

EFFICIENT ELECTRIFICATION AT EPRI

AUGUST 2017 NEWSLETTER

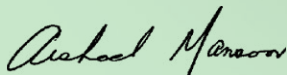
Could electricity account for 50% of energy end use by 2050? Could society look to electricity as essential in lowering cost, increasing comfort, and cutting emissions? EPRI sees real potential for this to happen, but it must begin with a detailed understanding of the opportunities, the challenges, the technologies, and the customer. EPRI's *Efficient Electrification* newsletter provides insights, news, and updates on the adoption and use of energy technologies and solutions that increase electricity's share of total energy use.

This month, we highlight EPRI's regional workshops on efficient electrification. We describe electrification technologies, including the next generation heat pump, energy management circuit breaker, and those that provide health and safety benefits. We link to electrification-related news articles, spotlight electric transportation news, summarize EPRI resources, and list upcoming electrification events.

EPRI's Efficient Electrification Initiative is integral to an Integrated Energy Network. It includes our forthcoming national efficient electrification assessment, extensive communication and outreach, creation of centers of excellence, future regional assessments, accelerated R&D programs, and supplemental R&D projects. We invite you to connect with us and to share your thoughts and suggestions.

Arshad Mansoor

Rob Chapman



Senior Vice President,
Research and Development

Vice President,
Energy and Environment

About EPRI's Efficient Electrification Initiative

"Electrification" describes the adoption and use of energy technologies and solutions that increase the share of total energy use served by electricity. Research points to its potential to increase economic productivity; lower costs of products and services; reduce CO₂ emissions; enhance air quality; reduce water consumption; improve public health and occupational safety; and enhance grid performance and asset utilization. EPRI's Efficient Electrification Initiative is aligning and expanding EPRI's research and development portfolio to:

- Analyze electrification's costs and benefits to electricity consumers and producers and to society.
- Develop and demonstrate advanced electric technologies.
- Support effective implementation of comprehensive electrification strategies.

TABLE OF CONTENTS

ELECTRIFICATION IN ACTION

Can Efficient Electrification Provide Health and Safety Benefits at Commercial and Industrial Facilities?

A recent EPRI assessment shows that the answer is “yes.” The use of efficient electric technologies in commercial and industrial facilities offers potential health and safety benefits for workers, such as reduced exposure to chemicals and emissions, reduced ambient noise, and reduced exposure to hazardous environments such as open flame and high temperatures. The EPRI assessment summarized the benefits in seven different applications, including these:

Electric Forklifts

Using electric forklifts to replace gasoline- or diesel-fueled forklifts reduces on-site emissions, such as carbon monoxide (CO), along with noise pollution from the internal combustion engine. Exposure to high levels of CO can lead to headaches, difficulty breathing, and at severe levels can lead to nausea, dizziness, and eventually death.

Commercial Truck Electrification

Electric truck refrigeration units and truck stop electrification reduce diesel idling at rest stops, providing healthier conditions for drivers and reducing on-site emissions of “criteria pollutants.”



Ultraviolet (UV) and Ozone Water Treatment

Replacing chlorine water treatment with electric water treatment processes, such as UV or ozone, can reduce chlorine exposure and associated risks of airway irritation, wheezing, difficulty breathing, sore throat, cough, chest tightness, eye irritation, blindness, and skin irritation.

Induction Melting

Replacing coke-fired cupolas with induction melting at iron foundries can improve site air quality for foundry workers, reduce ambient temperatures within the foundry, and reduce ambient noise. A Labor Occupational Health Program report identified hazards to foundry workers, many of which are directly associated with the coke-fired cupola.

Metal Fabrication

In the metal fabrication industry, replacing natural gas convection furnaces for heat treating applications with an [electric resistance-based salt bath furnace](#) reduces on-site emissions and exposure to open flame. Powder coatings cured with infrared or UV light reduce emissions of volatile organic compounds and reduce ambient workplace temperatures relative to facilities using heat-cured conventional liquid paint.

TECHNOLOGY SPOTLIGHT

The Next Generation Heat Pump: An Efficient, Environmentally Clean Alternative for the Largest Residential Energy Load

The U.S. Department of Energy reports that space conditioning accounts for up to 48% of the energy consumed within U.S. residences. To serve this load more efficiently, next generation heat pumps (NGHPs) offer new features that improve consumers' comfort, the power system's flexibility, environmental performance, and the use of electric system infrastructure. Consumer features include more comfortable discharge air temperatures, higher efficiency, higher heating capacity at low outdoor temperatures, variable operation for enhanced demand response, and built-in diagnostic capabilities.

With their space heating capacity at relatively low ambient temperatures, NGHPs can provide comfort in colder climates, with a larger portion of heating load fully carried by the heat pump cycle, and their inverter-driven variable speed components are more efficient than traditional fixed-speed heat pumps. These systems can be retrofitted without the need for modification to the electric system or residence.



Widespread adoption of next-generation heat pumps could:

- Save utility customers money.
- Enhance demand response.
- Reduce environmental impact of space conditioning.

Next Generation Heat Pumps:

- Offer a high-efficiency alternative to natural gas-fired and oil-fired furnaces.
- Use variable-capacity operation to save energy, enhance capacity, and add flexibility.
- Save utility customers money, with comfortable space conditioning in various climates.
- Reduce the environmental impact of residential space conditioning systems.

Because residential variable-speed heat pumps are a relatively new development, EPRI is launching a [supplemental project](#) to verify their field readiness and performance. The project will:

- Define various use cases for field testing; define a test protocol and metrics for evaluation.
- Use the test protocols to field test various manufacturers' NGHPs to verify capacity, efficiency, maintenance needs, flexibility, CO₂ reduction, and more.
- Assist manufacturers with designs that will make NGHP more efficient and grid connected.

Preliminary results of NGHP use cases showed energy savings in all four cities modeled (in various climate zones across the United States), compared relative to baseline propane or baseline natural gas use:

- Replacing a Propane Furnace: Based on the use case assumptions, a residential customer would save up to \$1,056 in annual operating costs by replacing a propane furnace with an NGHP (a 47% savings). A Minneapolis, MN, customer would save \$723 annually (40% savings relative to the baseline).
- Replacing a Natural Gas Furnace: Based on the use case assumptions, using NGHP with natural gas backup would save \$227 in annual operational costs in Seattle (43% savings compared to a baseline use with natural gas furnace), and \$31 annually in Kansas City, MO (4% savings compared to the baseline).
- Using NGHP to replace a single-speed heat pump (SSHP) would reduce peak electric power demand that is caused by electric resistance backup through the use of variable-speed operation. Projected typical peak electric power demand reductions are 33% in Seattle, 15% in Salt Lake City, 13% in Kansas City, 12% in Boston, and 15% in New York City.

To learn more, contact: Ron Domitrovic, rdomitrovic@epri.com, 865.218.8061 or Tom Reddoch, trreddoch@epri.com, 865.218.8120

ELECTRIFICATION WORKSHOPS

EPRI Takes Efficient Electrification on the Road with Regional Workshops

What are the benefits of efficient electrification? More than 120 participants from utilities across the United States and Canada participated in EPRI's regional Efficient Electrification Workshops in July 2017 to find out. The four workshops, hosted by FirstEnergy, the New York Power Authority, Pacific Gas & Electric, and the Tennessee Valley Authority, explored the concept of efficient electrification and reviewed EPRI research and development, including:

- Research programs and technology-focused supplemental projects
- The 2018 EPRI national electrification assessment
- State-specific assessments
- Utility-specific implementation plans

Emerging efficient electrification technologies include electric transportation, indoor agriculture, next-generation heat pumps, advanced industrial electric technologies, and more. Planned EPRI environmental efforts include:

- Analyze efficient electrification scenarios and their impacts to inform policy makers.
- Quantify potential improvements in air quality and associated benefits related to electrification.
- Analyze and quantify potential benefits and impacts of electrification with respect to water availability and quality, the environment, ecosystems, and biodiversity.

These energy technologies and solutions can increase economic productivity; lower costs of products and services; reduce CO₂ emissions; enhance air quality; reduce water consumption; improve public health and occupational safety; and enhance grid performance and asset utilization.

EPRI's national electrification assessment will provide analyses of the feasibility, value, and evolution of expanded electrification to customers, utilities, and society. It will document technologies and market adoption pathways that can inform various policy scenarios. These scenarios, in turn, may increase electricity's share of final energy from 19% today to as much as 50% by 2050. Associated benefits may include significant reduction of CO₂ emissions. EPRI is planning state-level analyses of expanded electrification.



Steve Strah, president of FirstEnergy Utilities, welcomes a packed house of participants from utilities across the United States to EPRI's Efficient Electrification Northeast Region Workshop. FirstEnergy hosted the event at its West Akron Campus in Ohio.

Workshop participants requested more information in the following areas:

- How utility customers adopt new electrification technologies and services
- How utility customers can obtain financing for these technologies and services
- How utility customers can justify the capital expenditures for these technologies and services
- How utilities can initiate an electrification program using relatively limited additional resources
- The optimal path for utilities when implementing an electrification program
- Emerging innovative technologies to accelerate electrification opportunities

EPRI is responding to these requests through supplemental projects, including assessment options, field testing technologies, and programs that support particular electric technology options.



EPRI Electrification Workshop participants

Did you miss the workshops and want to learn more? E-mail Annie Haas (ahaas@epri.com) to be added to our follow-up webinar invitation list and to subscribe to *Efficient Electrification*.

ELECTRIFICATION INNOVATION

More Than 200 Energy Management Circuit Breakers Are Operating at 13 Utilities

As part of a collaborative R&D project with utilities, EPRI and Eaton are testing Eaton's new circuit breaker, which is designed to improve utility service reliability through monitoring and control of consumer loads and provide customers information on their electricity use patterns. EPRI is testing and evaluating the impact of Eaton's energy management circuit breaker (EMCB) in the field, and will provide testing data to the 13 participating utilities. Research results are expected to be useful in helping participants better understand how to manage power demand. The device offers the potential to integrate new energy sources such as solar and battery energy storage with the grid, while enabling residential customers to manage their energy use.

With its ease of use and accurate circuit load monitoring, the EMCB can be instrumental in measuring and verifying activities, including any substitution of electrified loads such as energy efficiency and customer-owned generation. Studies are needed to verify its performance, especially with respect to its role in any efficient electrification strategy.

Two versions of EMCBs are operating: 1) a standard version, suitable for conventional loads, and 2) an electric vehicle (EV) compatible version, suitable for monitoring and controlling the charging of plug-in EVs. It's expected that EMCBs will support the effective integration of EVs as an electrification technology option.

"The EMCB technology puts some of the benefits of a smart, integrated grid in the hands of homeowners, and could transform the way consumers interact with electricity," said Arshad Mansoor, EPRI senior vice president for research and development. "This field test also provides a real-time, in-home assessment of how the EMCB can improve utility service and optimize the grid by supporting demand response, distributed energy resources, solar installation monitoring, energy storage, and energy management."

The EMCB combines circuit breaker protection in the customer's load center, with Internet connectivity and on-board intelligence. It can make residential and commercial circuits "smart" and provide energy use information for on-site energy management. Its information and control features can help improve overall grid reliability. Existing electrical panels can be retrofitted with EMCBs, requiring no additional hardware.

In EPRI's [EMCB field test](#) 13 utilities installed them in approximately 500 residences and businesses across the country. As of early August 2017, 373 EMCBs had been shipped, and 216 were active in the field. Participating utilities are American Electric Power; CenterPoint Energy; Dairyland Power Cooperative; Duke Energy; Exelon subsidiaries ComEd, PECO, and Pepco; Nebraska Public Power District; Pacific Gas & Electric; Seattle City Light; Southern Company; and Tri-State Generation and Transmission Association, Inc.

With the first phase scheduled to end in late summer of 2018, EPRI is looking to expand the project into a second phase in which participants continue their field activities and additional utilities can join the project. Phase I has identified new applications that can be expanded into full-scale projects in their own right, and potential pilot programs can be identified. Field deployments of EMCBs can use an experimental design that provides data sufficient to expand into pilot programs.

For more information, contact: **Tom Reddoch**, treddoch@epri.com, 865.456.3708, or **John Halliwell**, jhalliwell@epri.com, 865.218.8149.



Automakers, Cities, and Countries Announce Ambitious Electric Vehicle Plans

As plug-in electric vehicles (PEVs) gain market share, researchers are better able to measure their benefits, including increasing energy efficiency, transportation lifecycle cost savings, reducing environmental impact, providing grid storage, and enhancing fuel diversity, energy security, and economic growth. Drivers cite their instant torque, a quieter and smoother ride, and the ease of largely charging at home or work (no more trips to the gas station). Automakers are being joined by cities and countries worldwide announcing ambitious EV plans.

Among the countries with aggressive requirements or plans are [France](#), [Germany](#), [the UK](#), [Norway](#), [India](#), [China](#), and [The Netherlands](#). Cities such as, [Paris](#), [Madrid](#), [Athens](#), and [Mexico City](#), are moving to ban diesel cars. To meet growing demand for EVs, automakers such as [Tesla](#), [Volkswagen](#), [Ford](#), [Volvo](#), [BMW](#), and many others have announced global EV plans. "Sixty different PEVs will be available by 2021, and fully one-third of those are SUVs and crossovers," explains EPRI program manager of Electric Transportation Dan Bowermaster. "What's more, we're now seeing mass market-priced vehicles ([~\\$35,000-\\$40,000](#)) with a 200+ mile range coupled with increased DC charging power. These are huge developments in this market."

According to a [Bloomberg New Energy Finance forecast](#), by 2025 the falling cost of producing electric vehicles will result in EVs as affordable as comparable gasoline models. To help utilities' customers benefit from these decreased costs, EPRI has established a [supplemental project to examine various aspects of plug-in EV adoption](#) in utility service territories. Utilities can use project results in designing programs that encourage PEV adoption while helping provide utility customers information that helps them make better informed PEV purchasing decisions.

Fast charging infrastructure for PEVs is a key issue. "Even though 80-90% of PEV charging is done at the home, we need public charging infrastructure to instill customer confidence," said Bowermaster. "About \$1.4 billion for utility charging infrastructure and customer education is on the table right now, and we need to make sure that the right type of charging is available at the right places." The de facto charging capability today is 50 kW, but several manufacturers are planning 150 kW, 300 kW, and even higher.



ELECTRIFICATION IN THE NEWS

[Toyota and Mazda join forces on electric vehicles.](#)

Is this the end of the road for gas cars?

[Air conditioning is a lifesaver.](#) *It's also a potential disaster.*

[Volvo announces an end to manufacturing of cars with internal combustion engines.](#)

All cars made by Volvo from 2019 forward will be partially or completely battery powered.

[The Northeast Energy Efficiency Partnership's 2017 Regional Strategic Electrification Summit](#)

brought together a range of stakeholders to discuss recent research regarding electrification.

[The Electric Bioreactor Farm](#) *is a way to produce food from renewable energy. Finnish researchers created the synthetic food as part of the Food from Electricity project.*

Other News

- [The Economist](#) describes how higher production volumes and improved chemistry are decreasing the costs of lithium-ion batteries and expanding their potential applications.
- Improved air quality is a primary driver of the Los Angeles Metropolitan Transportation Authority's plan to [purchase 2,300 electric or hydrogen powered buses.](#)
- Through the [Electrification Futures Study: A Technical Evaluation of the Impacts of an Electrified U.S. Energy System](#), the National Renewable Energy Laboratory "is leading a research team to explore infrastructure investments needed and implications of a more fully electrified U.S. economy."
- [New York City has the U.S.'s largest urban agriculture system](#), and a city council bill is intended to address confusion and lack of regulation among growers.
- [A Bloomberg New Energy Finance report](#) projects that electricity demand from electric vehicles will increase 300-fold by 2040 to 5% of total electricity use.
- [Two Minnesota power cooperatives are field testing an electric school bus.](#) Great River Energy and Dakota Electric Association are testing the bus on long suburban and rural routes in cold weather.
- [By 2040, the French government will halt sales of petrol and diesel vehicles.](#) Emmanuel Macron's government announced this as part of planned targets under the Paris climate accord.
- [The UK government announced its plan to tackle roadside nitrogen dioxide concentrations.](#) The July, 2017 report lays out a comprehensive approach to meeting the statutory limits.
- [A Duke Energy electrification project will help reduce truck stop idling.](#) Duke Energy is installing 36 electric power outlets at the Merchants Distributors LLC distribution center in Hickory, North Carolina.
- [Electric vehicle rebates in Oregon will total \\$2500 or more](#) in a bill soon to be approved as part of a \$5.3 billion transportation plan.
- [An Indoor clothesline is commercially available technology.](#) Potential customer benefits include better care of fabrics due to no tumbling of clothes, efficiency due to no rotating motor, etc.
- [Chinese indoor "plant factory"](#) grows plants without exposure to contaminated outside air.

Get Involved

How can efficient electrification benefit you? To learn more or get involved in one of EPRI's programs, contact [Jimmy Herren](#) (West), [Brian Fortenbery](#) (East), or [Kevin East](#) (International).

UPCOMING EVENTS

- Sept. 11-14, 2017: [EPRI Power Delivery and Utilization Fall 2017 Advisory and Sector Council Meeting, Denver, CO.](#)
- Sept. 11-14, 2017: [EPRI Energy and Environment Fall 2017 Program Advisory and Sector Council Meetings, Houston, TX.](#)

Save the date (Aug. 20-23, 2018): Electrification 2018, the inaugural, international conference and exposition on efficient electrification, Long Beach Convention Center, Long Beach, CA.

EPRI RESOURCES

- [A Heating and Cooling Game Changer?](#) EPRI Journal, July 25, 2017.
- [Driving Cleaner Air in the Tennessee Valley](#), EPRI Journal, July 2017.
- [What Makes a Utility Customer Want an Electric Vehicle](#), EPRI Journal, July 2017.
- [Efficient Electrification Newsletter](#), July 2017 newsletter issue, 3002011480.
- Technology Innovation Quick Insight: ["Potential Health and Safety Benefits of Efficient Electrification,"](#) EPRI 3002011450, June 30, 2017.
- Technology Innovation white paper: ["The Role of Digital Utilities in Smart Cities: Leveraging Utility Information and Communication Technologies,"](#) EPRI 3002011385, June 12, 2017.
- [Customer Energy Savings and Societal Benefits Through Electrification](#), EPRI Journal, May 24, 2016.
- [The Three E's: A Triple Play of Economics, Efficiency and Environment](#), Public Power Magazine, May 1, 2017.
- ["An Overview of Advanced Energy Communities,"](#) EPRI white paper, EPRI 3002011115, April 20, 2017.
- Technology Innovation Quick Insight: ["Water Saving Opportunities with Electric Technologies,"](#) EPRI 3002011028, March 31, 2017.
- [A U.S. Consumer's Guide to Electric Vehicles](#), EPRI 3002009824, March 1, 2017.
- [Video: EPRI Electrification](#), August 4, 2016.

EPRI IN THE NEWS

- [EPRI's Integrated Grid work was highlighted in an article about how utilities are integrating distributed energy resources \(DER\) into the grid.](#) The Daily Energy Insider article noted that successfully integrating DER depends on the existing electric power grid, especially its distribution system, which wasn't designed "to accommodate a high penetration of DER while sustaining high levels of electric quality and reliability," from EPRI's 2014 paper, [The Integrated Grid: Realizing the Full Value of Central and Distributed Energy Resources.](#)
- Mark Duvall was heard on radio station KQED, a Bay area NPR affiliate, [discussing the relative value of dynamic charging for electric vehicles.](#) "If I have a car that has 300 miles of range and I only have to pull over every 4-5 hours for 15 minutes, do I really need dynamic wireless charging?" he asked.
- IEEE Power & Energy Society (PES) magazine featured an article by Arindam Maitra [about EPRI's work with microgrids and distributed energy resource integration](#) in a special edition on microgrid controllers (subscription required).

About EPRI:

The Electric Power Research Institute, Inc. (EPRI, www.epri.com) conducts research and development relating to the generation, delivery and use of electricity for the benefit of the public. An independent, nonprofit organization, EPRI brings together its scientists and engineers as well as experts from academia and industry to help address challenges in electricity, including reliability, efficiency, affordability, health, safety and the environment. EPRI's members represent approximately 90 percent of the electricity generated and delivered in the United States, and international participation extends to more than 30 countries. EPRI's principal offices and laboratories are located in Palo Alto, Calif.; Charlotte, NC; Knoxville, Tenn.; and Lenox, Mass.

3002011635

August 2017

Electric Power Research Institute

3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA

800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com © 2017 Electric Power Research Institute (EPRI), Inc. All rights reserved. Electric Power Research Institute, EPRI, and TOGETHER... SHAPING THE FUTURE OF ELECTRICITY are registered service marks of the Electric Power Research Institute, Inc.