Technical Consultant Team Suggestions for Heat Pump EM&V Study Areas

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Below are suggested areas of investigation regarding heat pumps and electrification.

In no particular order:

1. Market study of the quantity, capacity (tons), and age of central AC systems for both residential and small commercial buildings. This could identify the potential for savings when these units fail or reach end of useful life.
2. If data is not already available for CT, market study of the quantity, capacity and age of oil and propane furnaces and boilers for residential and commercial, and for commercial RTUs using gas heating.
3. Market study of through-wall air conditioners, window mounted air conditioners, classroom unit ventilators, and Packaged Terminal Air Conditioners (PTAC) to determine quantity, capacity and age. These could all be candidates for replacement by mini split heat pumps or HP equipped versions of PTACs or unit ventilators or window heat pumps.
4. An estimate of fuel displacement (in MMBTUs) per ton of heat pump capacity for the two climate zones of Connecticut (Coastal vs Inland) for Small C&I buildings. This would be valuable for claiming fuel savings through multiple C&I programs such as SBEA, Midstream or downstream.
5. A comprehensive review of the various flavors of HP units/systems on the market in terms of indoor units and system approaches and estimates of potential applicability (e.g., drop ceiling mounted, in between wall joists, etc.) There are now a lot more options that can be an improvement over the traditional wall mounted DMSHPs, but not sure whether most of them are just prototype or actually available, what the costs are, and what the applicability scenarios are. Consider a "heat pump potential study" as NMR conducted for RI that quantified the heat pump opportunities as part of their RASS.
6. For C&I, a better understanding of the costs and performance of VRF systems and different potential configurations of them, and in particular, retrofit applications.
    a. Related to above VRF, specifically would be good to include (but not limited to):
        i. investigate the costs and performance of dual refrigerant loop systems that can simultaneously heat and cool using waste heat from one to support the other for C&I buildings with core internal heat gains requiring cooling while perimeter still needs heat vs. traditional single loop systems.
        ii. Investigate the costs and feasibility in medium/large commercial buildings of:
            1. using existing pipe chases to run refrigerant lines, and then replacing (or supplementing) water coils in individual air handling units with HP condenser/evaporators.
            2. Use of existing hot and chilled water distribution systems with existing boilers/chillers at low delta temperatures to support water to air VRF systems, either relying on existing air handling units or new wall packs.
7. Investigation of occupant comfort and satisfaction with HP conversions.
    a. Humidity control issues if sizing more for heating load?
8. Cost/performance trade-offs in terms of sizing for retrofit applications and partial vs. full displacement
    a. Optimize for cooling

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   b. Optimize for heating
   c. Something in between?
9. Ability for simple swap out of gas/electric-AC RTUs with HP RTUs (e.g., can they cover full load, require electric resistance, larger size, are the footprints the same, etc.)
10. Interactions between HPs and controls and ability to setback temperatures.
   a. Also, assessment of trade-offs between setbacks even if you need electric resistance to bring back up to temperature vs. no setback (presumably the longer you can set back the more worthwhile it might be to still do that even if it is going to trigger resistance heating later). Would be good to understand where that balance typically is and any comfort implications.
11. We second Glen Eigo's suggestion for a look at air-to-water HP best practices. However, there are a number of potential issues with this worth investigating:
   a. Applicability/feasibility of simple conversions of hydronic systems and limitations in existing buildings given low exiting water temperatures. (Note, MA has been offering incentives for these equipment in 2022 and has rebated six through Q2. However, MA has done no market preparation for this technology that I'm aware of.)
   b. Does it make sense to rely on existing boiler back up or to simply boost water temperature?
      i. Is this feasible since presumably when boiler kicks in return water temperature would be too high and prevent HP function? – is there a configuration with parallel loops that is feasible?
      ii. Investigate costs/performance/feasibility of using HP only at lower outdoor temperatures and then simply do a complete switchover to the existing back up boiler at whatever temp the lower water temperature can't keep up (thus eliminating return water temperature issue).
   c. If air to water systems are used, can chilled water be distributed through existing radiation for cooling?
      i. Condensation issues?
      ii. Need for separate heat exchanger and air handlers?
   d. Costs/performance of simply adding some more radiation to make up for the lower water temp than to convert to ducts.
   e. Are CO2 (or other like R290) refrigerant (low GHG potential) units available? These supposedly can reach higher water temperatures than the current refrigerants. What is their cost/performance if so, or market status if still not commercially available?
   f. Investigate for commercial potential options through use of things like a separate or additional coils for air handling units so that the HP can put out whatever it can and then an existing boiler can separately distribute supplemental. Also, larger buildings with internal heat gains may be able to keep up with lower temperature water (I do know they make large "heat pump chillers" so presumably they have applications that work).
12. Investigate cost/performance/applicability of water to air systems for residential and commercial.
   a. Can an existing hydronic system support low temperature water distribution with dispersed ductless water to air heads?
13. For existing residential and small commercial buildings with hydronic systems, costs/performance/comfort trade offs of installing ductwork vs. DMSHP.
   a. For example, if a full basement and one story, might be very easy to put some ducts under floor. Similarly, attic space can offer opportunities for upstairs ducts.

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14. Some type of analysis tied to our metering study that considers trade-offs (break even?) between full HP displacement and the limited use of electric resistance heat tied to, say, 80% or 90% displacement.
    a. Should consider cost/performance implications for different fuel and system-type situations (e.g., gas vs. oil vs. propane, central vs. ductless, etc.)
15. Are homes/small businesses ducted for CAC good candidates for ASHP "drop-in" replacements.
    a. Issues of duct sizing, register locations, etc. that make this a more nuanced opportunity? (Note, the MA Companies initial Res. HP pilot was tied to going after hydronic homes with CAC. That didn't work out very well for them. We believe that MA has ceased offering Res. CAC incentives as a way to promote central HP installs, but I don't think they've looked at these issues either.)
    b. Capacity issues in meeting heating loads when replacing existing CACs with central heat pumps, including equipment sizing (e.g., heating loads are 3x cooling loads in CT), and ductwork design considerations and solutions.
    ~~a.~~
16. Costs/performance of large "HP Chillers" as replacements for large central chillers.
    a. These products are available and have been promoted as a simple conversion, but is the heating output sufficient?
    b. Does it require significant changes to radiation/distribution system to support heating with lower water temperatures?
    c. Are existing cooling towers able to support in heating mode?
        i. Issues of capacity, freezing, etc.?
    d. What hybrid options might exist for simple chiller to HP replacement plus supplemental HP heating through a VRF/AHUs or something else?
17. How will the IRA affect attribution? Income qualified customers are eligible for instant rebates up to $8K, and all other households are eligible for a $2K tax credit.
    a. This raises policy issues that need to be addressed, but perhaps EM&V can investigate attribution rates or other data that can support development of such policies. Also, estimation of likely future participation with IRA funding.
18. What programs are supporting hybrid dual fuel heat pumps? What products are available, and how does the cost compare to an all-electric heat pump plus backup fossil fuel? Can/should these be supported in CT? This last question may be a better suited for the PWG to answer, but the market research aspect would be very helpful to have first.
19. Alternative refrigerants and equipment that would allow "plug and play" solutions to existing hydronic distribution/boiler systems; what are they, how are they working (outside the US), what would it take to import them into CT, and how can we test them?
20. Heat pump options for water heating, especially in MF new construction.
    a. What is available, how have they performed, market gaps. Where are residential scale split systems and other apartment-sized options that allow for a small footprint?
    b. Central water heating systems with individual metering options to allow for tenant payment of electric bills.
21. Occupant behavior and heat pump performance; what guidance should we be providing customers after installing heat pumps? Is "set it and forget it" a more effective approach than integrated controls? Is the cost of controls worth the operating costs savings and potential market confusion between different fuels and systems? How do we best communicate with customers to ensure simple, clear messaging resulting in optimal performance?

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