

Flipping the Switch



New EPRI Initiative Aims to Unleash Electrification's Enormous Potential Benefits for Society

By Chris Warren

As the United States prepared to enter World War I in 1917, most American households, including the wealthy ones, lacked running water and a telephone. What happened in the ensuing 100 years to transform elusive luxuries into basic necessities? A big part of the answer: widespread availability of electricity and steadily advancing end-use technologies to harness its power.

“As we improved the quality of life in the American home through technology, we have increased electricity use,” said Mark Duvall, director of energy utilization at EPRI. “In the kitchen, refrigerators replaced iceboxes and electric stoves replaced wood-fired stoves. We added appliances, TVs, and other connected loads that made the house a cleaner, more comfortable place to live.”

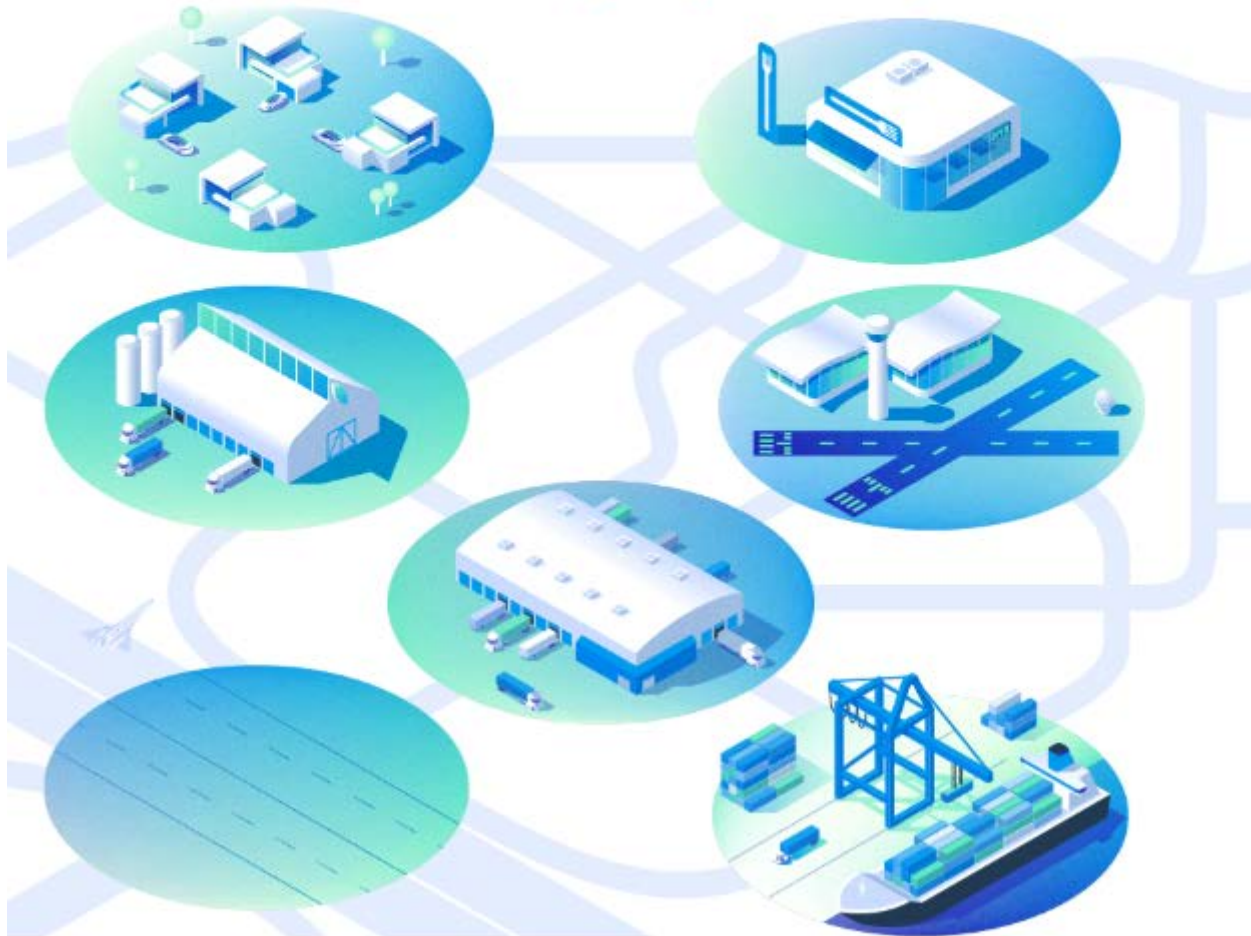
Today, new momentum is building for electrification to extend its reach and its benefits. In the residential, commercial, industrial, and transportation sectors, customers are switching technologies such as automobiles, forklifts, and furnaces from direct combustion of fossil fuels to electricity. The switch to electric vehicles (EV) illustrates benefits that are common across the board.

“If I buy a vehicle with an internal combustion engine today and drive it for 11 years, society will never realize any air quality or carbon improvements during that period,” said Rob Chapman, vice president of EPRI’s Energy and Environment Sector. “Compare that with a vehicle powered by the electric grid. Since 2000, the electric power sector has reduced emissions of criteria air pollutants by 80% and carbon dioxide by 20%. If we continue to ‘green’ the electric supply and make the grid more dynamic and flexible, EVs get cleaner the longer you have them.”

An Electrified World

The core idea behind EPRI's Efficient Electrification Initiative is that more widespread adoption of electric technologies can deliver significant environmental, economic, and productivity benefits to individuals and society. What could increased electrification look like in America's homes, businesses, farms, airports, and ports?

Click on the images of an electrified city of the (not so distant) future to learn more.



Click [here](#) to enter this interactive graphic about electrification.

Even as society's energy appetite grows, electrification points to new, diverse uses and benefits. EPRI estimates that Southern Company avoided approximately 5,000 tons of nitrogen oxide, sulfur oxide, and carbon dioxide emissions by choosing electric equipment instead of diesel to dredge at the Port of Mobile, Alabama.

Often, the most significant challenge to lower bills and a cleaner environment is that utility customers don't know what's possible with electrification. With support from EPRI, utilities have added a new component to their customer engagement strategies—identifying electric technologies that could save money for commercial and residential customers and educating them about these and other benefits.

The Efficient Electrification Initiative

According to the U.S. Energy Information Administration, today about one-fifth of America's final energy consumption is electricity, with the rest coming from direct combustion of fossil fuels such as coal, natural gas, and petroleum. The U.S. Department of Energy has chronicled how the burning of fossil fuels has provided more than 80% of the nation's energy for the past 100 years, enabling the first wave of electrification that provided running water, lit up homes, and switched on radios and TVs.

EPRI's wide-ranging Efficient Electrification Initiative aims to describe and enable the economic, environmental, productivity, and other improvements that individuals and society can realize through electrification using advanced power systems and end-use technologies. Launched in 2017, the initiative takes an in-depth, fact-based look at the benefits and costs of far greater electrification, analyzing scenarios in which up to 50% of energy end use comes from electricity by 2050. Participants include utilities, policymakers, regulators, manufacturers, consumers, and other energy sectors.

EPRI spearheaded the initiative as an extension of its [Integrated Energy Network](#), which describes a future with an integrated "system of systems" for electricity, water, natural gas, and transportation, along with a pathway to get there. The Integrated Energy Network encourages collaborative, innovative thinking to tackle the challenge of delivering cleaner, affordable, reliable energy to a global population expected to reach 10 billion by the end of the century. Efficient electrification will be instrumental in achieving this.

Drivers: Cleaner Grid, Advancing Technology, Customers

As innovative electric technologies are adopted along with significantly improved traditional technologies, the time is right for a closer examination of widespread electrification. Again, EVs are instructive. To become mainstream, electric cars, trucks, and buses need affordable batteries that enable significant driving range—and an enormous scope of research focuses on this. EPRI projects that EVs will reach price parity with internal combustion vehicles within the next five years.

As the penetration of natural gas and renewable energy technologies grows, the electric supply's carbon footprint declines. Also, the grid is becoming more efficient through the interconnection of advanced sensors, automation, and communication devices.

"There will be as much technological change in the next seven years as what occurred over the past 30 years," said Chapman. "These advances will occur in electric supply, grid, and end-use technologies. A more dynamic, flexible grid will help tap the potential of these technologies."

Electrification also is growing as a result of policy and corporate trends. Currently, U.S. cities and states have maintained or deepened their commitments to reduce greenhouse gas emissions and deploy renewable energy. California's 2030 targets include 50% of electricity from renewable sources and a 40% reduction in greenhouse gas emissions. To help achieve carbon reductions and improve air quality, the state is looking at cross-sector solutions that include transportation electrification. Large companies such as Google, [IKEA](#), and Walmart have committed to procure a large portion (in some cases, 100%) of their energy from renewables.

Customer attitudes and priorities also propel EPRI's initiative, even as they choose from expanding options in rooftop solar, EVs, smart thermostats, and numerous other end-use technologies.

"Residential customers want options, flexibility, and the ability to manage and control energy expenses," said Chapman. "Commercial and industrial customers want these as well, and they recognize that energy flexibility can translate into greater affordability, productivity, and safety."

A Focus on Analytics, Technology, and R&D Collaboration

Analytics encompasses modeling, simulation, and other data analyses to quantify the implications of widespread electrification.

“If you’re talking about how electrification benefits the consumer and society and leads to a cleaner environment and more affordable energy, you can’t say that without the analytics to support it,” said Chapman. “Our analytics team is looking at macroeconomic trends and scenarios for future carbon emissions to understand the impacts that increased electrification can have on air, water, and energy efficiency.”

In April 2018, EPRI released its [National Electrification Assessment](#) examining societal, customer, and utility impacts of 50% electrification by 2050. The analysis is based on EPRI’s recently updated U.S. Regional Economy, Greenhouse Gas, and Energy (US-REGEN) model.

“Over the past two years, we developed a very detailed model that equips us to track the consumption of energy by fuel and technology across the transportation, residential, commercial, and industrial sectors,” said Francisco de la Chesnaye, an EPRI senior program manager who is leading the analytical work. “The study’s key finding: Across a range of assumptions, economy-wide electrification leads to a significant reduction in energy consumption, spurs steady electric load growth, increases grid efficiency and flexibility, and reduces greenhouse gas emissions—even when there is no assumed climate policy.”

In 2018, EPRI will begin similar assessments of the impacts of expanded electrification for states and utility service areas (see box at end of article).

More widespread electrification depends on technological innovation. EPRI researchers collaborate with companies, national laboratories, and utilities to establish a pipeline of early-stage efficient electrification technologies. As these technologies prove their potential in the laboratory, they are put in the field as part of utility demonstration projects.

“We are focused on the devices that utility customers own, such as EVs, energy-efficient appliances, zero net energy houses, and energy storage,” said Duvall. “We’re accelerating our R&D in these areas and examining technologies that aren’t being addressed currently.”

New EV research includes an examination of consumer expectations regarding the availability of public fast-charging infrastructure. The results will help guide utilities, automakers, regulators, and policymakers as they make investment decisions about the type and number of charging stations necessary to make consumers comfortable purchasing EVs.

Electrified indoor agriculture has the potential to move food production closer to consumers and cut water use by 95%.

“Most areas of the country don’t grow their food year-round. Indoor agriculture could eliminate the land and climate barriers—making it possible to grow tomatoes during a Wisconsin winter,” said Duvall. “Think of the enormous reduction in transportation costs and emissions if 50% of the produce for New York was grown within 10 miles of the city. EPRI is monitoring demonstrations to validate environmental and productivity claims and better understand electricity demand.”

EPRI is working with member utilities to identify how they can help residential and commercial customers reap the benefits of electrification. Often, it’s a matter of pinpointing how a customer can benefit by adopting a specific technology. In many cases, customers simply don’t know how and where electrification can save them money or reduce pollution.

“The Efficient Electrification Initiative can provide opportunities to educate customers more broadly to understand the costs, benefits, and obstacles to adoption,” said Duvall.

In 2018, EPRI will develop an electrification R&D roadmap and begin an electrification cost-benefit assessment.

In August 2018, EPRI will host an [Electrification 2018 International Conference & Exposition](#) in Long Beach, California—a forum for utilities, government agencies, nonprofits, and other energy companies to share experiences and insights and learn about EPRI research findings. This will become an annual gathering to sustain momentum and chart a path forward. Stakeholders can identify avenues for collaboration, technologies requiring additional research, and policies that need to be formulated or reconsidered.

“Let’s bring all the stakeholders together and make the research transparent,” said Chapman. “We provide our unbiased research and facilitate the conversation. This is a key part of the initiative because so many people are interested in the benefits of electrification relative to other forms of energy.”

Dialing into State-Level Electrification

EPRI’s recent [National Electrification Assessment](#) found that economy-wide electrification leads to a large reduction in energy consumption and greenhouse gas emissions as well as significant improvements in grid efficiency and flexibility.

For a more detailed look at the opportunities and challenges, EPRI is using the U.S. Regional Economy, Greenhouse Gas, and Energy (US-REGEN) model for state- and utility-level electrification assessments. “The results of the national assessment serve as a starting point for our work at the state and utility level,” said EPRI Senior Program Manager Francisco de la Chesnaye.

The results will vary by state and utility service area. “Just as the electricity generation mix varies by state based on fuel prices and energy and environmental policies, energy consumption also varies,” said de la Chesnaye. “Over the next 5, 10, or 15 years, these assessments can provide electric utilities, policymakers, and regulators with actionable insights on critical issues such as capacity expansion.”

For example, de la Chesnaye points to the increase of electric vehicles that may result from a combination of state policies, consumer choice, and technology advances. When more electric vehicles are charged at night, state-level assessments can illustrate the potential impact across an energy system. “We can assess where that energy comes from,” he said. “How much will be from wind generation? Will baseload power plants have to cycle more, ramp up and down, or shut down? What are the implications for transmission?”

Key EPRI Technical Experts

Mark Duvall, Francisco de la Chesnaye