Heat Pump Primer

Panel on Beneficial Electrification and Energy Efficiency

Location: Public Utilities Commission, Hearing Rm A
Time and Date: Friday, September 21, 1:00-4:30 PM

Dana Fischer
Area Manager ME/NH
Energy use in American Homes

- Heating & Cooling: 43%
- Water Heating: 12%
- Lighting: 11%
- Computers & Electronics: 9%
- Appliances: 9%
- Refrigeration: 8%
- Other: 8%
Ductless Mini-Split Heat Pumps (ASHP)

Extract heat from outdoor air and move it to indoor spaces with the use of electric motors, driving fans and a compressor.

Reverse cycle to provide highly efficient cooling.

More than 300% seasonal efficiency in NH.

Among cheapest sources of heat available given local prices of electricity and fossil fuel.

Cold-climate models operate to -15F and beyond.
Heat pump water heaters

Extract heat from indoor air and transfer that heat into the tank.

~3X more efficient than a standard electric water heater.

Provide dehumidification when operating but cannot displace a dehumidifier where needed.

Best in semi-conditioned space (basement) with at least 100 sq ft of open area.
Basic Refrigeration Cycle

Air Conditioning Mode
Heating Mode
Room temperature air is heating by air flowing past coil with hot refrigerant.

Super cold low pressure refrigerant is warmed by outside air.

Expansion valve

Compressor

Indoor Unit

Outdoor Unit

Fan
Room temperature refrigerant is compressed making it hot.

Low pressure, cold refrigerant flows to indoor unit to extract heat energy from indoor air.
2.3M households in Norway
More than 50% have heat pumps.

If NH followed this trend, more than 200,000 heat pumps will be installed here in the next 10 years.

The total market for heat pumps in Norway

Efficiency Maine is proposing increases in heat pump program funding over the next 4 years. Now offering rebate of $2,000 to lower income homes.
<table>
<thead>
<tr>
<th>Residential</th>
<th>HSPF</th>
<th>System</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statewide</td>
<td>≥12</td>
<td>Single Zone</td>
<td>$500</td>
</tr>
<tr>
<td>Statewide</td>
<td>≥10</td>
<td>Multi-Zone</td>
<td>$750</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Commercial</th>
<th>HSPF</th>
<th>System</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statewide</td>
<td>≥12</td>
<td>Single Zone</td>
<td>$500</td>
</tr>
<tr>
<td>Statewide</td>
<td>≥10</td>
<td>2-Zone</td>
<td>$750</td>
</tr>
<tr>
<td>Statewide</td>
<td>≥10</td>
<td>3-Zone</td>
<td>$1,000</td>
</tr>
<tr>
<td>Statewide</td>
<td>≥10</td>
<td>4-Zone</td>
<td>$1,250</td>
</tr>
</tbody>
</table>
Rebate incentive is Cost Effective

EM calculation in their TRM only takes into consideration electrical savings of a high efficiency unit over an Energy Star rated heat pump.

Participant cost is the consumers portion of incremental cost.

# Heat Pump Water Heater Savings

Operational comparison of different water heating equipment using common efficiencies and current energy pricing.

A home using a oil boiler with a tankless coil will save over $2,000 in a 10 year period by installing a heat pump water heater.

$3,500+ in savings in 10 years for upgrading from an electric water heater.

<table>
<thead>
<tr>
<th>Energy Unit</th>
<th>Cost/Unit</th>
<th>Energy Factor</th>
<th>Annual Cost</th>
<th>10yr Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Heat pump water heater kWh</td>
<td>0.15</td>
<td>3.25</td>
<td>$144</td>
<td>$1,439</td>
</tr>
<tr>
<td>2. Natural gas instantaneous ccf</td>
<td>1.69</td>
<td>0.90</td>
<td>$196</td>
<td>$1,959</td>
</tr>
<tr>
<td>3. Natural gas storage tank ccf</td>
<td>1.69</td>
<td>0.67</td>
<td>$263</td>
<td>$2,631</td>
</tr>
<tr>
<td>4. Oil boiler w/indirect tank gal</td>
<td>2.86</td>
<td>0.80</td>
<td>$274</td>
<td>$2,737</td>
</tr>
<tr>
<td>5. Oil boiler w/tankless coil gal</td>
<td>2.86</td>
<td>0.60</td>
<td>$365</td>
<td>$3,649</td>
</tr>
<tr>
<td>6. Propane (LP) instantaneous gal</td>
<td>2.91</td>
<td>0.90</td>
<td>$376</td>
<td>$3,760</td>
</tr>
<tr>
<td>7. Propane (LP) storage tank gal</td>
<td>2.91</td>
<td>0.67</td>
<td>$505</td>
<td>$5,051</td>
</tr>
<tr>
<td>8. Electric tank kWh</td>
<td>0.15</td>
<td>0.92</td>
<td>$508</td>
<td>$5,084</td>
</tr>
<tr>
<td>Fuel Type (Units)</td>
<td>Cost per Unit Delivered</td>
<td>Heating System</td>
<td>See Details</td>
<td>Annual Cost</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------------</td>
<td>----------------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>1. Firewood (cord)</td>
<td>$250</td>
<td>EPA-certified wood stove</td>
<td></td>
<td>$1,039</td>
</tr>
<tr>
<td>2. Electric (kWh)</td>
<td>$0.15</td>
<td>ENERGY STAR® geothermal heat pump</td>
<td></td>
<td>$1,070</td>
</tr>
<tr>
<td>3. Electric (kWh)</td>
<td>$0.15</td>
<td>Ductless heat pump</td>
<td></td>
<td>$1,169</td>
</tr>
<tr>
<td>4. Natural Gas (ccf)</td>
<td>$1.69</td>
<td>parlor stove</td>
<td></td>
<td>$1,555</td>
</tr>
<tr>
<td>5. Wood pellets (ton)</td>
<td>$258</td>
<td>pellet stove</td>
<td></td>
<td>$1,610</td>
</tr>
<tr>
<td>6. Natural Gas (ccf)</td>
<td>$1.69</td>
<td>ENERGY STAR® boiler</td>
<td></td>
<td>$1,793</td>
</tr>
<tr>
<td>7. Wood pellets (ton)</td>
<td>$258</td>
<td>pellet boiler</td>
<td></td>
<td>$1,847</td>
</tr>
<tr>
<td>8. Natural Gas (ccf)</td>
<td>$1.69</td>
<td>ENERGY STAR® furnace</td>
<td></td>
<td>$1,941</td>
</tr>
<tr>
<td>9. Kerosene (gallon)</td>
<td>$3.47</td>
<td>space heater</td>
<td></td>
<td>$2,302</td>
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<tr>
<td>10. Oil (gallon)</td>
<td>$2.86</td>
<td>ENERGY STAR® boiler</td>
<td></td>
<td>$2,303</td>
</tr>
<tr>
<td>11. Oil (gallon)</td>
<td>$2.86</td>
<td>ENERGY STAR® furnace</td>
<td></td>
<td>$2,410</td>
</tr>
<tr>
<td>12. Propane (LP) (gallon)</td>
<td>$2.91</td>
<td>parlor stove</td>
<td></td>
<td>$2,985</td>
</tr>
<tr>
<td>13. Electric (kWh)</td>
<td>$0.15</td>
<td>baseboard</td>
<td></td>
<td>$3,425</td>
</tr>
<tr>
<td>14. Propane (LP) (gallon)</td>
<td>$2.91</td>
<td>ENERGY STAR® boiler</td>
<td></td>
<td>$3,441</td>
</tr>
<tr>
<td>15. Propane (LP) (gallon)</td>
<td>$2.91</td>
<td>ENERGY STAR® furnace</td>
<td></td>
<td>$3,726</td>
</tr>
</tbody>
</table>

**Heat Pump Space Heating Savings**

Operational comparison of different space heating equipment using common efficiencies and current energy pricing. Efficiency Maine Cost of Heating Comparison Tool. Equivalent heat output.

A home displacing 100% of the heat from an oil boiler can save over $1,000 per year by installing a high performance heat pump.

https://www.efficiencymaine.com/at-home/home-energy-savings-program/heating-cost-comparison/
Heat Pump Space Heating Carbon Reduction Comparison

Because of the large component of renewables in the electric grid mix in NH, carbon output from heat pump use is very low.

Greater than half reduction in carbon footprint per oil heated home for space heating plausible.

Table 5-1
2016 New England System Annual Average NOₓ, SO₂, and CO₂ Emission Rates (lb/MWh)

<table>
<thead>
<tr>
<th>State</th>
<th>NOₓ</th>
<th>SO₂</th>
<th>CO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecticut</td>
<td>0.23</td>
<td>0.03</td>
<td>572</td>
</tr>
<tr>
<td>Maine</td>
<td>0.36</td>
<td>0.14</td>
<td>678</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>0.45</td>
<td>0.15</td>
<td>897</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>0.23</td>
<td>0.07</td>
<td>573</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>0.16</td>
<td>0.01</td>
<td>930</td>
</tr>
<tr>
<td>Vermont</td>
<td>0.35</td>
<td>0.04</td>
<td>775</td>
</tr>
<tr>
<td>New England</td>
<td>0.31</td>
<td>0.08</td>
<td>710</td>
</tr>
</tbody>
</table>

MSZ-FH series

- **Specs:**
  - FH06: SEER 33.1 / EER 19.0 / HSPF 13.5
  - FH09: SEER 30.5 / EER 16.1 / HSPF 13.5
  - FH15: SEER 22.0 / EER 12.5 / HSPF 12.0
  - FH18: SEER 21.0 / EER 12.5 / HSPF 11.0 (20,250 @ 5°)
  - Only Compatible with MUZ-FHs & MXZ-C Family multi-zones

- **Features:**
  - Hyper-Heating (100% cap. @ 5°)
  - Human sensing i-see sensor
  - Two Section-Split Horizontal Fan/Vane System

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New Remote Controller

MITSUBISHI ELECTRIC COOLING & HEATING
- Full heating capacity to 5°F
- Guaranteed capacity to -13°F
- 18 kBtu to 48 kBtu Cooling
- 22 kBtu to 54 kBtu Heating
- Pre-Installed Base Heater
  — Activates in Defrost mode
Low Ambient Heating Capacity – MXZ-3C24NAHZ vs. MXZ-3C24NA

<table>
<thead>
<tr>
<th>Outdoor Ambient Temperature (°F)</th>
<th>Heating NAHZ</th>
<th>Heating NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>-13</td>
<td>90%</td>
<td>53%</td>
</tr>
<tr>
<td>-5</td>
<td>95%</td>
<td>69%</td>
</tr>
<tr>
<td>14</td>
<td>100%</td>
<td>83%</td>
</tr>
<tr>
<td>23</td>
<td>100%</td>
<td>96%</td>
</tr>
<tr>
<td>32</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>41</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>50</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>59</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Percentage Rated Capacity
Stands

QSMS1201/2
$165 - $180

QSMS1801/2
$190 - $205
Above snow line
Multi Zone

SEZ-KD
SLZ-KA
MSZ-FH
MFZ-KJ
MVZ-A
PKA Models: A
12-36,000 Btu/h

PLA Models: A
12-42,000 Btu/h

PEA/PEAD Models: A
12-18,000 Btu/h
24-42,000 Btu/h

PCA Models: A
24-42,000 Btu/h

PVA Models: A
12-42,000 Btu/h

PUZ Models: HA
30-42,000 Btu/h

PUY (Cooling Only) Models: A-NHA7

PUZ (Heat Pump) Models: A-NHA7
Wireless/Wifi

Wall-mounted/Wifi
MHK1

Wall-mounted/Wifi
kumo cloud

Wall-mounted/Wifi
kumo cloud

Wireless Interface:
PAC-USWHS002-WF-1

Thermostat Interface
PAC-US444CN-1

Hand-held

Wall-mounted
PAR-33MAA

Wall-mounted
PAC-USWHS002-WF-1

Wireless Interface:
PAC-USWHS002-WF-1

Thermostat Interface
PAC-US444CN-1

Hand-held

Wall-mounted
PAC-YT53CRAU

M & P-Series: Controllers
Thank you

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