NEEP COLD CLIMATE AIR-SOURCE HEAT PUMP MARKET TRANSFORMATION WORKSHOP GETTING TO INTEGRATED CONTROLS

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The Case for Better Controls

1. Why is this an issue?
2. The current situation
3. Benefits of better controls
4. Dream controls

Why is this an issue?

- Cold climate ductless air source heat pumps have great potential:
  - Customer energy cost savings and convenience
  - Cooling electric savings
  - Heating fossil fuel displacement for GHG reductions
  - Utility energy and peak load reductions
  - Etc.
- But, we're not seeing performance living up to potential
- Utility programs reconsidering DHP savings potential

Evaluation Studies - Vermont

- Vermont Department of Public Service (Cadmus)
  - 2015-2017
  - Preliminary results

Table 2. Overview of ccHP Energy Consumption and Heating Capacity Provided

Savings Type	Total Metered kWh	Metered kWh: Heating Mode	Metered MMBtu	VT TRM MMBtu	Realization Ratio	Relative Precision at 90% Confidence Interval*
Heating	2,043	1,826	20.8	51.6	40%	12.1%

* Based on variance in energy consumption per ton of heating capacity, normalized by nameplate HSPF.

Evaluation Studies - Maine

- Efficiency Maine Trust
  - NMR & EFG (2012-2013)

Table ES-4: Electricity Savings Realization Rates by Upgrade Type

	Evaluated Savings	Program Savings Assumptions	Realization Rate	±90% c.i.
Weatherization Only	299	1,140	26%	±8%
Heat Pumps Only	1,401	2,608	54%	±6%
Weatherization and Heat Pumps	1,438	3,824	38%	±5%
All	996	2,488	40%	±4%

- Emera Maine
  - EMI Consulting (2014)

2 **Increased use of heat pumps results in increased savings.** Participants that previously heated their homes with fuel oil and frequently used their heat pumps for heating were able to successfully offset fuel oil usage and significantly reduce their heating energy costs. Some participants remained skeptical and limited the use of their heat pumps. These participants did not offset as much fuel oil use, and therefore limited their savings.

Evaluation Studies – MA/RI

- Electric and Gas Program Administrators in MA and RI (Cadmus)
  - 2015-2016

Table ES-4. Average EFLH

Season	2013–2015 MA TRM	2014 RI TRM	Average Study EFLH	Average of Top 25% of Measured EFLH
Winter 2015	1,200	1,200	442	1,275
Summer 2015	360	360	218	499
Winter 2016	1,200	1,200	451	1,117

  - ~38% of the winter TRM expected values
  - BUT some ("top 25%") are running much more (nearly 3x the average), just about at the TRM value

What Does This Tell Us?

- People aren't using DHPs as expected
- For some consumers, they are operating them to meet their cooling needs, but not their heating needs
- DHPs only deliver the potential savings when operated properly to optimize savings
- If they aren't being used, they won't save
- What to do?
  - Better customer education
  - Better controls

The Current Controls Situation

- Temperature set by remote controller, monitored and adjusted based on return air flow through the top of the indoor head unit
  - Pro: No additional costly controls needed
  - Con: Doesn't control the temperature where you want it
- Incremental improvement with IR technology
- Remote thermostat to monitor temperature in room
  - Pro: Monitors temperature where you need it for better control to extend heat pump "reach"
  - Con: Adds cost. Still doesn't integrate with central heating system

Benefits of Better Controls

- Realized savings
- Increases utility benefits and cost effectiveness
- Reduces need for occupant interaction
- Maximizes fossil fuel and electric resistance displacement

Dream Integrated Controls Features

- Distributed indoor temperature sensors
- Outdoor temperature
- Current fuel costs
- Optimizes operation based on current fuel costs, real time system efficiencies and building load
- Demand response enabled
- Carbon accounting

Boiler/ Furnace

Ductless Heat Pump

Internet Connected

Dream Integrated Controls Functions

- Maintain set indoor temperature(s) at lowest operating cost
  - Remote sensors to boost heat in “droopy” zones
  - Ensure basements don’t freeze
- Prioritize operation of both systems based on a real-time economic analysis, considering:
  - Current fuel/electric costs pulled from the web in real-time
  - Outside air temperature used to help determine building load and needed output
  - Efficiency of each system
    - Calculate COP and capacity based on manufacturer performance curves
  - Real-time carbon accounting prioritization and cross-over

Dream Integrated Controls Functions Con't

- Demand response calls from the utility during peak times to shed load
- Run the central or heat pump system (or combination of systems) that costs the least to operate at any point in time
- Web-enabled to allow remote customer access and utility control
- Provide customer feedback on some key metrics to show that it is delivering heat at the least-cost
- Securely store the operational data for trouble-shooting and for future system evaluation
- With these features, you could guarantee that the customer minimizes their heating costs, which would be a great marketing angle

Immediate Term

- Include remote thermostat
  - Maintains room temperature
  - Minimizes customer input
  - Meet ENERGY STAR's emerging communicating thermostat specs?
- Customer education
  - "Set it and forget it"
  - Set central system (4 degrees) below DHP set point
  - Etc. (follow NEEP Guidelines)
- Address tankless coil (and non-cold-start) boilers
- Hear what Dana is learning in Maine
- Keep pushing manufacturers to develop better controls

Q&A

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