Northeast Energy Efficiency Partnerships

2016 NORTHEAST/MID-ATLANTIC AIR-SOURCE HEAT PUMP WORKSHOP

FACILITATED BY

DAVE LIS

Director of Market Strategies

NORTHEAST ENERGY EFFICIENCY PARTNERSHIPS

July 21-22, 2016

Thank you to our Workshop Sponsors!

About NEEP

Mission

Accelerate energy efficiency as an essential part of demand-side solutions that enable a sustainable regional energy system

Approach

Overcome barriers and transform markets via

Collaboration, Education and Enterprise

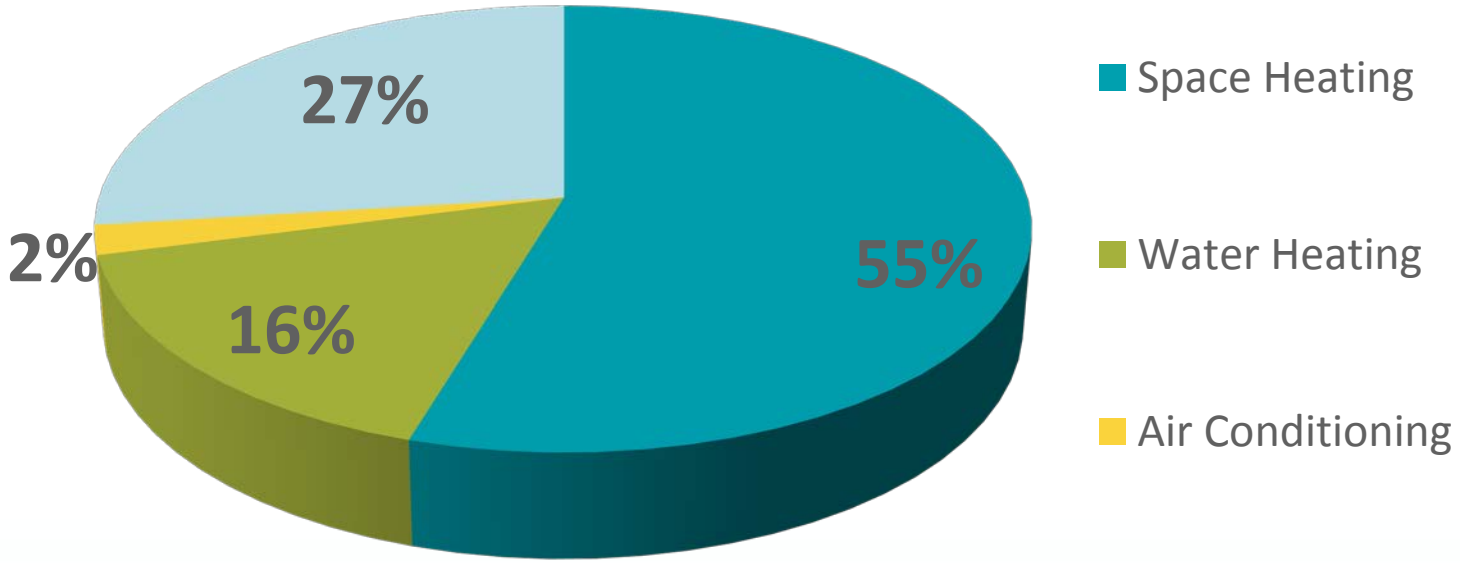
Vision

Region embraces **next generation energy efficiency** as a core strategy to meet energy needs in a carbon-constrained world

One of six regional energy efficiency organizations (REEOs) funded by the US Department of Energy (US DOE) to link regions to US DOE guidance, products and programs

SPACE HEATING WITH ASHPs

- Space Heating dominates residential energy consumption (site) in the Northeast



Source; 2009 EIA RECS

"YUGE" OPPORTUNITY

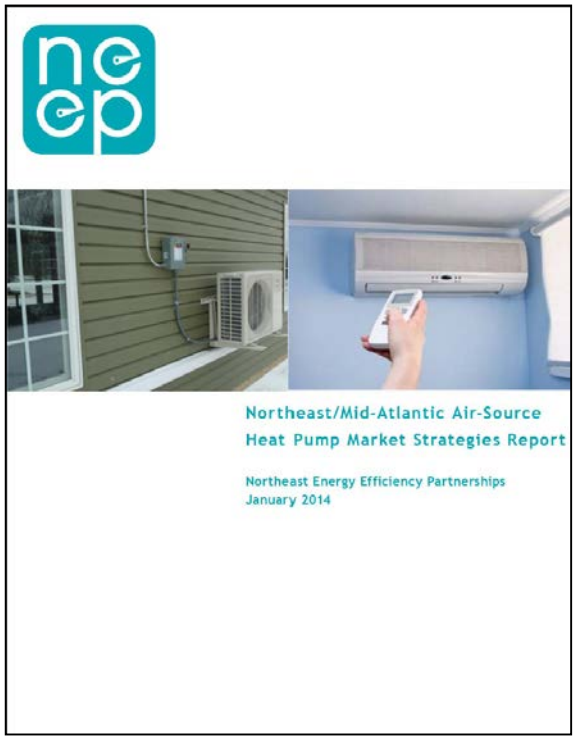
- Only approx. 1 million housing units (of 23 million) in the greater NEEP region (Northeast and Mid-Atlantic) heated w ASHPs in 2009.

NEEP'S PERSPECTIVE

- Expanded use of this technology in the region provides a pathway to multiple outcomes:

Regional NEEP Initiative

Northeast/Mid-Atlantic ASHP Market Strategies Report



www.neep.org/efficient-products/emerging-technologies/Air-Source-Heat-Pumps/index

RECOMMENDED MARKET STRATEGIES

1. Develop more accurate tools to predict energy and cost savings associated with ASHP installations, through collection of real world performance data
2. Develop standardized Metrics for Cold Climate ASHP Performance
3. Increase Consumer Awareness and Education
4. Expand HVAC Contractor Awareness and Education
5. Improve Integration of ASHPs with Other Heating Systems
6. Provide ASHPs at Affordable Costs to Consumers
7. Characterize policy implications of large scale deployment of ASHPs

PURPOSE OF TODAY'S WORKSHOP

- Bring together a collection of Air-Source Heat Pumps (ASHP) industry experts to encourage a productive dialogue
- Expose key market updates/trends
- *Contemplate regional market transformation strategies to accelerate adoption of high performance ASHPs (update to MS Report)*
- Strengthen regional coordination
- *Provide direction to NEEP's regional ASHP activities going forward*

MARKET TRANSFORMATION LENS

Defining Market Transformation (theory)

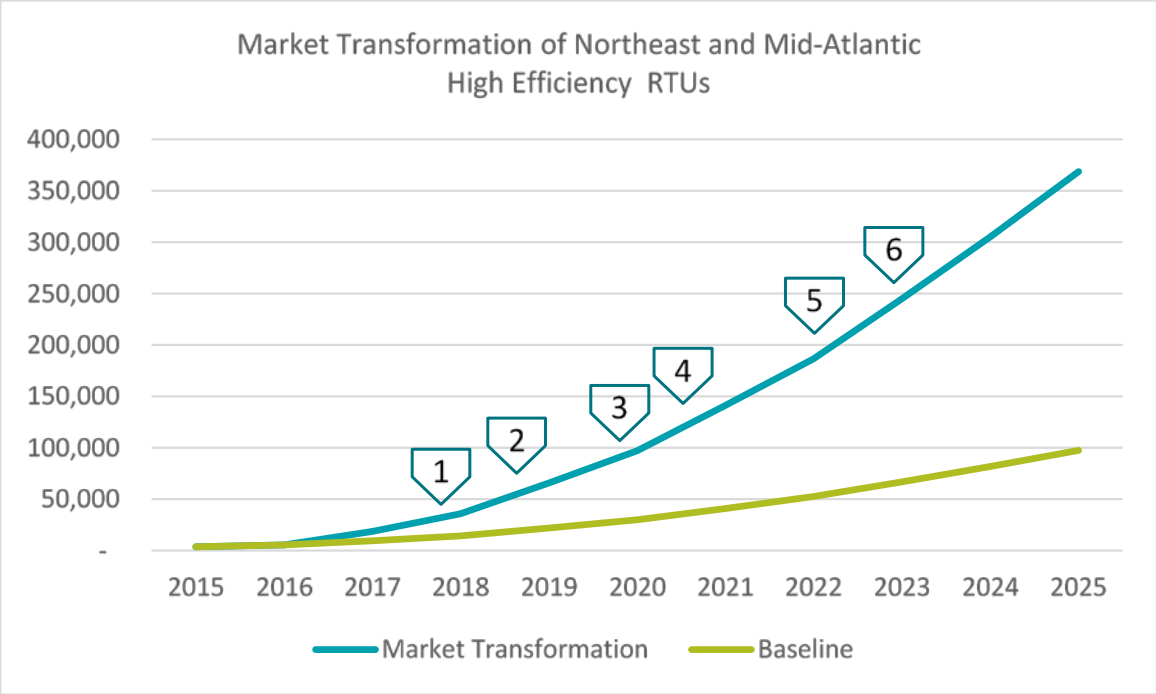
The strategic process of intervening in a market to create lasting change in market behavior by removing identified barriers and/or exploiting opportunities to accelerate the adoption of all cost-effective energy efficiency as a matter of standard practice.

ACEEE
American Council for an Energy-Efficient Economy

neea

Theory of Change

Figure ES-2. Market Transformation of High Performance RTUs



Formulate an overall theory of change that describes how a series of key strategies/interventions over time will overcome existing market barriers/leverage market opportunities and achieve the long-term-MT goal.

WORKSHOP AGENDA (DAY 1)

9:30 am	Welcome and Introduction
9:55 am	Market Updates/Progress Report
10:50 am	AM Break
11:10 am	Market Barriers and Opportunities
12:00	Lunch
12:30 pm	Critical Market Strategies (Small Groups)
1:30 pm	PM Break
2:15 pm	Prioritizing NEEP Activity (Small Groups)
3:30 pm	Wrap up & Next Steps

IMPORTANT LOGISTICS

- Speak up/Use Microphone
- Bathrooms
- Food
- Breaks
- Building restrictions

ANTI-TRUST GUIDELINES

- Today's process seeks to be:
  - Fair and Open
  - Intentionally structured to neither attempt to set prices nor to enable sharing of pricing and pricing planning among manufacturers
  - Without implying a refusal to deal with any party due to their participation or non-participation in any resulting cooperative activities
  - Limited in scope to market strategies related to energy efficient HVAC equipment in the Northeast/Mid-Atlantic Region

LET’S GET TO KNOW EACHOTHER

Level setting/ASHP Market Updates

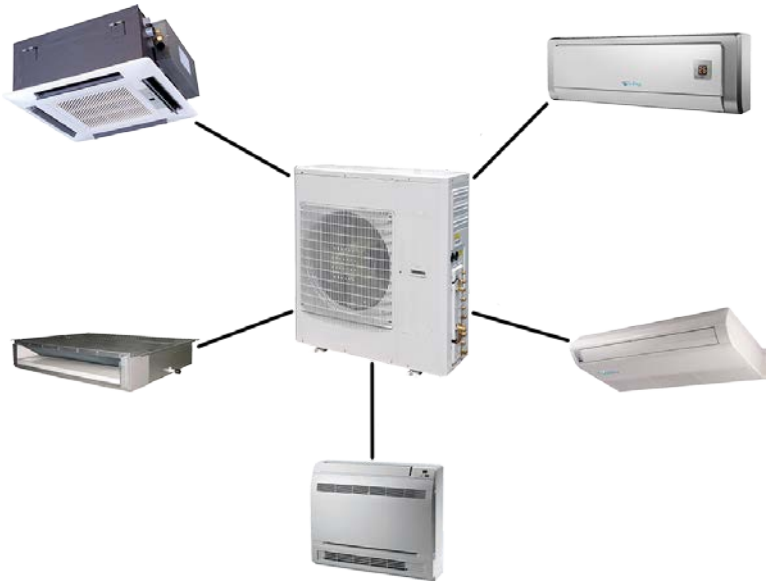
1. ASHP Regional Sales
2. Product offerings ASHP performance
3. DOE Minimum Standards/ENERGY STAR
4. ccASHP Specification
5. Test Procedure activity
6. Program Promotional Activity
7. Program Savings Assumptions
8. In-field Performance Research
9. Energy cost comparisons
10. Policy update as related to ASHPs
11. Carbon emission comparisons
12. Demand impacts (SWA)
13. Installed costs (SWA)
14. Consumer/Market Insights

Sizing the regional ASHP Market

- John Vaccaro, D&R International

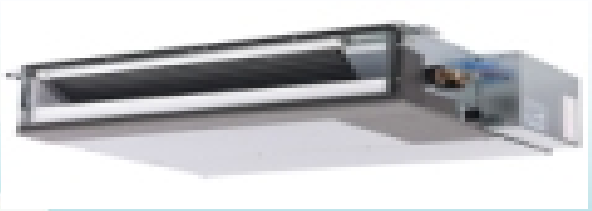
What's new in ASHP Product Offerings

Multi-Zone



Cold-Climate

Short-run/Mini Ducted Air Handlers



Integrated Controls

How are ASHPs performing?

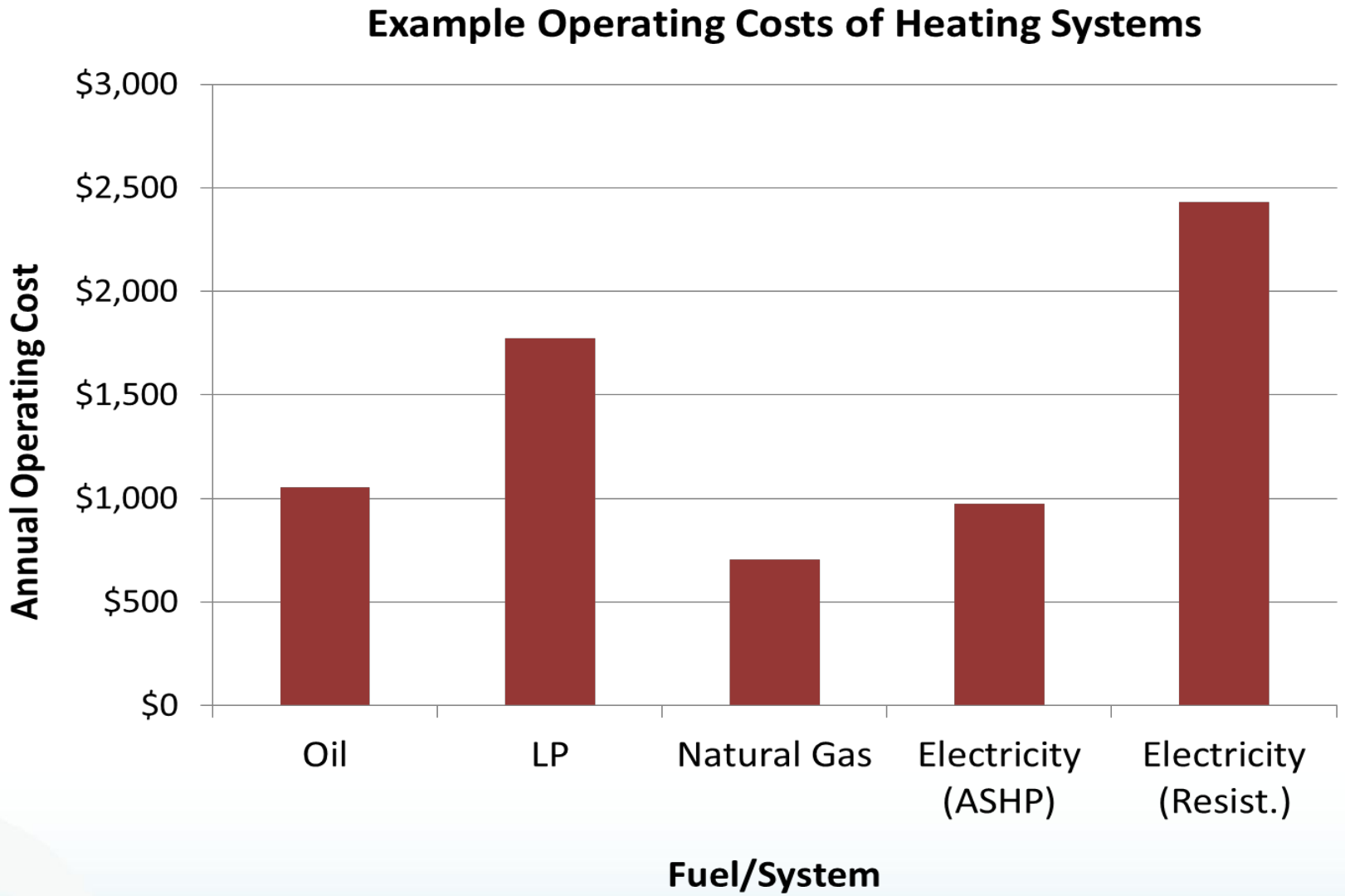
- 2014 NEEP Meta-study
  - Seasonal COPs ranged between 2.4-3.0
- 2015 DOE/Efficiency Vermont Study
  - Seasonal COPs ranged between 1.1-2.3
- Further Performance Research
  - Vermont Ductless Heat Pump Field Study (Cadmus), in the field
  - Massachusetts/Rhode Island Ductless Heat Pump Field Study (Cadmus), almost released

What do ASHP Cost Trends look like?

- Ductless Mini-splits
  - According to several studies over the past five years, prices have remained steady around $3,000-$4,000 (1-1.5 ton)
- Ductless Multi-splits/VRF
  - Recent NEEP study found;

Cost per ton:	
Multi-split	$3,728
VRF	$6,350
VRF with Heat Recovery	$9,198

Cost Comparison across heating systems



Regional Program Summary

- Extensive rebate programs across the region
- Broad range of required performance levels persists (HSPF, SEER, EER, COP@5F)
- Rebate levels range
  - Single-zone ductless approx $250-$500
  - Multi-zone ductless approx $300-$600
  - Ducted approx $200-$600

Program Energy/Peak Savings Assumptions

- Historically, program savings based on the difference in efficiency levels between high and base efficiency heat pumps
- Savings algorithms often very similar, and most primarily rely on HSPF (for heating savings) and SEER (for cooling savings). Then combined with capacities and hours of operation to obtain electric energy savings. Hours of operation are often specified for a specific region in the TRM
- In Connecticut, equations for ductless ASHP savings includes coefficients derived from a pilot evaluation study

Table 1. Some features of State Technical Resource Manuals.

ASHP Characteristics in TRM Energy Savings	CT	DE	DC	ME	MA	MD	NJ	NY	PA	RI	VT
Differentiation for ductless or mini-split ASHPs	X	X	X	X	X	X			X	X	X
Provisions for ASHPs offsetting fossil fuel		X	X			X					X

Cold-Climate ASHP Specification

- Launched in Jan. 2015
- ~150 products from 11 manus
- V2.0 Finalized in May, 2016 (Effective Jan. 1, 2017)
- Modest changes from V1.0
- COP@5F requirement unchanged (>1.75)
- Expanded performance reporting unchanged

DOE Standards/Test Procedure Activity

Current Central AC Standards (Jan, 2015)	Current Heat Pump Standards (Jan, 2015)
North Region- 13 SEER South Region - 14 SEER SW Region- 14 SEER, EER 12.2	All Regions- 14 SEER, 8.2 HSPF

Product Class	National		Southeast*	Southwest**	
	SEER	HSPF	SEER	SEER	EER
Split System Air Conditioners with a Certified Cooling Capacity <45,000 Btu/h	14		15	15	12.2/10.2***
Split System Air Conditioners with a Certified Cooling Capacity ≥45,000 Btu/h	14		14.5	14.5	11.7/10.2***
Split System Heat Pumps	15	8.8			
Single-Package Air Conditioners and Heat Pumps	14	8.0			11.0

2023 Effective Date
Direct Final Rule expected in August

CSA Test Procedure Development Effort

- Bruce Harley, Bruce Harley Energy Consulting

Policy activity related to ASHPs?

- Mass.- Revised Alternative Portfolio Standard
- R.I.- State Energy Plan targeting a 20% reduction in unregulated fuel use
- Vt.- RES & ”Energy Transformation Projects”
- N.Y.- NYSERDA being directed to “animate” markets on a fuel-neutral basis

End Use Heating Emissions by Technology

Based on 2007 NREL Figures from NEEP Report

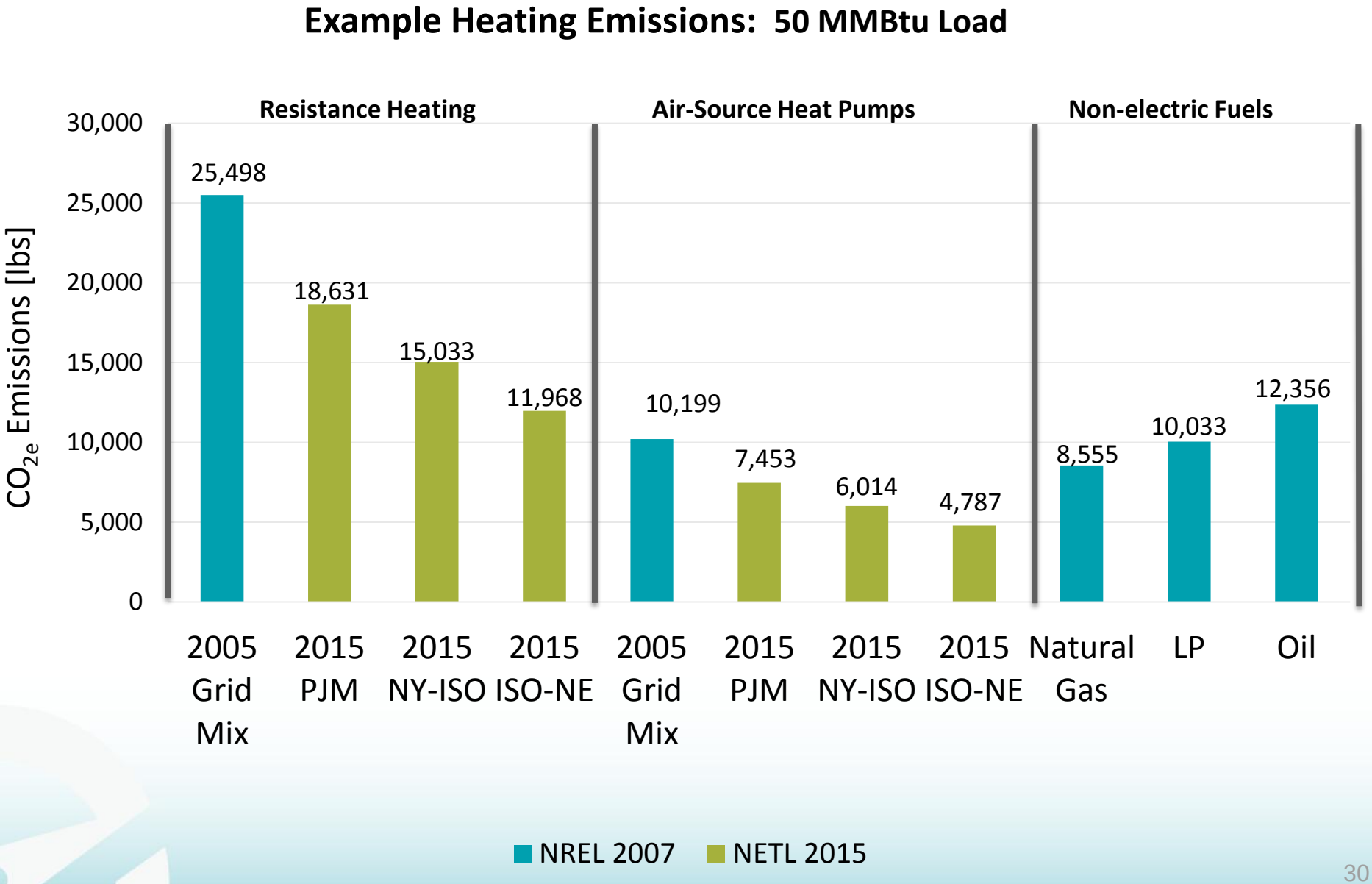
Table 4. Estimated greenhouse gas emissions (in equivalent pounds of CO2) for several fuels and systems.

Fuel	Oil	LP	Natural Gas	Electricity (ASHP)	Electricity (Resist.)
Seasonal Eff/COP	80%	90%	90%	2.5	100%
CO_{2e} [lbm]	26.9 per gallon	16.1 per gallon	14.9 per therm	1.74 per kWh	1.74 per kWh
Fuel and Emissions to meet 50MMBtu thermal load*					
Fuel used	450 gallons	608 gallons	556 therms	5,862 kWh	14,654 kWh
CO_{2e} [lbm]	12,356	10,033	8,555	10,199	25,498

*Fossil fuel system emissions include 750 kWh for fans, pumps, controls, etc. Values do not account for different distribution efficiencies of systems.

Emissions and the Changing Fuel Mix

2005 Assumptions Compared to 2015



ASHP Installer Guidance

- NEEP Project with DOE to develop designer/installer guidance on issues related to sizing/selecting/installing ASHPs in cold climates
- Come to session 1 tomorrow to provide input

ASHP Market Insights

- Pasi Miettinen, Sagewell

Northeast Energy Efficiency Partnerships

NEW YORK DUCTLESS HEAT PUMP BASELINE STUDY

JULY 21, 2016

Energy Futures Group

Energy & Resource Solutions

Recent Ductless Heat Pump Evaluations

- Vermont Ductless Heat Pump Field Study (Cadmus), in the field
- Massachusetts, Rhode Island Ductless Heat Pump Field Study (Cadmus), almost released
- Bonneville Power Administration: HVAC Market Intelligence Report, April 2016
- Navigant 2015 IEPEC heat pump papers:
  - A Ductless Heat Pump in Every Pot… or Home?
  - The Humpty Dumpty of Heating: Piecing Together an Understanding of Ductless Mini-Split Heat Pump Usage in the Northeast
- NEEA Residential Inverter-Driven Heat Pump Technical and Market Assessment (Navigant), June 2015
- Building America Case Study: Field Performance of Inverter-Driven Heat Pumps in Cold Climates (Connecticut, Massachusetts, and Vermont) (CARB, Efficiency Vermont), August 2015
- Heat Pumps Potential for Energy Savings in New York State (Optimal Energy)- July 2014
- Massachusetts Ductless Mini-Split Heat Pump Customer Survey Results (Cadmus), September 2014
- Emera Maine Heat Pump Pilot Program Final Report (EMI Consulting), September 2014
- Mini-Split Heat Pumps Multifamily Retrofit Feasibility Study (NREL), May 2014
- NEEA Northwest Ductless Heat Pump Initiative: Market Progress Evaluation Report #4 (Illume Advising), July 2015
- NEEA Consumer Messaging for Ductless Heat Pumps and Heat Pump Water Heaters (Illume Advising), July 2015
- What else is out there?

Major Market Trends

- **Market Health-** Sales strong, but have flattened (due to oil prices?)
- **Technology**- New products (multi-zone, short-run ducted systems) adding to ability to customize…Integrated controls still not there…ccASHP market expanding
- **Regional Policies** impacting Market…growing discussion of fuel switching, strategic electrification
- **Promotional Programs**- no big changes, mix of levels persists…renewable thermal growing
- **Installation practices**- Sizing/install questions continue
- **In-field performance research**- Close to new data (MA/VT/NY's PON)
- **Performance Metrics/Test Procedures-** Work underway to develop better performance metrics for ASHP (CSA)
- **Consumer perspective**- Cooling solution still dominant driver of sales

What are you seeing from this market?

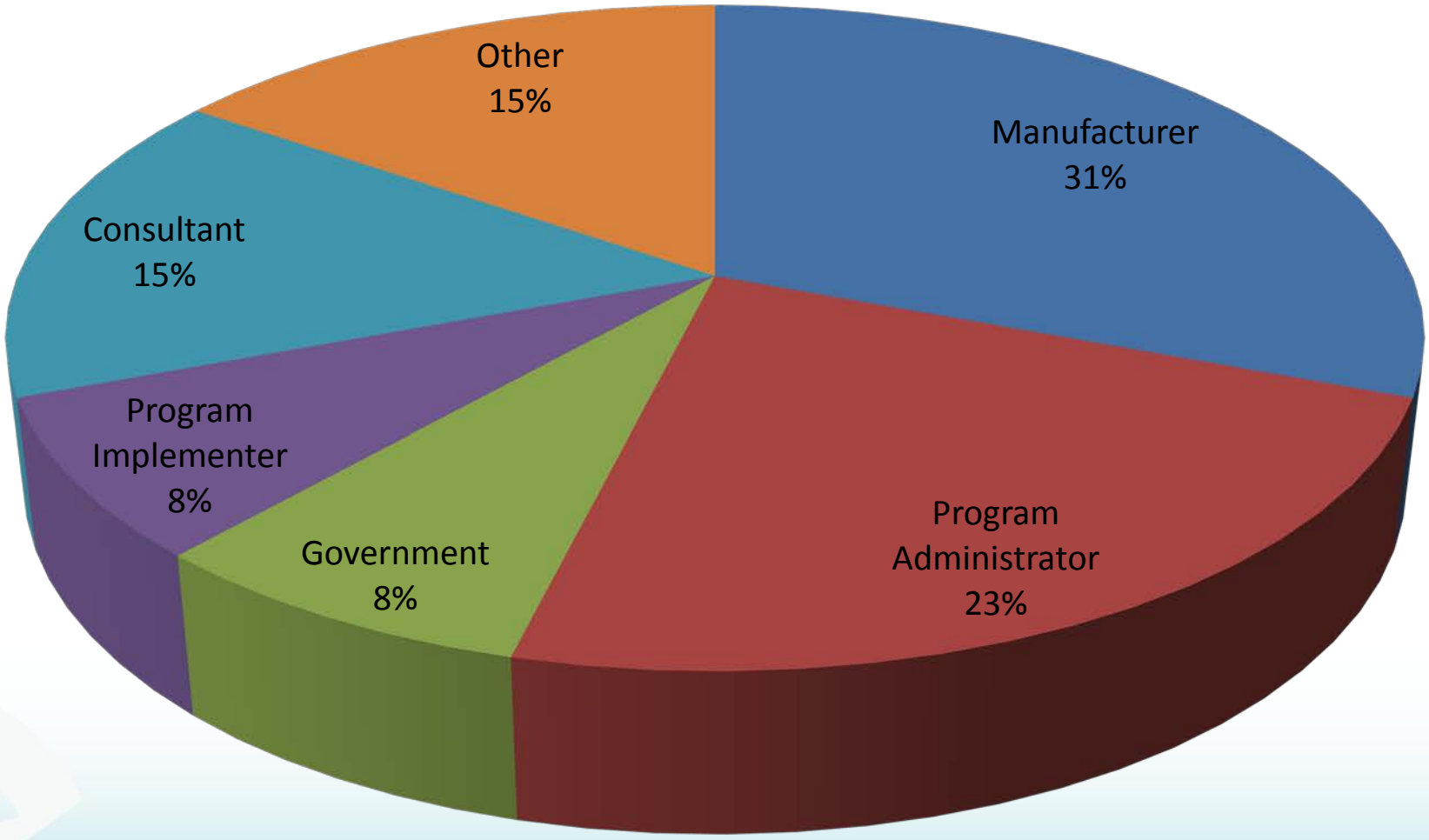
- Market intelligence to Share?
- Areas needing further digging?

PROGRESS REPORT

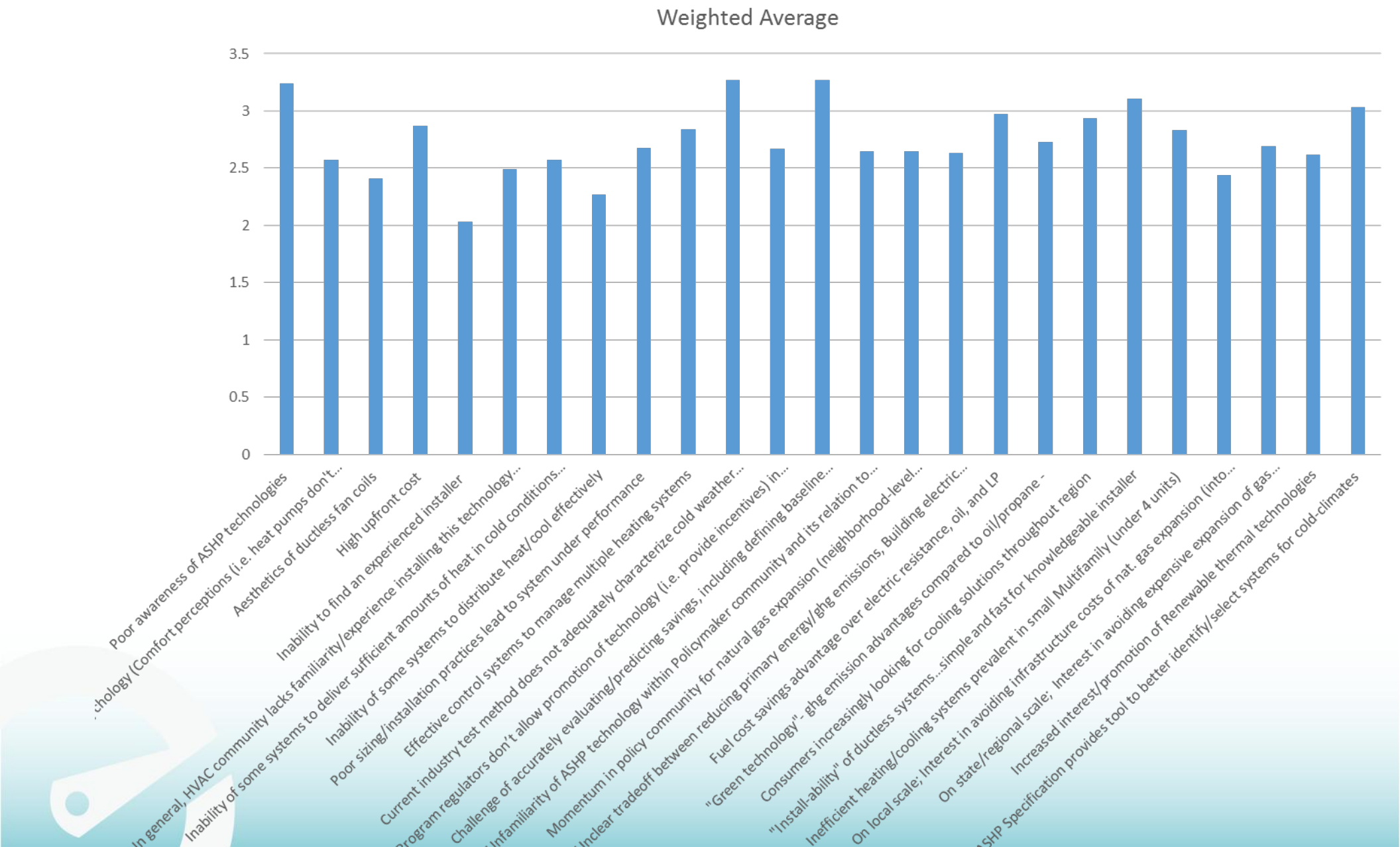
High Level Regional Strategies	Progress?
Develop more accurate tools to predict energy and cost savings associated with ASHP installations, through collection of real world performance data	
Develop standardized Metrics for Cold Climate ASHP Performance	
Increase Consumer Awareness and Education	
Expand HVAC Contractor Awareness and Education	
Improve Integration of ASHPs with Other Heating Systems	
Provide ASHPs at Affordable Costs to Consumers	
Characterize policy implications of large scale deployment of ASHPs	

Red= Little to none Orange=Some Yellow= Medium Green= Significant

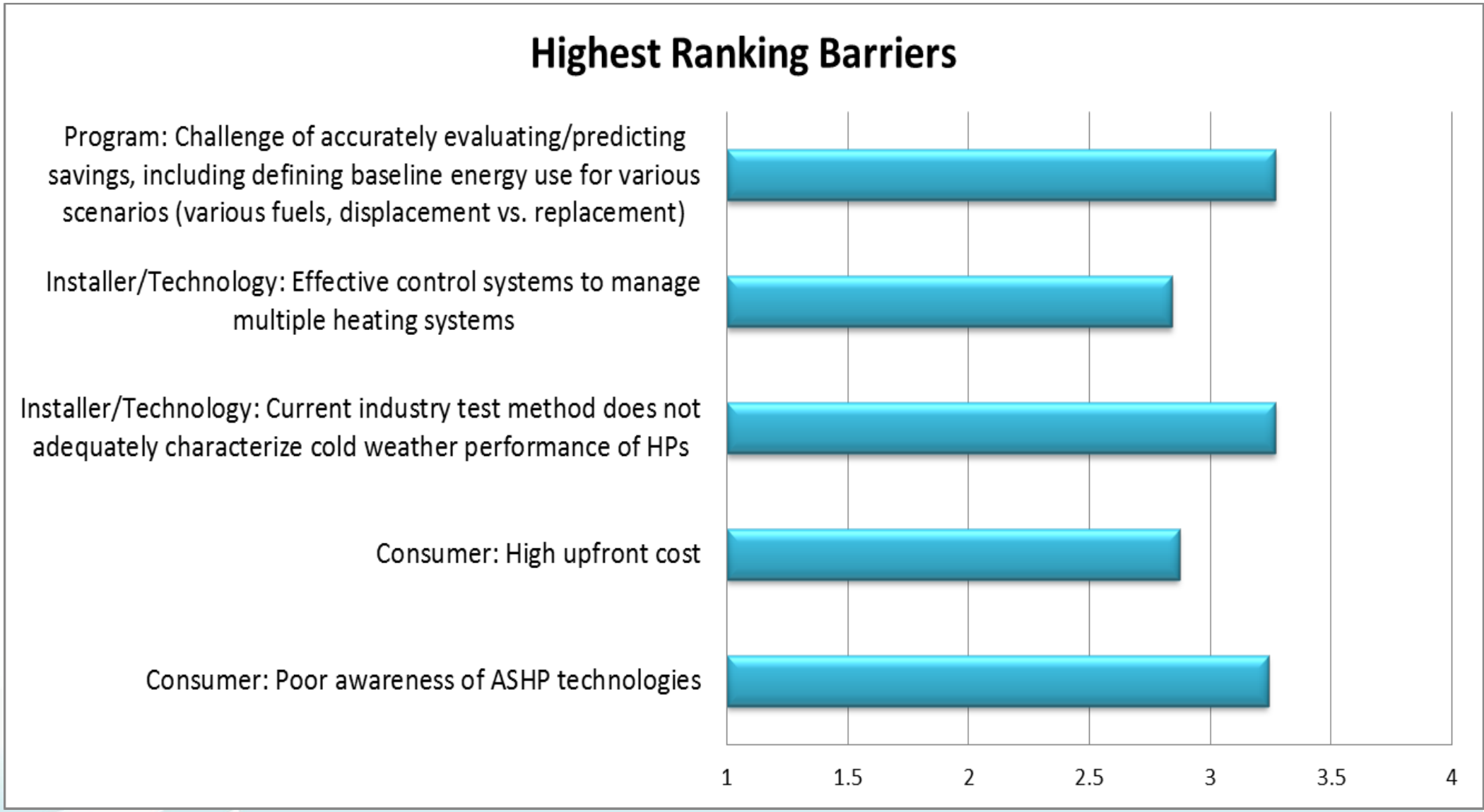
ASHP Market Barriers/ Opportuniteis Survey-39 responses



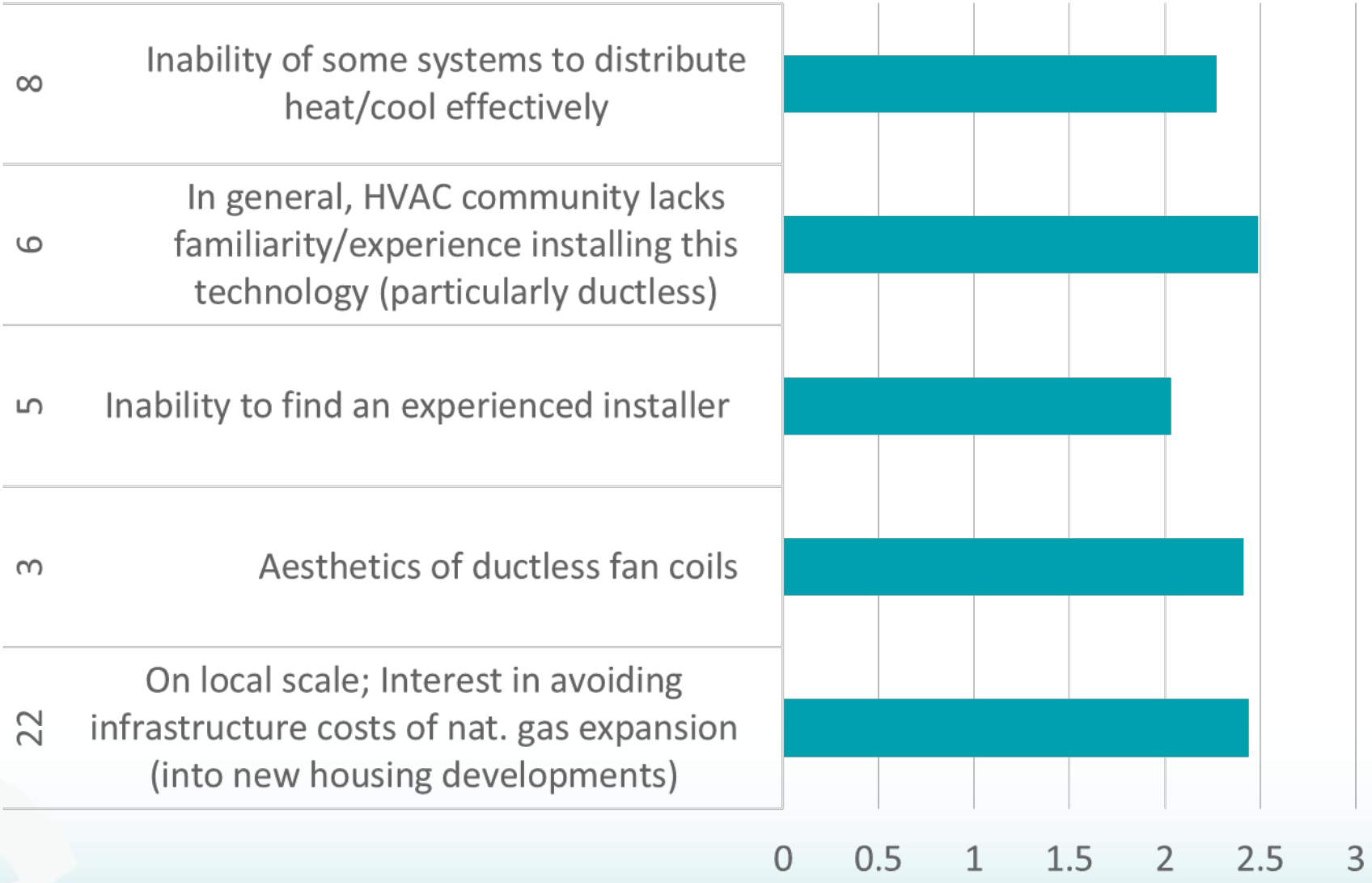
Survey Results



Highest Ranking Barriers/Opportunities



Lowest Ranking Barriers/Opportunities



Survey Observations

- Most proposed barriers/opportunities received scores suggesting that they remain obstacles to market growth or provide a valuable opportunity for market to leverage.

Consumer Comments

- Lack of awareness that heat pumps even exist, or if there is awareness especially a sense that "they don't work in cold climates" or "they don't work below freezing"
- Costs vary significantly in the market, with a large range in pricing for the installed cost of essentially the same system.
- With the drop in oil prices, comfort cooling is the main reason to buy in 2016
- All of these issues are getting less and less significant

Installer Comments

- Installers are available but may not themselves yet trust or be willing to recommend this technology for primary heat
- Many Northern installers are have limited experience with ducted heat pumps and don't offer them as an option.
- Poor informational feedback on how efficiently the unit is operating once installed
- Lack of readily available accurate information on system economics relative to oil and gas-fired systems.

Program Comments

- We can't develop savings calculations without seasonal COP values we can believe.
- We do need better models for savings for different types of equipment and in differing installation use cases.

Policy Comments

- The easiest way to get greater heat pump adoption is for regulators to allow electric utilities to promote fuel switching. This will create the larger carbon savings than energy efficiency programs - at no additional cost. Furthermore, the incremental electric sales will reduce electric rates.
- Regulators very rarely understand that electricity, when used in efficient heat pumps, is by far the cleanest heating fuel in terms of carbon emissions. Heat pumps in New England reduce natural gas home heating CO2 emissions by 40%+ and oil emission by 60%+.
- There is considerable policy misalignment between the jurisdiction with climate change response mandates and utility regulatory bodies' rules

Metrics Comments

- As far as ccASHP Spec and program promotion, it has to be proved. Show the math, using real #s on upfront costs, fuel savings, etc.

Barriers/Opportunities Categories

1. Cross cutting; Savings uncertainty (3.27)

Barriers/Opportunities Categories

2. Performance Metrics:
   - Current industry test method does not adequately characterize cold weather performance of HPs
   - Efforts underfoot to develop improved metrics/test procedures (CSA)
   - ccASHP Specification provides tool to better identify/select systems for cold-climates

Barriers/Opportunities Categories

3) Consumer (Awareness):

- Poor awareness of ASHP technologies (3.24)
- Negative perceptions/psychology (Comfort perceptions (i.e. heat pumps don't work in cold climates, noisy, long recovery from setback, “Electric heating is bad”, etc) (2.57)
- Leverage interest in green technologies (2.73)
- Leverage interest in Cooling solutions (2.94)

Barriers/Opportunities Categories

4. Installer
   - Poor sizing/installation practices lead to system under performance (2.68)
   - Uncertain how to identify ideal customer candidates (particularly ductless)

Barriers/Opportunities Categories

5. Technology
   - "Install-ability" of ductless systems...simple and fast for knowledgeable installer (3.11)
   - Unavailable/Ineffective control systems to manage multiple heating systems (2.84)
   - Inability of some systems to deliver sufficient amounts of heat in cold conditions (i.e. one for one replacement of existing system) (2.57)

Barriers/Opportunities Categories

6) Consumer (Affordability) and Program Promotion

- High upfront cost (2.87)
- Fuel cost savings compared to other heating system/fuels (2.97)
- Multi-family building owners offer economies of scale (2.83)
- New business models such as leasing/bulk purchase to grow sales/adoption
- Challenge of accurately evaluating/predicting savings, including defining baseline energy use for various scenarios (various fuels, displacement vs. replacement) (3.27)
- No established energy savings algorithms for ccASHPs
- Potential for programs to incorporate into DR efforts

Barriers/Opportunities Categories

7. Policy (Many ASHP Stakeholders are unfamiliar with policy barriers. All of these ranked relatively low.)

- Unfamiliarity of ASHP technology within Policymaker community and its relation to existing policy goals (i.e. energy/ghg reduction, ZNE buildings) (2.65)
- Program regulators don't allow promotion of technology (i.e. provide incentives) in fuel switching situations (2.67)
- Momentum in policy community for natural gas expansion (neighborhood-level and generation-level) (2.65)
- Unclear tradeoff between reducing primary energy/ghg emissions, Building electric load (2.63)

Key groupings

1. Cross Cutting (Savings uncertainty)
2. Metrics
3. Consumer- Awareness
4. Designers/Installers
5. Technology/Controls
6. Consumer- Affordability (Promotional Programs)
7. Public Policy

Opportunities

"Install-ability" of ductless systems…simple and fast for knowledgeable installer	3.11
ccASHP Specification provides tool to better identify/select systems for cold-climates	3.03
Fuel cost savings advantage over electric resistance, oil, and LP	2.97
Consumers increasingly looking for cooling solutions throughout region	2.94
Inefficient heating/cooling systems prevalent in small Multifamily (under 4 units)	2.83
"Green technology"- ghg emission advantages compared to oil/propane	2.73
On state/regional scale; Interest in avoiding expensive expansion of gas infrastructure, easing gas bottlenecks	2.69
Increased interest/promotion of Renewable thermal technologies	2.62
On local scale; Interest in avoiding infrastructure costs of nat. gas expansion (into new housing developments)	2.44

NEXT STEPS

- Circulate Slides
- Draft Region Market Transformation Strategy to be circulated to LAC
- Finalize Strategy Report in October/November
- Q4 Working Group Meeting (Oct)
- Contact NEEP if you'd like to join Regional ASHP Working group

WORKSHOP DAY 2- ASHP SIZING&INSTALL/ROUND-ROBIN

- 7:30am- Breakfast
- 8:30am- Welcome Back
- 8:40- 10:10 ASHP Installer Guidance Session
- 10:10-10:30 AM Break
- 10:30-12:30- Manufacturer “Round Robin”

Join us to our next events

- **Sept 20**: Residential Lighting Workshop
- **Sept 21**: Home Energy Management Systems Workshop
- **Sept 22**: EM&V 2.0 Workshop
- **Oct 21**: Rhode Island High Performance Schools Summit
- **Nov 9**: New Hampshire High Performance Schools Summit

THANK YOU!

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