AN E SOURCE WHITE PAPER

The electrification framework that benefits customers, the grid, and the planet

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POWERING WHAT'S **NEXT**

What is beneficial electrification?

Electrification is the increased adoption of electric end-use technologies. The concept isn't new; we've already seen three waves of it (see sidebar). But today, utilities, governments, and other stakeholders see electrification as a way to reach their energy, climate, and sustainability goals. For them, electrification is a strategy for reducing carbon and greenhouse gas (GHG) levels; modernizing and optimizing the electric grid; and creating social and environmental equity.

We call this approach beneficial electrification. It aims to improve social and environmental outcomes for as many people as possible by:

- Lowering the costs of energy use
- Reducing GHG emissions and air-quality impacts
- Improving comfort, convenience, and productivity
- Managing the electric grid efficiently

The electrification waves

We've already seen three waves of electrification. Each one has influenced our culture, economy, comfort, and health.

The first electrification wave spanned the late 1800s through the early part of the 1900s, when electricity brought new, clean, and safe lighting to households and businesses.

The second wave hit in the mid-1900s when people started buying convenience appliances like washing machines, TVs, refrigerators, air conditioners, and kitchen gadgets. At the same time, industries started automating their operations, delivering benefits to homes and companies.

The third wave was digital. It started with computers and expanded to the internet, Wi-Fi, digital music and movies, smartphones and other personal devices, streaming services, and many other now-essential inventions. This wave continues today.

Wave four will focus on reducing the environmental harm we caused in the first three waves. It will move electrification into the transportation sector, replacing fossil fuels as the main fuel source.

We have an opportunity to make the fourth wave as important as the previous waves. But we need to move quickly and make decisions that will help everyone, while ensuring that businesses, including energy utilities, remain viable and profitable.

Key sectors and applications for beneficial electrification

As a modern energy utility, you can lead the way toward beneficial electrification. You have influence over energy supply choices and grid infrastructure, access to customer-funded capital, and decades of experience designing and delivering demand-side management (DSM) programs.

You can use these advantages to design or refine beneficial-electrification programs for these key sectors:

- **Residential and commercial buildings.** Heat pumps, water heaters, and battery storage systems are examples of electrified technologies in residential and commercial buildings. You already have extensive experience with these technologies because they're common targets for DSM programs.
- **Transportation.** Personal vehicles, public transportation, school buses, shipping or freight vehicles, trains, and service or fleet vehicles are targets for transportation-electrification programs. You have a huge stake in ensuring that electric vehicles (EVs) connect to the grid in ways that keep system costs as low as possible.
- **Industrial processes and material-handling equipment.** Industrial process applications often use natural gas or other fossil fuels, so they're logical targets for electrification. Material-handling equipment such as cranes, forklifts, port equipment, mining equipment, and airport ground-support equipment are also good candidates for electrification.

Beneficial electrification and DSM

Your DSM programs reduce energy bills for consumers and businesses. They also lessen the environmental effects of energy use and relieve strain on electricity and natural gas distribution systems. By designing and managing these programs, your program administrators have developed expertise in:

- Program design and delivery
- Measurement and evaluation
- Technology deployment
- Market research
- Marketing
- Regulatory procedures

We predict that **electrification programs will quickly grow** in importance, following DSM's lead.

This expertise can help you create valuable beneficial-electrification programs that support your goals around energy savings, GHG-emission reductions, customer satisfaction, and profitability.

But there are differences between DSM and beneficial-electrification programs. For example, regulatory environments don't mandate beneficial electrification in the same way they mandate DSM (yet). And while many investor-owned utilities have shareholder incentives or earnings adjustment mechanisms for their DSM portfolios, they haven't yet applied those mechanisms to beneficial-electrification initiatives.

Despite these differences, we predict that electrification programs will quickly grow in importance, following DSM's lead.

What are the goals of beneficial electrification?

The goal of most beneficial-electrification initiatives isn't electrification. So what exactly are they trying to achieve?

Decarbonizing and improving environments. When paired with low- or zero-carbon electricity generation, beneficial electrification can be an important way to meet carbon- and GHG-reduction goals.

The strategy is simple: Electrifying end-use technologies shrinks the carbon intensity of the energy supply. When more end-use technologies draw from a cleaner energy grid, the levels of carbon dioxide and other GHGs drop. Reduced emissions from both the power and transportation sectors also improve local air quality in urban or industrialized zones, supporting a healthier environment for populations that live or work in these areas.

Reducing electric rates and optimizing the grid. Certain electrified technologies, like water heaters and EVs, can improve the operation of the electric grid, particularly as more renewable sources come online. These technologies can also store and dispatch energy. That means they can draw electricity while it's abundant, clean, and cheap to consume, while minimizing the effect of peak demand on the system. This increases grid utilization, improves load factors, and lowers electricity rates for all customers, not just those who adopt new technologies.

Reducing overall energy costs. Electrified technologies can lower customers' energy costs. For example, the cost to drive a mile in an EV might be half the cost to drive a mile in a gasoline-powered car. And in some areas, efficient heat pumps use less energy and save customers money compared to fossil-fuel options.

Ensuring that electrification meets social needs

Beneficial-electrification programs should improve the social and environmental outcomes of all consumers, regardless of their socioeconomic status. Legislators acknowledged this in the 2015 California Senate Bill 350, which advanced several of the state's climate goals. Some of the bill's language was also added to the California Public Utilities Code:

> Widespread transportation electrification requires increased access for disadvantaged communities, low- and moderate-income communities, and other consumers of zero-emissions and near-zero-emissions vehicles, and increased use of those vehicles in those communities and by other consumers to enhance air quality, lower greenhouse gases emissions, and promote overall benefits to those communities and other consumers.

When describing aspects of your beneficial-electrification strategy and programs, use precise terminology. Here are a few terms that can help you explain the components of beneficial electrification and how their interactions may inform your policy goals:

- **Environmentally beneficial electrification.** Defined as moving an end use from a nonelectric fuel to electrification that results in an environmentally superior outcome regardless of cost. You'll need to decide what "environmentally superior outcome" means for your jurisdiction, but most outcomes focus on carbon reduction.
- **Grid-efficient electrification.** Defined as any electrification of end-use applications that lowers electricity rates for all customers by boosting grid efficiency compared to what it would have been without electrification. Note that electrification can easily fail on this goal if it contributes to peak demand.
- **Economically efficient electrification.** Defined as any electrification in which the consumer sees an equivalent or better end-use result for lower overall costs (without cross subsidies).

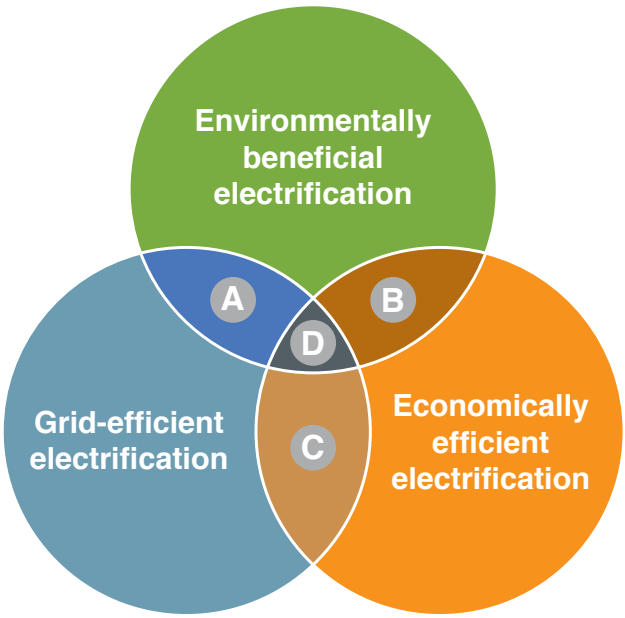
Electrification initiatives that aim to generate revenue by increasing electric load will miss the mark. They ignore the most important goals of beneficial electrification and can put upward pressure on rates, customer bills, and GHG emissions. When beneficial electrification is done in the absence of strategy or equity, there are few winners.

The beneficial-electrification framework

Now that we have a definition of beneficial electrification and we know what we're trying to achieve with it, we can start to develop programs based on the utility beneficial-electrification framework (**figure 1**).

Figure 1: The E Source beneficial-electrification framework

This framework shows how beneficial electrification can help your utility reduce carbon, lower rates, and save customers money.

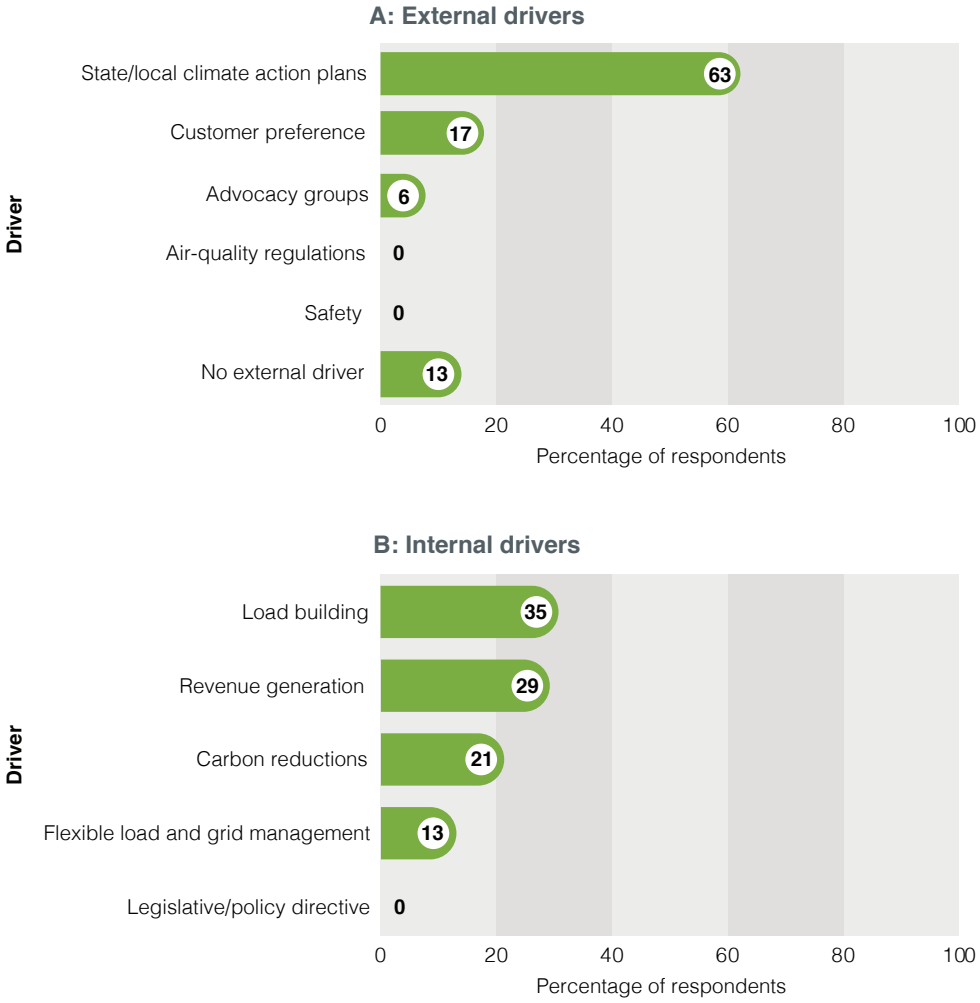


Environmentally beneficial electrification

Decarbonization has been the single greatest driver for beneficial-electrification initiatives and best represents environmentally beneficial electrification. States, provinces, cities, and even private companies continue to set carbon- and GHG-reduction goals. During an informal poll at the 2018 E Source Forum, many of our utility members told us that state and local climate action plans were the strongest external driver toward beneficial electrification. Load building and revenue generation, followed by carbon reduction, were the strongest internal drivers (**figure 2**). Check out the E Source infographic Strategic electrification: Insights to spark your interests for more data from our members.

Figure 2: Drivers of beneficial electrification

None of the utilities represented in our poll cited safety or air-quality regulations as an external driver of their interest in electrification (A). As for internal drivers, no utilities cited a legislative or policy directive (B).

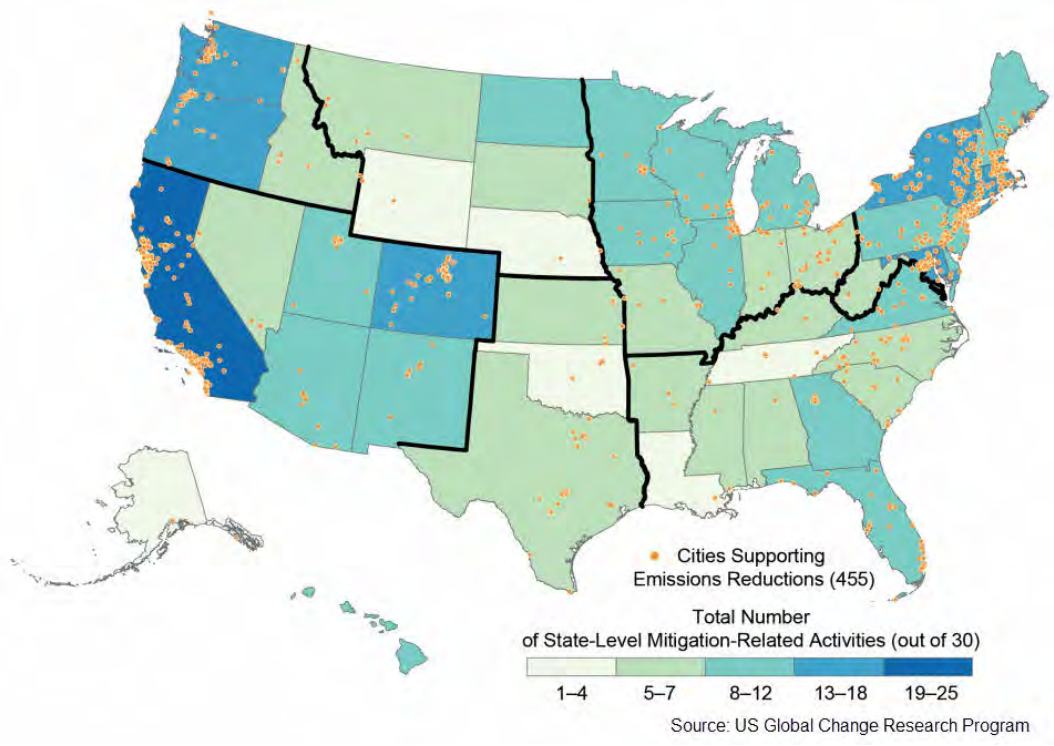


Base: 2018 E Source Forum utility attendees. A: n = 54; B: n = 52.
Percentages may not sum to 100 due to rounding.

The Fourth National Climate Assessment (PDF) from the US Global Change Research Program shows a snapshot of current emissions-reduction efforts across the country. It estimates that at least 455 US cities support emissions reductions and 110 US cities have emissions-reduction targets (**figure 3**).

Figure 3: US emissions-reduction efforts

This US Global Change Research Program map shows the number of state-level climate-mitigation activities as well as cities that are supporting emissions reductions.



Energy utilities responded to customers' demands for climate action. The Smart Electric Power Alliance's Utility Carbon Reduction Tracker identifies 44 utilities with emissions-reduction, carbon-reduction, or renewable-energy goals. These commitments underscore the necessary alliance between legislators and energy utilities to meet decarbonization and GHG-reduction goals. The Utility Dive article PNM, Avista commit to carbon-free goals on heels of state mandates describes this "growing alignment between state legislators and power providers in the push for cleaner generation." Utilities see beneficial electrification as a way to achieve these climate-mitigation goals.

Grid-efficient electrification

Electrified end-use technologies such as EVs, water heaters, and even smart thermostats can help utilities better manage the grid. These grid-enabled technologies can serve as flexible grid assets, allowing grid operators and consumers to manage electric load with system peaks, energy supply costs, and emissions efficiency in mind. These technologies can also store energy when renewables are abundant (and cheap), like overnight wind and afternoon solar, and dispatch it during times of higher demand.

Flexible load management with grid-connected devices can also help incorporate clean- and renewable-energy sources and address concerns around their intermittency. With more renewable sources like wind and solar coming online, grid operators are seeing their impacts on load shape during specific times of day and year. The concept of net load—the amount of electric load on the grid minus the amount of renewable-energy sources—presents specific challenges to grid operators: overgeneration and ramping, or the need to ramp up conventional supply-side resources as the share of renewable resources subsides. Read more about these intermittency issues in the RAP report Teaching the "Duck" to Fly (PDF).

Certain grid-enabled beneficial-electrification technologies, like EVs and water heaters, can help solve the problem of overgeneration and ramping up by storing energy when it's abundant to dispatch during the ramping period later in the day. As one example, the E Source white paper Battery killers: how water heaters have evolved into grid-scale energy-storage devices describes the benefits of grid-interactive water heaters, including intelligent load shifting and traditional demand response.

Economically efficient electrification

Economically efficient electrification highlights the overall economic benefits or costs that electrification might cause. Goals might include:

- Lowering the cost of producing an end-use function such as lighting or driving
- Increasing the number of jobs or decreasing unemployment
- Increasing the overall economic efficiency of markets by giving people more disposable income, which creates a multiplier effect

As you put together your beneficial-electrification strategy, you must consider economic efficiency because money drives change. Customers say they participate in utility programs because they want to cut their energy expenses. But, as we've seen in the DSM world, customers don't always think about life-cycle costs, and if they have to spend money up front, they're less likely to enroll. Encourage residential and business customers to participate in your electrification programs by offering them financing or rebates.

If you're in the early stages of designing a beneficial-electrification strategy, start by engaging with efficiency organizations and utilities in your region to learn about their beneficial-electrification goals. From there, identify stakeholders and additional partners.

Remember that the most important part of your strategy is customer benefits. Take a customer-first approach as you modify policy, rate design, cost-effectiveness, and regulatory incentives to ensure that customers benefit from your electrification plan.

Electrification through the customer's eyes

The success or failure of electrification depends on consumers' purchasing decisions. Electrification efforts will flop unless:

- Consumers see value in purchasing an EV over a vehicle with an internal combustion engine or an electric appliance over a fossil-fuel-powered one
- Property owners and managers see value in replacing their fossil-fuel-powered HVAC, water-heating, and cooking systems with electric equipment, and they see value in installing EV charging infrastructure (or their renters pressure them to make these upgrades)
- Small, midsize, large, and industrial businesses see value in purchasing electric systems and vehicles over alternatively fueled ones

People respond to messages that connect the dots between a product's value and their lives. Your electrification plan will be meaningful and relevant to customers only if you leave your priorities out of the conversation and clearly speak to the value that electric technologies offer over existing alternatives.

The psychology behind why people see value in one offering over another is complex, and numerous electric technologies have compelling attributes, but cost is the primary driver of residential and business customer participation in utility programs.

Why product cost-competitiveness matters

People aren't going to put their own, their family's, or their business's finances in jeopardy to help society decarbonize power generation and transportation. For consumers, property owners, or businesses to choose an EV, appliance, or system over an alternative, the electric product must be cost-competitive with the alternative and have the same or better functionality. Decades of DSM programs have taught us this lesson.

According to the E Source Residential Customer Insights Center, of the 29% of Americans who participated in an energy-related program or service from May 2017 to May 2018, 47% said they did it to save money. For the 19% of small, midsize, and large businesses that participated in a utility energy-efficiency program in 2018, the top three reasons they gave for doing so were because they got rebates or financing (52%), they liked the return on investment or payback (47%), and they wanted to reduce maintenance (41%), according to the E Source Business Customer Insights Center.

If the up-front or ongoing costs of an EV, appliance, or system are slightly higher than an alternative offering, only consumers with motivations beyond cost savings—whether comfort, environmental stewardship, social status, performance, or something else—will make the purchase. If this is the case with your offering, it's critical to segment your customers and target your marketing.

How to design electrification value propositions and messaging

When asked to choose between an uncommon product, like an EV, and a common one, people will choose the uncommon one only if they can see their life being better because of it.

As you promote your electrification programs, emphasize the quality-of-life improvements that electric technologies bring. An effective way to market EVs might be "Driving electric means fueling up in the comfort of your home and spending a third of what you do on gas." A heat-pump promotion might go something like this: "Choosing a heat pump means saving two-thirds on your home heating costs and getting a built-in air conditioner."

On your website or in your advertising, when you talk about the value of going electric, lead with terms and phrases that resonate with everyday people. If your messaging is too technical—for example, you explain the role electrification plays in the decarbonization of the economy—customers will tune you out. Take a commonsense approach to developing your value propositions and messaging, and test your concepts with real customers.

The branding potential with electrification

People rarely see utilities as leaders and champions of the environment. Rather, they see utilities as laggards and polluters. The branding implications of utility efforts to electrify and decarbonize are serious when you consider that 41% of Americans say they have personally experienced the effects of global warming, according to Yale University's and George Mason University's March 2018 Climate Change in the American Mind study. That's a 10% increase since March 2015.

This is your chance to win customers over with a new business model that creates cheaper, cleaner solutions. And customers want those solutions—65% of Americans agreed in 2018 that their utility should source more renewable energy, according to the E Source Residential Customer Insights Center.

To talk to customers about beneficial electrification in your brand communications, we recommend using language like "When you choose electric, you connect your commute, your home heating and cooling, your cooking, and your business to our increasing supply of renewable energy. By choosing electric, you're living a better life powered by our shared renewable resources: the sun, wind, and water."

Next steps for utilities

Electrification is a complex but worthwhile endeavor, considering the opportunities it can deliver to customers, the grid, and the planet. Plus, thanks to decades of work on DSM, you already know how to design, manage, promote, and measure programs. You can apply this knowledge to developing an electrification initiative. But the success of your initiative relies on coordination and planning.

Engage stakeholders within and outside of your utility.
In the early days of DSM, collaborative workshops allowed multiple stakeholders to not only be heard, but to also codesign programs, goals, and initiatives. This is also a good model for your electrification strategy.

Establish an overall set of objectives for your electrification strategy.
What goals are imperative and have management and stakeholders agreed to? What are the environmental goals? What are the regulatory constraints? Without specific goals, it will be hard to determine which electrification programs to develop.

Analyze grid effects and optimization.
The devil is in the details when it comes to how electrification technologies will affect the grid, the need for additional infrastructure, and the impact on rates. Dynamic modeling and forecasting can help you identify the technologies and controls that will help consumers realize all the advantages of electrification.

Convince regulators that electrification can benefit everyone.
If done correctly, electrification offers huge potential benefits for consumers and the environment. Partner with outside groups to encourage regulators to establish utility profit or revenue incentives to reward excellent, aggressive implementation.

Create an electrification potential roadmap.
Put together a methodology for studying the potential of electrification programs in your territory. Prioritize human factors, market acceptance, and policy or regulatory influences as dominant drivers of change. Use your experience with DSM potential studies to shape your methodology.

Create programs that customers actually want.
Use design thinking and collaborate with customers to identify and understand their wants and needs. If you craft an electrification initiative that meets only your utility's needs, customers won't participate and your brand will take a hit.

Deliver on your beneficial-electrification plan.
Utilities have an advantage in the electrification marketplace. Use decades of DSM failures and successes to jump-start consumer and trade ally engagement. For example, installing EV charging stations won't help you meet your beneficial-electrification goals if you don't help boost demand for EVs in your jurisdiction.

For over 30 years, E Source has been providing market research, data, and consulting services to more than 300 utilities and their partners. This guidance helps our clients advance their customer energy solutions and enhance their relationships, while becoming more innovative and responsive in the rapidly evolving market.

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