Black text: facilitator notes
Green: comments submitted on GoToWebinar during discussion

Workshop: Playing in the Sandbox: Pilot-Testing ET in California
Breakout Session: Commercial Secondary Windows
– On-Tap Experts: Natalie Hatheway and John Jennings, NEEA

Objective: Get first draft pilot testing plan for commercial secondary windows.
Outcome: Plan for a pilot test(s) to be implemented over the next year; report out at ET Summit 2021.

Discussion Points

- Identify market barriers unique to the emerging technology to be pilot tested
- Identify possible interventions against those market barriers
- Identify actors and venues (specific IOU programs, customer sites, sector, etc.)

Facilitator Summary

Most of the discussion centered on despite these secondary windows being great performers and relatively easy and fast to install, they are still not cost-effective in most jurisdictions if you only look at their energy savings. If you also look at their potential to reduce the size and O&M costs of HVAC, and the ensuing increase in worker productivity, they may be a more attractive investment. Some work needed to confirm performance and ease of installation in CA.

Discussion Notes and Comments Submitted – These are unedited draft notes.

Are these suitable for current EE programs or still pilots and then move to MT framework? Upfront costs are a critical barrier. Can this become cost effective to enter incentive portfolio now or in future? Is awareness only other barrier? Does this require a pilot?

Typical payback you're seeing?

- At NEEA we're just starting to see whether it is cost-effective in milder climates--and which bldg types and HVAC systems. Other barriers than cost and awareness: looking whether there's a need to also do installation training. Manufacturers say 20-60 mins/window and can train over the phone--but some manufacturers use their own install teams. Will see via market research team that will check installation to confirm that it is simple to do or whether more training needed.

Center for Emerging Bldg Techs examined it for 6 yrs--did a study then--was positive. Some commercial deployments-mostly in NYC--hi-cost area. Used 3P financing. Currently looking at light-weight double pane from Alcon windows-thin glass. Performance remarkable-outperforms all other 2nd windows seen-with super fast install. Snap-in in 3-10 mins. Challenge to examine--E savings remarkable, payback long with low utility rates. NREL has modelled small/medium/large building in climate zones with low/med/hi utility costs. Even at same price, quick install and great performance--few climate zones w/payback under 10 yrs. Hard for even GSA to pursue. Incentive would change that. Key for improving building shell performance.

3/30/300 $3/ft2 is cost of E related to bldg, 30$/ft2 is equipment and operations, and $300 is cost of people working there. For secondary interior windows benefiting all 3--reducing E, improving size of equipment for hvac and O&M, and improve comfort of employee--increasing productivity. Great integrated DSM solution.

What building façades can not use it? Why is it limited--and not used in residential?

- Great for residential--low E storm windows--rated by E Star now and certified AERC - listed on E Star from 3 manufacturers so far. Great performance. In NW 13% of SF homes still have single pane aluminum frame-and would be best market for these--helped support AERC develop certification and E Star but still not in NEEA programs. Good for weatherization programs by utilities.
- Few situations where it wouldn't work-most common very large curtain wall/picture window--where designers don't want interstitial mullions--largest is 8x10ft; most much smaller. Curtain wall would need thermally insulated frames. GSA NREL study: many manufacturers don't use insulated frames and are cheaper but perform worse. Ways to reduce costs--eg non-glass panes, suspended film, or combo-especially if have double gazed secondary window. But plastic is difficult to get low e to work with-other than polycarbonate. Also manufacturing improvements--w/LBNL--how help them improve manufacturing process. Cost is labor intensive. Install - skilled labor - do faster. Prep time to clean windows, or if dirty during shipping, or remove existing shading devices. Best to have a prep group go in first and then installers. Also key to do the measurements correctly. Most commercial bldgs have standardized aluminum frames-whereas in residential it changes a lot.

What are the seismic issues? Will the glazing pop out in an earthquake?

- They're fixed--either magnets (very strong) or screwed in. not a problem.

How do they compare with low E windows and thin triple windows?

- Not direct comparisons--started w/2ary instead of applied film--b/c also address frame infiltration that film wouldn't deal with. Triples-also interested-and looking at cost--but if doing a replacement--more expensive than 2ary.
- Regular triples are challenging due to size; thin triples--maybe can fit--not a lot of it-and c/e still a challenge--only used where c/e not an issue.

How much disruption is caused to occupants and time taken for installation? Why are residential folks doing it - safety or energy? Do window treatments like blinds have to be removed?

I can't seem to find Alcon Windows website? (It's here) Can you share who are the common suppliers for Commercial hospitals and hotels?

Silica aerogel is a great material to consider for glazing but it may be way too expensive. It is made by Aspen Aerogels.

Workshop: Playing in the Sandbox: Pilot-Testing ET in California
Breakout Session: Residential Ducted Variable Capacity Heat Pumps
– On-Tap Expert: Martin Vu, RMS Energy Consulting

Objective: Get a first draft pilot testing plan for residential ducted variable capacity heat pumps.
Outcome: Plan for a pilot test(s) to be implemented over the next year; report out at ET Summit 2021.

Discussion Points:
- Identify market barriers unique to the emerging technology to be pilot tested
- Identify possible interventions against those market barriers
- Identify actors and venues (specific IOU programs, customer sites, sector, etc.)

Facilitator Summary

Identify market barriers unique to the emerging technology to be pilot tested

The unique market barriers to the residential ducted variable capacity heat pump (VCHP) technology discussed during the 2020 ET Summit center on the following challenges:

1. **Misalignment Between AHRI Test Method Efficiency Ratings versus Field Performance Predictions (Proprietary Algorithms)**

   Background: The Air Conditioning, Heating, and Refrigeration Institute (AHRI) Test Methods (AHRI 210/240) establish Seasonal Energy Efficiency Ratio (SEER) and Heating Seasonal Performance Factor (HSPF) efficiency ratings for VCHPs. However, the CEC's Central Valley Research Home (CVRH) field assessment indicated that the AHRI Test Method may not be a reliable method to predict efficiency ratings because the test method does not use onboard controls during the test. Rather, the test method allows disconnecting the onboard controls where manufacturers may adjust VCHPs to operate VCHPs at an optimal fixed speed to maximum efficiency. Subsequently, VCHP efficiencies are recorded, labeled, and rated. This test method and efficiency rating approach are misaligned with real-world performance because home installations do not have the option to disable onboard controls to optimize VCHP efficiency

performance. The issue is further compounded as VCHP manufacturers design its systems with proprietary algorithms that are not well publicized. This creates uncertainty in predicting energy savings because fan and compressor control settings vary across VCHP manufacturers. Without visibility to the proprietary algorithms, incentives and compliance credits will be limited because VCHP manufactures have the ability to change the control schemes, which impact savings predictability.

Participant Feedback: A question came up by a participant asking the reasoning why annual energy savings for a SEER 19 VCHP unit was lower than a 14 SEER minimum code compliant split system ducted unit. As described in the background section, the moderator indicated that the problem was twofold: 1) the AHRI 210/240 test method, establishing efficiency ratings, was not a good predictor of energy savings and 2) VCHP proprietary algorithms vary across manufacturers and control schemes are not well publicized. Additional participants feedback stated:

- **Participant Feedback:** SEER efficiency ratings are focused on outside temperatures, which is why lower savings may be experienced for higher SEER products. There have been issues with developing performance curves with heat pumps and there is a need to work with manufacturers to provide performance curves. Heat pumps also saw barriers on sizing and electrical panel upgrades which are needed when moving from a gas furnace to a heat pump. Participant also indicated that when converting from a gas furnace system to a heat pump system, an electrical panel upgrade was typically included. However, the bigger issue concerned duct sizing and the capacity of fan. Therefore, if utilities fund a future pilot barriers of sizing ducts and electrical panel upgrades needs to be included in scoping of research.

2. Canadian Standards Association (CSE EXP07:19) Standardized Test Methods Not Yet Available

Background: Unlike AHRI 210/240 Test Method, the Canadian Standard Association Test Method (CSE EXP07:19) describes and enumerates load-based and climate-specific testing and rating procedures for heat pumps and air conditioners. However, the Canadian test method is either not yet in place or has not supplanted the AHRI Test Method to establish efficiency ratings based on load-based testing procedures. The new Canadian Test Method would impose a load on the VCHPs where the onboard controls are enabled to meet desired temperature thermostat set

points. Using the Canadian load-based test method would be more reflective of actual efficiency performance in the field because the test method enables onboard control features that are used in home installations.

3. Incentive programs constrained by regulatory framework

Background: California's utility rebates and incentives are based on full-load SEER/EER ratings. However, VCHP manufacturers indicate that benefits are seen and experienced when the system is operating at part load conditions. Furthermore, manufacturers indicate that testing VCHPs with inverter technology at full-load SEER/EER are not optimal because it requires additional equipment cost to satisfy those testing requirements. The problem is further complicated because incentivizing based on part load conditions and efficiencies are difficult because the variance in efficiency performances create a challenge in determining a fixed rebate amount. This has a compound effect because, absent utility rebates and the premium cost of VCHPs are passed down to the customer, which results in low market adoption. Additionally, CPUC dispositions do not allow for projects to calculate incentives based on code minimum efficiency baselines. Rather, custom incentive programs calculate based on industry standard practice (ISP) baselines, which are typically higher than minimum code efficiency baselines.

Participant Feedback: One participant indicated interest in purchasing and installing a mini split system himself for heating and cooling to avoid contractor costs and indicated that the estimated cost to install 2-zone split system was $2,500. He wanted any guidance on getting involved in future research.

Response to Participant Feedback: One response to this feedback indicated that a reason for the higher installation cost was attributed to the engineering design for correct sizing to do air side properly. As such, a barrier to this technology is that it may require more sophistication during the installation, which results in cost markups due to uncertainties. Therefore, one way to minimize these markup costs is to get installers familiar with the technology and insulate consumers from these added costs.

Identify possible interventions against those market barriers

Participant Feedback: One participant recommended that future research could entail a holistic total energy research approach rather than a single technology assessment approach where a combination of technologies could achieve higher energy savings to help increase market adoption and lower costs for consumers. The participant suggested that heat recovery strategies could be used to heat swimming pools or conditioned spaces from fridges and freezers

Response to Participant Feedback: Another participant indicated that he was aware of 7-11 convenient stores in Japan saw completely integrated HVAC and refrigerated systems where the heat dissipated from refrigerated display cases was recovered and used to heat the building. Participant indicated that these solutions are commercially available from different manufacturers including Sanden and Daiken. However, the challenge in bringing this solution into the U.S. market is gaining enough utility incentive support to help bring the cost down enough for market adoption. AHD recently acquired by Daiken and might be pushing those solutions into grocery stores.

Response to Participant Feedback: California's cost-effective regulatory framework make it difficult to achieve optimal energy savings claims, which impact utility rebates and incentives. More pilot studies could clarify what test method to use and work w/manufacturers to get quicker adoption. Feedback from manufacturers was that incentives dropped as a result of California's regulatory policies and it is much harder to market VCHPs now. Further field pilot studies are needed to support higher savings and possibly support higher rebates and incentives.

Identify actors and venues (specific IOU programs, customer sites, sector, etc.)

Participant Feedback: One participant inquired if there were any U.S. manufacturers of the VCHP technology as most of them appeared to be Japanese manufacturers.

Response to Participant Feedback: One participant indicated that VCHP manufacturers have huge factories throughout the United States including in Houston (Daikin), Indianapolis (Carrier), other parts of Texas (Trane), and Iowa (Lennox). Working with VCHP manufacturers to identify ways to minimize costs could help increase pilot efforts.

Additionally, the participant indicated that there are a couple dozen VCHP lab and field assessments already performed of these VCHPs that had some key findings including

1. **Electric and Gas Heating Situations**: Heat pumps can handle approximately 90% of California weather conditions.

2. **For Partial Load Efficiencies are High:** The main benefit of the VCHP technology center on part load efficiency where compressor and fan power can meet thermostatic setpoint conditions at lower power and energy.

3. **Research Indicates that Ducting is Important:** The research that the Western Cooling Efficiency Center (WCEC) conducted observed that ducting is super important for VCHP and improper ducting design and installation could negate any improved efficiency gains offered from VCHP part load conditions.

Discussion Notes and Comments Submitted – These are unedited draft notes.

Savings based on Fresno area single digit # of homes test. Why see lower savings for high SEER19 than SEER 16? Test method for rating units is not a good indicator of performance in the field. Need other ways to understand the performance-given proprietary algorithms that control the HVAC.

Any reason % annual energy savings of SEER VSHP was shown to be lower than lower SEER units?

SEER focused on outside temps--could see lower savings for higher SEER product. Have had the issue with hp as develop performance curves. Need manufacturers to provide performance curves. As a hp--saw barriers on sizing, electrical panel upgrades needed if moving from a gas furnace.

- If utils fund a pilot--don't recall base case situation they used in the report. For future pilots, barriers of sizing ducts and electrical panel upgrades needs to be included in scoping of research.

Why need to upgrade panel given that already have power provided to a condensing unit that is properly sized? Suspect that if swapping A/C w/indoor hp that no issue with panel--as would also get rid of resistance heating. Is it really an issue?

- Requested quote from contractors--when converting saw they included a panel upgrade--but bigger issue was duct sizing and capacity of fan.

Wanted to buy mini split system for heating/cooling -- any guidance on getting involved in the research? 2500$ for a 2-zone split system.

- Equipment costs Is part; engineering design for correct sizing to do air side properly.
- Couple of rooms that want to do It--can do himself--wants to avoid A/C contractor cost.

A barrier to this tech is that can have Installer drop and replace existing like-for-like. For new tech may need more Install sophistication will result In mark-up due to uncertainties. One of the barrier concerns--want to get Installers to become familiar and Insulate consumers from these added costs.

Any US manufacturers? seem most are Japanese.

- Martin: Mitsubishi, Daiken, … can offer longer list afterwards.
- Research/field testing of these VCHPs - couple dozen In field and report for CEC--detailed lab/field test for 3 VCHPs. 3 pts: 1) electric and gas heating situations; given 90% CA weather conditions can be handled by HP; 2) for partial load efficiencies are high--as running partially; 3) Mark Modera's WECC's group--saw ducting Is super Important for VCHP--as otherwise could negate the Improved efficiency otherwise. VCHP manufacturers--Daiken has huge factory In Houston. Lenox great facility. Carrier In Indianapolis. Trane In TX. All made here.

Regulatory C/E calc methods made It hard to make savings optimal. More pilot studies could clarify what test method to use and work w/manufacturers to get quicker adoption. Feedback from manufacturers was that Incentives went down and much harder to market them now. Believes this Is next challenge to look at.

Split techs that could be used for heating swimming pools, fridges/freezers to transfer that heat elsewhere via total energy approach? Use holistic view.

- Use heat recovery from freezer to heat a pool--don't know where looked at? Any others know of these holistic approaches?

- Add in DHW. I think there are some European MFRs doing this.

- Tesla has also mentioned using the Octovalve to do this for residential in the future.

7-11 stores In Japan--saw completely Integrated HVAC/ref systems - cooling for refrigerated cases can use that heat to heat building. Commercially available--Sandun, Daiken make these--trying to bring to the US and looking for utility support to bring them here. There might be a few doing these. AHD recently acquired by Daiken--and might be pushing those for grocery stores.

storage/solar--w/hp

Regarding VCHP, why are we focused on an air source equipment When we have Ground Source Heat pump technology available to us? This technology is a stable operation predictable and decreases the amount of Refrigerant required in the system and building both.

Workshop: Playing in the Sandbox: Pilot-Testing ET in California
Breakout Session: Central Multi-Family Heat Pump Water Heaters
– On-Tap Expert: Keshmira McVey, BPA

Objective: Get a first draft pilot testing plan for central multi-family heat pump water heaters.
Outcome: Plan for a pilot test(s) to be implemented over the next year; report out at ET Summit 2021.

Discussion Topics:

- Identify market barriers unique to the emerging technology to be pilot tested
- Identify possible interventions against those market barriers
- Identify actors and venues (specific IOU programs, customer sites, sector, etc.)

Facilitator Summary

The major market barriers for this ET would be locational constraints, jurisdiction requirements, and limited remote-control options.

Regarding locational constraints, some possible intervention strategies that could be piloted include: 1) plug-in-play models that allow for mixed equipment locations at facilities; 2) electrical panel capacity solutions; 3) solutions for ducting or volume space.

Regarding jurisdictional requirements, some possible intervention strategies that could be piloted include: 1) developing a statewide set of proposed standards to reduce installation ambiguity. Actors to support these efforts include installers, IOUs, CEC, and CPUC.

Regarding limited remote-control options, some possible intervention strategies that could be piloted include: 1) develop a retrofit solution to enable existing systems to be control-compatible; 2) support developers to create open-source control hardware and software; 3) test the potential for both standalone and aggregated potential for meaningful load shift. Actors to support this effort include IOUs (DRET program), CEC (party involved with JA13 requirements), equipment manufacturers.

Discussion Notes and Comments Submitted – These are unedited draft notes.

Mitsubishi unit is noteworthy – most MF "water plant" is a high likely to be a boiler system and have high energy intensity – working with SCE on a roadmap.

Some central water HP - some controls - can you retrofit them?

- Sanco2 gen3--has a thermistor for each unit--but had constrain--Gen4 has more control capability to control on/off and and output alarms.
- CTA2045 etc—yes—that's the goal.

Are there any noise (high decibels) issues with this technology that may be disrupting to occupants?

- One of the quiet products available around 40 dBa--some are more--and may need to address. The Sanco sound is less than environment.

Can this technology/design be applied for pool heating?

- Pool systems are multiphase systems so they are not geared toward pool heating. However, there are other techs that operate better as a hp heater for pools.

Load shifting capabilities--as larger than Individual units--would have more promise than single or aggregated single as a DR option?

- Yes--have more capabilities--looking at demo a Mitsubishi product Seattle 3/2021 and a few In CA In 2020-1 EPIC - to highlight load shifting In a few. Big DOE $ for that available.

Does the tool look at hourly data?

- The second revision of the tool will come with this simulation

What are the "structural" challenges with this plug and play design – especially when installing on roof?
Can Keshmira discuss any structural and seismic analysis, and how does that work with the plug and play, skid approach?

- Project dependent – jurisdictional based. Seismic provisions fix storage tanks to skid Itself. Some can be set on the roof If structure adequate to support It; In some has to be fixed to roof.

Where can Ecosizer tool be accessed? Is it open-source?

- Ecosizer.ecotope.com/sizer
- Calculation methodology mimics the ASHRAE methodology – opensource

What are the validation procedures/methods on the tool? how has it been validated?

- Multiple sessions by tech advisory committee. SCE/CEC and other engineers have looked at It; as well as manufacturers of heat pump water heaters. Calcs mimic ASHRAE Fundamentals

Any concerns about aesthetics if the rooftop is the install location?

- There are a good number of rooftops installs in CA – you could install condensers inside and tanks outside

It appears there are two skids, can the heat pump section be placed on the roof and storage tanks placed inside the building?

- Many are in mechanical spaces or garages. Doesn't need to be put on roof--2 skids--one for condensers and one for storage tanks. has that flexibility.

Has BPA also looked at hooking the products in parallel too? Are there any financial benefits in series vs parallel setup?

- SANCO2 are installed in parallel – tanks are connected in series

Can heat pump go on roof and storage tank Inside?

- Yes--great approach

Is there analysis done on first cost and operating cost compared to gas water heaters?

- Will look at different technologies, and energy usage of the systems – will allow for individuals to understand the savings between the types of HPWHs
- Ecosizer2.0 will help do these calcs for various CZs and annual E uses--will help designers, plumbers, utility folks to understand energy savings from a water heating tech to another.

Any types of storage mediums such as wax?

- Thermal storage is great – HP systems for heat and space.

Thermal storage has options--here b/c domestic hot water use that. Are looking also to heating spaces--w/o pressurized storage and other techs for thermal storage.

Ecosizer tool do hourly simulations? Bldg simulations also?

- Yes--will become simulation engine. Current shows 2-day simulation--will expand further

MF water plants typically a boiler high C Intensity. Working w/ SCE, SMUD, and PGE--better electrification roadmap--when put a central HP and electrify space heating and laundry--get 80% redux In C. Have techs ready today. Some In Europe. Encourage folks to get active in this sector.

Can anyone speak to reliability of these units?