NYSERDA DUCTLESS MINI-SPLIT HEAT PUMP (DMSHP) MARKET CHARACTERIZATION STUDY

FINAL REPORT

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Project Goal, Objectives and Deliverables

- Goal
  - The goal of this study is to: 1) establish current baseline and market activity for ductless mini-split heat pumps (DMSHP) in New York state; and 2) identify key indicators to track change in market activity over time.
- Objectives
  - Conduct market characterization research to respond to 19 identified research topics related to the New York State DMSHP market.
- Deliverables
  - Final Report (in PowerPoint format)
  - Market Actor Interview Guide
  - Spreadsheets with synopses of secondary data research and interview responses

Research Methodology/Sources

- Research included executing two separate methods of information gathering to characterize the New York DMSHP market:
  - Secondary Research
    - Survey of other jurisdictions' current, proposed, and cyclical studies, including NEEP Reports
    - Analysis of HARDI DMSHP sales data
  - Primary Research
    - Interviews of key market actors including manufacturers, distributors, and installers

Survey of Secondary Research

- Following a 2014 NEEP DMSHP Meta Study, an additional 18 reports were reviewed to support this DMSHP effort. Reports were scanned for relevant information related to the research topics. See Appendix F for full list of secondary data sources.

Overarching Conclusions

- DMSHP market is growing, but DMSHPs are still a niche product in residential and small commercial space heating and cooling market.
- DMSHP are performing roughly as advertised, but could do better with installer education (technical) and customer education (operations and maintenance), installation standards, and better controls.
- It's a complicated market with a lot of diversity in customer motivation, customer usage, and existing heating equipment interplay.
- Consumer awareness of DMSHP technology is low.
- Satisfaction is high for customers who have installed DMSHPs.
- Based on collection of market actor input, promotional activities are appropriate and incentives would be motivational at this stage of DMSHP market development.

Overarching Conclusions (continued)

- Key market barriers for DMSHPs include: Lack of consumer awareness/education, Lack of installer awareness/education, Technology capabilities, adequate controls, lack of accurate performance metrics, and upfront cost.
- Installer awareness of DMSHP technology is average, but deep, educated understanding of the technology is low to very-low (e.g., how/where to install, product benefits, how to sell, how to repair, how to instruct customer usage).
- Current DMSHP market is not being driven by energy/cost savings, as it was when oil/propane were expensive. Instead there are a variety of drivers from a customer perspective beyond energy cost savings including comfort, "going green", and flexibility to heat/cool.
- The DMSHP market is ripe for program intervention on multiple fronts, for example: efficiency and installation standards, installer education, customer awareness and incentives.

Findings/Conclusions for Key Research Topics

Awareness

Conclusion to Specific Research Topic

Research Task: Assess overall awareness of DMSHPs, including what/how the manufactures see the distributors' awareness, what/how the distributors see the installers' awareness, and what/how the installers see the customers' awareness.

- Key market actors think the "other" key market actors are generally aware of DMSHPs.
- Installers think customers have an "average" level of awareness.
- For both installers and customers:
  - Use marketing/advertisement/incentives to increase awareness.
- For *installers*, use training to develop informed, educated installers (which trickles down to customer).
- Need to distinguish between:
  - Aware: means a market actor knows technology exists
  - Educated/informed: means a market actor can install/sell/operate/repair the technology effectively.

Barriers

Conclusion to Specific Research Topic

Research Task: Identify barriers in the market that hinder adoption of DMSHPs.

- There are a variety of barriers in the market (technology, market, industry, and customer).
- However, many are potentially addressable through:
  - Marketing/advertising
  - Education/training
  - Incentives/financing – tied to "good" equipment and installs
  - In-field energy monitoring, followed by program redesign (in incentives, education, and marketing)
- Challenging areas to address:
  - Manufacturing plants being located overseas
  - Encouraging integration amongst control/thermostat design with monitoring embedded within
  - New manufacturers are "flooding the market with cheap products, limited access to parts and poor support"; risk of developing reputation that product doesn't work.

Customer Motivation - Hypothesized

Research Task: Determine primary consumer motivation for installing DMSHP: heating or cooling, or both, "going green", getting off fossil fuels or pairing with solar panels.

- Customers are installing DMSHPs for a broad array of reasons including cooling functionality, heating functionality, both heating and cooling functionalities, utilizing "green" technology, and saving money.
- Usage often changes as customer learns about/installs the technology.

Customer Satisfaction

Research Task: Assess satisfaction of current DMSHP users.

- Customers in New York, and around the New England region, are generally very satisfied with their DMSHPs.

Displaced Fuel

Research Task: Estimate displaced fuel/fuel costs per install by fuel type (fossil or electric).

- 2016 MA/RI Ductless Mini-Split Heat Pump Impact Evaluation suggests average annual fossil fuel use reduction of:
  - Displaced Oil- average of 46 gallons annually (Top 25%- average of 125 gallons annually)
  - Equates to $124/$337 in cost savings (@$2.70/gallon)

Distribution & Sales Channels

Research Task: Confirm product distribution channels and sales channels.

- Distribution and sales channels are generally "typical":

  Manufacturers ⟶ Distributors ⟶ Installers

  with the following caveats:
  - For manufacturers, all but one are reliant on products coming from Asia. This poses challenges and risks, such as delay in repair parts (decreases installer confidence).
  - Manufacturers and distributors offer a wide array of education and training; some are developing energy modeling tools for installers.
  - One installer is developing new leads through hosting town dinners to explain how DMSHPs work.
- When equipment fails, the homeowner's choice of equipment is likely to be greatly influenced by their contractor, what equipment is readily available, and price.

Impact Analysis

Conclusion to Specific Research Topic

Research Task: Develop per-unit impact analysis estimating changes in: greenhouse gas, summer/winter peak, Electricity use, Fossil fuel use (savings).

- 2016 MA/RI Ductless Mini-Split Heat Pump Impact Evaluation developed per unit savings estimates for a number of baseline scenarios including:
  - Electric resistance - 784 kWh avg. annual savings (top25%- 2622 kWh avg. annual savings)
  - Standard DMSHP - 166 kWh avg. annual savings (top25%- 423 kWh avg. annual savings)
  - Gas furnaces - 73 therms avg. annual savings (top25%- 198 therms avg. annual savings)
  - Oil boiler - 46 gallons avg. annual savings (top25%- 126 gallons avg. annual savings)
- While some operating conditions are likely to be more severe in NY, this study should serve as a relatively good proxy for how systems would be operated and perform in NY.
- DMSHPs are installed for a variety of reasons and customer usage varies depending on "application" to address a "problem area".
- The results of in-field performance studies should be used with caution when determining savings from these units, as customers often use an additional heating system simultaneously and/or use it to keep the room hotter than they would without the heat pump (when in heating mode).

In-Field Performance

Conclusion to Specific Research Topic

Research Task: Characterize in-field performance of ductless mini-split systems.

- DMSHP are performing roughly as advertised.
- 2016 MA/RI Ductless Mini-Split Heat Pump Impact Evaluation offers excellent data on in-field performance of DMSHP.
  - Average "metered" HSPF was 88% of the average "rated" HSPF (10.3 average rated HSPF vs. 9.1 average in-field HSPF)
    - This equites to a seasonal COP difference of 0.36
  - A number of different factors may have contributed to measured HSPF values falling below rated values including issues with HSPF rating, consumer usage, Site conditions, etc.
  - Correlation found between observed capacity and rated capacity.

Installer Value Proposition

Research Task: Confirm value proposition for installers, i.e., 1) understand the installers' business models, 2) what the drivers are for installers, and 3) how installers view the value propositions of the customers.

- Installers say customers interested in cooling "makes the phone ring" – but after that, installers often work with customers to increase their understanding of DMSHPs to realize more benefits.
- Installers generally see growth opportunity.
- Installers think marketing certainly would help.
- However, marketing needs to address that **the market is not focused on DMSHPs as an energy savings opportunity**, *solely* or *primarily* – but rather as a technology that solves problems and provides multiple benefits.

Market Actors

Conclusion to Specific Research Topic

Research Task: Identify and confirm key market actors by type, including assessing their potential roles in promoting technology and levels of activity.

- Key Market actors include manufacturers, distributors, installers, state/utility efficiency programs, and customers.
- Overall, the industry called out most market actors (except customers) as potentially being able to "do more" to drive the market..
- Areas of potential market support highlighted by interviewees include:
  - Customer incentives plus targeted marketing
    - Request for independent 3rd party to coordinate so that only installers who have been trained can provide incentive to customer.
  - Public education activity for the customer (using independent, 3rd party (non-industry) organizations to deliver.
  - Targeted technical training for installers and architects/designers for MF and new construction.

Market Indicators

Conclusion to Specific Research Topic

Research Task: Identify key market indicators to effectively track DMSHP market evolution as well as identify practical data sources to inform such indicators

- DMSHP sales data available from D&R International offers most robust opportunity to track DMSHP market in New York. Primary market research (via market actors) offers another key pathway to gather data related to sales, market share and promotional activity.
- While D&R International currently offers annual sales within NY state only by efficiency (HSPF and SEER) and size (tons), there are additional data that would be very useful for purposes of tracking the market in the future:
  - Sales data be broken out by climate zone/zip code. D&R reported that there is currently not sufficient geographical diversity of distributors reporting data to allow them to produce more granular market share calculations. This may change in the future.
  - Sales data for Cold-Climate ASHP (ccASHP) systems as defined by NEEP's ccASHP Specification
- Insufficient data to determine penetration of DMSHP in installed base; further building stock assessment studies in NY will be necessary.

Market Sectors

Conclusion to Specific Research Topic

Research Task: Estimate how the size of markets differ between residential, multi-family, small commercial, and which market sectors are the most ripe for further technology adoption.

- Based on market actor (manufacturers, distributors and installers) interviews, virtually no one in the industry systematically tracks sales according to "residential" versus "multi-family" versus "commercial"; answers are informed estimates.
- Interviewees suggest single-family residential systems currently dominate the market based on number of unit sales.
- However, many of the interviewees believe that multi-family retrofits is a "no brainer"; and the majority of the industry believes there is considerable opportunity in small commercial retrofits, as well as new construction for single family, multi-family, and small commercial.
- Although asked, no interviewees provided estimated percentages of what they thought market potential could be for growth.

Market Size

Conclusion to Specific Research Topic

Research Task: Assess the size of the current, and potential market and characterize the New York state market

- ~30,000 DMSHP installed in 2015 (HARDI Sales data, See Appendix C)
  - for context: ~150,000 gas furnaces installed in 2015
- Lack of available secondary data prevented research team from estimating baseline market share by climate zone for New York State. Primary research (Market actor interviews), similarly, did not offer insights into how local New York markets differed from each other.
- The vast majority of interviewees thought the DMSHP market will grow in the absence of market intervention, however, they believe considerably more growth is possible with market intervention.
- If low natural gas prices persist, it will be difficult to move current customers to DMSHP for heating in large numbers based on current economics.
- NYC seen as both a challenge, and an opportunity – in that very few DMSHP have been installed there, and at the same time unique challenges exist (i.e. zoning issues, locational placement of multiple units).

Maximizing Energy Savings

Research Task: Assess energy savings potential of current DMSHPs installations in New York (i.e. based on location/building type & size, could a different DMPSHP system have been installed to maximize energy savings?)

- According to installers, the DMSHP market is not currently evolving with a focus on energy savings, but rather a mix of benefits. Distributors and manufacturers also concurred that the technology provides a variety of benefits, of which energy savings is only a part.
- With fuel prices at all time lows, it is unclear how much the market can be directed to focus on energy savings without considerable program support.

Payback

Research Task: Estimate Simple payback by system type.

- Simple payback is determined by dividing cost by annual energy cost savings. Calculations depends greatly on an assumed cost. We have assumed full cost of installed system in our estimates. Alternatively, it could be assumed that a DMSHP system was being installed *instead* of a different technology in which case it would be appropriate to use the "incremental" cost between the two systems. Payback periods are greatly reduced if this assumption is made.
- Displacing existing electric resistance heating with DMSHP is the only current retrofit scenario with a reasonable simple payback: 8.7 years.
- With low energy costs, "payback" is not a key motivator for customers. DMSHPs are "problem solvers", i.e., utility of the system drives of the purchase. (See "Customer Motivation")

Potential Savings

Research Task: Assess potential future energy savings.

- 2014 NYSERDA Potential Study analysis offers best source of data for NY state:
  - Note that the 2014 analysis includes all Air-Source heat pump (ASHP) applications, without breaking out DMSHPs specifically.
- ASHP Analysis - For fuel-switching measures for residential space heating and cooling:
  - Cooling energy reduction (by 2034): ~1.4 Terawatt hours (TWh), or 27% of the cooling energy forecast.
  - Electric space heating Increase: ~25 TWh, which would increase the total residential and commercial electric forecast by about 42%.
  - Gas and petroleum fuel reduction for space heating: ~84% and 81%, respectively.
- ASHP Analysis - For non-fuel switching measures for residential space heating and cooling:
  - 1.2 TWh of savings, representing 27% of res space heating forecast
- Scope and budget didn't permit this 2017 study to develop new potential energy savings analysis. There may be opportunities to update the Potential savings analysis based on more recent performance studies. Assumptions that should be revisited include assumed system efficiencies and assumed displacement of fossil fuel when fuel switching.

Program Intervention Potential

Conclusion to Specific Research Topic

Research Task: Assess potential future impacts resulting from program intervention (e.g., anticipated increases in market share of high performance DMSHPs in absence of traditional per-unit measure incentives).

- Considerable growth is possible with program intervention.
- However, program designers need to be very clear on what they want to achieve (i.e. GHG reductions, customer savings, strategic electrification, or DMSHP market development)
- For more detail on market needs that programs should prioritize, see Appendix C. Some of the key activities based on market actor responses and lessons learned from other programs promoting this technology include:
  - Build awareness and demand across public market
  - Require technical and customer education for installers
  - Make the up front investment more attractive through rebates/financing
  - Develop robust QA and evaluation to ensure quality installations and program feedback.

Unit Cost

Research Task: Estimate unit cost by efficiency/capacity/system optimization (cooling/heating/both) (by manufacturer, distributor, and installer).

- Installed unit costs typically fall in $3500-$4500 per ton range, based on combination of primary and secondary sources.
- Per responses by one manufacturer and one distributor, unit cost ranges from $700 - $2,360 per ton depending on manufacturer and the cold climate performance
- Labor costs can vary considerably depending on the specifics of the project.
- 6/8 installers who provided estimated cost break-downs feel that equipment costs are 50% or more of the total project cost.

Upstream Decision-Making

Conclusion to Specific Research Topic

Research Task: Analyze upstream manufacturer and distributor sales and shipment decisions (e.g., decision-making related to production and distribution of this high-efficiency product).

- Many variables can impact sales and shipment decisions including:
  - Trends in sales
  - Public awareness/Customer demand
  - Demographics of various locations
  - Energy policies
  - Utility Promotions and Partnerships
  - Installer confidence
  - Customers wanting to save energy dollars
- Most variables that were highlighted could be seen as "outside" the individual manufacturer/distributors direct sphere of influence.
- Nevertheless, manufacturers and distributors continue to push for (and believe in future) market growth.

Research Opportunities

The research team identified a number of additional research areas that NYSERDA can consider for future work. In some cases this research might help in more fully characterizing the DMSHP market and/or market potential in New York.

- In-field monitoring research across a broad spectrum of applications and customer usages, with also monitoring other systems being used simultaneously to understand whole house energy use.
  - Consider reaching out to Vermont that has ongoing studies.
- Pilot integrated smart control systems for controlling DMSHP and central heating system.
- Explore upstream incentive interventions for maximum leverage of incentive investments.
- Explore newer generations of DMSHP technologies:
  - E.g., CO2 based refrigerants, integrated space/DHW systems
- Examine possible synergies with solar PV applications and the appropriateness of weatherizing homes with DMSHPs.
- On an annual or biennial basis, conduct market actor interviews (not necessarily the exact same actors) to gather current cost data and, corroborate sales data trends.