Myth:

Ductless Heat Pumps don’t work when it is cold out.
Heating System Performance versus Outdoor Temperature

**DHP & Oil Boiler efficiency vs. temperature**

- **High Efficiency Cold Climate DHP COP**
- **Boiler COP**

**DHP & Oil Boiler capacity vs. Temperature**

- **High Efficiency Cold Climate DHP Capacity**
- **Boiler Capacity**
- **Stnd DHP Capacity**
Metered COP: VT Evaluation
Myth:

Ductless heat pumps cost more than your oil system to run when it's cold out.
Heating System Costs v Outdoor Temperature

Assumptions:

- $0.16/kWh
- $2.75/gallon of oil

The cost of each unit of heat (btu) produced by a DHP varies as a function of outdoor temperature.

High efficiency ductless heat pumps cost less to operate than standard efficiency ductless heat pumps.
Temperature Time Series (hourly data)

Typical Meteorological Year

Hour of the Year (starting at January 1st 0:00)

- Portland TMY3 Dry-bulb (F)
- Caribou TMY3 Dry-bulb (F)
- Bangor TMY3 Dry-bulb (F)
"Binning" of Temperature for Analysis

- **Hours per Temperature Bin**
  - Outdoor Temperature (Tout)
  - Hours per Temperature Bin for Portland, Bangor, Caribou

- **TMY and Modeled Heating hours**
  - Outdoor Temperature (Tout)
  - Typical Annual Hours for Caribou and Caribou Gated heating
Modeled Results: Heat Supplied – High Efficiency Cold Climate DHP vs. Oil Boiler

- **Heat Supplied**
  - DHP heat supplied
  - Boiler heat supplied

- **Graph Details**
  - "max" capacity kBtu/h
  - Space Load kBtu/h
  - Capacity ASHP can deliver kBtu/h
  - ASHP actual delivered kBtu/h

- **Axes**
  - X-axis: 
    - "max" capacity kBtu/h
    - Space Load kBtu/h
  - Y-axis: 
    - 1,000 Btu/h
  - Labels: 
    - Tout

- **Data Range**
  - X-axis: -20 to 60
  - Y-axis: 0 to 30
Modeled Results: Cost of Heating – High Efficiency Cold Climate DHP vs. Oil Boiler

DHP & Oil Boiler cost vs. temperature

Cost of Heat Supplied

- Oil $/MMBtu
- High Efficiency Cold Climate DHP
- Stnd DHP $/MMBtu

- High Efficiency Cold Climate DHP
- Oil 'Make-Up'
- Only Central System

Annual Cost per Temperature Bin

Tout
Modeled Results: Cost of Heating – High Efficiency Cold Climate DHP vs. Standard Efficiency DHP

<table>
<thead>
<tr>
<th>Cost of Heat Supplied</th>
<th>Cost of Heat Supplied</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Efficiency Cold Climate DHP</strong></td>
<td><strong>Standard Efficiency DHP</strong></td>
</tr>
<tr>
<td><strong>Oil ‘Make-Up’</strong></td>
<td><strong>Blended Fuel ‘Make-Up’</strong></td>
</tr>
<tr>
<td><strong>Only Central System</strong></td>
<td><strong>Only Central System</strong></td>
</tr>
</tbody>
</table>

- **Base-only annual operating cost**
  - High Efficiency Cold Climate DHP: $1,189
  - Standard Efficiency DHP: $1,189

- **EE DHP + base annual operating cost**
  - High Efficiency Cold Climate DHP: $879
  - Standard Efficiency DHP: $996

- **$ saved estimated**
  - High Efficiency Cold Climate DHP: $310
  - Standard Efficiency DHP: $193

- **ASHP annual operating cost**
  - High Efficiency Cold Climate DHP: $650
  - Standard Efficiency DHP: $271
Modeled Results: “Cutover”

"lost" savings from not cutting off DHP $ 1.22
Maximize usage of your heat pump as your primary heating system.
Experiment with your heat pump settings to find the right balance. Consider setting your older system’s thermostat to at least 10 degrees cooler than your heat pump thermostat. By doing this, you will be using your older system only as back-up.
Myth:

You should turn down the temperature setting on your ductless heat pump at night and when you’re not home.
National Renewable Energy Laboratory Case Study

• Comparison of two identical houses using DHP’s as primary heat sources
  o One home sets the thermostat based on comfort and occupancy
  o One home sets the thermostat

• Long term Monitoring
• Short Term Comparison
Constant Set Point

From: https://www.nrel.gov/docs/fy15osti/63080.pdf
On Off Operation
Setback and Constant Operation

Constant set point house

On-off operation house

https://www.nrel.gov/docs/fy15osti/63080.pdf
Set it and Forget it.
Set your heat pump to a comfortable level. Then leave it alone. They are designed to maintain a steady temperature. Unlike with older heating systems, turning it down at night may not save energy.
Myth:

Ductless Heat Pumps will be used for air conditioning and break the grid in the summer.
Vermont published the evaluation of DHP’s in November, 2017
The evaluation found that on average DHP’s reduce cooling load:

<table>
<thead>
<tr>
<th>Savings Type</th>
<th>Baseline Category</th>
<th>Proportion from Homeowner Interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Window Air</td>
<td>Window Air</td>
</tr>
<tr>
<td></td>
<td>Conditioner</td>
<td>Conditioner</td>
</tr>
<tr>
<td></td>
<td>No Previous</td>
<td>Load Building</td>
</tr>
<tr>
<td></td>
<td>Cooling</td>
<td>14.5 SEER Heat Pump</td>
</tr>
<tr>
<td></td>
<td>14.5 SEER Heat Pump</td>
<td></td>
</tr>
<tr>
<td>Energy (kWh)</td>
<td>286</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>-146</td>
<td></td>
</tr>
<tr>
<td>Peak Demand (kW)*</td>
<td>0.284</td>
<td>0.158</td>
</tr>
<tr>
<td></td>
<td>-0.190</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weighted Average</th>
<th>74</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.11</td>
</tr>
</tbody>
</table>
The Vermont evaluation examine the AMI data before and after a DHP was installed.
  - Table reflects net savings:

<table>
<thead>
<tr>
<th>Previous System</th>
<th>$\Delta$ kWh (Normalized to Metered ccHP Size)</th>
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</thead>
<tbody>
<tr>
<td>No Cooling</td>
<td>-95</td>
</tr>
<tr>
<td>Fan only</td>
<td>-40</td>
</tr>
<tr>
<td>Window or portable AC</td>
<td>202</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>12</strong></td>
</tr>
</tbody>
</table>
Evaluations
Massachusetts published the evaluation of DHP’s in December, 2016
Vermont published the evaluation of DHP’s in November, 2017
  - Both studies found that the units were not being used as much as anticipated
Vermont may be most comparable to Maine
Integrated Thermostats
Integrated Thermostat

- 7 Homes with Mitsubishi DHP previously metered
- Honeywell Thermostat (VisionPRO 8000) integrated with DHP (through interface kit box PAC-US444CN-1) and Existing Central Heating System zone shared with DHP
- Remotely mounted wireless temperature sensor configured to control DHP and central system
- Droop between DHP and central system set to 2-3 deg F
- Before Thermostat Integration
  - 317 gallons of Oil offset with DHP
- After Thermostat Integration
  - 607 gallons of Oil offset with DHP
Lessons Learned
Lessons Learned

- DHP’s can deliver significant benefits to customers
- The more they are used the higher the benefits
- DHP’s operate differently than conventional systems
- Customer education and orientation is needed