Heat Pump Field Study

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Why do this study?

- Understand regional installation practices of air source heat pumps, last baseline study conducted in 2005
- Bonneville Power Administration has a quality installation program – Performance Tested Comfort Systems
  - Informs program savings with updated current practice baseline
  - Informs progress region has made since interventions starting in early 2000’s
  - Informs program on what to focus on, what is effective and not effective
  - Informs future regional savings potential
How did we do this study?

- Goal - Random sample of recent air source heat pump installs in single family homes

- Recruited homes that filed electric and mechanical permits data in last 3 years, data purchased from Buildfax

- Sent letters with an invite to an online survey

- If survey indicates home is eligible, call down list until geographical strata targets are met

- Visited 95 sites, half east of cascades, half west of cascades
Field Study Team
Data Collection

- Participant Interview and Survey
- Heat Pump nameplate information and thermostat settings
- Heat pump performance tests: Airflow, external static pressure, temperature split
- Duct blaster (leakage) test
- Blower door whole house air leakage test
- Home envelope and external duct audit
Use of Data

- Heat pump performance data informs how well the system was installed and commissioned

- Data from the air leakage tests (duct and whole home) along with the shell audit will be entered into two different sizing calculators
  - Regional Technical Forum developed calculator used by PTCS
  - Ecotope developed calculator developed for Idaho Power

- Regional Technical Forum will use the results to update regional Unit Energy Savings estimates
Baseline in 2005 vs 2018

- **Airflow**: 38% in 2005, 36% in 2018
- **External Static Pressure**: 6% in 2005, 5% in 2018
- **Refrigerant Charge**: 8% in 2005
Airflow

PTCS?

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<th>East</th>
<th>West</th>
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<td>High (&gt;500)</td>
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External Static Pressure

Count of Homes

PTCS?
- No
- Yes

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<td></td>
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Refrigerant charge

PTCS?

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<th>East</th>
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<td>Meets or exceeds</td>
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<tr>
<td>Meets or exceeds</td>
<td>5</td>
<td>10</td>
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No  Yes
Temperature Split

- Overcharged
- Undercharged

Graph showing temperature split with markers for PTCS and Non-PTCS.
Sizing Baseline then and now

- 2005 – Units tended to be undersized by 30%

- 2019 – 39% of units were undersized by 10% or more when compared to Ecotope tool. West of cascades sites tended to be undersized at a greater rate.

- 54% of units were undersized by 10% or more when compared to PTCS tool
Heat Pump Sizing

- Oversized
- Undersized

**Installed Heating Capacity (kbtu/hr)**

**Required Heating Capacity (kbtu/hr)**

- **PTCS**
- **Non-PTCS**
Heat Pump Sizing

- Oversized: 8 Non-PTCS, 10 PTCS
- Right-Sized: 35 Non-PTCS, 19 PTCS
- Undersized: 15 Non-PTCS, 8 PTCS
Controls – Auxiliary Lock Out

- 57% of all sites did not have the auxiliary lockout set at 35 F or below

- Excluding duel fuel sites (28%) 49% of sites did not have the auxiliary lockout set at 35 F or below

- Inefficient lockout settings tended to be set at 40F – 55F degrees

- Efficient settings tended to be set at 35F
Auxiliary Lock Out - PTCS

Excluding Dual Fuel

Including Dual Fuel
Controls – Compressor Lock Out

- At low outdoor temperatures compressors are less effective at meeting the heating load

- It is most efficient to let the compressor work at all temperatures as it will produce some part of the heating load

- If a cut out must be used it should not be cut out above 5 F
Compressor Lock Out Settings

- 28% of sites had the compressor locked out above 5°F
- Most of the 72% of sites with correct lock out had lock out disabled
What this all means...

- The baseline installation practices have not improved that much since 2005
- Refrigerant charge appears to be more of a problem than in 2005
- PTCS appears to only be most effective at ensuring the right lock out control settings
- Savings will change based on new baseline
- Still don’t know what the efficient case savings are, they are modeled