Next-Gen Heat Pumps: Meeting Residential and Small Commercial Customer Needs for Space Conditioning

- Bringing comfort to consumers at a fair total price
- Providing electrification options for electric utilities
- Reducing environmental impacts from space conditioning devices
- Addressing capacity and energy issues at electric utilities
- Identifying market potential for increased sales revenue

Background, Objectives, and New Learnings

According to the U.S. Department of Energy, space conditioning accounts for up to 48% of the energy consumed within U.S. residences. New heat pumps and air conditioners meeting the EPRI performance specification for "Next-Generation Residential Heat Pumps" are being brought to market with many new features. These systems offer the potential for improved consumer features like comfortable air temperature, higher efficiency, higher heating capacity at low outdoor temperature (including extreme conditions experienced during polar vortex events), variable operation for enhanced demand response and inbuilt diagnostic abilities. Inbuilt diagnostics help to maintain performance over time and enable remote access for enhanced service contracting.

Because residential variable speed systems are a relatively new development in the United States, the details of how they will perform in broad distribution are still uncertain. Many questions also surround their applicability and use as a resource for improved customer experience and for increasing end-use flexibility. Evaluating their true performance, examining their applicability in geographic regions, and understanding equipment sizing requirements are vital in order for customers to appropriately benefit from variable capacity systems as a resource. Various manufacturers have developed systems to meet the requirements for Next-gen HP technology. These systems, and any developed subsequently, are the intended technologies for this project. Next-gen HPs defined by the specification are unitary systems, both ducted and ductless, intended for residential and small commercial applications.

A notable key attribute of the Next-gen systems is high heating capacity at relatively low ambient temperature. This is intended to allow HP systems to be more applicable to northern U.S. climates, without relying excessively on a second-stage backup heat source—either electric resistance or gas. Though both second-stage options remain, they will be called on much less frequently because a larger portion of heating load hours can be fully carried by the heat pump cycle. Additionally, Next-gen systems are able to deliver higher supply air temperatures (higher than traditional single-speed counterparts) providing greater customer comfort and dispelling the myth that heat pumps are unable to generate hot air, in line with furnace experiences.

The purpose of this project is to conduct a large-scale field test of the Next-gen HP technology from multiple manufacturers with supplemental laboratory testing when new manufacturer implementations are provided. The field tests are functional in character as they are not deployed to gather statistically meaningful results. EPRI intends to develop a comprehensive set of use cases to guide both field and laboratory evaluations. From these use cases, EPRI intends to establish a test protocol to exercise the various devices during the testing to ascertain unit performance against a strict set of metrics created as a part of the use case development process.

This project seeks to provide new insight on the operation of advanced heat pumps in residential and small commercial space conditioning applications. The analytics outcomes should inform consumers, the HVAC manufacturing and installing industries, and utilities on the effectiveness of the Next-gen systems.

Benefits

Project participants will guide the development by building use cases and subsequently deploying Next-gen HP systems in their service territories. This project intends to assess the Next-gen HP's performance for a variety of use cases and address such issues as:

- Eliminating "cold air" issues historically identified with HPs to bring comfort to consumers
- Enhancing efficiency by eliminating resistance heat in temperate climates and reducing wintertime peaks
- Expansion of electric heating in all U.S. climates where HPs could replace gas/oil furnaces
- Realization of the benefits of converting the largest household load into a flexible end-use asset
- Reducing environmental stress by significantly lowering carbon footprint produced by fossil fuel sources
- Providing remote feedback on system status for enhancing maintenance programs

Project Summary

The project aims to match utility needs with available and pre-production heat pump products and to deploy units into utility service territories. The project aims to assess specific consumer and utility perceived benefits from Next-gen HPs and then develop use cases to match characteristics for each participant.

The project intends to deploy and test a minimum of five fully instrumented Next-gen HP systems within each participant's service territory as a basic part of the project, using protocols designed to exercise the features of the HP and measure it against the metric created with the use case development. For an extra fee, additional systems may be deployed by participants which may or may not be instrumented. If desired, customer feedback may be solicited through interview survey instruments. A variety of mechanisms may be used to facilitate these additional deployments, including an incentive managed by the utility, or turnkey installation through EPRI.

Each use case may serve as an effectiveness test to determine applicability to the participant. Data analysis and reporting for each participant is intended to summarize "lessons learned' from the field test.

An overall report will be developed to determine various geographic trends for the effectiveness of the Next-gen HP for heating applications. Also, the use cases will be assessed and evaluated for meeting overall project metrics.

Deliverables

- Develop participant specific use cases
- Program implementation plan (per utility)
- Five fully instrumented Next-gen HPs for each participant (participants may opt for additional installations)
- Test results by utility for applicable use case applications
- Individualized reports for each participating utility
- Final summary report

The non-proprietary results of this work will be incorporated into EPRI Program 170 Customer Technologies and EPRI Program 199 Electrification and made available to program members and to the public.

Price of Project

The collaborative is available to participants at three tiered levels based on distribution throughput:

- Less than 25,000 GWh $ 260,000
- 25,001 to 45,000 GWh $ 310,000
- Over 45,000 GWh $ 360,000
- Alternate for no Distribution $ 310,000

Contact EPRI for pricing for field deployment of more than five Next-Gen HPs. This project qualifies for SDF or TC funding.

Project Status and Schedule

The project began in April 2017 and will continue through September 2024.

Who Should Join

Any electric utility that has interest in customer programs, electrification options, environmental improvement, demand response, and a potential increase in electric sales should subscribe to this project.

Contact Information

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com).

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