Beneficial Electrification and Grid Opportunities

A digital report by the Active Efficiency Collaborative

What is Beneficial Electrification?

Beneficial electrification – transitioning end-uses powered directly by fossil fuels to electricity in circumstances where certain benefits are achieved – is accelerating in energy markets across the world. Efforts to electrify power grids are driven by multiple factors, ranging from technological innovations in end-use technologies, connectivity, and digitalization, to consumer interest and policy objectives such as cost savings, climate emissions reductions, and resilience.

Beneficial electrification is an example of an **Active Efficiency** approach. The Collaborative defines Active Efficiency as the combination of technologies and practices that "optimize the use of energy by integrating the benefits of traditional energy efficiency measures with the opportunities presented by digital technologies." This mix of technologies and practices enables energy consumption to be more time-dependent and integrated with flexible sources, and yields numerous, diverse benefits. Beneficial electrification has a number of Active Efficiency benefits. For example, switching from fossil fuel-powered to electric devices is often accompanied by greater energy efficiency in the device's performance. It also facilitates the digitalization of the device, enhancing the ability to modulate the timing of energy use to provide system-level benefits and enhance the reliability and resilience of the electric grid. This report describes these cross-system opportunities and suggests considerations for deploying beneficial electrification with an Active Efficiency mindset – focusing on impacts in the built environment as well as opportunities to achieve a more dynamic, efficient, and clean grid. **Utilities and utility regulators**, and **state policymakers** can dive deeper and the report also provides **regional insights** through the presentation of state-level data.

When is Electrification Beneficial?

Electrification is defined as the transition of end uses historically powered by fossil fuels to electricity. It is increasingly viewed as a critical element of decarbonization – providing opportunities to reduce greenhouse gases and other emissions, improve health outcomes, reduce costs, and improve grid management and resilience.

Not all electrification is beneficial: in some cases, the use of specific technologies or implementation strategies can reduce efficiency, increase emissions, or raise costs for consumers. Ambitious electrification goals – e.g., achieving 100% electrification – have proven more viable in new **residential buildings** and more challenging for **commercial buildings**. But the **trend toward electrification** continues, driven by policies, technological opportunities, and market trends. To focus attention on the constructive opportunities, the term "beneficial electrification" was **defined** by the Regulatory Assistance Project (RAP) as electrification in which one or more of the following conditions are met without adversely affecting the other(s):

1. Saves consumers money over the long run;
2. Enables better grid management; and
3. Reduces negative environmental impacts.

Recently, **others** have recommended the definition be amended to include a fourth condition: that beneficial electrification "improves product quality or consumer quality of life," a reflection of the fact that many consumers are motivated by a product's performance as well as its environmental impacts and costs. For example, many consumers switch from a gasoline to an electric vehicle not only to reduce greenhouse gas emissions and fueling costs, but **because** they enjoy the smoother ride, reduced maintenance, and special features like gamification and partial automation.

Many examples of electrification satisfy this definition. In addition to specific technologies, beneficial electrification can also include combinations of technologies across sectors. Residential electrification can include household equipment such as electric water heaters, space heaters (heat pumps), cooking equipment (including electric induction stoves), and household appliances like clothes dryers, lawn mowers, and leaf blowers. Commercial and industrial electrification opportunities include commercial building equipment (e.g., space heaters, water heaters, commercial cookers), forklifts, air compressors, and process electrification. Beneficial electrification of buildings is a key step in enabling the growth of **grid-Interactive efficient buildings** (GEBs),

One example technology is heat pumps used in heating and cooling. Electric heat pumps are often more efficient than fossil fuel-powered HVAC technologies and can be used in both hot and cold climates. Because of their enhanced efficiency, they can save consumers money and reduce negative environmental impacts compared to their fossil fuel counterparts. When coupled with smart thermostats, their use can be modulated to enable better grid management, such as by preheating or precooling spaces during times of lower demand and reducing energy use during peak hours.

which use distributed energy resources (DERs) to optimize energy use for grid services, occupant needs and preferences, and cost reductions in a continuous and integrated way. For GEBs, beneficial electrification through space and water heating and electric vehicles can increase the portion of their load that can participate in demand flexibility. Transportation electrification includes light duty vehicles, vehicle fleets, commercial trucks, freight trucking, trucking refrigeration, mass transit (buses), school buses, and even micromobility (e.g., eScooters). Agricultural electrification opportunities include grain drying, lighting, grain handling, water heating, and more.

The **acceleration** of the electrification trend is increasingly **viewed** as **inevitable**. As many state and local governments seek to **accelerate decarbonization,** low-carbon electricity is increasingly viewed as the preferred fuel. This is accompanied by the rapid and significant decreases in the costs of clean electricity generation. According to **Lazard**, utility-scale solar and on-shore wind became competitive with fossil fuel counterparts several years ago: in the United States, the costs of utility-scale solar averages $31/MWh and onshore wind $26/MWh, compared to $41/MWh for coal and $28 for combined cycle gas generation. In addition, electric devices (e.g., electric vehicles, space and water heaters) are falling in cost at the same time that their efficiency is improving. Greater connectivity and advances in information technology, which allow more advanced use of energy management and demand flexibility, further facilitate greater beneficial electrification.

Benefits of Beneficial Electrification

Beneficial electrification has numerous potential benefits. Some examples include:

- **Emissions Reductions:** Reduced pollutant emissions have both environmental and public health **benefits.** Reductions in greenhouse gas emissions can help utilities meet climate goals and targets, and reduced emissions of hazardous pollutants like nitrogen oxide, carbon monoxide, ultrafine particles, and formaldehydes improve health outcomes, e.g., by reducing likelihood of asthma and lung diseases. This is a **direct effect** in the case of electrifying transportation, which could lead to dramatic reductions in air particulate pollution, especially – but not only – when the electricity is sourced by clean power.
- **Energy Cost Savings:** Broad scale electrification at the residential level, paired with energy efficiency improvements and the integration of DERS (e.g., solar rooftop PVs, community-scale solar, or distributed storage) can lead to significant bill savings for customers in the mid- to long-term. This is **especially relevant** for new construction, transitions away from propane or heating oil, customers replacing both furnaces and air conditioners at the same time, and customers also pursuing rooftop solar investments.

- **Jobs and Economic Development:** Increased electrification is expected to drive economic development and create new job opportunities related to increased demand for all-electric appliances and energy efficiency upgrades. For instance, a **UCLA study** found that electrifying all of California's existing and new buildings could create more than 100,000 jobs (e.g., construction, manufacturing, and electricity generation and distribution jobs), even after accounting for job losses in the gas industry.
- **Enabling Cleaner Power:** With the help of smart technologies, beneficial electrification increases the scale of flexible loads that can be charged at times to optimize the use of renewable energy and reduce their curtailment. This eases the integration of renewables, and reduces the grid's reliance on fossil-fuel peaking plants.

A Spotlight on Grid Impacts

Beneficial electrification can have significant and complex impacts on the grid, including some **liabilities** as well as numerous **opportunities**. Fundamentally, whether additional electrification produces benefits or costs depends on how well its deployment is coordinated with grid impacts. For example, replacing millions of gasoline-powered vehicles with electric vehicles would reduce emissions, save people money, and not stress grid reliability so long as the EVs are charged at off-peak times.

Conversely, charging these same vehicles during peak times of the day could cause transmission congestion issues, require expensive upgrades, and possibly involve higher-emissions generation. A "do no harm" mindset for grid impacts is required at a minimum to ensure electrification meets the "beneficial" definition. However, when viewed at the system level, beneficial electrification has the potential to be positive and transformational, accelerating a paradigm shift toward greater efficiency in grid operations.

Scaling Up Demand Flexibility Through Beneficial Electrification

Historically, electricity demand was considered inflexible – consumers used electricity as desired, while grid operators, usually vertically-integrated utilities, were required to meet that demand by any viable means ("follow the load"). During critical peak events, the cost of **meeting this demand** can be astronomical, requiring not only **additional power generation** but also ancillary grid services and maintenance of the permanent infrastructure to carry the elevated power flows. Meanwhile, many consumers – especially residential and smaller commercial consumers – paid for electricity with flat rates, insulating them from the immediate financial implications of their electricity use during peak demand periods. The result has been an inefficient system with poor or nonexistent market signals, in which consumers have little incentive or ability to moderate or shift their energy use, and power system operators build out costly infrastructure to meet demand during those brief peak periods, with capacity that is otherwise underutilized.

In recent decades, the overall framework for the utility system has evolved to different extents across the U.S., resulting from market restructuring as well as the greater use of demand response programs and other demand-side management innovations. But the high costs of critical peak events and the lack of price signals for residential and commercial electricity consumers are still common issues. Now, there is potential for even more dramatic changes to address them.

Developments in end-use technology and connectivity, together with changing grid characteristics (especially the integration of renewable resources that are clean, but less predictable and flexible), have enhanced the value proposition for demand-side management tools. New models around the U.S. demonstrate that resource planning and power production do not necessarily need to be performed centrally to "follow the load" – the load itself can also "follow the supply." This presents an enormous opportunity to capitalize on a key characteristic of electricity: that the costs, impacts and benefits of using electricity change depending on the grid situation. When supply and demand can engage in a real-time system – especially where the value of responsive loads is known and there exists a fair mechanism to monetize it – a very different operating model is possible. And when greater quantities of load are connected and electrified, these opportunities can be scaled up.

The ability to modulate demand-side load can be described by the term demand flexibility (also "load flexibility"). When combined, beneficial electrification and demand flexibility can benefit the grid in multiple ways. Electrification creates a broader base of electric loads that can respond to the real-time operation of the grid; this ensures that electricity is used when it is abundant, affordable, and clean, and stored or conserved when it is scarce and expensive. The U.S. currently has a very large **untapped potential** to harness the flexibility of new and existing electrical loads. **Demand flexibility** is a high-value proposition; however, in many places it lacks a commensurate incentive that rewards customers for participating in flexible demand programs.

For Utilities and Utility Commissions

What Beneficial Electrification Can Achieve for the Grid

Electrification of transportation, building space and water heating, and heating operations in the industrial and agricultural sectors represents opportunities for electric utilities to grow load, increase asset utilization, and generate new revenues. These opportunities mitigate rate increases while achieving **significant societal benefits**. For many utilities and utility regulators, these objectives are appealing, but the path to achieving these benefits is neither simple nor immediate. For other stakeholders, especially natural gas utilities and petroleum industries, a shift to beneficial electrification raises concerns around market share, the possibility of stranded assets, and increased costs. As electrification continues to accelerate, how can this transition be guided to create the greatest good along the way?

Regulatory environments remain deeply siloed between different fuels; new partnerships and stakeholder connections are required to advance beneficial electrification – e.g., to incorporate transportation networks, and to ensure tailored solutions for customers' needs. The cost-benefit analysis for different beneficial electrification strategies can vary dramatically based on local context. In **commercial buildings**, for example, 100% electrification may be cost-prohibitive, while it remains more viable in **residential buildings**.

Additionally, advancing beneficial electrification must ensure consumer rates are affordable, maintain high delivery reliability, and ensure equitable distribution of costs and benefits. These challenges can be addressed through a combination of technological and economic innovations, each of which presents its own new opportunities. Though there is great interest in accelerating beneficial electrification, a national-scale transition will not happen overnight, providing time to develop strategies that are customized for specific grid needs and evolve with technological innovations, new capabilities, and the nature of a specific grid (e.g., whether it is more centralized or distributed, and to what extent it relies on technologies such as microgrids, distributed resources, and storage).

Each of these issues can be framed as a challenge and a commensurate opportunity:

Load Shape Management

Challenge

As space heating, water heating, transportation, and various industrial/agricultural loads shift from natural gas or fuel oil to electricity, the traditional load shape for the electric utility can change significantly (e.g., if 100% of space heating load is electrified, many utilities in cold climates will become winter peaking) and the increased amplitude of peaks can create greater challenges for the utility.

Commensurate Opportunity

"Smart" loads offer an opportunity to mitigate this challenge, especially when combined with storage (thermal or electrical), enabling a utility to engage buildings and industry as new generation resources.

Vehicle Electrification

Challenge

As electric vehicles proliferate, utilities will add new loads that may be charged in unpredictable patterns (e.g., location, time, duration, rate). These new loads may exacerbate peak demand, especially in suburban environments.

Commensurate Opportunity

The ability to engage vehicle charging systems to incentivize the desired timing, rate, or duration of charging can **significantly mitigate** this challenge, and potentially serve as a grid or distributed resource.

Capacity Management

Challenge

Many distribution service areas have limitations in their electricity delivery capacity, constraining the number of new loads they can serve without making significant new investments (e.g., upgrading feeder lines or substations, adding new assets such as batteries); this can drive up costs. In some urban service areas, utilities may have capacity limitations due to their existing infrastructure and/or geography (e.g., a lack of real estate available for a new substation or battery storage).

Commensurate Opportunity

Managing loads in a way that avoids adding new physical infrastructure has very high value. This includes maximizing the energy efficiency and other distributed energy resources (DERs) in the system.

New (Capital or Non-Capital) Assets

Challenge

As new investments are pursued in beneficial electrification, storage systems, and DERs, utilities will be challenged to assess the value of new assets such as grid-scale battery storage versus the value provided by "responsive" customers who manage their electricity consumption to the benefit of the larger system. Utilities will also have to consider seasonal storage as a means of managing system performance and cost.

Commensurate Opportunity

While current planning models and available economic data make it difficult for both utilities and regulators to evaluate these tradeoffs, **a number** of **field demonstrations planned** in the coming years can help address this challenge.

Equitable Costs and Benefits

Challenge

Even in the case where electrification satisfies all necessary criteria to be considered "beneficial" (including either reducing costs or having a neutral impact on costs for consumers), the benefits of the investment or program may not be equitably distributed. There may be differential impacts on industry players (e.g., natural gas utilities concerned about stranded assets) and/or among consumers (e.g., equity concerns between wealthy communities and frontline communities/communities of color).

In both cases, the clustering of benefits and costs may create actual or perceived unfairness, impacting the benefits achieved and complicating implementation.

Commensurate Opportunity

Beneficial electrification, like all investments, requires a proactive approach to consider its impacts to the energy system and the equitable treatment of consumers. Utilities and utility regulators should consider policies to ensure the transition benefits all affected customers.

Achieving this outcome requires a targeted approach and measurable and verifiable objectives. While the precise strategy must reflect local context, the following tools may be of use to ensure electrification is transformational for **low-income residents**:

- Assessment of customer needs (e.g., through surveys and outreach) and open communication with affected communities;
- **Prioritization of benefits** to communities most harmed by the extraction and burning of fossil fuels;
- Designing programs to ensure low-income customers do not experience significant cost increases for electricity and/or rent, such as by conditioning funding for building owners on **limits to rent increases** – a requirement that is also included in the federal Weatherization Assistance Program.

Resilience

Challenge

Greater reliance on electricity for end-uses has raised concerns about resilience. In a time where extreme storms and wildfires have become more frequent, there is concern that increased reliance on the electricity grid will make disruptions more damaging.

Commensurate Opportunity

Ensuring resilience in a beneficially-electrified world requires multiple considerations.

In the near term, hybrid systems, such as hybrid water heaters able to run on either natural gas or electricity, can be an important stepping stone to facilitate electrification while providing consumers with an option for different fuel sources.

Viewed at a system level, however, flexible, beneficially electrified loads – especially through microgrids – may be a critically important **resilience benefit** to help grid operators manage outages. This was observed in the recent 2020 wildfires in California, where various groups of microgrids delivered flexible load and provided backup electricity to help keep the lights on for Californians. For instance, six microgrids funded by the California Electric Program Investment Charge reduced load by about 1.2 MW per day when activated. On August 15, OhmConnect leveraged its network of home microgrids and networked home appliances to provide **220 MWh to the grid**, which could power more than 9,000 average American homes for a day.

Principles for Utilities and Utility Regulators

There are several principles that policymakers and regulators in the utility industry can use to guide beneficial electrification.

- **Build on a strong energy efficiency strategy.** Energy efficiency is often a least-cost investment, and by reducing energy use it both contributes to overall emission reductions and facilitates beneficial electrification. Further, the value of demand flexibility is enhanced when combined with energy efficiency to provide additional cost and energy savings. Energy efficiency results in smaller energy loads, which are operationally easier to shift to a different time of day and can increase utilization during periods with greater renewable resources available. Combined with grid-interactive strategies, energy efficiency can provide additional relief from system stress and further resiliency benefits.
- **Deploy smart meters, sensors, and controls that allow end-uses to communicate and respond to grid conditions.** Greater control over load shapes and aggregated end uses can enable improved grid management through load shifting, peak shaving, ancillary services, grid balancing services, load-following demand response, and regulation demand response. Depending on the program and rate design, these activities can keep overall costs low for consumers or directly save consumers money on their electric bills or appliance purchases. In contrast, the absence of these technologies could lead to severe grid consequences as electrification scales.
- **Simplify end-use operation through low-cost, turnkey, and automated solutions.** Most energy consumers – especially residential consumers – do not want to be inconvenienced by real-time choices about their energy consumption. Automating end-use operation in a way that simplifies interactions and enables demand flexibility is key for scaling up beneficial electrification in these markets.
- **Recognize the value of flexible load for grid operations and compensate asset owners for value delivered.** Beneficial electrification can provide flexible load and enable the incorporation of variable energy resources, thus reducing the need for non-renewable resources to meet demand peaks. This flexible load requires recognition and compensation, with incentives being more powerful than avoided costs.
- **Understand the marginal emissions impacts — both short- and long-term — of changes in load.** Recognizing the emissions from the addition of one more kWh used or avoided helps quantify the emission impacts associated with electrification.
- **Measure the impact of beneficial electrification on air pollution.** Determining the pollution impacts associated with different types of investments can assist regulators and utilities in developing a more complete picture of the relative benefits of electrifying certain end uses.

- **Account for the useful lives of different investments.** Providing customers with standard estimates of useful equipment life ensures that utilities and consumers can make informed decisions on investments such as water heaters, heat pumps, industrial boilers, or vehicles.

- **Design rates to encourage beneficial electrification.** Well-designed rates can send signals about costs of providing electricity at different times and can incentivize and maximize the benefits of beneficial electrification and smart, grid-interactive capabilities.

Examples of Implementation

Many utilities, regulators, and other stakeholders are exploring different models to implement beneficial electrification and demand flexibility. These examples provide some insights on different approaches and outcomes.

Adjustments to the Regulatory Framework

- CPUC changes guidelines to allow electrification in energy efficiency program funding: In August 2019, the California Public Utilities Commission (CPUC) unanimously voted to alter the 1992 "Three-Prong Test for Fuel Substitution," which determined which fuel substitution projects were eligible for ratepayer-funded program support. The decision resulted in **three main adjustments**: it designated the "baseline" for comparing energy and emissions savings, identified carbon emissions as the measure of environmental impact, and updated the methodology for determining fuel energy savings. The changes effectively allow building electrification to compete for **$1 billion** in energy efficiency funds.

Utility Programs – Incentives and Rebates

- Incentives for smart thermostats and demand response participation: Duke Energy's **EnergyWise Business Program** provides free smart thermostats and monetary rewards for participation in demand response events. During an event, Duke Energy sends a signal to customers' smart-thermostat-connected air-conditioners that cues the equipment to ramp down/reduce its energy use for a few hours.

- Incentives for high-efficiency electric equipment: **Georgia Power** administers a number of utility programs that replace equipment using non-electric fuel sources with high-efficiency electric equipment, such as the residential Home Energy Improvement program, Earth Cents New Home Program, Commercial Custom Program, and Small Commercial Direct install program.

Utility Programs – Financing Beneficial Electrification

- Orcas Power and Light Cooperative (OPALCO) **Switch It Up! On-BillTariff** beneficial electrification program: Administered by Washington State co-op OPALCO, the program finances the replacement of propane-powered residential and commercial equipment with electric, efficient equipment and EV charging stations. The program is supported by a $6 million zero-interest loan from the U.S. Department of Agriculture through the Rural Energy Savings Program.

- Loan financing options for heat pumps: In the New York State Clean Heat Program, utilities administer incentives for heat pumps for all customer sectors. The **program** provides two loan financing options — on-bill recovery loans and smart energy loans administered by NYSERDA's loan servicer — ranging from $1,500 to $25,000. The program requires contractors to follow best practices for heat pump selection and installation.

Demand Flexibility

- Heating Electrification Program and Flexible Load Management Pilot, Efficiency Vermont: In 2018, Efficiency Vermont published a year-long investigation into consumer products and energy management systems that could complement distribution utility demand response services. That same year, Efficiency Vermont partnered with Washington Electric Co-op (WEC) on a two-year pilot program called PowerShift that aims to enroll 100 heat pump water heaters and 100 electric resistance water waters with WiFi-enabled thermostats for demand response.

- Increasing Demand Response participation by creating better market signals: Portland General Electric is piloting a multi-year Smart Grid Test Bed in three neighborhoods that creates market signals through a combination of behavioral economics and technology deployment.

- Creating an independent marketplace to trade decentralized energy: To effectively promote flexible beneficial electrification, it is necessary for the benefits of this technology to be valued in the marketplace. In Europe, the **NODES** marketplace — created by Norwegian utility, **Agder Energi**, in collaboration with **Nord Pool**, a European power operator — was established in 2018 as an independent marketplace that allows European grid operators, energy generators and customers to "**trade decentralized flexibility and energy**." The first energy market that enables consumer participation, NODES has already enabled Western Power Distribution in the UK to procure 50 MW of flexibility services from August to September of 2020 alone. NODES leverages **Microsoft's Azure IoT** software to **collect** vast amounts of data and use **predictive forecasting** for energy optimization to ensure the market's smooth operation. The result is a more flexible grid that needs less infrastructure investments, allows **better control** over local grid congestion, and reduces renewable energy curtailment.

Utility Program Additional Resources

- Additional compilations of utility programs are available on **space** and water heating **State-by-state** and, at **rural coops**, specific to **heating**, at **rural coops**, and specific to **electric vehicles**.

For State Policymakers

Setting a Policy Environment that Guides Beneficial Electrification

In some states, policymakers are looking to beneficial electrification as a mechanism to address greenhouse gas emissions and/or other air pollutants regulated by the federal Clean Air Act, increase energy system and building resilience, moderate peak demand, lower electric system costs, and support grid modernization. In order to accelerate this progress, state policymakers can open up marketplaces for Active Efficiency technologies by developing targets for Active Efficiency and demand flexibility. In developing such policies, state policymakers, including State Energy Offices that advise or develop energy policies and plans, as well as utility regulators, should consider the energy resource mix of their state, the building stock, and the state of grid modernization efforts (such as deployment of advanced metering infrastructure) to support two-way communication flows. Policymakers, with input from State Energy Offices and utility regulators, should develop these targets in consultation with utilities, businesses, technology providers, and other stakeholders who can help policymakers understand the potential for Active Efficiency in the state.

As already noted, maximizing Active Efficiency through flexible, beneficial electrification can help achieve state decarbonization goals, integrate renewable generation and distributed energy resources (DERs), and increase resilience. However, there are many challenges to overcome before widespread deployment is achieved, and many states lack a clear vision and roadmap to do so. This is an area where state policymakers can have a catalytic impact.

Strategies include:

- **Establish a clear vision and roadmap.** Clear guidance empowers regulators to develop strategies promoting beneficial electrification that delivers on established goals.
- **Build on a strong energy efficiency strategy.** Energy efficiency is often a least-cost investment, and by reducing energy use it both contributes to overall emissions reductions and facilitates beneficial electrification. Further, the value of demand flexibility is enhanced when combined with energy efficiency to provide additional cost and energy savings. Energy efficiency results in smaller energy loads, which are operationally easier to shift to a different time of day and can increase utilization during periods with greater renewable resources available. Combined with grid-interactive strategies, energy efficiency can provide additional relief from system stress and resiliency benefits.

- **Ensure affordability and access to power for all.** Beneficial electrification efforts should adopt a multi-faceted, measurable approach to ensure equitable outcomes in all policies. Such a strategy could include elements such as the equitable allocation of system costs and benefits (both direct and indirect); commitments to prevent environmental and public health damage, especially to vulnerable and frontline communities; development of localized workforces; prioritization of infrastructure, such as multifamily retrofit programs and minimizing the potential for **stranded gas assets** (a critical component for low-income populations without accessible heating alternatives).

- **Develop state-wide analyses of the potential of demand flexibility.** Additional analysis is critical to understand the potential for demand flexibility to support improved reliability, resilience, and affordable energy, and its impacts on all consumers.

- **Use state-owned facilities as test beds for beneficial electrification and demand flexibility.** State-owned facilities, including government buildings and fleets, are valuable test beds to demonstrate and validate use cases while supporting workforce training and development.

- **Support the development of critical infrastructure, including smart meters and controls, which allow end-uses to communicate and respond to grid conditions.** These technologies are necessary to ensure electrification is beneficial. Greater control over load shapes and aggregated end uses can provide a range of grid support, including load shifting, peak shaving, ancillary services, grid balancing services, load-following demand response, and regulation demand response. The result can keep overall costs low for consumers or directly save consumers money on their electric bills or appliance purchases, depending on how programs and rates are set up.

- **Facilitate the aggregation of end-use loads.** To ensure beneficial electrification amplifies the potential of demand flexibility, policies should enable utilities and third-party energy service providers to aggregate residential and small commercial and industrial customers' loads and DERs to provide grid services and receive appropriate compensation for such services.

- **Work collaboratively with the industry to design rates, markets, utility compensation, and policy incentives.** Time-differentiated rates, Clean Peak Standards, markets and compensation for DER-provided grid services, and performance-based utility compensation can help advance Active Efficiency, beneficial electrification, and grid-interactive efficient buildings (GEBs).

- **Recognize the value of flexible load for grid operations and compensate asset owners for value delivered.** Beneficial electrification can provide flexible load that enables the integration of variable energy resources into the system, thus reducing the need for non-renewable resources to meet demand peaks. This load requires recognition and compensation, and incentives are typically more powerful than avoided costs. Currently, not all DERs are able to participate in wholesale electric markets, and some markets do not recognize long-term **resource value**.

- **Understand the marginal emissions impact of changes in load.** Properly assessing the benefits of electrification requires the ability to recognize and measure the emissions impacts from each additional kWh used or avoided.

- **Explore new metrics, like emissions efficiency, to measure the impact of beneficial electrification on air pollution.** Determining the pollution reductions associated with different types of electrification investments can assist regulators and utilities in assessing the relative benefits of electrifying certain end uses.

  Every government office can play a critical role, and collaborations across offices – and with utility commissions – are likely to achieve the most consistent policy frameworks. Legislatures can set emissions targets, allocate resources to programs, and guide tax policy. Governors' offices establish key priorities (like decarbonization) and voluntary targets, emit executive orders, develop programs, and rally collaboration among stakeholders and state agencies. State Energy Offices can **develop roadmaps** to advance Active Efficiency and GEBs policies and programs in their states and present analysis to aid decision-making.

  Some common challenges for setting a strong policy/regulatory framework **include** the need to test and validate performance of new technologies; quantifying economic benefits to the state and ratepayers; valuation of resilience, environmental and social impacts; insufficient qualified workforce to install technology; building owners that are unfamiliar with new technology; clarifying benefits of participation to facility owners and tenants; developing standards for communication; and rolling out advanced metering infrastructure and distribution management systems. Cybersecurity concerns must also be addressed. Fundamentally, building and facility owners as well as utility and grid operators must perceive benefits to installing and operating grid-interactive, demand flexibility functionality.

Examples of Implementation

Optimal policy design for beneficial electrification and demand flexibility varies significantly by local context, but many states are exploring different strategies and generating lessons-learned. The following examples of implementation provide some insights on different objectives, approaches, and outcomes, including the roles of key stakeholders.

Government Leadership Across Institutions

- **New York leads with Decarbonization:** Citing the need for rapid decarbonization, Governor Andrew Cuomo **announced** an additional $2 billion in energy efficiency and building electrification initiatives in January 2020. The New York State Public Service Commission approved ambitious energy efficiency and electric heat pump targets; taken together with programs through the New York State Energy Research and Development Authority, New York Power Authority, the Long Island Power Authority, and a previous PSC order on efficiency, New York State's investments in energy efficiency and clean heat investments will reach more than $6.8 billion from 2020 through 2025.

- **Electrification of Transportation in Colorado:** Colorado has implemented an integrated strategy to promote electrification of vehicles through legislation supporting electric vehicle tax credits, executive orders to establish a transportation electrification work group and zero emission vehicle program, PUC procedures to authorize electric utilities to recover costs on charging ports, and a Memorandum of Understanding with other states in the region to create an **Intermountain West Electric Vehicle Corridor**.

- **A Vision for Equitable Decarbonization in Minnesota:** The Minnesota Center for Energy and Environment has created a **2040 Vision** for Equitable Decarbonization of the Building Sector. This vision is intended to center "equitable decarbonization" – "the just and equitable transition from the carbon-intensive energy services... to decarbonized technologies and fuels in planned, managed steps." The vision considers disruptions to utility business models and regulatory frameworks, which may alter the use of incumbent energy infrastructure and impact costs to energy consumers. The vision also includes consideration of the future energy workforce, using flexible, efficient load as a resource, transitioning to decarbonized heat and other end uses, equitable utility regulation, and a "commitment to the public good."

- **Rebates for heat pumps in Maine:** The Efficiency Maine Trust (EMT) utilized aggressive online ad campaigns, public service announcements, and a strong partnership with more than 400 trade allies to promote the **electrification of space and water heating** with high-efficiency heat pumps. EMT provides tiered rebates, ranging from $500-$2,000, and financing on more than 55,000 high-efficiency mini-split ductless heat pumps that meet the minimum rating of 12 heating seasonal performance factor (HSPF). In 2019, EMT also crafted legislation that established a goal of installing 100,000 new high-performance heat pumps in Maine homes and businesses over five years and secured funding commitments of nearly $20 million/year for financial incentives to help achieve that goal.

Policy-Regulatory Collaborations and Sharing of Best Practices

- **NASEO-NARUC GEBs Working Group:** The National Association of State Energy Officials (NASEO) and the National Association of Regulatory Utility Commissioners (NARUC) direct the NASEO-NARUC Grid-interactive Efficient Building **Working Group**, with the support of the U.S. Department of Energy (DOE) Building Technologies Office and the Pacific Northwest National Laboratory (PNNL). This collaboration allows discussions and sharing of best practices on GEB technologies and applications; identifies opportunities and barriers for technical and policy issues; identifies state priorities and interests; informs policy, planning, programs and regulation; considers unregulated electric sector investments and implications; and advances GEB roadmap and pilot options.

- **NASEO-NARUC Joint Task Force on Comprehensive Electricity Planning:** Investments that relate to demand flexibility and DERs increasingly require regulatory and policy innovation with a greater emphasis on planning to overcome the challenges in integrating multiple systems. The National Association of Regulatory Utility Commissioners (NARUC) and the National Association of State Energy Officials (NASEO) convened a joint **task force** on comprehensive electricity planning that brought together representatives of State Energy Offices and Public Utility/Service Commissions from 15 states to consider how emerging technologies, decreasing costs, consumer preferences, new energy service providers, and state and local efforts are driving significant growth in DERs such as solar, storage, energy efficiency, demand management, and microgrids. The Task Force has compiled a large library of **resources** covering 15 areas of interest, and is developing state-led pathways toward a more resilient, efficient, and affordable grid through better aligning resource and distribution system planning.

- **Microgrids and Demand Flexibility in the California Wildfires:** Southern California Edison's Demand Response customers played a **critical role** in managing grid conditions on Labor Day weekend, 2020. When the California ISO (CAISO) dispatched SCE emergency demand response resources on September 5th, a load drop of nearly 1000 MW occurred in 30 minutes as recorded by SCE's SCADA systems. Demand response by SCE's customers played a critical role in **balancing** power and grid stability in the SCE territory, and also across the Golden State to avoid California ISO rotating outages. Similar experiences were illustrated by **EnelX**, which saw seven hours of demand response dispatches in one California demand response program (the Base Interruptible Program).

Additional Resources

Additional content, including a dynamic map of state-level data and additional examples of beneficial electrification in action can be found at **http://ActiveEfficiency.org/focus-areas/beneficial-electrification/**.

About this Report

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