

EER '23 IHP Workshop

10/16/2023

General notes:

- Important to note Clean Heat standards in CO and VT, and elsewhere. CO goal is 22% clean heat by 2030. Specifically, "in 2021, the [CO] General Assembly required gas distribution utilities—utilities that procure and distribute gas to retail customers such as residents and local businesses—to reduce greenhouse gas emissions by 4% by 2025 and by 22% by 2030, from a 2015 baseline." This will create opportunity for IHPs in those states.
- ACEEE should distribute case studies from the IEA HTHP annexes.
- Two challenges with IHP deployment:
 - Want to produce 250 F+ heat pumps (120 C) IHP but need to understand where the opportunities and applications are. What would be the source temperatures for the applications (waste heat or air source)? Will the source and sink be air to air, water to air, water to water, etc? Nyle needs demand info and data.
 - What is the sales channel? Will it be direct to the customer or through third parties (engineering design firms)
- Pilots are key and suppliers need to be engaged.
- Workforce development is critical.
- DOE focused FOA on IHPs is needed.
- Power grid build up to handle new industrial electric load is also critical.
- One sector that's particularly underexplored in terms of IHP potential is pharmaceuticals because of the need for simultaneous heating and cooling, as well as the fact that manufacturing is highly regulated and uninterruptible.
- IHPs are held accountable for their claimed COP in district heating applications.
- Case studies and pilots are needed, but who should run the program? Also, how do we ensure that adequate data is shared to serve the desired purpose to the market? Potential to tie amount of incentives to data made available.
- Selling heat as a business model needs additional evaluation.
- New domestic policies/environments that would help:
 - Domestic content pushed – Buy American act requirements (note only for Federal government procurement).
 - Bring US spark spread closer to EU spark spread.
 - District heating advancement.
 - Demand signals.
- Need to reduce upfront costs, even small amounts of support for design can help end-users get to the point of solicitation.

Steve Griffith - NEMA

- ~300 members, ANSII accredited, \$6 billion value.
- Refrigerant circuit
 - Exact type and amount used are designed.
 - Starts as a gas then enters compression valve that injects pressure and temp.
 - Afterwards they return to gas and go through the circuit again.
- How do you see a pilot be success?
 - Sponsor from the government
- NEMA working on the activities of distribution (transformers) and the grid; international transformers and switchgears delayed market, so need to stand up domestic.

- New DOE efficiency standard but too early if no supply
- Conversations with DOE and LPO
- Need to incentivize the supply of transformers.
- International vs domestic? Need to ramp up the manufacturing.
 - Different policies in agencies when it comes to build/buy America.
 - Energy cost in the U.S.
 - Europe concerned with their fuel/gas supply.
 - District heating and thermal networks
 - Sharing thermal loads with other people in the EU
- Scaling domestic production, what demand signal? Other than IRA tax credits, making sure the incentives don't go away, federal funding spurs the private sector.
- Consistent test methods
- Co-location of energy storage? Very congested on the grid so need other materials to alleviate the loads.
 - Issues with peaks
 - Load is negligible since it's pilot stage but might be a larger issue once they are highly implemented.
 - Comparison with EVs
 - Most attractive sometimes is a hybrid: electric with IHP.
 - 90 MW with one location
 - Customers can look at battery storage.
 - Combination of all the things to meet the need.
- Grid impacts of IHPs to be published soon for EU.
 - Datacenters are also a huge load.
- What does the load shape look like? Flatter because it's 24/7, DER isn't going to help as much.
 - Average project is ~0.5 MW in EU but moving to 5 MW on average.
 - Waste heat helps.
- GEA lead times 52 weeks: 1-3 MW not larger than X hp
 - CEOs wanting decarb driving the buying IHPs.
- Non energy benefits of IHPs: ESG goals will drive it.
 - Simultaneous heating and cooling load, energy cost levels out
 - Making IHPs competitive because of electricity prices
- Need demo projects in big applications! In North America!!!

IHP Panel (Ammi Amarnath - EPRI, Steve Koski - Cascade Energy, Ilia Krupenich – California Energy Commission, Chase Cortner – Southern Company):

- What is the current status of the domestic industrial heat pump market? Where do you see need for action to accelerate parts of the market?
 - Demonstrations needed but no one wants to be the first to install one, what's the impact on the facility, maintenance? Utility also trying to get data.
 - One of the customers (EU based) has a huge decarb goal upgrading from natural gas condensing boiler to IHP – year long process: willing to take the risk and absorb the upfront cost; had to educate the consulting engineer on how the IHP works instead of the boiler; working with local design firm.
 - The design firm would have the idea to propose these as an option.
 - Trust issues from the industry so need to build confidence.
 - Pinch technology, IHPs are so spread out so case studies are needed for all sorts of applications (MVRs, open cycle, semi-open); below 100°C, steam and HTHP.

- District heating uses low temp steam.
 - Putting together collaboratives and getting end-use customers to get excited.
 - No one wants to take the hit – financial, marketing, education, what’s the risk of not decarbonizing? Who’s taking the lead on pilot projects? Publicly available!!!
 - Potential need for a website where customers can submit what they need to gather their suppliers.
 - Technical ambassadors to create the opportunities.
- What would you add to the narrative theory of change?
 - Motivation. Strong market signals may push industry out of the state.
 - Workforce development – people in the industry to maintain particular equipment; headquarters wanted to decarbonize so had a plant manager who was hesitant to adopt IHP since they need to make quotas for their product, questions about servicing the equipment, downtimes, maintenance.
- Who should take responsibility for taking on the workforce?
 - DOE large effort on workforce development under the FOAs especially in DACs
 - Who will develop the materials? internal IHP slides developed by Chase in the R&D
 - Working with EPRI cut sheets, what applications, temp ranges, etc.?
 - Available to the public at no to low cost
 - Annex 58
- Importation issues: what do we see in terms of demand of IHP manufacturing?
 - GEA does not know how many to make each year? Sold 12 this year, NDAs; most are food and beverage, data centers, cement, plastics, where there is waste heat.
 - Big barrier of education: don’t know their heat units and what the sources and sinks are.
 - Heat pumps need continuous run, need high COPs but they rather save money for lower COPs.
 - Retrofits or new construction? Most are brownfields ~90%, the rest are greenfield.
 - Need a test lab to prove the COPs because it’s a big risk (\$million heat pumps)
- Custom design of systems are labor intensive – another potential place to offset cost upfront so that people can compare manufactures, take those that were not used as a learning experience rather than lost time and lost quote.
 - NEMA alliance to help (need scale though because thousands will not help much for millions)
- Boiler manufacturers are looking at expanding their product lines; partnerships with overseas companies by importing technology – incremental push from gas to electric to heat pumps.
 - Looking at combinations as well to push the market.
- Also help DOE to choose the right projects; keep reapplying.
- Utility funded assets pulled money from state, federal, utilities replicate the model from CHPs.
 - TVA based on 10c/kWh, but heat pumps save GWh; gives \$1 million.
 - 10-28c/kWh in MD
- Smaller steps can help for lower temperature applications which are still in the \$ thousands.
- Staged implementation process
- Low temperature steam market
 - 95° C MVRs GEA international pilots
 - 248° F water Armstrong Int’l
 - Not yet for steam application
 - Demo lab in Michigan for flashing of steam, compressing at higher pressure.
 - Education about waste heat in the industry! Heat recovery first

- Skyven: direct compression of steam thru MVR, upgrading waste heat, energy as a service model; leaving natural gas boilers in place for peak but IHPs for baseload.
- Everyone is thinking about how to make steam; what refrigerant to use for closed loop?
- In terms of IHP economics, do you see customers seeing IHPs as a way to avoid the cost of renewable natural gas as opposed to current natural gas market prices?
 - Go with supply contract that is all renewable natural gas but not accepting it as a total decarbonization.
 - What's cheaper? Demand reductions (EE/DR) should come first, focusing on renewables and paying the cost.

Breakout Session Discussion:

Group 1 (led by Paul Scheihing):

- Theory of change?
 - Workforce aspect should be incorporated, not just alluded to
 - Carbon pricing, other policy action that could magnify decarbonization impacts.
 - Thermal, energy storage and other decarbonization opportunities should be considered.
- Additional pilot opportunities?
 - What pilots are already in the U.S? Existing installations should be made as public as possible.
 - Need documented case studies.
 - Need to relieve customers' fear of sharing data, manage expectations by providing examples of what would and would not be shared.
- Supply chain uncertainty?
 - Suppliers say that service of IHPs is not an issue.
 - Facility managers see IHPs as a risk, they need help to re-balance plant heat load.
 - Need for education of engineering firms to design applications of IHPs.
 - Utilities can help reduce spark spread, use IHPs for load shaping.
- What can DOE do?
 - DOE could develop example small, medium and large heat pump package systems.
- Is there anything that you'd like to ask the group of IHP stakeholders while we're gathered? It can be specific or general. Are there any organizations, entities, or groups that you think will be critical to these market transformation efforts?
 - Accessing information and applying for grant funding is complicated.
 - Refrigerant uncertainty is significant barrier.
 - Definition of an industrial heat pump differs from EU (~ > 100 KW) to U.S (~ > 600 KW)
 - Need to design processes for lower temperatures first.
 - Carbon tax would solve IHP economics.
 - Rate structures of utilities is important, utilities could alter industrial rates. Some utilities will need to take a loss on IHP implementation. Will reduce rate with increasing electricity sales.

Group 2 (led by Neal Elliott):

- Theory of change?
 - How will AI and other technology developments affect the grid and IHPs?
 - Timeline is aspirational, not aware of any customers doing current customer segmentation analysis for IHP use.
 - Need to capture non-energy benefits, reducing insurance costs.
- Additional pilot opportunities?
 - Prefabrication of IHP components

- Supply chain uncertainty?
 - Essential to support training for IHPs.
 - Modeling decision tools are critical.
- What can DOE do?
 - Subsidizing, workforce development, training, government projects and facilities to host pilots.
 - Test center
- Is there anything that you'd like to ask the group of IHP stakeholders while we're gathered? It can be specific or general. Are there any organizations, entities, or groups that you think will be critical to these market transformation efforts?
 - Carbon tax, clean energy standards would make IHP economics much more favorable
 - Co-generation could be useful in terms of pushing IHPs to market

Group 3 (led by Andrew Hoffmeister):

- Theory of change?
 - Customer economics, hybrid potential, how to interact with gas utilities.
 - Energy storage, variable power
 - Role of energy audits and recommendations
- Additional pilot opportunities?
 - Tie incentives to data availability
 - List opportunities, base list of technologies. Market studies. Additional pilot opportunities. Clearinghouse
- Supply chain uncertainty?
 - Need source temperatures of waste heat.
 - How do we best partner with utilities to highlight certain subsectors?
- What can DOE do?
 - Reliability, size that customers want, what temps they need, to help with utility programming.
 - What's doable with demonstrations? What's useful? What's being done now?
- Is there anything that you'd like to ask the group of IHP stakeholders while we're gathered? It can be specific or general. Are there any organizations, entities, or groups that you think will be critical to these market transformation efforts?
 - ESG requirements, current lack of partnerships with that structure

Group 4 (led by Hellen Chen):

- Theory of change?
 - Integration
 - Look at from process side instead of through boilers focus.
 - Some people think they need high pressure steam, but they don't need that sometimes. De-steaming opportunity.
- Additional pilot opportunities?
 - Lighting push, VFDs
 - Incentivize like residential.
 - Ideal customer profile, where to apply today? Business type, customer type,
 - Food and beverage because of contacts in the industry, multi-national goals from European influence
- Supply chain uncertainty?
 - Helping first cost from utility
 - Financing utility bills

- But these are back end so need upfront cost.
 - Green bank role potentially
- State or government loans to utility but newer to utilities who don't know about these processes.
- Discount on electric rates.
- Total value over time
- CA energy efficiency total system benefits TSB CPUC mandate
 - But need to educate, break it down for people.
 - Can the utility provide this info?
- Income graduated fixed charges – more controversial, on demand side to bring down cost of electrification.
- Heat pump in building heating and cooling for utilities themselves? Or in the manufacturing supplying
- Utility takes on the risk? Contract is with the client, performance energy savings guarantee; client didn't need any money PSE&G vs monthly project payments; utility pays the client since they don't have the relationship with the utility
- What can DOE do?
 - Help transformers be made faster.
 - Matchmaker website
 - HRI ratings for industrial HP? Need customized heat pump because capex is lower to meet the same capacity.
 - European companies are moving to packaged IHPs, manufacturing line.
 - Replacement for boilers, waste heat recovery 50-60° C.
 - But for a process plant, need a whole pinch analysis for these.
 - Standardized for district heating/cooling 190° F.
 - Standards protect the customers, performance guarantee is more valuable to the customers.
 - So many startups, how are they doing that?? Need to make sure it's successful to get the market favorable.
 - Steam heating coils are always designed to its temps as are fans.
- Is there anything that you'd like to ask the group of IHP stakeholders while we're gathered? It can be specific or general. Are there any organizations, entities, or groups that you think will be critical to these market transformation efforts?
 - Refrigerants: end of the year R450?
 - 433z and e HFO but has ODP in closed cycle.
 - 1336 but has PFAs?
 - Natural high pressure above 50 bar but leaks are bad.
 - Synthetic first then let them get familiar with IHPs.
 - Need less volatile refrigerant policy.
 - Some people want to wait for a new refrigerant.

Ruth Checknoff & Cihang Yuan - RTC

- RTC and electrification not limited to just IHPs
- Thermal storage, renewables,
- Case studies: food and beverage, commercial products, none on IHPs yet
 - Solutions providers submitted the case studies for the IHPs.
 - P&G and a few other partners helped.
- Volatility is more about how the heat pumps will actually operate.

- Offer guarantees, absorbing the cost per unit or something similar.
- How to encourage info sharing? Cost saving and energy price not usually shared but willing to share lessons learned, best practices, etc.
 - Consumer facing brands which have climate goals.
 - Clean energy buyers alliance: renewable electricity deal tracker so a similar progress success sharing would be useful.
 - Encourage the competition in adopting IHPs.

Lowell Ungar - ACEEE

- FARM bill currently being considered by Congress.
 - Heat act proposed by Senator Welch (D, VT) and Senator Marshall (R, KS)
 - Need to develop the coalition behind it – industry endorsement to support the heat act.
- For multiple agricultural programs and REAP, rural businesses, rural utility services like co-ops.
 - Incentives for IHPs, technical assistance programs
- 40% of U.S. manufacturing are sited in USDA rural counties.

Ammi Amarnath - EPRI

- EPRI case studies but not all of them are available on the website.
- Over 30 pinch studies, optimize to do process to process heating.
 - Taking below the pinch and taking it above the pinch CU-6775 pinch tech primer
- Utility rate reform: clean, safe, reliable, affordable
 - Dynamic pricing – GHG emission cost since it will use the time and location of utility.
 - Electrification 2024 March 12 Savannah, GA: half day of IHPs, some time on high lift heat pumps and district energy