Why Every Home WILL Need a Heat Pump

In conjunction with the New York State Energy Research and Development Authority
A little bit about me...

- Background
- Envelope work
- Deep energy retrofits
- Heat pumps
- Writing

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Key Learning Objectives

By the end of this training, you will be able to:
• Articulate the benefits of cold-climate air source heat pumps in relation to New York’s clean energy goals
• Define a strategy for how to discuss, market, and sell air source heat pumps
• Explain associated NYSEDA incentives, utility rebates, other clean energy program options to customers and stakeholders
• Describe at least three situations where installation of ASHP's make good sense, and the reasons why
Why cold-climate heat pumps?

• Decarbonization/climate protection
  • “Beneficial electrification”
• Energy affordability
• Comfort, health
• Business opportunity
• Professional opportunity
Why are we here? Why Decarbonization?

Carbon Dioxide ($\text{CO}_2$) levels over the last 10,000 years
Temperature rise since fossil fuel introduction
New York State Clean Energy Goals
Climate Leadership and Community Protection Act (CLCPA)

- **Clean Energy Economy**: Over 151,000 clean energy jobs - **now**
- **Renewable Energy**: 6,000 MW of distributed solar - **by 2025**
- **Renewable Energy/Clean Energy Standard**: 70% electricity from renewable energy - **by 2030**
- **Renewable Energy**: 9,000 MW of offshore wind - **by 2035**
- **Carbon-Free**: 100% clean electricity - **by 2040**
- **GHG Reduction**: 85% reduction in greenhouse gas emissions from 1990 levels - **by 2050**

- **Resilient and Distributed Grid**: 1,500 MW of energy storage - **by 2030**
- **Energy Efficiency**: 185 TWh end-use savings in buildings and industrial facilities - **by 2030**
- **GHG Reduction**: 40% reduction in greenhouse gas emissions from 1990 levels - **by 2035**
- **Energy Storage**: 3,000 MW of energy storage; 30,000 employed in storage sector - **by 2050**
OVERVIEW OF THE STATE’S GHG EMISSIONS IN 2016: TOTAL EMISSIONS WERE 206 MMtCO$_2$e

ENERGY-RELATED EMISSION SOURCES

173 Million Metric Tons of Carbon Dioxide Equivalent (MMtCO$_2$e)

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Activity</th>
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<tbody>
<tr>
<td>36%</td>
<td>Transportation</td>
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<tr>
<td>30%</td>
<td>On-site fuel combustion from buildings (residential, commercial, and industrial)</td>
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<tr>
<td>15%</td>
<td>Electricity generation (including net imports)</td>
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<tr>
<td>3%</td>
<td>Other$^2$</td>
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NON-ENERGY EMISSION SOURCES

33 MMtCO$_2$e

Includes non-energy related sources such as substitutes for ozone-depleting substances,$^4$ landfills, and agriculture.
Path to zero-emissions buildings

- Increase efficiency
- Reduce loads

- Replace fossil fuel equipment

- Transition to 100% renewable grid
Energy affordability

Cost per 100,000 Btu, NYSEG/CNY region

- Electric baseboard
- Propane, 95% furnace
- Oil, 85% furnace
- Natural gas, 95% furnace
- Air source heat pump, 2.9 COP
Comfort and air quality

• **Comfort**
  - Addressing poor distribution
  - Bonus rooms/additions
  - High-quality AC

• **Air quality**
  - Combustion by-products
  - Ductwork issues
  - Dehumidification
  - Filtration & ventilation*
Market opportunity—single family sector

- 34% of NY households heat with oil, propane or electric resistance
  - ~1.75 million households

- 48% cool with window units, 15% have no air conditioning
  - ~3.3 million households

- >50% will require replacement in next 15 years

- Generous incentives statewide
  - Larger workscopes possible
A heat pump for every application

Three heat pump technologies that can meet your home energy and comfort needs

- Space heating and cooling
  - Air source heat pumps
- Hot water heating
  - Ground source (geothermal) Heat pumps
  - Heat pump water heaters

HPWH photo courtesy of Lincoln Barbour
AIR SOURCE HEAT PUMP IN HEATING MODE

1. Very cold refrigerant "warms up" as the outdoor air blows over it as it passes through the heat exchanger.
2. Refrigerant passes through the compressor which cranks up its pressure, causing its temperature to shoot up.
3. Hot refrigerant circulates inside, where air is blown over it, heating the home.
4. The cooler refrigerant circulates outside and passes through an expansion valve where its pressure is released. Its temperature drops again and the cycle repeats.

In summer, the direction is reversed, with the cold refrigerant coming inside to provide cooling, and collecting heat to release outside.
Introduction to Types of Heat Pumps

- Air source heat pumps
  - Mini-splits
Components of an Air Source Heat Pump
These are not your grandparents’ heat pumps...
MUZ-FH H2i HEATING CAPACITY AT LOW TEMPERATURES*

Outdoor Temperature Degrees FWB

% Heating Capacity

100%
78%
60%
0
-13 -4 0 10 17 25 30 35 40 47

MUZ-FH
Standard Heat Pump
Introduction to Types of Heat Pumps

• Air source heat pumps
  • Mini-splits
  • Hybrid (ducted) systems
Introduction to Types of Heat Pumps

• Air source heat pumps
  • Mini-splits
  • Hybrid (ducted) systems

• Domestic Hot Water
Heat pump water heaters

• 240V electric
• Uses indoor air to heat your hot water
• Has backup for meeting high demand
Introduction to Types of Heat Pumps

- Air source heat pumps
  - Mini-splits
  - Hybrid (ducted) systems
- Domestic Hot Water
- Ground source heat pumps
Ground source heat pumps

Benefits

• Super-efficient
  – ASHP: 250%+ efficient
  – GSHP: 350%-500%+ efficient
• Less drop-off in efficiency
• Long system lifetime
• Eliminate fossil fuels from your home
• Can also do domestic hot water
Size of an Average GSHP Loopfield

Horizontal 4-ton System
Ground Disturbance:
Roughly 33’ x 250’

Vertical 4-ton System
Ground Disturbance:
Roughly 20’ x 20’
The Social Benefits of Air Source Heat Pumps

• Air quality - no combustion involved
• No carbon dioxide produced
• Adds higher-efficiency cooling capacity to NY building stock
• Reduce NG infrastructure
• Reduces energy burden for LMI households
• Supports local, living-wage jobs
• Part of the larger decarbonization effort in New York
Homeowner Benefits of Air Source Heat Pumps

• Reduces heating & cooling bills
• Resolves comfort issues directly
• Replaces window air conditioners
• Heating & cooling easier to run to isolated areas in the home
• No carbon monoxide produced
• Fits seamlessly into any room

Can you find the heating system?
Common ASHPs applications

- Open floor plans
- Electric baseboard
- “Box swap” scenario
- Wood heat
- Steam/hydronic conversions
Selling Heat Pumps to Homeowners

**Homeowner “green lights”**
- Expensive fuels
- Older equipment
- Want to add cooling
- Environmentally conscious

*Incentives and financing remove barriers to sale*
Energy Audits can Ensure Successful Installation

• Good load calculations
  • Reduce costs
  • Improve performance
• Blower door & IR
• Simple shell measures
  • Air seal and insulate the attic
  • Air seal and insulate the rim joists
• Homeowner education
  • Familiarize with technology
  • Promote benefits
  • Discuss rebates and incentives
NYS Clean Heat Statewide Incentives (highlights)

Administered through utilities

Air source heat pumps
- $500 per outdoor unit for partial load systems
- $1000 per 10,000 Btuh max capacity at 5F for full load systems

Ground source heat pumps
- $1500 per 10,000 Btuh of rated capacity

Heat pump water heaters
- $700/ea

https://heatsmartcny.org/incentives
NYSERDA residential programs

- Assisted Home Performance
  - 50% matching grant up to $5000 for low-moderate income households
  - Recently expanded to 120% of area median income

- Financing
  - Smart Energy Loan and On-Bill Recovery Loan
  - Interest rate 3.49% to 7.49%
  - 15 year terms, loans up to $25,000

- Empower/LMI pilot

[https://www.nyserda.ny.gov/All-Programs/Programs/Residential-Financing-Options](https://www.nyserda.ny.gov/All-Programs/Programs/Residential-Financing-Options)
Case study

LMI customer, Tompkins County, replaced oil boiler & indirect tank with 3 head, 2.5 ton heat pump & heat pump water heater

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<tr>
<td><strong>Project cost</strong></td>
<td>$15,494</td>
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<tr>
<td><strong>Loan fee</strong></td>
<td>$150</td>
</tr>
<tr>
<td><strong>NYSEG ASHP Rebate</strong></td>
<td>($2,860)</td>
</tr>
<tr>
<td><strong>NYSEG HPWH Rebate</strong></td>
<td>($700)</td>
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<tr>
<td><strong>Assisted Home Performance</strong></td>
<td>($5,000)</td>
</tr>
<tr>
<td><strong>HeatSmart LMI incentives</strong></td>
<td>($2,300)</td>
</tr>
<tr>
<td><strong>Net cost to homeowner</strong></td>
<td>$4,784</td>
</tr>
<tr>
<td><strong>Monthly loan payment (15 years @ 3.49%)</strong></td>
<td>($34.18)</td>
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</tbody>
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Monthly oil savings $61.48; Monthly net +$27.30
The Commercial Benefits of Cold-Climate Air Source Heat Pumps

• Installation savings versus some central systems
• Operational savings, especially vs. oil, propane & electric resistance
• High-quality cooling
• Finer-grained control of temperatures
• Easier submetering
• Be ready to talk payback/ROI!
  • And comfort/productivity
• Looking to scale
• Shortage of technicians
• Multiple entry points
  • Envelope contractor
  • Mechanical contractor
  • Recent grad or career change
Design & installation needs to be done correctly, for air source heat pumps to gain more market traction

We are training professionals & technicians that are up to the challenge!
• Designing and sizing the equipment to the size and type of house
• Integration with existing systems
• Installation and commissioning
• Controls and measurement
• Consumer education/training
• Maintenance
Designing a system for the house and occupants

- Partial displacement or full load?
- Sizing calculations
- Ducted or ductless?
- System design
  - Equipment selection & placement
  - Duct design
- Thermostats and controls
  - Integration with existing systems
  - Home automation
Installation and commissioning

- Equipment
  - Location and mounting options
- Refrigerant piping
  - Flares and fittings
  - Brazing procedures
- Electrical and balance of system
- Testing and commissioning
  - Pressure-testing refrigerant lines
  - Evacuation
  - Refrigerant charge
  - Startup
Operation and maintenance
Making performance sustainable

- Customer education
- Preventive maintenance
  - Cleaning
  - Checking operation
- Troubleshooting
- Warranty and repairs
Next webinar in this series – 10/21/2020 4:30-6:00 pm

Webinar #2: The Air Source Heat Pump (ASHP) as an Integral Part of a Comfortable and Energy Efficient Home

• Air source heat pumps represent a significant opportunity for homeowners and contractors alike.

• This 1.5-hour webinar will make the case for expanding the business model of home performance contractors, HVAC contractors, and energy efficiency remodelers to adopt air source heat pumps as part of staying on the leading edge and honing a new market niche.

Register soon if you have not already done so!
Final webinar in this series – 10/28/2020 4:30–6:00 pm

Webinar #3: Air Source Heat Pump Installation Without Call-backs

• There are fifty ways to create call-backs during the installation of air source heat pumps, and usually only a few ways to get it exactly right based on the unique characteristics of each building.

• This 1.5-hour webinar will present best practices relating to installation guidelines and activities based on actual field inspections. *It is meant for ASHP installation technicians, quality assurance inspectors, and volunteers in local clean energy programs*

Register soon if you have not already done so!
Installing Air Source Heat Pumps without Call-backs
A one-day hands-on workshop in Ithaca NY on
11/7/2020 9 am – 4:30 pm
Get hands-on experience installing an air source heat pump with the experts. *Start to finish* - experience best practices up close and personal.

**Key Learning Objectives**
- Identify the basic ASHP installation procedure for multiple configurations
- Detect potential issues in the installation process and know how to address them
- Understand basic protocols for avoiding common ASHP installation errors
- Recognize best practices for managing refrigerant materials during installation
Questions?

• In conjunction with the New York State Energy Research and Development Authority