Mass Save**
- $300 per – 20 SEER/12 HSPF
- $100 per – 18 SEER/10 HSPF
- *Stay tuned for Central HP Heat Loan*
- 0% Loan/7 years

**Heat Loan**

**MassCEC**
- $500/system ccASHP – Single
- $500/ton ccASHP – Multi

**Muni-Helps**
- $250 18 SEER/9 HSPF
  - *Ashburnham, Boylston, Chicopee, Holden, Hull, Ipswich, Marblehead, Peabody, Princeton, Russell, Shrewsbury, South Hadley, Sterling, Templeton, West Boylston*

**Rhode Island**
- $300 per – 20 SEER/12 HSPF
- $100 per – 18 SEER/10 HSPF
New York

NYSERDA
Announced: Aug 17, 2017
$500 Contractor rebate
- ccASHP in any home.
- Entire state except Long Island
- Contractors must sign up to participate.
- Marketing available in September ($50k per contractor or distributor, cost share)

Participating Utilities
- Central Hudson Gas & Electric Corporation
- Con Edison
- National Fuel
- National Grid - Niagara Mohawk Power
- National Grid - Long Island (KeySpan Gas East Corporation)
- National Grid New York (Brooklyn Union Gas Company)
- NYSEG (New York State Electric and Gas Corporation)
- Orange and Rockland Utilities, Inc.
- RG&E (Rochester Gas and Electric Corporation)
2017 COMPREHENSIVE ENERGY STRATEGY

Draft Executive Summary: July 26th, 2017

CT GENERAL STATUTES SECTION 16a-3d

Connecticut Department of Energy and Environmental Protection
Strategic Electrification – Only works with this
Ductless is a small percent of the U.S. HVAC market but current building & energy usage trends indicate tremendous growth opportunity.
Product Life Cycle

- Introduction
- Growth
- Maturity
- Decline

Mass Market

Time

Product Sales
An Evolution has Occurred

**PAST**
- 1:1 Only
- Ductless Only
- Spot Cooling Only
- Niche Applications
- Little Brand Awareness

**PRESENT**
- Multi-Zone
- Ducted and Ductless
- Zone Comfort Solutions
- Whole House Applications
- Dominant Brand Awareness
Conventional Compressor

- High starting current results in energy loss
- On/off cycling results in temp fluctuations and lower efficiency
- Additional strain on system
- Noisier
**INVERTER Technology**

- High starting current results in energy loss
- On/off cycling results in temp fluctuations and lower efficiency
- Additional strain on system
- Noisier

- Starts current at lower level
- Ramps up to high rotation for faster heating/cooling
- Throttles back to maintain temperature
- Energy efficient and quieter

**INVERTER compressor**

**Conventional compressor**
Hartford Heating Season

- 100% less ccASHP than electricity/propane

Annual Hours

Source: Engineering Weather Data, Michael Kjelgaard,
**WHY HYPER-HEATING MATTERS**

In regions with sub-zero weather, traditional heat pumps can’t bring in enough heat. H2i units deliver heat even when outdoor temperatures are as low as -13°F, eliminating the need for supplemental heating sources. Hot Start technology provides warm air instantly, eliminating drafts.

- **Conventional Heat Pump**
  - 100% Capacity

- **Mitsubishi Electric MXZ H2i Heat Pump**
  - 100% Capacity

![Image showing comparison between Conventional Heat Pump and Mitsubishi Electric MXZ H2i Heat Pump]
WHY HYPER-HEATING MATTERS

In regions with sub-zero weather, traditional heat pumps can't bring in enough heat. H2i units deliver heat even when outdoor temperatures are as low as -13°F, eliminating the need for supplemental heating sources. Hot Start technology provides warm air instantly, eliminating drafts.

CONVENTIONAL HEAT PUMP

- 60% CAPACITY

MITSUBISHI ELECTRIC MXZ H2i HEAT PUMP

- 100% CAPACITY

23°F
WHY HYPER-HEATING MATTERS

In regions with sub-zero weather, traditional heat pumps can’t bring in enough heat. H2i units deliver heat even when outdoor temperatures are as low as -13°F, eliminating the need for supplemental heating sources. Hot Start technology provides warm air instantly, eliminating drafts.
Applications

• Single family homes & condos
• Hot and Cold spots
• Additions & renovations
• New construction
Solution is an opinion
Whole Home Solution
Whole Home Solution
5 single zone systems
Whole Home Solution
3 single zone systems
Whole Home Solution
3 zone system and 2 single zone systems
Whole Home Solution
3 zone system and 2 zone system
Whole Home Solution
5 zone system
Whole Home Solution

Which solution was right?
OUR LARGEST DEALERS DO SOMETHING OTHER THAN HVAC
THANK YOU
Heat Pump Trends, Strategies and Resources

Dave Lis, Northeast Energy Efficiency Partnerships
November 29, 2018
Northeast Energy Efficiency Partnerships

“Assist the Northeast and Mid-Atlantic region to reduce building sector energy consumption 3% per year and carbon emissions 40% by 2030 (relative to 2001)”

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.
THE FUTURE IS ELECTRIC!
Assumed Market shares in 2035 according to NEEP’s “Plausibly Optimistic” scenario reflects:

- **Residential Heat Pumps** -
  - 89% for delivered fuel systems
  - 68% sales share of today’s natural gas systems sales

- **Cars and Light trucks** -
  - 70% of Sales

Requires massive market transformations
NEEP’s Regional ASHP Initiative

- Launched in 2013
- Regional ASHP Market Transformation Strategy
- Regional Working Group
- Annual In-person Workshop
## ASHP 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 |
Highlights of Regional Policy/Program - Buildings

VERMONT
- Incentives for ASHPs and HPWHs through Efficiency VT and utilities
- GMP leasing ASHPs and HPWHs for RES compliance

NEW HAMPSHIRE
- Developed first-in-nation RPS carveout for renewable thermal
- ASHP and HPWH rebates from individual utilities

MAINE
- Significant uptake in residential ASHP/HPWH through Efficiency Maine rebate and financing programs (over 20,000 rebates FY14-FY16)

MASSACHUSETTS
- Integrating renewable thermal energy into Alternative Portfolio Standard
- ASHP, GSHP, and HPWH rebates via state and utility programs
- Solarize Mass Plus will include heat pumps, EVs, and storage
- Strategic electrification and DR included in efficiency programs with expanded cost-benefit test.

NEW YORK
- New York REV
- NYSERDA developing rebate program for GSHP; targeting heat pump cost reductions
- NYSERDA Clean Energy Investment Plan

CONNECTICUT
- Heat pump rebates available through Energize CT

RHODE ISLAND
- Exploring workforce development programs to drive heat pump uptake (e.g. engaging delivered fuel dealers)
Key Market Barrier/Opportunities

- Sizing/Installation crucial to system performance.
- New systems, new applications challenge longstanding tools and practices.
Introduction

High-quality installations of air-source heat pump (ASHP) systems generate referrals, increase sales, reduce callbacks and improve customer comfort and satisfaction. Installation practices also have a major impact on efficiency and performance of an ASHP system. Efficient ASHPs have seen significant sales growth in colder climates in recent years. The recent generation of cold-climate ASHPs, combined with insights from large-scale installation programs and installers, has led to a better understanding of the full range of practices to ensure maximum system performance and customer satisfaction. This guide provides a list of these best practices, as well as homeowner education and system setup guidance, to help ensure efficient air-source heat pumps and happy customers in cold climates.

Heat pumps should always be installed by licensed, trained professionals. Always follow manufacturer’s specification and installation instructions, and all applicable building codes and regulations. All installers should attend a manufacturer’s training or preferred installer program.

ASHPs come in a number of configurations, and in some cases the following guidance may be specific to one or more of those system types. There are many variations and terms used, but these guidelines will focus on the following broad categories: “ductless ASHP” refers to any non-ducted cassette type indoor unit (including wall-mount air handlers, floor mounted consoles, in-ceiling cassettes, etc.); “mini-duct ASHP” refers to remote air handlers that are typically designed for compact, concealed-ceiling or short-duct configurations; and “centrally ducted ASHP” refers to whole-house systems with central air handlers. The icons shown here are used below to indicate when guidance is specific to a certain system type. All items without icons are generally applicable to all ASHP configurations.
Installation Best Practices: Categories

- Line Set
- Recommended Tools
- Refrigerant Tubing
- Refrigerant Charge
- Condensate Drain
- Outdoor Unit Installation
- Indoor Unit Installation
- Placement of Indoor Unit
- Ducting Considerations
Introduction

Leading HVAC manufacturers report significant growth in the installation of air-source heat pumps in some of the colder regions of the U.S., including the Northeast.¹ Many of the systems being installed today are “ductless” and variable-capacity. The systems are being installed in a variety of different residential applications, from limited zoned solutions to more comprehensive whole house solutions. System sizing and selection practices have not always kept up with this varied and dynamic landscape of ASHP installations, especially for colder climate installations. System performance, including energy efficiency of the systems, can be negatively impacted by poor sizing and system selection, as is customer comfort. This document was developed to assist installers in sizing and selecting ASHPs for cold climate applications, while maintaining high efficiency, performance, and customer satisfaction. NEEP’s Assessment Report — Air-Source Heat Pump Installation Practices in Cold-Climates — provided insight into current sizing and selecting practices and informed the development of this Guide.

There are many types of equipment and a wide variety of common applications for ASHP installations in cold climates. Combinations of single and multi-zone, mini-split, “ductless” or “mini-duct” systems, or more conventional centrally ducted air-handler systems, may be installed in existing or new homes. The purpose may be conventional: provide all the required heating and cooling for a house or a large section of a house, or for a single zone or addition. But it may be less conventional: many mini- and multi-split systems are installed in homes to provide a partial offset to a conventional heating system that uses an expensive or carbon-intensive fuel. When the objective of installing an ASHP is reducing operating costs or emissions, conventional approaches to sizing and selection may need revising. Standard approaches don’t fit many of these applications, and may even prevent installers from offering the most cost-effective, optimal solutions to their customers.

This guide is organized into five main application types to allow users to more easily match guidance to their specific installation. The applications are:
Application Sheets

Guide To Sizing & Selecting Air-Source Heat Pumps in Cold Climates
A companion to NEEP's Guide to Installing Air-Source Heat Pumps in Cold Climates

Heating (or Heating & Cooling) Displacement
Application Description
Customer currently relies on heating guides or cooling cost per square area of home. Heating guides are based on specific design conditions and do not account for local climate differences. Cooling cost per square area of home is based on local climate differences and specific design conditions.

Suggested AHIP System Configuration
(2000 sq ft+ Home, Multi-Zone Diagram, Multi-Unit, Multi-Split, Commercial Friendly)

Suggested Treatment of Existing HVAC System
Leak detection and repair as needed to ensure proper operation of new system.

Further Guidance
- Consider heat pumps for new homes, as they are more efficient than traditional systems.
- Insulate homes properly to reduce heat loss and improve energy efficiency.

Full Heating System Replacement
Application Description
The current system is not meeting the customer's needs or is reaching the end of its lifespan.

Suggested AHIP System Configuration
(2000 sq ft+ Home, Multi-Zone Diagram, Multi-Unit, Multi-Split, Commercial Friendly)

Suggested Treatment of Existing HVAC System
Complete system replacement._leak detection and repair as needed.

Further Guidance
- Consider heat pumps for new homes, as they are more efficient than traditional systems.
- Insulate homes properly to reduce heat loss and improve energy efficiency.

Isolated Zone
Application Description
One or more zones that are not currently heated but could benefit from a heating system.

Suggested AHIP System Configuration
(2000 sq ft+ Home, Multi-Zone Diagram, Multi-Unit, Multi-Split, Commercial Friendly)

Suggested Treatment of Existing HVAC System
Leak detection and repair as needed to ensure proper operation of new system.

Further Guidance
- Consider heat pumps for new homes, as they are more efficient than traditional systems.
- Insulate homes properly to reduce heat loss and improve energy efficiency.

New Construction or Gut Rehab
Application Description
A new construction or gut rehab project that could benefit from a heating system.

Suggested AHIP System Configuration
(2000 sq ft+ Home, Multi-Zone Diagram, Multi-Unit, Multi-Split, Commercial Friendly)

Suggested Treatment of Existing HVAC System
Complete system replacement. Leak detection and repair as needed.

Further Guidance
- Consider heat pumps for new homes, as they are more efficient than traditional systems.
- Insulate homes properly to reduce heat loss and improve energy efficiency.

Targeted Cooling Solution
Application Description
Customer currently relies on heating guides or cooling cost per square area of home. Heating guides are based on specific design conditions and do not account for local climate differences. Cooling cost per square area of home is based on local climate differences and specific design conditions.

Suggested AHIP System Configuration
(2000 sq ft+ Home, Multi-Zone Diagram, Multi-Unit, Multi-Split, Commercial Friendly)

Suggested Treatment of Existing HVAC System
Leak detection and repair as needed to ensure proper operation of new system.

Further Guidance
- Consider heat pumps for new homes, as they are more efficient than traditional systems.
- Insulate homes properly to reduce heat loss and improve energy efficiency.

References
- Air Conditioning Contractors of America, Manual 5 - Residential Load Calculations (5th Edition), 2017, Air Conditioning Contractors of America
- www.energystorage.org
- www.npe.org
### Heating (or Heating & Cooling) Displacement

<table>
<thead>
<tr>
<th>Application Description</th>
<th>Customer primarily desires to reduce heating (and/or cooling) cost for central area of home. Heating is supplemental when the existing heating equipment is not at or near the end of its service life. The main tradeoff is between initial cost vs. savings and comfort in remote zones.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Suggested ASHP System Configuration</strong></td>
<td>For this application, typical configurations include 1-zone ductless, or 1-3 room mini-duct located to serve central living space (for reduced installed cost). Alternatively, larger 2-5 zone system, ductless and/or mini duct, can be configured to serve home widely for better comfort and savings (higher installed cost). In some cases, a new single-zone central heat pump may make sense but that is more likely a whole-house replacement.</td>
</tr>
<tr>
<td><em>(Single/Multi-Zone Ductless, Mini-Duct, Centrally Ducted)</em></td>
<td>rastructure to strategically cover key living areas per customer needs. Size each zone to heating load of area(s) to be served (block load): total will be undersized for whole-house design heating load. If cooling comfort is desired by customer, size to larger of heating or cooling load for each zone.</td>
</tr>
<tr>
<td><strong>Suggested Treatment of Existing HVAC System</strong></td>
<td>Left in place, provides heat only as needed. A centrally ducted system may also provide mixing of house air for improved comfort.</td>
</tr>
<tr>
<td><strong>Sizing Strategy Overview</strong></td>
<td></td>
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<tr>
<td><strong>Load Calculation</strong></td>
<td>See “Getting Load Calculations Right” to ensure accurate load calculations.</td>
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<tr>
<td><strong>Equipment Selection Considerations</strong></td>
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<tr>
<td><strong>Oversizing Concerns / Tradeoffs</strong></td>
<td>Heating capacity of system at or near outdoor design temperature is a secondary concern. Undersizing somewhat for heating should improve efficiency and reduce overall heating costs, even though central system may be used slightly more. High efficiency at predominant winter outdoor temperatures will reduce operating cost.</td>
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<tr>
<td><strong>Cooling oversize is mitigated by variable-speed equipment; if minimum speed cooling capacity is over 130% of design cooling load, look for equipment with a higher ratio of heating to cooling capacity, or a larger turn-down ratio (a lower minimum capacity), or both.</strong></td>
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<tr>
<td>Manufacturer</td>
<td>Brand (If applicable)</td>
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<tr>
<td>Daikin</td>
<td>RXG09HVJU</td>
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New resources

- 2018- Updated Installer Guides
- 2018- New Installer VIDEOS!!
- 2019- Consumer Buying Guidance
- 2019- Case Studies of ASHP Installations
With your help.....
To access resources...

- Link to NEEP’s ASHP Website/Resources
  
  http://www.neep.org/initiatives/high-efficiency-products/emerging-technologies/ashp

- Dave Lis, NEEP
  - djlis@neep.org
  - 781-860-9177 (x127)
Financing & Customer Engagement
Smart-E Loan Heat Pump Results in Connecticut

- **Ductless mini-splits most common**
- Then air source heat pumps, heat pump water heaters, and geothermal
- **Heat pumps can sell even when oil prices are low**
- **Cooling** and comfort are the big customer drivers
- **One third of heat pump projects were part of multi-measure jobs**
- Heat pumps + solar, insulation or other HVAC

### SMART-E LOANS with HEAT PUMPS

<table>
<thead>
<tr>
<th>Year</th>
<th>Loans</th>
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<tr>
<td>2013-2016</td>
<td>174</td>
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<tr>
<td>2017</td>
<td>400</td>
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<tr>
<td>2018</td>
<td>116</td>
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</tbody>
</table>

- Ductless mini-splits: 67%
- Air Source heat pump: 18%
- Heat pump water heater: 11%
- Geothermal: 4%

**Bill & Lisa**
Newtown, CT

Solar, heat pump helps couple save money and stay comfortable.
# Case Study: Using Special Promotions with CT Market Transformation in Mind

## During 2017 Campaign
- 6x increase in volume – 10x increase in heat pump volume
- 54 new contractors
  - Majority of new entrants are HVAC
  - Brought total to 300
- 85% of contractors used product during campaign
  - vs. 60% in the year before

## After Campaign – 2018
- Volume didn’t collapse!
  - 2018 run rate is 3-4x higher than the volume before campaign, including heat pumps
- Continue training contractors
  - Over 400 now
  - Majority of new entrants still HVAC
- Some contractors now funding their own buydowns with lenders
Engaging Customers

- Stay engaged with EnergizeCT
  - Rebates, Smart-E Loan, CT Heat Loan

- Building out your company website with informational resources on the technology and available financing
  - What am I buying and how can I pay for it?

- Connect with a Smart-E Lender to promote your business
  - On-site events
  - In-branch displays

- Work with CT Green Bank to co-brand marketing materials
Heat Pump Market: Discussion