2023 Q1 Emerging Technology Quarterly Newsletter

WHAT'S NEW:

NEEA's Emerging Technology and Product Management team had a strong start to 2023 with its exploration of efficient products. Q1 2023 highlights include the following:

- Published a supply side assessment study in January 2023, on central heat pump water heaters (HPWHs) for multifamily buildings to recognize the most effective mechanisms to transform the central HPWH market for multifamily applications.
- Also in January 2023, published a study of high-performance windows to understand the incremental cost of manufacturing them and what market interventions can help increase the availability and adoption of them.
- Concluded Phase 1 of the micro variable speed heat pump field study.
- Concluded the paired washer-dryer testing and published Version 2.0 of the NEEA Dryer Test Procedure.
- The U.S. Department of Energy (U.S. DOE) published a pre-publication final rule to adopt the ANSI/CTA-2037D test procedure, which NEEA played a critical role in developing.

Please reach out to anyone on the team with any questions or suggestions on NEEA's emerging technology work. We'd love to hear from you.

~ **Eric Olson**, Manager, Emerging Technology & Product Management ~

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Product Summary & Readiness Levels

	PRODUCT	PROGRAM*	FUEL TYPE	SECTOR	ELECTRIC SAVINGS POTENTIAL**	PRODUCT PERFORMANCE*	MARKET/ COMMERCIAL*	PROGRAM READINESS*
Products	Paired Washer-Dryer	RPP	Electric, Gas	Residential	TBD	5	5	5
	Ultra-High Definition TVs	RPP	Electric	Residential	57	4	5	5
	Residential Laundry Field Study	RPP	Electric, Gas	Residential	N/A	5	5	5
HVAC	Very High Efficiency Dedicated Outside Air Systems	VHE DOAS	Electric, Gas	Commercial	85	4	4	3
	Variable Refrigerant Flow (VRF) System	N/A	Electric, Gas	Commercial	TBD	4	4	2
	Efficient Rooftop Units	N/A	Gas	Commercial	30	4	3	4
	Heat Pump Rating Representativeness	VSHP	Electric, Gas	Residential	TBD	4	5	4
	Heat Pump Advanced Features and Capabilities	VSHP	Electric	Residential	TBD	3	5	4
	Micro VSHP Field Study	VSHP	Electric	Residential	TBD	1	3	1
	Heat Pump Ready ENERGY STAR Manufactured Homes	VSHP	Electric	Residential	TBD	4	5	3
	Hybrid Gas-Electric Heat Pump	N/A	Electric, Gas	Residential	TBD	1	2	1
Building	High-Performance Windows	HPW	Electric, Gas	Commercial	60	4	3	4
	Secondary Windows	Window Attachments	Electric, Gas	Residential	35	4	5	4
Lighting	Luminaire Level Lighting Controls	LLLC	Electric	Commercial	75	4	4	3
	LLLC with HVAC Control	LLLC	Electric, Gas	Commercial	358	3	2	3
Water Heating	Combination Hot Water and Space Heat	N/A	Electric, Gas	Residential, Commercial	130	1-4	1-3	2
	Heat Pump Water Heaters in Confined Spaces	HPWH	Electric	Residential, Commercial	TBD	2-5	3-4	2-5
	Integrated Residential GHPWH	N/A	Gas	Residential	TBD	3	1	2
	Split System Heat Pump Water Heater	HPWH	Electric	Commercial	50	3	3	3
	Integrated Commercial Heat Pump Water Heater	HPWH	Electric	Commercial	50	3	3	4
	Central Commercial Heat Pump Water Heater	HPWH	Electric	Commercial	50	3	3	3
Motors	Commercial & Industrial Fans	N/A	Electric, Gas	Commercial, Industrial	176	5	4	2
	Power Drive Systems	XMP	Electric	Commercial, Industrial	TBD	4	3	4
Other	Machine Learning (ML) Building Controls	N/A	Electric, Gas	Commercial	TBD	1	2	2

* **Program Acronyms Defined:** Retail Product Portfolio (RPP); Ductless Heat Pumps (DHP); Variable Speed Heat Pumps (VSHP); Very High Efficiency Dedicated Outdoor Air Systems (VHE DOAS); Residential New Construction (RNC); Luminaire Level Lighting Controls (LLLC); Heat Pump Water Heater (HPWH); Efficient Gas Water Heaters (EGWH); Extended Motor Products (XMP); High-Performance Windows (HPW)

** Technical **electric savings potential** for the region in aMW

* **Readiness Level Definitions** provided on page 29; **Rating Scale** 1=low 5=high

Fuel Type Symbols: Electric Gas

Sector Symbols: Residential Commercial Industrial

Paired Washer-Dryer Testing

Product Description: Residential appliances for washing and drying clothes.

Project Objectives: Measure the total energy required to wash and dry the same "real-world" load of laundry in matched washers and dryers, including compact washers with heat pump dryers, and front- and top-load washers with electric and natural gas heated dryers. This testing is leveraging previous NEEA work on both clothes washers and dryers. The testing also seeks to inform NEEA staff whether the previously established "real-world" load should be revised with an industry standard ANSI/AHAM HLD-1-2010 textile load, with 100% cotton textiles, to increase industry acceptance and to better ensure reproducibility.

Project Status: The final Version 2.0 NEEA Dryer Test Procedure and Summary of Changes and Rationale Analysis are available on https://neea.org/our-work/high-efficiency-clothes-dryers.

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Product	5	Comm/Market	5	Program	5

Ultra-High Definition (UHD) TVs

Product Description: 4K UHD TVs with various forms of advanced display technologies.

Project Objectives:

- Update United States Department of Energy (U.S. DOE) TV test procedure and International Electrotechnical Commission (IEC) test clip to
  1) adequately address existing features such as Automatic Brightness Control (ABC) and Motion Detection Dimming (MDD) to prevent gaming of test results by manufacturers; and
  2) incorporate emerging technologies such as UHD, true and upscaled high dynamic range (HDR), increasing panel brightness and stand-by power.
- Update ENERGY STAR® specification to address issues with ABC/MDD, address new energy-consuming features such as UHD, and to account for the U.S. DOE test procedure and IEC test clip updates.
- Conduct retail testing of up to 150 TVs using updated draft test clips and draft test procedure. Use data analysis results to inform final test clip, final test procedure and future ENERGY STAR specification.

Project Status: ENERGY STAR v9 went into effect in October 2022 and currently has over 30 TVs on the list including TVs from at least one major manufacturer. At the Consumer Electronics Show 2023 in early January, industry stakeholders announced continued work toward a voluntary agreement to report TV energy usage per the test procedure. Lastly, in February 2023, the U.S. DOE issued a pre-publication final rule to adopt ANSI/CTA-2037D as the required test procedure for TVs.

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Product	4	Comm/Market	5	Program	5

Residential Laundry Field Study

Product Description: Residential appliances for washing and drying clothes.

Project Objectives: Conduct research to leverage NEEA's Residential Building Stock Assessment households by selecting a statistically representative sample of households and studying their laundry use patterns and equipment energy use. This study collects data on water usage, load sizes, textile mix, washer and dryer cycles selected, how efficiently washers remove water from the load, and how efficiently dryers dry clothes. These insights will allow updates to energy savings opportunities, inform future U.S. DOE rulemakings, and facilitate collaboration with other partners to replicate the study in their territories.

Project Status: Training of technicians and participant recruiting are still underway with monitoring of the first group of sites scheduled in Q2 2023.

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Product	5	Comm/Market	5	Program	5

Very High Efficiency Dedicated Outside Air Systems (DOAS) Optimization

Product Description: A system-based approach for commercial HVAC systems that uses high efficiency heat recovery ventilation (HRV) or energy recovery ventilation (ERV) that features 82% or greater sensible effectiveness; a high-performance heating and cooling system that meets ENERGY STAR performance standards; ventilation fully separated from heating and cooling; and right-sized heating and cooling equipment.

Project Objectives: Test and validate HVAC systems utilizing the very high efficiency DOAS design principles with multiple HVAC designs, including forced air and chilled beam designs, against conventional equipment. Results will inform improved modeling of very high efficiencyDOAS design principles in various building types and equipment selection.

Project Status: Three sites are currently being monitored: Harder Mechanical Contractors, Inc. in Portland, OR with ERV and VRF heating/cooling system, will be monitored through Q2 2023; Sartori Elementary School in Renton, WA, with multiple ERVs, active chilled beam system for heating and cooling with an air-cooled chiller and condensing gas boilers, will be monitored through Q1 2023; SERA Architects in Portland, OR with ERVs and variable refrigerant volume heat pumps, will be monitored through Q4 2023.

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Product	4	Comm/Market	4	Program	3

Very High Efficiency Dedicated Outside Air Systems (DOAS) in Multifamily Applications

Product Description: A system-based approach for commercial HVAC systems that uses high efficiency heat recovery ventilation (HRV) or energy recovery ventilation (ERV) that features 82% or greater sensible effectiveness; a high-performance heating and cooling system that meets ENERGY STAR performance standards; ventilation fully separated from heating and cooling; and right-sized heating and cooling equipment.

Project Objectives: Test very high efficiency DOAS design principles in a multifamily application with highly efficient DOAS and HRV equipment in an application with electric resistance in the dwelling units. The research seeks to understand the potential energy savings opportunity when usage of in-unit electric resistant heaters is reduced. Monitoring data will also support very high efficiency DOAS modeling improvements.

Project Status: Two Downtown Emergency Service Center buildings in Seattle, WA are currently being monitored, with results expected in mid-2023.

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Product	4	Comm/Market	4	Program	3

Field Validation of Variable Refrigerant Flow (VRF) System Performance in Cold Climates

Product Description: NEEA staff are partnering with the Northeast Energy Efficiency Partnerships (NEEP) to integrate NEEA's VHE DOAS specification into a U.S. DOE-funded project that aims to validate VRF performance in cold climates.

Project Objectives: Measure in situ cold climate performance of rated VRFs. The study will include the measurement of energy use and refrigerant leakage.

Project Status: NEEP continues its work with manufacturers of the VRF equipment to determine whether it is possible to calculate the real-time coefficients of performance (COPs) of these systems. In addition, NEEP is working to determine the best times of the heating and cooling seasons to measure refrigerant leakage. Data collection is now complete with analysis underway.

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Product	4	Comm/Market	4	Program	2

Efficient Rooftop Units (ERTUs)

Product Description: Packaged, weatherized, commercial natural gas indirect air heating systems that may or may not include ventilation, air conditioning or both. ERTUs are mounted externally to a building and capture heat from the products of combustion (flue gases) to achieve a minimum thermal efficiency (TE) or annual fuel utilization efficiency (AFUE) of 90%. Also includes non-condensing products that use modulating gas valves.

Project Objective: Evaluate the performance of ERTU products through field trials in multiple climates. The first test site is located in Winifred, MT, and evaluated an AAON unit over a nine-month period that concluded in June 2022. The Montana State University (MSU) Integrated Design Lab is managing this project.

The second site, in Portland, OR, is testing units from two manufacturers—a high-efficiency Daikin unit and a standard-efficiency Trane model. The units will be tested over nine months. Results will inform plans to promote and accelerate the adoption of ERTU products.

Project Status: The installation of the units in Portland will be complete in late Q1 2023 after which monitoring will commence. For information on the Montana test site results, please contact Jeff Rigotti.

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Product	4	Comm/Market	3	Program	4

Heat Pump Rating Representativeness

Product Description: Heat pumps that can vary their speed to meet heating and cooling demands, enabling the heat pump to operate across a wider ambient temperature range and to have superior performance under low load conditions.

Project Description: NEEA is working collaboratively with NEEP; the Air-Conditioning, Heating, and Refrigeration Institute (AHRI); BC Hydro; Natural Resources Canada (NRCan); New York State Energy Research and Development Authority (NYSERDA); Southern California Edison; Xcel Energy; and U.S. DOE to determine the representativeness of different heat pump test procedures. The study will observe heat pump performance in a controlled field installation and compare those observations with corresponding laboratory test results. NEEA will investigate the heat pump test procedures prevalent in North America (CSA SPE07 (formerly EXP07) and U.S. DOE Appendix M1) and identify which method more accurately represents energy use. Additionally, key conditions and sequences (e.g., defrost, variation of compressor speed at part load) affecting instantaneous power demand and overall energy use will be investigated.

Project Objectives:

- Identify how well U.S. DOE Appendix M1 represents field performance.
- Identify how well CSA SPE07 represents field performance.
- Identify essential pieces of information that must be captured by any heat pump test procedure to accurately represent heat pump performance (e.g., any controls sequences that are particularly impactful to performance).
- Determine critical performance indicators that could effectively be used to differentiate efficient equipment in a Qualified Products List (QPL) in advance of wide availability of modified test procedures.

Project Status: Progress continues on the cold climate data collection phase of the project with field testing concluding in March 2023. Fundraising for lab testing to compare actual field performance vs. lab performance with CSA SPE07, U.S. DOE Appendix M1 (AHRI 210/240) and a controls verification protocol is underway.

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Product	4	Comm/Market	5	Program	4

Heat Pump Advanced Features and Capabilities (Improvements)

Product Description: Variable speed heat pump (VSHP) features and capabilities not covered by current AHRI metrics. These include emerging technology distinctions such as auto-demand response, adaptive defrost, and low-energy crankcase heaters that have potential incremental performance gains.

Project Objectives: Conduct a literature review and gap analysis and develop work plans that address knowledge and technology gaps. If successful, these features and capabilities will become part of NEEA's VSHP program.

Project Status: The Low Load Efficiency work plan is complete, and progress continues on the individual work plans for Cold Climate Capable; Minimization of Auxiliary/Supplemental Heat; and Connected Diagnostics. Completion of the work plans is expected in Q2 2023.

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Product	3	Comm/Market	5	Program	4

Micro VSHP Field Study

Product Description: A small heat pump designed to condition a single room. The heat pump may be installed in a window, like a window air conditioner, or portable so it can easily be moved from room to room.

Project Objectives: Conduct consumer research and field test micro heat pumps in Q4 2022–Q1 2023. This project consists of a small sample (16 total units) placed in a selected sample of homes. The principal research goal is to understand the customer experience and develop an assessment of the product's market readiness. The secondary goal is to gather information to guide estimates of energy savings potential and to determine the units' effectiveness at displacing energy used by the pre-existing heating system.

Project Status: Phase 1 research concluded in mid-Q1 2023, and the field deployment (Phase 2) is scheduled for March and April 2023. A report for both phases is expected to be published in late Q2/early Q3 2023.

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Product	1	Comm/Market	3	Program	1

Heat Pump Ready ENERGY STAR Manufactured Homes

Product Description: Manufactured homes that can be shipped as "Heat Pump Ready" to comply with the new ENERGY STAR manufactured home specification.

Project Objectives: The updated ENERGY STAR Manufactured Home specification will go into effect May 31, 2023, and requires that such homes be equipped with a heat pump. The revised Northwest Energy-Efficient Manufactured Housing Program™ (NEEM) specification for a Heat Pump Ready ENERGY STAR manufactured home will enable factories to sell homes prepped for a heat pump installation in the field. It also enables installation tracking to ensure the homes meet the ENERGY STAR spec.

1. Conduct HVAC contractor interviews to ensure product acceptance.
2. Develop a mechanical and electrical specification; document process changes to achieve ENERGY STAR specification levels.
3. Develop a database to enable tracking of products that meet the ENERGY STAR specification.

Project Status: The contractor research is complete, and four elements have been identified to improve the installation of heat pumps in the field. ENERGY STAR and U.S. DOE have also released tax credit threshold specifications for ENERGY STAR-rated manufactured homes.

An analysis of the Inflation Reduction Tax Act identified elements of the specification that would benefit NEEM and the unique way that ENERGY STAR homes are certified in the Northwest. Northwest Energy Works is expected to present a report by Q3 2023.

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Product	4	Comm/Market	5	Program	3

Hybrid Gas-Electric Heat Pump

Product Description: Integrated modulating gas heat pump and electric air conditioner (GHPAC) that uses natural refrigerants. Gas heat pump performance is 40kBTU/hr (11.7 kW); electric AC performance is 1.5 RT.

Project Objectives: Evaluate the performance of this integrated system in a laboratory setting with goals set for a heating coefficient of performance (COP) of 1.45 at 47°F and a target seasonal energy efficiency ratio (SEER) of 16.

Project Status: Testing is complete and achieved a heating COP of 1.42 at the design condition, and the chiller portion achieved a COP of 3.0. Further product development is expected in the next two years.

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Product	1	Comm/Market	2	Program	1

Primary High-Performance Windows (HPWs)

Product Description: Primary window using three panes of glass (or film or rigid plastic), two of standard thickness and a center thin pane of glass (or film). The overall thickness and weight are similar to standard double pane windows.

Project Objectives:

- Identify manufacturing technical needs for production of thin triple pane windows.
- Provide technical assistance on production processes (adapting double glazed equipment or new lines).
- Research motivating factors for increasing production of thin triple pane windows.
- Identify barriers in the supply chain.
- Investigate enhancements in thin triple pane window technology.

Project Status: With strong support from NEEA, ENERGY STAR Program Requirements for Residential Windows, Doors, and Skylights v7.0 was finalized in Q4 2022 and will go into effect in October 2023, lowering the U factor requirements from 0.27 to 0.22 for the northern climate zone. The new specification will give NEEA additional leverage in transforming the HPW market in the Northwest. Collaboration efforts continue through the U.S. DOE-funded Partnership for Advanced Window Solutions (PAWS), and NEEA is exerting national influence on windows markets to the benefit of the Alliance's Northwest stakeholders.

Although NEEA's collaboration with Habitat for Humanity (Bend, OR) is delayed due to rising material costs and interest rates, other efforts with volume builders are moving forward. In November 2022, NEEA collaborated with a national builder to include high-performance windows in a planned 100-home development. The build is expected to take place in the next 2-3 years. HPWs are a path to code credits.

Work continues evaluating benefit/cost ratios for single- and multifamily markets.

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Product	4	Comm/Market	3	Program	4

Study of High-Performance Window Incremental Manufacturing Cost

Product Description: Primary window using three panes of glass (or film or rigid plastic), two of standard thickness and a center thin pane of glass (or film). The overall thickness and weight are similar to standard double pane windows.

Project Objectives: Identify and quantify the incremental manufacturing cost of upgrading window thermal properties to support efforts to rapidly transform window markets in the Northwest to meet ENERGY STAR v7 window performance criteria.

Project Status: NEEA contracted with Stephen Selkowitz Consultants to explore several technical pathways to make the required thermal improvements. The report concluded that upgrading to a thermally enhanced double glazed window, or a shift to a triple glazed window, can be achieved at an incremental manufacturing cost of approximately $1.80–$2.10 per square foot. The complete report, including impacts to consumer pricing, is available on neea.org.

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Secondary Windows

Product Description: Retrofit products comprised of one or more panes of material such as glass, polymer or acrylic, with or without low-e coatings, which are mounted in a frame that is attached either to the interior or exterior of existing windows without replacing the primary glass or frame.

Project Objectives: Increase familiarity with product costs (for both materials and installation in the Northwest), product energy savings, market opportunity in the Northwest, installer capability and market drivers, especially value proposition for owners and owner representatives.

Project Status: Installation of commercial secondary windows at all six pilot sites is complete: 915 Broadway (Vancouver, WA); Romney Hall (Bozeman, MT); Crane Aerospace & Electronics (Seattle, WA); SBH Legal (Portland, OR); Creekside Business Park (Beaverton, OR) and Big Sky Economic Development (Billings, MT). Post-installation metering will continue at specific sites until mid-2023. A comprehensive technical report is being drafted and is expected to be finalized in mid-2023.

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Product	4	Comm/Market	5	Program	4

Luminaire Level Lighting Controls (LLLC)

Product Description: Advanced lighting control systems, either with wireless sensors or with LLLC, to provide occupancy-sensor and light-level control plus energy metering.

Project Objective: The Next Generation Lighting Systems (NGLS) program's prior competitions in 2017 and 2018 selected connected lighting for testing installation, commissioning and energy performance in a real-world test location. In 2021, NGLS added a new project studying the installation, color tuning, energy monitoring and occupancy/daylighting performance of the system with the possibility of future studies.

Project Status: NGLS and NEEA continue to collect data from the NEEA office install. In 2023 NGLS hopes to conduct additional studies on the LLLC system, which has not been possible with limited site use due to COVID-19. NGLS continues to look for additional whole-floor space sites in 2023.

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Product	4	Comm/Market	4	Program	3

Luminaire Level Lighting Controls with HVAC Control

Product Description: LLLC with additional sensors and supports for HVAC control.

Project Objectives: Determine whether additional energy savings are possible from more granulated sensors in every general lighting fixture. Analyze different HVAC control strategies in terms of how the controls look at the information being collected by the lighting sensors.

Project Status: This project remains on hold as NEEA looks for new partners with whom to work; however, as many businesses' employees start to return to the office, NEEA hopes that site identification can resume by summer 2023.

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Product	3	Comm/Market	2	Program	3

Combination Hot Water and Space Heat

Product Description: An integrated appliance providing space and water heating. Production options include different refrigerants and water, air and refrigerant working fluids.

Project Objective: Demonstrate the performance and adaptability of these systems to provide space conditioning and domestic water heating systems in existing homes and small commercial applications.

Project Status:

- Electric
  - In November 2022, NEEA convened a group of architects, engineers, installers and raters for a multifamily new construction design charrette to develop solutions that can be tested and verified for the proper integration of HPWHs into new construction low-rise multifamily structures. The recommendations are currently being tested in the lab with results expected by Q2 2023.
  - Additional research updates can be found in the other water heating project.
- Gas
  - Stone Mountain Technologies, Inc. (SMTI) 80kBTU/hr gas heat pump —The field performance evaluation is ongoing; field testing includes multifamily and single-family residential sites and is continuing in 2023.
  - Vicot Solar Technology Co., Ltd gas heat pump 20 kW (68kBTU/h) — Expecting unit delivery to GTI Energy by Q2 2023.

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Product	1-4	Comm/Market	1-3	Program	2

Heat Pump Water Heaters (HPWHs) in Confined Spaces

Product Description: An electric powered air-to-water heat pump, generally with a backup electric element, used for domestic hot water.

Project Objectives: Understand the performance impacts on HPWHs of different room volumes, specifically small spaces like utility closets, and test different interventions at restoring efficiency compromised by a small enclosure.

Project Status: "The Amazing Shrinking Room" report and Product Council presentation recording highlighting findings on neea.org. Other stakeholders outside the region are utilizing the test bed to extend to other products and solutions. The results are anticipated to be shared with NEEA in Q2 2023.

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Product	2-5	Comm/Market	3-4	Program	2-5

Integrated Residential Gas Heat Pump Water Heaters (HPWHs)

Product Description: A HPWH using either an adsorption or absorption thermal cycle powered by natural gas.

Project Objectives: Evaluate the performance of a prototype, full-size, adsorption gas HPWH.

Project Status: The dimensions of the overall prototype are encouraging at 28" x 28" x 59" (WxDxH). A measured first hour rating > 75 gallons was also encouraging. A COP > 1 on a low heating value was achieved.

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Product	3	Comm/Market	1	Program	2

Split-System Heat Pump Water Heaters

Product Description: Split-system HPWHs separate the heat pump from the water tank. These products offer a heat pump alternative for locations where the integral product doesn't physically fit. While only one split-system product has been available to date, more manufacturers are entering the market. 2023 shows promise for four more manufacturers to enter the market.

Project Objective: Lab and field test commercially available split-system water heaters to confirm performance and compliance with NEEA's Advanced Water Heating Specification.

Project Status: Commercial multifamily HPWHs from Nyle, Mitsubishi and WaterDrop, which uses an ECO2 engine, have been added to the Commercial Multifamily Heat Pump Water Heater Qualified Products List. Additional products are expected to be added in the upcoming months from several manufacturers new to the split-system HPWH market.

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Product	3	Comm/Market	3	Program	3

Integrated Commercial Heat Pump Water Heaters

Product Description: Similar to integrated residential HPWHs, commercial applications cover a broad range of hot water uses.

Project Objective: Conduct a feasibility study to determine in-field COP, resistance heat utilization and success in keeping up with hot water demand.

Project Status: NEEA is testing an updated version of the A. O. Smith CHP 120, a 120-gallon commercial HPWH. Baseline monitoring is now complete on the six-story, 59-unit building, with the units in all-electric mode. Analysis of the installation and performance revealed several findings: A mixing valve was improperly sized and calibrated, and the mechanical room does not have sufficient air volume and makeup air to run the water heaters in heat pump mode, resulting in the room getting too cold. Due to the mixing valve and room volume issues, the unit is using more electric resistance heating than anticipated. NEEA's contractor has installed additional monitoring equipment and is working with the manufacturers and the market outreach staff to devise solutions.

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Product	3	Comm/Market	3	Program	4

Central Commercial Heat Pump Water Heaters

Product Description: Commercial HPWHs used in multifamily buildings with central water heating and a distribution system. Several products are available and new products from major manufacturers are expected soon.

Project Objectives: Test design tools and new HPWHs as efficient electric solutions for central water heating. The results should lead to an updated product specification, test method and potentially a QPL. NEEA staff are supporting a couple of projects in this area, one with the Bonneville Power Administration and one with New Buildings Institute and the California Energy Commission.

Project Status: The Ecosim tool continues to be enhanced and is anticipated to be available in early 2023, in addition to the Ecosizer tool. The latest updates for the QPL are available on the Advanced Water Heating Specification/Resources section of neea.org.

The Central Heat Pump Water Heaters for Multifamily Supply Side Assessment Study, developed by the New Buildings Institute, was published in January 2023. The findings and recommendations in this report delineate the most effective mechanisms to transform the central HPWH market for multifamily applications.

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Product	3	Comm/Market	3	Program	3

Air-Conditioning, Heating, and Refrigeration Institute (AHRI)1430 Electric Water Heater Connectivity Standard

Product Description: Hardware and software to make water heaters grid-flexible and controllable.

Project Objective: Support efforts to harmonize connectivity standards among several standards, including AWHS 7.0, ENERGY STAR, California JA13, OpenADR and others.

Project Status: This project is complete. AHRI 1430 is now final and published on the AHRI website. OEMs can now voluntarily certify products, which will allow for further product differentiation in the market.

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Product	3	Comm/Market	3	Program	3

Commercial and Industrial Fans Product Research

Product Description: Stand-alone fans that are not embedded into packaged units.

Project Objective: The Fan Energy Index (FEI) describes the fan efficiency at a design point compared to a "minimally compliant" reference fan at that same operating point. FEI is the best metric to characterize "efficient fans" at a particular operating point. Proper sizing of the fan for design conditions leads to more efficient operations; however, FEI is rarely used by designers and specifiers in their fan selection. This project seeks to understand the barriers to using FEI as a design consideration.

Project Status: NEEA completed a regional market share report characterizing the relative size and composition of key fan manufacturers in the Northwest and is now in the process of identifying which manufacturers to partner with as program development activities move forward.

NEEA's Market Research and Evaluation team is leading efforts on a more robust market characterization study to understand fan distribution in the Northwest, in addition to understanding the decision-making process in selecting a fan to further identify points of influence for market intervention.

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Product	5	Comm/Market	4	Program	2

Power Drive Systems (PDS) and Power Index (PI) Research

Product Description: Power drive systems, or the combination of an electric motor and variable speed controls to provide feedback to the equipment.

Project Objective: This project builds off NEEA's work developing the PI metric with the National Electrical Manufacturers Association (NEMA), describing the percent of power savings expected from a complete PDS. This project will continue researching how PI can be used as a tool to calculate savings when retrofitting an adjustable speed drive (ASD) to a motor-driven system, establishing minimum PI values, and understanding power quality requirements for PDS. Additionally, the research will provide a high-level market characterization and an initial technical potential estimate for the region.

Project Status: NEEA contracted with Cadeo Group to better understand the market and savings opportunities associated with the use of an adjustable speed motor in both variable and constant loads (i.e., a PDS) in the Northwest. The report, available on neea.org, includes

1) a product overview, including information on energy savings opportunity;
2) a market characterization to estimate the technical potential, understand how incentive programs currently influence adoption, and describe the PDS supply chain; and
3) barriers and potential strategies to address and overcome these barriers.

Product Manager: Rick Dunn
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Product	4	Comm/Market	3	Program	4

Compressed Air Leak Detection Equipment Evaluation

Product Description: Equipment used to identify compressed air leaks, typically in manufacturing and process applications.

Project Objective: Test the Prosaris™ OL1 Leak Detection Platform against typical leak detection equipment in a side-by-side analysis to determine its speed, ease of use and accuracy compared to typically used equipment.

Project Status: The field test is complete and the summary memo is available for download on neea.org. The Prosaris OL1 yielded quantitative results similar to those of typical leak detection equipment. Additionally, the Prosaris OL1 provides an easier-to-use data gathering and reporting platform.

Product Manager: Rick Dunn
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Machine Learning (ML) Building Controls

Product Description: Applying artificial intelligence (AI) systems to adjust, improve and optimize control of equipment to accommodate changing conditions such as use, occupancy, comfort, air quality, time of use rates and demand response automatically and continually.

Project Objective: Field test one or two products to validate manufacturers' claims.

Project Status: BrainBox has four locations in Seattle completely deployed, with a fifth site pending. Data is currently being collected, and BrainBox reports that initial results are positive. NEEA's site selection was delayed slightly to Q2 2023.

Product Manager: Eric Olson
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Product	1	Comm/Market	2	Program	2

MARKET & COMMERCIAL READINESS

	Level 1: Pre-commercial	Level 2: Limited	Level 3: Niche	Level 4: Growing	Level 5: Wide
Supply Chain Maturity & Market Demand	Not commercially available or limited, pre-commercial availability	Commercially available outside of region Requires special order Limited market awareness	Commercially available in Northwest from one manufacturer through standard channels Niche market demand	Commercially available in Northwest from at least two manufacturers Growing market demand	Commercially available from 2+ manufacturers, well developed supply chain across region Wide market demand

PRODUCT PERFORMANCE READINESS

	Level 1: Unvalidated	Level 2: Engineering Validation	Level 3: Lab Validation	Level 4: Limited Field Validation	Level 5: Confirmed
Savings Reliability & Fitness for Use	Manufacturer claims energy savings but not validated by unbiased experts	Concept validated by unbiased expert via technical review and engineering calculations	Independent lab testing of product features and energy use in typical applications with clear baseline established	Lab and small-scale field testing across broader range of applications and systems conditions	Reliable prediction of performance across the range of intended applications; fully evaluable savings via established protocols by regional or national bodies

PROGRAM READINESS

	Level 1: None	Level 2: Exploratory	Level 3: Preliminary Pilots	Level 4: Full-scale Pilots	Level 5: Ready
Cost Effectiveness Knowledge *(technical and market potential, product cost at scale, non-energy benefits)*	None or very limited	Performance readiness at 2; initial market size calculated (units per year)	Performance readiness at 3; product cost at-scale estimated	Performance readiness at 4; product costs at or trending towards at-scale levels; preliminary estimates of non-energy benefits	Performance readiness at 5; CE calculations based on solid estimates or proven values
Market & Program Knowledge	None or very limited	Preliminary research exposes barriers and/ or similarities to other successfully transformed markets warranting further efforts	Market research illuminates barriers and opportunities to intervene; preliminary logic model developed; small-scale pilots	Formal market characterization underway; larger-scale pilots to test program elements and barrier removal	Formal logic model developed; market characterization and large-scale pilots prove out program design and barrier removal
Risk Assessment *(Market, Program, Regulatory)*	No risk assessment	Limited risk assessment	Preliminary risk assessment complete - major categories of risk understood	Well-developed risk assessment - no major unresolved risks	Periodic risk assessment process in place

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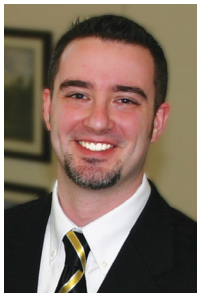

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TOGETHER We Are Transforming the Northwest

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Cascade Natural Gas Corporation — A Subsidiary of MDU Resources Group, Inc.
P.U.D. Chelan County
Clark Public Utilities
EnergyTrust of Oregon
Idaho Power — An IDACORP Company
NorthWestern Energy
NW Natural
Pacific Power
Portland General Electric
PSE Puget Sound Energy
Seattle City Light
Snohomish County PUD — Public Utility District No. 1
Tacoma Power — Tacoma Public Utilities